



# Book Of Abstracts

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# **ResCon12**

## **Research Student Conference**

**School of Engineering and Design, Brunel University**  
**18-20 June 2012**

**Chair:** Prof. Luiz Wrobel, Deputy Head of School (Research)

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#### **Advanced Manufacturing and Enterprise Engineering**

Dr. Harris Makatsoris with research student Rajab Alsayegh

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#### **Design**

Dr. Hua Dong with research students Koogin Han, Rafael Mello and Yu-Han Wang

#### **Electronic and Computer Engineering**

Dr. Jo Cole and Dr. David Smith with research students Mohammadreza Behjati, Hamdullah Mohib and Duncan Leggat

#### **Mechanical Engineering**

Dr. Bin Wang and Dr. Jun Xia with research student Chao Xu

### **Research Office:**

Carole Carr, Research Office (Manager)

Janet Wheeler and Rebecca Byrne

# **Foreword**

## **Welcome note from the School of Engineering and Design**

It is my pleasure to welcome you to ResCon12, the Fifth School of Engineering and Design Research Student Conference. This annual event, which is now a regular feature of the School calendar, aims at giving our research students an opportunity to practice their oral and written presentation skills by presenting their research findings to their colleagues, academic members of staff and industrial collaborators.

This year's event is the biggest yet, with around 130 oral and 70 poster presentations, to be given over three days. As usual, the School will be offering a number of prizes to the top abstracts, oral and poster presentations.

The abstracts contained in this book focus on a particular aspect of the students' research, selected to appeal to a diverse audience rather than attempting to describe their entire doctoral project. They have all been peer-reviewed by academics and fellow research students. We would encourage all participants to ask questions and provide comments on the oral and poster presentations, to maximise the feedback given to the students.

The ResCon Committee, composed of academics and research students, has invested considerable time and effort to ensure the success of the event. They deserve our appreciation in organising every aspect of the conference. The School is particularly grateful to Dr. David Smith and Dr. Bin Wang, who produced this book of abstracts, and to Carole Carr, Janet Wheeler and Rebecca Byrne, from the SED Research Office, whose administrative support was crucial in making this event successful.

I trust you will enjoy the conference and will find these three days interesting and informative.



Professor Luiz C. Wrobel

Deputy Head of School (Research)

School of Engineering and Design

Brunel University, UK

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# Advanced Manufacturing and Enterprise Engineering Abstracts

## Organizing Committee

Harris Makatsoris

Rajab Alsayegh

## Design of a test piece for energy consumption assessment on a CNC milling machine

*Behnoor Afsharizand, Kai Cheng*

**Keywords:** ERWC modelling, Energy consumption modelling, Carbon footprint analysis, Quantitative analysis, CNC machine tools.

### Introduction

There are some dominant factors in a CNC machine tool and its associated machining operations, which have the significant effect on the energy consumption, resource utilization and waste production of the machine system and therefore its carbon footprint (E-R-W-C). However, the accurate quantitative analysis of the energy consumption and carbon footprint of a CNC machining system is a challenge because of the multiple factors involved and the complexity and diversity of the machine operations. Furthermore, the quantitative analysis and modelling of the energy consumption and carbon footprint of the machine system is fundamentally essential for optimal control of the machine and the associated CNC operations particularly for energy/resource efficient manufacturing purposes.

In this paper, a holistic integrated ERWC modelling approach is proposed on quantitative analysis of the energy consumption and carbon footprint of a CNC machine tool. The approach is based on modelling energy consumption with resource utilization and waste minimization in the machine system in an integrated manner, by using the axiomatic design and grey relational analysis. MATLAB-based programming is used as a tool for simulating the ERWC models and solutions, mathematical modelling and transformation of ERWC data matrices in particular. The modelling approach is evaluated and validated with empirical data and a case study on a Bridgeport CNC milling machine.

### Methodology

In this paper, a holistic integrated approach for modelling the energy consumption and carbon footprint of machine tools is presented by taking account of the energy, resources use and wastes produced in the machine system collectively. The paper is organized firstly by introducing the integrated ERWC modelling approach. The computational analysis/procedure, constraints and solutions, and implementation aspects are then discussed by using MATLAB programming environment. A case study supported with experimental data is followed on evaluating and validating the approach and models developed. Finally, the paper concludes with discussions on the potential and application of the approach and modelling for sustainable manufacturing purposes.

Since for modelling purposes the systems should be analysed comprehensively, structuring the main features of the ERWC model is the first fundamental action to be carried out. The modelling approach for building ERWC should emphasize in these definitions: Modularity, Hierarchy, Flexibility and Multi-functionality.

### Results

The case study presented here is based on the actual data collection from a Bridgeport VMC 500x milling machine while performing a process of cutting a straight slot of various depths out of a work piece. The roughing operation has been performed on the vertical axis of the Bridgeport CNC machine with the cutter size of 8 mm diameters having two teeth. An aluminium block has been cut in 150 mm width and 300 mm length as a work piece. Water-based soluble oils have been used as lubrication and coolant system. Basically, energy consumption of the machine tools will be changed by the tool size and machining setup

parameters. To consider the machining operations as a dynamic system which changes all the time, we defined a boundary with 9 machining parameter inputs based on the contribution they have on the energy consumption, resource utilization and waste production of the machine tools [1]. (e.g. feed rate, cutting speed, depth of cut, idle time, tool path, process sequencing, lubrication, warm up time and chip wastes)

The machine tool parameters which were selected for the case study as to satisfy the independency of the variables in the AD approach. So, they completely fit in our model presented by Axiomatic study of machine tools.

### **Conclusion**

Machining operations are highly energy consuming and harmful for the environment. Developing a systematic/holistic model that encompasses energy consumption, resource utilization and waste production of the machine tool operations has been disputed widely. Building specific international standards for the same purposes mentioned before can be a proof of the severity, which needs to undertake on the machining operations. Based on the European commission framework released in July 2012, the energy measurement of the CNC machines operations should be defined by specific and quantitatively measurable key performance indicators (KPI). Also, formulating multi objective ERWC model, for better analyzing the CNC machines operations became dominant these days. The most cumbersome for modelling the ERWC exists in the complexity between the machine tools parameters. Thus, the approach for finding an appropriate ERWC model integration which estimates all the dynamic behaviour of the CNC machines presented in this paper. The presented approach for ERWC modelling has been illustrated with a case study on the Bridgeport milling machine at the end. We replicated 9<sup>th</sup> individual roughing operations for designing the case study. MATLAB based software has been designed for the analytical calculation purposes. The outcomes from the case study verified the AD/GRA approach for formulating the ERWC model based on the prepared scenarios. The model can be used for further analysis of the machine tool performance and capabilities.

### **Future plans**

Comparing the results from the built ERWC model needs to be presented with a designed test piece as a standard. There is no standard test piece for measuring and analyzing the energy consumption of the machine tools same as resource utilization and waste production. The next step would be conducting a research for generating appropriate CNC machines tool paths for designing test piece. The test piece also should be a good sample of the research. It should encompass every combination of the tool paths based on the machining strategy.

### **References**

1. Campatelli, G. Analysis of the environmental impact for a turning operation of AISI 1040 steel, *IPROMS Conference*, 2009.

## IT capabilities, Absorptive Capacity and Innovation Performance

*Abdulrhman, Albeshier, Rebecca, De Coster*

**Keywords:** Dynamic Capabilities, Absorptive Capacity, IS capabilities, IT capabilities, Innovation Performance

### Introduction

This research attempts to develop a framework that helps to understand how firms could utilise their resources to improve their innovation performance. Innovation is a complex phenomenon and is affected by both the macro and micro environment of a firm (Carlsson, 2006). Yet a key pillar in innovation is knowledge (Carlsson 2006; March, 1991). Therefore, a firm ability to learn is key to trigger better opportunities for innovation prosperity (Eisenhardt & Martin, 2000). A well-known theory that encapsulates knowledge as core for firms' competitive advantage is 'Absorptive Capacity'. Zahra and George (2002) argue that the path of knowledge development in a firm can be divided into four stages: knowledge acquisition, assimilation, transformation and exploitation. An organisation absorptive capacity augments routines that manipulate resources to maximize the knowledge development in these four stages (Zahra and George, 2002).

This study attempts to understand how information technology IT would enhance the firms' absorptive capacity. The IT capabilities of a firm represent an important source for competitive advantage. The strategic value of information technologies is at heart of information system research (Overby et al., 2006). A plethora of research has used the resource-based-view to confirm that IT capabilities can be characterized as valuable, rare, inimitable and non-substitutable. Yet these characteristics were not attributed to simply acquiring hardware and software assets. It is a result of how strategically IT resources are reconfigured to insure sustainable fulfillment of outward and inward needs of an organisation (Wade & Hulland, 2004). To best of our knowledge, few attempts have been made to understand the relationship between IT capabilities and innovation performance (Benitez-Amado et al, 2010). Few work effort have been made to understand if IT capabilities would influences the dynamic nature of the absorptive capacity and hence increase the chances for innovation success. This research hypnotized that at each stage of the absorptive capacity a specific IT capability is important to maximize each stage output. Moreover it is argued that 'absorptive capacity' mediates the relationship between 'IT capabilities' and a firm's innovation performance.

### Design/Methodology/Approach

This study attempts to empirically test the research framework by the means of quantitative research. The targeted data is a primary data based on Saudi firms.

### Findings/Results

The literature review and key interview have revealed a research framework. A questionnaire was developed based on previous research and reviewed by academic and industry experts.

### **Conclusion / Discussion**

Expected in the end of the 2012

### **Future plans / directions**

In the near future with the availability of data there will be a good chance for publication. The primary data collection will be started as scheduled and three years is probably sufficient to successfully accomplish this research aims and objectives.

### **References**

- Benitez-Amado, J., Llorens-Montes, F. J., & Perez-Arostegui, M. N. 2010. Information technology-enabled intrapreneurship culture and firm performance. *Industrial Management & Data Systems* 110(4), 550-566.
- Carlsson, B. 2006. Internationalization of innovation systems: A survey of the literature. *Research Policy* 35(1), 56-67.
- Eisenhardt, K. M., J. A. Martin. 2000. Dynamic capabilities: what are they? *Strategic Management Journal* 21(10-11), 1105-1121.
- March, J. G. 1991. Exploration and Exploitation in Organizational Learning. *Organization Science* 2(1), 71-87.
- Overby, E., A. Bharadwaj, V. Sambamurthy. 2006. Enterprise agility and the enabling role of information technology. *European Journal of Information Systems* 15(2), 120-131.
- Wade, M., J. Hulland. 2004. Review: the resource-based view and information systems research: review, extension, and suggestions for future research. *MIS Q.* 28(1), 107– 142.
- Zahra, S. A., G. George. 2002. Absorptive Capacity: A Review, Reconceptualization, and Extension. *The Academy of Management Review* 27(2), 185-203.

## Service Innovation : Consumer Acceptance of M-commerce in the Airline Sector

*Mohammed Algethmi, Rebecca De Coster*

**Keywords:** mobile commerce, innovation diffusion, value creation, e-commerce, airline initiatives, technology acceptance.

### Introduction

The growing number of mobile gadget users was a result to the advances in mobile technologies (Kim et al,2008).These advances and using the internet through mobile devices allow consumers to do many activities via their mobile devices such as: make online purchases ,download appropriate information, to engage in a series of educational and entertainment services , and to communicate with each other (Rose et al ,2011).Also, mobile devices have increased the availability ,frequency ,and speed of communication (Scharl et al ,2005).

The positive prospect of m-commerce is driven by its unique features and characteristics that can provide customers with added value (Siau et al,2001;Sharma and Deng,2002; Tang and Veijalainen,2001) not existing in traditional e-commerce , these features include ubiquity, anytime anywhere access, personalization, flexibility, localization, and the ability to access the needed information .Similarly, Clarke,(2001) demonstrated that mobile commerce has four value proposition attributes over traditional e-commerce : convenience , personalization , Ubiquity ,and localization.

This paper will focus on how does mobile commerce solutions contribute to the airline industry in term of creating a value to their customers through the process of purchasing Airline tickets, booking, check – in, seat selection, flight status. As m-commerce facilitate the whole process of travel process ,due to the clear advantages of anytime-anywhere connectivity ,convenience and the needless to visit the firm's offices or to interact with the company's representatives.

This paper will contribute to knowledge by providing a proposed framework for the consumer acceptance of mobile commerce in Saudi Arabia by using innovation diffusion theory and technology acceptance model, which may help and guide marketers and decision makers in Saudi Airlines to address the significant factors that concern the consumers during their service delivery.

### Proposed framework

The research will look to develop a proposed framework which build on significant innovation characteristics by Rogers and the technology acceptance model by Davis that will be tested with Saudi Arabian Airlines as a case study to shed light on the motivators and inhibitors that affecting the consumers to accept mobile commerce in Saudi Arabia.

(Mallat et al.,2006) argued that in m-commerce context ,the adoption of mobile technologies have been tested in some researches by integrated TAM and IDT which present significant means for mobile services adoption and use explanation (e.g.Lee,et al.,2003; Kleijnen,et al.,2004; Hung,et al.,2003).Thus ,this research use TAM and IDT as fundamental theories for the proposed model and incorporated it with some other factors from the literature such as: social influence, personal innovativeness, mobility ,use situation, and perceived risk.

## Methodology

This research targets to test and to validate the proposed model and the related hypothesis . A cross-sectional survey is conducted by developing a questionnaire, This questionnaire is piloted to a random sample of Brunel University students .

The questionnaire as a gathered information tool is divided into two sections ,the first section is about the demographics characteristics including gender ,age ,nationality ,and previous related internet experience .While the second part is related to the proposed model constructs that is perceived ease of use ,perceived usefulness ,social influence , compatibility ,mobility ,use situation ,personal innovativeness ,and perceived risk. The survey used 1 to 5 Likert Scales to study the respondents behavior to these factors , where 1 indicates "strongly disagree " and 5 indicates "strongly agree ".

## Findings

SPSS (v.18.0) is used to analyze the data to obtain descriptive statistics, and scale reliability analyses. The instruments were initially examined to establish the reliability of scales. The Cronbach's alpha coefficients range from 0.749 to 0.884 that go beyond suggested value of 0.70 (Pallant, 2007). These alphas equal to 0.749, 0.806, 0.827, 0.849,0.874 and 0.884 for mobility , perceived ease of use, perceived risk , perceived usefulness, social influence, and compatibility , respectively.

## Future plans

Field study will be conducted during the July and August 2012 to collect data in Saudi Arabia.

## References

- Clarke, I.( 2001), Emerging value propositions for m-commerce, *Journal of Business Strategies*, vol. 18, pp. 133–148
- Hung, S.-Y., Ku, C.-Y., and Chang, C.-M.,( 2003), Critical Factors of WAP Services Adoption: an Empirical Study, *Electronic Commerce Research & Applications*,2, 1, , 42-60.
- Kim, D.-Y., Park, J. and Morrison, A. M. (2008), A model of traveler acceptance of mobile technology. *International Journal of Tourism Research*, 10: 393–407.
- Kleijnen, M., Wetzels, M., and de Ruyter, K.,( 2004),Consumer acceptance of wireless finance, *Journal of Financial Services Marketing*, 8, 3 , 206-217.
- Lee, M.S.Y., McGoldrick, P.J., Keeling, K.A., and Doherty, J.,( 2003) Using ZMET to explore barriers to the adoption of 3G mobile banking services, *International Journal of Retail & Distribution Management*, 31, 6, 340-348.
- Mallat, N., Rossi, M., and Tuunainen, V. K., Öörni, A. (2006), The Impact of Use Situation and Mobility on the Acceptance of Mobile Ticketing Services. In Proceedings of the 39th Hawaii International Conference on System Sciences, Hawaii.
- Pallant, J. (2007). SPSS Survival Manual, (Third edition), England: McGraw Hall, Education.
- Rose, S., Hair, N. and Clark, M. (2011), Online Customer Experience: A Review of the Business-to-Consumer Online Purchase Context. *International Journal of Management Reviews*, 13: 24–39.
- Scharl,A,Dickinger,A, and Murphy,J.(2005), diffusion and success factors of mobile marketing, *electronic commerce research and applications*,vol.4,pp.159-173
- Sharma S. and Deng, X .(2002), An empirical investigation of factors affecting the acceptance of personal digital assistants by individuals, *Proceedings of the Americas Conference on Information Systems*, 1892-1834.
- Siau K, Lim E-P Shen Z. (2001), Mobile commerce: promises, challenges, and research agenda. *Journal of Database Management* 12(3): 4–13.
- Tang, J., and Veijalainen, J. (2001) ,Using agents to improve security and convenience in mobile ecommerce, *Proceedings of the 34th Annual Hawaii International Conference on System Sciences*.

## Integration of Molecular Dynamic with Computer Vision

*Rajab Alsayegh, Harris Makatsoris*

**Keywords:** Molecular Dynamics (MD), Computer Vision, Gestures Recognition, Artificial intelligence, Material Modelling and Manipulate the Molecules.

### Introduction

This research study sets out to develop better molecular/nanostructure design tools that are interactive helping users with limited experience to better understand what it is they try to design, to try to simulate a type of force to combine and separate the molecules and to interact with the digital world without markers (keyboard and mouse) by using physical work or the senses. Furthermore, this research is remarkably challenging and innovative because it will open up new horizons for development and knowledge by building a clear base from which to develop the computer vision also enabling the design and creation of new materials. The aim of this research to reach to Multi Scale Approach by integrating computer vision (e.g. Gesture recognition & Artificial intelligence), Molecular Dynamic (e.g. Molecular modelling & Material modelling) and intuitive understating of atomic scale. By doing this, we will be able to interact with molecules via our senses, for example, by using our hand gestures to deal with molecules. All these topics that will be integrated have been analysed and developed to highly advanced levels. For example, scientists who specialise in the area of computer vision have created a revolutionary device called Kinect that can be used and manipulated in different areas. This device is able to control PC computers and laptops via hand gestures without using markers (mouse & keyboard).

In addition to this, scientists in atomic scale and molecular modelling have been able to analyse molecular structure on a scale of 0.1-10nm using Atomistic-based simulations such as molecular dynamics, molecular mechanics and Monte Carlo-based methods (M. Fermeglia & S. Pricl, 2009). These methods are now widely used in material design. The fast and precise prediction of new computational material properties is needed before they can be further developed and produced effectively. These properties must be predicted before preparation, processing and portraying qualities in order to be effective. This is especially important where material properties are dependent on their nanostructure, such as in the field of polymer nanocomposites. “Advances in computational materials science in general will continue to facilitate the understanding of materials and materials processing, the prediction of properties and behaviour, and the design of new materials and new materials phases, thus facilitating the application of process system engineering to more sophisticated and innovative processes” (M. Fermeglia & S. Pricl, 2009). Interactive simulations are evolving quickly and effectively due to the increasing access to powerful computational infrastructures and new computer hardware devices. Desktop computing is now hosting such applications and the techniques can be applied to the study of very large molecular systems comprising hundreds of thousands of atoms. This strong increase in raw computing power has led to faster and bigger multiprocessors and multi core architectures.

### Design/Methodology/Approach

The approach in this research, I finished the first step of the integration by making the Kinect (the device I mentioned in the introduction) control the visualizer called Jmol (this visualizer is able to show the molecules in 3D form) and the next step will be integrating the molecular

dynamic simulator with Kinect and Jmol. After doing that, I will be able to get results that will help me to show my contribution.

### **Findings/Results**

I did not reach to this part yet but the expected general results of this research, after integrating the areas mentioned in the introduction together, will allow faster simulation, better control and more accurate results, making it easier to design and discover new materials that can be used in the industrial field.

### **Conclusion / Discussion**

The results so far, giving me direction to my research. Furthermore, I have found that my PhD project very interesting and will open up new horizons for development, knowledge, design and creation of new materials.

### **Future plans / directions**

I am currently on track to complete my PhD within the three year time scale.

### **References**

- M. Fermeglia, S. Pricl, *Multiscale molecular modeling in nanostructured material design and process system engineering*, University of Trieste, Department of Chemical, Environmental and Raw Materials Engineering, Piazzale Europa 1, 34127 Trieste, Italy, 2009.

## The Impact of Saudi Arabia's Culture on Human Resource Management Practices within the Public Sector

*Hattan Alsharif, Susan Grant*

**Keywords:** HRM, Culture, Societal, Public sector.

### Introduction

Human resource management practices and policies of any organisation are significantly influenced by the sets of norms and values that are common within the surrounding societal cultures. This research will investigate the extent to which societal cultures and employees' values contribute in shaping the practices and policies of human resource management in any organisation within the public sector, specifically municipalities in Saudi Arabia. Finally, based on the findings and outcomes of this research and interviews, conclusions and recommendations can be drawn out to provide explanations for this significance of societal cultures over HRM practices and policies.

### Design/Methodology/Approach

In order to provide further details regarding the influence of societal cultures, interviews will be conducted along the different levels of management within three main municipalities in Saudi Arabia. These interviews will provide assistance in highlighting the essential elements of societal culture that mainly affect the human resource management practices and policies.

### Findings/Results

The research is at the literature review stage, which is meant for exploring the existing literature concerned with the impact of the societal culture on the human resource management practices and policies across the world, in order to establish the main concepts surrounding the societal culture and its impact upon HRM practices and policies.

### Conclusion / Discussion

So far, the explored literature supports the main argument of the research. Furthermore, the interviews stage in the research work plan will help further validate the argument of the research.

### Future plans / directions

The work is going well according to the research plan, which means that the research will be concluded within the original timeframe set for the research. As for the future plans for the upcoming year, there will be three main targets to be accomplished. First target will be concluding the literature review chapter by the end of May after exploring further elements within the area of research. Second target will be finalising the methodology chapter upon concluding the literature review. Third target will involve conducting interviews within the targeted organisations within the public sector in Saudi Arabia, which will include conducting interviews with personnel from different levels across the targeted organisations.

## **References**

- 1- Aycan, Z. (2000). Cross-cultural industrial and organizational psychology: Contributions, past developments, and future directions. *Journal of Cross-Cultural Psychology*, 31, 110–128.
- 2- Erez, M. (1994). Toward a model of cross-cultural industrial and organizational psychology. In H. C. Triandis, M. D. Dunnette, & L. M. Hough(Eds.), *Handbook of industrial and organizational psychology*, Vol. 4. (pp. 559 – 607) (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.
- 3- Hofstede, G. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills, CA: Sage.
- 4- Hofstede, G. (1991). *Cultures and organizations*. London: McGraw-Hill.
- 5- Huselid, M. A. (1995). The impact of human resource management practices on turnover, productivity, and corporate financial performance. *Academy of Management Journal*, 38, 635–672.
- 6- Joshi, A., & Martocchio, J. J. (in press). Compensation and reward systems in a multicultural context. In D. L. Stone & E. F. Stone-Romero (Eds.), *The influence of culture on human resource management processes and practices*. New York: Taylor and Francis.
- 7- Judge, T. A., & Bretz, R. D. (1992). Effects of work values on job choice decisions. *Journal of Applied Psychology*, 77, 261–271.
- 8- Kristof-Brown, A. L. (2007). Person–organization fit. In S. G. Rogelberg (Ed.), *Encyclopedia of industrial and organizational psychology*, Vol. 2 (pp. 620–621). Thousand Oaks, CA: Sage Publications.
- 9- McManus, M. A., & Ferguson, M. W. (2003). Biodata, personality, and demographic differences of recruits from three sources. *International Journal of Selection and Assessment*, 11, 175–183.
- 10- Stone, D. L., & Stone-Romero, E. F. (2004). The influence of culture on role-taking in culturally diverse organizations. In M. S. Stockdale & F. J. Crosby (Eds.), *The psychology and management of workplace diversity* (pp. 78–99). Malden, MA: Blackwell Publishing.
- 11- Stone-Romero, E. F., & Stone, D. L. (2007). Cognitive, affective, and cultural influences on stigmatization and its impact on human resource management processes and practices. *Research in Personnel and Human Resources Management*, 26, 117–167.
- 12- Stone-Romero, E. F., Stone, D. L., & Salas, E. (2003). The influence of culture on role conceptions and role behaviors in organizations. *Applied Psychology: An International Review*, 52, 328–362.
- 13- Tayeb, M. (1997), “*Islamic revival in Asia and human resource management*”, *Employee Relations*, Vol. 19 No. 4, pp. 352-64.

## **Design of an innovated Delta robot integrating with ‘mobile working force’ and ‘plug-and-produce’ method: modeling, simulation and implementation perspectives**

*Xun Chen, Kai Cheng*

**Key words:** Mobile working force, implemented with robotic

### **Introduction**

Adaptive Manufacturing is a kind of production model that could help a company to meet the customer demands and guarantee both quality and quantity in time by using advanced technology and strategy. But, in the present international situation, the cost tendency of employees is steadily upwards. Labor shortages have loomed even in China, the most populous country in the world in recent years. If a factory doesn’t intend to pay much money to realize Adaptive Manufacturing, it will be badly in need of ‘flexible workers’. Mobile working forces are the best substitutes for ‘flexible workers’ because of their ‘plug-and-play’ characteristics, modules and good adaptability. Application of mobile working forces will enable factories to improve efficiency and reduce expenses.

### **Aim:**

To develop a ‘Plug-and-produce’ delta robot implemented with ‘mobile working force’.

### **Design/Methodology/Approach**

- Mechanical design (reconfigurable end-effectors)
- Modular Controller architecture (PMAC, data bus)
- Modular controller interface
- Software architecture (reconfigurable parameters, reconfigurable tasks)
- Modeling and simulation: adding a rotational degree of freedom (a UPU leg), mathematical models, Matlab simulations)
- The different functions of mobile working force are composed of standard modules with machines which are inserted into the robot control interfaces

### **Findings/Results**

Simulation of the positioning corresponds to the robot’s end- effectors and the angle of the arms should be. Physical robot is in processing.

### **Conclusion / Discussion**

The ‘plug-and-produce’ based approach and the associated ‘Mobile Workforce’ methodology is a solution to manufacturing companies, especially for manufacturing SMEs and labour-intensive factories to realize Adaptive Production. A Mobile Workforce is a solution to

companies, especially to small-or-medium-size factories and labor-intensive factories to realize Adaptive Manufacturing.

The present outcome renders a solid foundation for the optimal design of the robot system and its physical implementation. In the future research would be focus on implementation perspective and the solutions of the real time problems such as intertie, gravity, and etc.

### **Future plan**

The physical implementation of the robot system is starting in workshop and expected to complete soon. So the simulations and the theoretical method is going to integrated with experiments. Control interface is building up and expected to be finish shortly.

My proposal is trying to develop a ‘plug-and-produce’ robot, so this is going to contain reconfigurable design on the end effectors.

The mathematical positioning method that is now using on the robot is expecting innovation and I would try to improve. The research direction of ‘mobile working force’ integrated in adaptive manufacturing system may lead to me to present journal papers.

### **Reference**

- [1] S. Briot, V. Arakelian, V. Glazunov, Design and analysis of the properties of the delta inverse robot. Rennes Cedex, 1990.
- [2] M. P. Groover, Fundamentals of Modern manufacturing, 3rd ed., USA: J. Wiley & Sons, Inc., 2007.

## A Novel Approach to Supply Chain Risk Management

*Bilal Chuddher, Harris Makatsoris*

**Keywords:** Supplier risk, knowledge discover, credit scoring

### Introduction

Supply chains have become more complex and vulnerable to catastrophic events, changing market behaviour and upstream supply uncertainty [1]. An organization's dependency increased on supplier's capabilities and consequently, their risk profile due to increased outsourcing. Supplier with higher risk probability can have significant impact on the organization's revenue performance [2]. For example in 1997 Boeing faced losses because a key supplier failed to deliver the crucial components. In 2007 due to earth quakes in Japan, Toyota, Honda, Suzuki and Mitsubishi halted their production plants because their main suppliers were located in affected area. And in 2001, Land Rover faced difficulties in deliveries due to a key supplier filed for bankruptcy [3-5]. These examples clearly show that due to dependencies of companies on each other exposed them to more risks in supply chains. Supply chain disruption is not only due to catastrophic events but also due to day to day problems including quality, delivery time etc [6]. So the companies should analyse the supplier risk level before awarding business to them.

Supply chain risk management (SCRM) is a developing field in boarder horizon of supply chain management [7]. Different methods are being used, ranging from formal qualitative models to informal quantitative approaches to supply chain risks. Most of the quantitative work is done using analytical hierarchy process (AHP) and mathematical programming and simulation, focusing on optimizing the number of supply base and the order size allocation [8]. High reliance on suppliers for global manufacturing enterprise forces them to address supplier's risks and integrate risk management with supply chain management [9-11].

The purpose of the research is to develop a risk assessment model to assign a risk score to a given supplier that is likely to fulfil or having higher probability not fulfilling the supply contract obligations in terms of quality, delivery and price. The risk assessment model will be constructed by implementing data mining techniques on historical data about supplier's past performance on supply risks (quality, delivery, price) and supplier characteristic (manufacturing capabilities, technologies, management, finance, environment, etc). The essence of credit scoring is used for proposed model to assess the risk associated with new supplier entering supply network. The proposed model also uses the behaviour scoring ideology to assess risk of supplier already a member of supply network.

### Design/Methodology/Approach

The proposed methodology consists of three main phases,

- a) Identification of risks and their sources
- b) Collection and development of data base
- c) Implementation of data mining to build functional model

The first stage is the identification of possible parameters, which can measure and represent the identified risk in supply chain due to supplier. These parameters are identified based upon the literature review and discussion with industry experts in supply chain risk management (SCRM) and supplier management. These parameters are related supplier's characteristics and performance, such as, production capabilities, quality, delivery, lead time, financial status and supplier's external environment.

Second phase consist of identification of different data sources and collection of data from available data source to develop a database.

The third phase consists of three steps. First step is exploration of historical data by using Pareto analysis and graphical analysis techniques. Second step is the implementation of classification and clustering techniques to discover the behavior patterns that can reveal the important supplier's characteristics (manufacturing capabilities, technologies, finance, environment, etc) related to supply risks (quality, delivery, price) in historical data. An open source data mining software tool "WEKA" will be used to implement data mining techniques. Finally, third step is to construct a functional model based on results of proceeding step to provide the supplier risk score. An object oriented computational language will be used to build the final model.

### **Findings**

Supply chain risk and their sources have been identified, which shows diversity across industries and value purchased. A comprehensive set of parameters to identify these risks have been formed, which can be implemented across different industries with little customization. The work on data collection and generation is being done and initial results will be produced.

### **Discussion**

It has been found that the supplier risk management is a diverse process. There should be a standard platform with defined parameters, which can be implemented across the industries with little customization. This research will provide foundation for a standard platform for supplier risk assessment, which can be used with supply chain operational reference (SCOR) model.

### **Directions**

Currently, research seems to be on track.

### **References**

1. Juettner, U. (2005), "Supply chain risk management", International Journal of Logistics Management, 16(1):120-41.
2. Archie L and Kevin M.C. (2009), Analyzing risks in networks to facilitate outsourcing decisions International Journal of Production Research, 48(2): 593- 611.
3. Radjou, N. (2002), Adapting to Supply Network Change, Forrester Research Tech Strategy Report, Cambridge, MA.
4. Hayashi, Y., Smith, R. and Chozick, A.(2007), "Quake bring safety issue to fore; plant standard in focus after radioactive leak; Japan's auto output hit", Wall Street Journal, 19: 4
5. Sheffi, Y., Rice Jr., J.B., (2005), A supply chain view of the resilient enterprise, MIT Sloan management Review, 47(1):41-48.
6. Jorn H. T., Daniel H. (2009), An empirical analysis of supply chain risk management in the German automotive industry, International Journal of Production Economics.
7. Ritchie, B., Brindley, C., (2007), Supply chain risk management and performance a guiding frame work for future development. International Journal of Operations &Production Management, 27(3):302-322.
8. Dani, S. (2008), prediction and managing supply chain risks, supply chain risk a handbook of assessment, management, and performance, Zsidisin, G.A., Ritchie, B. (eds.), Springer science business media LLC, New York.
9. Hallikas, J., Karvonen, I., Pulkkinen, U., Virolainen, V., Tuominen, M., (2004), Risk management processes in supplier networks. International Journal of Production Economics, 90(1):47-58.
10. Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J., Handfield, R.B., (2007), The severity of supply chain disruptions: design characteristics and mitigation capabilities. Decision Sciences, 38(1):131-156.
11. Micheli, G.J.L., Cagno, E., Di Giulio, A., (2009), Reducing the total cost of supply through risk-efficiency-based supplier selection in the EPC industry. Journal of Purchasing & Supply Management, 15(1):166–177.

## Design of an internally cooled smart cutting tool and its application in adaptive machining

*Saiful Bin Che Ghani, Kai Cheng*

**Keywords:** Internally cooled smart tool, neural network, adaptive machining, tool condition monitoring

### Introduction

Internally cooled smart cutting tool is a solution for industrial needs of having eco-friendly machining, high material removal rate, low tool wear and better surface finish. A smart monitoring system is developed on a neural network base to monitor the tool and machining condition. Environmental friendly closed-loop internal cooling can reduce the cutting temperature, thus reduce tool wear and increase machining accuracy. Adaptive control is a cognitive solution by varying the coolant flow rate and cutting feed rate to provide optimum machining temperature. Validation by experimental and simulation results show the application of smart internally cooled cutting tools in adaptive machining can improve machining key indicators such as cutting temperature, cutting forces and surface finish quality. The tool life span is also increased significantly in internally cooled smart cutting tools in comparison to the tool life in conventional dry machining.

### Design/Methodology/Approach

The internally cooled smart cutting tool is designed based on the concept of smart but simple module. The design process includes the design of the cutting insert, tool holder and internal cooling structure. The design of the cutting insert and tool holder must follow the baseline rules that the cutting insert and tool holder must be easy to be accepted by the industries standards and integration with the current machining configuration requires minimum modification. Another consideration in designing the cutting insert and tool holder is to associate the smart module in the design. This consideration includes the placement of multiple sensors and building of a module for data exchange. Meanwhile, the design of internal micro cooling involves the studies of heat transfer, fluid dynamics and mechanical structure. Three main cooling designs have been proposed in two cutting materials, i.e. high speed steel and tungsten carbide. The design models are built in Pro/Engineer and then the models are then simulated in the software ANSYS workbench environment and Fluent CFD package. The efficiency and functionality of the models are optimized by utilizing the DesignXplorer, an optimizing tool in ANSYS Workbench that is based on Design of Experiment (DOE) method.

The optimized models are then manufactured to be tested in real machining environment. Among the machining process involve in fabricating the prototypes are electro discharge machining (EDM) of hard material of the insert (tungsten carbide with 6% cobalt) and micro milling with 5-axis Kern machine of the internal cooling adapter. The assembly of the internally cooled smart cutting tool with the coolant module peripheral (i.e. micro pump and coolant tank) and the machine tool is completed by equipping the system with measuring equipment, i.e. pyrometer for measuring rake face temperature, thermocouples for measuring the inlet and outlet temperatures, microscope for measuring flank wear and dynamometer for measuring cutting forces. The materials of the workpiece used in the experiment are aluminum alloy (AL6082) and mild steel (EN3). In this experiment water with anti corrosion additive is used as coolant media. The cutting parameters are designed based on the Taguchi method and full factorials DOE. The responses from the experiment are cutting temperatures, cutting forces, surface finish qualities, chip formations and tool life.

The ultimate functionality of the smart tool is to be able to utilize the feedbacks from the machining process to monitor the tool and process condition and also to use them cognitively to suit the machining objectives such as high productivity, high tool life or good surface finish. Artificial Neural Network (ANN) is the tool to train the system to understand the machining process and later, the tool will cooperate with adaptive machining codes programmed in Visual C++ environment to establish dynamic communication with CNC machine driven by FANUC 21i-TB control.

### **Findings/Results**

Three models of internally cooled cutting tools have been designed. The three models are open reservoir plan, multi micro channels and jet impingement cooling. All the three models show efficiency to reduce the cutting temperature at their own right. Simulation shows that with the current experimental requirements such as cutting parameters, pump specifications, materials and tool configurations, the design using impingement jet cooling is the best option. The experimental results show smart cutting tool with internal jet impingement cooling can reduce the cutting temperature up to 39%, can reduce the cutting force up to 64% and can improve the surface finish up to 60%.

The inlet and outlet temperatures provide useful information to be utilized in adaptive machining as the real time acquired data imitate the trend of the cutting forces and are sensitive enough to detect abnormality in machining such as chatter, built up edges (BUE) and tool wear.

### **Conclusion / Discussion**

Internally cooled smart cutting tool is a solution for current industrial needs to increase tool life, eco-friendly manufacturing, good surface finish and high productivity.

Internal coolant flow can be controlled to control optimum cutting temperature, thus longer tool life and more predictable surface finish could be achieved.

Back propagation feed forward Artificial Neural Networks (ANN) are employed to develop on-line decision making support systems in adaptive machining.

Empirical results show that feed rate plays pronounced effect in temperature rise, thus give good indicator for adaptive control.

### **Future plans / directions**

I cannot finish within three years as I still need to integrate the internally cooled smart cutting tool in adaptive machining environment. The integration requires me to write a program for communication between the cognitive paradigms in the local PC and the CNC controller of the CNC machine.

### **References**

- [1] Sun X., Bateman R., Cheng K., Che Ghani S. Design and analysis of an internally cooled smart cutting tool for dry cutting. Proc. IMechE Vol. 225 Part B Journal Engineering Manufacture, 2011
- [2] Che Ghani S. Cheng K, Sun X, Bateman R, Modelling and analysis of the temperature distribution of a micro-channel internally cooled smart cutting tool in machining AlSi7, 4M Conference, Stuttgart, November 2011
- [3] Che Ghani, Cheng K, Sun X, Bateman R, Optimizing heat transfer rate in an internally cooled cutting tool: FE-based design analysis and experimental study, ICPM 2011, Liverpool, September 2011

## Airport terminal performance factor generated from Arena built simulation model by PSO and optimized through MATLAB

*Mohammed Gronfula, Maysam Abbot*

**Keywords:** Airport terminal, performance factor, Arena, simulation model.

### Introduction

As airport operator concerns, performance of airport terminal should be measured. There is good piece of research is presented since Lemer (1992) who relate performance of the terminal to movement of passengers their bags between aircraft and ground transportation by airport operator and airlines with comfort, convenience and cost according to the capacity. Later Barros (2007) argues that transfer passengers have quite different needs than those of originating and terminating passengers as they do not use airport access roads or other facilities related to it. In the other hand Chung-Hsing Yeh (2002) offers a fuzzy decision making approach for assessing passenger service quality based on the idea of the degree of optimality with an overall service performance index for airports. In conditions of controllable passenger service attributes the index assists the airports to understand their relative grading. Correia (2008) suggested Overall level of service (LOS) measures and claim it is useful to evaluate the overall LOS in a single scale, according to passengers' views. His method consists of monitoring passengers and gathering some socio-economic and physical variables that might influence the user evaluation of the airport as a whole.

### Methodology

Level of service is intended to be captured in Hajj terminal of King Abdul-Aziz airport in Jeddah airport during specific time of the year as it is prior to the holy pilgrimage on eighth of Dulhejjah month of the year 1432 H Corresponding to fourth of November 2011. As the arrivals to that terminal according to PPMDC the company that operate and manage the Hajj terminal, a month earlier every year this survey started by the third of October and lasted till the end of the month. The survey held in different timing noon and evening to assure a wide range of participants. The questionnaire inspired by proposed overall level of service measures for airport passenger terminals of Correia et al. (2008). Factors that considered in this survey are found in Yeh and Kuo (2001). At the time the questionnaire prepared there was known information should not be gathered in presented Correia et al. (2008) approach which related to type of flights (domestic or international) and it is international in our case. Another one was related to the purpose of the trip in this case they all coming for performing Hajj. While other following specific information was gathered in same suggested way:

User opinion about LOS: five levels of rating were used in proposed questionnaire:

1-unacceptable, 2-poor, 3-regular, 4-good and 5-excellent.

Gender: male or female

.

## **Findings**

### **Summary of responses**

A hundred passengers were interviewed in survey at Hajj terminal of King Abdul-Aziz international airport the survey was applied on Oct 2011 where passenger interviewed after their arrival at the end of the process. All the passengers were intending to perform Hajj in Makkah. The result is presented in percentages as below table show that. Results were put in percentage format for the following factors: Processing time in the airport terminal, Delay in the airport terminal, Comfort Cleanliness in the airport terminal, Courtesy of staff in the airport terminal, Convenience in the airport terminal, Information visibility, Security, Service. Each one ranked with five categories: 1-unacceptable, 2-poor, 3-regular, 4-good and 5-excellent. Highest were in 4 for most of the factors.

## **Results and SPSS**

The gathered data especially from the aspect of passenger satisfaction analyzed and how that correlates with the services that have been handled by the company which may effect on the overall measure of satisfaction. The correlation of some of the measured between them and Correlation is significant at the 0.05 level (2-tailed).

## **Conclusion**

This analysis handful to do some optimization which can lead to better performance in the service based on the timing and that can be shown in the simulation model.

## **Future plans**

The optimization will take place on PSO with the MATLAB integration to generate better scenarios. This will end in three years without the writing.

## **References**

1. Anderson Ribeiro Correia, S.C. Wirasinghe, and Alexandre G. de Barros, "A global index for level of service evaluation at airport passenger terminals," *Transportation Research Part E: Logistics and Transportation Review* 44, no. 4 (July 2008): 607-620.
2. NeuroPie and NeuroPie, "Airport Performance Management", n.d., <http://www.neuropie.com/en/services/aviation-expertise/airport-performance-management.html>.
3. Elton Fernandes and R.R. Pacheco, "Efficient use of airport capacity," *Transportation Research Part A: Policy and Practice* 36 (March 2002): 225-238.
4. Chung-Hsing Yeh and Yu-Liang Kuo, "Evaluating passenger services of Asia-Pacific international airports," *Transportation Research Part E: Logistics and Transportation Review* 39, no. 1 (January 2003): 35-48.
5. Anderson Ribeiro Correia, S.C. Wirasinghe, and Alexandre G. de Barros, "A global index for level of service evaluation at airport passenger terminals," *Transportation Research Part E: Logistics and Transportation Review* 44, no. 4 (July 2008): 607-620.
6. Andrew C. Lemer, "Measuring performance of airport passenger terminals," *Transportation Research Part A: Policy and Practice* 26, no. 1 (January 1992): 37-45.
7. Anderson Ribeiro Correia, S.C. Wirasinghe, and Alexandre G. de Barros, "A global index for level of service evaluation at airport passenger terminals," *Transportation Research Part E: Logistics and Transportation Review* 44, no. 4 (July 2008): 607-620.

## Network Capability Model on the Formation of Capable Teams

*Ehsan Hosseini, Alireza Mousavi*

**Keywords:** Capability Modelling, Human Networks, Homophily, Skills Diversity

### Introduction

This research proposes a generic statistical model for measuring and predicting the capability of a network (group) of individuals that are given a task to be completed. The model is designed to be flexible enough to be applicable to a variety of scenarios. The potential applications for the model are: project management, group sports and games. The key feature of such model is to enable team builders and group leaders assess and compare the capability of human based networks and thus measure the levels of achieving a specified outcome. In other words the reason for this research work is to provide decision makers with objective instrument that enables them to measure capability of assembled teams. The proposed empirical models will also allow team builders to assess the effect their intervention on team capability may have.

### Design and Methodology

A review of relevant literature was conducted in the areas of management science, human resource management, business strategy, project management and manufacturing to establish a definition for capability. To ensure that our definition of capability would be as universal as possible, we focused on the commonalities in industrial systems. By industrial systems we mean a group of individuals with common values that possess a mixture of inherent or acquired resources that they use to achieve a common goal.

Our approach therefore combines a resource based analysis and theories of human-based networks for measurement of collective capability. To the best knowledge of the authors capability evaluations in industrial systems to date, have remained subjective and case based. Due to the evolving nature of human resource employment from long term permanent employment to short term project based employment, it seems that introduction of a formal and encompassing set of techniques for team building process would be a timely proposition.

The proposed model consists of three parameters, (i) level of homophily of the network (based on different demographic characteristics), (ii) level of network's structural balance, and (iii) level of skills diversity among the members within the group. The three parameters will be used to predict capability that can be used as a reasonable indication of outcome. The source of information for the parameters comes from two questionnaires which were designed by the researcher. The first questionnaire was mainly aimed to collect information about individuals' (group members') capability profile. Consequently second questionnaire was designed and aimed to collect information about the individuals' network relationships within their group. The collected statistical data from two questionnaires then used in further stages in the research, using two mathematical methods (multiple regression and fuzzy sets) to test the conceptual model, previously introduced in the research and finally nominate the

best and most accurate model which can predict networks' capability level. In a summary the main stages of doing this research can be bullet listed as below:

- Literature review on the concept of capability, human networks, statistical modelling, human resource management and project management (Done)
- Nominate the three parameters for the proposed model, (Done)
- Build up a conceptual model based on three nominated parameters, (Done)
- Design two questionnaires with the aim of collecting required statistical data to test the conceptual model, (Done)
- Using collected data with two mathematical methods to test different models, (In progress)
- Nominate the best and most accurate model (Future plan of the research)
- Publications and presenting the finding of the research nationally and internationally (Future plan of the research)

### **Finding and results**

As in current stage of the research we are in the middle of the process of analysing the collected data, our current outlook is that the final results and achievements of the research will be ready to be presented on the ResCon conference in June 2012.

### **Future Plans**

The future plan in this research mainly includes finishing data analysis process and nominating the best and most accurate model. In addition publication in national and international conferences and journals based on final results of the research is our another future plan in this research.

### **Conclusion**

The proposed research will, if successful, provide clues on how to construct best teams in different environments to achieve the desired outcome. In other words the final results of this research will identify a common ground for assessing and predicting the human networks' applied capability in performing a specific project. The research can contribute to the current knowledge and practice by defining criteria for applied capability assessment and developing an algorithm to capture networks' applied capability.

### **References**

Prell, C., 2012. *Social Network Analysis*. Sage Publications Ltd.

## Abrasive flow machining; simulation and optimisation of flowpath in oilfield exploration tooling

*Mitchell Howard, Kai Cheng*

**Keywords** AFM, ANSYS, simulation, flow deburring, surface finishing, polishing

### Introduction

In times of economic uncertainty, the UK's manufacturing sector is critical to its recovery. Data released by the Manufacturing Technologies Association shows that during 2011 'machinery and related products' outperformed all other manufacturing sectors in terms of revenue, with some companies boasting up to 68% increase in orders on 2010 figures. This research is rooted deep in machine tool development, concerned with the capability of the abrasive flow machining (AFM) process. AFM utilises a viscoelastic shear-thickening fluid (STF) loaded with superabrasive micro-grit; the compound, referred to as 'media', is pumped by a hydraulic system through the internal cavities of engineering components, altering the surface as it travels.

AFM's widespread acceptance is limited by the number of variables in the process and their interrelationships; this paper relies on a dataset obtained through prior research employing a standard test-piece design and a  $2^4$  factorial test strategy. Development of a system to accurately predict the effects of the AFM process has not been attempted before. With the advent of fluid dynamics software packages, the researcher is now able to approach AFM's greatest challenge – transferability of results from a test-piece to any given production part.

### Design/Methodology/Approach

This paper aims to describe a method of selecting AFM process parameters to achieve a predefined result. Difficulties in achieving this objective stem from the number of variables, of which there are approximately 25, although the majority are dependant. As the variables can be grouped into machine, media or geometry categories, it is useful to attempt the control of two sets while altering combinations of the third. Attempting to establish the significance of factors from a large group of dependant variables will not produce useful data. The dataset used in this paper is obtained by controlling media and geometry parameters while varying the parameters of the machine; the output is critical to introducing another set - the geometry. The dataset is useful to perform analysis and develop a predictive model for the testpiece geometry - but this is largely irrelevant when we move to a different component. By using Ansys to simulate each of the 16 machine parameter combinations, it becomes possible to draw parity between physical results and the way in which geometry affects the velocity in certain areas. Without Ansys, the clear, quick and concise display of flowpath (indicating velocity and pressure) is not possible in a workshop environment. Once the effects of media surface speed are determined in terms of roughness, edge rounding and ovality, we can begin to predict results in a new geometry.

### Findings/Results

Completion of the dataset described in the introduction is being finalised – machining is complete, measurement is being undertaken. Application to the simulation system has already started. The AFM process has several effects on the test-piece being used; roughness improvement, radius generation, surface texture alteration and form change. These characteristics are worthy of a paper in themselves, particularly the radii and roughness results. The ResCon paper will however focus on marrying-up simulation settings to accurately describe the physical results from the prior dataset. From this point, prior data obtained through trial and error in production parts will be simulated using the same settings

(Ansys Fluent/Polyflow), to obtain a simulation strategy that coincides with both sets of physical results.

### **Conclusion / Discussion**

Previous work points strongly towards the existence of a flowpath in components whereby the velocity of media is altered by the geometry of the part, exhibiting Bernoulli's principle. However, the velocity and pressure do not change in a uniform fashion, as proven through images of hole form captured earlier. There is a strong likelihood that the combination of pressure and velocity coupled with geometry dictate the ultimate effects of the AFM process. So far, basic simulation has proven that the technique is suitable for displaying the velocity and pressure in any given part. The variation of results within the test-piece has shown that the parameters used for the initial data collection are suitable to obtain useful results and are certainly applicable to a simple simulation model. They have also highlighted other opportunities for research, such as the three separate and distinct types of finish observed, the overall capacity of the machine and the importance of media homogeneity. It is likely that this paper will advise the use of processing parameters that (in some oilfield exploration tools that Mollart produce) the current AFM machine is incapable of realising. The conclusion will likely be to suggest increasing of machine capability, i.e. an increase in motor and hydraulic line capacity, or a redesigned media that operates effectively with lower viscosity. From the perspective of the paper's technical output - it provides a basis for further flowpath optimisation and a solid grounding for introduction of parts from Mollart's subcontract service - although at this stage only with media and workpiece material used in initial data collection.

### **Future plans / directions**

The industrial nature of the EngD programme ensures that relevant progress is shown. While the project is a complex one, the researcher has a wealth of information and support at his disposal and has made good progress since changing sponsoring company. The project has applied for additional government funding (written by a previously successful applicant) with deliverables attached to financial penalties, further ensuring the project's success.

Further to the methodology section, the inclusion of changing media parameters is out of scope for this paper, but further work will aim to clarify the limits of media. Through industrial trial and error testing, it has become clear that the media viscosity introduces a physical limit to the action of the superabrasive grit and the maximum velocity.

### **References**

- Fang, L., Zhao, J., Li, B., & Sun, K. (2009). Movement patterns of ellipsoidal particle in abrasive flow machining. *Journal of Materials Processing Technology*, 209(20), 6048-6056.
- Fang, L., Zhao, J., Sun, K., Zheng, D., & Ma, D. (2009). Temperature as sensitive monitor for efficiency of work in abrasive flow machining. *Wear*, 266(7-8), 678-687.
- Jain, R.K., Jain, V.K. & Dixit, P. (1999) "Modeling of material removal and surface roughness in abrasive flow machining process", *International Journal of Machine Tools and Manufacture*, vol. 39, no. 12, pp. 1903-1923.
- Kumar Jain, R., & Jain, V. K. (1999). Simulation of surface generated in abrasive flow machining process. *Robotics and Computer-Integrated Manufacturing*, 15(5), 403-412.
- Mao, T. F., Yang, S. C., Tsai, F. C., Hung, J. C., & Yan, B. H. (2010). Materials and Manufacturing Processes, 25(9), 965-973.
- Szulcynski, H. & Uhlmann, E. (2002) "Material Removal Mechanisms in Abrasive Flow Machining", *Proc. of the 17th Annual Meeting of the ASPE, St. Louis, Missouri, USA*, pp. 677.
- Wang, A. (2009). Uniform surface polished method of complex holes in abrasive flow machining. *Transactions of Nonferrous Metals Society of China*, 19, s250-s257.

## Assessment of a thermoacoustic heat engine to reuse low temperature wasted heat in food manufacturing

*Jurriath-Azmathi Mumith, Harris Makatsoris*

**Keywords:** Wasted energy, Thermoacoustics, design, optimisation, DeltaEC

### Introduction

There are a large number of industrial processes at high temperatures which result in wasted heat, such as chlorine production in the chemical industry, aluminium melting in the materials industry, and baking in the food industry. In recent years efforts have been made to recover this wasted heat in energy saving projects, as there is greater legislation and encouragement from governments to reduce impact on the environment and decrease dependency on fossil fuels.

Here, the problem under investigation is in a baking factory which is shut down for the weekend; it is then initiated on Monday morning to bring the system up to the required operating conditions, which requires several hours. During this start up time, when attempting to bring biscuit dough to a specific tolerance, the process is prone to variations in temperature, and the dough is considered waste. In another part of this baking process, wasted heat is expelled from a baking oven into the atmosphere in an exhaust gas flue. This work considers a way of utilising this wasted heat to bring the system up to the required operating conditions and hence reduce the startup time and eliminate the wasted dough.

A method of recovering this wasted heat was proposed which would only require a thermoacoustic heat engine and a transducer, to convert the thermal energy of the wasted heat to acoustic energy in the thermoacoustic heat engine, and then to electrical energy in the transducer. The engine consists of two heat exchangers, a stack of parallel plates, which is all enclosed in a cylindrical tube and which is the solid container for the acoustic wave produced. The advantages of the thermoacoustic heat engine are its simple design, ‘no moving parts, no exotic materials, and no close tolerances or critical dimensions’ [1]. It is therefore cheap to manufacture and would require minimum maintenance, which is desirable in the food industry which has small margins of profit.

Using a thermoacoustic heat engine to recover the low temperature wasted heat in the food industry has not been considered before, due to its relatively low efficiencies, but as an emerging field of research the performance of the engine continually increases as understanding of the subject area increases, and previous literature has shown that there is definite potential in the technology [2].

### Design/Methodology/Approach

As there are existing electroacoustic transducers with high transduction efficiencies, this work focused on the design of the thermoacoustic heat engine, attempting to optimise the acoustic power output. Therefore 18 design parameters which have a direct effect on the performance of the thermoacoustic heat engine were considered. An optimisation process was carried out based on two design criteria, minimisation of losses and maximisation of acoustic power output of the engine, in order to assess the potential of the thermoacoustic heat engine in the present application. From previous literature it was possible to know the range of values of the design parameters in which maximum acoustic power and minimum losses could be obtained. Therefore the design parameter values were varied within these ranges during the optimisation process to determine at which value(s) the design criteria were met.

The design and optimisation process of the thermoacoustic heat engine was carried out in DeltaEC, a software which calculates details of how thermoacoustic equipment performs, and can help to design equipment to achieve desired performance [3].

### **Findings/Results**

The maximum stack efficiency that the thermoacoustic heat engine is capable of in this model is 10.35% at 150°C at the high temperature end of the stack and a heat input of 860.78W. But there are various losses of acoustic power in other parts of the engine which diminish the thermal efficiency of the entire engine to 2.64%. This was due to acoustic losses predominantly lost in the two heat exchangers and the resonator. Therefore by adjusting the heat exchanger plate length somewhat, it was possible to reduce viscous losses and deliver 40W of acoustic power output. Currently, with this power output it could be possible to power low level applications such as electronics.

### **Conclusion / Discussion**

The system appears to be very sensitive to small changes in geometry of the stack and thermal properties of the working fluid. The crucial point that is observed is that efficiency increases with increasing input temperature, as a higher temperature difference  $\Delta T$  is possible across the stack. This is the disadvantage of such applications that expel low temperature wasted heat. But the results show an underlying potential in performance of the thermoacoustic heat engine to convert the wasted heat to a more useful type of energy.

### **Future plans / directions**

It is necessary in future work to consider other parts of the engine which contribute to significant losses, such as the design of the heat exchangers as well as the resonator in an attempt to minimise these losses and increase the overall performance of the thermoacoustic heat engine. It is hoped that ultimately, this heat recovery system will not only solve the original problem but the electric power produced can be used in other applications around the factory, utilising the wasted heat in every exhaust gas flue.

### **References**

- [1] Swift, G.W. Thermoacoustic engine. J. Acoust. Soc. Am. 1988; 84(4):1145-1180.
- [2] Backhaus, S. Traveling-wave thermoacoustic electric generator. Appl. Phys. 2004; 85(6):1085-1087.
- [3] Ward, Bill. Clark, John. & Swift, Gregory. 2008. Design Environment for Low-amplitude Thermoacoustic Energy Conversion: DeltaEC Version 6.2 User Guide. [e-book] Available at: <http://www.lanl.gov/thermoacoustics/DeltaEC.html> [Accessed at 5 July 2010].

## Performance Measurement - assessment of systems and frameworks for monitoring oil operations

*Adel Nouara, Rebecca De Coster*

**Keywords:** Performance measurement- Performance management

### Introduction

Currently, there is a great interest in performance measurement with many companies as it is the process of quantifying the efficiency and effectiveness of action, Andy Neely (1995).

Performance measurement (PM) has become a popular topic for both industrialists and academics. PM has been widely viewed as an indispensable pre-requisite for management – as an old adage often attributed to Lord Kelvin says, “if you cannot measure it, you cannot improve it”. In this capacity, PM has become a firmly established element of performance management.

The purpose of this paper is to identify performance metrics and categorise them based on specific aspects of facility performance measurement in order to facilitate a holistic performance assessment also, to examine the changing drivers of oil operations in Libya and their strategic importance and the associated evolution of operational performance and metrics for National Oil Companies (NOCs)

### Approach

Case study based on survey and interviewing of senior people of Oil services companies in London and Libyan national Oil Company.

### Findings

National Oil companies (NOCs) matter because they dominate the proven Oil reserves that are expected to supply the world's growing need for liquid fuels. Also in many countries the Oil sector dominates the economy and is seen as the major source of economic development.

This analysis relies on extensive literature search of extant research papers, assessment reports, surveys and presentations to identify metrics. Metrics are arranged in appropriate categories based on their purpose and content. The paper identifies metrics for performance measurement and classifies them into two major categories financial and operational. The list presents metrics with their description and unit of measurement.

### Discussion

The purpose of performance measurement is to comprehend the impacts of management decision-making on success and failure of the portfolio and to suggest possible improvements (Cable and Davis, 2004). Performance metrics represent indicators of performance that can be used for a genuine comparison within and between organizations. Performance metrics provide an essential common platform for comparison, Ho et al. (2000).

Thus, performance measurement is essential- particularly in order to perform comparisons and develop strategies for improvements. Furthermore its focus must be not only on costs, but also on issues that shape the physical environment of the organizations. Kincaid (1994)

### Future plans

For the second and third year to develop a conceptual framework for performance measures of current and future oil operations and the associated asset management for field operations and to test the conceptual framework by evaluating it in the context of the deployment of applications using performance management technologies or any other method appropriate.

### References

-Azzone, G., Masella, C. and Bertele, U. (1991), “Design of performance measures for time-based companies”, International Journal of Operations & Production Management, Vol. 11 No. 3, pp. 77-85.

- Bititci, U.S., Mendibil, K., Martinez, V. and Albores, P. (2005), "Measuring and managing performance in extended enterprises", International Journal of Operations & Production Management, Vol. 25 No. 4, pp. 333-53.
- Bourne, M., Kennerley, M. and Franco-Santos, M. (2005), "Managing through measures: a study of impact on performance", Journal of Manufacturing Technology Management, Vol. 16 No 4, pp. 373-95.
- Davis, S. and Albright, T. (2004). "An investigation of the effect of balanced scorecard implementation on financial performance", Management Accounting Research, Vol. 15 No. 2, pp. 135-53.
- Flapper,S.D.,Fortuin, L. and Stoop, P.P. (1966),"Towards consistent performance management systems", International Journal of Operations & production Management, Vol. 16 No. 7, pp.2-7.
- Franco, M. and Bourne, M. (2003), "Factors that play a role in "managing through measures", Management Decision, Vol. 41 No 8, pp. 698-710.
- Hopwood, A.G. (1972), "Supplement. An empirical study of the role of accounting data in performance evaluation", Journal of accounting Research , Vol. 10 No. 3, pp. 156-82.
- Hoque, Z. and James, W. (2000), "Linking balanced scorecard measures to size and market factors: impact on organizational performance", Journal of Management Accounting Research, Vol. 12, pp. 1-17.
- Ittner, C.D., Larcker, D.F. and Meyer, M.W. (2003), "Subjectivity and the weighting of performance measures: evidence from a balanced scorecard", The Accounting Review, Vol. 78 No. 3, pp. 725-58.
- Kaplan, R.S. Norton, D.P. (1992), "The balanced scorecard – measures that drive performance", Harvard Business Review, Vol. 70 No. 1, p. 71.
- Keegan, D.P., Eiler, R.G. and Jones, C.R. (1989), "Are your performance measures obsolete?", Management Accounting, pp. 45-50.
- Kerssens-van Drongelen, I.C. and Bilderbeek, J. (1999), "R&D performance measurement more than choosing a set of metrics", R & D Management, Vol. 29 No. 1, p. 35.
- Malina, M.A. and Selto, F.H. (2001), "Communicating and controlling strategy: an empirical study of the effectiveness of the balanced scorecard", Journal of Management Accounting Research, Vol. 13, pp. 47-90.
- Misterek, S., Dooley, K. and Anderson, J. (1992), "Productivity as a performance measure", International Journal of Operations & Production Management, Vol. 12 No. 1, pp. 29-45.
- Neely, A. (1998), Measuring Business Performance, Economist Books, London.
- Neely, A. (2005), "The evolution of performance measurement research: developments in the last decade and a research agenda for the next", International Journal of Operations & Production Management, Vol. 25 No. 12, p. 1264.
- Atkin, B and Brooks, A. (2000), Total Facilities Management, Blackwell Science, Oxford.
- Cohen, R., Standeven, M., Bordass, B. and Leaman, A. (2001),"Assesing building performance in use 1: the probe process", Building Research and Information,Vol. 29 No. 2, pp. 85-102.
- Cotts, D.G. and Lee, M. (1992), The Facility Management Handbook, AMACOM (American Management Association), New York, NY.
- Cripps, S. (1998), "Calgary K-12 district benefits from the facilities management evaluation program", Facilities Manager Magazine.
- Deru, M. and Torcellini, P. (2005), performance Metrics Research Project-Final Report, National Renewable Energy Laboratory, Golden, CO.
- Douglas, J. (1993/1994), "Developments in appraising the performance of buildings", Structural Survey, Vol. 12 No. 6, pp. 10-15.
- Hinks, J. (2004) "Business-related performance measure for facilities managements", in Alexander, K., Atkin, B., Brouchner, J.and Haugen, T. (Eds), Facilities Managements: Innovation and Performance, SPON Press,New York, NY , pp,97-107
- Hitchcock, R.J., (2002), High Performance Commercial Building System Program, Element 2-Project 2.1 – Task 2.1.2, Standardized Building Performance Metrics, Final Report, Building Technology Department, Lawrence Berkeley National Laboratory, Berkeley, CA.
- Ho, D.C.H., Chan, E.H.W., Wong, N.Y. and Chan, M. (2000), "Significant metrics for facilities management benchmarking in the Asia Pacific region", Facilities, Vol. 18Nos 13/14, pp.545-55.
- Kincaid, D.G (1994), "Measuring performance in facility management", Facilities, Vol. 12 No. 6, pp. 24-7.
- Lebas, M.J. (1995), " Performance measurement and performance management", International Journal of Production, Economics, Vol. 41 Nos 1-3, pp. 23-35
- O'Sullivan, D.T., Keane, M.M. Kelliher, D. and Hitchcock, R.J. (2004), "Improving building operation by tracking performance metrics throughout the building lifecycle (BLC)", Energy and Buildings, Vol. 36 No. 11, pp. 1075-90.
- Preiser, W.F.E. and Vischer, J.C. (2005), Assessing Building Performance, Elsevier, Oxford.
- Varcoe, B.J. (1996), "Facilities performance measurement", Facilities, Vol. 14 Nos 10/11, pp. 46-51.
- Yuan, J., Zeng, A.Y., Skibniewski, M.J and Li, Q. (2009), "Selection of performance objectives and key performance indicators in public-private partnership projects to achieve value for money", Construction Management and Economics, Vol. 27 No. 3, pp.253-70.

## A universal culturally oriented Supply chain network: Exploring the potential for an umbrella culture within a Supply chain network and its impact on supply chain performance

*Pooneh Pahlavanzadeh Irani, Susan Grant*

**Keywords:** Supply Chain Management, Organizational Culture.

### Introduction

The importance of different dimensions of culture is well known to executive managers in implementing and developing any initiative such as SCM, but there is little research conducted on the importance of a cultural dimension and cultural orientation of the supply chain and its impact on achieving an efficient SCM and it is a relatively novel area of studies, which has been highlighted by some researchers in past few years and considering the increase of interest regarding the effectiveness of SCM both in academics and practitioners' environment, this area worth the effort if it can develop a connection between SCO culture and an effective SCM system

For the first time McAfee et al (2002) discussed the importance of corporate culture (shared values, beliefs, assumptions and patterns of behavior) for the long-term relationship to be successful. Mentzer et al. (2001) emphasize on supply chain orientation (SCO) as the key for all organization across supply chain to be able to implement supply chain management. He defines the SCO as "the recognition by an organization of the systemic, strategic implication of the tactical activities involved in managing the various flows in a supply chain." In particular SCO culture enhances the integrated planning across the supply chain and result more value for each firm within the chain (Mello & Stank 2005; Bowersox et al 2003).

The aim of this research is to examine the potential and effect of a common culturally oriented supply chain on supply chain performance. The objectives of this study are to explore the potential for an umbrella culture within the supply chain network and its impact on chains' performance. This will be done through exploring the culture of the chain's 'leader' firm and how it is grounded and developed over time. Also to explore the culture of SME's working as suppliers within the chain and how their culture is grounded and developed and has been changed and modified by joining the supply chain network. To identify the closeness and similarities of each network's players with the chain's 'leader' and to see how much their change in terms of their values are oriented toward the leaders' values in order to form an overarching common culture within the chain. Compare the performance of each supply chain network and the level of similarities of its players in terms of culture to explore the link between supply chain performance and the supply chain oriented culture.

### Methodology

Studying culture in organizations is mainly involved with qualitative methodologies. Thus the methodology of this research will be qualitative and based on the semi-structured interviews. (Denison, 1996).

According to Smircich (1993) "three forms of evidence may be used in the study of organizational culture; information, reports from informants and the researcher participation within the setting." We intend to adopt these techniques in order use comparative case study model. Face to face interview and observation will be the means of collecting case study's data which is not exist in current databases.

SME's machine tool manufacturers in United Kingdom have been defined as a group worthy of investigation in this area. Not just because it is a vitally important industry, but it is considered to be a good reflection of the health of manufacturing in general in individual countries (Ashburn, 1993). Despite the level of internationalization of machine tool industry within UK, we intend to select all manufactures form UK companies and the target participants for the case are owner manager and senior manager. Data on supply chain performance and organization's policies to implement SCO can be obtained from owner managers or senior managers who have access to operational and performance data.

The two cases which will be examined each consists of (a) a main leading actor, as Network final customer, which is common in both network (b) the set of small actors (at least three) with any kind of tie to main leader, and (c) all ties among the small actors and between them and the leader. We tent to extent this research beyond the boundary of one firm and study at least three firms' relationship within a network of supply chain based on a SCO culture.

### **Findings and Conclusion**

As this research is still in the early stage of its research design, the interview and the structure and type of interview has not become clear and started yet.

### **Future plans / directions**

As the research has not been reached to the end of first year, and the methods and research design has been cleared enough to start planning the data gathering and design the interview's structure, it can be claimed that the research is on Track to be finished by the end of third year.

### **References**

- Ashburn, A. (1993), "1992 machine tool output: world total drops by \$8 billion". American Machinist February, Vol. 137, No. 3, pp. 32-7.
- Bowersox, D.J., Closs, D.J. and Stank, T.P. (2003), "Understanding and mastering cross-enterprise Collaborative supply chain management", Supply Chain Management Review, Vol. 7 No. 4, pp. 18-29.
- Denison, D.R. (1996), "What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars", Academy of Management Review, Vol. 21 No. 3, pp. 1-36.
- Grant, S.B., (2009), "Supply chain orientation in UK machine tool manufacturing SME's", 16th International Annual EurOMA Conference.
- Lorenzoni, G. (2010), "Genesis of a research field: district, network, strategic network", Journal of Management & Governance, Vol. 14, No. 3, pp. 221-239.
- Mello, J.E., Stank, T.P. (2005) "Linking firm culture and orientation to supply chain success", International Journal of Physical Distribution & Logistics Management, Vol. 35 No. 8, pp.542 - 554
- Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G. (2001), "What is supply chain management", in Mentzer, J.T. (Ed.), Supply Chain Management, Sage, Thousand Oaks, CA, pp. 1-26.
- Miles, M. B. and Huberman, A. M. (1994). "Qualitative data analysis: an expanded sourcebook", (2<sup>nd</sup> ed.), Sage.
- Min, S., Mentzer, J.T. and Ladd, T. (2004), "A market orientation in supply chain management", working paper, Department of Marketing, The University of Oklahoma, Norman, OK.
- Schein, E.H. (2004), "Organizational Culture and Leadership", (3th ed.) Jossey-Bass Publishers, San Francisco, CA, (1th ed. 1985)
- Smircich, L., (1983), 'Studying organizations as cultures' in Morgan G (eds) Beyond method: Strategies for social science research stage London.
- Srivastava, R.K., Shervani, T.A. and Fahey, L. (1999), "Marketing, business processes, and shareholder value: an organizationally embedded view of marketing activities and the discipline of marketing", Journal of Marketing, Vol. 63, Special Issue, pp. 168-79.

# **Measurement and Analysis of Transit Hazards in Commercial Truck Transport Environment within the Bulk Tea Supply Chain in Kenya as a Basis for Establishment of a Focused Pre-shipment Protocol for Packaged Goods in Kenya**

*Arthur Rimeria, Joe Au*

**Keywords:** Transport hazards, physical tea quality, focused simulation.

## **Introduction**

Distribution packaging enables products to survive transit physical hazards of transportation and distribution. These may include shock, vibration changes in relative humidity, temperature, pressure and even compression. Increasing stringent demands in the world trade, varying transport and distributions conditions and international competition, now demand that a more focused transit hazard analysis and evaluation be carried out within a defined distribution channel for optimal package design. [4]. This would ensure packaging meets the protective needs of the product as well as the economic and environmental requirements of the shipper and user. This just Right packaging is designed and certified against just right pre-shipment testing which adequately simulates the hazards of actual transportation distribution [2,5,10]. There is no documented data on road transport hazard analysis for bulk tea supply chain in Kenya against which pre-shipment testing of goods can be carried out to optimize package designs [8]. Earlier work in the bulk tea packaging in Kenya concluded that the current packaging may not be optimal and recommended further work on supply chain road transport hazard analysis [8]. In order to carry out meaningful simulated package tests for road shipment environment, accurate conditions of the expected distribution hazards must be known including their levels and even sequence. [3,4,13] The total cost of pre-shipment performance testing versus the total benefits derived, indicates that the total cost for performance testing has an exponential correlation to the potential economic benefit [5]. Businesses can therefore save money by optimizing their pack designs by carrying out focused simulated laboratory pre-shipment testing using actual road shipment conditions.

This research aims at measuring and analysing hazards of vibration, shock, temperature and relative humidity within bulk tea truck transport environment. Use that data to formulate a suitable focused laboratory simulated pre-shipment testing protocol for goods within this distribution channel. In addition, this work is expected to find out how road hazards of vibration and shock affect physical quality of tea during shipment via laboratory simulation of measured transit hazards.

## **Design/ methodology/approach**

Four commercial trucks mounted with articulating tri-axle trailers were used one for each bulk tea shipment route. Transit conditions during the entire journey of each truck used were measured using Lansmonts' Saver 3x90 miniature data logger. These self-powered data recorders had capability to measure vibration, shock, relative humidity and temperature for both time and signal triggered inputs. The data loggers were firmly mounted inside the trailer bed at the left rear axle end in each truck. The data recorders had memory, data transmission and download capabilities that allowed download of data into the computer at the end of the journey for subsequent analysis. The loggers had tri-directional accelerometers that enabled them to measure vibration and shock in the vertical, lateral and longitudinal directions. Speed and location of the trucks was monitored at every two minute intervals using a fleet management system from River-cross Ltd. The analysed field data was used to carry out simulated laboratory testing.

The laboratory simulation work was carried out using specially designed rig consisting of Perspex tubes (25.4mm internal diameter) fixed firmly on an aluminium 330mmx150mmx10mm base

plate. Various tubes were mounted with various loosely fitting known-weight round bars that were designed to simulate dynamic loading at various heights of the shipping container. Two control tubes one mounted on the vibrator without any loading and the other receiving no treatment at all were also provided. The tubes were filled with black CTC (cut, tear and curl) tea ( particle size  $2\text{mm} < x < 1\text{mm}$ ) to pre-determined volumes. The assembly was fixed to a programmable vibration table that was programmed with the power density spectra data obtained from the field data analysis. The table produced shaped random vibrations that simulated actual road travel conditions. Particle size distribution and density analysis was carried out at various intervals during the simulation using stainless steel hand held sieves and laboratory scales respectively. Tea moisture content changes were carried out using laboratory oven cabinet set at  $103^{\circ}\text{C}$ . Tea particle surface configuration of the start tea stock and that of resulting tea fractions at the end of the experiment were carried out using Scanning Electron Microscope in order to monitor any changes occurring as a result of transit hazards simulation.

### **Results/Findings**

Power density spectrum (PSD) and shock response spectrum (SRS) for each trip in the vertical, longitudinal and lateral planes were produced from both the timer and signal controlled trip record raw data. The vehicle speed versus time graphs were also produced for each vehicle trip. Time versus acceleration plots were generated. A composite PSD spectrum was produced from the trip G rms and used in Laboratory simulation.

The PSD plots from the tested routes differed indicating the differences in road conditions within those routes. The differences could be attributed to shocks resulting from uneven road surface, differing road surfaces, railway crossings, unmarked speed bumps, worn out road shoulders, sudden truck turns and breaking as well as differing vehicle suspensions. The SPDs also differed significantly from those done in North America[11], Europe[7], Japan, Brazil[9], Thailand[3,13], China[2] and India[12] depicting the differences in the road conditions in those areas and those found in Kenya. The Plots also differed from the ISTA [14] and ASTM [1] recommended test levels. The ISTA and ASTM test levels are significantly lower than the test results from this study indicating that those tests may not be appropriate for use in the Kenyan supply chain situation in order to optimize pack designs.

### **References**

- 1.American Society for Testing and Materials International.ASTM Standards, Vol 15.09: Packaging. ican 100 Barr Harbor Dr., West Conshohocken, PA 2002.
- 2.Baird T, Young D. The China Project: an assessment of china shipping and handling environments. ISTA PST Newsletter 2004.
- 3.Chonhenchob, V., Singh P. " Packaging performance comparison for distribution and export of papaya fruit". Packaging Technology and Science, 2005, Vol. 18, pp. 125-131.
4. Emblem A, Emblem H. (1996) Fundamentals of Packaging Technology. Iop, U.K. pp. 341-342
- 5.Kipp, W. " Accelerated random vibration with time- history shock for improved laboratory simulation". Paper presented at IOPP 2001 Annual membership meeting March 29, 2001, San Jose, California.
6. Lu,I., Shiina, T. and Satake T. " Analysis of shock and vibration in truck in Japan". Packaging Technology and Science, 2008, Vol. 21 (8) pp. 479-489.
7. Martinez,M., Singh, P. and Ballester, V. " Measurement and analysis of vibration levels for truck transport in Spain as a function of payload,suspension and Speed".Packaging Technology and Science,2008, 21 pp. 439-451.
- 8.Rimberia A." Investigation into possibilities of reduction material used in bulk tea packaging by KTDA factories in Kenya. M.sc dissertation, 2006, Brunel University, London.
9. Rissi, O., Singh, P.,and Singh,J." Measurement and analysis of truck transport environment in Brazil". Packaging Technology and Science,2008,Vol.21(4) pp. 231-246.
10. Rouillard, V. and Sek, M. " Monitoring and simulating non-stationary vibrations for package optimization". Packaging Technology and Science, 2000,Vol. 13, pp. 149-156.
11. Singh, J.,Singh,P. and Joneson,E. " Vibration for leaf spring and air ride suspensions, and development of tests to simulate these conditions" Packaging Technology and Science,2006,19 pp. 309-323
12. Singh, P., Sandhu, S., Joneson,E.,andSingh. J. " Measurement and analysis of truck and rail shipping environment in India". Packaging Technology and Science,2006, Vol.20 (6), pp. 381-392.
13. Singh, P., Jarimopass B., and Saengnil W." Measurement and analysis of vibration levels in commercial truck shipments in Thailand and its impact on packaged produce". Packaging Technology and Science, 2005,Vol. 18 pp. 179-188.
- 14.[www.epac-china.com/uploadfile/20110328112158143.pdf](http://www.epac-china.com/uploadfile/20110328112158143.pdf)- Packaged -products for parcel delivery.

## Simulation-based analysis on geometry of a diamond cutting tool applied to Nano/Micro cutting

*Samira Sayad Saravi, Kai Cheng*

**Keywords:** Turning cutting tool, Dynamic system

### Introduction

There is a need to study various aspects of micro-cutting to have a better understanding of the physics and mechanical features in one picture; although with details. These aspects include tool design, application output, machining system, etc. In this presented work, the aim is to increase cutting tool life by considering different tool features and cutting conditions. Moreover, the main approach to the project is to have a scientific understanding which includes physical characteristics and mathematical methods.

### Design and approach

In general, Finite Element Method (FEM) and Molecular Dynamics (MD) have been used as powerful methods for cutting tool analysis (Ozel and Zeren, 2007; Romero, Anciaux, Molinari and Molinari, 2011). In this paper, a scientific approach is been demonstrated.

#### 1. Tool life

Tool life depends on many factors such as tool material and geometry, cutting parameters (cutting speed, feed, and depth of cut), work material, machining operation and other machining parameters. Tool wear leads to tool failure and decrease the tool life (Astakhov and Davim, 2008). Among different types of tool wears, crater wear is the one that can weakens the tool wedge and increases the possibility for tool breakage (Marinov, 2011). In order to reduce the chance of the tool breakage, which happens by crater wear, the specific Rake angle can be avoided as one of the machining parameters. For this purpose, plasticity theory and Dynamics systems' modelling have been engaged by MATLAB and Simulink.

#### 2. Plasticity work

Theory of rigid-plastic crystal deformation expresses that the crystal follows a mode of deformation that minimizes the developed plastic power (Kato,2008); therefore, when maximum plasticity work appear, the crystal orientation of the diamond opposes with the deformation direction.

The total power on turning tool includes the work from the shear friction and the work from the friction between the chip and rake face in sticky zone; to obtain the plasticity work, strain tensor in crystal coordinate system should be founded (Bishop and Hills, 1951). Consequently, the total friction force can be defined by the plasticity work. A diamond tool, with slip system [111] <110>, has been considered for this study.

#### 3. Dynamic system (Rake angle)

The friction stress is approximately equal to the yield shear stress of the material at sticking zone where the chip moves over a material, stuck on the rake face of the tool. A specific rake angle is resulted by knowing the machining conditions and the friction force. This angle

assumed to be in the range of [-10, 10]. The used theoretical model is based on the oblique cutting force model proposed by Armarego and Brown (1969).

### **Results and discussion**

Investigation of crater wear and plasticity power, for tool breakage, resulted to specific rake angle in terms of increasing the tool life. The rake angle for the presented machinery conditions (case study) has founded -10.

### **Conclusion and further plans**

Currently, the project is more focused on two different aspects: Experimental evaluation, related applications. In terms of experimental evaluation for tool wear and breakage, modeling and experimental comparison should be researched.

In addition, the presented study is been linked with other aspects of simulation and modeling based on the Nano/Micro cutting (i.e. applications such as creating micro features). Finally, the whole project will be completed for the expected defined time.

### **References**

- [1] Romero, P. A., Anciaux, G., Molinari, A., J. F. Molinari J. F., 2011. Friction at the tool-chip interface during orthogonal nano-metric machining, Laboratoire de Simulation en Mecanique des Solides (*LSMS*);
- [2] Kato, N., 2008. Mechanical Micromachining effect of Crystallographic Anisotropy on Machining Forces, *Doctor of Philosophy in Mechanical Engineering*, Indian Institute of Technology Madras;
- [3] Marinov, V., 2011. Manufacturing Technology, Tool wear and tool life, *North Dakota State University*;
- [4] Özel, T., Zeren, E., 2006. Finite element modeling the influence of edge roundness on the stress and temperature fields induced by high-speed machining, *Springer-Verlag London Limited*;
- [5] Bishop, J. and Hill, R., 1951, A theory of the plastic distortion of a polycrystalline aggregate under combined stresses, *Philosophical Magazine*, 42, p. 414-427;
- [6] Armarego, E. J. A., Brown, R. H., 1969. The Machining of Metals, *Prentice-Hall Inc*, Englewood Cliffs, New Jersey;
- [7] Astakhov, V. P., Davim, J. P., 2008. Tools (Geometry and Material) and Tool Wear, General Motors Business Unit of PSMi, USA, *Springer*, p. 361;

## An experimentation for analytical investigation on micro/nanometric cutting mechanics and physics

*Worapong Sawangsri, Kai Cheng*

The micro/nanometric cutting mechanics and cutting physics are critical needed to investigate because there are quite different from those conventional cutting. Even though there are numbers of research works investigating on the micro/nanometric cutting mechanics and physics by simulation techniques, just a few papers are conducting based on experimental investigation. In this paper, the experimental set up for the 3 particularly theoretical proving of micro/nano cutting mechanics and physics which conduct on 3-axis diamond turning machine equipped with FTS are presented, particular include minimum and undeformed chip thickness investigation, dynamics cutting force and loop stiffness controlled, and micro texturing features and environmental disturbances effected on quality and functionality of surface finish. The experimental results can be further analysed and discovered, and then can be clearly explained the phenomena of the micro/nano cutting physics and mechanics namely the size-effect and specific cutting energy, the behaviors of micro cutting forces, the surface finish under micro-ploughing or rubbing process due to the radius of the tool's cutting edge is on the same order as (or smaller than) the undeformed chip thickness. The validated simulation will be presented in a separated paper.

### **Introduction**

The aim of research work:

1. To prove the micro/nanometric cutting physics and mechanics by both experiments and simulations

The objectives of research works:

1. Minimum and undeformed chip thickness (depth of cut) related with practical term
2. Dynamics cutting force and loop stiffness controlled
3. Micro texturing features and its effects/environmental disturbances effect on quality and functionalities of surfaces finish

### **Design/Methodology/Approach**

Machine and devices:

1. 3-axis diamond turning machine
2. The FTS equipped with Piezoelectric actuator
3. AE sensor
4. 3-component force sensor
5. Confocal gauge/sensor (from Polytec Ltd.)
6. Zygo profilometer

## **Findings/Results**

The official experiments will be started by the middle of April 2012. All experimental results will then be collected, analysed and presented in the near future

## **Conclusion / Discussion**

The micro/nano cutting physics and mechanics will be proved based on the experimental results as the following issues:

1. Minimum/undeformed chip thickness
2. The size-effect and specific cutting energy
3. Micro cutting forces and its behavior
4. Dynamics stiffness
5. Micro textures and environmental disturbances effect on surface finish
6. Surface finish under micro-ploughing or rubbing process

Ultimate results analysis will then be explored by this research works:

1. Exactly values of minimum/undeformed chip thickness based on experimental investigation
2. Maintained and/or optimum cutting forces
3. Increasing quality and functionality of surface finish (by reducing micro textures and environmental disturbances effects)
- 4.

## **Future plans / directions**

The validated modeling and simulation will be implemented after the experiments

## **References**

- [1] D. Dornfeld, S. Min, Y. Takeuchi. (2006) ‘Recent Advances in Mechanical Micromachining’, *Annals of the CIRP*, Vol. 55, pp745–768.
- [2] Richard E. Devor, Kornel F. Ehmann, Shiv G. Kapoor. (2004) ‘Technology Assessment on Current Advanced Research in Micro-Machining and Related Areas’, *AMT - The Association For Manufacturing Technology*, December 2004.
- [3] W.B. Lee, C.F. Cheung. (2001) ‘A dynamic surface topography model for the prediction of nano-surface generation in ultra-precision machining’, *International Journal of Mechanical Sciences*, Vol. 43, pp961-991.
- [4] X. Luo et al. (2003) ‘An investigation on the mechanics of nanometric cutting and the development of its test-bed’, *International Journal of Production Research*, Vol. 41, no. 7, pp1449–1465

## Design of an Electrochemical Machine for the Automotive, Aerospace and Medical Sectors

*Alexandre Spieser, Atanas Ivanov*

**Keywords:** electrochemical micromachining, control, pulse generator, fuzzy logic

### Introduction

Electrochemical Micro-Machining ( $\mu$ ECM) is an innovating non-conventional machining process based on the phenomenon of electrolysis. This process requires the maintenance of a small inter electrode gap of a range from 2 to 10 micrometers between the anode (workpiece) and the cathode (tool-electrode) in order to have acceptable results from the process in terms of feature resolution and productivity. This process offers achieving of very high aspect ratio and very good surface integrity of the machined features.

This paper conducts the investigation in the different problematic areas of Electrochemical Micromachining (often referred to as  $\mu$ P ECM or  $\mu$ ECM). The aim of this paper is to address the problems met during development of the  $\mu$ ECM technology and to present the current state-of-the-art solutions in this area. The literature review regards all the worldwide developments ranging from machine and motion control issues to power supplies, electrolytes and process control problems.

This paper discloses the developed control system for the process based on fuzzy logic, allowing efficiently to drill small holes (typ.  $\phi 100\mu\text{m}$ , 1mm depth) in hard-to-machine materials (18NiCr6 alloy) while protecting the tool from being damaged by short circuits.

In order to have a localized electrochemical dissolution of the workpiece material, it is needed to be applied ultra-short current pulses. Therefore a power supply producing ultra-short current pulses was developed which is incorporated into the main control system. The new power supply is able to deliver current pulses going up to 25A, with a minimum pulse width of 50ns at a multi-MHz frequency (typ. 8MHz).

### Design/Methodology/Approach

Development of the new micro Electrochemical technology and related equipment is a complex engineering task requiring interdisciplinary knowledge. On one side there are requirements for the mechanical structure of the machine and its mechanical static and dynamic characteristics. On the other hand it is the process requirements which are related deeply into the electrochemical dissolution of metals exposed in an electrolyte cell and passed current through the electrodes. Also should be considered that development of the power supply providing ultra-short pulses and high current is demanding electronic task. Additionally, there is a report of how such process should be controlled and how the motion control is affected by the behavior of the electrochemical cell.

At present, a test rig has been designed and the control algorithm has been implemented using LabVIEW. The control algorithm consists of a fuzzy logic algorithm embedded in a state-machine allowing it to react to unexpected events such as short circuits. This fuzzy logic is based on monitoring and maintaining constant current through the interelectrode gap. The position of the tool electrode is controlled with respect to the variation between the desired value of the machining current and its actual value. Providing

that the electrolyte properties are maintained constant, this should ensure constant distance between the electrodes and therefore predictable quality of the produced features. Furthermore, a bespoke made pulse generator is being developed explicitly for this process

### **Findings/Results**

Holes have been successfully drilled in workpieces made of iron and 18NiCr6 alloy. However, the localization of the machining and efficiency of the used current needs further to be improved.

The basic circuitry necessary for the pulse generator has been prototyped and is working as expected. Tuning of the parameters to get a better pulse shape and higher frequencies is ongoing.

### **Conclusion / Discussion**

The above results show that the micro electrochemical technology is a viable technology for producing micro features. The present lack of localization is mainly due to the limitation of the minimum pulse width and of the frequency. Additional problems occur due to the inductance of the cables connecting the electrodes. The minimum pulse width (time ON) achieved so far is 200ns pulses. The results suggest that low inductance cable should be used to connect the pulse generator to the machining cell.

The results from the development of the pulse generator are very encouraging. The present prototype can work at a frequency of 8MHz with a duty cycle of 20%.

### **Future plans / directions**

I am currently on track to complete within the three year time scale.

### **References**

1. Bhattacharyya, B. Doloi, P.S. Sridhar (2001) *Electrochemical micro-machining: new possibilities for micro-manufacturing*, Journal of Material Processing Technology 113 (2001) 301-305
2. Bhattacharyya B., Malapati M., Munda J. (2005) *Experimental study on electrochemical micromachining*, Journal of Materials Processing Technology 169 (2005) 485–492
3. Bhattacharyya B., Malapati M., Munda J. (2007) *Influence of tool vibration on machining performance in electrochemical micro-machining of copper*, International Journal of Machine Tools & Manufacture 47 (2007) 335–342
4. Bhattacharyya B. (2007), *RECENT DEVELOPMENTS IN ELECTROCHEMICAL MICRO MACHINING*
5. Bilgi D. S., Jain V. K., Shekhar R., Kulkarni A. V. (2006) "Hole quality and interelectrode gap dynamics during pulse current electrochemical deep hole drilling", Int J Adv Manuf Technol, DOI 10.1007/s00170-006-0572-9
6. Burkert St., Schulze H.-P., Gmelin Th., Leone M. (2009) "The pulse electrochemical micromachining (PECMM) - Specification of the pulse units -" International Journal of Material Forming (2009), vol. 2, n°1, pp.645-648
7. Cagnon L., Kirchner V., Kock M., Schuster R., Ertl G. (2001) "Electrochemical Micromachining of stainless steel by ultrashort voltage pulses"
8. Kock M., Kirchner V., Schuster R. (2003), *Electrochemical micromachining with ultrashort voltage pulses-a versatile method with lithographical precision*, Electrochimica acta Volume 48, Issues 20-22, 30 September 2003, Pages 3213-3219
9. Kozak J., Rajurkar K. P., Ross R. F. (1991), *Computer simulation of pulse electrochemical machining* , Journal of Material processing Technology, 28 (1991) 149-157
10. Kozak J., Rajurkar K. P. (2000), "Study of dimensional limitation of electro-chemical micro-machining" [http://www.aspe.net/publications/Annual\\_2000/PDF/POSTERS/PROCESS/POLISH/KOZAK.PDF](http://www.aspe.net/publications/Annual_2000/PDF/POSTERS/PROCESS/POLISH/KOZAK.PDF) (Accessed on 22/04/2011)
11. Kozak J., Siems D. W., Chandarana N. A., Malicki S., Salgaocar P. (2004), *Electrochemical machining*, University of Nebraska Lincoln [http://www.home-machine-shop.com/Down-Load/Electrochemical\\_Machining.pdf](http://www.home-machine-shop.com/Down-Load/Electrochemical_Machining.pdf)(Accessed on 1/02/05)
12. Kozak J., Rajurkar Kamlakar P., Makkar Yogesh (2004), "Selected problems of micro-electrochemical machining", Journal of Materials Processing Technology 149 (2004) 426–431
13. Kozak J., Gulbinowicz D., Gulbinowicz Z. (2008) "The Mathematical Modeling and Computer Simulation of Pulse Electrochemical Micromachining" Engineering Letter, 16:4, EL\_16\_4\_14
14. Labib A. W., Keasberry V.J., Atkinson J., H. W. Frost (2011) "Towards next generation electrochemical machining controllers: A fuzzy logic control approach to ECM", Expert Systems with Applications 38 (2011) 7486-7493

# **The Conceptual Design of 3D Miniaturised / Integrated Products as Examined through the Development of a Novel Red Blood Cell / Plasma Separation Device**

*David Topham, David Harrison*

**Keywords:** 3D, Integration, Microsystems, Microfluidics, Medical

## **Introduction**

The EPSRC-funded project 3D-MINTEGRATION suggested that there should be benefits from miniaturisation and integration in 3 dimensions as opposed to the conventional 2D planar “chip” approach.

A real product is needed to demonstrate and quantify the benefits of that concept. There is also a need to explore and test the special issues that may affect designers and design teams in the 3D micro-world, where physical effects differ from everyday experience

This work addresses the above requirements, whilst developing a product concept that can generate societal benefits.

## **Design/Methodology/Approach**

The notion that a 3D miniaturised/integrated approach should be beneficial, is being examined through the design, prototyping and testing of a device for separating plasma from whole blood.

The experiences and observations arising during the course of the conception and development of the device form the backbone of this thesis, which is proceeding in five topic areas:

Topic 1 Conceiving of a mechanistic transform from a 2D diagram of a physical principle to generate a series of 3D instances, from which candidate structures could be selected and assessed according to their operational and manufacturability merits.

Topic 2 The difficulties of conversing about the intangible - increasingly, product designers need to use principles which are beyond human experience (eg, micro-, nano- , quantum etc).

Topic 3 Determining whether there can be realisable benefits associated with designers being more directly connected to underlying physical principles rather than working through expert intermediaries.

Topic 4 Devising and performing hands-on constructional experiments to gain insight into physical properties at the micro- scale through macro-observable effects.

Topic 5 Mapping the issues uncovered onto the standard phases of design from conception through to embodiment, and constructing a checklist of procedures

## **Findings/Results**

Results so far include:

- A target design concept, with calculated dimensions for the critical parts
- The construction and operation of a bench test bed to examine the operation of the critical parts

The bench experiment has yet to yield repeatable results. The reasons for this are thought to be three-fold:

- Forces of unexpected magnitude at the microscale may be distorting critical dimensions in the experimental apparatus
- Flaws reported by Doyeux et al regarding the Zweifach–Fung hypothesis for particle behaviour at a bifurcation in fluid flow, a hypothesis used by myself and many others as a basis for design
- Like other workers, I may be using geometry not representative of the conditions foreseen by the Zweifach–Fung hypothesis

In order to investigate whether other workers have successfully exploited this form of separation, patent searches have been conducted with the following results to date:

- The searches confirmed that the topic of Red Blood Cell / Plasma separation is one of value and interest.
- Further insight was gained into the medical conditions and procedures which should benefit from the technique
- The difficulties of separation are widely described

Few useful examples were found regarding the use of the Zweifach–Fung effect, save for one, by Angeles Ivón Rodriguez Villarreal et al.

### **Discussion / future activity**

The latter patent casts further doubt on the exact nature of the separation process, but its diagrams and photographic evidence add insight into possible improvements in the design of my current experimental apparatus. Accordingly, in support of Topics 1 and 4 on page 1 of this abstract, the experimental approach is ongoing, with refinements to the robustness of the construction and detail changes to the geometry of the fluid channels.

In addition to the experimental work, new activities are planned:

- Deploying a web-based questionnaire to gain evidence and examples of difficulties, activities and successes in the topic areas 2, 3 and 5.
- Organising a practical workshop to explore the issues of topic areas 2, 3 and 5.

### **Timescales**

The work remains as part-time, although in the context of industrial activity in the allied field of Integrated Smart Systems. Thesis submission is planned for September 2013.

### **References**

Spheres in the vicinity of a bifurcation: elucidating the Zweifach–Fung effect, V. DOYEUX, T. PODGORSKI, S. PEAPONAS, M. ISMAIL AND G. COUPIER, Universite Grenoble. J. Fluid Mech. December 2010.

METHOD AND APPARATUS FOR SEPARATING PARTICLES IN A FLUID, Angeles Ivón Rodriguez Villarreal et al. Application number: 12/933,308, Publication number: US 2011/0084033 A1, Filing date: Mar 19, 2009.

## Analysis Dark goals of Electric Power Transmission Company by using a CW Curve

*Chen Wang, Qing-Ping Yang, Kai Chen, Shuxi Wang*

**Keywords:** EPTC, EPTC's strategy

The electricity transmission network controls electricity energy flows, ensuring the equilibrium between electrical of the supply and demand. Since electricity cannot be stored, electricity transmission plays an important role in smart grid strategy. Indeed electric power transmission company (EPTC) plays an essential role. Meanwhile, the targets of top 16 countries of electricity generation (1996-2006) in the world can be achieved based on a sensibly considered chose of the EPTC uniquely and typical examples. This paper identifies lessons from the electrical generation rank changes of global top 16 countries of electricity generation for choosing pertinent EPTC uniquely and typical examples. Therefore, a novel "CW Curve" is proposed. Three countries EPTC examples are proposed. Therefore those EPTC examples will be help to find dark goals by analysis their both the disadvantages and advantages of EPTC regulation strategies for setting up an effective Smart Grid Strategic (SGS).

### **Introduction**

With the rapid growth in energy demand, we have to reflect and devise on strategies to achieve energy demand objectives with increasing environmental protection and improving energy efficiency. Indeed electric power transmission company (EPTC) plays an essential role. Meanwhile, the targets of safeguarding the environment and improving the energy efficiency can be achieved based on a sensibly considered research of the EPTC and implementation of related international energy policies.

Since EPTC is special. We call it a Natural Monopoly sector in electric power market [1]. Firstly, through our research of CW Curve, we are focused on three EPTCs by three countries, including China, South Korea and UK. Those all are the largest EPTC in those countries including National Grid of UK, SGCC of China, KEPCO of South Korea.

UK power market mode is Pool Bilateral Trade. The 37.5% of UK electricity supply produced from gas accounts for approximately 35% of the total gas in 2003 shown in Figure 1. The dominance of natural gas is plain to see, a direct result of its historic cheap plentiful supply, clean burning and a privatized energy market. UK gas originates almost entirely from the North Sea, with a small amount able to be imported through the interconnector with Belgium. The extraction rate from the North Sea peaked in 2000 and has been falling since, production 2003 was 12% down from the peak. This data is from the Department of Trade and Industry.

### *British regulation skills of energy and electrical*

The British regulation skills of energy and electrical also focus on sustainable development and the environment in means of price control. It has shown on the Transmission Price Control as well. The Transmission Price Control Review (TPCR) sets out the incentives part to incentive the electricity transmission companies for reducing Sulfur Hexafluoride SF6's leakage rates, a very powerful greenhouse gas used as an insulating agent in high voltage switchgear, as an assistant skill of the encouragements provided through the EU Emissions Trading Scheme (ETS). In the TRCR, Ofgem also focus on UK's future of other key environmental impacts related with the transmission networks operation. For example, environmental impacts of losses, noise and visual amenity and so on. Moreover, the TPCR

also sets up related term about environmental impacts of under-grounding of electricity transmission lines [2].

#### *Chinese regulation skills Energy and electrical*

The major legal mechanism is the Electricity law, passed in 1995, which was the electricity sector was controlled by governmental fiat. In March 1998, China government issued a “reorganization of regulatory agencies and the restructuring of state owned companies”. In this part, Chinese government’s main idea to build a streamline, simplify and further centralize the tools of control in the energy industry. The next structural reforms followed in 2002, with the set out of the State Electricity Regulatory commission (SERC), and extra governmental restructurings were set up during 2003 and 2004. It was announced in February 2005. Figure 2 below shows China energy regulatory framework and E&C Regulation Framework. In adding to this, Premier of the State Council, Wen Jiabao announced the Regulations on Electricity Regulation in February 15, 2005[3]. Moreover, the Regulations on Electricity Supervision and Control was announced in February 25, 2005. Therefore, the two policies have shown China’s the majority work so far to build a competitive energy market. [4]

### **Conclusion**

Therefore, Sate Grid Corporation of China, KEPCO, National Grid, those three EPTCs will be investigated and analyzed in the future study, and then an effective SMS will be proposed in the future work.

### **Acknowledgments**

I am indebted to all the people who have provided support, guidance and friendship during the course of my research. In particular, I would like to thank my supervisors, Dr Qing-Ping Yang, Prof. Kai Chen for their great knowledge and indispensable guidance throughout this paper.

All the members in Brunel deserve my heartfelt expression of thanks for their generous help, fruitful discussion, and delightful cooperation.

Finally, I want to express my deep-felt appreciation to my family for their loving support and encouragement during the period of my studying.

### **References**

- [1] Chen Wang, Qing-ping Yang and Yong-Hua Song, “Power Crises Study for Restructuring China’s Energy Regulation Using Equilibrium Theory” in World Congress on Engineering and Computer Science 2010, San Francisco, USA 20-22,2010, pp. 889–893.
- [2] The International Energy Agency (IEA), “Energy Statistics and Energy Balances”, Full detailed time series are available from 1960 to 2003 for most OECD countries and from 1971 to 2003 for all other countries.
- [3] F.Q.Shi, “Analysis of China’s Elasticity Ratio of Energy Consumption. China Center for National Accounting and Economic Growth”, Peking University. 2005, pp.8.
- [4] Hui Ren, University of Wisconsin-Madison, North China Electric Power University, “Electric Power Industry in China”, Feb. 6, 2007.



# **Civil Engineering Abstracts**

**Organizing Committee**

**John Bull  
Nihad Salih**

## Stability of Dams Constructed on Problematic Substrates

*Nihad Salih, Philip Collins*

**Keywords:** Gypsum rocks, artificial gypseous soils, Mosul dam, gypsum rock fissures, artificial gypseous soils, four-point bending

### Introduction

Gypsum bearing rocks, which are highly dissolvable, cover approximately seven million square kilometres of the globe; that is more than 20 percent of the ground surface. Gypsum-rich substrates are undesirable from an engineering geology perspective, especially when they occur under hydraulic structures [3, 4, 7, and 8]. Water flow through gypsum, causes narrow fissures and fractures to enlarge by chemical dissolution. This enlargement can be enhanced by high hydraulic gradients near and immediately downstream of dam sites [5, 9]. Also, seepage through gypsum rocks in a dam's foundations can create larger cavities [8]. The research described in this paper, examines the stability issues of dams built on gypsum-rich substrates in Mosul, Northern Iraq and other areas. The research will provide: a) a novel database of knowledge through the study of long-term changes in the mechanical properties of gypsum as a result of dissolution; achieved though simulation of real-world conditions in terms of applied load and groundwater influences over the short and long term; b) a comparison between Iraqi and UK gypsum rocks' mechanical properties - this provides an insight into how subtle changes in composition and structure affect rock response to dissolution and loading; c) an understanding of gypseous soil response to dissolution and loading, using artificially-prepared gypseous soils based on real Iraqi material.

### Methodology

This research involves field and laboratory work. Field work includes gypsum rock collection from Iraq and the UK, with laboratory work of long term and short term experiments. For the experiments, gypsum rock samples were prepared as follows: cylinders (54 mm in diameter and 135 mm in length) [1,2], thin layers (54 mm in diameter and 20 mm in height) and two sizes of four-point bending beams (240 x 40 x 20) mm and (140 x 40 x 20) mm. A modified oedometer apparatus was developed to collect data under atmospheric and 5.0 bar water pressure conditions, similar to those conditions that occur beneath the Mosul Dam. Artificial gypseous soils were prepared similar to the real samples collected from Iraq. These artificial soils were loaded under saturated conditions over a long period of time. The water used for the experiments was changed every seven days, with conductivity and pH readings being recorded at each change.

### Findings

The results show that the Iraqi and the UK rock samples exhibit general similarities in terms of composition, structure, solubility and mechanical properties. However, some notable differences in mechanical response were recorded and correlated with subtle differences in the characteristics of the rocks. The failure load increased with increased clay and marl content of the gypsum rock fissures. Pink gypsum, reflecting the presence of Mg, Al, Si, S, Ca, Pb and O, is stronger than white in both the thick layer and thin layer conditions. Confinement of the thin-layer gypsum rock samples increases instantaneous strain and decreases gypsum dissolution. In contrast, an increase in water pressure increases gypsum dissolution.

## Conclusion

A range of robust methods have been developed to provide high quality data. Stability problems associated with gypsum under dams can develop over different time periods and can reflect subtle differences in the characteristics of the gypsum. While, the context of the research is provided by the Mosul Dam in Iraq, the findings can be applied to other sites.

## Future Plan

Experimental work is nearing completion and is being written up. The thesis will be submitted within the three year period.

## References

1. ASTM 2010, *Standard Test Method Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures*. ASTM Standards D7012-10; (Approved 15/01/2010).
2. Bieniawski Z.T., Franklin J.A., Bernede M.J., Duffaut P., Rummel F., Horibe T., Broch E., Rodrigues E., Van Heerden W. L., Vogler U.W., Hansagi I., Szlavin J., Brady B.T., Deere D.U., Haweks I., Milovanovic D. 1978. *Suggested Methods for Determining the Uniaxial Compressive Strength and Deformability of Rock Materials*. International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts, **16 (2)**, 135-140.
3. Cooper A. H. and Saunders J. M. 2002. *Road and Bridge Construction across Gypsum Karst in England*. Engineering Geology, **65**, 217-223.
4. Dreybrodt W., Romanov D. and Gabrovsek F. 2002. *Karstification below Dam Sites: a Model of Increasing Leakage from Reservoirs*. Environmental Geology, **42**, 518-524.
5. Fengxianga C. and Mingjiang W. 1983. *Investigation of the Engineering Properties of a Dam Foundation Containing Gypsum Seams*. Technical Note, Rock Mechanics and Rock Engineering **16**, 275-280.
6. Inspection of Mosul Dam (formerly Saddam Dam), Tigris River, Iraq 2003. Internet URL: [www.envirozan.info/EZ\\_Docs/Dams/Mosul\\_Dam.pdf](http://www.envirozan.info/EZ_Docs/Dams/Mosul_Dam.pdf), downloaded 30-11-2011.
7. James A.N. and Kirkpatrick I.M. 1980. *Design of Foundations of Dams Containing Soluble Rocks and Soils*. Q. J. Eng. Geol. London, **13**, 189-198.
8. Maksimovich N.G. and Sergeev V.I., 1984. Effect of Chemical Injection Stabilization on Gypsum Stability in the Foundation of Hydraulic Structures. Translated from Gidrotekhnicheskoe Stroitel'stvo, **7**, 30-32.
9. Romanov D., Gabrovsek F. and Dreybrodt W., 2003. *Dam Sites in Soluble Rocks: a Model of Increasing Leakage by Dissolution Widening of Fractures beneath a Dam*. Engineering Geology, **70**, 17-35, 2003.

## Development of Sawdust-Crete Using Wood Waste And Low Cost Inorganic Binders

*Eboziegbe Patrick Aigbomian, Mizi Fan*

**Keywords:** Sustainable development Traditional Lime, Sawdust-Crete, Affordable Housing, Materials

### Introduction

Construction industries rely heavily on conventional materials such as cement, granite and sand for the production of concrete. The high and increasing cost of these materials has greatly hindered the development of shelter and other infrastructural facilities in developing countries. There arises the need for engineering consideration of the use of cheaper and locally available materials to meet desired needs, enhance self-efficiency, and lead to an overall reduction in construction cost for sustainable development.

The objective of this study was to investigate the feasibility of making sawdust-wastepaper-lime and sawdust-wastepaper-cement composites with the aim of producing sustainable panel (Sawdust-Crete) which is lightweight, with good insulating properties and able to withstand considerable amount of impact load.

### Experiment

A number of samples consisting of various proportions of sawdust, lime, cement and wastepaper were prepared. A total of 42 samples were made based on volume ratios of sawdust to lime and sawdust to cement (1:2 and 1:1 respectively). Some samples were made with both Traditional lime and cement together while some samples were mixed with paraleg (DSM) resin. This was done in order to investigate bonding strength of bricks made with a view to improving on sawdust-lime and sawdust-cement bonding for better strength properties. Mass was measured with the use of a weighing balance and density was thus derived from mass and volume of block samples. Composites were tested for compressive strength with the use of a universal machine (Instron compression test machine) as they cracked due to compression.

### Results

Highest mean compressive strength value achieved was 0.8MPa for 100 x 100 x 100 mm composites made of sawdust-lime ratio of 1:2 with 75% wastepaper of sawdust. Lowest mean compressive strength achieved was 0.06MPa for 100 x 100 x 100 mm composites with blocks made of sawdust-cement ratio of 1:2.

As blocks were not destroyed at 40 percent failure, they continued to support considerable amount of load even after initial failure. Composite block were also tested for their insulating properties with C-Therm thermal conductivity analyser. Thermal conductivity values ranged from 0.046 – 0.07 k (W/mK) which shows a possible use of Sawdust-Crete as insulating materials when compared with the values of polyurethane foam and wood which are 0.02 and 0.09 – 0.04 respectively. Composite blocks were found to be unfit for load bearing wall construction and medium heavy load wall construction as a result of poor compressive strength. Owing to the nature of lightweight of composites, Sawdust-Crete with the addition of embellished wall finishes can be used for interior wall panelling requiring no considerable amount of structural performance.

## **Conclusion**

It was observed that mix workability decreased significantly as the proportion by weight of waste paper and sawdust increased. Strength and dimensional stability of samples decreased with decrease in percentage proportion of waste paper. Higher proportions of waste paper showed significant reduction in density of samples.

## **Future work**

Major work necessary for the completion of my work includes:

- ❖ Improving the strength of composite blocks made
- ❖ Designing of a system
- ❖ Mechanical tests on composite blocks for structural application
- ❖ Life cycle analysis of composite blocks

## **References**

1. Arnaud, L. & Cerezo, V. (2001). Physical Evaluation of Construction Materials Based On Hemp. Ph.D. Thesis.
2. Avén, S. (Ed.) (1984). Handbook Build - Materials, Products and Work Technique. Liberförlag, Stockholm.
3. Blankenhor, P.R. (1994). "Compressive strength of wood cement composites", Forest products Journal,.44, 56-64.
4. Holmes, N. (1976), "Environment and the industrial society". Holder and Stoughton Publishers, Great Britain, pp 169-180.
5. Wei Y. M .and Tomita B. (2000). Effects of five additive materials on mechanical and dimensional properties of wood cement bonded boards. Journal of Wood Science. 47; 437-444.
6. Wolfe R. and Gjinolli A.E, (1996 ). Assessment of Cement-Bonded Wood Composites as a Means of Using Low-Valued Wood for Engineered Applications. International Wood Engineering Conference 1996. USDA Forest Service, Forest Products Laboratory, USA.
7. A.Zziwa, S. Kizito, A. Y. Banana, J. R. S. Kaboggoza, R. K. Kambugu and O. E. Sseremba, (2006) Production of composite bricks from sawdust using Portland cement as a binder.

## Assessing cracking in early-age concrete due to restrained shrinkage with Elliptical ring specimens

Olayinka Oladiran, Xiangming Zhou

**Keywords:** Restrained, shrinkage, concrete, early-age, cracking

### Introduction

The complexities of early-age cracking of concrete and other cement-based materials are yet to be fully understood. Over the years, cracking has led to premature deterioration, which effectively shortens the service life of concrete structures and presents a potential hazard. In light of this, the role of concrete shrinkage as it affects this serviceability behavior (cracking) should not be neglected. Concrete shrinks when it is subjected to a drying environment particularly at early ages. Consequently, if concrete is restrained from shrinking freely to a certain extent, tensile stresses will develop and concrete may crack in view of the fact that concrete has a low tensile strength especially at early ages. Nevertheless, the extent of shrinkage is indeed the driving force for early-ages cracking of concrete, but whether cracking will occur or not is also dependent on the restraint in the structure and the stress relaxation, which may be particularly high in early-age concrete<sup>[1]</sup>. This undesirable phenomenon undoubtedly reduces the load carrying capacity of concrete members and indeed accelerates deterioration hence yielding premature failure. Over the years, a number of test procedures have been developed to assess how susceptible a given concrete mixture may be to cracking. Although free shrinkage measurements are useful in comparing different mix proportions, they do not provide sufficient information to determine how concrete will crack in service<sup>[2]</sup>. Rather, cracking tendency of concrete has been mainly evaluated under restrained conditions by qualitative means through a variety of cracking tests, such as the ring, the beam, and the plate tests, among which the circular ring test has been used for assessing cracking tendency of mortar and concrete for decades due to its simplicity and versatility<sup>[3]</sup>. However, the circular ring test has a low degree of restraint, resulting in a fairly long time before the first visible crack is observed<sup>[1][4]</sup>. In a bid to overcome the problems from traditional circular ring tests, He and Colleagues<sup>[5]</sup> proposed a modified ring test by using elliptical shaped specimens to increase stress intensity in concrete to promote crack generation and propagation in concrete. Because of this, characterising cracking sensitivity of concrete can be achieved in a short period so that the new elliptical ring test is appropriate for faster and large amount of materials evaluation. This paper investigated how the elliptical ring specimen can provide information for a simple geometry to enable an improved understanding of early age cracking of concrete.

### Approach

The circular and elliptical ring specimens for restrained shrinkage tests were cast around a solid structural steel ring. The ring series were sealed at the top and bottom surface with an aluminum foil and a plastic thin film while the ring was permitted to dry from the circumference after the framework had been removed. The setup typically comprises of structural steel, strain gauges attached to the inner surface of the steel rings on points at mid-height equidistant to each other, an environmental chamber and a data acquisition system such as a desktop computer running suitable data analysis software. Cracking in restrained concrete ring specimens was monitored via output data generated by the data logger and observed continuously until crack occurs, starting from day (0); ring specimens were demoulded and then moved into the environment chamber till crack was initiated and subsequent propagation ensued.

## Results

Most cracked specimens occurred at similar positions on the elliptical ring geometry along the long principal axis an area central of the specimen geometry, although the crack position of some specimens appeared closer to the minor axis which is considered to be more sensitive or/and stiff. Though it is expected that the elliptical rings will crack earlier than circular rings due to stress concentration caused by elliptical geometry, experimental results obtained herein showed circular rings cracked earlier than the elliptical rings.

## Conclusion

- The positions where initial cracks appeared on the elliptical rings specimens suggests that, crack propagation will appear at particular positions, due to the stiffness provided by the ring geometry and non-uniform stresses experienced as a result of restraint provided.
- The experimental results so far suggest that specimens placed under controlled temperature and relative humidity cracked earlier than specimens under fluctuating environmental conditions. Therefore placing specimens under a controlled environment is essential for running tests in the future.

## Future plans

Numerical analysis using FEA application is already been used for simulating the behavior of concrete under restrained shrinkage and will be subsequently calibrated by experimental results already obtained. The numerical model will take into account the effects of heat release in concrete elliptical ring due to cement hydration, drying and heat release to ambient air from the exposed surfaces of the elliptical ring, heat conduction between concrete ring and the steel core, restraint from the central steel core and development of strengths, stiffness and fracture resistance of concrete with time.

## References

- [1] A. Bentur, and K. Kovler (2003), "Evaluation of Early Age Cracking Characteristics in Cementitious Systems," *Mater. Struct.*, 36(3), pp 183-190.
- [2] S.P. Shah, W.J. Weiss, and W.Yang (1998), "Shrinkage Cracking – Can It Be Prevented?" *Concr. Int.*, 20(4), pp 51-55.
- [3] J.M. Moon, and J. Weiss (2006), "Estimating Residual Stress in the Restrained Ring Test under Circumferential Drying," *Cem. Concr. Comp.*, 28(5), pp 486-496
- [4] J-H Moon, F. Rajabipour, B. Pease, and J.W. Weiss (2006), "Quantifying the Influence of Specimen Geometry on the Results of the Restrained Ring Test," *J. ASTM Int.*, 3(8), pp 1-14.
- [5] Z. He, X.M. Zhou, and Z.J. Li (2004), "New Experimental Method for Studying Early-Age Cracking of Cement-Based Materials," *ACI Mater. J.*, 101(1), pp 50-56.

## Modelling of steel connections at elevated temperatures

Shuyuan Lin, Zhaohui Huang, Mizi Fan

**Keywords:** Beam-to-column connection, Component-based model, Fire, Steel Structures

### Introduction

Structural engineers and architects have a responsibility for incorporating fire safety into their building designs in order to minimize loss of life and property. One aspect of this is to ensure that structural stability is maintained if a fire develops. For last two decades, extensive research has been carried out on the behaviour of steel-framed buildings under fire conditions. It is well known that robustness of steel connection is vital important to the fire resistance of steel-framed composite buildings. The development of effective connection models is a key issue in this research field. Hence, the main objective of this PhD project is to develop a robust 2-noded connection element for modelling the connections between steel beam and column at elevated temperatures. The model developed in this research will be implemented into the program *Vulcan* developed by primary supervisor for 3D modelling of steel-framed composite buildings in fire. After the new development, a series of comprehensive parametric studies will be conducted to deeply understand the influence of the connection on the fire resistance of steel and composite structures. Based on the results achieved in this research some constructive design recommendations will be proposed.

During the first year, the behaviour of bolted end-plate connection between steel beam and column at elevated temperature was thoroughly investigated and a robust 2-noded connection element for modelling flush and extended end-plate connections has been developed. The model is the further development of the connection element proposed by Huang<sup>[1]</sup>. In Huang's model, the resistances of tension and compression for the end-plate connection are found to be conservative compared to the test results. This is because that Huang's models are based on the formulas proposed in Eurocode 3 Part 1.8<sup>[2]</sup> with the extension to fire. Hence, in this research a robust model was developed for more accurately predicting the tension and compression resistances of end-plate connections under fire conditions. In this model the connection failure due to bending, axial tension and compression, shear is considered. Also the influence of the axial force of the connected beam on the connection has been taken into account. The new developments were incorporated into Huang's two-noded connection element for predicting the behaviour of end-plate connections at elevated temperatures.

### Methodology

In this research a ‘component-based’ method has been adopted to analyse the behaviour of components in tension and compression zones within the end-plate connections. The connection is regarded as a set of individual basic components. For the tension zone, the starting point of the research is based on the model developed by Spyrou<sup>[3]</sup>. The connections are represented using equivalent T-stub models. The three failure mechanisms of the T-stub are also considered in the model. Based on more than 40 T-stub tests at elevated temperatures conducted by previous researchers, three displacement criteria are proposed for three failure modes in order to capture the tension resistance of individual bolt row with high accuracy. For each failure mode, the tension resistance of T-stub has multi-linear relationship with the applied displacement criteria. The final tension resistance of an individual bolt row is taken as the minimum value of tension resistance of three failure modes.

For the compression zone, the final compression resistance of an individual connection is taken as the smaller value of the resistances of column web and beam flange. The model is the further developments of Block's model<sup>[4]</sup> and the Eurocode 3 Part 1.8<sup>[2]</sup>. The moment-rotation

relationship of an end-plate connection is determined from the tension resistance of each bolt row and compression resistance of the connection. Also tension, compression and shear capacities of the connection are calculated in the proposed model.

## **Results**

For validation of the new 2-noded connection model a total of 22 end-plate connection tests has been used. The validation includes 8 connection fire tests without the axial force, 12 tests subjected to axial force at both ambient and elevated temperatures and 2 fire tests on the beam-to-column sub-frame. The comparison results show that the predictions provided by this new model match well with the experimental data.

## **Conclusions**

In this study a new connection model is developed for accurately predicting the behaviour of the end-plate connections at elevated temperatures. In the model the connection failure due to bending, shear, axial tension and compression are considered. Also the influence of the axial force of the connected beam on the connection's behaviour is taken into account. This model is very computationally effective and can be applied to whole building modelling in the real structural fire engineering design.

## **Future Plans**

The next phase of the research will be mainly focused on the developments of connection models for simulating the behaviour of partial end-plate and fin plate connections in fire. Those connections will be represented as two-noded connection elements. The main challenge of the research is to develop a proper procedure for determining the moment-rotation curve of the connection based the tension and compression of individual bolt row. After those developments, comprehensive parametric studies will be conducted to assess the influence of connection robustness on the fire resistance of steel and composite structures. Based on this study some constructive design recommendations will be proposed.

## **References**

- [1] Huang, Z. A connection element for modelling end-plate connections in fire. *Journal of Constructional Steel Research*, 2011; 67(5): pp.841-853.
- [2] European Committee for Standardization CEN. *Design of steel structures, Part 1.8: Design of joints. EN 1993-1-8*, Eurocode 3, Brussels 2005.
- [3] Spyrou, S., Davison J., Burgess I.W., Plank RJ. Experimental and analytical investigation of the “tension zone” component within a steel joint at elevated temperatures. *Journal of Constructional Steel Research* 2004; 60(6): 867–896.
- [4] Block, F.M., Burgess, I.W., Davison, J.B. and Plank, R.J., A Component approach to modelling steelwork connections in fire: behaviour of column webs in compression. In: *Proceedings of the ASCE Structures Congress*, Nashville, 2004.

## Fire resistance characterization and modeling of natural fiber reinforced polymer composites

Alexander Naughton, Mizi Fan

**Keywords:** Fire resistance, natural fibers, polymers, composites

### Introduction

One of the many factors impeding the adoption of innovative sustainable materials such as natural fibre reinforced polymers (NFRP) into the construction industry is the strict fire regulations for construction materials. A fire rating is required for a construction material in order to ensure it can maintain the structural integrity of a building for a prescribed period of time (BSI, 1987). BS 476 dictates the appropriate standard full-scale fire test for construction materials. The standard full-scale fire test is restrictive to research as it is expensive, time consuming and provides only pass/ fail information. Research and development of materials with respect to fire is more commonly associated with reaction to fire tests which cannot provide information to predict performance in a full-scale fire resistance test.

This research program has developed a bench scale test methodology to characterize and model the fire resistance of innovative composite materials thereby providing a bridge between fire reaction and fire resistance research. It is hoped that the method can be used to provide the research and development of materials with a powerful cost saving tool to predict the performance of innovative materials with respect to full-scale fire resistance tests. The methodology has been used to characterize and model the fire resistance of hemp fibre reinforced polyester composites, contributing to the scientific knowledge of NFRPs exposed to fire and high temperatures.

### Approach

This research program has been conducted at the Building Research Establishment (BRE) Watford. It is based on a four stage test methodology designed to provide complimentary data to characterize and model the fire resistance of NFRP materials: a bench scale fire test method, oven testing at relatively low temperatures, tensile tests at ambient temperatures and microscopic analysis of fire damaged materials.

The bench scale fire test method is known as ‘the reduced cone calorimeter’ as it is based on a reduced version of the cone calorimeter test (Bregulla, 2003). The ‘reduced cone calorimeter’ ignores reaction to fire data in deference to physical data obtained by changing the boundary conditions of the test and measuring the transition of heat with respect to time and depth (Bregulla, 2003). By changing the boundary conditions, controlling the exposure time and applying a constant heat flux of 25 kW/m<sup>2</sup>, samples are only partially destroyed and are available for further microscopic analysis and mechanical testing allowing physical phenomena to be categorically related to the temperature/time curve through the depth of the sample. Residual tensile strength is measured by subjecting damaged and undamaged material to tensile tests (BSI, 2012). The oven tests analyze the effect of specific constant temperature on the degradation of material and mechanical properties. Char depth and degradation characteristics are then analyzed microscopically. Non-woven hemp fibre reinforced polyester has been chosen as a representative NFRP material. The experimental program is based on a fractional factorial experimental design in order to statistically analyze the effect and interaction of various material and environmental parameters. The parameters chosen for this study are fibre volume fraction ( $V_f$ ), void content ( $V_v$ ), matrix volume fraction ( $V_m$ ), density ( $\rho$ ), thickness ( $h$ ) and exposure time.

## Findings

Mechanisms for thermal degradation occur in distinct stages associated with material properties.

The dominant material parameters for thermal resistance are density ( $\rho$ ) and thickness ( $h$ ) (Babrauskas, 2005). With a reduction in  $h$  there is a reduction in thermal resistance and an increase in the rate of thermal degradation. With an increase in fibre volume fraction ( $V_f$ ) there is an increase in char depth ( $h_{char}$ ) which can help insulate against thermal degradation (Beyler and Hirschler, 2002).  $V_f$  is the dominant factor with regard to residual tensile strength ( $\sigma_r$ ) of fire damaged material. Thermal degradation alters the failure mode of tensile samples which become more brittle with increasing temperature. With an increase in temperature from the glass transition temperature ( $T_g$ ) to char temperature ( $T_{char}$ ) there is an exponential decrease in tensile strength. The reduction in tensile strength with respect to temperature has been modeled. Delamination between layers of hemp fibre mats has been observed. The voids created by delamination prevent the propagation of thermal damage and alter crack propagation in tensile tests.

## Discussion

The mechanisms for thermal degradation and the failure modes of fire damaged tensile samples have been characterized. A model has been developed to calculate  $\sigma_r$  for fire damaged material. The model is a definite integral that is based on experimentally derived functions for  $\sigma_r$  with respect to temperature ( $\sigma_r(T)$ ), temperature ( $T$ ) with respect to depth ( $T(h)$ ) and a calculation of  $h_{char}$  with respect to  $T(h)$ . The model has been verified with experimental results and an error of below 10% has been found. The efficacy of the model suggests that the test method can provide adequate data to characterize and model the fire resistance of NFRPs. It also suggests that the method can be used to derive models for a variety of other composite materials.

## Directions

At the end of the 3 year term of this PhD in June 2012 it is hoped that refinements and additions to the model can be made, two papers can be completed for publication and a first draft of the thesis completed.

## References

- Babrauskas, V. (2005) "Charring rate of wood as a tool for fire investigations", *Fire Safety Journal*, vol. 40, no. 6, pp. 528-554.
- Beyler, C.L. and Hirschler, M.M. (2002) "Thermal decomposition of polymers" in *SFPE Handbook of fire protection engineering* NFPA, Quincy.
- Bregulla, J. (2003) *Investigation into the fire and racking behaviour of structural sandwich panel walls*, University of Surrey.
- BSI (2012) *BS EN ISO 527-1:2012 Plastics. Determination of tensile properties. General principles*, BSI.
- BSI (1987) *BS 476-20:1987. Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)*, BSI.

## **An Investigation into the Provision of Low-Cost Housing**

*Ghadeer Alfandi, Nuhu Braimah*

**Keywords:** Low-Cost, Cost overrun, Time overruns, Housing, Government, Kuwait

### **Introduction**

Housing considered as a global need affecting people and play significant role in economic development and advancement in both developed and developing countries. Housing provision has become a major problem facing the Kuwaiti Government. Residential houses in Kuwait are known to be expensive compared with other countries in the region. Efforts for finding ways and methods to avoid the cost overrun and time delay of houses will significantly affect the residents and national expenditures of the construction sector, but there are still limitations associated with those conventional methods. Ramadhan (2011) examined the role of the government in providing housing care in Kuwait and he concluded that the applicants waiting period should be reduced in an orderly manner with providing alternatives of less costly housing.

Delay and cost overrun are considered as a risky problem encountered in construction projects. This research aims to develop a decision support system that will guide decision makers in the best way to lower the cost of housing while ensuring suitable time in delivery of housing projects. The specific objectives include: (1) Identify the most significant causes/reasons affecting time schedule and cost overrun; (2) Develop a decision support system by using the significant factors to quantify and assess the impact of reasons on time and cost of the project; (3) Present mitigation and treatment method to reduce the negative impact of time and cost overrun causes in housing project in Kuwait.

### **Methodology**

These objectives will be achieved by reviewing relevant literature research, conducting interviews with experts in Kuwaiti housing sector.

### **Findings/Results**

My plans to collect data are expected in the middle of 2012, and the conclusion is expected to be in the beginning of the 2013.

**References**

- [1] Ramadhan, M., Al-Musallam, M., Nasseb, A. (2011) .The Public Housing Program in Kuwait: An Assessment of Financial Constraints and Future Challenges. Journal of the Gulf and Arabian Peninsula Studies, 37(142), July 2011.

# The impact of procurement method on construction project performance in Libya

*Alaeedin Ghadamsi, Nuhu Braimah*

**Key words:** Traditional Procurement Method, Design & build Procurement Method, Selection Procurement Criteria, Project Performance Criteria

## Introduction

Project procurement has been described as an organized methods or processes and procedures used by clients to obtain or acquire construction products. The selection and use of an appropriate procurement method is considered one of the most significant parameters that lead to success of projects. Today, there are a number of different types of construction procurement in use but each type (traditional, design and build, construction management, etc.) has a great influence on project performance in terms of time, cost and quality [1][2].

In last few decades, a large number of construction projects in Libya representing more than 70% of the country's projects have suffered from severe cost and time overruns. Literature suggests that one of the most important reasons for this poor performance relates to the use of inappropriate construction procurement methods by project clients. The literature also suggests that more than 95% of the country's projects were delivered by traditional methods. The lack of client's knowledge and experience with the new types of construction procurement consider the main reason that make projects clients in Libya prefer using traditional procurement type [3]. As a contribution to finding solution to this problem, this research seeks to investigate the impact of construction procurement methods on project performance towards developing a model that demonstrates the relationship between procurement selection criteria and project success factors.

The rest of the paper is structured as follows. First, proposed methodology for undertaking the study. This is then followed by results and analysis. The final section of the paper presents conclusion.

## Methodology

The proposed methodology for undertaking the research mainly involves three steps. Firstly is undertaking an intensive review on construction procurement methods and their selection criteria and Project performance criteria. Second step involves collecting data, under two stages. The first stage is preliminary survey which sought to find out the most commonly used procurement methods in Libya. Questionnaire technique and telephone interview was used to collect this data.

The second stage is the main survey. This stage seeks to gather information on how the popular procurement methods as obtained by stage 1 effect project performance in terms of time, cost and quality. Questionnaire technique was used to collect this data. The questionnaire was originally designed in English and later translated into Arabic, the mother tongue of the participants in order to ensure the full understanding of the questions.

A total of 200 questionnaires were handed out personally to the construction organizations working as clients, contractors and consultants in Libya. Only 125 questionnaires were received. Registered contact persons in those organizations were the first approached by email or telephone in order to ask them if they or other more suitable persons in their organizations were willing to participate in the study. Hence, it was up to the contact person to choose the most suitable respondents given. The third step involves analysis of date.

Data collected will be analysed statistically using descriptive statistics, correlation and regression analysis.

## **Results**

The results showed that there are 22 criteria considered the main criteria for selection of construction procurement method. Some of them are appropriate for traditional method while the others are suitable for design and build method. The criteria of price competition, scope definition, quality level, client involvement, controllable variation, and allocation of responsibility, functionality, planning and designing time, cost certainty, time certainty and managing and organizing project are suitable for traditional procurement method. However, the criteria of flexibility of changes, Quick delivery of construction processes, Quick of project commencement, effective communication, Single point of responsibility, Risk transfer, reducing project time, Reducing project cost, Working relationship, contractor's experience and efficiency and less conflict are appropriate for design and build procurement method.

The results also showed that the main criteria of measuring and evaluating project performance are time cost and quality. It also demonstrated that more than 95% of Libyan constructions projects are procured by traditional method while around 5% of them are procured by design and build method. The results of the main survey analysis expected in the end of July.

## **Conclusion**

Construction projects in Libya have suffered from cost and time overruns in last few decades. The main reasons for these problems relate to the use of inappropriate construction procurement methods by project clients. An initial field survey comprising semi-structured telephone interviews and questionnaires to find out the most appropriate construction procurement methods in Libya have been conducted. The survey covered clients and contractors. It was found that more than 95% of Libyan construction projects were delivered by traditional procurement method. However, around 5% were delivered by design and build method. The results analysis of the main survey expected in the end of July 2012 however, the discussion in the end of October 2012.

## **References**

- [1] Alhazmi, T. and McCaffer, R. (2000) "Project procurement system selection model", *Journal of Construction Engineering and Management*, vol. 126, no. 3, pp. 176-184.
- [2] Abdul Rashid, R., Mat Taib, I., Wan Ahmad, W.B., Nasid, M.A., Wan Ali, W.N. and Zainordin, Z. M (2006) "Effect of procurement systems on the performance of construction projects", *Padang*, pp. 1.
- [3] Libya, PPA (Public project authority) (2009). The Annual monitoring and follow-up report of Libyan construction projects.



# **Design Abstracts**

## **Organizing Committee**

Hua Dong  
Koogin Han  
Rafael Mello  
Yu-Han Wang

## Design management applications to improve female academics' work environment

*Nouf Al Nassar*

**Keywords:** Design strategy, design research, ergonomics, female academics, work environment and its improvement

### Introduction

In today's world, higher education institutes face same level of competition to survive and grow as profit making businesses. Unlike businesses, the universities have major aims of creating intellectual capital and disseminating knowledge to students which requires high quality environments for both academics and students. This ultimately results into university managing services to two of their most important customers: students and academics (Rees and Porter, 2009). This is the scenario wherein design management can bridge the gap between customer demands and universities' ability to provide an appropriate work environment for teaching, learning and research (Hutton, 2009). Design management can give form to ideas (Sharma and Poole, 2010); help to achieve organizational goals as successful outcomes (Best, 2006).

### Purpose and Context

This study has its research context defined by the boundaries of theoretical perspectives in design management and ergonomics whilst analyzing their application in universities. The sample is drawn from the universities within Saudi Arabia, UK and USA which aims to provide the comparison and benchmark for designing world class universities. This would also foster the credibility to create a design of better work environments to female academics. The study aims to be context driven design strategy study which describes and explores the philosophy of design studies using soft system and hard system thinking. Within these contextual boundaries of design management to ergonomics of work environment, the purpose of this research study is to develop design management strategies and a model to utilize for improving work environment of female academics in Saudi Arabia. This will facilitate to find out how universities can be designed to meet the needs and demands of female academics. The study involves the main case of university from Saudi Arabia so as to study and analyze the design management aimed at improving work environments for female academics whereas comparative analyses from two global and high ranking universities selected. Though rapidly expanding, institutes exclusively for females are comparatively less in number and lack the design management. For example, two of the frontline organizations, King Saud University and Princess Nora University are currently building their campuses for women. Therefore, a study focused on the design of this particular segment would be both useful and of academic interest.

### Literature links and research problem

The ongoing literature analyses suggest that females have different work place demands compared to males (Kaplan, 1993). Owing to this gender gap, many women have to settle for less at work (Corby and Stanworth, 2009); females are well represented in service sectors such as library (Cornelius and Skinner, 2008) however researchers have claimed that there is the need of better work places design and overall environments for females (Hadfield and Sen, 2009; Myerson, 2010; Soltani et al, 2010). Also, there is a tendency to underplay or disregard the value that proper design can create for women (Bellard and Koskela, 1998). The literature

review has been divided into mainly analyses of university design models, physical and cognitive issues of work environment, ergonomics in the work place and factors affecting female academics work environments at universities. Major factors identified are ergonomics – design issues; gender and cultural issues; management – job satisfaction and empowerment issues; administrative issues and CATWOE relationships within the stakeholders.

Therefore, the aim emerging from the above mentioned literature and research problem is 'to formulate a design management strategy and its application to improve the work place for female academics'. Meeting this aim would require to review design research, design management concepts; to improvement such as physical and cognitive factors and ergonomics using design management techniques and tools; and to determine the needs and preferences of female academics in the work place from case studies of Saudi Arabia.

### **Design/Methodology/Approach**

The study ultimately aims to formulate a design management model suited to female university in Saudi Arabia. The course of action that leads us to determining such a model would be divided into two principal phases; philosophy and strategy. The philosophy aspect of the research would rely on how the information is received through the primary research conducted for this study and analysed to interpret how the university design can be improved or altered to better facilitate the female population. The proposed research design in three phases includes: focus groups of female academics to study issues of concern and to review design solutions; photo audit, archival documents and observations analyses; and final phase of interviews and questionnaires of female academics to test the applicability of the proposed design model.

### **Conclusion**

This study would aim to contribute by analyzing and presenting a relatively lesser explored aspect of design management that is customized design for women in the Arabian higher education industry. Primary and secondary data would be collected and interpreted to understand and lay out the principle dimensions of design in these universities. The study attempts to formulate a strategy proposing a design model which takes into account the finer details when catering to a predominantly female population in the organization. The study also provides a starting point for further research to dig deeper into the design management strategies in the distinct scenario of the Saudi Arabian region.

### **References**

- Bellard and Koskela, 1998; Best, 2006; Corby and Stanworth, 2009; Cornelius and Skinner, 2008  
Hadfield and Sen, 2009; Hutton, 2009; Kaplan, 1993; Myerson, 2010; Rees and Porter, 2009;  
Soltani et al, 2010 (Full References not quoted here due to space constraint however available on request to first author directly).

## Developing an inclusive heating control interface: initial user testing

*Nicola Combe\*, David Harrison and Hua Dong*

\* Buro Happold, Sustainability Team, 17 Newman Street, London, W1T 1PD

**Keywords:** inclusive design, heating controls, thermostats, prototyping

### Introduction

This research forms part of an engineering doctorate in Environmental Technology, which is sponsored by Buro Happold and Brunel University. The aim of the research project was to develop a greater understanding of the impact people have on their energy consumption in domestic buildings. A secondary aim of the research was to design a product to be manufactured under license for the sponsor organization. To this end the focus of the research has been on the user interaction with heating control systems within the domestic environment. The novelty of the project lies in the application of an inclusive design approach with the specific aim of reducing energy consumption and the associated environmental impacts.

This paper discusses the development of an interface prototype to provide a more inclusive alternative to digital programmable thermostats. Current heating control systems have been found to exclude users unnecessarily, particularly amongst older age groups. Flexibility in use is an important aspect of inclusive design therefore the interface is designed to be usable on a range of devices. The interface provides the same level of control over duration and temperature of heating as current digital programmable thermostats. However the system aims to remove some of the barriers identified previously to enable users to reduce their heat energy consumption.

### Research Approach

Following the detailed assessment of current heating controls ten design principles were identified, which had potential to reduce the user exclusion of energy management systems. The heating control prototype was developed with these principles in mind. Initial paper prototypes were developed using Adobe Illustrator and tested with six participants. Adobe Flash was used to build the final interactive application, which incorporates the feedback from the initial user testing.

### Results

Initial user testing was completed using low-fidelity paper prototypes with six participants aged 23-36 years old. The participants were handed screens and encouraged to draw where they would press on the interface to achieve three small tasks. Based on where they indicated they would press they were provided with the next screen which would be available to them.

Four significant usability issues were identified during the initial testing. These are to be rectified prior to the development of the final prototype. The issues translated into the following design changes on the interface:

- Providing a help button on all screens available to the user
- Adding a link to the current settings summary on the home screen
- Removing the on/off switch which was deemed redundant
- Clarification of the interaction between saving a setting and moving to the next setting

## **Conclusions**

The use of paper prototypes was particularly helpful in identifying high-level usability problems at an early stage in the design process. Despite only a small number of participants taking part common points of confusion were easily identified. Several of the participants commented that the interface was simple compared to their current systems at home. This is a positive contrast to the previous results, which found that frustration and mental demand were perceived highly when using exiting controls.

## **Future Work**

Formal usability testing of the final prototype system is currently underway with future results to be reported in the thesis. Results will examine task success rates, cognitive load placed upon users and time taken to achieve the task. The participants will be an even split of younger and older users between 60-80 years old. This will allow for tentative comparisons to be made with the results from the previous study.

Thus far any such energy savings has been modeled suggesting possible saving of up to 14.5% annually at a specific housing development. Further modeling at different housing developments may help strengthen the argument that inclusive controls could save energy. At this stage the research tentatively suggests that more inclusive heating controls may save energy and enable more sustainable user behavior within domestic buildings.

## Product Development and Life Cycle Assessment of Novel Retrofit Technologies Incorporating Silica Aerogel Insulation

Mark Dowson<sup>1,2</sup>, David Harrison<sup>1</sup>, Gideon Susman<sup>2</sup>

<sup>1</sup>School of Engineering and Design, Brunel University, London, UB8 3PH, UK

<sup>2</sup>Sustainability and Physics team, Buro Happold Ltd, London, W1T 1PD, UK

**Keywords:** Building Refurbishment, Energy Efficiency, Translucent Insulation

### Introduction

The aim of this Engineering Doctorate (EngD) is to design and develop new cost effective retrofit technologies to reduce demand for heating and artificial lighting in existing buildings. The thermal performance of our existing building stock must improve significantly for the UK to meet its target of an 80% reduction in CO<sub>2</sub> emissions by 2050, against the 1990 baseline. For instance, the country's 26 million dwellings are estimated to be responsible for 27% of all UK CO<sub>2</sub> emissions, yet between 75-85% of the current UK building stock will still be in use by 2050. Currently, approximately 3 million homes in England contain full single glazing, 8 million contain 'some' single glazed windows and up to 13 million contain first generation double glazing installed over 20 years ago. Many of these units do not meet modern standards and are not cost effective to improve through conventional double or triple glazing. By comparison, 6.6 million homes contain 'hard to treat' external walls with no cavity, which are expensive and disruptive to insulate, often limited by available space and planning restrictions. Up to half of these properties might never be upgraded without stronger incentive schemes, active promotion and technological innovation.

### Design/Methodology/Approach

There is an opportunity to design better insulation solutions using translucent insulation materials, the most promising of which is 'silica aerogel'. This unique nano-porous material has the best insulating properties of any solid, retaining up to 4 times as much heat as conventional insulation, whilst being highly transparent to light and solar radiation. Solid tiles of transparent aerogel, produced in research laboratories, are considered to be the 'holy grail' of future glazing technology. Alternatively, low cost translucent granular aerogel, produced on a commercial scale, can be encapsulated and retrofitted to buildings in a variety of novel applications. Prior to this research, there had been no field studies investigating the performance of granular aerogel applied to existing windows or solid walls to improve their thermal properties. This research project seeks to contribute to this area, supported by economic evaluation and life cycle assessment (LCA) to verify the financial payback period and environmental impact of each technology.

### Findings/Results

This research has three core case studies [1-3]. The first involves the design, development and in-situ testing of a proof of concept prototype to improve the thermal performance of existing windows. A 10mm thick polycarbonate panel filled with granular aerogel was retrofitted to a single glazed window and reduced 80% of heat loss, equivalent to modern triple glazing. If developed further into secondary glazing or sliding shutters, for example, payback periods of 3-9 years were predicted; significantly less than new glazing, which can often exceed a 20 year payback. In follow up study, an LCA was conducted to measure the environmental

impact of the raw materials and electricity usage during aerogel manufacture. Samples of aerogel were made in a lab, which had not been refined to reduce its environmental impact. Despite this, parity between CO<sub>2</sub> burden and CO<sub>2</sub> savings were predicted in 0-2 years. The third case study involved the design, development and in-situ testing of a fully functional solar air collector prototype, retrofitted to a south facing solid walled end-terrace in South-East London. During a cold sunny week in November, the prototype pre-heated the dwellings mechanical ventilation system to 30°C, enabling the house to maintain comfortable conditions of 21-22°C, without additional heating. Payback periods of 7-13 years were calculated and an LCA found the CO<sub>2</sub> burden could be recovered in 1 year.

### **Conclusion / Discussion**

This research finds that silica aerogel can provide a measurable benefit when applied to building retrofits, not just operationally and economically, but environmentally as well. A number of cost effective insulation solutions, have been developed, which are thin, lightweight and capable of significant energy savings. This is valuable, since there is a large proportion of the UK's existing building stock cannot be improved cost effectively using conventional retrofit measures.

### **Future plans / directions**

This four year industrial doctorate will be complete by the end of 2012. The thesis will include a full review of the UK retrofit market, conventional and emerging insulation solutions. It will also include supporting case studies of a whole house refurbishment aiming to cut 80% of its CO<sub>2</sub> emissions, as well as an investigation of aerogel applied to doors and passive solar walls.

### **References**

- [1] M. Dowson, D. Harrison, S. Craig, Z. Gill, Improving the thermal performance of single-glazed windows using translucent granular aerogel, *International Journal of Sustainable Engineering*, Volume 4 (2011), pp. 266-280, Available: <http://dx.doi.org/10.1080/19397038.2011.558931>
- [2] M. Dowson, M. Grogan, T. Birks, D. Harrison, S. Craig, Streamlined life cycle assessment of transparent silica aerogel made by supercritical drying, *Applied Energy Journal* (2011), Article in press, Available: <http://dx.doi.org/10.1016/j.apenergy.2011.11.047>
- [3] M. Dowson, I. Pegg, D. Harrison, Z. Dehouche, Predicted and in situ performance of a solar air collector incorporating a translucent granular aerogel cover, *Energy and Buildings Journal* (2012), Article in press, Available: <http://dx.doi.org/10.1016/j.enbuild.2012.02.007>

## Sketch-based System for Conceptual Design

*Islam Gharib, Shengfeng Qin*

**Keywords:** sketch, sketch-based system, conceptual design, design cognition

### 1. Introduction

The ultimate aim of the conceptual design stage is to find a solution for an existing problem, investigate design space, or explore an idea. Within this stage designers practice these different tasks in different ways although most of them use sketching as an initial method. Freehand sketching is still considered the best way of expressing ideas among designers' communities even with the development of computer hardware and CAD systems.

This paper reflects on the real requirements of the sketching process in the conceptual design stage depends on data collected via questionnaire within the design students, design academic staff and professional designers and a framework developed in [3]. The sketch system presented in this paper consists of two windows, one for 2D sketching and the other for 3D modeling. An IGES (Initial Graphics Exchange Specification) file can be produced and used within traditional CAD system for faster editing and modification.

### 2. System description

#### 2.1. 2D Sketching

The 2D sketching window is an easy sketchpad that can be manipulated as a piece of paper for drawing. It also can be used for hand writing and adding notation. Designers can start sketches from scratch or open old sketches that have been sketched before by themselves or by others. This sketchpad is compatible to JPEG file format which is most common within traditional 2D painting and photo editing software.

#### 2.2. Rough 3D Modeling

Gestures create primitives and extrusion objects that are used to build the 3D models. Gesture, as a term, refers in sketch-based modeling to hand marking; entered with a stylus or a mouse, that indicate scope and commands [5]. From this point the user can build a rough 3D model as he is doing with traditional CAD systems. The users just need to memorize some few gestures instead of complicated icons and menus in CAD systems.

##### 2.2.1. Gesture Design

In the light of Tian et al. [6] study that showed basic features to pay attention to when designing gestures, we did an extended study of 3D primitives and objects of extrusion and how people tend to draw them. This study showed that each primitive can be drawn by sequence of strokes to get the shape that can differ from one individual to another.

##### 2.2.2. Gesture Recognition

We developed a three level algorithm of gesture recognition consists of segmentation process, strokes number recognition, and gesture validation test. In the segmentation process we used an algorithm used in [2]. It works through two steps. Step one: calculate the distances between points  $i$  and the line which is connected by the first point and the last point of each stroke to find the maximum of the distances. Step two: if the maximum exceeds an appropriate amount, so a new point is added and segmentation is done.

Stroke number recognition is important to find out the appropriate validation test. The last level which is the validation test for gestures makes a comparison between the gesture entered and gestures in the system library to ensure that gesture entered is valid to create a 3D model.

### **2.3. Outputs**

An IGES file was produced to transfer data to the other CAD system for editing. An algorithm used in [1] was developed to transfer data with the feature recognition. The output file was tested with Autodesk Inventor [4] software and it gave the complete allowance to the user to edit the 3D model.

## **3. Results and discussion**

The structure of the system allows the user to get a friendly sketching environment that makes him focus on the design itself. More integration with other design teamwork members can be achieved. Also, integration with traditional CAD system was developed to reduce time consumed in moving from conceptual design stage to detailed design stage.

## **4. Conclusion & further work**

This study investigated sketching process in the conceptual design stage and presented a sketch system which allows users to sketch freely and explore ideas in an initiative way. Integration in the 2D sketches and the 3D modeling levels were developed. Future work will focus on 3D modeling development to make the 3D creation more efficient and convenient.

## **References**

- [1] ABOUL NASR, EMAD S., and KAMARNI, ALI K.: A New Methodology for Extracting Manufacturing Features from CAD System. Computer & Industrial Engineering 51, 2006, pp. 389-415.
- [2] FANG, G., HE, L., KONG, F., and ZENGFANG, L.: An Online Sketching and Gesture Editing System for Conceptual Design. 7<sup>th</sup> International Conference on computer-Aided Industrial Design and Conceptual Design, 17-19 Nov. 2006, pp 1-6.
- [3] GHARIB, ISLAM and QIN, SHENGFENG, A Multi-Windows Approach for Sketch-Based Conceptual Design System, Theory and Practice of Computer Graphics 2010, Sheffield, UK, 6-8 September 2010, pp 231-239.
- [4] <http://usa.autodesk.com/autodesk-inventor/>
- [5] RHYNE, J. R. and WOLF, C. G.: Gestural Interfaces for Information processing Applications. Tech. Rep. PC12179, IBM T. J. Watson Research Center, IBM Corporation, P.O. Box 218, Yorktown heights, NY10598, September 1986.
- [6] Tian, F., CHENG, T., WANG, H. and DAI, G. Research on User-Centered Design and Recognition Pen Gestures. The Proceeding of Computer Graphic International 2006, CGI 2006, LNCS 4035, pp. 312-323.

## Mapping Design Process and Radar Analysis of Design Activities

Stephen Green, Mark Young

**Keywords:** Design process, Design space, Design impact, Design process mapping

### Introduction

There is considerable interest in quantifying the impact of professional design activity: At a policy level the UK Design Council (2008) identify that 80% of UK business agrees that design will help them stay competitive in the current economic climate. The UK DCMS (2010) identifies that design contributes £1.6bn of the £59.1bn GVA generated by UK Creative industries and various government reports highlight the potential of design and the creative industries to contribute to the future economic wellbeing of the UK (eg Cox, 2005, Sainsbury, 2003, Dyson, 2010). Although it is noted that nearly 80% of businesses surveyed stated that designers are only; *quite good*, through to; *not good at all*, at communicating the value of design activity (Design Council, 2007). At firm level the DBA's Design Effectiveness Awards or the European Design Management Award aim to highlight individual cases of the positive impact of design activity.

These initiatives do not necessarily lead to a finer grain understanding of the ingredients and recipe for design impact. Design is a component of Innovation, and within this field there are numerous examples of models and methodologies with goals of identifying the constituent factors and added value of innovation (Smith, 2005). Within design there is more limited evidence of systematic explorations of how value is derived from design activity. However what is supported by over 40 years of design research is the concept of design process at the core of all design activity. Whilst there are numerous views on models of design according to the aims of the modeling exercise; design process does provide a starting point for evaluating design activity.

### Design/Methodology/Approach

The study builds on key features derived from design process modeling literature to create a design process mapping technique as a basis for evaluating the performance of instances of design activity. The resulting design process maps can be evaluated with what is defined as a *HEET radar*. HEET is an acronym for *Human, Environment, Enterprise and Technology*, with each contextual factor representing a pole of the radar which can be graded, either for a project as a whole, or at stages along the project process chronology. This data can then be used to generate radar graphs according to specific sets of data. This modeling concept and evaluation technique has been applied in various longitudinal studies of undergraduate design Major Projects at two leading UK Design Schools (Brunel and Kingston). The data was generated by researchers and design staff and encompasses review of a total of 304 projects over 3 years. The results are a basis for evaluating the performance of the Major Project work. For example analysing the design impact of a specific Major Project or group of design projects; either from a pedagogic point of view, or, for the students, for project planning purposes.

### Findings / Results

Results to-date highlight, amongst a range of factors, that the mapping and evaluation techniques *can* effectively visualise issues of relevance and concern for design pedagogy; confirmation of a range of issues explored within design process literature, and therefore that the techniques have a value in examining these contemporary design research challenges.

## **Conclusion / Discussion**

Further research activity is identified with objectives to explore how these modeling and evaluation techniques might be applied in professional contexts as a basis for developing methods for exploring and communicating design impact. Therefore developing more understanding of how design can contribute to future economic, social, technological and environmental wellbeing.

## **Future Plans / Directions**

The mapping and radar analysis methods are outcomes and components of a broader study relating to the context discussed in the introduction. These initial elements relate to the ‘core’ design process. Current and ongoing work is exploring, through Design Business Association case studies, *output* factors in successful design work together with factors within the broader commercial environment of these projects. The complete body of work is building towards final research outcomes which are intended to introduce new knowledge to the field of understanding and communicating potential design impact: with the overall PhD working title of *Predicting Design Impact*.

## **References**

- Cox, G, (2005), *Cox Review of Creativity in Business: building on the UK's strengths*, HM Treasury, London
- DCMS (2010), *Creative Industries Economic Estimates: Headline findings*, DCMS
- Design Council (2008), *Design in Britain 2008*, Design Council
- Design Council, The (2007), *The Value of Design Fact finder Report*, Design Council
- Dyson, J (2010), *Ingenious Britain*, James Dyson
- Sainsbury, D, (2003), *Competing in the global economy: the innovation challenge*, DTI
- Smith, K (2005) Measuring Innovation, chapter in *The Oxford Book of Innovation*, eds Fagerberg, J, Mowery, DC, Nelson RR, Oxford University Press

## **Design leadership for communication improvement via experiential design delivery at the initial stages of new product development**

*Koogin Han, Joseph Giacomin*

*Design Management/ HCDI*

**Keywords:** Communication Improvement, Design Leadership, Experience creation, Fuzzy Front End (FFE) of New Project Development (NPD)

### **Introduction**

Contemporary markets are complex and demanding and success requires many factors covering both the broad range of tangible elements as well as the increasingly important intangible factors such as branding and customer experience. Indeed, Design has been known to deal comfortably with complexity, ambiguity and innovation; design can differentiate products and services and add value that creates a unique selling proposition. However, the relationship between design and marketing is not an easy one, and many companies do not take advantage of design benefits. The recognition of the gulf between marketing and design has been well documented for decades (Clark and Smith, 2008). Particularly, managing the conflict between design and business management is vital to create a better success rate within the experience economy. Adding to this, a newly formed project team consists of multidisciplinary members that have a lack of understanding about other team members, differing expectations, and confusion about a project direction in the beginning. Experience of interactive participation generates more satisfaction, effectiveness and productivity in an organization (Osland, Kolb, and Rubin, 2001). Increasingly, events are not only designed for external commercial purposes, but also planned to transform companies' internal growth. The goal of experience design is to orchestrate experiences which are "functional, purposeful, engaging, compelling, and memorable" (McLellan, 2000). That is, experience can be a design leader's communication toolkit to resolve miscommunication as well as to encourage the same project direction in NPD team members. This research considers experience as a key trigger in promoting better understanding of design delivery amongst multidisciplinary non-design NPD team members. For non-design team members, it can be difficult to fully appreciate and empathize with the suggested new product concepts; thus, designers need to provide a variety of approaches to simulate the intended customer experience and to illustrate the potential benefits for the business

### **Design/Methodology/Approach**

In order to create a strategic design model, literature reviews have been conducted prior to a primary research plan. The reviewed areas included leadership theories and studies in order to determine feasible abilities for design leadership, NPD team communication typology, people's understanding process, and creating and managing experiences in the event industry and experience economy and applied behavior change studies, which explore how people' behaviors are influenced by their surroundings and can be changed instantly by designed experience. Synthesized insight will be applied in the primary research, based on mixed-method methodology and a positive deviance strategy which is a behavior change program throughout the observation of certain people (the positive deviants) whose uncommon but successful behavior leads to better solutions for specific problems than those achieved by their neighbors, colleagues, or competitors. The program participants' pre-existing thoughts and behaviors can be radically changed by experiencing the customized program (Marsh, Schroeder, Dearden, Sternin, and Sternin, 2004). Thus, the first primary research will be taken by finding and observing the designers who are positive deviants and successfully deliver design experiences to non-designers. The similarity of uncommon but successful behaviors is a key factor. The findings from literature survey and the primary research will create a strategic design model which will be formulated in terms of logical and functional steps. This will be tested and measured throughout by pragmatic simulation. The

simulation participants will complete the post-questionnaires about their simulation experiences. Measurement criteria will be the non-design team members' understandings about the intended design concept, linking the potential customer's experience and the organization's benefits and NPD direction agreement.

### **Findings and Results**

Key insights are the definition of design leadership and the experience creation method. Design leadership is not a position but rather design leading process activity within an organization, and consists of being a craft expert and a good design communicator, in order to share a vision with internal colleagues and target users. Leaders commonly have a self-confidence trait (Hill and Ritchie, 1997:499 in Judge, Bono, and Gerhardt, 2002) and either Charismatic or Participative leadership styles (Cheung et al, 2001). Secondly, better understanding comes from concrete experience through interactive participation, which generates more satisfaction, effectiveness, and productivity in an organization. Experience creation has two aspects: content and context. Delivering content in experience is often seen as a journey. Within the context part, relational and physical elements influence customer participation differently. Designing context decides the level of participant involvement required to have experiences through sensory stimuli. Sensual elements and psychological benefits associate with the physical environment. Thus, aligning the right content and context by integrating the physical environment and relational elements, including sensorial stimuli, can be effective and efficient. The experience must be designed as a journey planning.

### **Conclusion/ Discussion**

All researched factors lead to a hypothetical model for communication improvements. This model may become a new competitive advantages process. Project teams initiated by marketing, technology or other disciplines will significantly benefit from using the design leadership methods in particular using them to create experiential approach to the team communication. This research suggests design leadership is needed to envision and share about distinctive market opportunities of new multidisciplinary projects through experiencing the future benefits. Indeed, marketers and other multidisciplinary players need to engage with design leaders from the beginning to maximize the capability of design.

### **Future Plans**

Synthesized insight from the first part of research will be formulated for the primary research based on Mixed Method Methodology and Positive Deviance Strategy. The anticipated outcome from the primary data will be formulated to create the strategic design model which is explained in the methodology section.

### **References**

- Cheung, S., S. T. Ng, et al. (2001). "a satisfying leadership behavior model for design consultant." International Journal of Project Management 19: 421-429.
- Clark K. and Smith R. (Summer 2008), *Unleashing the Power of Design Thinking*, Design Management Review, 19(3), 8-15
- Judge, T. A., J. E. Bono, et al. (2002). "Personality and leadership: A qualitative and quantitative review." Journal of Applied Psychology 87(4): 765-780.
- Marsh D., Schroeder, D., Dearden K., Sternin J, Sternin M. (2004) *The power of positive deviance*. British Medical Journal ; 329; 1177-1179.
- McClellan, H. (2000) Experience Design. Cyber Psychology & Behaviour. 3.1. 59-69
- Osland, J, Kolb, D, and Rubin I(2001), *Organizational Behavior: An Experiential Approach*(7<sup>th</sup>ed.), Prentice-Hall, Inc. New Jersey USA

## A Human Centred Software Agent for Online Social Networking

*Hojung Kim, Joseph Giacomin*

*Design / Human Centred Design Institute*

**Keywords:** Complex Network, Conceptual Model, Human Centred Design, Human Centred Software Agent, Online Social Network, Software Agent

### **Introduction**

The online social network is a web-based service that allows individuals to construct a public or semi-public profile within a bounded system, articulates a list of other users with whom they share a connection, and views and traverses the list of connections and those made by others within the system. Due to the indiscreet proliferation of the online social network, there have been complexity and privacy issues recently. In particular, excessively large number of types and service providers of online social network have resulted in lack of attention to those services. Moreover, different identifications are needed for each online network service. Many simple things, each with its own rules of operation, for example the frequent demands for passwords, could result in complexity. Consequently, users must manage friend lists, connections, contacts or networks separately for each service, which is called “walled garden problem”. The privacy issue, which has already been being discussed in several studies, is also predicted to get worse although service providers offer some solutions to keep users’ accounts and privacy protected.

In order to resolve the complexity and privacy issues of the online social network, this research focuses on the automated, autonomous, and intelligent software agents. Software agents are computational systems that inhabit some complex, dynamic environment, sense and act autonomously in this environment, and by doing so realise a set of goals or tasks for which they are designed. While several research papers on the software agents deal with issues from various fields such as computer science, information systems or artificial intelligence, there have been no known publications on the software agents from the viewpoint of human centred design that focuses on the emotional, social, humane, or ethical aspects. Therefore, this research aims to develop a conceptual model of a human centred software agent to help people dealing with the complexity and privacy issues of the online social network.

### **Methodology, Approach and Findings**

A friend recommendation agent has been observed as a representative example of the software agents in online social network. It has obviously contributed to the growth of the online social network by helping people not only to find their friends easily but also to hide the underlying complexity of the task. However, in terms of the complexity issue due to the walled garden problem, it is arguable to say that software agents, including the friend recommendation agent, need to cover as many different services as possible, namely decentralisation. In this context, the author has identified the most appropriate type of the software agent to be a networked, distributed, and fixed agent. Collaborative, communicative, and adaptable attributes of the software agents are also considered to be the key aspects for the complexity issue. Furthermore, as the fundamental role of the human centred design is to obtain an understanding of people's needs, desires, and experiences that transcend people's actual realisation, it is important to focus on the privacy issue which is critical but hidden and invisible to people. Accordingly, the human centred software agent is strongly expected to resolve both issues of complexity and privacy simultaneously by combining the key attributes of software agents and human centred design within the current context of the Internet.

A brief review was performed of the relevant literature and it was found that the evolution of the Internet could be categorised into six aspects – technological, informative, accessible, intelligent, social, and complex. Among the identified categories, the most commonly encountered one was “social”, and the author also identified “complex” to be the main factor contributing to the Internet evolution. They were traits that distinguish the current Web environment from previous ones. Therefore, it is arguable that the online social network can be regarded as a typical platform of the current Web context, and several researchers claim that the online social network can be considered to be a complex network.

Comprehensive review of theoretical approaches of the online social network usage such as Technology Acceptance Model, Expectation-Confirmation Model, Uses and Gratifications Theory, and Unified Theory of Acceptance and Use of Technology was also accomplished, and it was possible to understand people’s fundamental motivations and gratifications in using the online social network and to consider how the online social network will change as the Internet evolves.

Moreover, through a review of the relevant literature on the general concept of the software agents such as definition, history, characteristics, and typology, it was possible to identify what was meant by “software agents” within the context of the cyberspace, the online social network in particular. Case studies investigating established conceptual models of various types of existing software agents were also conducted in order to understand how they work. Finally, literature on the general concept of human centred design was reviewed for defining the term “human centred software agents”, and for discussing the necessity for human centred design of software agents.

### **Conclusion / Discussion**

Based on the findings so far, it was possible to identify the current context, and to consider the future of the Internet and online social network. Moreover, it had been clarified that the research on human centred software agents is necessary to help people coping with the complex online social network and keeping their privacy. Furthermore, this paper gives a specific direction for the next phase of the research.

### **Future plans / Directions**

In the next phase, the research will focus on investigating the main criteria for developing the conceptual model of the human centred software agent for online social networking based on the discussion in this paper. Especially, primary research techniques such as expert interviews, observations, and a questionnaire will be conducted in order to identify decisive factors that can help people dealing with the complexity and privacy issues of the online social network.

## Public Service Design for Fear of Violent Crime (FOVC)

*Hyun-jin Kim, Joseph Giacomin*

**Keywords:** Fear of Crime, Females, Gender stereotype, Stereotype threat, Public service, Service design

### Introduction

Fear of crime is a common and widespread social problem which leads to a fractured sense of community, neighbourhood, and public places. In the underground, females express more fear of crime than males and consequently exhibit behavioural changes like avoiding use of isolated places in the underground and tubes at specific times. Recently, design has been researched related to crime in terms of the influence of the physical environment and products on crime prevention (Colquhoun, 2003): Defensible Space (Newman, 1972) Crime Prevention through Environmental Design (Jeffery, 1971; Crowe, 1991) and Design against Crime projects. Typically, design research on crime has focused on crime prevention and fear of crime has not been researched as a separate domain unlike in criminology or criminal psychology. However, even though fear of crime and crime are somewhat correlated with each other, research on fear of crime claims that it should be dealt with as a separate problem from crime itself due to the paradoxical aspect of fear. Females express higher fear of crime contrary to their relatively low victimization rates compared to males who express low fear of crime but have a high possibility of being involved in crime. Therefore, the aim of this research is to create a design model for the public tube service which address gendered fear of crime in order to ameliorate females' fear of the underground.

### Design/Methodology/Approach

This research is designed in four parts in order to propose a design model for public tube service to ameliorate females' fear in the underground. Firstly, the influential factors which are able to account for females' higher fear than males have been researched through literature review. For a deeper understanding of fear, the process of fear formation and the fear acquisition system of humans has been investigated. Moreover, gender and gender difference also have been researched in order to find the influential factors on the differently expressed levels of fear between two different sexes from a social interaction point of view. Secondly, qualitative research is planned to identify the differences between males and females in interpreting the social and physical environment in the underground regarding their safety. The third step of the research is to identify the fear-evoking stimuli which are paired with crimes and perceived safety signs to females in the public tube service environments. At this stage, a quantitative research method will be employed to collect and analyze the data. Lastly, with the data from the second and third step of the research, the role of service design and appropriate approach for public tube service design will be identified.

### Findings/Results

Females' highly expressed fear is understandable from a social point of view. From the literature review, it has been found that learning has a critical role in fear and gender acquisition. Learning plays a pivotal role in generating fear and interpreting the situational context. In addition, gender refers to socially created distinctions which are associated with being masculine or feminine. Gender assigns roles of being male and female and behaviours of each dimorphism which is deemed as proper or acceptable to be exhibited by males or females. It encourages gender stereotypes; moreover, gender stereotypes affect the expression

of fear. Research on the paradox of fear has consequently pointed out that the socially expected behaviour and characteristics of females and males affect how they express their feelings and vulnerability (Akers, 2009). In the case of men, because of expected masculinity, men are not likely to admit their vulnerability or emotions while females do not feel reluctant to express their fear. Moreover, as a result of socialized passivity, females' vulnerability and the fear of rape which is deemed as a reason of women's fear of crime, is amplified. These influences can be explained by 'stereotype threat' which refers to the concern about being judged by the stereotypes of the group where the subjects socially belong and the concern about proving this belief through their own actions (Banyard, et al, 2010).

### **Conclusion / Discussion**

Gender stereotype threat explains females' high fear of crime in social interactions. Travelling on the tube, social interaction with strangers always occurs and at certain points, females believe that they may be in danger due to the fear stimuli inherent in the stereotype. Service design in the user-experience dimension is creating a service interface which enables users not to have an unexpected or fearful experience. Therefore, the relationship between the influence of the stereotype and tube service design in interpreting fear stimuli must be defined in order to ameliorate gendered fear in the underground. In this context, three research questions are set for primary research.

*R.Q.1) How does gendered fear of crime affect interpretation of the social and physical environment during service encounters?*

*R.Q.2) In which circumstance do females believe that they are safe and what do they associate with safety in the underground and the other way around?*

*R.Q.3) What design criteria or procedure could be used to provide a framework for addressing these issues of public service?*

### **Future plans / directions**

In order to find answers of these research questions, mixed research methods will be used to collect data. Research for data collection is going to be divided into three parts and is going to be separately conducted and analyzed. Over the next academic year the data will be collected and analysed after developing research design formulation.

### **References**

- Colquhoun (2003), Design out crime: Creating safe and sustainable communities, Architectural press.
- Banyard, et al. (2010), Essential Psychology, Sage Publication Ltd.
- Akers (2009), Social Learning and Social Structure: A General Theory of Crime and Deviance, Transaction Publishers

## Art into luxury fashion industry

*Youjung Lee, Busayawan Lam*

**Keywords:** Luxury fashion brand, Brand communication, Experience design, Contemporary visual art, In-store art experience

### Introduction

The notion of luxury has transformed from traditional conspicuous luxury goods to a new experiential luxury sensibility with intangible qualities to main consumers of luxury brands due to the emergence of the “new luxury” and changes in luxury consumption style like “trading up”. In respond to significant changes in the appetite for luxury brand consumption, luxury fashion branding has become as much about branding customer experience to provide an insight into brand lifestyle as the product (Atwal and Williams, 2009).

In order to provide quality branded experience, contemporary visual art has been applied to luxury fashion flagship as a creative communication tool. There have been several theoretical researches that explain the effect of art infusion on consumer evaluation of products. Moreover, recently, Hagtvedt and Partrick (2008) demonstrate that the association with art favorably influence on brand image via luxurious and creative connotation.

However, there is little research that investigates how art might be most effectively associated with brand (Hagtvedt and Patrick, 2008). Especially in luxury fashion branding, lots of luxury fashion brands heavily rely on the creative director's intuition while they apply visual art experience to their retail store. And there has not yet been any design research that offers a systemic branding strategy in applying visual art experience to fashion branding. Therefore, this research aims to develop a framework to assist luxury fashion brand managers to apply in-store art experience as an effective brand communication tool to enhance perceived brand identity.

### Design / Methodology / Approach

Literature review has been conducted to investigate the current challenge of luxury fashion industry and to evaluate emergent theories of the relationship between brand communication and experiential branding. The related theories of contemporary visual arts and their impact on brand image have also been investigated while conducting literature review. In order to identify main problems and challenges of the use of visual art experience for effective brand communication, the major cases of use of art experience were analyzed as primary research (i.e. Louis Vuitton with Takashi Murakami and Stephen Sprouse, Commedes Garscon with David Lynch and Takuma Nakahira). In order to validate the result of case study and to gain a comprehensive understanding about the current use of art experience, interview with 12 professionals from different areas – art, brand and fashion – is planned as primary research. Moreover, questionnaire survey will be carried out to know the effect of using fit artwork on brand communication and to know the effect of knowledge and expertise about artwork on audience's hedonistic rewards and brand identity communication.

### Findings / Results

The first conceptual model consisted of four hypotheses were generated from literature review. The details of hypotheses are as follow:

- H1. As an effective brand communication tool to enhance perceived brand identity, the selected artwork should fit with brand identity to send out coherent signs.
- H2. In-store art experience by using fit artwork with brand identity can be an effective brand communication tool to enhance perceived brand identity, irrespective of types of

consumer experience of art.

- H3. Aesthetic experience viewers having knowledge and expertise of the artwork get higher hedonistic rewards than other types of viewers.
- H4. Developing an in-depth knowledge and expertise of the artwork enables viewers to get an enhanced perception of the brand identity and get higher hedonistic rewards than other types of viewers when brand use fit artwork with their brand identity.

In order to prove H1 and H2, case studies about the use of in-store art experience were employed.

In literature review, the author discussed how contemporary visual artist has been regarded as personal brand in the art market from philosophical and marketing point of view. Based on this theoretical perspective, the brand identity components of contemporary visual artist were identified as brand physique, awareness, personality and brand value. Through literature review, it was also clarified that artist's personal value, personality and the social norm impact on the nature of their artwork as a product. Thus, in the case study, the fit between brand identity of luxury fashion brand and contemporary visual artwork has been evaluated through analysis of brand identity of luxury fashion brand and identity of cotemporary visual artist personal brand.

### **Conclusion / Discussion**

Through analysis of the success and failure cases of in-store art experience, main problems and challenges in applying art experience have been addressed. Also, the different results of brand communication in terms of using fit or less fit artwork have been identified through analysis of the case studies. The findings from case studies support H1 and also would be the fundamental background to conduct next phase of this research- questionnaire and interview.

### **Future plans / Direction**

In order to confirm the findings from case studies and support H1and H2, in-depth interview will be conducted. Also, in order to prove H2, H3 and H4, questionnaire needs to be carried out by using the result of case studies in the next phase. Once four hypotheses are proved after conducting planed primary researches, the first conceptual model will be confirmed as a final model. All planed primary researches are expected to complete until end of July 2012.

### **References**

- Atwal and Williams (2009) Luxury brand marketing – the experience is everything. *Journal of Brand management*, Vol.16, pp. 338-346.
- Hagtvedt and Partrick (2008) Art and the brand: the role of visual art in enhancing brand extendibility, *Journal of consumer psychology*, 18, pp.212-222.

## Design management led future forecasting model for mobile communications

*Rafael Mello, Busayawan Lam*

*Design Management*

**Keywords:** Design management, Mobile telecom industry, trends

### Introduction

The evolution of mobile telecommunications industry can be divided in two main phases. During the first stage, geographic markets (e.g. Japan, Northern & Western Europe and United States) created their own approaches relying on domestic financial investments and strict policies from local governments to expand this sector (Steinbock, 2003). Later, the market deregulation attracted new players to this industry, increasing competition. The second stage of the wireless industry started with the emergence of the mobile internet that promoted dramatic changes in the landscape (Funk, 2001 cited in Funk, 2009). It assisted established companies to expand their business in a global scale and encouraged the entrance of new stakeholders in the mobile chain (Steinbock, 2003) such as Apple and Google from the computing industry. The current market is highly fragmented comprising a complex network of firms competing to deliver innovative solutions.

Alongside these changes, the roles of design management evolved from assisting the construction of the wireless network foundations to the creation a new generation of hardware and software. In addition, understanding market trends and their impacts on NPD becomes a paramount activity for mobile companies. Regarding these issues, there is a clear need to create a framework that addresses potential new roles for design management moving from a company centered to a collaborative approach with other players. Therefore, the aim of this research is to develop a design management led future forecasting model for mobile communications.

### Methodology

This study comprises both secondary and primary research methods. Regarding secondary data collection tools, an extensive literature review and two case studies were used to investigate the wireless industry and how design has been used in this sector. The literature review addressed three main topics: the evolution of the mobile telecom industry; major trends in the current wireless landscape and the roles of design management. Apple and Google were the two case studies selected due to their increasing dominance in the wireless arena and breakthrough use of design to deliver innovative solutions (e.g. iPhone and Android mobile OS). Also, these examples depict their mobile ecosystems and possible design implications of these strategies.

In order to collect fresh information, in-depth interviews with experts from different backgrounds were carried out to understand and explore their views about the wireless industry, (including current trends) and the use of design by different players. These processes helped this research to have a holistic view about the sector and how design has been used, its limitations and future roles.

## **Findings/Results**

The mobile internet was the key factor that attracted companies from different sectors to the wireless industry. Concerning the use of design a strategic tool, several examples show the wide scope applications of this tool: handsets (e.g. iPhone), mobile OS (e.g. Android), services (e.g. App Store) and online platforms (e.g. Facebook). Thus, the marketplace became saturated. In this scenario two companies, Apple and Google, are gaining momentum and their innovative solutions are driving this industry. Even though they pursue different strategies, the first launched the iPhone (hardware) and while the second released the Android (software) (Holzer and Ondrus, 2011) both companies are competing to make successful their mobile ecosystems. Moreover, Google's increasing bargain power towards its Android mobile OS was a critical issue mentioned by interviewees, bringing opportunities and challenges for mobile manufactures. Finally, these experts also stated that understanding market trends and how design can take advantage of them become a critical factor to gain competitive advantages. For example, the 'social media' trend has been used as a 'platform' for new services, games and handsets with optimized related functions.

## **Conclusion / Discussion**

The mobile internet promoted outstanding changes on the wireless sector and design has been playing an utmost role in this dynamic sector. Taking into account the establishment of Apple and Google's mobile ecosystems that comprises manufactures, mobile OS, exclusive services, mobile apps developers, value delivered to customers became more intangible. Also, companies are concerned about capitalizing on market trends by aligning their efforts to produce better solutions and achieving market differentiation. Therefore, as customers' value (through products and services) are being co-produced by a network of different stakeholders in the mobile chain, new roles of design management must address these industrial collaborative demands in order to maximize firms' resources, by forecasting unexplored opportunities and delivering better products.

## **Future plans / directions**

In order to achieve the proposed aim, some interviews with experts and users (including mobile apps developers) still need to be done focusing, majorly, on how they interact with technology and possible innovative uses of handset features (including hardware and software). After that, drafts of the proposed framework can be created in order to be critically analyzed by previous interviewees. This process will be based on a research technique known as 'Delphi panel', where experts are asked to present their views about a specific topic until they reach a consensus about the subject.

## **References**

- Funk, J. L. (2009) The emerging value network in the mobile phone industry: the case of Japan and its implications for the rest of the world. *Telecommunications Policy* 33 (1–2), 4–18.
- Holzer, A. and Onbrus, J. (2011) Mobile application market: A developer's perspective. *Telematics and Informatics* 28 (1), 22-31
- Steinbock, D. (2003) Globalization of wireless value system: from geographic to strategic advantages. *Telecommunications Policy* 27 (3-4) 207-235.

## Corporate Level Design Policy for Innovative Manufacturing in the UK

*Jea Hoo Na, Youngok Choi*

*Design Policy and Management*

**Keywords:** Design Policy, Innovative Manufacturing

### Introduction

Over the years, influence of design has been expanding into a wider context within businesses. It is not just about aesthetical flare and appropriate functionalities anymore, but an essential part of making business successful (Mozota 1990; Press and Cooper 2003; Valtonen 2007). Subsequently, the ‘design thinking’ can bring positive influence as a strategic business tool for increasing competitiveness (Brown 2009; Martin 2009). This change in the paradigm of design has been noticed by business leaders and it is increasingly becoming an agenda that companies are starting to take seriously. However, the use of design within manufacturing sector in the UK does not embrace these changes which can be a pivotal disadvantage for them to prolong competitiveness in the global stage. For an effective convergence of design thinking within strategic management of business, it is essential that it needs corporate level policy that not only guides the infusion of design in new product development (NPD) but also in management of the business itself. Hence the key questions for this research are (i) what is the role of design in innovative manufacturing? (ii) what do the changes in design paradigm mean for innovative manufacturing companies? and (iii) How can corporate level design policy be developed and implemented? With these research questions in mind, the aim of the research is to create a corporate level design policy guideline for innovative manufacturing companies in the UK.

### Methodology

There are four key stages of the research. First is the investigation of innovative manufacturing in the UK including overall perspective of manufacturing sector. This research was conducted by reviewing the current literature including government papers, journals, books and both on-line and offline articles. Furthermore, series of interviews with academic experts in manufacturing were conducted to establish initial definition of innovative manufacturing and the relationship with advanced and high value manufacturing. Three 30-60 minutes semi-structured face-to-face interview method was used to obtain deeper insights of the interviewees. The second stage was constructed to establish the current role of design within innovative manufacturing. At this stage, an exploratory questionnaire survey with UK manufacturers was conducted to better understand their views on design and its importance within the company. An on-line survey tool ‘SurveyMonkey’ was used to create and distribute the questionnaire for easy access and completion of the survey. Microsoft Excel was used to analyse the results. In addition, semi-structured face-to-face interviews with manufacturing companies’ directors or partners are to be conducted to further investigate the design in manufacturing. The third stage of the research is to critically review the current corporate level business policy and design policy. The methods that will be used to conduct this research are further literature reviews and industry expert interviews. In this key stage, the establishment of rationale for corporate level design policy in manufacturing, especially innovative manufacturing in the UK will be generated. This will then lead to the fourth stage of creating guideline for a corporate level design policy guideline.

## Results and Discussion

The literature review indicates that the UK manufacturing is going through changes. The emerging economies such as Brazil, Russia, India and China (BRIC) means that the UK manufacturing can no longer compete on the price (PWC 2009). Furthermore, the BRIC countries are seeking to increase their capabilities in high-value manufacturing which has been an area of competitive advantage for UK manufacturers (BIS 2010). From the academic expert interviews conducted in conjunction with various literature, the innovative manufacturing is described as ‘manufacturing in which the innovation in products and processes is a priority and where there is continuous investment in research and development to produce new and/or improved products and processes’. In the increasingly global and competitive market environment, the UK government is recognising that innovative manufacturing as a key driver for developing and utilising advanced manufacturing and subsequently the high-value manufacturing to be more competitive. In this era of changing manufacturing, design is being used within the manufacturing industry in forms of Design for Manufacturing and Assembly (DFM/A or DFMA) and product/engineering design. The main focus of DFMA is to design collection of parts to optimise the manufacturing-production. Undoubtedly design is important capability within manufacturing companies, especially for innovative manufacturing firms. However, it is more often still treated as activities in operations level (designing), not as a corporate level strategic tool (design thinking) as the questionnaire result show that design is used mainly to develop new product and in production/manufacturing. The most anticipated outcome of design was increase in sales which further indicate that the view of design by manufacturers are yet to expand beyond operational level design. However there are some encouraging signs from the survey where overwhelming percentage of companies are seeing design spend as a ‘necessity’ and ‘future investment’ rather than an extra cost, which gives an indication that design is an integral part of manufacturing operation.

## Conclusion and Further Plans

The need for design to be taken as a business management level tool to encourage and maximise innovation within manufacturing is very real. Technological innovation needs to be converged with design led innovation for the manufacturing outcome to successfully accepted by the market whether it is for B2B or B2C. Therefore, further research on practical and feasible method to encourage and embrace design thinking within innovative manufacturing has to be conducted.

## References

- BIS (2010). Manufacturing in the UK: An Economic Analysis of the Sector, Department for Business Innovation & Skills.
- Brown, T. (2009). Change by Design: How Design Thinking Transforms Organisations and Inspires Innovation. NY, HarperCollins.
- Martin, R. (2009). The Design of Business: Why Design Thinking is the Next Competitive Advantage. Boston, Harvard Business Press.
- Mozota, B. B. d. (1990). Design as a Startegic Management Tool. Design Management: A Handbook of Issuew and Methods. M. Oakley, Butler and Tanner: 73-84.
- Press, M. and R. Cooper (2003). The Design Experience: The Role of Design and Designers in the Twenty-First Century. Ashgate Publishing.
- PWC (2009). The Future of UK manufacturing: Reports of its Death are Greatly Exaggerated. Observations, Analysis and Recommendations, PriceWaterhouseCoopers.
- Valtonen, A. (2007). Redefining Industrial Design: Changes in the Design Practice in Finland. Helsinki, University of Art and Design Helsinki.

## 3D printed thermal management medical device

*Esteban Schunemann, Sarah Silve, Richard Bateman*

**Keywords:** Ice-therapy, Thermal, Cryotherapy, Rapid, Prototype, Trauma

### Introduction

The treatment of soft tissue injuries is normally done by the well established Ice, compression and elevation method. The application of ice, although effective, has to be limited to intervals of 10 minutes in order to avoid causing injury to the soft tissue due to frost bite [1]. Little progress been made in terms of developing alternative methods. Similarly, there has been little development towards monitoring and regulating the cooling effects and patients temperature when using the current method.

This research aims to offer a new concept of treatment which addresses the afore-mentioned issues of monitoring and further aims to develop bespoke solutions for individual patients by 3D printing the required structure. With this method it is possible to adjust the internal arrangement and fine tune the performance of the device to match the patient's needs; furthermore electronics and sensors can be embedded into the device at the time of printing, making monitoring and regulation plausible.

The objective is to investigate the suitability of the 3D printed structure as a thermal monitoring and regulation device by using a built in array of thermo couples supported by thermal imaging.

Information obtained from these tools will be used to iterate and improve the design of the device to produce a proof of concept demonstrator.

### Design/Methodology/Approach

The printing of the structures will be done using a three axis conventional CNC machine equipped with a pneumatic nozzle based deposition head. The build method is in many ways similar to that used by FDM where filaments of melted material are deposited layer by layer to form a solid object. Whilst a very large range of materials could be used with this system; previous work undertaken by has highlighted acetoxy silicone as a good candidate material for this proof of concept.

A medical device of this nature could take several forms depending on the patient's requirement as the premise of the project implies. As such, for the sake of simplicity; the medical device for the proof of concept will be in the form of a cuff designed to be worn on the wrist or lower arm.

Targeting a joint requires the structure to be flexible enough to allow movement while still maintaining good contact with the surface of the body in order to accomplish its primary task.

The proposed structure is a two wall tube with a complex internal lattice formation between the walls that permits liquids to flow through it. The lattice is sectioned internally into several chambers to aid in liquid flow. The temperature and pressure of the liquid is controlled by an external pump.

## **Findings/Results**

The research carried out up to this point has shown that printing a range of cuff structures is feasible with the current equipment and with wall sizes from 3mm to 15mm; wider walls would also be possible and although not yet tested to destruction the samples have been found to be sufficiently watertight. The layer wise deposition method is very effective at producing watertight structures as long as the layers align.

## **Conclusion / Discussion**

Once the simple proof of concept device has been successfully tested, future work will look at optimizing the thermal efficiency of the device through the use of computer simulation, improving the design and process capabilities to develop truly bespoke solutions and culminate in a functioning medical device ready for medical trial testing. Eventually the work will include the development of similar devices for other areas of the body, particularly for use in head trauma situations. [2]

## **References**

1. Domhnall C. Mac Auley. (2001). Ice Therapy: How Good is the Evidence?. *Orthopedics and Clinical Science*. 22 (5), 379-384.
2. Changlian Zhu. (2006). Intraischemic mild hypothermia prevents neuronal cell death and tissue loss after neonatal cerebral hypoxia– ischemia. *European Journal of Neuroscience*,. 23 (1), 387-393.

## Elevating The Perception of Design-led innovation for Saudi Arabia Airlines

*Maha Shams, Busayawan Lam*

**Keywords:** Design, Innovation, Organisational Culture, Design Management, Airline Industry.

### Introduction

The role of design-led innovation has been dramatically shifted into becoming a key beneficiary business tool. Most successful organisations have acknowledged this shift, by changing their organisational culture into raising the understanding of the value of design and innovation. This change has been shown to enhance customer satisfaction. Thus increase profitability and competitiveness within a given market. The real challenge for any organisation is to understand design and innovation implementing it effectively and efficiently. This study focuses on the airline industry considering all design disciplines in a customer's journey (i.e. pre-flight, onboard, post-flight). In reference to 'Skytrax' the world's leading star ranking in the airline industry, the researcher measures the value of design for leading airlines (4 stars or higher) in Skytrax in comparison to a 3 star ranking airline. Bruce and Bessant (2002, p.38) believe 'good design does not emerge by accident, but as the result of a managed process'. It is hoped that the research presented here will advance the knowledge in the design management field by developing a conceptual framework that may change an organisational culture toward a design-led innovative organisation. Based on an extensive literature review, most design management models focus on helping companies manage design resources and to make effective use of design as a tool. However, in organisations where design and innovation is not perceived as a strategic tool, it is crucial to change attitudes and perceptions of design-led innovation, before effective management programs can be implemented.

### Aim and Objectives

To elevate the perception of design-led innovation within Saudi Arabia Airlines (SAA), by creating a design management conceptual model (DMCD).

1. To review existing design management models and relevant theories.
2. To investigate the current understanding of design-led innovation and design management process for SAA.
3. To critically examine the gap between the current use of design-led innovation in SAA and those of the leading airlines.
4. To identify appropriate strategic approaches and examine DMCM for SAA.
5. To evaluate the proposed model in terms of whether it has the potential to enhance the perception of design-led innovation for SAA, allowing it to increase customer satisfaction and drive the company toward being one of the world leading airlines.

### Design/Methodology/Approach

The researcher chose Saudi Arabia Airlines (SAA) as the 3 star airline from Skytrax, where design is used at the project level only compared against the top leading airlines in the world. The primary data is conducted as a design audit, which is a snapshot of the current state of the company targeting the stakeholders of the airline (i.e. Frequent fliers, SAA employees, and SAA top management). The design audit used a combination of qualitative and quantitative methods such as (questionnaire, in-depth interviews, observation and creative session) in order to triangulate the research outcomes. The research started with questionnaire then interviews and observation, which were conducted in the early stages of the research, each part the researcher developed the DMCM. The final part of the research will be the creative session

which will be used as a tool to test and analysis the DMCM with SAA employees. Hence this part will strongly demonstrate the modification and development of the final DMCM. As a result the model will encourage design-led innovation to be embedded in the organizational culture.

### **Findings/Results**

The research findings aim to enrich the knowledge base in the field of design management. By developing a conceptual framework that could be used to transform the organisational culture of an organisation. Therefore leading to change the mindset of key people within an organisation to deliver effective and efficient design-led innovation. According to the design audit conducted for SAA employees and frequent fliers, the research findings focus on the value of design and innovation in SAA and the need of creative people in the organisation. Furthermore design management and user involvement is seriously lacking – even at the design project level. As a result, the research should significantly assist SAA to develop an organizational culture that encourages design-led innovation in the organisation. The DMCM aims to strengthen this approach. Therefore it can be applied to support the implementation of design management at all levels and across different disciplines. The model will have the potential to enhance the perception of design-led innovation beginning from top management right through to the entire organisation. This model will be designed to have the flexibility to be customized for the benefit of design managers for other industries as well.

### **Conclusion / Discussion**

This research aims to propose a new conceptual model, for enhancing the perception of design-led innovation at SAA and assist the organisation towards changing the mindsets of people in the organisation. This project intends to change attitudes and perceptions of design-led innovation by demonstrating a strong relationship between key factors that influence design and innovation in the organisation. The outcome of the design audit examined the key factors: firstly a survey was conducted to identify customer's satisfaction level and use of design in the customer journey. Secondly, the interviews investigated SAA's strategy, structure, support mechanism, behavior towards design-led innovation and communication, which helped in creating the DMCM. Thirdly, the observations supported the outcome of the interviews reinforcing the model's potential to integrate design-led innovation into an organisational culture in an organisation.

### **Future plans / directions**

The progress and results of the design audit will be examined by a creative session to find out if the model will help promote design-led innovation in the organizational culture of SAA. The contribution of this research will be fulfilled after completing this examination.

### **References**

Bruce, M. and Bessant, J. (2002). *Design in business:strategic innovation through design*. Edinburgh Gate, England: Person Education Limited.

## Understanding and ranking resident's requirements in care homes

*Sanaz Sbdollah Shamshirsaz, Hua Dong*

**Keywords (3):** Voice of Customer (Voc), Demand Qualities, Residents

### 1. Introduction

The twenty-first century will be seen as an acceleration of the aging of the global population. Due to increasing the life expectancy and the growing complexity of needs associated with the aging population it is estimated that the number of care home places in UK will require an 82% increase, about 630,000 extra spaces, by 2030.

Despite many advances in care homes quality over recent decades, serious quality problems such as the neglect and isolation conditions of residents have been reported. In most research the lack of voices of older people in care homes is absent and usually other people such as professionals and families speak for them.

This study aim is to capture the voice of the residents regarding their needs and requirements in care homes for the improvement of the quality in the UK.

### 2. Methodology

To satisfy customers, organisations should understand their customer' real needs and requirements. Voice of Customer (VoC) is an effective means of capturing needs and requirements.

#### 2.1 Obtaining VoC Data

For obtaining the VoC data on customer needs and requirements, different methods such as focus groups, brainstorming, interview, customer remarks and complaints method are proposed (Duhovnik et al., 2006 ; Aghlmand et al., 2008). To capture detailed information on customer needs, in-depth structured interviews with a small sample of customers (say 12-15 is highly recommended (Mazure, 1997).

*Sample.* In this study a small sample of 15 residents were recruited; the selection criteria being the ability to communicate, speaking English, having cognitive capabilities to participate in the research, residing in the care home for at least 4 weeks. Interviews were conducted at three different care homes, during a period of 3 months.

#### 2.2 Organizing needs and requirements

For structuring resident's requirements or demanded qualities (DQs), recorded DQs were sorted in a hierarchy from the residents' point of view. Affinity diagram were used to categorise DQs into subgroupings based on their underlying similarity. These groupings were the same as demand qualities but at a higher of abstraction.

#### 2.3 Creating comparison matrix for each group

The analytical hierarchy process (AHP) is a multi-criteria decision technique for hierarchy and prioritising complex factors (Chaplin et al., 2000); it was used to create ratio rankings for all the demand qualities.

Affinity diagrams were then converted to tree diagrams for ranking. Each tree diagram starts with the higher ranked DQs data on the trunk and leads to lower ranked DQs on the leaves.

### **3. Results**

Sixty-four residents' needs and requirements were identified through the Voice of Customer interview; these demand qualities were then divided into five groups: residents, facilities and services, environment, caregivers and activities. Through analysis of the residents' ranking, "family visits" and "accrue medical care" were identified as the most important requirements.

### **4. Discussion and Conclusion**

Residents are well aware of their needs and requirement, even those with cognition issues. Interviewing a small group of residents proved effective in capturing key needs and requirements.

The residents' requirements are broadly related to (other) residents, facilities and services, environment, care givers and activities. The most valued are "family visits" and "accrue medical care".

### **5. Future work**

Future work includes collecting information from a larger sample of residents to understand the level of care home resident's level of satisfaction. The highly-ranked residents' demand qualities will be used in the survey questionnaire.

### **References**

- Aghlmand, S., F. Akbari, A. Lameei, K.Mohammad, R. Small and M.Arab, 2008. Developing evidence maternity care in Iran: A quality improvement study. *Biomedical central pregnancy and childbirth*, 8:20dio:10.1186/1471-2393-8-20
- Chaplin, E. and Terninko, J. (2008), *Customer Driven Healthcare: QFD for Process Improvement and Cost Reduction*, ASQ Quality Press, Milwaukee,WI.
- Duhovnik, J., Kusar, J., Tomazevic, R. and Starbek, M. (2006), "Development process with regard to customer requirements", *Concurrent Engineering*, Vol. 14 No. 1, pp. 67-82.
- Mazur, G.H. (1997), "Voice of customer analysis: a modern system of front-end QFD tools, with case studies", *Proceedings of the ASQC's 51st Annual Quality Congress, May 5-7, ASQ Quality Press*, Milwaukee, WI.

## Using Islamic-Art in branding to deliver a Distinctive Customer Experience

*Hadeel Silsilah, Busayawan Lamand, Sarah Silve*

**Keywords:** Islamic Art, Commercial products, Cultural images, Customer experience

### Introduction

Continuous changes in the economy have encouraged brands to search for new ideas and concepts of developing competitive advantages in order to offer different, yet attractive, products. Organisations excel in creating strong visual identities, and image can encourage consumers' positive attitudes (Dowling 1993). Brands today not only try to differentiate their products' image, style, message and experience, but also seek to reach the highest level of consumer loyalty and appreciation. Previous research discovered strong relations between a favourable visual identity/image and superior business performance. Currently, global brands are trying to inject cultural values into their products in order to penetrate new markets. They need to maintain the global brand identity while adding a cultural flavour into their designs to increase sales. Noticeably, there has not been any significant development in terms of applying Islamic art to international brands/products. Recently, top brands such as Coca-Cola and Starbucks have applied Islamic art to their products to celebrate Ramadan in the Islamic countries despite the fact that these brands do not have any Islamic roots. They clearly want to make their products appeal to Islamic markets.

### Aim & Objectives

The aim of this research is to "develop a conceptual model for applying Islamic Art in branding to deliver a unique brand experience". In order to achieve this aim, there are four five objectives to be completed.

1. To find out the underlying values and benefits behind Islamic Art in brands.
2. To investigate how Islamic Art and culture can be incorporated in brands.
3. To analyse the impacts of the current use of Islamic Art in brand performance.
4. To evaluate the potential of the conceptual model.

### Methodology

The research goals were divided into three main stages. First Stage, focus on conducting secondary research. Based on the literature analysis, second stage is to conduct primary research methods such as, survey, interviews, and case studies. In third stage, the draft and final guidelines prototype will be proposed after conducting two stage experiments. Usefulness, comprehensiveness, appropriateness, clarity, and branding purpose are the areas to be measured by two focus groups of six participants each with different backgrounds such as, graphic designers, artists, brand/Design Managers, and Marketing Director/ Marketing person.

### Findings

Culture acts as a stringent screener that considerably influences message meanings because the encoding and decoding of messages is fundamentally different between cultures, particularly Eastern and Western cultures. "Due to differences in culturally based traditions, religions, and histories, individuals in distinct cultures tend to hold a different set of values and preferences. These cultural differences are, in turn, reflected in the content of marketing communication" (Aaker, 2000). Beyond the functionality issues, accommodating aesthetic elements that appeal to user emotion is extremely crucial in the development of a "user-centric" design (Norman, 2004).

The following points represent key Challenges and design direction on using Islamic art and cultural expression in brands:

- **Islamic art symbols and cultural reference in commercial products:**

It is important to understand the cultural impacts and people's perception of Islamic art symbols and graphics. Graphics should be modernised to a certain extent to deliver the Islamic cultural value and enrich it by the use of Islamic art. Graphics should be developed from the user's perspective.

- **Colour combinations including patterns and textures:**

According to studies; colour can enhance brand recognition by up to 80%. Moreover, different cultures react to colours in different ways, which may require colour testing in the market.

- **Dealing with alphabets and Arabic calligraphy:**

It is considered the strongest element of Islamic art. Also highly appreciated in the Islamic culture as it is the language of the Quran. Many types of Arabic calligraphy exist and each developed in a different period of history. Using calligraphy can significantly enhance value and recognition.

## **Conclusion**

The study clearly indicates that certain images and symbols of Islamic art embedded in commercial products are widely recognised and acceptable. However, these images need to be properly designed so that they can be understood easily and accurately. In addition, the level of awareness of Islamic art and Islamic symbols varies considerably from one person to another. Thus, experimental research is considered crucial in order to address key elements to use Islamic art in brands. Moreover, the process will assist in the construction of the final guideline.

## **Future directions**

The research goal will be achieved after conducting the experiments 1 and 2. By the end of this year, analysis of research experiments is going to form the main contribution of conducting guideline cards. Thus, the research will be finished by the end of third year 2012. However, the writing will continue for few months later.

## **References**

- Aaker, D. A., & Joachimsthaler, E. (2000). *Brand leadership*. New York: Free Press
- Dowling, G. (1993). Developing your company image into a corporate asset. *Long Range Planning*, 26(3), pp.101-9.
- Hoadley, E. (n.d.). The Functions of Color in Human Information Processing. *Loyola University Maryland - A Jesuit University in Baltimore, MD*. Retrieved February 12, 2012, from <http://www.loyola.edu/lattanze/workingpapers/index.html>
- Norman, D. A. (2004). *Emotional design: why we love (or hate) everyday things*. New York: Basic Books.

## Fashioning ‘Conspicuous Creation’ – a user-focused design approach for wearable technologies

*Odette Valentine, Sharon Baurley*

**Keywords:** Wearable technology, open design, connectedness, desirability, fashion, cultural probes

### Introduction

Despite the human user being the central component of a wearable system; to date, the user has rarely been visible within the development of wearable technology (WT) aka ‘smart clothing’ or ‘wearable computing’. The aim of this study is to evaluate how placing the user conspicuously within the design process can challenge ‘technology push’ mechanisms that currently marginalise users and potentially hinder mainstream, commercial adoption of WT [1]. In this respect the work is novel in its socially deterministic approach to the development of WT. Whereas WT has been touted as the future of fashion; this research proposes fashion (when seen as an agent, representative of fluid social and aesthetic meaning) can, conversely, drive the future of these technologies. This paper rationalizes the mix of primary research methods being deployed to evaluate and optimize this human-centred, fashion-focused design approach.

### Approach

Leaving room for adaptation and personalization of products and services by users is an expanding movement within current design practice. ‘Open Design’ facilitated over diffuse communities via digital media, based upon shared knowledge and reciprocity[2], has the potential to more closely align end-products with individuals’ needs and desires; and to equally offer the ‘prosumer’ (i.e producer + consumer)[3] a unique experience of making and appropriating. An initial contextual survey identified a growing number of DIY/hacker-style blogs/websites devoted to creating WT and electronic textiles. These give exposure to finished products but also enable skilled amateurs to share technical knowledge on how to appropriate and source materials and construct soft circuits. Thus primary research is engaging an ‘Open Design’ process that actively involves users in co-designing meaningful WT via digital tools for communication and creation; but uniquely from a creative fashion design perspective i.e. a move from conspicuous consumption [4] to conspicuous creation.

### Methodology

Based upon a co-design loop [5], the primary research falls into three areas:

**Situation & Inspiration:** Preliminary area of work attempting to scope out the current design networks for WT outside of large commercial organization, and the current use of digital tools and media within those networks. This will be done via traditional questionnaires and interviews targeted at lead proponents of the design/hack/DIY maker approach WR (via a recruited panel of *thought leaders*) and also at their audiences i.e. attendees at WT courses, followers of WT blogs. It also seeks to develop contextual and inspirational design input for future WT development via user-centric enquiry around acceptance factors (identified within the literature and contextual survey) that have relevance to both modern digital technologies and fashion. Thus ‘cultural probes’ [6] are being deployed within target user groups. Novelty labeled as ‘curiosity-kits’ to appeal to participants, this ethnographically-based method of probes will explore every day experiences and contexts of: (a) human connection through objects; (b)‘coolness’(desirability); that contribute meaning to personal technologies. A ‘curiosity-kit’ is currently in preparation which will provoke responses via: a diary-like clock exercise for mapping daily ‘connections’; sets of photography and drawing tasks, and a mock-

up task using fabric swatches, fabric ink pens and safety pins. The aim is to obtain a wide and qualitative appreciation of how people make and interpret ‘connection’ and what objects (high- & low-tech) they use to make those connections, and if these could better translate to wearable solutions. Probe outputs and corresponding follow-up workshops will be used to inspire & contextualise design briefs & challenges for the WT open design community.

**Generation & production:** Aims to facilitate hands-on open design for wearable technologies via physical and virtual workshops (via online design challenges) and hack sessions. The aim is to test whether the user-identified aspects of coolness and connection can stimulate tangible design ideas for WT and to understand how the outputs of physical making exercises can be optimally fed-back to the online community to motivate product iteration.

**Utilisation & Evaluation:** Seeks to experience, assess and iterate the outputs of the *Generation & Production* phase based on user interaction with the artefacts produced; evaluated through workshops and potentially (time permitting) a technology probe.

The primary research is participatory in nature – the researcher is both facilitator and actor in the design process. The research will develop a pilot digital platform for open-design to enable interactions between users and designer/makers and free flow of design information. Commencing as a simple blog for dissemination of the user research outputs /design challenges, it will morph in response to the needs, gaps identified by the initial scoping exercise and user feedback.

## Findings

Initial questionnaires conducted with attendees of a *Fashioning Technology* course [7] and members of the London Soft Circuit & Wearable Tech group revealed that they are interested in making wearable tech as much for ‘others’ as for themselves. Most respondents were using online resources to learn about making WT (predominantly for technical info and sourcing) and a vast majority was positive towards developing WT via an online collaborative network; although few were currently sharing and discussing their own projects in this manner.

## Discussion

Initial results support the hypothesis that providing user/makers with research/design inspiration derived from user research (such as the probe exercises) will be useful to them in their design process as it will expand their knowledge of ‘others’ needs/desires. Findings also suggest there is an opportunity space for aesthetic, human centred design knowledge within online design communities.

## Future plans / directions

In constructing ‘curiosity-kits’ it has become apparent that digitally-based activities using web 2.0 tech (e.g. tablet/mobile apps) would update the probe methodology for digitally fluent participants. Tentative steps have been made in this direction by using online photo galleries for data collection. This approach could be enhanced via collaboration with a multimedia developer.

## References

- [1] Dunne, L. (2010) “Smart Clothing in Practice: Key Design Barriers to Commercialization”, *Fashion Practice: The Journal of Design, Creative Process & the Fashion Industry*, vol. 2, no. 1, pp. 41-pp. 41–66.
- [2] van Abel, B., Klaassen, R., Evers, L. et al.: *Open design now: Why design cannot remain exclusive*. Bis, Amsterdam (2011)
- [3] Toffler, A. (1980) *The third wave*. Collins, London
- [4] Veblen,T.(1899) *The Theory of the Leisure Class*, Dover Publications, New York (2004 edition)
- [5] Faud-Luke, A. (2009) [www.faud-luke.com](http://www.faud-luke.com)
- [6] Gaver,W.; Dunne,T. & Pacenti,E. (1999) “Cultural probes”, *interactions*, vol. 6, no.1, pp.21-29.
- [7] *Fashioning Technology* (2011), Evening course, 11 Oct- 6 Dec 2011, V&A Museum, London

## An Exploration of Modular Woven Electronic Textiles by Design Practice

Priti Veja, Sharon Baurley

**Keywords:** Electronic Textiles, Woven Design, Modular Design, Weaving

### Introduction

Textiles are an ideal medium that can fit the transition of hard technology onto a more familiar soft substrate. Electronic textiles (e-textiles) are an area of increasing interest in recent years due to their potential applications such as wearable computing/ technology, responsive personal environments and other product end uses [1].

E-textiles is still a relatively new area of development that aim to truly integrate electronics into and onto textiles; ultimately striving to fuse the two areas together to enable functioning e-textile products [2].

This research is an experimental enquiry of e-textiles materials development through hand woven design practice. The research adopts a design approach to constructing woven soft circuits. Through integrating electronic components via the weaving process, this produces responsive and adaptive woven e-textiles whilst pushing the boundaries of traditional weaving methods. The intention of the research also extends to enhancing and advancing the progression of e-textiles by more considered design through woven structural manipulations that seek to exploit their full potential.

Modular formations have been employed as a design format for the e-textiles, as these will be used to configure multiple modules that can operate in a sequence or as an independent unit. The aim is to develop a series of innovative woven e-textiles samples that will expand into a range of e-textiles modules with integrated connections to create a modular system. The modular design provides adaptable and multifunctional textiles for a variety of end applications.

### Methodology/Approach

Weaving is a form of constructed textiles where the process involves a warp (the vertical threads) and the interlacing of the weft (the horizontal threads). The most basic woven structure is known as plain weave where alternative threads are interlaced and locked into position. There are a vast number of established woven structures used in woven textiles; each producing a different surface texture, visual aesthetic and tactile quality. The weaving processes implemented to make the physical samples of e-textiles in this research are woven by hand on a 24 shaft Arm Patronic dobby loom. Each warp draft is exclusively designed so that it is suitable to execute the type of woven cloth required. The loom is set up and threaded by hand, and weft yarns are selected depending upon the tactile quality needed. One method of manipulating the weaving process is to weave multilayer cloths simultaneously; this technique is commonly known as double cloth when two layers are woven. Using a block draft threading plan and applying a woven double cloth structure enables sections of the cloth to control and interact the layers to make them isolated, enclosed (woven pockets) or exposed. This method is heavily applied to much of the practical output to allow for better integration of electronic components.

The design process followed from concept through to making the woven e-textiles is a series of stages that are instigated and are crucial to the final outcome. Inspirations for the form and function of textiles are sought and used to translate through to the ideation process, that organize and formulate breakdown of ideas to take forward into sketching and making paper/ fabric prototypes. The prototypes help to envisage the physical forms of the textiles and

the complexities of the electronics integration that are then circuit tested. Woven structures are designed and planned to suitably fit each part of the e-textile that are executed via the weaving process. The end samples are tested and analysed, where the results are also used to inspire and reiterate for further sampling.

### **Current Findings**

To date, the research has successfully created functional woven e-textile soft circuits. These are preliminary samples, but have offered a foundation to build developments from that will help to strengthen more sophisticated outcomes. The ability to use woven methods for interactive e-textiles that are able to react and adapt have proved to be possible. Woven manipulations techniques have enabled the integration of some electronic components (both standard and e-textile tailored components) during the weaving process, that are able to imitate electronic circuit behaviours (i.e. soft battery holders, switches, connectors and resistors). By analysing the functions of the e-textile samples, these outputs are implemented back into the design process to improve on and translate to build designs for modular e-textile configurations.

### **Conclusion / Discussion**

Innovative weaving methods have produced a collection of e-textile soft circuits. Analysis of the experimental e-textiles are used as drivers for the next sampling range, which is an ongoing process to simplify and manipulate woven techniques that are suitable for e-textiles. Each collection seeks to improve and challenge novel approaches and functions to woven e-textiles. The samples produced will provide direction to translate these designs into modular formations.

Integrating electronics into woven fabric, forming e-textiles, has vast application in future products. As new technologies and interactive connected products are becoming popular amongst users, this will see more e-textiles being used for these products.

### **Future plans / directions**

The modular e-textiles are planned to be applied to design research workshops with designers and lay persons to evaluate their function and to probe suggested appropriation for potential contexts of use. This would open dialogues of context for specific applications of woven e-textiles for future expansion of this research.

Future research will continue to work through an experimental design-focused process to develop more advanced woven e-textiles; exploring e-textiles on larger scales, with more complex weave structures and to progress them onto a jacquard loom and for potential commercial weaving.

### **References**

- [1] Marculescu, D. et al. 2003, “Electronic textiles: A platform for pervasive computing”, *Proceedings of the IEEE*, vol. 91, no. 12, pp.1995-2018
- [2] Berzowska, J. 2005, “Electronic Textiles: Wearable computers, Reactive Fashion and Soft Computation”, *Textile: The Journal of Cloth & Culture*, vol. 3, no. 1, pp. 58-74



# **Electronic and Computer Engineering Abstracts**

## **Organizing Committee**

Jo Cole

David Smith

Mohammadreza Behjati

Hamdullah Mohib

Duncan Leggat

## Centralized dynamic wavelength assignment to save network capacity

Rafed Sabbar Abbas, Hamed Al-Raweshidy

Electronic and Computer Engineering, Optical Fiber Network

**Keywords:** Multicast (MC), network capacity, dynamic wavelength allocation (DWA), wavelength-division multiplexing (WDM), light splitting (LS), wavelength conversion (WC) and Highest Number of Destination (HND) algorithm

### Introduction

Dynamic wavelength allocation (DWA) in multicast (MC) switching has been investigated in this paper. The aim for this investigation is to maximize the network capacity and minimize the blocking probability in the wavelength division multiplexing network (WDM). By using light splitters (LS) and wavelength converters (WC) in the joint nodes, the WDM network has been improved. By using our multicast switch the power, delay and desperation have been reduced. The results show that our new algorithm called Highest Number of Destinations (HND) has increased the network capacity compared with previous work.

Wavelength allocation is divided into three types: the static wavelength allocation, dynamic wavelength allocation and hybrid wavelength allocation.

**The static wavelength allocation:** is to connect a specific wavelength to a fixed client and it will not be used to any other costumer.

**The dynamic wavelength allocation:** is to connect any available wavelength to any requested client and may be reconnect the same wavelength to another costumer in different time when it is available.

**The hybrid wavelength allocation:** is mixed of the static and dynamic wavelength allocation.

### Design / Methodology / Approach

Opnet, VPI and Labview softwares are used for this work.

#### Greedy Algorithm with Wavelength Conversion:

There are two algorithms proposed in [1] and they are called greedy algorithms. Using greedy algorithms are to minimize network capacity decreasing after each wavelength multicast. We have proposed a wavelength conversion in the network to increase network capacity. The results were successfully improved the network performance compared with the greedy algorithms. [2]

#### Multicast Switch:

We have proposed a new multicast switch and compared its work with two other multicast switches.

In our produced switch [2], we decreased number of splitters, decreased the conversion degree ( $d$ ), and the conversion range between the input and output wavelength has been minimized [13] (convert  $(\lambda_1)$  to  $(\lambda_2)$  better than convert  $(\lambda_1)$  to  $(\lambda_5)$ ). Our new switch called (C-S-C-S) and there are four steps.

#### HND Algorithm:

We have gone deeply in the algorithms performance and we have proposed a new algorithm [3] to increase network capacity without using wavelength conversion because of its highly cost. We called our proposed algorithm Highest Number of Destinations algorithm (HND): Performance of our algorithm is to calculate the number of destinations ( $D_k$ ) is the wavelength  $\lambda_k$  can reach. The number of destinations ( $D_k$ ) for each wavelength is only computed once in the (HND) algorithm.

$(C_k)$  is the cost of assigning wavelength  $(\lambda_k)$  to reach these  $(D_k)$  destinations.

## Findings / Results

The results regarding our multicast switch are calculated the conversion cost as in equation (1) and showing that our suggested switch has very low conversion cost.

We have used a range from 1520nm-1520.8nm and 1520nm-1600nm to show the advantage of using our switch which works with low wavelength conversion range. The simulation results showing also that the delay for both (s-c and s-c-s) switches are greater than our switch (c-s-c-s).

The simulation results proved that the performance of HND has been always better than DCG and SCG performance with deferent design of networks.

The performance of HND with WC is better than all other methods. While wavelength conversion is high costly, we suggest to use HND technology in passive optical network (PON) and HND with conversion in the active optical networks (AON).

## Conclusion / Discussion

In this paper we have proposed a new multicast switch and it has been proved that it has less number of splitters and converters compared with others work. That means our switch is cheaper and energy saving. By our suggested switch we have also decreased the conversion degree, and the conversion range between the input and the output wavelength.

The performance of the proposed switch has been built with a network working with a new multicast algorithm. Our new algorithm is proved in simulation results that it increased network capacity and it has optimization compared with other algorithms. Converters are highly cost and therefore we have used them in sparse scenario.

## Future Plans / Directions

I am on track to complete within the three year time scale, or just some few months more than three years. I just need to complete programming C++ codes and software design.

## References

- [1] Jianping Wang; Biao Chen; Uma, R.N.; , "Dynamic wavelength assignment for multicast in all-optical WDM networks to maximize the network capacity," Selected Areas in Communications, IEEE Journal on , vol.21, no.8, pp. 1274- 1284, Oct. 2003.
- [2] R. S. Abbas, H. Al-Raweshidy; , "*New Multicast Switch-Based Multicast Wavelength Allocation Algorithm to Increase Network Capacity*", first international conference, Baghdad, Iraq, 2012.
- [3] R. S. ABBAS, H. S. Al-Raweshidy, N. Radhi, E. Alabdkreem, "New Multicast Switch and Algorithm to increase Network Capacity", 12<sup>th</sup> international conference, Jouniah, Lebanon, 2012.

## Evaluating augmented, non-augmented and spherical simplex unscented Kalman filters in the presence of weak and strong additive noise

Jahanzeb Akhtar, Dr Roger Powell

Centre for Sensors and Instrumentation

**Keywords:** UKF, augmented and non-augmented, additive noise

### Introduction

The extended Kalman filter (EKF) has widely been used for nonlinear state estimation but the unscented Kalman filter (UKF) [1, 2], is frequently being used due to its advantages over the EKF. The UKF and EKF are compared in terms of accuracy [2, 3] and it is shown that UKF follows the true estimates more accurately. The other advantage is that UKF is comparatively easy to implement as it avoids calculations of the Jacobians.

The augmented and non-augmented Kalman filters have previously been analysed [6, 7]. Yuanxin Wu and Dewen Hu [7] investigated these two forms of UKF and came to a conclusion that augmented form is more accurate as compared to non-augmented form, whereas Fuming Sun, Guanglin Li and Jingli Wang [6] described that augmented UKF does not always have preference over the non-augmented UKF and that their performance is affected by the level of noise.

The paper will be structured as follows. A general overview about UKF will be presented, which subsequently covers the mathematical description of its versions, augmented and non-augmented. An approach which allows using fewer sigma points called Spherical simplex sigma point Kalman filter (SSSPKF) [4], based on its unscented transformation [5], will also be presented.

These algorithms are compared in terms of their robustness against measurement and process noise with the help of a simulation. And finally, comparison of these approaches and the results followed by the conclusion will be presented.

### Design / Methodology / Approach

The UKF [1] uses the whole distribution on  $x$ , not just the mean, to place sigma points and implicitly linearise the dynamics, which we call the unscented transform. In one dimension the sigma point roughly corresponds to the mean and a standard deviation point; the UKF generalizes this idea to higher dimensions.

A set of sigma points is chosen so that the sample mean and covariance is  $\hat{x}$  and  $P_x$  respectively. The following non-linear function “ $h$ ” provides the mapping between the states ( $x$ ) and the measurements ( $y$ ).

$$y = h(x)$$

The nonlinear function is applied to each point in turn to yield a cloud of transformed points, and  $\bar{y}$  and  $P_y$  are the statistics of the transformed points. UKF will be used as a track reconstructor in particle tracking problem.

### Findings / Results

The augmented, non-augmented and spherical simplex UKFs were implemented on a 2-dimensional non-linear system known as Van der Pol (VdP) oscillator using Matlab. It was observed that the non-augmented UKF is more accurate as compared to augmented and spherical simplex UKFs. But in the case of strong noise, the augmented UKF outperforms the other two forms. The strong noise affected the SS-UKF the most. These algorithms were analyzed by varying different noise levels and it was observed that none of these always have preference over the other but they are scenario dependent.

Fifteen computer runs were carried out and average elapsed times for the non-augmented, augmented and spherical simplex UKFs was recorded. SS-UKF is computationally efficient as compared to the other two algorithms since fewer sigma points are calculated and propagated through nonlinear process and measurement functions. Then, the non-augmented UKF is computationally less expensive because the number of sigma points calculated and propagated is less as compared to augmented UKF. For 2-dimensional system, 8, 10 and 13 sigma points are required to be calculated and propagated through the nonlinear process and measurement functions on each iteration, for SS-UKF, non-augmented UKF and augmented UKF respectively.

### **Conclusion / Discussion**

There is a trade-off between accuracy and computational complexity when two forms of UKF and SS-UKF are compared. Non-augmented UKF performs better in the presence of weak additive noise, whereas augmented UKF provides better results when the noise is strong. SS-UKF is computationally less expensive as compared to the augmented and non-augmented UKFs, but is less accurate. Now, there is a choice of three different types of UKFs that can be used according to the desired performance measure.

### **Future Plans / Directions**

The UKF will be implemented on the particle tracking problem, where currently EKF is being used as a track re-constructor. UKF will be compared with the EKF in terms of efficiency. Afterwards, UKF will be evaluated in terms of its robustness against bad data (outliers), and its capability to reconstruct weakly observable modes/states (degree of observability problem). Solving large dimensional alignment problem using parallel computing is also an area of future research. These tasks should be done within 8 months time approximately. And then thesis writing should be started and any improvements should be made.

### **References**

- [1] Simon J. Julier, Jeffrey K. Uhlmann, "A new extension of the Kalman filter to non-linear systems", 1997.
- [2] Colin McManus, "The Unscented Kalman Filter for State Estimation", 2010.
- [3] Eric A. Wan and Rudolph van der Merwe, "The Unscented Kalman Filter for Nonlinear Estimation", 2000.
- [4] Eric A. Wan and Rudolph van der Merwe, "Spherical Simplex Sigma-Point Kalman Filters: A comparison in the inertial navigation of a terrestrial vehicle", 2008.
- [5] Simon J. Julier, "The Spherical Simplex Unscented Transformation", 2003.
- [6] Fuming Sun, Guanglin Li, Jingli Wang, " Unscented Kalman Filter using Augmented State in the Presence of Additive Noise", 2009.
- [7] Yuanxin Wu, Dewen Hu, " Unscented Kalman Filtering for Additive Noise Case: Augmented versus Nonaugmented", 2005.

## Finding the MRAI optimum value of BGP to reduce the convergence time without harming the scalability

*Eatedal Alabdulkreem, Hamed Al-Raweshidy, Maysam Abbod*

**Keywords:** BGP, MRAI, Convergence Time

### Introduction

The internet consists of thousands of computer networks from all around the world [1]. Each network is typically known as a domain or an Autonomous System (AS), which is controlled by a common administrative entity. The Border Gateway Protocol (BGP) is the *de facto* routing protocol between various (AS) in the internet [2]. This protocol allows us to receive the email, surf the web, and connect to whatever desired internet data within milliseconds. That is why it is considered to be the glue that binds networks in the internet and their individual policies together.

BGP is a path vector routing protocol, which means that the BGP speaking system will exchange network reachability information between the BGP systems to find the most efficient path for the data in the Internet. When a BGP router comes up to the internet it establishes connection with its neighbour, which is the other BGP routers that directly communicate with, then it will download the entire routing table of each neighbour router. When a BGP router detects a routing change, an update messages will be sent, the message could be announcement for a new path or withdrawal for a path which does not exist anymore [3]. The convergence time is the time required to reroute packets after a routing change. It has been found that the current convergence delay could stretch into more than hundreds of seconds and can lead to highly packets drop rates [4].

One primary cause for the slow of the BGP convergence is the Minimum Route Advertisement Interval (MRAI), which is a timer with a default value of 30 sec [1]. This timer will force the BGP routers to wait for at least 30 sec before sending advertisement for the same prefix. Even though, this will avoid the storms of the BGP advertisement, according to [5] it may cause unnecessary delayed for the important BGP advertisement. Since the 30 sec is not the optimal value for every network topology, it varies from network to network. Previous studies [6, 7, 8] have agreed on the significant influence of the MRAI on the BGP convergence time, they observed that reducing the MRAI will reduce the convergence time. Finding the optimal value for each network is extremely hard [3]. That lead to the absence of the optimal value for this timer, and made individual network operators decreasing the MRAI timers. This leads to greater timer settings diversity across the Internet. Even though decreasing MRAI timer is intended to improve the routing convergence, it has been found that, ironically, the routing convergence substantially worse because of the timer heterogeneity [9].

This paper aims to find the optimum value for the MRAI timer which improves the convergence process and does not harm the scalability. As until know there is no specific value that is used by all the networks around the internet, there is a need to examine different networks with different configurations to find the value that balances between the convergence time and the scalability. This will be done using the OPNET and the Matlab tools.

## **Design / Methodology / Approach**

1. Generate different networks graphs similar to the internet topology, with different number of nodes, edges, and average degree. The graphs either generated by BRUTE model, or generated from the AS graph extracted from routing tables of the BGP at University of Oregon Route Views Project.
2. Use the contraction method as a reduction method to sample the graphs to meet the simulation tool requirement. To be able to work on a large number of nodes, as the method will remove more than 70% of the whole graph.
3. Configure different scenario for each graph by the OPNET tool, and for each scenario apply different values of the MRAI between 1-9; and collect the results for the convergence time and the number of update messages.
4. Based on the result provide a module using Neural Network in Matlab.
5. Apply the PSO on the model to get the optimum value for the MRAI timer.

## **Findings / Results**

Based on the result have been gathered so far the MRAI timer value should be about 6-10 times smaller than the default value, but the final and optimum value expected by the end of April.

## **References**

1. H. Guo, W Su, H Zhang, and S Kuo, "On the convergence condition and convergence time of BGP", Scincedirect, vol. 34, no. 2, 2011, pages 192-199.
2. Y. Rekhter and T. Li, "A Border Gateway Protocol 4 (BGP-4)" RFC 1771, 1995.
3. M. Yannuzzi, X. Masip-Bruin, and O. Bonaventure, "Open issues in interdomain routing: a survey", network IEEE, vol. 19, no. 6, 2005 ,pages 49-56.
4. C. Labovitz et al., "Delayed Internet Routing Convergence," Proc. ACM SIGCOMM, 2000.
5. T. Griffin and B. Presmore, "An Experimental Analysis of BGP Convergence Time," Proc. IEEE ICNP, 2001, pages 53-61.
6. B. Wang, "The Research of BGP convergence time", ITAIC, vol.2, 2011, Pages 354-357.
7. J. Qiu, R Hao, and X. Li, "The optimal Rate\_limiting timer of BGP for routing convergence",IEICE, vol.88, no.4,2005 pages 1338-1346.
8. N.Laskovic, L. Trajkovic, "BGP with an adaptive Minimum Route Advertisement Interval",IEEE, 2006.
9. A.Fabrikant, U.Syed, and J.Rexford," There's something about MRAI: timing diversity can exponentially worsen BGP convergence", IEEE INFOCOM, 2011.

## Design of a neural predictive controller for nonholonomic mobile robot based on posture identifier

Ahmed Al-Araji, Maysam Abbod, Hamed Al-Raweshidy

Wireless Networks and Communication Centre

**Keywords:** Nonholonomic Mobile Robots, Adaptive Predictive Control, Neural Networks, Trajectory Tracking

This paper proposes an adaptive neural predictive controller to guide a nonholonomic mobile robot during trajectory tracking. The structure of the controller consists of two models that describe the kinematics and dynamics of the mobile robot system and a feedforward neural controller. The models are modified Elman neural network and feedforward multi-layer perceptron respectively. The modified Elman neural network model acts as the position and orientation identifier. The feedforward neural controller is trained off-line to find the reference torques, which controls the steady-state outputs of the mobile robot system. The feedback neural controller is based on the posture neural identifier and quadratic performance index optimization algorithm to find the optimal torque action in the transient state. Simulation results show the effectiveness of the proposed adaptive neural predictive control algorithm; this is demonstrated by the minimised tracking error.

### Introduction

The aim of the present paper is the utilization of a simple approximation neural network to predict the posture of the nonholonomic mobile robot for N-step-ahead and to design an adaptive nonlinear neural controller with optimization algorithm. The predictive optimization algorithm for N step ahead could be generated excellent feedback control action in order to reduce the effect of external disturbances. Simulation results show that the proposed controller is robust and effective in terms of fast response and minimum tracking error and in generating an optimal torque control action despite of the presence of bounded external disturbances [1, 2, 3, 4 and 5].

### Design / Methodology / Approach

The approach to control the mobile robot depends on the available information of the unknown nonlinear system can be known by the input-output data only and the control objectives. The predictive optimization algorithm is used to determine the torque control signal for N-steps-ahead and to use minimum torque effort. The torque control signal will minimise the cost function in order to minimise the tracking error as well as reduce the torque control effort in the presence of external disturbance.

The proposed structure of the adaptive neural predictive controller consists of:

- a) Position and Orientation Neural Network Identifier.
- b) Feedforward Neural Controller.
- c) Feedback Neural Controller.

### Findings / Results

The main advantage of the presented approach is the analytically derived control law which has significantly high computational accuracy with predictive optimization technique to obtain the optimal torques control action and lead to fast response with minimum tracking error of the mobile robot for different types of trajectories with continuous gradients such as

(lemniscates) with bounded external disturbances. Simulation results show that the five step-ahead prediction gives better control results, which is expected because of the more complex control structure, and also due to taking into account future values of the desired, not only the current value, as with one step ahead.

### **Conclusion / Discussion**

The proposed control scheme minimises the quadratic cost function consisting of tracking errors as well as control effort. Simulation results illustrated evidently that the proposed adaptive neural predictive controller model has the capability of generating smooth and suitable torque commands without sharp spikes. The proposed controller has demonstrated the capability of tracking lemniscates desired trajectories and minimises the tracking error approximately 0.01m for five steps ahead-prediction.

### **Future Plans / Directions**

Are you on track to complete within the three year time scale? Yes

### **References**

- [1] R-J Wai and C-M Liu, Design of dynamic petri recurrent fuzzy neural network and its application to path-tracking control of nonholonomic mobile robot. *IEEE Transactions on Industrial Electronics*, 56(7), 2009, pp. 2667-2683.
- [2] F.N. Martins, W.C. Celesta, R. Carelli, M. Sarcinelli–Filho, and T.F. Bastos–Filho, An adaptive dynamic controller for autonomous mobile robot trajectory tracking. *Control Engineering Practice*. 16, 2008, pp. 1354-1363.
- [3] J. Ye, Adaptive control of nonlinear PID-based analogue neural network for a nonholonomic mobile robot. *Neurocomputing*. 71, 2008, pp. 1561-1565.
- [4] M.K. Bugeja, S.G. Fabri and L. Camilleri, Dual adaptive dynamic control of mobile robots using neural networks. *IEEE Transactions on Systems, Man, and Cybernetics-Part B: CYBERNETICS*, 39(1), 2009, pp. 129-141.
- [5] Jun Ye, Tracking control for nonholonomic mobile robots: integrating the analogue neural network into the back-stepping technique. *Neurocomputing*. 71, 2008, pp. 3373-3378.

## Extract depth map from holoscopic image using auto hybrid disparity analysis algorithm

*Eman Alazawi, Amar Aggoun, Maysam Abood*

**Keywords:** 3D-Holoscopic Image, Depth Map, Automatic Thresholding, Mask Enhancement

### Introduction

Integral image is known as a three dimensional imaging technique for glassless Holoscopic Image (HI). A major requirement for modern electronic 3D image data processing systems consists of creating a depth map from this three Dimensional Holoscopic Image (3DHI). Hence, a significant problem in 3DH content processing is being able to indentify 3D objects in the scene, also known as a 3D depth map [1].

3D imaging is a significant role in today's society and in the future. This creates a more realistic viewing experience to real life. This has created a new market because of the potential and capability to viewing and displaying these images. 3D holoscopic imagining creates full colour 3D optical models. The images produced by this method eradicate the effect in which objects are flattened in to discrete depth planes. The images exist independently of the viewer's position. 3D images can operate under incoherent illumination and allows a more conventional live display [2].

In aid to improve the next generation of HI techniques based on 3DTV, a robust process of generating a depth map from 3-DHI must be investigated. This new viewing system technique benefits the users by minimization of eye tensioning effects that could results in headaches and sicknesses, the ability of being able to obtain image data with just a single aperture camera. This captured image can then be replicated on a predictable flat panel display with a lenticular lens foil [2,3,4].

This study is aimed at translating depth information embedded in a planar recording of a 3D-HI by an algorithmic approach. By using various technologies for 3D object extraction and recognition, this algorithmic approach extracts depth information from HI and displays the 3D object with high and lower quality from a single camera capture. In this technology, the information necessary for 3D spatial representation exists in 2D format. Segmentation is a process for indentifying 3D objects in the scene. The main purpose of this is to develop a technique for depth estimation of a 3D holoscopic video segmentation. As a starting point, the work described in [2,3] will be considered.

### Design / Methodology / Approach

The methodology involves three different steps;

Firstly, a high performance language for technical computing such as MATLAB is used to implement a hybrid algorithm combining “ Feature block pre-selection” and “consistency post-screening” technique along multi-baseline and neighborhood constraint and relaxation techniques. This step aims to pursue and extract a depth map data file corresponding to the Unidirectional Integral Image UII data through Viewpoint Image Extraction (VPIE). To set feature blocks from Two-Dimensional ViewPoint Images (2-DVPI), an automatic threshold technique based on feature detection has been implemented in a Hybrid Disparity Analysis Algorithm (HDAA). This technique of selecting feature blocks automatically is based on the distribution of variances in the sub-dividing non-overlapping images. A threshold is selected for variance after calculating the mean and variance for each chosen block. The main advantage of this method is that it is much less time-consuming than manual thresholding [4] and can be applied to a large number of images. An application for this proposed algorithm to Unidirectional Holoscopic Image (UHI) to extract 3D information map (Disparity map) is

discussed. The second step is to generate Auto-Mask to enhance the depth map using the FBPT blocks as seed points to grow on the Region Of Interest (ROI) to separate the foreground from the background. The final step is image segmentation using automatic mask enhancement techniques to separate the 3D information map (depth map) from background (noises).

### **Findings / Results**

The algorithm is now tested on a Unidirectional HI (Horse man and Tank, respectively) choosing the fifth VPI as a reference image. Results have proven to show that using automatic threshold techniques are more efficient and less time consuming and also emit less noise than manually selecting features. Automatic Feature block Pre-selection Threshold (AFBPT) technique results show that selecting features from VPI improves the efficiency of the proposed algorithm. As the number of neighboring blocks increase, experimental results have shown improvements on the feature selection and extraction through this automatic technique, which appears on the final depth map results.

### **Conclusion / Discussion**

Accurate depth measurement has achieved on the testing Horseman and Tank data and depth maps.

The results indicated the differences of automatically and manually feature selecting. It shows a slightly higher difference with the new method (AFBPT) than the manual threshold results (FBPT) [4].

### **Future Plans / Directions**

New automatic feature blocks selection technique is to be determined by using edge detection methods based on Multi-Quantization Adaptive Local Histogram Analysis (MQALHA).

### **References**

- [1] Amar Aggoun, “3D Holoscopic Imaging Technology for Real-Time Volume Processing and Display” Signals and Communication Technology, 2010, IV, 411-428, DOI: 10.1007/978-3-642-12802-8\_18., 2010,
- [2] Wu, C., Aggoun A., “Depth measurement from integral images through viewpoint image extraction and a modified multi-baseline disparity analysis algorithm”, J. Electron. Imaging 14, 023018, doi:10.1117/1.1902998, (May 05, 2005).
- [3] Chun Hong Wu; McCormick, M.; Aggoun, A.; Kung, S.Y.; ” Depth Mapping of Integral Images Through Viewpoint Image Extraction With a Hybrid Disparity Analysis Algorithm”, diurnal of display technology, Vol. 4, No. 1, pp101-108,2008.
- [4] Y. Nakagawa and A. Rosenfeld, “some experiments on variable, thresholding,” Pattern Recogn. 11, 3, pp. 191–204, 1979.

# A data model for processing financial market and news data in electronic financial System for investors with non- financial expertises: the case of Saudi Arabia

*Abdulaziz Aldaarmi, Maysam Abbod*

**Keywords:** Capital Asset Pricing Model (CAPM), Fama and French 1993 (FF1993), Decision Support System (DSS), Particle Swarm Optimization (PSO), Fuzzy logic Operators (FL).

## Introduction

Some studies have found evidence that stock returns are predictable using micro and macro variables, others failed to find any support at all for the ability of certain micro or macro variables to predict returns. In other words, evidence of the predictive ability for a given variable has not always been found. The mixed results make it difficult to determine which particular micro or macro variables (if any) are reliable.

Therefore, the problem of this study is to examine whether the predicting power of stock return can be improved in Saudi Arabia Stock Exchange (Tadwal) by using computer-based information systems (artificial networks).

Moreover, this study argues the efficiency of Saudi Arabia Stock Exchange. If attempts to improve the predicting power of stock return in Saudi Arabia Stock Exchange through the use computer-based information systems made the market inefficient, then there are two possibilities. This inefficiency may be due to the fact that it is an emerging market. Alternatively, the predication power of stock return in Saudi Arabia Stock Exchange (ASE) cannot be improved by using the computer-based information systems.

According to this problem, I can introduce the following objectives:

- 1- Determining the accuracy of computer-based information systems in predicting stock price movement for companies traded in Saudi Arabia Stock Exchange (Tadwal).
- 2-Comparing the capital asset pricing model (CAPM) and Fama and French's three factor model to the predictive power of computer-based information systems using artificial networks.
- 3- Specifying a model that may predict the stock return in Saudi Arabia Stock Exchange (Tadwal) by applying the factor of CAPM model, the three factors of Fama and French model at the micro level.

## Design / Methodology / Approach

The Models:

1-CAPM Model

$$R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + \varepsilon_i$$

2-Fama and French 1993 Model

The equation of this model:

$$R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + \gamma_i R_{SMB} + \delta_i R_{HML} + \varepsilon_i$$

We tested the FF model to find if the three factors (market return, size and book-to-market ratio) affect the portfolio return (if the coefficients are significantly different from zero) by conducting the GMM regression and time series (HAC) to find out if the value of intercept  $\alpha$

equals zero or not. Its being equal to zero would mean the FF model captures the cross sectional variation in stock returns.

If the intercept in the three factor model was closer to zero than the intercept in the CAPM model, then the FF model would capture the cross sectional variation in stock better than CAPM model.(fama&French,1993; fama&French,2004)[1][2].

### **Findings / Results**

The Expected Results:

- 1- The three factor model will have bigger explanatory power than the CAPM.
- 2- It will show that three factors do a good job in explaining the common variation in stock returns and capturing the cross-section of average return.
- 3- Finally, it will show that Artificial Neural Networks are useful in predicting stock return in Saudi Stock Exchange, which means that there is an evidence of Saudi stock inefficiency at the weak form.

### **Conclusion / Discussion**

The famous Fama and French model can be applied in developed and emerging markets; the analysts in Saudi Arabia should use it in pricing the stocks and portfolios variables Market, Size and Book to Market Value should be considered in any further pricing models.

Talking about the Market Efficiency side; even though the Saudi Arabia Market improves its efficiency, it still is an emerging market, and investor can benefit from Artificial Neural Networks and get abnormal return.

### **Future Plans / Directions**

During the study period (2007-2011) the researcher has collected all available stock prices relating to all companies in Tadwal [3].

In the coming month, I will run the GMM Generalized Methods of Moments Regression for Fama and French and CAPM Models using the E-views and Matlab.

### **References**

- [1] Fama, E. and French K. (1993), “Common Risk Factors in the Return on Stocks and Bonds,” Journal of Financial Economics, 33, 3-56.
- [2] Fama, E. F., and French. K. R. (2004), “The Capital Asset Pricing Model: Theory and Evidence.” Journal of Economic Perspectives, 18, 25-46.
- [3] Saudi Stock Exchange (Tadawul) <http://www.tadawul.com.sa/> (accessed February 16, 2012).

## Investigation of the biological and medical waste management in Riyadh, Saudi Arabia

*Abdullah Al-Hadlaq, Wamadeva Balachandran, Zayed Huneiti*

**Keywords:** Waste Management, Medical Waste, Biohazard Waste, Waste Generation.

### Introduction

As in many other developing countries, the generation of regulated medical waste (RMW) in Saudi Arabia has increased significantly over the last few decades. Waste generation depends on numerous factors such as waste management methods, administrative categories of the hospital establishment, specializations of the hospital, ratio of reusable items in use and the number of day-care patients. For proper handling of waste generated, it is equally important to predict the amount of waste generation beforehand.

The management of medical waste is of great importance due to its potential environmental hazards and public health risks. In the past, medical waste was often mixed with municipal solid waste and disposed in residential waste landfills or improper treatment facilities in Riyadh city. To realize a sustainable development within hospitals, it is necessary that the need to maintain a balance between effective infection control and a good ecological environment is recognized and supported by health-care workers and the hospital management (Daschner and Dettenkofer, 1997).

In order to quantify the amount of medical waste generated in Riyadh, a research study was carried out with the desire to propose an efficient management system that will reduce environmental risks and economic costs as well as improve social acceptability. The main goals of this study were to characterise the biohazard wastes generated by these hospitals, to report the current status of medical waste management, to provide a framework for the safe management of these wastes at the considered hospitals as well as to recommend establishing training programs on the proper waste management for all healthcare workers. The paper is aimed to present the results of the study which was undertaken

### Design / Methodology /Approach

The methodology for conducting this study can be broken down into four major tasks, these are:

Development of the questionnaire; identifying the main waste generators in Riyadh city; conducting site visits to a selection of waste generators; and analysis of results in order to make projections regarding waste generation and management procedures in the selected hospitals.

The objective questionnaire based on the guidelines of the safe management of waste from health care facilities (WHO 1999), was administrated in each hospital. Health care manager, nurses, waste handler both inside and outside hospitals were among those interviewed.

### Findings / Results

The study revealed that of the total hospital waste generated, approximately 10% is hazardous, 85% is general (non risk) waste while a small percentage (5%) is labelled as highly hazardous. There are different estimates regarding the share of hazardous and non-hazardous constituents of healthcare waste. The percentage of 10 -25 % of healthcare waste is regarded as hazardous (medical waste) and may create a variety of health risks. While the pathological and infectious waste represent 15% sharp, chemical and pharmaceutical waste represent 1% and 3% of the general waste respectively. In addition, less 1% is considered as special waste such as radioactive or cytotoxic waste pressurized containers or broken thermometers and used batteries (pruss et al 1999 and Sharma 2002).The World Health Organization (WHO)

estimated the total medical waste per person per year is anywhere to be from 0.50 to 3.00 kg/bed/day in both developing and less developed countries. The study has shown that the total waste generation rate for government hospitals is about 4,733kg/day, representing an average of waste generation rate of 0.5kg/bed/day. While the total waste generation rate for the private hospitals is in the region of 2,107kg/day, giving an average of waste generation rate of 0.75kg/bed/day.

For the government hospitals according to the survey operating rooms OR was most frequently listed as the largest source of medical waste while ER was cited the second. For the private hospitals according to the survey operating rooms OR was most frequently listed as the largest source of medical waste while OB\GYN was cited the second.

### **Conclusion / Discussion**

Health care waste management in Riyadh's hospitals is not up to the mark. The general awareness on the subject is very much lacking on part of managers, producers, and handlers of waste.

The generation of medical waste in health care facilities has been increasing in quantity and variety, due to the wide acceptance of single-use disposable items. The management of medical waste has been of major concern due to potentially high risks to human health and the environment. Incineration with emission control and microwave irradiation will be dominant as a medical waste treatment because other common treatment methods will no longer be available in the near future Other potential treatment technologies, such as plasma arc, should be examined as alternatives to incineration in order to better manage medical waste in Riyadh's hospitals. The paper lists several recommendations.

### **Future plans / Directions**

To continue with the data analysis and the write up of my PhD. I plan to finish writing up by the end of October 2012.

### **References**

1. F.D. Daschner, M. Dettenkofer, Protecting the patient and the environment—new aspects and challenges in hospital infection control Journal of Hospital Infection, Vol. 36, Issue 1, Pp 7-15, 1997.
2. The World Health Report, 1999.
3. Prüss, Annette Giroult, Eric Rushbrook Philip, Safe management of wastes from health-care. ISBN 92 4 154525 9 (NLM classification: WA 790), 1999.
4. Sharma, Hospital Waste Management and its Monitoring. Jaypee Brothers Medical Publishers (P) Ltd. New Delhi, pp 96, 2002.
5. World Health Organization (WHO) 2000. Safe health-care waste management Aide mémoire for a national strategy for healthcare waste management, at World-Wide Web,[www.healthcarewaste.org](http://www.healthcarewaste.org).

## **Performance measurements and analysis of CDMA in Iraq**

*Kassim M. Al-Hassani, John Cosmas*

### **Introduction**

Iraq may be considered as the largest wireless market in the Gulf region. A key driving factor in the market of wireless communication is the enormous growth in the mobile phone market over the last five years leading to almost 20 million subscribers in 2008. Moreover, there are several technologies and services working in Iraq; three GSM, CDMA national operators and three CDMA provinces operators. The recent growth in the mobile phone market and the next-generation wireless technologies in the Iraqi Wireless Communication market is based on Global System for Mobile (GSM) communications and Code Division Multiple Access (CDMA) standards.

My Research to investigate the performance and interferences in the services and the reasons for the bad QoS. Many questions addressed and studied methodically and answered clearly: Do the Multi-Coalition Forces cause the interferences, jamming, higher rate of calls drop and false ringing? Or they are caused by bad design and planning; Do we need to optimize our network due to the large number of users? This will include Analysis of the providers and measurements of performance and reasons for the deterioration of wireless services. Measurements from all service providers and government agencies will be gathered.

On the other hand, efficient utilization of frequency allocations among the Ministry of Communications (MoC), Iraqi National Communications and Media Commissions (CMC) and Private Operators will be discussed as well as planning and optimization of their networks, i.e. area coverage), operators' management of frequency and the allocation of the right channels and enough Band guards by the CMC.

Recommendations for the best approach for deploying the Wireless communication technologies, methods to improve the quality of service and how to manage the frequency more efficiently.

## Analysis of energy management in hospitals

*Saleh Alhurayess, Mohamed Darwish*

**Keywords:** Energy management, Energy management in hospitals, Energy consumption in medical centres

### Introduction

Huge amounts of energy are consumed by hospitals to improve the health environment for patients. This energy needs to be stable and continuous. Therefore, it is necessary to manage energy consumption. The main aim of such an energy management program is to optimise energy consumption in order to reduce costs and save energy.

The purpose of this research is to analyse energy consumptions in hospitals, taking into account different types of loads (air conditioning, medical equipment, etc.). The research will present how present energy management programmes in hospitals are implemented and how future energy management can be put in place. The research will also evaluate facilities and identify energy-saving opportunities through the characterisation of energy types used in hospitals.

### Design / Methodology / Approach

This research focuses on the study of energy consumption in hospitals in Saudi Arabia (as a case study); it also surveys energy programmes and presents action plans to optimise energy consumption. The research is focusing on hospitals due to the demand for the stable and continuous source for energy. In addition, the research is targeting in collecting data for the secondary and tertiary hospitals in healthcare services in Saudi Arabia. The research will measure the awareness of staff in hospitals in energy management. The research faces some problem such as difficulty in finding the information and the long process of getting permission to acquire the data.

The research is aimed at presenting an action plan and suggesting framework for managing energy and reducing energy consumption in hospitals; it is guided by some standards in energy management. For example, ISO 50001:2011 and BS EN 16001:2009 can help hospitals to specify the requirements to create, implement, maintain, and improve energy management systems and the applicable requirements for the use of energy [1][2]. In addition, the implementation of IEEE Standards (739-1995) can help to improve practical energy management in hospitals by providing a standard design practice to help engineers from an energy perspective to assess electrical options and establish engineering procedures and techniques [3].

### Findings / Results

By studying energy consumption and types of loads, researchers have concluded that air conditioning and appliances (especially medical equipment) in hospitals in Saudi Arabia consume the highest amounts of electrical energy. For example, it is reported that 42% of electrical energy in public and private sectors, including hospitals, in Saudi Arabia is used for appliances, about 38% is used for air conditioning, and 20% is utilised for lighting [4]. Furthermore, it is calculated energy consumption, determining that air conditioning, appliances, and lighting use the most electricity; they reported that air conditioning in hospitals consumes the most energy[5].

### **Conclusion / Discussion**

The energy management programmes are essential for hospitals especially in Saudi Arabia where the demand for air conditioning is increasing due to the hot weather and in the same time the air conditioning is the highest consumer for energy in Saudi Arabia. However, the results and findings are encouraging and within the direction of the research.

### **Future Plans / Directions**

The conducted questionnaire and model will be tested; recommendations and suggested framework will be written. This research will be finished within three years of PhD.

### **References**

- [1] ISO 50001:2011, International Organization for Standardization(ISO), 2011.
- [2] BS EN 16001 ‘Guidance and requirements for energy management systems’, British Standards Institution, 2009.
- [3] IEEE Standards (739-1995): “IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities”, IEEE, 1996
- [4] Ahmad A, Abdelrahman MA, Billote WC. 1994. “Analysis of electric energy conservation in a commercial building in Saudi Arabia”. Proceedings of the 2nd Saudi Symposium on Energy Utilization and Conservation, November 27–30. Dhahran, Saudi Arabia
- [5] Dincer, I., Hussain M. M. and Al-Zaharnah, I. (2004), “Analysis of sectoral energy and exergy use of Saudi Arabia”. International Journal of Energy Research, 28: 205–243.

## E-health readiness and challenges facing e-health deployment in nursing: Jordan as a case study

*Rasmeh Al-Huneiti, Wamadeva Balachandran*

**Keywords:** E-health, E-health readiness

### Introduction

E-health is a collective term that broadly encompasses the disciplines of health informatics, telehealth and e-learning. The most often quoted definition for e-health is: an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the use of Internet and related technologies. E-health characterizes the technical development, state-of-mind, way of thinking, attitude, and commitment for networked global thinking, to improve healthcare using Information and Communication Technology (ICT) [1].

E-health Readiness refers to the preparedness of healthcare sectors for the expected transition brought by programs linked to ICT. Literature on e-health readiness reflect the fact that the best way to implementing, integrating and embedding e-health systems into routine health care practice is a challenge for health service managers and clinicians.

The objective of this study is to investigate the current e-health readiness in Jordan from the perspective of nursing community, with the focus on the main challenges which hinder e-health adaption and implementation within the nursing profession.

### Design / Methodology / Approach

A comprehensive questionnaire was developed with the aim to gather information about the current use and readiness of e-health. A sample of 241 nurses working at both government and private hospital in Jordan were surveyed. To achieve the full understanding of the questions by nurses who use English as a second language, the questions concentrated on the main issues with short and simple wording. The completed questionnaires were collected and analyzed using Statistical Package for Social Sciences (SPSS) software.

### Findings / Results

The completed questionnaires were checked to ensure completeness, consistency and readability. Then, the responses were arranged in a form that enabled them to be analyzed. Furthermore, to facilitate comprehension the results were arranged in three clusters (high, medium and low) in accordance to the degree of importance. Quantifiable data from the questionnaires were coded into the Statistical Package for Social Sciences for analysis. SPSS was used because it is considered to a reliable software package for the statistical analysis of data that is widely used. Statistical techniques were then used to analyze the data collected

from the survey. The results showed that the top challenges facing e-health implementation are of educational related aspect.

### **Conclusion / Discussion**

The results revealed that nurses lack the necessary knowledge towards e-health processes and applications. Consequently, a plan for promoting and providing education on the benefits and use of e-health processes and applications, as for ICT, is a paramount. This is principally in agreement with findings of reviewed literature [2-3]. It was pointed out that training and infrastructure has the potential to facilitate the implementation of e-services including e-health [2]. Internet has been considered as a way to streamline healthcare administrative costs and improve communication among healthcare organizations [3]. The integration of ICT in healthcare has been slow due to the lack of infrastructure, high cost, computer illiteracy, restrictive telecommunication legislations, the lack of human capacity in the field of e-health and the lack of systematic education in e-health [4-5]. Moreover, Health literacy has been identified as a public health goal for the 21st century and a significant challenge facing health care globally [6]. Hence, the outcome from this study justifies the need to establish an educational framework for e-health implementation since e-health is an opportunity to improve efficiency, reduce costs, facilitate communication and enhance patient care.

### **Future Plans / Directions**

To replicate the study in Qatar to draw up a conclusion related to the challenges of e-health adoption in developing countries in order to develop a model that can be implemented in GCC countries and the neighboring countries.

### **References**

- 1 Eysenbach, G., 2001. What is e-health? [online] Available at: <<http://www.jmir.org/2001/2/e20/>> [Accessed 1 Feb 2012].
- 2 Thinyane, M., 2006. Preliminary Investigation into the Implementation of ICTs in Marginalized Communities. [pdf] Available at: <http://www.satnac.org.za/proceedings/2006/papers/No%202013%20-%20Thinyane.pdf> [Accessed on 1, Nov, 2011].
- 3 Hugenholz ,N. et al ,2008. Effectiveness of e-learning in continuing medical education for occupational physicians ,Occupational Medicine 2008; Volume 58,370-372
- 4 Mars, M., 2010. ELearning for e-Health in Africa,Global Telhealth 2010,10-12 November. Fremantle, Perth, Western Australia.
- 5 Edirippulige, S., (2008) Pre-registration nurses: an investigation of knowledge, experience and comprehension of e-health, Australian Journal of Advanced Nursing, Volume 25 Number 2. Australia.
- 6 Norman, C. and Skinner, H., 2006. E-health Literacy: Essential Skills for Consumer Health in a Networked World, Journal of Medical Internet Research.2006; Apr-Jun; Volume 8(2).

## UK electricity market modeling using combined conjectural variation equilibrium method and hierarchical optimization algorithm

*Amir Hessam Alikhanzadeh, Malcolm Irving*

*Electricity Market Analysis, Brunel Institute of Power Systems (BIPS)*

**Keywords :** BETTA, bilateral electricity market, Conjectural Variation equilibrium models, Hierarchical optimization method, Nash equilibrium, Pattern-Search algorithm

### Introduction

This Paper focuses on bilateral electricity market, like BETTA, using equilibrium modelling to reduce the exposure to the risks. In BETTA environment where, all the participants compete in both spot market bidding and bilateral contract trading using equilibrium model, Conjectural Variation (CV) equilibrium model helps to manage the market participation risks<sup>1</sup>. The main formulation and analysis of Conjectural equilibrium for bilateral market will be reviewed also, in order to use this approach a Conjectural Variation (CV) should be defined for each firm; this conjecture is a belief or prediction of a player on the response of its rivals in terms of changing its output quantity, which can be defined as:

$$CV_{ij} = \frac{\partial q_j}{\partial q_i} \quad j \neq i$$

### Design / Methodology / Approach

It is essential to mention that this approach is based on Nash Equilibrium, which means when the market reaches equilibrium each firm doesn't have any incentive to change its strategy and their strategies are the best response to their rivals'. The main objective of each participant in the market is making more profit and since the BETTA is a double-sided market where both generation and supply companies participate; therefore the objective functions for generation and supply firms can be defined respectively as<sup>2</sup>:

$$\begin{aligned}\pi_{ig} &= p_d q_{ig} - C_{ig}(q_{ig}) & (i = 1, \dots, n) \\ \pi_{id} &= p_r q'_{id} - p_g q_{id} - f_{ci} & (i = 1, \dots, m)\end{aligned}$$

Where ' $\pi_{ig}$ ' and ' $\pi_{id}$ ' are the profits, ' $q_{ig}$ ' is the output quantity of GenCo  $i$ , ' $q_{id}$ ' is the purchased value of SupplyCo  $i$ , ' $q'_{id}$ ' is the amount of electricity sold to end-users by SupplyCo  $i$ , ' $p_d$ ' is the initial inverse demand curve, ' $p_g$ ' is the initial inverse generation curve, ' $p_r$ ' is the electricity retail price, ' $f_{ci}$ ' is fixed cost e.g. salary of employers and cost of equipment and etc. and ' $C_{ig}(q_{ig})$ ' is the cost function of each GenCo .

It will be discussed and calculated in the full paper that, the outputs of each GenCo and SupplyCo are functions of CVs:

$$q_{ig} = \frac{e - f q_{ig} - b_i}{f(2 + CV_{ig}) + c_i}, \quad q_{id} = \frac{p_r - e' - f' q_{id}}{f'(2 + CV_{id})}$$

Both ' $e$ ' and ' $e'$ ' are intercepts of inverse demand and generation curve respectively, also ' $f$ ' and ' $f'$ ' are the slopes of those curves and can be updated through a co-ordination algorithm, consisted of a conjectural variations equilibrium model of an oligopolistic set of generators with a corresponding oligopsonistic equilibrium model of a set of supply companies.

Hence, the co-ordination algorithm contains these steps:

*Step 1) Initialize inverse demand curve and generation curve:*

$$e^{(0)} = 100, e'{}^{(0)} = 10, f^{(0)} = 1, f'{}^{(0)} = 1$$

*Step 2)* Define the generators' cost function variables,  $a_i, b_i, c_i$  for oligopolistic market and retail price,  $p$ , for oligopsonistic market.

*Step 3)* Define the  $CV_{ig}$  and  $CV_{id}$  based on historical data and technical characteristics of each generator and supplier respectively.

*Step 4)* Computing the output of each generator company,  $q_{ig}$ , and the purchased amount of electricity by each supplier,  $q_{id}$ , using Eq. (25) and Eq. (26).

*Step 5)* Calculating the  $\sum_{i=1}^n q_{ig}$  and  $\sum_{i=1}^m q_{id}$ .

*Step 6)* Computing the value of prices in oligopolistic and oligopsonistic market,  $P_g$  and  $P_d$  based on inverse demand function and inverse generation function respectively.

*Step 7)* Using Hierarchical Optimization method, try to:

$$\text{Min } (\sum_{i=1}^n q_{ig}^{(k)} - \sum_{i=1}^m q_{id}^{(k)})^2 + (p_g^{(k)} - p_d^{(k)})^2 \quad (27)$$

where, all  $\sum_{i=1}^n q_{ig}^{(k)}$ ,  $\sum_{i=1}^m q_{id}^{(k)}$ ,  $p_g^{(k)}$  and  $p_d^{(k)}$  are functions of  $\{e, f, e', f'\}$ . MATLAB can be used in order to perform this least square optimization problem.

*Step 8)* If the objective function satisfied, the equilibrium point  $(\sum_{i=1}^n q_{eq}^*, p_{eq}^*)$  can be calculated then go to *step (9)*. If not, the optimizer keeps increasing the number of iterations,  $k = (k + 1)$ , and:

$$e^{(k+1)} = e^{(k)}, e'{}^{(k+1)} = e'{}^{(k)}, f^{(k+1)} = f^{(k)}, f'{}^{(k+1)} = f'{}^{(k)}$$

then go to step (4).

## Conclusion / Future Work

The assumed curves are iteratively adjusted with the objective of obtaining a 'match', in both quantity and price, between the two equilibrium models. This match can be found by a hierarchical optimization approach, using Matlab Pattern-Search optimization method, in which a coordination level optimization adjusts the slopes and intercepts of the supply and demand curves until a minimum imbalance between the two equilibrium models is found (the below figure). The coordinated solution, which can be viewed as representing a virtual broker between the oligopoly and the oligopsony, determines the output levels of all generators and the purchase levels of all suppliers. Future works would contain a unique method to consider CVs Calculations and BM modelling.

## References

- <sup>1</sup> X. P. Zhang, Restructured Electric Power Systems: Analysis of Electricity Markets with Equilibrium Models, 1<sup>st</sup> ed., US: Wiley Press-IEEE Press, 2010.
- <sup>2</sup> Song, Y. Ni, F. Wen, Z. Hou, F. F. Wu, "Conjectural variation based bidding strategy in spot markets: fundamentals and comparison with classical game theoretical bidding strategies" International Journal of Electrical Power & Energy Systems, vol. 26, issue 10, pp. 797-804, Dec. 2004

## User-centric multi-policy optical internet flow modelling management

*Mohammed Al-Momin, John Cosmas*

*Computer Networks*

### **Introduction**

The future Internet is likely to involve many organizationally distinct network users such as broadcasters, communication, and games service providers and it is impossible to predict what policies these users may need in the future. Therefore the future Internet is likely to provide not only a data plane that is high capacity, through the provision of modern optical and wireless access and core networks, but also a policy framework that allows service providers to define and evolve their own policies for their services to reflect their business needs and government regulations, whilst also meeting service provider demand for some level of control of QoS through the control over route selection and resource allocation.

In order for the network to act on the declared policies of service providers, these policies must be published to all management nodes in the network [1]. These management nodes may be centralized or distributed. If they are centralized, like in the OpenFlow system [2], then the management node is responsible for controlling a group of routers to make route selection and resource allocation decisions based on knowledge of the state of the whole network and the requested policies of their users. It is also responsible for publishing to other management nodes the states of its network of routers and the policies of its service providers that are being managed in order to maintain a holistic understanding of the state of the whole network. If they are distributed then the management node function is hosted on each router. Route selection and resource allocation decisions continue to be holistic because routers continue to publish to each other its state and the policies of service providers that are being managed.

In this paper we extend this fast network flow model to calculate route selection and resource allocation decisions for transporting a mix of different types of traffic with a range of different policies.

### **Design / Methodology / Approach**

#### **Network Modeling**

The Iraqi national optical network was chosen for this work to analyze loss, end to end delays and load balance over the various fiber links. Each city was represented by a node in the OMNeT++ model with a particular population taken from [3]. 40Gb.

#### **User Behaviour**

Motorola's research group in [4] monitored the usage of the different Internet applications in the United States. These statistics were depended in our work.

## Applications Within Policy Types

In our network we hypothesize four classes of policies for service providers:

1. Broadcast Provider: In this class, acceptable losses are guaranteed for the broadcasting applications such as streaming audio, streaming video and IPTV.
2. Triple Play (Television, Telephone, Internet) Provider. In this class, low losses and low delays are guaranteed for the real time television and telephone applications such as VoIP and video communications, whereas acceptable delays are to be guaranteed for the Internet applications such as web browsing, streaming audio, streaming video and IPTV.
3. Gaming and Second Life Provider. (See Table 5). Providers in this class guarantee low losses and delays for gaming applications and acceptable losses but unguaranteed delay for the second life applications.
4. Unclassified. (No quality of service is guaranteed).

## Findings / Results

The results will be shown of the performance of different resource allocation algorithms to manage the traffic demand from the users and service providers given the declared policies. Loads rates over links when using the unclassified policy and when using applications aware policies will be shown to prove the feasibility of our policies.

## Conclusion / Discussion

Using our proposed technique will contribute to offer a better QoS for some application types which are the most important for the user.

## References

- [1] Han Hee Song; P.Yalagandula, “Real-time End-to-end Network Monitoring in Large Distributed Systems” 2nd International Conference on Communication Systems Software and Middleware, 2007. COMSWARE 2007 Bangalore. 7-12 Jan. 2007, pp1 – 10.
- [2] Manuel Palacin Mateo, “OpenFlow Switching Performance”, Politecnico Di Torino in Telecommunication Engineering, 2009, Italy.  
<http://www.mendeley.com/research/openflow-switching-performance/>
- [3] United Nations Office for the Coordination of Humanitarian Affairs (OCHA) “*Basra Governorate Profile*”, July 2009.  
[www.iauiraq.org/reports/GP-Basrah.pdf](http://www.iauiraq.org/reports/GP-Basrah.pdf)
- [4] Michael Needham, John Harris “Traffic and Network Modeling for Next Generation Applications” IEEE International Symposium on Broadband Multimedia Systems and Broadcasting - Multiple Technologies for Multimedia, March 31 – April 2, 2008, Las Vegas, Nevada USA.

## Maximum power point tracking for photovoltaic system: modified perturb and observe algorithm

*Mohammed Alqarni, Mohamed Darwish*

*School of Engineering and Design, Brunel University*

### Introduction

In the past decades, there has been a huge growth in the use of the renewable energy sources. Photovoltaic energy is one of these sources which is free and can be transformed easily to electricity. On the other hand, the high cost and low conversion efficiency consider as the main issue about this energy system.

Therefore, research has been conducted to improve the performance of the PVs aiming to harvest the maximum possible power at different weather conditions as any weather change would affect the PV output. The I-V and P-V characteristics of a typical PV unit for several temperatures and irradiance points are varies as they affected by these two factors. For each P-V curve there is a maximum power point (MPP) which needed to be found and operate at. For that, the maximum power point tracking (MPPT) becomes an essential part of each PV system.

There are many techniques have been utilised to track the MPP and locate the  $V_{mpp}$  and  $I_{mpp}$  where the PV should operates. One of these algorithms is Perturb and Observe (P&O) method [1, 2] which is the most commonly used due to it is simplicity and few measurements required. It works by perturb the terminal voltage frequently and compare it with the previous measured value and then decreases or increases the voltage until the MPP reached. The disadvantages of this method are the oscillation around the MPP in the steady state condition resulting in power losses and in poor tracking when the weather changes frequently.

This paper suggests a solution to the above problem. An irradiation sensing unit, connected to the system, senses the irradiation level regularly (specific time can be adjusted) and send the new value to the P&O unit to start the algorithm under the new irradiation level.

### Design / Methodology / Approach

The full paper will contain simulation and test results for a 75 watts solar panel under different operating conditions

Through the period from July 2011 to March 2012 a strong background has been built about the topic by reading and searching several sources like recent journal articles, electronic databases conferences papers. These helped to produce the idea of this paper after deep investigation in this topic. The next step is to improve the skills in the simulation software to be able to simulate the new model and analyse the output

### Findings / Results

The plan is to design the circuit by June 2012 and simulate it using MATLAB/Simulink. After getting the simulation result the circuit will be build and test on the lab by August and finally, the conclusion is expected to be in the beginning of the 2013.

## **References**

1. K. Hussein, I. Muta, T. Hoshino, and M. Osakada, "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions," *Generation, Transmission and Distribution, IEE Proceedings-*, vol. 142, no. 1, pp. 59–64, 1995.
2. M. Ngan, C. Tan, "A study of maximum power point tracking algorithms for stand-alone photovoltaic systems", Applied Power Electronics Colloquium IEEE, 2011.
3. T. Esram, P. Chapman, "Comparison of Photovoltaic Array Maximum PowerPoint Tracking Techniques", *IEEE TRANSACTIONS ON ENERGY CONVERSION*, VOL. 22, NO. 2, JUNE 2007.
4. S. B. Kjær, "Design and Control of an Inverter for Photovoltaic Applications," Ph.D. dissertation, Aalborg University - Institute of Energy Technology, January 2005.
5. D. S'era, "Real-time Modelling, Diagnostics and Optimised MPPT for Residential PV systems", Ph.D. dissertation, Aalborg University - Institute of Energy Technology, January 2009.

## Energy efficiency model for LTE-femtocell systems

*Saba Al-Rubaye, John Cosmas*

**Keywords:** Femtocell, LTE, energy efficiency, 4G wireless systems, Cognitive networks

### Introduction

The concept of Long Term Evolution (LTE) networks has become a vision of access networks. This becomes more important for future access networks that combine many new wireless terminals and services. In this regard, femtocell systems are assuming an increasingly important role in cellular coverage that represents an opportunity for operators to provide higher quality indoor access at a low cost, obviating the need to deploy costly infrastructure, by reusing existing broadband connections [1]. However, deploying femtocell systems lead to an increase in macrocell coverage and the capacity of networks [2]. The paper presents a highly scalable concept, which uses adaptive power consumption methods in order to achieve better performances that are possible for future mobile networks by exploiting daily variations in the system traffic.

This work enhances the existing power models for load assessments, providing a first analysis from an energy efficiency approach of these two methods, considering a fully loaded network at the peak hours and improves the overall energy consumption figures of a network.

### Design / Methodology / Approach

Different deployments can be considered, with a variable number of femtocells and different possible positions in the cell. Femtocell systems are deployed to compare different network systems scenarios. However, within these scenarios we have compared two systems to assess how the change in network configurations will affect the energy consumption in the adapted network, named: "system 1" and "system 2". The work has compared power usage in these two different system networks by calculating the percentage of powers that are required in all BSs in the networks. This analysis will provide us with a clear idea about which system deployment approach is more beneficial in terms of energy saving.

In this paper we consider the impact of power consumption for performance assessments and demonstrate how capacity formulas can be utilized in this framework. System model approach is essential since it is useful to make decisions based on logic supported by analysis of measured and desired performance. The main goal of the power consumption management model is to make input parameters available for the simulation of total power consumption in 4G communication networks.

System-level simulations are used to examine performance of the new LTE-femtocell systems algorithms in different scenarios. C++ system programming and advanced OPNET version 16.1 simulations are used to test the network performance with the femtocell power consumption model. The goal of the simulation is to assess the proper operation of the model and evaluate the improvements in the power consumption that can be made as a function of the network size. On the other hand, it is important to understand the performance of different strategies, e.g. power efficiency and packets delivery times. Analytical results show that total energy consumption in the network per unit area was increasing once femtocell base stations are engaged that operate with a 20dBm input power. Alternatively, energy consumption was found to decrease slightly when employing femtocell base stations that operate with a 10dBm input power.

### **Conclusion / Discussion**

In this paper we consider the impact of deployment femtocell strategies on the power consumption of 4G wireless networks. We consider designs featuring varying numbers of femtocell base stations per cell in addition to conventional LTE sites. A new methodology was proposed in order to model the power consumption on LTE-femtocell base stations. Different scenarios have been proposed in order to demonstrate the impact of two-tier network factors. LTE-femtocell system's power management schemes are examined that aim to optimize the coverage of femtocell and reduce the power consumption in future mobile communication systems. The key achievement of the new femtocell model is the increase in network capacity for outdoor users. The simulation results show that our schemes are able to save 30% of energy consumption in LTE femtocell systems and this is a first promising step towards green communications. Finally, the experiments show that for the studied traffic scenarios and under the employed power consumption models, the power savings from deployment of femtocells are practical in heavily loaded scenarios and strongly depends on the offset power consumption of both LTE and femtocell sites.

### **References**

- [1] Saba. Al-Rubaye, "Green Radio over Fiber and Femtocell Access Network", in Proc. 25th Wireless world research forum (WWRF#25), London, UK, 2010, pp.1-5
- [2] Saba Al-Rubaye, Anwer Al-Dulaimi, and John Cosmas, "Pilot Power Optimization for Autonomous Femtocell Networks", in Proc. IEEE Wireless Advanced (WiAd), London, UK, 2011, pp. 170 – 175.

## A novel technique to enhance throughput and fairness over wireless mesh networks

*Oussama Al-Sabek, Rajagopal Nilavalan*

**Keywords:** Wireless Mesh Networks, Congestion Control, Fairness, TCP

### Introduction

Wireless Mesh Networks have gained a huge popularity for the last few years due to their advantages of self-organizing, rapid deployment, and easy maintenance. Wireless Mesh Networks (WMNs) are multi-hop networks classified into three categories: Infrastructure-less WMNs, infrastructure WMNs, and hybrid WMNs. Infrastructure-less WMNs consist of mesh clients which can communicate only with each other directly in an ad hoc manner. Infrastructure WMNs where a hierarchical architecture is existed consisted of a backbone of mesh routers and mesh clients, mesh clients access the wireless network through mesh routers only. Mesh routers, then, can serve as bridges to connect the wireless network to the internet. Finally, hybrid WMN is similar to infrastructure WMN; however, a mesh client can access the wireless networks through another mesh client [1].

Congestion control is a key issue in Wireless Mesh Networks. The issue of congestion has been identified in all kinds of computer networks as a result of heavy traffic load in networks where a lack of resources and unmanaged conditions are existed. Hence, congestion control purpose is to prevent or reduce any overloading or congestion may occur all over the network nodes and links. Provided that WMNs are multi-hop networks using radio channels as a medium to perform the communications among nodes, this makes the task of congestion control is more sophisticated [2].

Fairness is a major issue in wireless mesh networks. The throughput unfairness is a critical problem in wireless multi hop environments where the nearest nodes to the gateway get a higher chance to transmit and receive data, whereas the further nodes get less and less chance to transmit and receive. The unfairness in WMNs is due to mainly two layers mechanisms interacting over a wireless multi-hop network: MAC (IEEE802.11b, for instance) and transport (TCP) layers. Moreover, the contention on the wireless medium among different flows leads to a serious unfairness where the nearest to the gateway get more bandwidth while other flows which are a few hops away may starve [3]. Thus, solutions have been proposed in the literature to accommodate the unfairness issue. Those proposals can be classified according to their functionalities as: Mac layer [4], network layer [5], transport layer [6], or cross layer techniques [7]. Also, some of which is distributed while others are centralized.

In this research, a novel enhancement to [8] is proposed. This makes an end-to-end transport-layer technique that not only assures fairness in WMNs, but also improves the throughput for all the active flows that transmit simultaneously to the gateway which is in turn connected to the internet.

### Design / Methodology / Approach

A literature review on different techniques for fairness issue in multi-hop wireless networks was carried out. Then a simulation platform NS2 used for implementing and modelling the proposed technique. Implementations of 3,5,7 chain flows with four different packet sizes (128, 256,512,1024)B have been done, and intensive analysis with LibreOffice Calc software to show the efficiency of the proposed technique.

## **Findings / Results**

Aggregate throughput enhancement has been achieved with good fairness index (>0.9). For example, in a three flows chain topology (4 nodes) a throughput enhancement ratio ranges from 3.87% (packet size= 128B) to 3.50% (packet size= 1024B) with fairness index of (0.999). For a five flows chain topology (6 nodes) a ratio of 13.46% (packet size= 128B) to 13.62% (packet size= 1024B) with fairness index of (0.9345- 0.9128). As for a seven flows chain topology (8 nodes) a ratio of 24.30% (packet size= 128B) to 20.35% (packet size= 1024B) with fairness index of (0.9708- 0.9258).

## **Conclusion / Discussion**

A practical enhancement to end-to-end transport-layer technique that aims to improve throughput and fairness in WMNs has been proposed. The analysis show promising results. The technique would be tested on different topologies and scenarios. Also, an answer to the question whether this technique would perform well in a mobile environment will be a future work.

## **References**

- [1] I. F. Akyildiz, X. Wang and W. Wang , "Wireless mesh networks: a survey," *Computer Networks*, pp. 445-487, 2005.
- [2] B. Sadeghi, A. Yamada, A. Fujiwara and L. Yang, "A Simple and Efficient Hop-by-Hop Congestion Control Protocol for Wireless Mesh Networks," in *the 2nd Annual International Wireless Internet Conference* , 2006.
- [3] O. Gurewitz, V. Mancuso, J. Shi and E. Knightly, "Measurement and Modeling of the Origins of Starvation of Congestion-Controlled Flows in Wireless Mesh Networks," *IEEE/ACM Transactions on Networking*, vol. 17, no. 6, pp. 1832-1845, Dec 2009.
- [4] O. Shagdar, K. Nakagawa and B. Zhang, "Achieving Per-Flow Fairness in Wireless Ad Hoc Networks," *Electronics and Communications*, vol. 89, no. 8, pp. 37-49, 2006.
- [5] K. Xu, M. Gerla, L. Qi and Y. Shu, "TCP Unfairness in Ad Hoc Wireless Networks and a Neighborhood RED Solution," *Wireless Networks*, vol. 11, pp. 383-399, 2005.
- [6] J. J. Galvez, P. M. Ruiz and A. F. Skarmeta, "Responsive on-line gateway load-balancing for wireless mesh networks," *Ad Hoc Networks*, vol. 10, pp. 46-61, 2011.
- [7] J.-Y. Yoo and J. W. Kim, "Impact of TCP ACK Losses on TCP Fairness in Wireless Mesh Networks," in *Global Telecommunications conference*, 2009.
- [8] T.-C. Hou και C.-W. Hsu, "Achieving Fair Throughput among TCP Flows in Multi-hop Wireless Mesh Networks," *IEICE Transactions on Communication*, vol. E93-B, no. 4, pp. 916-927, 2010.

## The potential of health clinic PV system for a rural area in southern Iraq using RETScreen software

*Wisam Al-Yasiry, Ahmed Zobaa, Mohamed Darwish*

*Brunel Institute of Power Systems*

**Keywords:** Photovoltaic (PV); Stand-alone system; rural area in south Iraq; System Design, Solar energy cost

### Introduction

The use of clean energy technologies has increased greatly over the last 20 years especially in the developing countries; one of these technologies to be used is the photovoltaic (PV) technology. The need for reliable and low cost electric power in isolated areas of the world is the key force driving the world wide photovoltaic (PV) industry today; simply the PV is the least cost option. The purpose of this research is that most of the rural areas in southern Iraq are still undeveloped and in a disorganized state, so there is a need to provide these areas with electricity. Small standalone photovoltaic (PV) electrification systems play a big impact to power health clinics in southern Iraq.

Although Iraq enjoys a huge amount of solar radiation during the whole year, it is capable of providing plentiful and reliable electricity, but this resource is largely untapped by the country. One of the difficulties with powering health clinic is that there is often limited space for a sizeable PV output, so for best use of the available space, an enhancement of efficiency is required to generate more energy per unit area.

### Design / Methodology / Approach

The Photovoltaic system was modeled using RETScreen software, RETScreen is an Excel based clean energy project analysis software tool that helps decision makers quickly and inexpensively determine the technical and financial viability of potential renewable energy, energy efficiency and makes financial sense. The output parameters used in the system are shown below;

- Best technology to be used in the rural area to provide electricity.
- Investigate and calculate the annual energy production or energy savings.
- Investigate and calculate the financial feasibility indicators, such as Internal Rate of Return (IRR), simple payback, net present value, cash flows and annual life cycle saving, GHG emission reduction costs, Energy Production Costs.
- Investigate the annual reduction in the emission of greenhouse gases stemming.
- Determine how uncertainty in the estimates of various key parameters may affect the financial viability of the project.

## **Findings / Results**

This study investigates how performance varies across the different climates with the aim of deriving a series of suggestions that could help optimise system design and encourage the uptake of photovoltaic technology PVT in the future. As well as investigate the energy efficiency improvements, system output and energy cost production. As a result, The total Clinic load capacity was found to be 31.6 kW h/day, the system consists of PV modules, batteries, charge controller, inverter, and the necessary wiring and safety devices to generate electricity. The system feasibility analysis was performed using the RETscreen software developed by the Natural Resources of Canada, then this feasibility compared with the another study that use HOMER software developed by the National Renewable Energy Laboratory (NREL).

## **Conclusion / Discussion**

Using the RETScreen software computer model, we investigate the most economic system for a remote health clinic in southern Iraq by having daily load of 31.6 kW/h. This research aims is to evaluate, assess the viability, performance and optimising the design of PV clean energy systems by; generating accurate demand profiles which can be intelligently matched with renewable supply, integrating photovoltaic systems to form health clinic, optimising the properties of systems for different climates and improving existing simulation models. The total initial cost, net present cost, and cost of electricity produced from the system investigated and compared with other system existed. Also this study is to show that using generator alone to generate electricity is more expensive than using photovoltaic technology PVT to provide electricity. Further investigations and research need to be do in the future.

## **References**

1. Ali Al-Karaghouri, L.L. Kazmerski , ‘Optimization and life-cycle cost of health clinic PV system for a rural area in southern Iraq using HOMER software ‘ , *Solar Energy*, Volume 84, Issue 4, April 2010, Pages 710-714.
2. Klein, S.A. and Beckman, W.A., Loss-of-load Probabilities for Stand-Alone Photovoltaic Systems, *Solar Energy* 39, 6, 499-512, 1987.
3. <http://www.retscreen.net>

## Geographical ant mobile ad hoc routing protocol

*Saman Hameed Amin, Hamed Al-Raweshidy*

This paper proposes a new geographical Ant routing protocol for ad hoc network. This protocol inspired by Ant colony algorithms which reacts dynamically and cognitively towards networks environments changes. This protocol uses local geographical information collected by the travelling ants and combines it with mapping algorithm to represent a temporary global source to destination geographical information. This information is used to select a more stabilized route as well as avoiding the use of long range link which have low throughput.

### Introduction

There is no fixed or predefined infrastructure for mobile ad hoc network. In order to enable data transfer in such a network, each node needs to send control messages to set up a route to its destination node. Intermediate nodes act as routers in order to enable multi-hop communication. One of the main problems in ad hoc network is to find a route between source nodes and their destination with good QoS. Another problem emerges due to nodes mobility as its main reason for route break. Finding new route may cost too much time and degrade network performance.

The routing protocols designed for multi-hop mobile ad hoc networks in existence can be generally classified as proactive routing protocols, such as OLSR and DSDV, as well as reactive routing protocols, such as AODV and DSR. There is another kind of protocols which combine both reactive and proactive approaches called hybrid routing protocols. One way to overcome route breakage is by using ant colony (ACO) routing protocol which is a hybrid routing protocol. In ACO routing protocols, node dynamically reroute data packets to next best node whenever a route break takes place. New forward ants will try to find a new best route and data route will gradually migrate to the new route.[1, 2]

The physical properties of communication channels have a major effect on the data rate and the quality of communication. Distance is one of the primary factors that determines data rate in wireless network.[3] geographical information (position and speed) is used to select more stable routes. Selecting routes that are expected to endure longer are preferred and will add significant performance improvement to the network [4].

### Design / Methodology / Approach

The proposed protocol aims to improve the route selection method. Most of above ad hoc routing protocols try to find shortest path with minimum number of hopes, while in our approach we try to select nodes depending on the distance between them and select the links with better quality. At the same time, we try to minimize the number of nodes. These selecting processes take places locally rather than at the destination node in a distributed fashion which is more suitable for ad hoc networks. However, the destination node computes the overall link quality which will be used by the backward ant in the reinforcement learning process. Moreover other protocols assume fixed data rate while our approach is for multiple data rate network. Another important feature in our approach is that we try to select the more stable route depending on speed and direction of movement of the nodes. For example, if two routes have the same number of nodes and the same distances, our protocol will predict which of them will remain valid for longer time and tries to select it.

The selection of next forward node is depending on the position, speed and direction of the node and its neighbour. First we compute the time to live between the nodes. The first constraint on how to select a node is to have high time to live value. The second constraint is coming from the idea that we don't like too close to each other nodes to be in a linking route because they will add more processing delay and they decrease the throughput. Finally, nodes that are close to boundary of transmission range cannot be guaranteed to support the routing link for long time and they have low bandwidths. The overall process of the selection is done through a mapping criteria. This information is combined with the pheromone concentrate to represent the probability of selecting that node by the forward ant. At the destination, the route quality is measured and is send back by backward ant to update the pheromone table.

### **Conclusion / Future Plans**

We proposed a new ant colony algorithm in which the geographical information is used to estimate the link quality which results in better bandwidth selection and more stable routes. The proposed protocol could be enhanced by adding another link quality metrics to it like The Expected Transmission Count (ETX) metric which may reduce the selection of congested nodes in the network.

### **References**

- [1] S. S. Dhillon, X. Arbona, P. V. Mieghem, “ Ant Routing in Mobile Ad Hoc Networks,” Third International Conference on Networking and Services ICNS, 2007, pp. 67
- [2] Sh. Marwaha, J. Indulska, M. Portman, “Biologically Inspired Ant-Based Routing In Mobile Ad hoc Networks (MANET): A Survey,” Symposia and Workshops on Ubiquitous, Autonomic and Trusted Computing, UIC-ATC, 2009, pp. 12 - 15
- [3] C. T. Hieu ; Ch. S. Hong, “ A new routing protocol with high throughput route metric for Multi-Rate Mobile Ad-hoc Networks,” IEEE Workshop on Local and Metropolitan Area Networks (LANMAN), 2010, pp. 1 – 5
- [4] A. T. Cabrera, A. G. Mozos, E. Casilar, “On the Suitability of Using the Residual Lifetime as a Routing Metric in MANETs,” Telecommunications: The Infrastructure for the 21st Century (WTC), 2010, pp. 1 – 6.

## Accelerating & enhancing of 3D integral imaging algorithms on embedded platforms

*Inas Arusi, Amar Aggoun*

**Keywords:** 3D Integral Imaging, Ray Tracing, GPU, FPGA, Hardware, interpolation

### Introduction

The purpose of this research is to accomplish the task of accelerating the computer generation of 3D integral imaging produced by integral ray tracing on the embedded platforms. And accomplish the task of enhancing 3D integral imaging computer generation algorithms by experimenting with different algorithms.

Ray tracing algorithm is a computationally exhaustive algorithm, and ray tracing integral images consumes more processing time than normal images. The implantation of the algorithm on embedded platforms such as FPGA, and GPU, is being investigated in order to accelerate and enhance the generation of photo-realistic 3D integral images. The aims of this research are:

- Implement the 3D integral imaging lens view algorithm on FPGA and GPU platforms to optimise the computation time of the ray tracing the integral images
- Investigate with different interpolation methods to enhance 3D integral images generated from ray tracing algorithm.

### Design / Methodology / Approach

Tracing rays is a recursive process, which has to be carried out for each individual pixel separately.

Ray tracing is always claimed as being too computational. Efficiency is therefore a critical issue and has the focus of much research from the beginning. Facing the task of accelerating the process of ray tracing, three strategies were generally considered [1]:

- Reducing the average cost of intersecting a ray with the scene,
- Reducing the total number of rays intersected with the scene, and
- Replacing individual rays with a more general entity.

Previous software implementation [2] to accelerate ray tracing algorithms proposed method used is integral imaging lens view algorithm that had been developed through geometrical analysis of the generation of integral image. The spatial coherence information within micro-images is used to speed up the generation of photo-realistic still 3D integral imaging. The software developed will be used as guide line for this thesis, also to compare the final results with hardware implantation.

The proposed hardware illustrates a significant speed improvement over the software method, by parallelizing time consuming and repetitive processing tasks that form the inner loop of the reconstruction algorithm and favour hardware implementation. It demonstrates optimized data utilization by applying specific memory data arrangements [3].

## Findings / Results

The research materials I have looked at so far have given me significant insight on what will be entailed in this research. The research topics I have been looking through are:

- (1) Computer generation of 3D integral imaging and the need for acceleration the integral ray tracing
- (2) The enhanced 3D integral imaging computer generation algorithm using interpolation process
- (3) Understanding the algorithms of previously developed software tool [2] and experimenting with different interpolation methods to enhance the 3D integral imaging.

My work on task 1 and 2, which been listed above, is nearly complete, although I'm still searching for additional examples to present the concepts more clearly. Most of the materials related to task 2 have been gathered, and I have written a rough draft of the sections from different journals and theses. I'm working on organising this information to be more presentable for future reference, in fact, that is where most of my time on this research seems to be going. Also, I am still in the process of analysing and experimenting with the codes of the software developed [2], to gain a practical understanding of the software and be able to investigating with different algorithms later in the project.

## Conclusion / Discussion

At this point, the materials I have looked at so far have given me significant insight on what will be entailed in this research. I am still looking through different research materials to gain better insight on the concepts. Also, I have been reading through the codes of the software tool for [2], to gain a practical understanding of the software and be able to investigate with different algorithms. However, I had experienced some problems with software to generate the desired images, due to the missing files and sources. At the moment, I am still working on analysing the software, before moving on to experiment with different interpolation methods and implanting the software algorithms on FPGAs or GPUs platforms.

## Future Plans / Directions

For future progress, I will be working on the problems I have faced when experimenting with software of 3D integral images and investigating further with different interpolation algorithms for 3D integral image enhancement, in order to overcome the 3D missing information, and implement the algorithms developed on embedded platforms such as GPU and FPGA.

## References

- [1] Andrew Glassner, editor. "An Introduction to Ray Tracing," Academic Press, 1989.
- [2] D Mahmod Geat Eljdid, "3D Content Computer Generation for Volumetric Displays, ", PhD Thesis, Brunel University, UK, 2007.
- [3] D. Chaikalis, G. Passali, N. Sgouros, D. Maroulis, and T. Theoharis, "Near Real-Time 3D Reconstruction from InIm Video Stream," Department of Information and Telecommunications, University of Athens, Greece, 2008.

## Critical evaluation of wide area monitoring systems from a GB transmission system operator perspective

*Phillip Ashton, Gareth Taylor*

*Brunel Institute of Power Systems*

**Keywords:** Phasor Measurement Unit, Smart Grid, Synchrophasor, Wide Area Monitoring

The Phasor Measurement Unit (PMU), with its ability to directly calculate the power systems state variable, is deemed vital to achieving the wide area monitoring and control requirements of the Smart Grid. Making effective use of the data however, is not without its challenges and the successful deployment of such a synchrophasor-based system requires enhanced testing and validation. The development of PMU's on the GB system is going through an evolutionary process to determine the practical applications of the technology in terms of data resolution and device location. This paper focuses on the development of wide area monitoring systems (WAMS) on the GB System, discussing relevant future scenarios. We also draw comparisons with a University based WAMS installed at the domestic supply level, looking at the capability of such a system to monitor the transmission network.

### Introduction

The WAMS at National Grid is in the early stages of its deployment. PMU's have been installed on the transmission system of England & Wales primarily through upgrades to digital fault recorders. PMUs currently report back to a single Phasor Data Concentrator (PDC) for oscillation analysis, where alarms are sent to the energy management system (EMS) to alert the operators when the system is believed to be approaching instability. The primary role of the system has been to monitor any oscillatory behaviour between the generators in Scotland and those of England & Wales, as an inter-area mode had been previously identified at around 0.5Hz involving all of the GB system [1]. This remains a cause for concern across the main constraint boundary, the 2 double 400kV AC circuits that connect the Scottish Network with the North of England.

Progression of the existing WAMS is dependent on gaining confidence in the accuracy of the synchrophasor measurements, realised through comparisons with traditional metering data and the state estimator (SE). The installation of additional PMU's limited to scheduling of outage plans or coordination with existing substation works, demands reliability from the existing devices. The ability to compare the WAMS at National Grid with that described in [2] is another useful approach. This WAMS, based at the domestic supply level from 4 UK Universities, may also offer a number of advantages through ease of installation, furthering the visibility of the system and potentially increasing the viability of synchrophasor based applications.

### **Design / Methodology / Approach**

Data is to be compared from both the National Grid WAMS and that of the University based system for all noteworthy transmission system incidents, to assess the visibility of such events at the domestic supply level; the following measurements will be compared:

- System frequency.
- Voltage magnitude and phase angle.
- Recordings of oscillations.
- PMU Latency (Delay from measurement to arrival at PDC)

In addition the above should determine the suitability of the University based system to provide various WAMS applications to the transmission system operator (TSO).

### **Findings / Results**

Experiences of National Grids WAMS to date have determined a number of issues, predominantly with the availability and with that the reliability of data provided. This is limiting the progression of synchrophasor-based applications. In addition the devices, reporting data at 50Hz, are transmitting substantially higher volumes of data than traditional metering or monitoring systems and are already consuming large volumes of network bandwidth, thus highlighting the necessity to improve communications infrastructure at the substation.

Initial results have suggested that the provision of synchrophasor data from the domestic supply based WAMS would certainly be a good solution to increasing the observability of the network, potentially through wide area frequency monitoring. The obvious advantages realised through choice and ease of installation, further investigations are still required to determine the suitability for other more advanced applications.

### **Conclusion / Discussion**

The paper discusses the suitability of a WAMS based at the domestic supply level to observe system incidents on the transmission network. Looking at the proposed benefits to the TSO enabling improved wide area monitoring and situational awareness.

### **Future Plans / Directions**

Going forward the research will be directed according to major projects taking place at National Grid and how these will have an impact on the deployment of PMU's across the network. Short-term focus is on comparing state estimator results with data obtained from the National Grid PMU's to assess the suitability of the devices to either enhance or replace traditional state estimation.

### **References**

- [1] A. Myles, “Application of Power System Stabilisers on the Anglo-Scottish Interconnection”, British system operation experience, IEE Proc. Generation, Transmission and Distribution, Vol 135, Iss 3, May 1988
- [2] V.Terzija, P.Regulski, L.P.Kunjumuhammed, B.C.Pal, G.Burt, I.Abdulhadi, T.Babnik, M.Osborne, W.Hung. “FlexNet Wide Area Monitoring System”. IEEE Power and Energy Society General Meeting, July 24 – 28, 2011 Detroit, Michigan, USA.

## Bluetooth navigation system for blind people

*Muhammad Irfan Aziz, Thomas Owens*

**Keywords:** Navigation System, Blind People, Bluetooth, Camera

### Introduction

The initial intention of this research was to study Ultra Wideband (UWB) Receivers, but this work did not materialize due to the diminishing support of industry for UWB. Therefore, Bluetooth was chosen as the area of study because of its rapid expansion in recent years and as it is expected to be one of the technologies which will be using UWB in the future. The scope of this research is that a pilot should be made in which Bluetooth is used as a medium for the guidance of the blind people, with the aim that it can be used for the navigation of the blind people either at its own or in conjunction with the cameras. As far as this research is concerned, there is no previous utilization of Bluetooth for such purpose, making it unique and original idea.

### Design / Methodology / Approach

The overall plan was to understand the Bluetooth itself, and then study the literature concerning the navigation system designed so far for the blind. Bluetooth has been used in some cases just to communicate between the devices. After the literature review, simulation and practical work had to be undertaken, and then based on these simulations and practical work results would be recorded and analysed.

### Findings / Results

Bluetooth wireless is a short-range communications technology with the key features of robustness, low power, and low cost. It was designed to operate over the Industrial, Scientific and Medical (ISM) band of 2.4 GHz which is free to use in most of the world [1]. Wireless Local Area Networks (WLAN) [2], Radio Frequency Identification (RF-ID) Tags [3], Global Positioning System (GPS) [4], Somatosensory Navigation Systems [5], Acoustic Navigation Systems [6], Camera-based Navigation Systems [7], and Bluetooth-enabled Navigation Systems [8] have been used in the following use-case scenarios: On-Campus Navigation, Smart-House Navigation, Museum Tour, Traffic Signal Crossing, Shopping Mall Experience, General Indoor Navigation, General Outdoor Navigation, and Navigation to Public Transport.

### Conclusion / Discussion

To understand the context of the above discussion it is important to realise that much of the resources being devoted to the purpose of developing navigation systems for the blind people come from charities and not from government organizations. It is, therefore, advisable that resources be directed towards increasing the number of trained guide-dogs instead of over-ambitious research projects. Use of a camera for the navigation for the blind people is the best option, keeping in view that all the obstacles in the path of a blind user, especially smaller ones, are not always detectable by other means like an ultrasound detection system or even by laser or light detection systems.

Following the investigation of envisaged use-cases and research carried out so far on these scenarios, it is recommended that focus of future research should be concentrated towards navigation of public transport, on-campus navigation and shopping mall navigation. In addition to these scenarios, the technologies to be concentrated upon are use of cameras in conjunction with Bluetooth devices.

## Future Plans / Directions

The above analysis and discussion emphasises that the problem of Navigation for the blind people can be viewed from two different perspectives: effectiveness of the proposed technology and usefulness of the particular scenario. There are two technologies worth mentioning here which have the potential to deliver practical navigational aids for the blind people. The first one is the use of a camera and other is Bluetooth; at a later stage both of these technologies can be combined for maximum benefit. Similarly there are two specific use-case scenarios which seem to be more frequently encountered by a blind person than others: shopping in a mall and navigating to the public transport system, although it may be argued that on-campus navigation or crossing the road at signals are equally important.

In the proposed scenarios, the central server could easily be managed by placing it locally in the same vicinity. In the initial setup, a human observer might be required to monitor and guide the blind user, until the algorithm for autonomous routing has learned routes along which the blind user could navigate through their local area.

I am unlikely to finish off in stipulated 3-year timeframe due to a number of problems mostly relating to my family and adjusting to the environment and academics after about 16 years of professional life, but I am confident to finish within next year.

## References

- [1] B. A. Miller and C. Bisdikian, *Bluetooth Revealed*. Upper Saddle River, NJ: Prentice Hall PTR, 2001.
- [2] K. Alhajri, N. Al-Salihi, V. Garaj and W. Balachandran, "The performance of WiFi network for application in a navigation system for visually impaired people," in *Wireless Telecommunications Symposium, 2008. WTS 2008*, 2008, pp. 243-249.
- [3] S. Willis and S. Helal, "A passive RFID information grid for location and proximity sensing for the blind user," *University of Florida Technical Report Number TR04-009*, 2004.
- [4] A. Marsh, M. May and M. Saarelainen, "Pharos: Coupling GSM and GPS-TALK technologies to provide orientation, navigation and location-based services for the blind," in *Information Technology Applications in Biomedicine, 2000. Proceedings. 2000 IEEE EMBS International Conference on*, 2002, pp. 38-43.
- [5] N. Henze, W. Heuten and S. Boll, "Non-intrusive somatosensory navigation support for blind pedestrians," in *Proc. EuroHaptics*, 2006, pp. 459-464.
- [6] J. M. Loomis, R. G. Golledge and R. L. Klatzky, "Navigation system for the blind: Auditory display modes and guidance," *Presence*, vol. 7, pp. 193-203, 1998.
- [7] S. Treuillet, E. Royer, T. Chateau, M. Dhome and J. M. Lavest, "Body mounted vision system for visually impaired outdoor and indoor wayfinding assistance," in *Conference & Workshop on Assistive Technologies for People with Vision & Hearing Impairments*, 2007, .
- [8] A. Dabrowski, P. Kardys and T. Marciniak, "Bluetooth technology applications dedicated to supporting blind and hearing as well as speech handicapped people," in *ELMAR, 2005. 47th International Symposium*, 2005, pp. 295-298.

## Cognitive spectrum allocation and interference mitigation in 4G LTE-advanced networks

*Mohammadreza Behjati, John Cosmas*

*Wireless Networks and Communications Centre (WNCC)*

**Keywords:** LTE-Advanced, Cognitive Radio, Inter-cell Interference, Carrier Aggregation, Dynamic Spectrum Allocation, Femtocell

### Introduction

Recently Long Term Evolution (LTE) network was proposed by network operators to attract and satisfy the requirements of network commercial and domestic clients. As an enhancement to LTE, LTE-Advanced (LTE-A) is a true 4G evolution step, that has recently been standardized in 3GPP Rel-10 and approved by ITU and IMT-Advanced [1].

The critical factors of data rate, delay and capacity, as well as energy consumption and deployment costs are the main evolving points on LTE-A, which have been targeted by network operators to fulfill their responsibilities to their customers. Furthermore, cell interference should be also taken into account for the network planning. On the other hand, Cognitive Radio (CR) is being investigated as a reconfigurable networking technology to improve the spectrum efficiency for the wireless access technologies like LTE and LTE-A, as well as Radio over Fibre (RoF). The Observe-Orient-Decide-Act (OODA) procedure of cognitive networks has made it self-aware, with the capability of adapting itself to obtain more efficient communications, whilst taking into account the end-to-end goals. In this research, the new features of LTE-A will be proposed in a cognitive manner to mitigate the network challenges and difficulties [2].

### Design / Methodology / Approach

LTE is adopting transmission technologies such as multi-input multi-output (MIMO) and multiple access schemes to obtain maximum possible throughput in minimum possible time. The peak data rate of 1 Gbit/sec with 100 Mbit/sec data rate in downlink using orthogonal frequency division multiple access (OFDMA) and 50 Mbit/sec data rate in uplink using single carrier frequency division multiple access (SC-FDMA) attract network users to employ this technology, even if they would need to wait for LTE-A base stations being setup on their local area. Furthermore, intra-cell interference is already avoided due to the use of OFDMA technique in LTE downlink, but inter-cell interference needs to be mitigated. Interference mitigation/cancellation techniques in LTE-A will help providing smooth voice and data transmission, by increasing the quality of signal and network performance [3].

The strategies for the intelligent use of spectrum are urgently required, since the currently available unlicensed spectrum is reaching its limits and there is a large and growing demand for the wireless access and applications. To alleviate this problem, spectrum sensing and dynamic spectrum allocation (DSA) technologies are being proposed to be implemented, which exploit techniques such as co-operative multi-point (CoMP) and multi-antenna transmissions, carrier aggregation and relaying, as well as interference coordination strategies, to assign users the best spectrum with the lowest inter-cell interference. Our cognitive strategies also propose the using of femtocell in role of home evolved node B (HeNB) as well as macrocell in role of evolved node B (eNB), as the secondary and primary users respectively in LTE-A platforms [4], [5]. The proposed infrastructure allocates proper spectrum to the primary and secondary clients, avoiding interferences among them and depending on channel estimations.

## **Findings / Results**

The inter-cell interference mitigation has significant influences in our simulation results comparing to the high interference-considered scenarios. The enhanced channel estimation and allocation schemes will result in less interference and higher signal to noise ratio (SNR), and therefore smaller number of packet drops within the network, which leads to get higher quality of service (QoS). Furthermore, reduction in packet drops also results in obtaining higher data traffic throughput, and higher SNR in transmission, aims to obtain better quality of received signal within the LTE-A network.

## **Conclusion / Discussion**

By further investigations, we will be finding out that some parameters like power consumption and implementation costs deserve more consideration in details. The commercial issues are very important alongside with network strategies, if we want to involve practical implementation in this research. Anyway, the research results which we have found out, could confirm our expectations and motivate us to undertake further investigations in this area with more commercial prospects.

## **Future Plans / Directions**

- More investigations on the new releases of network features in LTE-A and beyond.
- Finding out the significant parameters to overcome the difficulties in existing LTE.
- Developing of networks scenarios, e.g. campus network, lorry femtocell transmissions, etc.
- Implementation of machine to machine (M2M) communications within the network.
- Static and dynamic deployments of inter-cell interference in LTE and LTE-A.
- Simulation and evaluation of the proposed plan by deploying on practical test beds.
- Proposing the work to be made up in real networks within the scales of project.

## **References**

- [1] Y. Yang, H. Hu, J. Xu and G. Mao, "Relay Technologies for WiMAX and LTE-Advanced Mobile System," IEEE Communications Magazine, October 2009.
- [2] K. H. Mahmoud, Cognitive Networks-Towards Self-Aware Networks, England: Wiley, ISBN: 978-0-470-06196-1, 2007.
- [3] N. Tabia, A. Gondran, O. Baala and A. Caminada, "Interference Model and Evolution in LTE Networks," IFIP WMNC'2011, France, 2011.
- [4] A. Attar, V. Krishnamurthy and O. N. Gharehshiran, "Interference Management Using Cognitive Base-Stations for UMTS LTE," University of British Columbia, IEEE Communications Magazine, August 2011.
- [5] E. Dahlman, S. Parkvall and J. Sköld, 4G LTE/LTE-Advanced for Mobile Broadband, USA: AP-Elsevier, ISBN: 978-0-12-385489-6, 2011.

## Magnetic DNA Biosensor for point-of-care diagnosis

*Sara Chaychian, Wamadeva Balachandran*

*Electronic and Biomedical Engineering, Centre for Electronics Systems Research*

**Keywords:** Magnetic Beads, Magnetic detection, Pathogenic DNA, Molecular diagnosis, Planar Coil

### Introduction

Detection of biomolecular interaction in medical and biosensor research is of fundamental importance, these biosensors are used in different types of application such as: public health, clinical and environmental analysis. High sensitivity, specificity and short processing time are the most important characteristics of DNA biosensors. Existing technology for point-of-care diagnostics require bulky instrumentation, resulting in delayed initiation of treatment but integration and miniaturization of these systems with the help of biosensors offer a low cost and rapid detection technique. This research aim is to develop a Magnetic DNA biosensor for Pathogen detection. This sensing technique will be incorporated into a handheld, disposable microfluidic chip for Point-Of-Care diagnostic for sexually transmitted disease.

### Design / Methodology / Approach

A new magnetic sensor based on planar coil is investigated for DNA based pathogen detection. In particular, DNA associated with the pathogens which carry sexually transmitted diseases are detected in this work using the developed magnetic sensor. Change in inductance of the planar coil due to the DNA hybridization is measured to detect the DNA of interest. We present both simulation and experimental results. Simulation is performed on FEA based multi-physics software, COMSOL. The experimental set-up consists of immobilized probe DNA on a gold substrate and planar coil underneath the gold layer and associated electronics for inductance measurements. The Simulation results are compared with commercially available AA002 type Magnetic GMR sensor with linear sensitivity of 0.1 – 1(mT) Magnetic field associated with an electronic amplifier circuit. This technique can potentially be extended to detect several different types of Bacterial pathogens and can be modified for multiplex quantitative detection.

### Results / Conclusion

At first the GMR sensor results are calibrated and compared with the sensor characterizing results getting from company. The experimental test has made on two different substrates, cover glass and gold slide substrate and sensor shows sensitivity to the magnetic beads below 50 nl volume. Simulated coils are able to produce magnetic field strength, sensitive enough for our detection purposes. According to the experimental results the 30mT magnetic field from micro size coil is promising for detection of single size bead and expanding the detection system with DNA Microarrays for multiplex detection.

## **Future Plans / Directions**

For complete evaluation of our simulation results the actual coil needs to be fabricate with MEMS technology.

## **References**

1. Daniel L, et al, "Magnetoresistive-based biosensors and biochips" TRENDS in Biotechnology Vol.22 No.9 September 2004
2. Uei-Ming Jow, Maysam Ghovanloo, "Modeling and Optimization of Printed Spiral Coils in Air, Saline, and Muscle Tissue Environments" IEEE, Oct. 2009
3. Tim Damrow, Brent Hagemeyer, Hassan Ismail, Ryan Oldham "Optical, Electrochemical, and Magnetic DNA Biosensors – An Overview" 2009 Northern Illinois University, USA
4. C. Fournier-Wirth and J. Coste, "Nanotechnologies for pathogen detection: Future alternatives?" Biologicals 2009
5. O. Lazcka, F.J Del Campo, F. Xavier Munoz, " Pathogen Detection: A perspective of traditional methods and biosensors " Biosensors and Bioelectronics 2007

## Evaluation of IEEE 802.11 in handling multiple broadcasting audio data in wireless ad-hoc networks

*Christos Chousidis, Rajagopal Nilavalan*

*Wireless Multichannel Audio Networking*

**Keywords:** Audio Networking, wireless, ad-hoc, broadcasting

### Introduction

Audio networking is an increasing field today, which introduces new exiting possibilities for the professional audio industry [1]. But it also drastically changes the way audio systems will be designed, built and used. Today's networks have enough bandwidth to transport hundreds of high quality audio channels, replacing hundreds of kilograms of cabling in conventional analogue audio systems [2]. Today there are many systems on the market that distribute audio over Ethernet but the majority of sound installations are not using them yet. The reason that audio network is not as popular is that still demand the installation of a local network. The design and evaluation of a wireless digital audio distribution system, seems to be an accomplishable challenge. IEEE 802.11 as the primary wireless technology in computer networking has made wireless networks widely available and inexpensive. Although many problems must be solved in order this technology became able to handle the type of data traffic demanded by a live audio application [3]. In this paper an extended test is taking place in order to identify the ability and the limits of 802.11 standards to handle multi-broadcasting audio transmission.

This research is addressed in the wireless real time broadcasting of multichannel audio. It is focused in applications like live musical performances and studio recording, where large number of audio streams has to be transmitted from various sources to multiple destinations. In order to replace conventional analogue distribution systems and improve the utility of existing audio networking systems, a wireless multichannel audio distribution platform, must be established. The existing research so far in reliable wireless broadcasting cannot fulfil the needs for multi-channel audio broadcasting as it doesn't take in account the specific characteristics of such an application, as they described in the next paragraph [4]. This work performs a series of comparative test in different versions of 802.11, different frequency bands and different bit rate, in order to examine the limits of the protocol in multiple broadcasting environment.

### Design / Methodology / Approach

In a live music performance all sound sources send audio data simultaneously. They also all need to receive the audio data from all other sources of the network for monitoring. To fulfil the needs of such application, broadcasting is needed. To make the implementation simpler and easily managed no Access Point it is used. The proposed wireless network is an ad-hoc network with some specific characteristics. Those are:

- ✓ No hidden Node
- ✓ Sensitivity in Delay
- ✓ Not chance for rebroadcasting as it consumes time and bandwidth
- ✓ Maximum avoidance of collisions needed (as we have no rebroadcasting)

A simulated network is designed and adjusted to fulfil the multi-broadcasting, live music environment. A number of scenarios created, increasing gradually the number of stations and

testing different physical characteristics. The simulation platform used in this work is OPNET modeller 17.1

To represent a data load created by a live music band playing, a data traffic is calculated based on standard rhythm played at tempo 120. The packet generator was adjusted with the appropriate characteristics in order to achieve a bit rate of 0.67Mbps, similar to the payload created by an audio stream of 16 bit/ 44.1 KHz sampling rate, (PCM, no compression).

### **Findings / Results**

The results showed that 802.11 standards can handle this type of application, until certain limit which depends on the type of physical, the physical data rate and the frequency band is used (e.g. 2.6 or 5 GHz). Another interesting result is that, the problem it is not the data delivery abilities of the standard, but the collisions occurring, as many stations competing to gain access to the medium and then broadcast to all the others. CSMA/CA with random backoff works satisfactory when the number of stations is small but, as it is not designed for broadcasting, cannot guarantee reliable transmission in such application when the number of stations increases. The RTS/CTS protection mechanism cannot implement in broadcasting.

### **Conclusion / Discussion**

The results resulting from the above tests give to this research two different directions. First, a modification of the 802.11 MAC algorithm can be developed in order to minimize collisions with a protection mechanism suitable for this kind of applications. The ability of CTS-to-self mechanism, described in 802.11 standard, to minimize the number of collisions has also to be examined. Secondly, other type of packet data transmission mechanisms must be investigated (e.g. TDMA, FDMA and CDMA) in order to create a reliable multi-broadcasting system for real time audio transmission.

### **Future Plans / Directions**

The remaining of the third and the whole of the fourth year of this research (5 years part-time) will be dedicated in implementation and evaluation of a modified 802.11 MAC algorithm for reliable wireless audio broadcasting and also to examine the possibility of implementing for this purpose, other type of packet data transmission mechanisms such as TDMA, FDMA and CDMA. The fifth year will be dedicated in writing the thesis and publications.

### **References**

- [1] Yamaha System Solution “white paper”, an introduction to networked audio, Yamaha Comersial Audio 2006, C. bakker H.Hamamatsu T.Harrison
- [2] Audio Engineering Society (AES), Technical Committee on Network Audio Systems, White paper, “Best Practice in Network Audio”, 2009
- [3] A. Floros T. Karoudakis, Delivering high-quality audio over WLANs, AES 116<sup>th</sup> Convention, 2004
- [4] Brad Williams Tracy Camp, Comparison of Broadcasting Techniques for Mobile Ad Hoc Networks, 3rd ACM international symposium on Mobile ad hoc networking & computing, 2002

## Enabling technologies for the self-testing of sexually transmitted infections

*Pascal Craw, Wamadeva Balachandran*

**Keywords:** Sexually transmitted infections, Point-of-Care diagnostics, Mobile Healthcare, Lab-on-a-Chip, Molecular Diagnostics

### Introduction

Sexually transmitted infections (STIs) pose a growing burden on healthcare systems worldwide. Whilst cures and treatments are now readily available, the prevalence of STIs continues to grow rapidly. The pivotal factor in this epidemic is large number of undiagnosed cases which in turn leads to the further spread of disease. Current diagnostic methods require invasive samples to be collected by a healthcare professional and for this sample to be forwarded to a diagnostic laboratory for analysis taking up to 5 days. This testing scheme requires a complex “diagnostic chain” including expensive healthcare infrastructure, trained operators, complex, bulky equipment and a considerable time-to-result during which patients often fail to return for results and follow up treatment.

To address this problem, portable self-testing kits offering on-the-spot results have been suggested. The DoCLab, within the Centre for Electronic Systems Research at Brunel University is exploring the use of DNA diagnostics for use in such kits. DNA-based testing kits currently exist but are large, complex and expensive. In order to ensure sensitive, specific and valid detection of pathogens on a miniaturized platform suitable for so called ‘point-of-care’ use a device would need to integrate and automate several complex steps, outlined below:

1. Sample collection from a patient. Urine offers a non-invasive, abundant sample containing the target pathogens from which a DNA based test can be developed.
2. Sample preparation. DNA from the target pathogens is a biomarker indicating the presence or absence of disease. This DNA must be isolated from the sample matrix with high efficiency in order to provide a sensitive diagnostic test.
3. Amplification of isolated DNA. The small quantities of DNA isolated from clinical samples is well below the detection limit of existing technology, for this reason enzyme mediated amplification of the DNA must take place prior to sensing of the analyte (DNA)
4. Detection of DNA is used as a marker for the presence or absence of disease. Any proposed device for this purpose must specifically discriminate the presence or absence of DNA from the preceding steps in order to provide a valid assay result.

The purpose of this PhD work is to identify the key bottle necks in the development of such point-of-care nucleic acid tests and find novel solutions which enable the realization of portable, automated self-testing kits for the diagnosis of STIs.

A thorough literature review has been undertaken and used to identify key bottlenecks. Resulting in a focused plan to develop technologies to address the following key aspects of a point-of-care system:

1. Design of a rapid handheld device to extract DNA from urine samples in a manner that is suitable for first time users to perform with minimal instruction.
2. Development of an isothermal DNA amplification device incorporating fluorescent detection of amplicons.

These two areas form the two key streams of my PhD research and the starting point for experimental work.

For DNA extraction, a modified syringe was initially developed for patient use. Housing a silica membrane through which a urine sample in a extraction buffer could be manually pumped. The DNA in the urine sample would selectively bind to the membrane, under specific chemical conditions, whilst other cell debris would pass through.

For DNA amplification key isothermal technologies were reviewed and are currently under optimization. A device combining amplification, fluorescence detection and temperature regulation within a small footprint has been designed and fabricated.

### **Findings / Results**

Sample preparation syringe was shown to successfully isolate DNA from samples. The process however was still too complicated to be used without personal instruction and the reagents used were incompatible with certain materials used in the fabrication of the filters. Thus research is now focusing on the development of alternate solid phase extraction technology to be implemented on this device with the hope of further process simplification and using less reactive reagents.

Isothermal amplification optimisation reactions have led to a well characterized assay which is now ready for use on the newly fabricated platform. The small volumes being used on this device (25uL) necessitate the use of highly sensitive optics in order to detect the small signal changes seen during DNA amplification. This optical detection system is currently being optimized to enhance sensitivity and reduce noise.

### **Conclusion / Discussion**

This project is not only addressing the feasibility of novel technology but also the simplification, automation and miniaturization of said technology, into a format compatible with self-testing use by untrained operators. Results to date suggest that individually the technology is quite possible but the challenge of integrating these technologies remains to be addressed.

Within this 3 year time scale I envisage completion of my targets, namely:

1. Sample preparation system for self-testing DNA diagnostics.
2. Design, fabrication and evaluation of an isothermal amplification, fluorescence detection systems for self-testing use.

## A novel quick-response decision making platform to combine event tracker real-time unaware sensitivity analysis and manufacturing process modellers

*Morad Danishvar, Ali Mousavi*

*System Engineering Group,*

**Keywords:** Key Performance Factor (KPF); EvenTracker; Real-time system

### Introduction

Production managers are challenged by the difficult task of dealing with all related Information in a decision-making process while solving various problems that involve several resources with different policies. According to [1], which targeted a number of literature review and interviews with industry experts, there is no quick response decision-making tool in the industry to help managers evaluate the result of their optional decision. This can be due to information overload and lack of prioritising systems.

Large scale data acquisition systems receive large quantities of input variables which need high sampling frequency and heavy computational process. So called sensitivity analysis is minimizing this computational overhead and eliminate unimportant input variable that have least impact on the system[2],[3] . Sensitivity analysis techniques help to concentrate on information that has the most significant impact on system response. Many existing techniques are time consuming and reliance on historical data, then used in real-time application. EvenTracker [4] is an event-driven sensitivity analysis technique uses cause-effect logic relationship between input and output variable to speed up filtering unimportant data. This technique does not require prior knowledge of statistical and analytical relationship between input and output variables. These advantages help large scale real-time data acquisition systems to filter out less important inputs from calculation that it helps to reduce computational time, cost and complexity of data acquisition equipments.

The Proposed EvenTracker is capable of meeting the demands of real-time execution and can be used in large and complex system; however, finding a model of these complex systems which represents the real output of system is curial. This work presents a cost/benefit analysis of an automated process modelling platform that combines EvenTracker and manufacturing process modellers [5].

### Design / Methodology / Approach

Define a cost model and key performance factors:

Regarding to that general aim is to minimize cost or maximise profit, key performance factors (KPF) that define the model should be indentified regarding to nature of the production/business .Each KPF has own specific weight regarding to role of importance in that production/business.

As a case study, in a number of interviews conducted with cement production mangers and the latest literature, we identify cement production key performance factors (KPF), such as: customisation, productivity, resource utilisation, and efficiency. It proves that these factors have the highest influence on the production process, contributing to high labour and processing overheads within the cement production industries.

$$P = f(RU, CS, PR, EF)$$

Where:

- Resource Utilisation deals with production planning, scheduling, flow of material, production policies, and resource availability i.e. busy, idle, available, mean-time between failure of machines, shifts, and capacity issues.

- Customer Satisfaction will be measured as the function of variation between customer expectation and product provided. A proposed Customer Oriented Route and Evaluation (CORE) technique measure how much the actual production process and product specification satisfies is [6]. This includes pass the environment rules, packaging, content, traceability, freshness, and price.
- Productivity can be associated with Yield.
- Efficiency deals with wastages e.g. rejected parts and energy.

Ranking KPFs according to their importance with respect to profit and then are broken down into key performance indicators (KPI).

Concept of the proposed framework is base on that the system platform should link to various sources to get input data and provide meaningful information. These sources could be:

- Shopfloor data: shopfloor PLCs and SCADA carry sensors and actuators outputs
- ERP/MRP data
- Customer Demand

This information can be collected in real-time or at specified intervals based on their nature and availability which are determined by system experts and EvenTracker scheduler. Consequently, EvenTracker and proposed model are able to find sensitivity index and eliminate unimportant inputs and make decisions by collecting values from various sources and translate them to a common metric and allowing for optimisation and increasing profit.

### **Conclusion / Further Work**

It is clear that current propriety information management systems alone are not enough to evaluate cost/benefit in real-time systems. Various researches have been done in this area; however, they just cover historical data and are so sluggish. In this work, the proposed EvenTracker is integrated to information system platform to eliminate unimportant inputs and consequently, speed up model's algorithms and meet the optimal cost and benefit in real-time systems.

For future research, one objective could be developing genetic model to enhance capability, accuracy and applicability. Since there is no unified model to whole manufacturing process, so research on an automatic design of neurofuzzy model is recommended.

### **References**

- [1] H.Muna, A. Mousavi, &M. Sarhadi , “An intelligent decision and management support tool”, The Third European Conference on Intelligent Management Systems in Operations, Salford, UK, June 2005.
- [2] D. P. Durkee, E. A. Pohl, E. F. Mykytka, ”Sensitivity analysis of availability estimates to input data characterization using design of experiments”, Int. J. Quality& Reliability Engineering, 14,pp. 311–317, 1998.
- [3] A. Saltelli,“Sensitivity Analysis for Importance Assessment”, *J. Risk Analysis*, 22(3), pp.579-590, 2002.
- [4] S. Tavakoli, A. Mousavi,” Event Tracking for Real-Time Unaware Sensitivity Analysis (EvenTracker)”, Submitted to Transactions on Knowledge and Data Engineering,2010.
- [5] A. Mousavi, M. Hamdi, & M.Sarhadi , “Knowledge-Based Quick-Response Decision Making in the Food Processing Industry”, International Journal of Industrial Systems Engineering, 2(1), pp. 99-122 ,2007.
- [6] A.Mousavi, P. Adl, R.T. Rakowski, &A. Gunasekaran ,“Customer Optimisation Route and Evaluation (CORE)’, International Journal of Computer Integrated Manufacturing, 14(2), pp.236–243, 2001.

# A reliability-based routing scheme for Vehicular Ad hoc Networks (VANETs) on highways

Mahmoud Hashem Eiza, Qiang Ni

Wireless and Networks Communications

**Keywords:** VANET, highway, route reliability, QoS, routing protocols, OMNet++ simulator

## Introduction

- VANETs are a special form of mobile ad hoc networks (MANETs). It provides the communications among vehicles on the roads with no need of infrastructure. In this way, the vehicles can exchange real time information and drivers can be informed about the road traffic conditions. The special characteristics of VANETs like high mobility and frequent changes of network topology create many technical challenges. These challenges need to be resolved in order to deploy VANETs effectively. The routing reliability is one of the most critical issues where, the established route should be the most reliable one among all other routes to the destination.
- The aim of this paper is to propose a new reliability-based routing scheme for VANETs. This proposed scheme will facilitate the quality of service (QoS) support in a highway traffic scenario. The novelty of this work lies in its unique design of routing protocols by taking into account the mathematical distribution of the vehicular movements and link breakages.

## Methodology / Approach

### Proposed Reliability Model

Our link reliability is defined as the probability that an active link remains available for a certain time interval [4]. This link reliability is calculated based on a mathematical model called link reliability model. It is a probabilistic function that can predict the future status of a wireless link between two vehicles based on the location information, movement direction and velocity.

The route reliability value can be obtained from the multiplicative product of the link reliability values over all links along the route between the source and the destination. The route reliability is set to the minimum reliability value of its formed links. If we have multiple routes then, we will choose the maximum value for the route reliability. This means that we will use the most reliable route available.

### Our Reliability-based Routing Protocol: AODV-R

To evaluate the performance of the proposed scheme, we chose Ad hoc On-Demand Distance Vector (AODV) routing protocol to apply our modification. In order to fulfil the requirements of our proposed scheme, AODV routing messages: Routing Request (RREQ) and Routing Reply (RREP) and routing table entries will be extended.

The route discovery process in AODV-R is the heart of our scheme. It allows multiple RREQs and RREPs processing/sending in case that we get better values for the route reliability. This will lead to multiple routes from the source to the destination. The decision will be taken based on the most reliable route. Choosing the most reliable route will give better delivery ratio and less link breakages and will improve the overall performance of the routing process.

## Findings / Results

### Simulation setup

We used OMNet++ simulator to build our simulation scenario and compare to the standard AODV. The scenario is 5000m long highway with three lanes for vehicles to move. The vehicles' average velocity for each lane is: 40 km/h, 60 km/h and 80 km/h, respectively. We will present two simulation experiments to check the performance of our proposed scheme. The first experiment considers the velocity changes and the second one considers the packet size changes. The following three main performance measures are considered: packet delivery ratio, routing overhead and routing error messages generated.

### Simulation Results

The simulation results for both experiments show that our proposed scheme responds better than AODV to the changes of network topology i.e. highly dynamic topology. It gives better delivery ratio and less routing errors (less links breakages). On the other hand, the routing overhead of AODV-R is slightly higher than AODV's one because it allows the destination/intermediate nodes to send multiple replies for the same routing request.

AODV-R gives a stable performance when the data packet size is over MTU. Even though the network topology is almost stable, the route stability becomes more important issue in this case. Because any link breakage during the packets' fragments delivery process will cause the fail of the whole data packet delivery.

### Conclusion / Discussion

In this paper, we focused on applying the route reliability constraint on the routing process in VANETs. Although this proposed scheme has a high computational cost, it can give better delivery ratio and less routing error messages. AODV-R is choosing the most reliable route among all possible routes to the destination. It still gives a slightly higher routing overhead because it allows multiple RREPs to be sent for the same routing request. This scheme is considered as a first step toward the facilitation of QoS support in the routing protocols designed for VANETs.

### References

- M. Nekovee, "Sensor networks on the road: the promises and challenges of vehicular ad hoc networks and vehicular grids" In Proc. Of the Workshop on Ubiquitous Computing and e-Research, Edinburgh, UK, May 2005.
- Ghassan M. T. Abdalla, Mosa Ali Abu-Rgheff and Sidi Mohammed Senouci, "Current trends in vehicular ad hoc networks", University of Plymouth-School of Computing, Communications & Electronics, UK and France Telecom-Research and Development CORE, France.
- Kevin C. Lee, Uichin Lee and Mario Gerla, "Survey of routing protocols of vehicular ad hoc networks", UCLA, USA.
- Qiang Ni and Zeyun Niu, "A joint MAC-routing protocols design for enhancing QoS in IEEE 802.11p-based Vehicular ad hoc networks", Wireless networks and communications centre (WNCC) Research Report, School of Engineering & Design, Brunel University, London, UK, 2011.

## Depth mapping of integral images using a hybrid disparity analysis algorithm

*O. Abdul Fatah, A. Aggoun*

**Keywords:** 3D Imaging, Integral Imaging, Depth map, Mask, Foreground

This paper presents the results of a depth map algorithm applied to recorded integral images. The proposed algorithm is an extension previous work by introducing a mask to remove background noise.

### Introduction

Integral Imaging (II) is a technique that is capable of creating and encoding a true volume spatial optical model of the object scene in the form of a planar intensity distribution by using microlens arrays [1]. With recent progress in the theory and microlens manufacturing, II is becoming a practical 3D imaging technology and is attracting much interest in the 3D area.

II requires only one recording in obtaining 3D information and therefore no calibration is necessary to acquire depth values. The compactness of using Integral Imaging in depth measurement has attracted the attention of other researchers as novel depth extraction techniques are reported in [2-4]. In most reported techniques the depth information is obtained by viewpoint image extraction and disparity analysis. Each viewpoint image represents a 2D parallel recording of the 3D scene from a particular direction.

A drawback of the work reported in [2-4] is that the window size for matching has to be chosen experimentally. More recently, a method was reported which addresses the problem of choosing an appropriate window size, where a neighbourhood constraint and relaxation technique is adapted by considering the spatial constraints in the image [5]. This paper presents an extension to the work presented by Wu et. al. [5] to further improve the depth estimation by removing the background noise from the depth map.

### Design / Methodology / Approach

The proposed approach is able to reduce unwanted noise that appears on the foreground. This is carried out by applying foreground detection model, where a binary mask is generated at this stage. The binary mask is formed using morphological operations, thus it is only applied to the reference viewpoint image. The reference viewpoint image is the middle viewpoint image in the given integral media file. The reason for considering the middle viewpoint image as a reference image is to compensate both left and right side of an image features, in addition the middle viewpoint is also considered during depth calculation. The logical operators erosion, reconstruction and dilation are applied to the middle viewpoint image then a threshold is acquired on the segmented image. The threshold is equal to the maximum intensity value in the object to obtain the foreground mask with an offset value. The offset value is considering depending on the individual images. The foreground mask clearly points out the miscalculated regions on the depth map, when it is incorporating on the depth map. The mask is used to

detect the foreground from the background and reduces the noise considered as a foreground on a background during depth calculation. The proposed approach removes noise on the depth map to its minimum and returns depth map with clear object contour.

The full paper describes in detail the algorithm that was used and provides more background to the scope of this research work.

### **Future Plans / Directions**

I am working with European project in the area of depth map extraction and currently my research work is on track. I am hoping to submit my thesis in May 2013 at the same time as the project finishes.

### **Acknowledgements**

The authors gratefully acknowledge the support for this work that is funded by the EU under the ICT program as the project 3D VIVANT (3D LiVe Immerse Video-Audio INteracTive Multimedia), ICT-2010-248420.

### **References**

- [1] Okoshi, T.: Three-Dimensional Imaging Techniques. Academic Press, Inc., London, UK. (1976).
- [2] Wu, C., *et. al.*: Depth extraction from unidirectional integral image using a modified multi-baseline technique. Proc. SPIE Electronic Imaging Symposium, San Jose, California, USA, (2002).
- [3] Arimoto, H., Javidi, B.: Integral three-dimensional imaging with digital reconstruction. Optics Letters, 26(3), 157-159(2001)
- [4] Park, J., Jung, S., Choi, H., Kim, Y., Lee, B.: Depth extraction by use of a rectangular lens array and one-dimensional elemental image modification. Applied Optics, 43(25), 4882-4895 (2004).
- [5] Wu, C., *et. al.*: Depth Map from Unidirectional Integral Images using a Hybrid Disparity Analysis Algorithm. IEEE Journal of Display Technology, 4 (1), 101-108, (2008).

## Metamaterial Antenna

*Roohollah Haghpanahan, Rajagopal Nilavalan*

*Wireless Communication System*

**Keywords:** Metamaterials, negative refraction, optical transformation, general effective medium theory, rapid design of metamaterials, non-resonant metamaterials

### Introduction

There have been increasing interests in metamaterials in the past 10 years in the scientific communities. Metamaterials are sometimes called left-handed materials or negative refractive index materials. Metamaterials are inherently artificial materials and cannot find in nature.

Based on *Wikipedia*, the metamaterial is defined as “a material which gains its properties from its structure rather than directly from its composition”. The above definition reflects certain natures of metamaterial, but not all. Actually, *a metamaterial is a macroscopic composite of periodic or non-periodic structure, whose function is due to both the cellular architecture and the chemical composition* [1].

In our research progress, our aim is to improve small profile antenna performance by taking advantages of metamaterial properties. To achieve this goal deep understanding of field and wave electromagnetic as well as photonic crystal structure, effective medium approach and optical transformation are required.

### Aims / Objectives

Our research aim is to improve small antennas performance. Some desired goals which are investigating in our research are as follows:

- Make antenna profile smaller
- Increase antenna gain
- Increase antenna operation bandwidth

Our objectives which are needed to be done to achieve our aims can be listed as follows:

- Detailed understanding of electromagnetic wave behaviours
- Detailed understanding of Drude-Lorentz modelling theory
- Detailed understanding of Crystal photonic structure
- Detailed understanding of effective medium approach
- Knowing how to use the optic transformation theory

### Design / Methodology / Approach

In last academic year we have tried to define a work frame and methodology. To design a metamaterial element we divide the design process in three.

In the system level design, spatial distribution of the material parameters is computed related to the desired function of the metamaterial. The optical transformation is used to calculate the spatially varying permittivity, permeability, refractive index and so on. The computation can be analytical, and when the problem is too complicated to solve by analytical solutions it can be numerical as well [2]. The particle level design outputs the optimized geometric parameters of the metamaterial particles for each set of material parameters. It has four sub-steps as follows.

In sub-step 1, a small number of metamaterial particles with different geometric parameter values are simulated as samples. From the simulated transmission  $T$  and reflection coefficients  $R$ , the local field responses of the simulated particles defined as permittivity and permeability

are then retrieved, which are in the form of Drude–Lorentz model when the metamaterial particles are resonant. In sub-step 2, the curves of permittivity and permeability are fitted with a Drude–Lorentz model if the metamaterial particles are resonant and by Taylor expansion if they are non-resonant. In sub-step 3, a mathematical relation between the Drude–Lorentz model and the geometric parameters of physical dimensions of the metamaterial particles is set up. Another fitting process is carried out to obtain the mathematical relation between the geometric parameters and the Drude–Lorentz parameters/the Taylor coefficients obtained in sub-step 2 by Taylor expansion.

In sub-step 4, by sweeping through the available geometric parameters, material parameters are calculated by the mathematical relation obtained in sub-step 3, in order to search for the geometric parameters which optimize the material parameters. The sweeping procedure takes into consideration the fabrication precision limit and the practical physical dimensions. The output level incorporates all the different metamaterial particles whose dimensions are determined by previous level and generates integrated masks for fabrication<sup>[2]</sup>.

### **Future Plans / Directions**

In next academic year we will investigate the theory for metamaterial structures supported by simulations conducted with the commercial finite element method solver, Ansoft HFSS.

The research strategy for next year comprises three steps; in first step we will elaborate on the theories which are involved in our work such as effective medium approach, Drude-Lorentz models, optical transformation and the photonic crystal medium. In second step, the existing resonant and Non-resonant metamaterial structures will be investigated. Eventually, in third step we will try to improve the existing metamaterial structure performance.

### **References**

- [1] Tie Jun Cui, David R. Smith, Ruopeng Liu, "Metamaterials Theory, Design, and Applications", Springer, 2010.
- [2] Liu, R., Ji, C., Mock, J.J., Chin, J.Y., Cui, T.J., Smith, D.R." Broadband ground-plane cloak", Science **323** (5912), 2009.

## Smart grid information use cases for electricity storage modelling within the IEC common information model

Nigel Hargreaves, Gareth Taylor

**Keywords:** Common Information Model, Interoperability, Smart Grid, Energy Storage

### Introduction

The IEC Common Information Model (CIM), IEC 61970 (Energy Management System Application Program Interface, EMS-API) [1] is the basis of one of five core smart grid interoperability standards identified by the National Institute of Standards and Technology (NIST) [2]. The CIM provides an object-oriented, scalable and extensible semantic ontology for modelling power system resources. Successive releases of the CIM, driven by power utility information use case requirements, are evolving as this Unified Modelling Language (UML) reference model supports new scenarios for power system operation and management that will arise over the next ten years.

Probabilistic, weather-dependent supply and dynamic demand, coupled to network design migration away from centralised power stations, requires smart grid operation by utilities to have greater situational awareness relying on high definition modelling of network resources including reserves held in a variety of forms of energy storage (ES). The advent of operational scenarios with significant renewable generation is driving the need for ‘new’ ES devices to assist with grid frequency support, voltage regulation and demand shifting as *balancing ancillary services*, [3]. These needs are beyond the scope for mature storage technologies such as pumped hydro, that require specific geographic conditions. Examples of new grid-scale ES devices under trial on the GB network, include an 11kV-connected 200kWh hour Li-Ion ES unit in Norfolk [4] and a 500kW cryogenic ES unit in Slough [5]. Worldwide, Li-Ion battery ES installations offer services including capacity release for generators to avoid load shedding, reserve capacity and energy arbitrage up to 32MW [6]. 4MW Sodium-sulphur (NaS) batteries are being used in Texas to provide outage back-up [7] and larger installations (34MW+) in Japan to stabilize output from wind farms [8]. There are also ES developments using multiple flywheels capable of delivering tens of MWs for frequency regulation [9]. New strategic planning scenarios at National Grid, the GB Transmission System Operator, consider the need to model ES systems including aggregated electric vehicle-to-grid capabilities. We examine whether current structures within the CIM are satisfactory to accommodate these new paradigms of electricity storage and view this work as original.

### Design / Methodology / Approach

We assess the current version of the CIM to support future smart grid scenarios conceived within Control Strategy Development at National Grid. We will evaluate its structure to support novel ES technologies in respect of the above scenarios and propose extension of the UML classes where necessary to accommodate previously un-modeled energy storage systems likely to be required for smart grid balancing.

### Findings / Results

We have identified a need for extending the CIM to model conventional fuel stores such as coal piles and distillate tanks from the perspective of energy security and supply resilience as part of the future smart grid paradigm. This is in addition to development of UML to support novel ES technologies is still in progress.

## Conclusion / Discussion

The results of our investigation suggest that there is a requirement to extend the CIM with a new package of UML classes dedicated to ES. This could reflect the change in perspective towards smart grid operational scenarios from conventional grid management.

## Future Plans / Directions

This work will be completed within the three-year time scale as part of the total research contribution. It may be of sufficient importance to be presented to the International Electrotechnical Commission for consideration to modify the IEC 61970-301 international standard.

## References

- [1] CIM Users Group, 2012. Draft 61970cim14v15\_61968cim10v31.  
<http://cimug.ucaiug.org/CIM%20Model%20Releases/Forms/AllItems.aspx>
- [2] NIST, 2010. NIST Identifies Five “Foundational” Smart Grid Standards.  
[http://www.nist.gov/public\\_affairs/releases/smartergrid\\_100710.cfm](http://www.nist.gov/public_affairs/releases/smartergrid_100710.cfm)
- [3] Makarov, Y., Du, P., Kintner-Meyer, M., Jin, C., Illian, H., 2012. Sizing Energy Storage to Accommodate High Penetration of Variable Energy Resources. IEEE Transactions on Sustainable Energy, Vol. 3, No. 1
- [4] ABB, 2011. Energy storage – smoothing the transition to smarter grids.  
<http://www.abb.com/cawp/seitp202/4ec961176b95a792c125793100300be8.aspx>
- [5] Highview Power Storage\_2012. Large scale cryogenic energy storage demonstration plant.  
[http://www.highview-power.com/wordpress/?page\\_id=303](http://www.highview-power.com/wordpress/?page_id=303)
- [6] AES Energy Storage, 2011.  
[www.aesenergystorage.com/nodeorder/term/2](http://www.aesenergystorage.com/nodeorder/term/2)
- [7] Electricity Transmission Texas, 2011. ETT Brings Largest Utility-scale Battery in the United States to One of the Oldest Cities in Texas.  
<http://www.ettexas.com/projects/presnas.asp>
- [8] Kawakami *et al.*, 2010. Development and Field experiences of Stabilization System using 34MW NaS Batteries for a 51MW Wind Farm. IEEE.
- [9] Beacon Power, 20MW Flywheel installation, Stephentown NY, USA.  
[www.beaconpower.com](http://www.beaconpower.com)

## Pattern recognition with weightless neural networks

*Kazimali Khaki, John Stonham*

**Keywords:** Pattern Recognition, Neural Network, Random Mapping

### Introduction

The solution presented in this paper offers real-time recognition processing, and a single pass training facility, and has produced results which are significantly better than other methods applied to this data [1], with error rates two orders of magnitude less than hitherto reported. The MIT database has been chosen for this paper because it offers more challenging recognition problems. Each image contains a face, but it is unconstrained in terms of position, background, lighting and clothing. The database was first used by MIT, where, they converted each image into a 3D computer representation, and achieved an overall recognition percentage of 88%, this paper reports on an algorithm that results in 99.9% accuracy.

### Design / Methodology / Approach

Modern technology allows a direct interface between a camera and a digital neural network, with information being captured at the pixel level, and this allows the network to evolve its functionality. Hence, using this methodology offers the potential to remove the problematic feature extraction stage, resulting in enhanced performance.

The ‘test’ folder of the MIT-CBCL database consists of 10 image sets; each contains 200 images of an individual. The images vary in size, ranging from 100x100 to 115x115 pixels. Resizing is done initially to bring all images to a constant 100x100 pixels. This is done using subsample normalization, which does not change the values of any of the pixels in the image; rather it deletes rows and columns of pixels to reduce the overall size of the image. The database was then divided into a set of 100 images of each of the 10 subjects which were used solely for training the neural network. The remaining set of similar size was used solely for testing.

The algorithm developed and used in this work is a random n-tuple mapping on grayscale images, where each image is divided into 200 sets of 5 pixels groups. An n-tuple state is then obtained by using a ranking transform which eliminates the requirement for pixel thresholding operation [1]. The digital neuron then correlates the recurring states obtained from the training phase with the current input from the test pattern. The algorithm is stated below:

$$\text{Images} \xrightarrow{\text{Threshold}} \text{Input Vector: } I_i..I_{i+j} \quad \text{Function} = \sum(n_1, n_2, n_3, \dots, n_t) \\ \text{where: } I_i \in (0,1) \quad \text{where: } n_i - i^{\text{th}} \text{ state of sample at} \\ \text{position } I_j .. I_n$$

$$n \text{ sample} \longrightarrow \text{subset of } I - I_j, I_k \dots I_n \quad \text{No. of Functions} = \frac{N}{n} \quad \text{where: } N = i*j \\ \text{where: } j, k, \dots - \text{random numbers} \quad n = 5$$

To avoid the threshold, for each n-tuple  $I_j$  to  $I_n$  is ranked.

Ranks:  $I_j \geq I_k \dots \geq I_n$  is state 0  
through to  
 $I_j \leq I_k \dots \leq I_n$  is state  $(n! - 1)$

The algorithm makes use of a single layer weightless neural network, with no hidden layers. The training requires a single pass through the training set; therefore no error back propagation is required. This results in very fast training, of the order of 10 frames a second in simulation. The number of neurons in the network depends on the size of the image, and is calculated from the number of pixels divided by the n-tuple size.

### **Findings / Results**

The training set and testing set consisted of 10 individuals, each with 100 unique images. The algorithm had a training and testing rate of 10 images per second in a computer simulation, and produced a recognition accuracy of 99.9% overall, with a 0.1% False Rejection Rate (FRR) and 0.1% False Acceptance Rate (FAR). This compares with the 88% accuracy published by MIT [1] and it also shows significant savings in processing time. Additionally it should be noted that the memory requirements for a single neuron which is in effect implementing a 6 variable logic function, is 128 bits, and as 2000 neurons are used per net, the system has an efficient hardware implementation capability with a total storage requirement of 250kB; this is independent of the size of the data set being processed.

### **Conclusion / Discussion**

The 99.9% accuracy with the MIT database has resulted in one error in 1000 images. It should be noted that these results have been obtained from an un-optimised system. The training and feature sampling strategies have been randomly specified. It is therefore expected that robust error free performance can be achieved in an optimised system. It may be noted that error free classification has been achieved with other public domain databases, namely AT&T and Yale.

### **Future Plans / Directions**

At the current stage, the pattern recognition stage has been kept aside as all results are excellent, however without face detection the algorithm can only be used in certain situations. At the moment a face detection algorithm is being developed using the same algorithm the pattern recognition is based on, and it seems to be better than the opencv haar detect based on preliminary testing. The PhD is on track, and the thesis is to be handed in by September/October 2012.

### **References**

B.Weyrauch, J.Huang, B.Heisle and V. Blanz. "Component-based Face Recognition with 3D Morphable Models" 2004.

Credit is hereby given to the Massachusetts Institute of Technology and to the Center for Biological and Computational Learning for providing the database of facial images.

## Cognitive radio based MAC protocols for wireless ad hoc networks

*Abdullah Masruba, Hamed Al-Raweshidy*

*Wireless Networks and Communications Centre*

**Keywords:** Wireless Networks; Medium Access Control (MAC); Cognitive Radio (CR)

### Introduction

With the rapid growth in wireless applications, the radio spectrum becomes acquiring a fundamental importance. Recent reports show that almost all the available spectrum has been allocated. However, extensive measurements indicate that a large amount of licensed spectrum remains unused at a specific time or a slot level. This accelerated the emerging of Opportunistic Spectrum Access (OSA) concepts guiding to a Cognitive Radio (CR) technology. To increase the spectrum efficiency, Cognitive MAC (CogMAC) users can be enabled to access the spectrum and use temporally the spectrum spaces unused by a licensed user, which is also known as spectrum holes or white spaces. If these holes are further used by the licensed user, CogMAC users should have the ability to vacate the channel and move dynamically to another spectrum hole or stay in the same band altering the transmission power level to avoid interference. However, interference between licensed users and unlicensed users can be occurred when licensed users are located in the same communication area of those who are licensed. To overcome such a problem, some aspects and functions related to the spectrum and the interference management such as spectrum sensing, spectrum management, spectrum sharing, spectrum mobility, and coordination need to be more investigated.

The contribution of this paper is to investigate a CR-based MAC protocols for wireless ad hoc networks. We aim to focus on a Cognitive MAC protocols for a no licensed user which can be enabled to access the large amount spectrum unused by a licensed user in an intelligent way without causing any harmful interference with the licensed one. We propose a cognitive MAC protocols based on the theory of Partially Observed Markov Decision Process (POMDP) which sense the radio spectrum, detect the occupancy state of different primary channels, and then opportunistically communicate over unused channels (spectrum holes). The objective is to benefit as much as possible from the available spectrum opportunities by making efficient decisions on which channels to sense and access which ensure maximizing the throughput of the secondary user.

### Design / Methodology / Approach

We propose a POMDP-based scheme to find sensing and access policies to optimise the CR network. Our design is specified by a finite set of states  $S$ , set of control actions  $A$ , a transition probability  $P$ , and a reward function  $R$ . The main goal behind using this strategy is to maximise the throughput of unlicensed users by maximizing the expected sum of rewards:

$$R^T = E\{\sum_{t=1}^T R(T)\} \quad (1)$$

We consider a spectrum consisting of  $N$  independent channels, each channel with bandwidth  $B_n$  ( $n = 1, \dots, N$ ). These  $N$  channels licensed to primary users which have an authority to communicate over it according to a synchronous slot structure. The presence and absence of the primary users in each channel of the network can be modelled as alternative time intervals of busy and free states. We consider each channel is divided into  $T$  slots and the network state in a slot  $t$  ( $t = 1, \dots, T$ ) is given by  $\{S_1(t), \dots, S_N(t)\}$ , where  $S_n(t) = 1$  when the channel is free and  $S_n(t) = 0$  when the channel is busy. We finally define the transition reward. We assume that each used channel will give an amount of reward

$$R(t) = \sum_n S_n(t) B_n(t) \quad (2)$$

Where  $S_n(t) \in \{0, 1\}$  is the state of channel  $n$  in slot  $t$ , and at the beginning of each time slot, and using the belief vector  $\Lambda(t)$ , the secondary user decide to access the channel:

$$n^*(t) = \arg \max_{n=1,\dots,N} [\lambda_n(t) B_n(t)] \quad (3)$$

### **Findings / Results**

Two scenarios of POMDP-based cognitive MAC protocols based on greedy sensing approach are considered. In the first scenario we assume that the number of primary channels are three independent channels, each with bandwidth  $B = 1$  and number of slots  $T = 30$ . We also consider prior knowledge about the channels transition probabilities  $\{P^{01}, P^{11}\}$ . In the second scenario we consider that the transition probabilities are fixed at a specific values. We apply this scenario to different number of channels  $\{N = 2, 3, 4, \text{ and } 5\}$ . Our simulation results show that the throughput of SU can be enhanced overtime. By increasing the number of channels, SUs can perform more spectrum efficiency.

### **Conclusion / Discussion**

In this paper, we have presented a POMDP-based cognitive MAC approach for wireless ad hoc networks. Using multiple channels and assuming a slotted structure for the primary network, we proposed that unlicensed user opportunistically makes optimal decisions for sensing and access based on the information state. By updating the knowledge of the network state based on all past decisions, observations and then the transition probabilities, the secondary user perform more spectrum efficiency. Our results demonstrate an improvement in the throughput using greedy strategy.

### **Future Plans / Directions**

Sensing errors, both false alarm and miss-detection probabilities, need to be considered in future work. In addition, PHY and MAC layers need more investigation to achieve an optimal cross-layer approach which can enhance the performance of OSA in CR wireless ad hoc networks.

### **References**

- [1] Q. Zhao and B. Sadler, "A Survey of Dynamic Spectrum Access," IEEE Signal Processing magazine: Special Issue on Resource-Constrained Signal Processing, Communications, and Networking, vol. 24, pp. 79–89, May 2007.
- [2] I.F. Akyildiz, W.Y. Lee, K.R. Chowdury. "CRAHNs: Cognitive Radio Ad Hoc Networks," Journal of Ad Hoc Networks, p.810-836, ScienceDirect, 2009.
- [3] A. Masrur, H. Al-Raweshidy, M. Abbod, "Cognitive Radio Based MAC Protocols for Wireless Ad Hoc Networks," The Fourth International Conference on Developments in eSystems Engineering (DeSE'11), pp. 465-469, Dubai, UAE, December 2011.

## MATLAB-aided teaching and learning for engineering mathematics students

*Abdul Majid Mohammed, Wamadeva Balachandran, Zayed Huneiti*

**Keywords:** MATLAB, Engineering Mathematics, University Calculus, Teaching and Learning

### Introduction

Technology in general and computer in particular have greatly influenced both teaching and learning of mathematics. Mathematical software can steer students' learning at a pace that is suitable to their own level and speed. Besides, assistive computer sessions can help weak students to improve their mathematical and problem-solving skills. This produces a truly authentic learning environment where students are actively engaged in the learning process. The literature is rich in the identification of issues related to the positive impact of the use of mathematical and computational software in classroom. It has been reported that the integration of advanced computing algebra systems in classroom teaching had positive impact on students' achievement in mathematics, Tokpah, L. (2008) [1]. However, not many studies have been conducted on the use of MATLAB in teaching and learning of undergraduate engineering mathematics. The effectiveness of the conventional lecture method can be greatly improved by integrating MATLAB in teaching and learning of engineering mathematics, Liang et al (2009) [2], Brake (2007) [3], and Cretchley (2000) [4]. This is because MATLAB provides a powerful interactive and dynamic working environment. There is an ever growing concern with regard to the decline of mathematical skills, uneven preparedness, commitment to and enjoyment of studying mathematics of students on entry to engineering disciplines. Therefore, an urgent need for integrating MATLAB in the teaching of calculus for the freshman engineering students at University of Ha'il was felt. Currently the teaching and learning of mathematics is mostly traditional at the university. The decision of incorporating MATLAB in teaching and learning of freshman mathematics has been made in an attempt to motivate students and help them to develop the necessary concepts and skills. In particular, the choice of MATLAB stems from the fact that it is a powerful multi-purpose and widely accessible scientific software package which is currently being used in most, if not all, engineering subjects, and is the software package most favoured by researchers, educators, professional engineers and mathematicians. Hence, mastering MATLAB will certainly help students in other courses as a learning tool as well as it will be beneficial after graduation.

### Design / Methodology / Approach

This paper describes an ongoing research study conducted with 81 freshman engineering students in a conventional teaching and learning environment where MATLAB is integrated into a traditional calculus course. To enhance collaborative learning and problem solving, a MATLAB manual was prepared which contains lab activity worksheets for mathematical tasks to be performed in a group setting. Problem-solving was emphasized in classrooms and enhanced through the use of MATLAB. To achieve the objective of the research, several data collection tools have been developed and used. The tools include: students questionnaires,

students focused group interviews, group discussions with students, and video recordings of the MATLAB sessions as well as the observation of in-class and in-lab students learning.

### **Findings / Results**

Initial analysis of the data, the retrospective students' views expressed in the interviews and group discussions have revealed that an overwhelming majority of students enjoyed the use of MATLAB in learning mathematics which in turn has a positive effect on their attitudes in learning mathematics. Cronbach's Coefficient Alpha was computed to check the internal reliability of the questionnaire items. It was found to be 0.97 which falls in the range of acceptable score of 0.70 to 1.00. About 73% of the students (45% strongly agreed, 28% agreed) have indicated that MATLAB has helped them in understanding calculus. However, 13% of the students (4% disagreed, 8% strongly disagreed) disliked the use of MATLAB. A comprehensive analysis of the data collected is currently ongoing.

### **Conclusion / Discussion**

Students' mathematical weaknesses and flaws in their reasoning were identified by conducting different classroom quizzes and tests. It is anticipated that the implementation of a more comprehensive plan with MATLAB as a supplement to motivational instructional techniques will enhance students' learning process and improve their mathematical skills. This will play a pivotal role in fostering a successful student-centred learning environment. MATLAB-based learning as a supplement to traditional classroom instruction promoted active learning which has helped students to develop a stronger conceptual understanding of the subject matter. In addition it was observed that students' interaction with the course content has increased. Their performance in regular class work and weekly quizzes/tests has improved.

### **Future Plans / directions**

- An assessment of the impact of the MATLAB on the students' mathematical achievement will be further investigated. Further study will be carried out depending upon the completion of the current case study.
- The number of research variables will be increased to address students difficulties in mathematics as outlined in the literature review summary.

### **References**

1. Tokpah, L. (2008). The effects of computer algebra systems on student's achievement in mathematics. (Doctoral dissertation, KenState University College).
2. Liang, Jiajuan; William S Y (2009). A MATLAB-Aided Method for teaching calculus-based business mathematics, American Journal of Business Education, Dec. 2009; Volume 2, Number 9; ProQuest.
3. Brake, Mary L. (2007). MATLAB as a Tool to Increase the Math Self-Confidence and the Math Ability of First-Year Engineering Technology Students, The Scholarship of Teaching and Learning at EMU: Vol. 1, Article 5.
4. Cretchley, P., Harman, C., Ellerton, N., Forgarty, G., (2000). MATLAB in Early Undergraduate Mathematics: An Investigation into the Effects of Scientific Software on Learning, University of Southern Queensland.

## Quality optimisation in 3D video communication over heterogeneous networks

*Hamdullah Mohib, Abdul Sadka*

*Center for Media and Communications Research*

**Keywords:** 3D video, UMTS, H.264/MVC

### Introduction

The Internet, a heterogeneous network, has become a household commodity in most of the developed world where it is more affordable. It has also become an essential tool for development. With over 1 billion users connected to it already and growing, the demand for this worldwide network is rapidly increasing. Access networks such as 3G (UMTS) enabled phones are now seamlessly becoming the gateway to the internet for more and more people. Quality optimisation of 3D video in such a network is essential and hence an optimisation technique with an effective error concealment strategy to satisfy 3D video immersive expectations is required. Taking the current state-of-the-art in 3D systems and future trends, we have been focusing to grasp the 3D video communication value chain including 3D content generation, delivery, post-processing and display. We discovered challenges such as 3D multi-user communication, 3D over 4G networks, distributed 3D video coding, scalability issues and universal 3D access, and finally potential approaches to investigating these challenges.

### Design / Methodology / Approach

The research is split into two areas, network simulation and video codec optimisation. The first part is setting up the simulation network using the OPNET simulator which is a network of heterogeneous networks, i.e. UMTS, WiMAX, WiFi and all connected via cable to the Internet. This is currently being built.

The second part is the 3D video optimisation. The results of the simulation will be used to investigate and assess improvements in the video compression for delivery. We will, for example, investigate the dynamic parameter assignment and packet priority based on the importance of the information being delivered and channel restriction. For this section, I have the encoders and the objective evaluation tools already accumulated.

### Findings / Results

In an error free condition and no bandwidth limitation, 3D video encoded with the H.264/MVC provides an acceptable level of perceptual video quality. The results of our experiments will show the effect of error prone channel conditions which will increase the bit error rates. We will demonstrate the effect of quality degradation caused by packet drops and present error resilience techniques that will improve the perceptual video quality over error prone heterogeneous networks.

## Conclusion / Discussion

We have created a heterogeneous network of three error prone wireless networks connected to each other via the Internet. The model, created in OPNET allows me to experiment with the effect of the network conditions on the video, which will then be used to improve the quality of the video encoding with respect to its Network Abstraction Layer (NAL). It is expected that the optimisation of the video quality will be improved by adding dynamic parameter selection and assigning priority levels to various packets being transmitted. We will also apply adaptation at the edge of every network in our experiment and test their impact on the perceptual quality of the 3D videos at the receiver. The improvements will be simulated again using the same model to test the results and observe whether the expected improvements appear. Over time, I anticipate adding new nodes and equipment to the model, necessary for an improved end to end video communication.

## Future Plans / Directions

The three nodes model of the network will provide the foundation for our testing and quality optimisation. Each network independently provides a separate transmission mechanism and uses different protocols and channel protection. The nodes on these networks will be communicating with the nodes within their own network and with the nodes in the other two networks. Taking the different bit rates allowed and the channel conditions into account, we will experiment with different adaptation techniques at the edge of every network. For example, we expect deterioration of video quality and higher packet loss when a video stream is transmitted from a WiMAX network node to a UMTS node. Due to the error prone condition of the UMTS network and the ability to accept lower resolution, the perceptual video quality of the 3D video being transmitted will be much lower. We aim to improve this with our proposed adaptation layer at the network edge so that it is more robust in scalability and error resilience by applying optimisation techniques specific to the destination network.

We will also do reverse adaptation where a 3D video transmitted from a low resolution device over an error prone wireless network such as UMTS to more generous networks in terms of bandwidth and channel conditions such as WiFi and WiMAX. In the case of WiFi for example, the channel is in most cases free from the packet drops caused by environmental conditions and with slower mobility expectation on the part of the nodes. The resolutions and the speed of packet delivery will be expected to be much higher than that of the source node at the UMTS network. Our proposed adaptation layer, at the edge of such networks, will up-sample the 3D video resolution to meet the expected end user perceptual video quality.

These experiments are in line with our current work and will be built as an extension on the current network model created. The research is currently expected to complete within the assigned 3 years time frame with an estimated submission date of 30 August 2013.

## References

1. 3D video communications: Challenges and opportunities, Guan-Ming Su et.al, INTERNATIONAL JOURNAL OF COMMUNICATION SYSTEMS, Int. J. Commun. Syst. 2011; 24:1261–1281
2. 3D Multiple Description Coding for Error Resilience over Wireless Networks, PhD thesis, Abubakar Sadiq Umar, School of Engineering and Design, Brunel University, September 2011

## Development of high temperature transducers for continuous guided wave monitoring of superheated steam pipes

*Abbas Mohimi, Wamadeva Balachandran*

**Keywords:** Power Plants, Continuous Guided Wave Monitoring, High Temperature Piezoelectric, Curie Temperature, Lithium Niobate, Impedance measurements

### Introduction

In power plants, there are many kilometres of pipe work carrying superheated steam. The high temperature and pressures in these pipelines can lead to failure due to fatigue, cyclic loading and creep and if undetected can lead to catastrophic safety, environmental and financial consequences.

Continuous guided wave monitoring has been identified as a possible method to detect and monitor the growth of structural defects in superheated steam pipes in the power plants. Guided wave inspection of pipes normally involves array of transducers mounted around the pipe to generate ultrasonic wave modes. This technique has been successfully employed at ambient temperatures, but the high temperatures experienced in power stations (up to 580°C) present practical challenges.

The key challenge is to develop transducers that can withstand these conditions. This is largely due to the limited Curie temperature of the piezoelectric materials, above which their piezoelectric characteristics are compromised. Lithium Niobate (LN) has been identified as a piezoelectric ceramic that has a reported Curie temperature of 1150°C. The piezoelectric coefficients of materials give an indication as to how they will perform as transducers. This data for a shear type LN is not available for high temperatures. This can be carried out by performing impedance measurements at high temperatures.

In this paper initial results of high temperature impedance-frequency measurements for LN, and ultrasonic performance of the current state-of-the art Teletest® transducers plus the initial prototype transducers have been reported. The prototypes were assembled in the same manner as the Teletest transducers. Lead Zirconate Titanate (PZT) and LN were used as the piezoelectric material and were assembled using high temperature adhesives. The initial ultrasonic experiments for the LN show that it can be used at temperatures up to 460°C to transmit and receive guided wave signals at up to 200kHz. This will enable design and manufacture of high temperature transducers for continuous guided wave monitoring of power plants.

### Design / Methodology / Approach

Ultrasonic signals were generated and received using pulser-receiver hardware known as the Dolphin. Transducers under evaluation were subjected to both transmission and reception tests, by using a reference transducer permanently fixed to one end. A steel bar (12mm in thickness and 1.5m in length) was used as the waveguide. A jig was used to hold the transducer in place, and also enabled 200N load to be applied to the transducer to provide sufficient coupling. A hotplate was placed under the test transducer. The transducers were connected to the pulser-receiver unit, and tested at room temperature and then at high temperature. The peak-to-peak amplitude of the fastest arriving wave mode was measured in reception and transmission mode for all the transducers.

A jig to hold the piezoelectric elements was produced, and then placed inside the furnace to perform impedance measurements at up to 600°C. The characteristic frequencies, capacitance,

density and dimensions of samples were used to calculate the dielectric, elastic and piezoelectric coefficients.

### **Findings / Results**

The PZT transducers with and without high temperature adhesives worked up to approximately 350°C. The transmission and reception quality of the transducers assembled with high temperature adhesives was improved, and followed the trend reported in literature [1]. The transmission and reception quality of LN transducers prepared with high temperature adhesives were inferior to the PZT transducers. However, the transducers worked up to approximately 460°C (maximum temperature of the hotplate).

The impedance measurements performed of LN at ambient temperatures are in agreement with the manufacturer datasheet. The high temperature measurements are being performed.

### **Conclusion / Discussion**

The Teletest transducers could operate at near the Curie temperature of the PZT (350°C), but with a significant drop in ultrasonic performance, and the transducers failed structurally. The performance improved significantly when high temperature adhesives were used instead. Also, the transducers were structurally sound. This improvement in transducers can enable in-situ high temperature guided wave inspection of petrochemical pipeline at up to 250°C. The LN transducers worked up to 460°C, but the transducer failed structurally due to the temperature limitation of the adhesives. Development of transducers that can operate up to 580°C should be feasible with LN using alternative joining techniques, such as vacuum brazing.

The current experimental set-up for high temperature ultrasonic measurements is repeatable and can provide relative comparison between the performance of different types of transducers. It should be possible to perform more high temperature ultrasonic measurements, and with improved accuracy using a hotplate with better temperature control or using a large furnace that could house the wave guide.

### **Future Plans / Directions**

- Vacuum brazing trials will be performed to investigate the feasibility of producing LN transducers that can operate up to 580°C.
- High temperature impedance measurements should give an indication how the LN transducers should behave at high temperatures.

### **References**

1. Berlincourt D, Krueger H. H. A and Near C., "PROPERTIES OF MORGAN ELECTRO CERAMIC CERAMICS", Morgan technical ceramics [Online] Available at: <http://www.morganelectroceramics.com/resources/technical-publications/?301Redirect> [Accessed on 20 May 2011]

## Combined scalability techniques for improved and flexible scalability with H.264/AVC extension

*Sanusi Muhammad, Abdul Sadka*

*Centre for Multimedia and Communication Research*

**Keywords:** Scalability, H.264/AVC, Temporal, Spatial, Quality

### Introduction

The emergence of new applications and rapid change of technological devices has call for an improved multimedia communications techniques and algorithms in the area of conversational and non-conversational applications. H.264/AVC is the current video codec standard developed by ITU-T video Coding Experts Group (VCEG) and the ISO/IEC Moving Experts Group (MPEG). H.264 design has achieved an enhanced compression performance and provides scalability and network user friendly coding techniques namely Temporal, Spatial and Quality (SNR) scalability techniques [3]. Temporal refer to the smoothness of picture, Spatial is the size or detail on the picture and Quality is the fidelity of the video signal. H.264/AVC was initially designed to be a codec with long term objectives (H.26L) as its tool are everyday experimented and redesigned for better efficiency [4]. H.265 (HEVC) is the recent codec which provides 2x efficiency than H.264 at the same video quality.

The aim of this research is to develop improved combined scalability techniques from the conventional techniques. The techniques are temporal+spatial+quality (t+s+q), temporal+spatial(t+s), and temporal+quality(t+q). Variable coding parameters are also experimented which determined the optimum for scalability. The effects of additional layering within each of the technique is also experimented. These improved techniques provide high level of scalability which will automatically make a network friendly environment. The techniques are evaluated and validated using packet loss simulation, objective and subjective analysis.

### Design / Methodology / Approach

The design of the techniques focused to achieve a network preventive control and network aware control. To meet this aim the following approaches are considered; decision making algorithm, use of efficient coding parameters, scalability combined techniques and adaptation of a conceptual frame work that describe adaptation from source encoder to application user.

The research involves extensive use of H.264/AVC Extension codec. The coder was studied and customized for the research aim. The usage of the H.264 codec involves experiments with various coding tools and parameters, and use of combined scalability techniques to establish their effects on the video scalability through analysis of both ends of the coder and network influences. Others include packet loss simulator for bitstream packets verification and validation. Opnet tool is used to simulate a heterogeneous network environment to test the techniques performance on real-time.

### Findings / Results

The experiments show that a combined technique is a better technique with higher level of scalability especially when best encoding parameters are used. Several and different sequences are required to make a valid conclusive experiments as the motion, detail and camera movements are varied between the sequences. The three techniques developed showed differences in terms of their level of scalability, bitrates saving and complexity of the bitstream. In the research, objective and subjective results are obtained and analyzed. The

objective assessment involves evaluating the scalable bitsream base on bitrates and peak signal to noise ratio (psnr). Subjective evaluation involves the use of human to give a score for the reference and impaired sequence. The subjective assessments were realized using Double Stimulus Continuous Quality Scale (DSCQS) as recommended by the ITU [1]. The result variation is compensated for by repeating the test with several sequences and several assessors. Other metrics used in evaluating the results include packet loss simulation and bitstream complexity in terms of packet size and coding time [5].

### **Conclusions / Discussion**

1. The technique t+q showed better efficiency with cif resolution than the other techniques. The technique embeds several scalability levels ranging from low to high quality videos. The nature of this technique has given it a powerful flexible scalability which eases the bandwidth burden of service delivery and can open market for service providers.
2. The combination of both temporal and quality scalability provides a better prediction than just quality scalability within the bitstream. From the experiments conducted, with a bandwidth of 100kb/s, q achieved < 28dB while t+q achieved ~32dB.
3. It can be concluded from the results which show the objective performances of the techniques and scalable layers, the derived techniques are better in terms of performance, high level and flexible scalability. For example 14 layers of t+q have 87.20kb/s, 122.60kb/s, 182.20kb/s, 258.30kb/s, .....506kb/s discrete levels of bitrates.
4. Each of the techniques can be adapted to suit particular application demands which include internet, streaming, storage, mobile, satellite, video conferencing and other real and non real time. A Scalability Decision Algorithm is now adapted

### **Future plans / directions**

1. Running the experiments under different channel conditions.
2. Completion of evaluation metric implementation + compare the performance of techniques.

### **References**

- [1] ITU-R Recommendation BT.500-11: methodology for the subjective assessment of the quality of television pictures” pp.15-18, 2002.
- [2] E.G. Richardson, ‘H.264 and MPEG-4 Video Compression’, John Wiley & Sons Ltd, The atrium, Southern Gate, Chichester West Sussex PO19 8SQ, England, pp 160-222.
- [3] H. Schwarz, D. Marpe, ‘Overview of the scalable Video Coding Extension of the H.264/AVC Standard’, IEEE Transactions on circuits and systems for video technology, Vol.17, NO.9 September 2007.
- [4] M. ghanbari, “Standard Codecs: Image compression to Advanced Video Coding”, The Institution of Electrical Engineers, London, United Kingdom 2003.pp194-310.
- [5] H. Sohn, H. Cheon., ‘Perceptual Quality measurement for scalable video at low spatial resolution in mobile environments’, multimedia on mobile devices 2009, SPEIE Vol.7256, 72560 PP1-5.

## Extracting foreground in video sequence using segmentation based on motion, contrast and luminance

Muhammad Nawaz , John Cosmas

**Keywords:** Foreground Detection, Blockbased motion estimation and Pixelbased Foreground Detection, Morphological Operation

Foreground detection is an important step in various video content analysis systems such as object tracking, recognition and counting. Due to the limitations of each algorithm based on its merits and demerits, so far, there is no consensus on the most effective method due to varying nature of videos. Accuracy and timely computational processing are the two main constraints. Whilst other methods only detect the approximate motion part(s) of object(s) in a video, this paper presents a novel approach to detect the motion part(s) and associated object(s) to get the whole subject. Our work detects foreground by using a new automatic masking technique. The proposed technique uses a set of morphological operators to separate foreground and background. The proposed algorithm is an extension of previous works [1-3]. A complex video sequence was tested to detect comprehensive foreground regions of moving object(s).

### Introduction

This paper presents the results of Extracting Foreground in Video Sequence using segmentation based on Motion, Contrast and Luminance. This new approach is primarily based on Morphological Operations (MOs) such as opening by reconstruction and closing by reconstruction to detect the foreground. The foremost achievement of this paper is the extraction of a coherent foreground based on motion, contrast and luminance.

$$\text{Foreground} = M_{partO} + S_{partO} : S_{partO} \in M_{partO}$$

(1)

Where:  $M_{partO}$  represents Motion part and  $S_{partO}$  is the Static part of the Object in the Equation (1).

The most technically difficult task in coherent foreground detection is finding motion associated part ( $S_{partO} \in M_{partO}$ ) as compared to  $M_{partO}$ . Generally, segmentation is among one of the most technically difficult topics of image processing due to numerous reasons. This is especially true for video, where there are more than one frames having different number of moving objects, contrast variations, motion speed and various luminance per frame. Segmentation process is also the prerequisite for many further image processing algorithms. Existing segmentation algorithms do not guarantee the same accurate results for different type of images [1, 4-6]. The selected video for the implementation of the proposed algorithm is quiet complicated as there exist variation in contrast, luminance and motion for the same frame captured from the video under experiment. So far, researchers have targeted only simple videos with uniform backgrounds or less number of objects for motion segmentation [1,7]. Recently, work has been published on foreground detection on simple videos but not sufficient work has been done on foreground detection using multi featured videos [1,7]. MOs are used on binary images to remove noise or irrelevant details.

### Design / Methodology / Approach

Our work is mainly divided into two processes; they are executing in parallel to detect coherent foreground: the first one is block-based motion estimation and the second is pixel based foreground detection. The reason for the usage of both blockbased motion estimation and pixelbased methods for foreground detection is that to compensate the missing foreground

areas and also to add motion part(s). The result of block-based motion estimation on the video sequence yields a segmentation with huge noise. For this purpose, a couple of MOs such as clean, bridge, dilation and erosion are applied to remove the isolated pixels, bridge them if unconnected , expand and shrink pixels respectively. As a result, a sufficiently noiseless blockbased motion estimated foreground is obtained. Second process operates on the same image but is at pixel level. Original frames are cleaned from noise using MOs, Opening by Reconstruction and Closing by Reconstruction. In-order to obtain pixel based foreground, Regional Minima was used. For such purpose MOs are applied to segment the image into different intensity values, where the lowest and the highest intensities are used to determine the foreground and background, respectively. To extract the foreground from the segmented image, a threshold needs to be set appropriately to cover the reasonable contour of the foreground. To determine the threshold, the essential steps are taken as follows. Firstly, the minimum intensity value is determined from the segmented image and then a set of offset value is added with the minimum intensity value to compensate the whole foreground object. After setting the threshold, a binary mask is generated from the segmented image. In this foreground binary mask, which is based on pixels, the binary numbers “1” and “0” represent foreground and background, respectively. Thirdly, the resultant binary mask is combined by OR logical operator with block-based motion estimation mask to generate the final binary mask. A sufficient coherent foreground, in RGB format, is obtained at the end of this whole process.

### **Conclusion / Discussion**

This paper presents a simple and effective algorithm to segment foreground from background using motion, contrast and luminance. Referring to previous work [1-3, 7] on images shows that our final result has produced better foreground in terms of noise reduction, consistency of segmented object contour.

### **Future Plans / Directions**

I am currently on track to submit my thesis within the three year time scale for my PhD.

### **References**

- [1] P. Kelly, J. Diego, P.-M. Agapito, C. O. Conaire, D. Connaghan, J. Kuklyte, and N. E. O'Connor., "Performance analysis and visualisation in tennis using a low-cost camera network," in Multimedia Grand Challenge Track at ACM Multimedia, 2010.
- [2] Nawaz, M.; Cosmas, J.; Adnan, A.; Ali, M.; , "Inter-intra frame segmentation using colour and motion for region of interest coding of video," Broadband Multimedia Systems and Broadcasting (BMSB), 2011 IEEE International Symposium on , vol., no., pp.1-4, 8-10 June 2011. [3] A. Barjatya, "Block Matching Algorithms for Motion Estimation", in Technical Report, Utah State University (2004).
- [4] H. B. Kekre, Tanuja K. Sarode, and Bhakti C. Raul. Color image segmentation using Kekre's fast codebook generation algorithm based on energy ordering concept. In Proceedings of the International Conference on Advances in Computing, Communication and Control (ICAC3 '09). ACM, New York, NY, USA, 357-362, 2009.
- [5] Belongie, S.; Carson, C.; Greenspan, H.; Malik, J.; , "Color- and texture-based image segmentation using EM and its application to content-based image retrieval," Computer Vision, 1998. Sixth International Conference on , vol., no., pp.675-682, 4-7 Jan 1998,
- [6] Nikhil R Pal, Sankar K Pal, A review on image segmentation techniques, Pattern Recognition, Volume 26, Issue 9, Pages 1277-1294, September 1993.
- [7] Andr'eKaup and TilAach, "Efficient Prediction of Uncovered Background in Interframe Coding Using SpatialExtrapolation", in: "IEEE International Conference onAcoustics, Speech and Signal Processing, Volume 5: IIImage and Multidimensional Signal Processing", Adelaide,South Australia, pp.V501-V504, 1994.

## Cross layer design for multiuser OFDMA systems with cooperative game and dMMPP queuing considerations.

Ilias Nikolaros, Qiang Ni

**Keywords:** *cross-layer, cooperative game theory, dMMPP, NBS, OFDMA, resource allocation*

### Introduction

High data rates and low delays in 3G & 4G wireless networks are essentials in order to support the desired QoS demands. This necessity has led to the adoption of more sophisticated techniques at the physical layer (PHYL) such as orthogonal frequency division multiplexing (OFDM). The respective multiple access scheme is known as OFDMA.

In cross-layer optimization we can differentiate schemes which are aiming to minimize the total power required [1], schemes which are aiming to maximize system's aggregate throughput [2] and schemes which are providing proportional fairness among users [3]. Some OFDMA resource allocation proposals do not take into account the queue status ignoring MAC's layer influence. However most of the cross-layer designs have totally ignored the fairness issue in resource allocation leading to totally unfair approaches.

Nash Bargaining Solution (NBS) is the most well know theorem in game theory and has been employed in many proposals [4] [5] [6].

In [2] authors propose a cross-layer design which maximizes total system's throughput without any fairness consideration. A max-min (M-M) fairness scheme which provides the minimum requirements to the users and equally distributed the rest resources to them in a wireless networks, is proposed in [7], achieving very poor overall performances. Also a proportional fairness resource allocation in OFDMA system, which arises in NBS when the user's initial utility function is equal to zero, is presented in [8]. A fair resource allocation scheduler based on NBS and coalitions for OFDMA systems is presented in [4]. The later scheduler is shown to achieve overall performances close to maximal rate schemes (i.e. [2]) and noteworthy superior performances than M-M while, the fairness index is close to one (1). Fair resource allocation proposals based on NBS have been also presented in [5] where simulations showed that NBS is a trade-off between fairness and aggregate system's capacity, and [9] where a suboptimal algorithm based on NBS has been developed for dynamic subcarrier assignment and then power allocation is performed based on the existing subcarrier allocation.

### Design / Methodology / Approach

All the above mentioned works regarding cooperative game theory do not consider the queue status as well as some of the rest and thus can be characterized as schedulers in spite of cross-layer design schedulers. Moreover the solutions of the NBS based schedulers arise by programming methods and not through analytical mathematics like in non-NBS cross-layer schemes [2] and [10], with the exception of our work in [6].

In this work we proposed two cross-layer schemes based on symmetric NBS (S-NBS) and asymmetric NBS (A-NBS) for OFDMA downlink systems. According to symmetric case all users have the same priority and resources are fairly distributed among users, whereas in asymmetric case, users with higher weight than the others have higher priority and fairness is maintained firstly among users who belong in the same class (same weight) and secondly among classes of users with different weights. Different classes of users can be supported by both schemes; however in A-NBS cross-layer scheme users with high priority can be supported more effectively according to their weights, than users who have lower weight.

Unlike the most proposals in which infinite queues are considered, in our case the queue status for each user is described by a dynamic Markov modulated Poisson process (dMMPP) [11] with finite queue length and incoming packets . In addition our utility cost price function takes into account the average queue length as well as each user's normalized delay besides the rate, result in a more parameterize and fair outcome while in most cases rate constitutes the cost function. Finally the optimal subcarrier and power allocation is derived through analytical method for both S-NBS & A-NBS.

### **Future Plans / Directions**

Future work will be to accomplish the simulations in order to validate our model. The solution of our mathematical model shows that we can achieve a trade-off between efficiency and fairness.

### **References**

1. Cheong Yui Wong, C Y Tsui, Roger S Cheng, and K B Letaief, "A real-time sub-carrier Allocation Scheme for multiple Access Downlink OFDM Transmission," in *IEEE VTC*, 1999, pp. 1124-2218.
2. D Hui, V Lau, and W Lang, "Cross-Layer Design for OFDMA Wireless Systems with Heterogeneous Delay Requirements," in *IEEE, ICC*, Instabul, 2006, pp. 5325-5330.
3. F P Kelly, A Maulloo, and D Tan, "Rate Control for Communication Networks: Shadow Prices, Proportional Fairness and Stability," *Journal of the Operational Research Society*, vol. 49, pp. 237-252, 1998.
4. Z Han, Z Ji, and K J.R Liu, "Fair Multiuser Channel Allocation for OFDMA Networks Using Nash Bargaining Solutions and Coalitions," *IEEE Transactions on Communications*, vol. 53, no. 8, pp. 1366-1376, August 2005.
5. Guopeng Zhang and Hailin Zhang, "Adaptive resource allocation for downlink OFDMA networks using cooperative game theory," in *IEEE ICCS*, Krakow, 2008, pp. 98-103.
6. Charilaos C Zarakovitis, Ni Qiang, Ilias G Nikolarios, and Oliver Tyce, "A Novel Game-Theoretic Cross-Layer Design for OFDMA Broadband Wireless Networks," in *IEEE, ICC*, Cape Town, 2010.
7. L Tassiulas and S Sarkar, "Maxmin Fair Scheduling in Wireless Networks," in *IEEE INFOCOM'02*, New York, 2002, pp. 763-772 vol.2.
8. Hanbyul Seo and Byeong Gi Lee, "Proportional-fair power allocation with CDF-based scheduling for fair and efficient multiuser OFDM systems," *IEEE Transactions on wireless communications*, vol. 5, no. 5, pp. 978-983, May 2006.
9. Tiankui Zhang, Zhimin Zeng, Chunyan Feng, Jieying Zheng, and Dongtang Ma, "Utility fair resource allocation based on game theory in OFDM systems," in *IEEE ICCCN*, Honolulu, 2007, pp. 414-418.
10. Charilaos C Zarakovitis, Qiang Ni, and Dionysios Skordoulis, "Cross-layer design for single-cell OFDMA systems with heterogeneous QoS and partial CSIT," in *IEEE WCNC*, Budapest, 2009, pp. 1-6.
11. Paulo Salvador, Rui Valadas, and Antonio Pacheco, "Multiscale Fitting Procedure Using Markov Modulated Poisson Processes," *Telecommunications Systems*, vol. 23, no. 1/2, pp. 123-148, June 2003.

## **Stochastic meter placement algorithm for active distribution networks suitable for parallel processing**

*Nazia Nusrat, Malcolm Irving, Gareth Taylor*

*Brunel Institute of Power Systems,*

**Keywords:** Meter Placement Algorithm, State Estimation, Distribution System, Parallel Processing

### **Introduction**

The distribution system state estimation (DSSE) tool sits in the heart of smart distribution network management systems as it estimates the network conditions that are input to various control functions, asset management software, demand management tools and other functions. The DSSE tool relies on the available measurement information from meters in the network [1][2]. The quality of estimated information is highly dependent on the amount and type of measurement data provided to the estimator. Presently there are very limited numbers of sensors at medium to low voltage levels, many of which provide incomplete measurement information which is less useful to the DSSE tool. The DSSE tool for future distribution networks will use large numbers of pseudo-measurements, along with some virtual measurements and real measurements that should be limited in number for economic feasibility [2].

We propose a stochastic meter placement method that identifies the best meter positions to improve voltage magnitude estimation and numerical robustness of the optimization problem. The proposed method can be divided into smaller sized sub-problems which are assigned to a multi-processor system enabling parallel operation and reduced computation time.

### **Design / Methodology / Approach**

The proposed algorithm performs extensive assessment for each possible meter position and evaluates the assessment outcomes to find the best placement of the sensor. The measurement instruments are placed sequentially. A Monte-Carlo simulation based assessment is performed taking into consideration the high level of uncertainties in pseudo measurements. Each Monte-Carlo study creates a measurement set and assesses the performance before and after hypothetically placing a new meter into the measurement set. The assessment is performed by calculating the improvement of four parameters that we term performance evaluation parameters, these are:

- The maximum voltage estimation error for each Monte-Carlo simulation and calculated mean of all maximum voltage estimation errors;
- The maximum voltage estimation error for each Monte-Carlo simulations and the maximum of all maximum voltage estimation errors;
- The mean of all voltage estimation errors for all Monte-Carlo simulations;
- The Gain Matrix condition number for each Monte-Carlo simulation and the mean/max of all condition numbers.

These four values are calculated before and after placing the additional meter. Once the assessment is completed for all candidate solutions, the selection operation is performed. In this process the algorithm evaluates the assessment outcomes and selects the candidate position that gives the best possible improvement based on the four performance evaluation parameters.

The proposed meter placement algorithm is divided into three major parts. These are INITIALIZATION, ANALYSIS and SELECTION processes. The process continues unless the desired level of estimation quality is achieved.

The ANALYSIS section involves the major computation and is time consuming. As the Monte-Carlo studies for each candidate position are independent, this part can be performed taking the advantage of parallel computation technology. For example, if we have P number of processor available, we can distribute N number of different candidate positions to each of P processors to perform the ANALYSIS where the total number of candidate positions is  $P \times N$ .

### **Findings / Results**

We applied the methodology on different sizes of networks e.g. 77 bus networks, 40 bus networks. The 77 bus networks required 6 Voltage magnitude and power flow sensors and the 40 bus network requires 6 voltage magnitude sensors only to reduce down to voltage magnitude error estimation down to 1%.

### **Conclusion / Discussion**

The outcomes of the application of the proposed algorithm reach our target mostly. It requires few numbers of sensors to achieve the desired estimation accuracy. As assessing each meter position through heavy Monte-Carlo simulation becomes computationally expensive, the application of parallel processing is proposed to reduce computation time. The future work will include application of the concept of parallel computation and investigation on required computational time.

This work is a part of the PhD research entitling ‘Development of Scalable Distribution System State Estimation’. The overall research is meeting up most of the time lines. The final thesis is expected to submit in early 2013.

### **References**

1. N. Nusrat, M. Irving and G. Taylor, "Development of Novel State Estimation Algorithms for Active Distribution Networks", Proceedings of the 46th International Universities Power Engineering Conference (UPEC), pp1-6, Sept. 2011.
2. R. Singh, B. Pal, R. Jabr and R. Vinter, "Meter Placement for Distribution System State Estimation: An Ordinal Optimization Approach", IEEE Transactions on Power Systems, vol.26, no.4, pp2328-2335, Nov. 2011.

## Radio delivery over fiber-optic GI-POF cable for home application

*Uchenna Okonkwo, Hamed Al-Raweshidy*

*WNCC Group*

**Keywords:** Radio-over-fiber, direct-modulation DFB laser, optical carrier suppression (OCS), PF-GI-POF, optical mm-wave generation

### Introduction

The use of optical fiber in delivering wireless service has been around for many years and it is behind majority of the core networks used in telecommunication and in metropolitan area networks (MAN) as it allows high data rate transmission. The next stage for the telecom operators is to move closer to the home and even inside the residential vicinity to deploy fiber optics services simply because of its benefits in facilitating very large data rates. The use of silica optical single-mode fiber (SMF) in the home although advantageous isn't cost effective as it is susceptible to damage (easily by the user) and a slight bend affects the received signal power. For these reasons the use of a polymer optical fiber (POF) is best fit [1]. The module of POF that has been widely researched on is the graded index perfluorinated plastic optical fiber (GI-PF POF). It has a large core diameter which allows easy handling and splicing, it's capability to be flexible allows easy installation in the home premises around and inside walls and corners [2]. The aim of this research is to produce a feasible and cost effective method to deliver wireless channels over POF cables. The types of wireless services considered in this research are firstly, the Radio channels i.e. mobile channels and secondly, the broadband services. In Radio, the aim is to carry microwave signals over the highly dispersive and (attenuation) lossy POF. Special techniques such as remote generation of the millimeter (mm) wave signals (60GHz and above) at the central station rather than at the receiver antenna unit (RAU) in the users home before transmission, facilitates a cost effective network as it reduces cost of installation and maintenance because maintenance and upgrades can be done from the central station. In broadband channels, the same remote generation of baseband signal applies only in this case the aim is to increase data rate and reduce loss witnessed in the POF cables. For each of the two wireless service deliveries different network architecture can be designed.

### Design / Methodology / Approach

Due to the preliminary stage of this research the delivery of 60 GHz mm carrier wave radio signal to the user's home via POF cable optically and all-optical up-conversion is the chosen method in constructing low cost and high-transmission performance in the radio over fiber system. Although there are several methods of optical mm-waves generation; my *initial* chosen method is the use of Optical Carrier Suppression (OCS) method because of its lowest spectral occupancy and lowest bandwidth requirement for components which makes it ideal for downlink transmission [3]. In this design, a direct-modulation laser is used to generate a continuous wave and modulation of the 2.5 Gbps pseudorandom bit sequence (PRBS) electrical signal and a dual-arm Mach-Zehnder external modulator (MZM) biased at  $v_p$  and driven by two complementary RF signals to formulate OCS. The optical mm-wave is

transmitted to the base station (BS) via a 10km SMF cable and 100m GI-POF cable. At the BS, the optical mm-wave signal was converted from optical to electrical signal using a PIN photodetector. The mm-wave signal was then filtered using a bandpass filter and amplified to increase signal power before down-conversion by a mixer with a clock signal. As a result of weak signal power an amplifier was used on the signal after down-conversion before a low pass filter was used to obtain the required baseband signal. The properties of the signal was analysed and the electrical waveform and BER was observed.

### **Findings / Results**

The down-converted 2.5Gbps signal was detected by a bit-error rate (BER) analyzer and its eye diagram also after transmission over both 10km of SMF and 100m of GI-POF cables. The experimental Bit-error-rate BER and receiver sensitivity were observed also with the power penalty after transmission.

### **Conclusion / Discussion**

The proposed architecture to generate optical mm-wave by using a direct-modulation distributed feedback (DFB) laser and an external modulator with OCS modulation method is a well established method [3]. However the results obtained in this experiment are insufficient as the 2.5Gbps data being transmitted over both 10km of SMF and 100m of GI-POF cables had unacceptable power penalty.

### **Future Plans / Directions**

More progress needs to be done in designing an architecture that will improve on the already observed BER result and also have the power penalty reduced considerably (perhaps below 1dB). Although the result of the experiment isn't sufficient, the method of generating optical mm-wave using only one external modulator is cost effective and not complex, [3] compared to other well known methods that use two external modulators. The future work to be done is to derive a more simplified architecture. Furthermore, the delivery of both wireless services for radio and broadband purposes have not been addressed in this report as of yet due to further research time needed to understand and implement the technique.

### **References**

- [1] Y. Koike, “POF Technology for the 21st Century”, in Proceedings of the Plastic Optical Fibres (POF) Conference, 2001, pp 5 - 8.
- [2] Y. Watanabe, “Current Status of Perfluorinated GI-POF and 2.5 Gbps Data Transmission over it”, in Proceedings of OFC '03, USA, 2003, pp. 12 - 13.
- [3] Lin Chen, Tazhi Pi, Hong Wen and Shuangchun Wen “All-Optical mm-wave Generation by using Direct-modulation DFB Laser and External Modulator” Periodicals, Inc. Microwave Opt Technol Lett 49: 1265–1267, 2007.

## Simulation of photovoltaics for defence applications: Power generation assessment and investigation of the available integration areas of photovoltaic devices on a virtual infantryman

*Ioannis Paraskevopoulos, Emmanuel Tsekleves*

*Virtual Reality Simulations, CMCR*

**Keywords:** 3D simulation, solar energy harvesting, computer simulation, infantry soldier, product integrated photovoltaics (PIPV), wearable photovoltaics

### Introduction

Despite the modern advances in military technology the infantry soldier continues to play a very significant role in defence. In the age of stealth jets, nuclear munitions and guided weapons, it is still the infantry soldier that examines and secures a location to ascertain whether the target area is cleared and the enemy is defeated. The modern infantry soldier utilises the electronic technology and resources available today, in order to penetrate into hostile and difficult terrain where armoured vehicles cannot trespass and overcome the enemy. The power requirements of such electronic technology, critically essential for the modern soldier, are much higher when compared to the power requirements of a civilian counterpart. Furthermore, the environment of operation is far more hostile and challenging than those of the civilian applications and the loss of power may endanger the infantry soldier's life. That is the main reason behind the massive overload of batteries constituting the 25% (source Ministry of Defence of United Kingdom, MoD of UK) of the overall equipment load (including lethal, survival and communication). This fact indicates that there is an uncontested restriction of manoeuvrability, operational range and a significant physical and cognitive burden.

The recent advances in the field of sustainable energy and particularly the innovative flexible and wearable photovoltaic (PV) technologies could offer a potential solution to this issue, by removing, or reducing at a great extent, the use of batteries. The Solar Soldier project, which is partly funded by the Defence Science and Technology Laboratory (DSTL) of the MoD of UK and the Engineering and Physical Sciences Research Council (EPSRC), investigates this research challenge. Part of this project is the work presented by this article which focuses on how one could integrate the PV technology epitomizing the Solar Soldier concept from a human interface and design perspective. The objectives of this challenge are twofold:

- To assess the incorporation of the PV technology on the uniform and equipment of the infantry soldier.
- To measure and evaluate the effectiveness of each area (amount of power generated under various scenarios) as well as to investigate the areas that yield the same power values all over their extent for further research on usability (human comfort, intuitiveness).

The bounds of this paper include and present the study of the second objective with a focus on the effectiveness of the proposed system. The usability of the device is examined by liaising and interacting with the Infantry Trials and Development Unit (ITDU) of the DSTL in order to acquire more in depth knowledge on the casualties and motional habits of infantrymen during military operations. The effectiveness of the device is measured by employing the use of Virtual Simulations.

### **Design / Methodology / Approach**

The problem stated in the Introduction of this paper requires the employment of a virtual framework able to conduct a number of experiments and collect measurements, which are impossible to collect due to the hazardous nature of the real environment. The methodology that fulfils the development of such a virtual framework is Modeling and Simulation (M&S). The application of M&S presented in this article is aimed at applying an existing feature of a 3D authoring commercial software, 3D Studio Max Design (3DSMD), by extending its capabilities and applying it to simulation of daylight for sustainable energy applications of military interest. The lighting analysis system of 3DSMD will be employed in a virtual military environment framework. The light sensors are employed as design assets by the software and attached on specific areas of the soldier's uniform and equipment to assess the incorporation of PV technology.

### **Conclusion / Discussion**

Infantry soldiers today carry around a lot of electronic equipment which have high power consumption requirements. This forces them to carry, in dismounted operations, several heavy and bulky batteries which increase dramatically their total equipment load. Renewable energy technology such as the incorporation of PVs can substitute batteries and relieve the soldier from the physical and cognitive load. This study has proposed a virtual simulation framework that mimics closely the military environment for the purposes of investigating the integration of PIPV technology on the infantry soldier, by analyzing and measuring the effectiveness of light capture on various areas of the uniform and equipment of the soldier. The examined case studies covered several basic military environments as well as the several potential areas of integration of the PV device after interacting with the army. After performing the simulations, the resulting data were organized and presented in such a manner enabling the classification of the examined areas in order of power generation efficiency. The derived overall classification infers draft yet qualitative guidelines for any designer or practitioner of wearable military applications.

### **Future Plans / Directions**

I am not currently on track to finish this year because my research funding has finished and so I have to work in part-time jobs. This fact significantly restricts my time for research.

## Prevention of erroneous beam shutdown in electron beam welding process

*T. Parthipan<sup>1,2</sup>, C. Ribton<sup>1</sup>, P. Mudge<sup>1</sup>, R. Nilavalan<sup>2</sup>, W. Balachandran<sup>2</sup>*

<sup>1:</sup> TWI Ltd., Granta Park, Great Abington, Cambridge, CB21 6AL

<sup>2:</sup> School of Engineering and Design, Brunel University, Uxbridge, UB8 3PH

**Keywords:** Electron Beam Welding, flashover, inverter, PSpice

Optimizing the control of fault-recovery-sequence during flashover in Electron Beam Welding is presented. High voltage flashover in the welding gun column causes defects deep in the work piece. The deployed flashover response system is based on 12 year old technology and is slow during recovery. The research focuses on optimising this response time so that the threat of introducing weld defects or void in weld is minimised or completely avoided. A computer system model, based on PSpice, has enabled the current system to be characterised and control parameters that enhance the fault-recovery-sequence time to be optimised. All relevant model constructs have been developed and are currently being evaluated. Early simulations at system level produced results that closely mapped practical measurements. Simulation work on the interaction of the fault detection circuit with the rest of the system is planned before new enhancement parameters are implemented and evaluated.

### Introduction

The Electron Beam Welding (EBW) process melts the work piece by transforming the kinetic energy of the high velocity electron beam into heat upon impact. Very high acceleration voltage ( $V_{accl} = 150$  kV) is used to accelerate the electron beam. Welding is generally carried out in vacuum or in reduced pressure welding-chambers. This is to avoid high voltage breakdown and emission source (cathode) deterioration in the electron gun (Sanderson, et al., 1998). Welding volatile elements leaves contamination in the gun column. These contaminations when excited (excited molecules) cause high voltage flashovers - a scenario that shorts the  $V_{accl}$  to ground and interrupts the beam generation and welding process. A 100 kW H-Bridge inverter power-supply system provides the  $V_{accl}$ . It is implemented with flashover detection circuit that turns off the output voltage for about 20 ms if the flashover is detected and then ramps it back up to  $V_{accl}$ . The total recovery time is about 30 ms which is long enough to re-establish the vacuum integrity and short enough to resume welding before the weld pool solidifies. Most excited molecules have a life time in the region of  $10^{-8}$  s before they return to their ground state (Gallagher, et al., 1983). Moreover the minimum voltage to maintain a discharge once it has been established (discharge extinction voltage) is well over 0V (Gallagher, et al., 1983). This implies the output voltage does not have to be shut down. This research has analysed the following:

- Shortest recovery time permitted by the discharge life time and the optimum EBW power-supply system response time.
- Maximum allowable peak current and discharge extinction voltage condition to ride through fault rather than completely shut down the weld beam.

### Design / Methodology / Approach

The EBW power-supply system is a complex architecture that makes it difficult to obtain required measurements, and parameterizing the control vectors is almost impossible. The research utilizes computer system modelling techniques to develop the system that can be

simulated for analysing the circuit. This method forms a virtual test platform that can be simulated for various scenarios and functionalities.

### **Findings / Results**

Extensive modelling work has been carried out to achieve simulation results that closely map practical results. Practical results at component or subsystem level are not available. Hence individual component model simulation results are being compared against datasheets. Simulation work experiences convergence issues due to tight simulation settings. Present work looks into relaxing the simulation settings and/or replacing the model constructs with less complex models without compromising accuracy. Simulations with tight relative accuracy produce results that closely map the practical results and datasheet values.

### **Conclusion / Discussion**

Modelling the EBW system allowed the system to be studied at component level which opened up ways of parameterizing and analysing the system behaviour at very lower level. Accuracy of the simulation results rely on the accuracy of the models and the tightness of the simulation settings.

### **Future Plans / Directions**

Available computing power and the infrequent access to the EBW system has significantly limited progress. Three different stages have been identified where the research can conclude, namely:

- Stage1: Completion of system model that can be tuned/parameterized to identify optimization parameters for enhanced fault recovery sequence
- Stage2: Implementing optimized parameters in the real system and measurements.
- Stage3: Analyse the effect of the new implementation on weld quality

The research is on track to achieve stage 1 and the researcher is aiming to accomplish stage 2. Stage 3 has been identified as a task that can be carried out by welding specialists as further work.

### **References**

1. Gallagher T J and Pearmain A J High Voltage Measurement, Testing and Design [Book]. - Bath : John Wiley & Sons Ltd, 1983.
2. Sanderson A and Ribton C N The development of RF excited guns and intelligent power supplies for EBW at upto 150kW and 300kV [Conference] // 6th International conference on welding and melting by electron and laser beams. - Paris, 1998. - pp. 611-621.

## Combining digital signal processing methodologies in real time analysis of seismological recordings

*Fragkiskos Pentaris, John Stonham*

**Keywords:** wireless structural health monitoring, seismological recordings, accelerator sensors

### Introduction

The aim of this research is to establish an efficient wireless structural health monitoring system (wSHMs) in one or more buildings and to monitor them in, an urban area.

Monitoring the structural state of a building is essential for the safety of the people who work, live, visit or just use it as well as for the civil protection of urban areas. Many factors can affect the state of the health of a structure, namely man made, like mistakes in the construction, traffic, heavy loads on the structures, explosions, environmental impacts like wind loads, humidity, chemical reactions, temperature changes and saltiness, and natural hazards like earthquakes and landslides. Monitoring the health of a structure provides the ability to anticipate structural failures and secure the safe use of buildings especially those of public services.

This work will review the state of the art and the challenges of a wireless Structural Health Monitoring (WiSHM) and will establish a wireless structural monitoring system in one or more buildings trying to monitor, measure and correlate acceleration recordings with seismological data. Several features and specifications of WiSHM like wireless sensor networking, reliability and autonomy of sensors, algorithms of data transmission and analysis are going to be discussed, developed and improved in order the WiSHM system to be efficient (Brownjohn, De Stefano, Xu, Wenzel, & Aktan, 2011; Chintalapudi, et al., 2006; Jinping Ou & Hui Li, 2010; Lu & Loh, 2010; Ramos, Aguilar, & Lourenço, 2011).

### Design / Methodology / Approach

The above aim will be achieved through the following objectives:

1. Study the related literature to wireless structural health monitoring, civil structural health monitoring in intelligent infrastructure and related research work.
2. Study the appropriate wireless health building monitoring system and install it.
3. Define and configure the necessary parameters-variables for the optimum measurement of acceleration of a structure.
4. Correlate the acceleration data with seismological data and identify possibly similarities or differences.
5. Study and correlate the environmental noise where a structure is exposed with the seismic excitation that affects on it.
6. Study and develop all the technological requirements for an effective wireless structural health monitoring system.

Methodology in research is determinant for the evolution and development of a scientific project.

Initially study of the state of the art in wireless SHM in order to learn and identify the technological requirements, that a wireless SHM system needs, in order to function efficiently. Second is the supply of the appropriate wireless structural health monitoring system and its installation.

Third is the configuration of data acquisition, data synchronization and communication between the nodes and the central base.

Fourth step is the suitable algorithms for the data analysis.

Last is going to be the correlation of the acceleration data of the SHM system with seismological data for the same time period and the same buildings.

### **Findings / Results**

- Study of the literature review and the state of the art for wireless structural health monitoring systems (papers, journals and conference proceedings).
- Critical review of the study and a poster for the principles in wireless structural health monitoring systems to the “EGU 2012”.
- Study of methods for digital signal processing (fourier, wavelets)
- Study of seismological recordings analyzed with wavelets
- Analysis of seismological recordings with matlab

### **Conclusion / Discussion**

In conclusion a WiSHM system should have high autonomy, if available with power harvesting, optimum synchronization, high data rate analysis of the sensors and algorithms able to analyze the recorder data and identify or reveal the valuable information of a structure response.

### **Future Plans / Directions**

- Research and buying of the appropriate wireless structural health monitoring system
- Research for more buildings installations and integration.
- Research for algorithms of analysis of the acceleration data from WiSHM system

### **References**

1. Brownjohn, J., De Stefano, A., Xu, Y.-L., Wenzel, H., & Aktan, A. (2011). Vibration-based monitoring of civil infrastructure: challenges and successes. *Journal of Civil Structural Health Monitoring*, 1(3), 79-95.
2. Chintalapudi, K., Fu, T., Paek, J., Kothari, N., Rangwala, S., Caffrey, J., et al. (2006). Monitoring civil structures with a wireless sensor network. *IEEE Internet Computing*, 10(2), 26-34.
3. Jinping Ou, & Hui Li. (2010). Structural Health Monitoring in mainland China: Review and Future Trends. *Structural Health Monitoring*, 9(3), 219-231.
4. Lu, K. C., & Loh, C. H. (2010). *Development of wireless sensing system for structural health monitoring*. Paper presented at the Earth and Space 2010: Engineering, Science, Construction, and Operations in Challenging Environments © 2010 ASCE.
5. Ramos, L. F., Aguilar, R., & Lourenço, P. B. (2011). Operational modal analysis of historical constructions using commercial wireless platforms. *Structural Health Monitoring*, 10(5), 511-521.

## **Investigating the effectiveness of the use various types of material to support of existing mixed elearning tools for learning language using algorithms**

*Kawther Rekabi, Emmanuel Tsekleves*

**Keywords:** Adaptive e-learning, Mixed ability learning, Algorithms for adaptive e-learning, Algorithms for mixed ability e-learning, Algorithms for personalised e-learning

### **Introduction**

The main aim of this research thesis was to investigate the effectiveness of different types of materials for the supply and support of mixed e-learning study for mixed e-learners. A qualitative and quantitative research methodology was employed for this investigation and included students and their teachers.

The primary purpose of this research is to study the effect of using adaptive Tools on Teaching /Learning a Language for mixed learners and in enhancing the adaptive e-learning process. The focus is on researching and using adaptive tools for learning a Language, with multimedia environment that will facilitate and enhance the acquisition of a secondary language for children and adults between the ages of 6 and 65+ years.

The application of adaptive e-Learning to education is mainly structured into four issues. First, what part of the components of the learning process is adapted? (pace of instructions, sequence of contents that can be modified). Second, what information does the system use for adaptation (user knowledge, preference, cognitive capabilities and learning goals)? Third, how does the system gather the information to adapt to (didactics rules & layout standards)? And lastly, what does the system adapt (pedagogical model), (Burgos, 2006; Burgos & Colin, 2005).

### **Design / Methodology / Approach**

The purpose of the study conducted was to try to process a set of qualitative attributes and values of the mixed adaptive e- learning properties. The intention was to then use these qualities (if they were satisfactory) in the subsequent studies which were to be conducted in Corydon School for Arabic and Kurdish studies, and INTO UEA London both of which offer international students, intensive preparation for undergraduate and postgraduate study in the UK. Launched at UEA and currently expanding to other universities, programmes provide extra language teaching and academic development for international students.  
<http://www.uea.ac.uk/partnerships/intouea>.

Over the last 20 years, many studies have used questionnaires to assess adaptive e-learning in a variety of contexts, including education, counselling, health studies, business and management.

The primary purpose of this research is to study the effect of using mixed e-Learning for three existing Tools on Teaching /Learning a Language and in enhancing the e-learning process for mixed learners. The focus was on researching and designing algorithms that conduct one of the existing interactive multimedia mixed e- Learning Tools.

The concept of user testing is an extremely important one and the final part of discusses the methodology that should be employed in order to achieve a quality-assured, accurate set of quantitative and qualitative data that can be analysed to investigate the effect of the three existing mixed e-learning tools.

## **Findings / Results**

An analysis of the data gathered indicates that the mixed e-learning material for students and teachers is seen as contributing the most to student learning using mixed e-learning tools session. These are followed by learn and play material, Songs, Games and Cartoons a material according to student responses and Songs, Games and Cartoons a material according to teachers responses. One can see additional variations in the responses between students and teachers.

More precisely, students have a more wide spread in their responses for all types of mixed e-learning material and have a more strong view on the usefulness of e- learning material. Teacher responses on the other hand, show a more combined view on the use of Learn and play for mixed e-learning delivery with equally positive responses on scales.

When we consider the same issue of distribute mixed e-learning tools but without a teacher being present the responses of both students and teachers vary. In particular when students are interest to complete all tasks without a teacher being present, they prefer to use mixed e-learning application material using their own laptop.

## **Conclusion / Discussion**

It is interesting here that both teachers and students indicate that games and cartoons materials for mixed e-learning are having a higher effect on student independent learning. This could be due to the fact that games, especially when combined with music and songs, forms the most immediate substitute medium for teachers, since students would be able to see them and listen to their instructions. Students also feel very comfortable with e-learning tools material songs and games and especially learn and play material since this forms a natural and familiar way of conducting teaching and facilitating independent learning. So our main aim here is to use an algorithm to find optimal adaptive mixed e- learning sequences.

## **Future Plans / Directions**

My plan is to write one paper or two papers on the subject of my PhD area in adaptive mixed e-learning.

## **References**

1. Burgos and Corbalan (2006) Burgos, D., Corbalan, G.: "Modelado y uso de escenarios de aprendizaje en entornos b-learning desde la práctica educativa"; III Jornadas Campus Virtual, Madrid (2006).
2. BURGOS, D., COLIN, T., ROB, K. (2006), "Representing Adaptive strategies in IMS learning Design", *Conference paper on TENCompetence*, Sofia, Bulgaria 14th March 2006, [www.dspacwe.ou.nl/bitstream/1820/718/1/ADELE\\_BurgosSpeacht\\_19May06V2.pdf](http://www.dspacwe.ou.nl/bitstream/1820/718/1/ADELE_BurgosSpeacht_19May06V2.pdf) , retrieved on 17th March 2007

## Intelligent control system for power system stability

*Abdulhafid Sallama, Maysam Abbod, Peter Turner*

*Control Engineering, Power System*

**Keywords:** power quality, neuro-fuzzy system, particle swarm optimization

### Introduction

Electric energy is the main form of energy supplied to the consumer at the end-use in today's world. There is always a need to make the generation and transmission of electricity, more economical, stable and reliable, to face the growing demand for energy that would result in an increase in the percentage of faults happening. Power system generation and customer equipment are usually designed to operate within the range of  $\pm 5\%$  of the nominal voltage. Therefore many types of equipment perform poorly at low voltage such as less illumination, overheating, and performance degradation [1]. This paper describes the design, tuning and implementation of advanced power system stability controller using neuro-fuzzy system (NF) [2], and particle swarm optimisation (PSO), which upgrades the NF system through tuning the Gaussian membership functions. The tuned controller shows better results compared to the latest conventional multi-band stabiliser (MB). The controller is designed to reduce the effects of sudden disturbances on the national grid as a result of faults. This in turn protects the equipment and users.

Currently, most advanced power system stabilisers try to compensate power fluctuation by adjusting the system parameters to prevent the power grid from going into an inter-area mode [3], or disturbance after fault occurrence. This is usually done in order to return the grid to its normal operation as soon as possible. Another advantage of the compensation is to maintain the grid stability and prevent out of control (oscillation) conditions. These usually occur with high voltage overshooting and long periods of instability. This problem has been handled by designing complex control systems, containing sophisticated electronic circuits, which monitor the network and the generators, at different levels and stages [4]. However, such systems still suffer from overshooting and lengthy period of instability.

This work is based on designing and tuning a NF controller in different stages [5]. The first stage is the manual design and tuning of the controller. The second stage is the utilisation of the MB stabiliser behaviour under worst cases scenario, such as a fault happening at three phases at the same time, which is a high risk to the grid and a great challenge for control systems. In this stage the controller behaviour is used to train the NFL controller [6]. The final stage is the tuning of the controller using PSO.

### Design / Methodology / Approach

The proposed methodologies for the research task as experimental research mainly involves undertaking an intensive review on relevant literature review, then modelling and constructing the nonlinear process which consists of a generator and an electrical grid. The system is simulated in MATLAB & Simulink which consists of the controller and the optimiser (PSO). The first step is to design the system using the MB controller which different simulations are conducted, namely normal conditions, 1 phase fault, 2 phase fault and 3 phase fault. The time response of the controller (output, control action, errors and overshoots) are recorder and utilised as a training signal for the NF controller. Finally, designing and optimisation of the NF controller using the PSO. In this research the Power System Toolbox has been used to simulate the power system, ANFIS to design the NF controller. While the PSO was coded in command line which calls the Simulink model each iteration so that the parameters optimisation can be achieved.

## **Findings / Results**

Simulation results of the standard MB system and the optimised NF controller system has shown good improvements using the NF system which can be summarised as follows: Comparison between the NF and the MB stabilizer for a single phase faults shows that the response time has been reduced from 5 sec to 1.99 sec. While for the 3 phase fault, the response time has been reduced from 4.7 sec to 3 sec. Moreover, the overshoot was also reduced from 11.3% to 1.5%, with 1 peak fluctuation where as the MB stabilizer has reached the steady state after 5 peaks oscillation.

## **Conclusion / Discussion**

To conclude, it has been shown that the NF has better performance compared to the MB stabiliser, in particular when the former was trained on 3 phase fault conditions with the aid of PSO to select the scaling factors automatically. However, single phase fault has also produced good training data which the controllers have performed well. This type of control is far better than the standard stabiliser (MB) in terms of its behaviour during fault and normal conditions.

## **References**

- [1] B. Kirby and E. Hirst, "Ancillary service details: Voltage control," *Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 1997.
- [2] J. S. R. Jang and C. T. Sun, "Neuro-fuzzy modeling and control," *Proc IEEE*, vol. 83, pp. 378-406, 1995.
- [3] A. Feliachi and X. Yang, "Identification and control of inter-area modes," *The 33<sup>rd</sup> IEEE conference on Decision and Control*, pp. 4061-4066, vol. 4, 1994.
- [4] B. Sumanbabu, S. Mishra, B. Panigrahi and G. Venayagamoorthy, "Robust tuning of modern power system stabilizers using bacterial foraging algorithm," *IEEE Congress on Evolutionary Computation, CEC 2007*, pp. 2317-2324, 2007.
- [5] H. Bevrani and P. R. Daneshmand, "Fuzzy Logic-Based Load-Frequency Control Concerning High Penetration of Wind Turbines," *IEEE Journal on Systems*, 2011.
- [6] J. S. R. Jang, "ANFIS: Adaptive-network-based fuzzy inference system," *IEEE Transactions on Systems, Man and Cybernetics*, vol. 23, pp. 665-685, 1993.

## DVB-T2 system modelling and performance for different transmitter configurations and receiver capabilities

*Fatimaalzhra Salman, John Cosmas*

**Keywords:** Channel estimation, OFDM, SISO, Linear interpolation, Spline Estimator

### Introduction

Orthogonal Frequency Division Multiplexing (OFDM) has been widely applied in wireless communication systems, due to its high data rate, transmission capability with high bandwidth, efficiency and its robustness against multipath delay. At the transmitter, the physical layer of the system can be configured to operate with different QAM orders, number of sub-carriers and number of pilots depending on the operational needs of the TV service provider, whilst at the receiver the pilot-aided channel estimation can use a variety of different algorithms for estimating the frequency response of the channel. In this paper we quantify the differences in physical layer performance of the DVB-T2 system for different combinations of transmitter, receiver configurations and radio communication environments in order to ascertain which is the most effective transmitter configuration given a range of different receiver configurations and radio communication environments.

### Design / Methodology / Approach

In this paper we explore the performance of a pilot based channel estimator and equaliser for DVB-T2 for the 8 different pilot patterns. We test our system using different types of Channel estimation function with increasing levels of sophistication namely: a Linear interpolation(Step) and Spline Least Squares Best Fit estimators which have been proposed to estimate the Channel's Frequency Response (CFR) between the pilots' location [1] [2]. In addition, we test the performance using different QAM orders for all estimation methods and different pilot patterns in different radio environments.

### Findings / Results

We obtained performance results by producing Bit Error Rate (BER) against SNR graphs for different configurations such as different QAM modulation orders, number of sub-carriers and different type of pilot patterns for Rural Area radio environment and a Additive White Gaussian Noise channel. We selected PP1 and PP7 as an example of pilot patterns. The orders of QAM that have been selected are: 4, 16, 64, 256. We found that when QAM order increases, the bit errors increase, and as noise distortion levels increase the Spline Least Squares Best Fit estimator performs better than the Linear interpolation (Step). In addition, the PP1 performs better than PP7 at low SNRs because for PP1 there is more pilot cells are transmitted with less number of data cells but for the PP7 less number of pilot cells are transmitted with more number of data cells.

### Conclusion / Discussion

After obtaining the results we found that at low SNRs, the Linear Interpolation (Step) estimator follows the noise whilst the Spline Estimator plots a least squares best fit line through the noise which best approximates the multipath fading. At high SNRs, the noise has

negligible effect on the estimate whilst the Spline Least Squares Best Fit has difficulty dealing with discontinuities that occur with deep fades.

### **Future Plans / Directions**

The implementation of the channel estimator and equaliser functions for the SIMO will then be incorporated within the DVB-T2 MATLAB model as a future work. In addition, we will develop an adaptive system for the equaliser that adapts its configuration parameters depending on the radio transmission channel in our Matlab model and for the final thesis.

### **References**

- 1- Yushi Shen, Ed Martinez, Freescale, Channel Estimation in OFDM systems, Semiconductor Application Note 2006.
- 2- Li Fu, Songlin Sun, Xiaojun Jing, Hai Huang, Analysis of Pilot Patterns and Channel Estimation for DVB-T2, IEEE, 2010

## Multi-level inverter with desire harmonics

*Musamer Shamil, Mohamed Darwish*

*Power Electronics, Brunel Institute of Power Systems*

**Keywords:** Multilevel inverter, Harmonic source, Inverter

### Introduction

A single Phase multilevel Inverter used mainly to generate a less harmonics waveform, the general idea is to present a different type of application for the single phase Multilevel Inverter. This type that can be mainly used to generate any type of waveform that can carry any value of harmonic, this is mainly used in testing purposes, or can also be used as filters, to reduce the reactive power. The aim is to design and control two cascaded H-Bridged inverters [1] to produce the maximum levels with optimum switching angles.

### Design / Methodology / Approach

There are many ways to connect the inverter to result a multi-level inverter, the most common method is by connecting two H-bridge in cascade, this method can be used by using either a single power source with two capacitors to divide the input voltage into two voltages, or by using two different voltage source. If two equal voltage sources was used then this will limit the maximum levels of the inverter to five levels, however to maximise the levels of the inverters two unequal voltage source can be used and by changing the switching patten more levels can be produced.

The important part of this design is the control technique used to generate the output waveform, in order to identify the switching angles, two approach was adapt, the first one is to give near results by using curve fitting, and then using the try and error method to identify the best switching angles. This method can take a while and can change the results to a very far switching angle as it will work with range of angles to be either added or subtract from the original angles that was found using the curve fitting.

The second method is by using some mathematical approach that can identify the switching angles; this method is more powerful, as it can result in more accurate switching angles, with less undesired harmonic distortion [2]. The program used to calculate and simulate the calculated angles is Matlab; by identifying how many levels is the inverter, and what are the values of the desire harmonic needed to be generated.

### Results / Conclusion

The program should result the values for the switching angles and can directly feed them to the Multisim simulation that can simulate the switching angles to find the harmonic distortion, this only used to verify the final values. The switching function [3] is a very powerful method that was adapted in this research, to calculate the switching angle, as by been able to produce the exact desire output in math, we can identify the switching timing and analyse the results to calculate the harmonic spectrum, this can help to find an accurate switching angles.

The second approach still not finished, but the initial results is very promising to show good results, as to be able to produce any multilevel square waveform, calculate the switching

angles, and calculate the total harmonic distortion, can help to identify the best output result of the switching angles, and save time to obtain the correct results.

### **Future Plans / Directions**

This can be summarised as follow, first is to continue on the Matlab simulation in order to find the correct method to find the most accurate switching angles using the switching function, secondly as part of the project is to build and verify the results, the circuit board was already build but the Micro-processor is still in programing using some calculated switching scenarios, to verify the simulated results.

### **References**

- [1]F.Peng, Mar/Apr.2001”A generalized multilevel inverter topology with self-voltage balancing” IEEE Trans, Ind.Appl, vol37,no2,pp.611-618
- [2]F.S.Kang, S.J.Park, S.E, Cho, C.U,Kim,T.Ise Dec.2005 ”Multilevel PWM inverter suitable for the use of stand-alone photovoltaic power systems,” IEEE Trans. On energy conversion, vol20,no.4,pp.906-915
- [3] C.C Marouchos, 2006, “The Switching function Analysis of power Electronic circuits” London, The institution of engineering and technology, UK.

## A hybrid parallel active filter in off-line UPS system with proposed control strategy

*Sanar Shamil, Mohamed Darwish*

*Power Quality and Protection*

**Keywords:** active filters control

### Introduction

In the recent years the issue of power quality has raised in our world as technology rises, with the new technology the drawing of reactive power is becoming a serious issue and harmonics are being discussed widely, the increase of non-liner loads drawing non-sinusoidal current is affecting the power quality of the systems.

Thus the performance of an off-line UPS system with an inverter circuit acting as an active filter is proposed and analyzed in this paper, it starts with an over view of current harmonic distortion problems and solutions, then followed by the most common methods used to operate and control active filters.

### Design / Methodology / Approach

There are many ways to control an active filter to achieve the elimination of current harmonics, some of them include multi transformation, some has been simplified to use only the method of the P-Q theory where the method used in this purposed circuit is much simpler and eliminate the use of any transformation there for resulting a simple mathematical approach than can be considered more effective than others.

the system contains one full bridge inverter that has two modes of operation, the first is when there's AC main supply where the inverter act as an active filter while charging the back-up battery, while the second mode it supply the load with the required energy from the back-up battery, in both modes of operation the inverter is controlled to achieve a pure sinusoidal line current leaving the supply with no current harmonic and improve the power factor.

The circuit is preformed and analysed using (matt-lab simulink) tools, and currently being built in the electrical labs to verify the theoretical work and the simulation.

### Findings / Results

Implementing a circuit such as a UPS system comes with harmonics due to the rectifier and the switches, these harmonics affect the main supply and thus the high cost and the poor power factor. Applying the active filter to the UPS system resulted in a high performance in reducing these harmonics generated by the loads and thus improving the power factor and the supply.

By taking a reference of the current harmonic generated by the load and including it in a control loop for the inverter/active filter, the inverter generated an equal yet opposite harmonic so it can cancel those generated by the load.

## **Conclusion / Discussion**

By simulating the proposed circuit and obtaining the results, it is fair to say that the proposed circuit is preforing its objective and the results measure to the expectations, however there is always the point of improving the preformance and updating the results with more experiments that is already taking place.

More over the use of certain programs and gaining skills in oprating these programs is always a major issue in research, a lot of skills were gained in this progress and yet a lot of skills are yet to be gained in the near future which is essentional to the completion of the task at hands.

## **Future plans / Directions**

Th continue the lab work in building the circuit to test and verify the simulation results in the main objective in the being time, that is fairy applicable and will be done with in the time limit available.

However this project has to be taken to other level such as deeper research in the control loop of the active filter, also bigger application can be tested and implemented in future time.

## **References**

- [1] El-habrouk M. , Darwish M. K. , Mehtap. 2000 “ Active power filters”
- [2] Tarak Ghennam, mohamed Darwish, 2008 “A Hybrid Parallel Active Filter / Off-Line UPS Unit for Computer Loads”
- [3] Mauricio Arends. , Luis F.C. Monterio. “ A control strategy for shunt active filter”

## Oncological positron emission tomography volume classification based on artificial intelligence approach

*Mhd Saeed Sharif, Maysam Abbod*

**Keywords:** Artificial Neural Network, Medical Volume Analysis, Positron Emission Tomography, Tumor

### Introduction

The prevailing application of positron emission tomography (PET) in clinical oncology and the increasing number of patient scans have led to a real need for efficient PET volume handling and the development of new volume analysis and classification approaches to aid clinicians in the diagnosis of diseases, planning of treatment, and patient fast recovery. Medical volumes can be acquired using different medical modalities such as positron emission tomography (PET), computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound. PET is a tomographic technique which is used to measure physiology and function rather than anatomy by imaging elements such as carbon, oxygen and nitrogen which have a high abundance within human body. PET plays a central role in the management of tumour beside the other main components as diagnosis, staging, treatment, prognosis, and follow-up. Due to its high sensitivity and ability to model function, it is effective in targeting specific functional or metabolic signatures that may be associated with various types of diseases [1], [2], [3], [4], [5].

There are many techniques for segmenting medical volumes [1], in which some of the approaches have poor accuracy and require a lot of time for analysing large medical volumes. Artificial intelligence (AI) technologies can provide better accuracy and save decent amount of time. Artificial neural network (ANN), as one of the best AI technologies, has the capability to classify, measure the region of interest precisely, and model the clinical evaluation. ANN is a mathematical model which emulates the activity of biological neural networks in the human brain. It consists of two or several layers each one has many interconnected group of neurons. The main aim of this research is to evaluate the capability of ANN to detect and classify the region of interest (ROI), tumour, in PET volumes. The best ANN architecture design has been also evaluated for the proposed PET volume classification. Thresholding, clustering and multiresolution analysis (MRA) approaches have been used also to segment the ROI, and they are used as truth ground to compare the outputs of the artificial neural network. Promising results have been achieved utilising phantom and clinical PET volumes.

### Design / Methodology / Approach

The 3D PET volume acquired from the scanner goes through the preprocessing block, where thresholding, and median filter are utilised to remove external artefacts and enhance smoothly the quality of slices features. The optimal class number is determined by plotting Bayesian information criterion (BIC) values against different values of number of classes K. K values are between 2-8 and is not further increased, as in this medical application, any additional separation is unnecessary based on expert consultation and comments. This number is fed to ANN which classifies each processed slice into the corresponding number of classes, where each voxel is classified into its corresponding class. The classification performance is evaluated then using confusion matrix (CM) and receiver operating characteristic (ROC) curve. The outputs are finally selected and displayed.

## **Findings / Results**

Initial experiments have been carried out on different ANN designs, and the optimum one has been selected for the proposed PET application. Different PET data sets including phantom and clinical data sets have been used in this study to evaluate the performance of the proposed system based on ANN. One of these data sets is the Zubal PET phantom data set which has simulated tumors with different sizes. The optimal class number obtained from BIC plot is 5 classes. The misclassification value for this data set is 4.068348E-04, and the area under the ROC curve (AUC) is 0.9998, which indicates a good ANN performance for classifying this data set. Promising results have been also achieved for clinical data sets.

## **Conclusion / Discussion**

An artificial intelligent approach based on ANN and BIC has been proposed for 3D oncological PET volume classification. A detailed evaluation has been carried out on the system outputs, which has shown promising results. The performance evaluation has been carried out using CM, misclassification value and AUC of ROC curve. The ROI is precisely classified in all phantom and clinical data sets. An objective and subjective evaluations based on the clinical expert has been carried out. The application of different clinical data sets has also shown promising results in detecting and classifying patient lesion.

## **Future Plan / Directions**

Ongoing research is focusing on the exploitation of other artificial intelligent techniques to validate the performance of the existing solutions.

## **References**

- [1] H. Zaidi and I. El Naqa. PET-guided delineation of radiation therapy treatment volumes: a survey of image segmentation techniques. *European Journal of Nuclear Medicine and Molecular Imaging*, 37:2165–2187, 2010.
- [2] D. A. Mankoff, M. Muzi, and H. Zaidi, "Quantitative analysis in nuclear oncologic imaging", in Quantitative Analysis of Nuclear Medicine Images. Edited by H. Zaidi, Springer, New York, pp. 494-536, 2006.
- [3] D. Montgomery, A. Amira and H. Zaidi, "Oncological PET Volume Segmentation Using a Combined Multiscale and Statistical Model", *Medical Physics (The American Association)*, 34 (2), February 2007.
- [4] P. Dendy, B. Heaton,"Physics for Diagnostic Radiology" , *Institute of Physics*, 2002.
- [5] A. Webb,"Introduction to Biomedical Imaging", *IEEE Press Series in Biomedical Engineering*, 2003.

## Power quality disturbances and barriers evaluation in Libyan distribution networks

S. S. Sultan, M. K. Darwish

**Keywords:** PQ Survey, LDNs, PQ Disturbances, PQP Barriers, PQP framework, PQP Benefits

### Introduction

Since the early 1999, tackling power quality disturbances has been a priority for Libyan distribution Networks (LDNs). Statistical analysis results show that in the last two decades, LDNs have not implemented power quality program (PQP). This is mainly because there is no power quality department established yet, to influence the measurement of power quality disturbances (PQDs). This absence of a power quality department is due to lack of awareness on the part of top management regarding the importance of power quality. As a result, lack of power quality awareness has led LDNs to face twelve significant difficulties through not implementing PQP. Data were collected from LDNs, both from departments and individual staff members. Both SPSS 15.1 and Nvivo 9 were used in performing the analysis. Out of 16 barriers, 12 were statistically significant different since the P value <0.05), which indicated that Libya distribution systems have already surmounted a few of the barriers to implementing a PQP effectively. In general, the finding shows that LDNs suffer the four factors of PQP barriers. These are F1, lack of awareness, F2, lack of top management attention, F3, lack of resources and F4, lack of PQ involvement. The qualitative analysis results also showed that lack of implementing power quality program, was due to some difficulties, which still exist. The findings are applied to build a PQP framework guideline to be implemented in LDNs. The PQP framework is consisted three essential phases. Phase one designed to increase the awareness level. Phase two is involved in preparation of PQP, which contains seven crucial requirements. Phase three is designed to prevent the outstanding problems from phase 1 and 2 of not reoccurring again to determine both the weaknesses and obstacles facing the implementation. The overall benefits of PQP implementation, which would have a positive impact on LDNs, are 11 benefits.

### Design / Methodology / Approach

Power quality surveys were sent to LDNs head managers, middle managers, engineers, technicians and employees, and it conducted in April-June 2009. Of 540 copies, 441 copies were returned, of which 397 were appropriate for data analysis, giving a response rate of 81%. The data were analyzed by using (SPSS). In addition, 44 face to face interviewees participated in this study to investigate why there are barriers to PQP implementation. The interviews were transcribed and coded by using NVivo 9 [4].

The disturbances which considered as highly significant are long interruption is pointed approximately 45 % in WDN, 34 % EDN and 52% SDN. Voltage sags and swells are other disturbances which are considered to be as highly significant and recorded 44 % in WDN, 30% in EDN and 43% in SDN among other disturbances and they are occur so often in both three networks. Roughly 43 % in WDN, 26% in EDN and 44% in SDN refer to under voltage as one of the most disturbances which occur constantly.

### Results / Discussion

The ANOVA test, out of 16 barriers, 12 were statistically significant different at the P value <.05. The significant barriers are BA1, lack of staff awareness, skills and experience, BA2, lack of end users awareness, BA4, lack of long-term strategy and planning, BA5, lack of top management commitment, BA6, lack of network designing, BA7, lack of distribution networks infrastructure, BA9, lack of top management responsibility, BA10 lack of training

courses and support, BA11, lack of financial resources, BA13, lack of PQ measurement, BA14, lack of PQ consultants and BA15, lack of PQ standards. SDN2 faces three factors; F1, lack of awareness, F2, lack of top management attention, and F4, lack of PQ involvement, whereas WDN1 and EDN4 face F1, lack of awareness, F4, lack of PQ involvement and F3, lack of resources. As a result, it can be inferred that Libya's distribution systems have so far struggled to implement PQP effectively.

An acceptable model was developed on the basis of these factors. It is clear that all these factors are significantly correlated, since all p values are less <.05 and are substantially affected by the lack of awareness of the implementation of PQP in Libyan distribution networks. It also indicates that the two factors most highly affected by lack of PQ awareness are F2 ( $\beta=34.5\%$ ) and F3 ( $\beta=31.6\%$ ). As a result, the regression analysis shows that the linear relationship between the outcomes, which is PQP, is explained by the model and predictor factors [5].

The overall results of PQP implementation benefits, which would have a positive impact on increasing end users' awareness, increasing their satisfaction, improving PQ performance, reducing end users' complaints, monitoring and measuring PQ disturbances, providing PQ diagnosis systems and databases, reducing the huge losses through PQ costs, increasing top management awareness, increasing the employees' skills and awareness, increasing PQ training courses and providing strategic planning in LDNs.

### **Conclusion / Discussion**

Significant power quality surveys and studies were critically reviewed to determine the critical factors regarding the implementation of PQPs. A power quality survey was conducted in LDNs west, east and south, networks as example one of distribution utilities in less developed countries. The survey provided various conclusions about occurrence of PQ issues, their sources and equipment affected LDNs. The large distribution networks WDN1, SDN2 and EDN4 faced some particular barriers, unlike the smaller distribution networks in LDNs. These four factors appeared in USA, European, India, Malaysia, Latin America, Brazil, Germany, Pakistan, Austria, France, Italy, Poland, Portugal, Slovenia, Spain and UK. Finally, the regression was sufficiently representative to conclude that the relationship between the model and the depended variables of power quality awareness is very strong and not accident.

### **References**

- [1] General Electrical Company of Libya, "Annual report," GECOL, Tripoli, Libya, 2009.
- [2] A. H. Hadod. Libyan electrical power sector. GECOL. Tripoli, Libya. 2009.
- [3] M. R. Wadi, M. F. Bara, O. Carlson and K. M. Elarroudi, "Voltage stability analysis for the southwest libyan electrical power system: Problem simulation and analysis," in Universities Power Engineering Conference (UPEC), 2009 Proceedings of the 44th International, 2009, pp. 1-5.
- [4] D. Silverman, Ed., Interpreting Qualitative Data. Thousand Oaks, California: Sage, 2006.
- [5] H. M. S. Chandana Herath, V. J. Gosbell, S. Perera and D. Stirling, "Power quality survey factor analysis using multivariable linear regression (MVLR)," in Harmonics and Quality of Power, 2008. ICHQP 2008. 13th International Conference on, 2008, pp. 1-5.

## A RISC microcontroller based voltage regulator module with fuzzy logic controller for processor core in mobile communication systems

*Monaf Tapou, Hamed Al-Raweshidy*

*Wireless Networks and Communication Centre*

**Keywords :** Fuzzy Logic Control, VRM (Voltage Regulation Module), Buck Converter, Microcontrollers, DVS (Dynamic Voltage and Frequency Scaling)

### **Introduction**

Designing digitally controller voltage regulation modules (VRM) for mobile computing devices requires careful selection of components, choosing of a proper circuit topology and finally adopting a control scheme that will produce response figures conforming to the requirements laid down by the target processor manufacturer. This process is complicated by several factors that lead to making tradeoffs between efficiency, voltage ripple and dynamic response. Passive and active components selection is made to ensure higher power efficiency along with being in conformity with the performance figures required by the target processor power requirements and must maintain compatibility with the dynamic voltage scaling (DVS) scheme adapted by the processors under investigation. A Choice of a suitable intelligent control scheme must be made that would suffice the stability and dynamic response requirements of power supply specifications set by the design requirements of the target processor.

This paper describes the design of Buck converter that has a fuzzy controller implemented using a RISC based microcontroller along with a choice of hardware components that will ensure better efficiency while delivering good stability and a dynamic response that complies with the requirements of the target processor. System simulation was carried out using a model realized using Simulink\Matlab. Simulation results showed that the fuzzy controller has the capability of providing response characteristics that makes it comparable with PID controllers, more appropriate for implementation in an application requiring variable output voltage and more apt for implementation using microcontrollers.

### **Design / Methodology / Approach**

In designing a DVS compatible VRM the first step is identifying the target processor, as an example, a processor is selected from Intel XScale family of DVS compatible processor namely the PXA270. The power requirements for this processor are as recommended by manufacturer to require five separate converters one of which must be DVS compatible in order to utilize the power reduction capabilities of this processor. The DVS compatible converter works in two main modes.

- Regulation mode where the converter tries to keep the voltage supplied to the load constant.
- Tracking mode where the regulator starts changing the output voltage as requested by the DVS scheduler.

Component choice must be made while keeping in mind several targets, the prime targets are efficiency and compatibility. Other targets are reliability, cost effectiveness and compactness. The choice of the microcontroller that will perform the regulation and tracking control action is to be made to furnish the required. This has been done by comparing features of microcontroller families from several manufacturers while keeping in mind the power consumption figure for the microcontroller in addition to integrated peripherals and instruction set.

The pulse width modulator frequency that is to be implemented using the microcontroller is selected to be 40 KHz. This figure will make it possible to implement the

digitally controlled buck converter while maintaining low power operation of the microcontroller in use. In addition to that, the low frequency will not generate any effective harmonics that can interfere with the operation of wireless communication elements implemented in the mobile computing device.

Selection of other components will ensure higher efficiency operation. In case of switching elements, the MOSFET transistors, these will be selected according to their figure of merit (FOM) which is based on channel ON resistance ( $R_{DSon}$ ) and gate charge ( $Q_G$ ) these two figures reflects the conduction losses of the device and its drive charge requirements. Low ESR capacitors and Inductors made with advance ferromagnetic materials will have additional contribution to higher efficiency.

### **Findings / Results**

From the conducted simulations and testing with various Fuzzy logic and traditional controllers, it has been observed that the Fuzzy controller can deliver performance figures and operational flexibility required without demanding exact mathematical models or the need for complex computational power to perform. Therefore this controller design would be very applicable when RISC based micro-power microcontrollers are considered settings,

### **Conclusion / Discussion**

The proposed fuzzy controller performance was compared against a tuned PID controller. The results promote using the fuzzy based controller with much better flexibility and lower software overhead than the case when controller structure of another type would be suggested. The overall system efficiency is expected to be higher than 92% that can be maintained over wide operating conditions by adapting different operating modes.

### **Future Plans / Directions**

In addition to main circuit of the VRM, the design is augmented by several additional circuitries that aids better efficiency operation and provides protection to load against over-voltage/ over-current incidents.

### **References**

- [1] A. Soto, P. Alou, J.A. Cobos, and J.Uceda, "The Future DC-DC Converter as an Enabler of Low Energy Consumption System with Dynamic Voltage Scaling," in *Proceedings, Industrial Electronics Society Conference, IEEE 2002 28<sup>th</sup> IECON 02*, pp. 3244-3249.
- [2] D. Šaletić and N. Mastorakis, "A Contribution to the Design of Stable Fuzzy Controllers," in *Proceedings of the 9<sup>th</sup> WSEAS International Conference on Fuzzy Systems*, May 2-4, 2008, pp.54-60.
- [3] NIC Components, *Selection Guide for Low ESR Capacitors*, Japan, Nippon Industries Company Ltd, 2011.
- [4] N. Mohan, T.M. Undeland and W.P. Robbins, *Power Electronics: Converters Applications and Design*, USA, John Wiley and Sons 1995.
- [5] T. Pering, T. Burd, and R. Brodersen, "Dynamic Voltage Scaling and the Design of a Low -Power Microprocessor System," in *Proceedings, Power Driven Microarchitecture Workshop*. ISCA 1998.
- [6] Z. Zahng and D. Maksimovic, "Digital PWM/PFM Controller with Input Voltage Feed-Forward for Synchronous Buck Converters," in *Proceedings, Conference on Applied Power Electronics*, 23<sup>rd</sup> Annual IEEE, APEC, Feb. 2008, pp. 523 – 528.

## Towards autonomous detection of anomalies in recordings from test drives based on a training set of normal instances

*Andreas Theissler, Ian Dear*

**Keywords:** anomaly detection, machine learning, vehicle electronics, data mining

### Introduction

Modern vehicles have 40 to 80 electronic control units (ECUs) interconnected via the in-vehicle network. During test drives the network communication is recorded in order to locate faults [2]. The resulting data volume is huge, e.g. recording 1000 signals at a cycle time of 50 ms, results in a multivariate time series with 72 million data points per hour. Therefore manually analysing each recording in detail is not feasible.

This work addresses the question: How can we cope with the soaring data volume and complexity of recordings from test drives caused by the ever-increasing complexity of vehicles? We propose to use machine learning to support domain-experts by pointing them to the relevant parts in the recordings. The aim is to (1) learn normal behaviour from recordings, and (2) autonomously report deviations as anomalies, which can be faults in ECUs, sensors, or actuators.

### Design / Methodology / Approach

Considering recordings from test drives, there is no training set with representative anomalies, because this would imply that knowledge of all fault states and corresponding recordings exist. This prevents using a traditional two-class classification approach, since a non-representative set of anomalies leads to poor decision functions. Hence, we view the problem as a one-class classification problem [3], i.e. learning from a training set of normal instances.

A classifier is required that (1) is robust to noise (anomalies) in the training data set, (2) is a one-class method, but can be enhanced using anomalies, and (3) performs satisfactory with very few adjustable parameters. Most classifiers are not directly applicable for one-class classification problems. A variety of classifiers was evaluated comprising a one-class adaption of k-NN and LOF, neural networks, and derivates of support vector machines [1]. The choice was to use support vector data description (SVDD) [3], which finds the decision boundary by surrounding the normal instances by a hyper-sphere, optimising the trade-off between error rate and volume.

The input data is resampled to common and equidistant time stamps and then transformed to feature vectors by transforming the values at each time point  $T_i$  to one feature vector  $F_i$ . Since SVDD is sensitive to scaling, the feature vectors were normalised using z-score. SVDD with an RBF kernel is trained on the normal feature vectors, optimising the parameters  $\nu$  and  $\gamma$  using grid search.

Since the aim is pointing experts to abnormal subsequences, from the classified feature vectors, subsequences in the time series are formed with a non-overlapping window. The subsequences are then classified based on the fraction of abnormal data points w.r.t. a threshold, allowing to control the ratio between undetected and falsely detected anomalies.

### Findings / Results

In order to validate the idea in a controlled environment, experiments with a brushless DC motor were conducted, measuring signals like velocity and DC current. This type of motor is commonly used in vehicles, e.g. in the power train of hybrid and electric vehicles.

A variety of experiments was conducted with promising results. One experiment, described in more detail in [4], yielded the following results. A recording of 3 minutes was selected as the

training set, and a recording of 10 minutes as the test set. From 11 anomalies, manually injected by altering the motor's load, 10 were correctly detected corresponding to an anomaly detection rate of 90.1%.

Analysing the results, it was found that for a detection system to be useful in practice, rather than only aiming for a high anomaly detection rate, a high precision on the abnormal class is crucial, i.e. from the reported anomalies, the fraction of true anomalies should be high. A precision rate of 97.4% was achieved on the abnormal feature vectors and of 83 % on the abnormal subsequences.

### **Conclusion / Discussion**

The results so far show the feasibility of the approach in a controlled environment, giving direction to further research. The next step is to work on entire data bases of recordings from test drives, either simulated or real. Therefore future work will address (1) data reduction, (2) feature extraction, and (3) the application of different models to independent groups of time series in the recordings.

In addition to classification, one challenge is how to find a training set that is representative for the system's normal behaviour and that does not contain anomalies. Identified ways are to investigate the training data using visual data mining as we proposed in [5], or use data from a thoroughly tested vehicle, or from HIL or SiL simulations.

### **Future Plans / Directions**

Regarding the time scale, I expect to complete the PhD within one more year, summing up to five years, which is well within the time scale of a part-time PhD.

### **References**

- [1] Duda, Richard O. and Hart, Peter E. and Stork, David G., 2001. Pattern Classification (2nd Edition), Wiley-Interscience 2001.
- [2] Marscholik, Christoph and Subke, Peter. 2008. Road vehicles - Diagnostic communication. Hüthig GmbH und Co. KG.
- [3] Tax, David M.J., 2001. One-class classification. Concept-learning in the absence of counter-examples, PhD Thesis. Delft University of Technology
- [4] Theissler, Andreas and Dear, Ian. 2012. Detecting anomalies in recordings from test drives based on a training set of normal instances. Proc. IADIS European Conference Data Mining 2012. IADIS Press, Lisbon (to be published)
- [5] Theissler, Andreas and Ulmer, Daniel and Dear, Ian. 2010. Interactive Knowledge Discovery in recordings from vehicle tests. Proc. 33rd FISITA World Automotive Congress. Budapest, Hungary.

## Semi-automated facial animation generation for the hearing impaired

Achilleas Tsitroulis, Emmanuel Tsekleves

**Keywords:** 3D animation techniques, 3D face, facial animation

### Introduction

People with Hearing impairments comprise a significant part of human population across all ages. It is estimated that 23% of population in the age of 18-44, 29% in the age of 45-64 and 43% in the age of 65+, have hearing impairments [1]. Currently there is a lot of research conducted in the area of facial animation for the purposes of facial animation recognition and generation for the hearing impaired. This is because facial animation play a crucial role in communication amongst the hearing impaired. The aim of this PhD is to focus of the semi-automated facial animation and audio generation for the hearing impaired. A 3D face will be created in order to analyse the speech of the non-hearing impaired person (HIP) and to generate the corresponding 3D facial animation. In particular, there will be a facial animation of the mouth's lips, guided by the rules of the English phonetic alphabet. This animation will be in correlation with the voice of the non HIP.

### Design / Methodology / Approach

The whole approach will be performed in an open source/free 3D animation software. That software should be compatible with: several and different facial animation techniques, various methods of facial expressions, options in setting arguments of words of the British dictionary and a further transformation of those arguments to facial animations, options for hand gesturing and the ability of the complete and smooth mix of the above. In order to create the suitable 3D animation of the mouth's lips, which is part of the whole facial animation, research should be done in all the possible 3D facial animation techniques. There are several facial animation techniques that may be useful in our project. Those techniques came up from a research in approved journals, books, papers and e-libraries like: IEEE, ACM, Elsevier and Springer.

### Findings / Results

Video/image based 3D facial animation techniques will be excluded. These techniques are not suitable for the current project because of incompatibility and smoothing animation issues. Below are various facial animation techniques with their characteristics, which have been researched:

1. Polygon Meshes: Have flexible surfaces. Polygons and meshes define the level in details a 3D model has. Harsh edges are a flaw of that technique. 2. NURBS: There is a parametric representation and specific weight of control points. There are problems around nose and eyes. 3. Subdivision Surfaces: Is a method of creating surfaces and has the advantages of polygon meshes and NURBS. Furthermore, it is computationally complex. 4. Volumetric Models: They are part of “voxels” but they are not suitable for real time animation. 5. Key Frame Interpolation: Interpolating the intermediate in-between frames. “Linear”, “quadratic” and “cubic spline” are different interpolation methods. This technique is limited to the available information sets. 6. Free Form Deformation: Volumetric objects could be deformed with the use of a cubic lattice. There is a big possibility of jerky animation. 7. Parameterization: Parameter sets are used. 8. Facial Action Coding System (FACS): Action units (Aus) are used

but this technique has difficulties in arbitrary expressions. 9. Minimal Perceptible Actions (MPA): There are muscle movements and a normalization attribute but there are problems in different models. 10. MPEG4: It has more details than FACS and MPA. 11. Pseudo Muscle Models: Simulation of the effects according to the real muscles. In addition, there are computationally simple. 12. Blend Shapes: Is a key frame based method. It can be used with polygonal or NURBS. 13. Bone Rigging: Bones connected by joints. It is a problematic technique. 14. Vascular: It is useful for emotions and it actually changes skin's color.

### **Conclusion / Discussion**

The success of the project will be ensured by choosing the right combination of those. Through "Results" section, very useful information could be found regarding facial animation techniques and the predicted use of each one. A combination of "Polygon Meshes" and "Key-Frame Interpolation" methods will be employed. Furthermore, there is a possibility of using "NURBS" at some less complex facial areas. "Parameterization" will be used if the "parameter division" approach is adopted. "Pseudo Muscle Models" may be also used. "Blend Shapes" technique has potentials in the project. Thus, this technique will probably be employed. "Volumetric" method will be discarded as it is not suitable for real time animation. Also, "FACS" and "MPA" will be excluded; "MPEG 4" is better than "FACS" and "MPA" and it may be used. In addition, "Bone Rigging" method suffers from issues regarding movement. That is because, the real face has so many different muscles co-operating with the corresponding bones, making the whole procedure extremely complex.

### **Future Plans / Directions**

Facial expressions are an essential part in 3D facial animation. They denote feelings and emotions of the speaker. Thus, in order to create a more realistic simulation, facial expressions should be incorporated. After the research and literature review is completed, the system requirements would be defined and prototyping and experimentation would be commenced employing a user-centered design and producing 3D avatars. The final outcome of the PhD would be a tool that semi-automates in a 3D environment facial expressions, lip-syncing and gestures (sign-language) for the hearing impaired.

### **References**

- [1] National Academy on an Aging Society, "Hearing Loss, a problem that affects quality of life", Number 2, December 1999
- [2] Ding Huang, Wei Lin, Hong Yan, "Modeling of Facial Expressions Using NURBS Curves", Lecture Notes in Computer Science, Volume 2252/2001, pp 216-223, DOI: 10.1007/3-540-45336-9\_26

## Development of a laboratory based XRF facility for measuring elemental abundance ratios in planetary analogue powder samples

Thomas Walker, David Smith

**Keywords:** Swept-charge device, X-ray spectroscopy, X-ray fluorescence, elemental abundance, planetary analogue

### Introduction

This paper describes the use of a swept-charge device (SCD) silicon X-ray detector in a laboratory based X-ray fluorescence (XRF) facility for calculating elemental abundance ratios from planetary analogue powder samples. The facility was developed to support the Chandrayaan-1 X-ray Spectrometer (C1XS) detector development and calibration activities prior to the flight of the instrument onboard the Indian Space Research Organisation (ISRO) Chandrayaan-1 mission to the Moon in 2008 [1, 2, 3]. The test facility has subsequently been used to carry out XRF analysis of homogenous samples made from mixtures of MgO, Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub> powders, all of grain size <44 µm, across a range of mixture ratios and at a high level of X-ray flux data in order to develop an algorithm which will allow the calculation of elemental abundance ratios. The operation of the SCD, the XRF test facility, the sample preparation methodology and the first sample test results are discussed in this paper.

### Design / Methodology / Approach

The laboratory setup used was located at Brunel University within the Centre for Sensors and Instrumentation. The equipment utilised for this study is the same test facility that was used to characterise the C1XS flight detectors and is described in detail in [4]. The facility comprises a desktop vacuum chamber with attached Oxford instruments tungsten (W) filament X-ray tube. X-rays pass through an aluminium (Al) tube and are then collimated into the main chamber.

Target materials are mounted onto a central aluminium octagonal sample holder. This holder can be rotated to allow different target materials to be in the path of the X-ray beam. A standard 90° phase angle geometry (incidence and emergence angles both 45°) was used for all measurements. Target samples created on copper slides were attached to the aluminium holder using Kapton tape.

The detector module housed within the test facility camera head contains four CCD54 devices, with detector number 2 positioned directly in front of the sample. All spectral data were taken using detector number 2, which obtained the highest X-ray flux of the four detectors on the module. Detector number 2 is also the device closest to the PRT measuring the temperature of the cold finger, ensuring the data collection temperature was actually -20 °C.

To obtain the test data, MATLAB routines were created to record and analyse 50 ‘frames’ of data, where 1 frame is equivalent to 500 full linear SCD readouts, a readout containing 570 individual samples. The 50 frames described above are displayed as a spectrum calibrated to energy in keV, with event processing used to give an isolated event spectrum. The calibration to energy was obtained using a suitable line in each spectrum, this being silicon in most cases.

For the purpose of the experiments outlined in this paper, the following oxide powders were obtained; silicon dioxide, magnesium oxide and aluminium oxide.

To create the test samples, the silicon dioxide was combined with magnesium oxide and aluminium oxide in the following volume % ratios: 50:50, 80:20, and 20:80. A novel sample

preparation method was used in which a copper slide was covered with carbon tape and then pressed into a Petri dish containing the oxide powder mixture. The sample preparation process was repeated using different Petri dishes of the same ratio mixtures to check for repeatability in the resulting XRF spectra obtained.

### **Findings / Results**

The results so far show a stable and repeatable method for sample preparation. The results are now stable and accurate enough to produce an algorithm which can interpret the elemental abundance of the sample so the facility can be calibrated.

### **Conclusion / Discussion**

This paper has described the use of swept-charge devices in obtaining XRF spectra from planetary analogue powder samples. A novel way of preparing simple oxide powder samples in different mixture ratios has been discussed.

The collected oxide powder sample XRF spectra can now be verified using the RAL abundance algorithm, or similar algorithm, to interpret elemental abundances from the XRF line flux data.

### **Future Plans / Directions**

Future work will be focused around developing an algorithm which takes into account the X-ray input spectrum and quantum efficiency of the CCD54 detector to calculate elemental abundances from the XRF line flux data produced by the Brunel test facility. This further study will provide continued support to the C1XS data analysis activities and allow the effect of different elements being in different grain fractions within lunar soil to be quantified.

The PhD is on track for completion on 31st August 2012.

### **References**

- [1] M. Grande, et al., *The C1XS X-ray Spectrometer on Chandrayaan-1, Planetary and Space Science*, vol. **57**, (2009), pp. 717-724.
- [2] I. A. Crawford, et al., *The scientific rationale for the C1XS X-ray spectrometer on India's Chandrayaan-1 mission to the moon, Planetary and Space Science*, vol. **57**, (2009), pp. 725-734.
- [3] C. J. Howe, et al., *Chandrayaan-1 X-ray Spectrometer (C1XS) – Instrument design and technical details, Planetary and Space Science*, vol. **57**, (2009), pp. 735-743.
- [4] J. Gow, D. R. Smith, A. D. Holland, B. Maddison, C. Howe, P. Sreekumar, J. Huovelin, M. Grande, *Characterisation of Swept-Charge Devices for the Chandrayaan-1 X-ray Spectrometer (C1XS) instrument, Proc. SPIE*, vol. **6686**, (2007).

## A novel approach to distributed energy resource planning using NSGA-II

I. Zamani, M. Irving

*Power and Renewable Energy, Brunel Institute of Power Systems*

**Keywords:** NSGA II, Multi-objective, Distributed energy resources

Increasing share of distribution generation in electrical energy supply has made the distributed energy resource planning (DER) more significant as improper placement, capacity or number of distributed generation (DG) units in power systems would increase power loss as well as jeopardising the system operation. Diversities and conflicting nature of objectives, uncertainties about benefits or drawbacks of the existing optimization techniques, and suitability for discreet domain problems project more appeal in the invention of efficient and robust techniques in resource planning. In this paper, a new application of multi-objective optimization techniques for siting and sizing of potential DGs has been investigated. The system is modelled in Matlab using a fast non-dominated sorting genetic algorithm (NSGA-II) within a planning horizon.

### Introduction

Stochastic methods referred to as evolutionary algorithms have gained considerable popularity in recent decades for engineering problems [1]. These solution algorithms avoid complex mathematical equations and do not require the evaluation of derivatives. Consequently, they are suitable for discreet domain problems, such as power system problems in which nodes or busbars are considered as members of discrete sets. The main drawback of such heuristic techniques is the potentially large volume of calculations, which imposes a computational burden and prolongs the calculation time. This disadvantage is not so significant today as the power of computers has greatly increased.

Our planning goal is to find optimum locations and sizes of distributed generators to be introduced into a distribution network. This problem is becoming more significant as emphasis is shifting from large central fossil power plants to small cleaner resources close to the consumers. For this reason, the penetration of DGs has been increasing, contributing to the abatement of various environmental and technical concerns. If the planning is not done precisely, it could contradict the above-mentioned objectives and may lead to an eventual drop in reliability of the system.

There are many objectives to be considered in power system planning, so it is appropriate to examine techniques which are based on multiple objectives rather than a single objective. The technique applied in this paper is called Multi Objective Evolutionary (MOE) optimization. The MOE technique is based on the Pareto-front concept, which is a set of solutions in the  $n$ -space of the objectives (for  $n$  objective functions) [2]. As in every kind of optimization, three main aspects must be defined: criterion functions (or objective functions), design (or control) variables, and constraints. It should be noted that the objectives should be chosen meticulously, as Non sorting genetic algorithm II (NSGA-II) tends to fail when the number of objective functions is too great. Beyond about ten objective functions, the algorithm can behave like random sampling [5].

## **Design / Methodology / Approach**

In this paper, the system is modelled in Matlab using a fast non-dominated sorting genetic algorithm (NSGA-II) based on a Gaussian mutation [3], intermediate crossover and binary tournament selection. As the name implies, in non-dominated populations (of candidate solutions), none is dominant or strictly better than any other. In other words, all the solutions are assigned the same rank. The program invokes a function which evaluates system variables, including voltage magnitudes and phase angles, using the Matpower 4.1 power flow [4].

## **Findings / Results**

IEEE 30 node test system has been used for the experiment. The objectives applied in this paper are defined as: minimizing load average voltage deviation, real power loss and investment plus operational cost based on an hourly cost function over a 5 year planning horizon. The experiments have been undertaken on the IEEE test system to yield a compromise solution for the best location and size of the embedded generation. It is also possible to take into account the trade-off solutions for an unspecified the number of Distributed Energy Resources (DER).

## **Conclusion / Discussion**

In this paper a novel DER planning was proposed to tackle with the problem of finding optimal size and site of distribution generations in distribution networks. The method is based on NSGA-II algorithm. The method was tested on IEEE test model to verify the efficiency of the algorithm.

## **Future Plans / Directions**

In future different objective functions will be examined on larger scale networks. Modifying NSGA-II codes will also be of interest for the sake of reducing the calculation and time and increasing the robustness of the algorithm.

## **References**

1. K. Y. Lee, M.A. El-Sharkawi, "Modern heuristics optimization techniques with applications to power systems". IEEE Power Engineering Society
2. K. Deb, A. Pratap, S. Agarwal, T. Meyarivan, "A fast and elitist multiobjective genetic algorithm: NSGA-II", IEEE Transactions on Evolutionary Computation, vol.6, no.2, pp.182-197, Apr 2002
3. Matlab Global optimization toolbox: User's Guide (r2011b).
4. R. D. Zimmerman and C. E. Murillo-Sanchez, "MATPOWER 4.1 User's Manual, 2011."
5. J. Knowles, D. Corne, "Quantifying the effects of objective space dimension in evolutionary multi-objective optimization". Proceedings of the 4th International Conference on Evolutionary Multi-criterion Optimization (pp. 757–771). Berlin: Springer.

## Assessing value-at-risk with Monte Carlo simulation

*Yu Zhao, Maozhen Li*

**Keywords:** Monte Carlo, Value-at-Risk (VaR), Parallel Computing, MatLab

### Introduction

The research has been focused on Monte Carlo methods to assess Value-at-risk (VaR). VaR is a general measure of risk developed to equate risk across products and to aggregate risk on a portfolio basis (Huu, Van and Issouf, 2010). There are three methodologies for calculating VaR: parametric method, Monte Carlo technique and historical technique. Monte Carlo technique is adopted in this research because it estimates VaR by simulating random scenarios and revaluing instruments in the portfolio, which can produce accurate estimates. Monte-Carlo analysis is by far the most powerful method with all its model capabilities to compute VaR and probably the most comprehensive approach to measuring market risk if the modeling is done correctly. One of the big drawbacks is its computational time due to the computing complexity of  $O(n^2)$ . For instance, to measure the VaR for a portfolio of 1,000 assets with 1,000 sample paths, the total number of valuation amounts is 1 million.

### Design / Methodology / Approach

Matlab is used for Monte Carlo simulation. To speed up Monte Carlo simulation, parallel computing technologies will be applied (Rosenthal, 2000, p207). One challenge is how to distribute small Monte Carlo computation jobs among a number of core processors in a multi-core system. Large numbers of parallel computing experiments are to be conducted.

According to Monte Carlo's characteristics, more experiments, much closer to the truth value. But the reality is that extremely large sample values tend to crash the computer before the computation finishes (Rosenthal, 2000, p214). Because all available parallel computers have different speeds and some of them are spread out across the intranet, or have high user load, or may be down. Due to the heterogeneity of computing resources, load balancing algorithms would be needed to ensure high efficiency in computation.

### Conclusion / Discussion

Parallel Monte Carlo is a feasible way to speed up its computation. However, the way that Monte Carlo is parallelized can affect its accuracy in estimation significantly. One future work will be to investigate techniques such as data parallelization and computation parallelization and evaluate their effects. Another work will be to look at load balancing schemes to better utilize the resources of multi-core computer systems.

**References**

1. Huu, T.H., Van, S.L. and Issouf, S. (2010) *Stochastic Simulation and Applications in Finance with MATLAB Programs*. England: John Wiley & Sons Ltd.
2. Rosenthal, J. S. (2000) ‘Parallel computing and Monte Carlo algorithms’, *Far East Journal of Theroretical Statistics*, 4, pp207-236.

## Geographical information systems data modeling for urban planning

*Adel Zidan, Maysam Abbod*

**Keywords:** Settlements, Government planning, Housing, Growth

### Introduction

There is rapid increasing in population in all over the world however governments have the responsibility to provide their people infrastructure, housing and all facilities they need, this process should be done in advance to avoid many problems for instance random settlements and the cost of demolition the unplanned areas or the pressure that people make on their governments when there is shortage of housing or any other needs, moreover this process will help governments to save money and time. In addition, that helps to protect the environment and improve the outlook of cities. This research is aimed to develop a model for Libya using cellular automata to enable government to predict the trends of growth then prepare areas in advance. For some reasons the second generation plan implementation in Tripoli has stopped for a long time. As a result, people being encouraged to build houses in open areas, later on when the government decided to implement the third generation plan was faced many problems and in some places was forced to demolish these random settlements. In order to avert this problem the research is looking for solutions through model which gives decision makers opportunities to plan and develop areas in advance.

The main area is Tripoli (capital of Libya), city of about 1.800.000 people which has some urban planning problems. This research aims to give the planning authority in Tripoli the possibility to expand the city in the right way with the best suitable plans, making the authority more efficient by using technology, protecting the environment inside and around the city, avoiding the random settlements, and reducing the cost of preparing lands.

### Methodology

Digitizing a city map using Matlab then embedded the map into a model of cellular automata (CA) with consideration of natural constraints and the country's policy as well as increasing of population percentage. The type of city map which be used is land use map which has many sectors such as residential area, industrial area, agricultural area etc. The growth in the city can be predicted specific rules that can be introduced in CA. The city growth will be linked to the population growth and the available resource.

### Results

Simulation results will be showing which areas will be growing and enable the authority to choose the suitable plan for each place and estimate the cost and time will take to develop.

### Conclusion

Helping governments to save money and time can be achieved using advanced technology to predict, control the growth, and build modern cities. However the research currently is at the maps digitizing stage, yet the result are expected to emerge shortly.

## Future Work

There is a big work to be done and should finish within three years as planned. Designing model of cellular automata it will be next stage then integrating the city map and analyze the result of the model, the last stage will be writing up.

## References

1. Buresut, J.H. (2004). Decision making, planning and design for the conservation of indigenous vegetation within urban development. *Landscape and urban planning*. 439-452 (68), P
2. De Geert, R.S., Dewulf, G. (2010). Applying the lessons of strategic urban planning learned in the developing world to the Netherlands: A case study of three industrial area development projects. *Habitat International*. 34 (471-477), 1-7.
3. Wu, D., Liu, J., Wang, S., Wang, R., (2010) Simulating urban expansion by coupling a stochastic cellular automata model and socioeconomic indicators 24. 235-245
4. Eben Saleh, M.A. (2001). The evolution of planning & urban theory from the perspective of vernacular design: MOMRA initiatives in improving Saudi Arabian neighborhood. *Land Use Policy*. 18 (179-190), 1-12.
5. Ferreira, J., Condessa, B., Almeida, J., Pinto, P. (2010). Urban settlements delimitation in low-density areas—An application to the municipality of Tomar (Portugal). *Landscape and urban planning*. 97 (156-167), 1-12.
6. He, J., et al, Framework for integration of urban planning, strategic environmental assessment and ecological planning for urban sustainability within the context of China, Environ Impact Asses Rev (2010), doi:10.1016/j.eiar.2010.09.002.
7. Al-Ahmadi, K., Heppenstall, A., See, L., Hogg, J., (2010) Modeling Urban Growth Dynamics using Cellular Automata and GIS
8. Meier, R.L., Quium, A.S. (1991). Planning and designing new urban settlement estuaries: Bangladesh. *Landscape and urban planning*. 21.
9. Rebelo, E.M. (2011). Urban planning in office markets: A methodological approach. *Land Use Policy*. 28 (83-95), 1-13.
10. Urban Planning Agency (2007) Regional Development Plan. Tripoli Region.
11. Urban Planning Agency (2007) 2<sup>nd</sup> Generation Plan Evaluation. Tripoli Region.
12. Williams, W.K. (1968). Computers in urban planning. *Socio-Econ. Plan. Sci.* 1 (297-308), 1-12.



# **Mechanical Engineering Abstracts**

**Organizing Committee**

**Bin Wang**

**Jun Xia**

**Chao Xu**

## Experimental investigation the effects of Nitrogen and Hydrogen addition on the combustion and exhaust gas emissions

*Mohammed Abahussain, Thanos Megaritis*

*Centre for Advanced Powertrain and Fuel Research*

**Keywords:** exhaust gas recirculation, particulate matter nitrogen, oxide hydrocarbon

### Introduction

Purpose: To meet the future more stringent NOx and PM emission regulations and reduce environmental pollution.

Scope:

Aim of the research, including its originality: Overcome the disadvantages of Exhaust Gas Recirculation by replacing EGR by Nitrogen and hydrogen injection in order to control soot and PM level (Ladommatos N., Abdehalim S., Zhao H.,1999). That experiment will be achieved by supplying both elements directly from their bottles into the combustion chamber for the experimental purpose. The application of this system on a production vehicles "engine" will be performed as part of future work (Tsolakis A., Megaritis,2005). This experiment was proposed in order to achieve advanced clean diesel combustion technologies, in order to meet the future more stringent NOx and PM emission regulations and reduce environmental pollution.

### Design/Methodology/Approach

The experiment took place in the Centre for Advanced Powertrain and Fuel Research in Brunel University. The experiments have been carried out using a modern high speed direct injection diesel engine "Ford Puma". This type of engine was manufactured by Ford Motors Company as a prototype for the Duratorc series of engines. Furthermore, this pre-production prototype engine block is based on the 2.0L HSDI Ford Duratec engine. This engine is supplied with a standard production Ford Zetec head, four valves per cylinder, high-pressure common rail and twin camshafts (McWilliam, L., Megaritis.2008). The engine is controlled and monitored using a Schenck eddy-current dynamometer.

The engine is supplied with hydrogen and nitrogen from two bottles controlled by gas mass flow controllers, which shows precisely the supplied amount of hydrogen and nitrogen in the intake manifold. Both gases are injected through the intake manifold into the combustion chamber. Nitrogen is used to control the oxygen level to keep the temperature as low as possible in order to control the NOx forming level in the combustion (Poola, R. B,2000). The Hydrogen is used to improve combustion and emissions (McWilliam, L., Megaritis.2008). EGR bypass system is fitted into the engine. The Horiba MEXA 7170 gas analyser measure EGR, CO, CO<sub>2</sub>, NOx, O<sub>2</sub>, THC, Lambda. The smoke is monitored by a smoke meter.

### Findings/Results

The tests that have been done up to date covered EGR and Nitrogen tests under low engine speed 1500 RPM and 42.7NM load as fixed conditions with three injecting timing (3BTDC,6BTDC,9BTDC) and two injection pressure (800Bar,1000Bar). The obtained results

from these experiments confirm previous findings from research in this field (Ladommatos N., Abdehalim S., Zhao H., 1999). In particular, the main trend that has been focused on was the NOx trend, the replacement of 10%, 20% and 30% intake air with EGR showed significant reduction in NOx trend in all the above conditions as a result of O<sub>2</sub> control. The nitrogen was used as a substance for EGR to keep the O<sub>2</sub> level similar to the tests that were approached using EGR. The N<sub>2</sub> test has shown lower trend of NOx than EGR. The nitrogen supply had a negative effect on CO, THC and PM as these trends have shown a significant effect in both EGR and N<sub>2</sub> enrichment.

### **Conclusion / Discussion**

The results obtained by EGR and Nitrogen have shown an excellent effect on reducing NOx but also showed an increase in PM emission. However, previous experiments have shown that reduction in CO and PM could be achieved by hydrogen enrichment to have more complete combustion (Bromberg L., 2006), but that could affect the NOx trend. Nevertheless, an enrichment of both gases could reach an optimum over all trends.

### **References**

- Heywood, John B (1988). *Internal Combustion Engines Fundamental*. US: Mcraw hill International Editions . 567-640.  
(Heywood, John B,1988)
- Stone, R. (1999) *Introduction to Internal Combustion Engines*. 3rd edn Hampshire : Macmillan Press LTD (Stone, R,1999)
- Bromberg L., Cohn D.R., Rabinovich A., Alexeev N., Samokhin A., Hadidi K., Palaia J., Margarit-Bel N., 'Onboard Plasmatron Hydrogen Production for Improved Vehicles', MIT Plasma Science & Fusion Center Research Report PSFC JA-06-3, 2006.
- Kimura S, Osamu S, Ogawa H, Muranaka S. 'New combustion concept for ultra-clean and high-efficiency small DI diesel engine', SAE Technical Paper Series No. 1999-01-3681, 1999.
- Kimura S, Osamu A, Kitahara Y, Aiyoshizawa E. 'Ultra clean combustion technology combined a low temperature and premixed combustion concept for meeting future emissions standards'. SAE Technical Paper Series No. 2001-01-0200, 2001
- Ladommatos N., Abdehalim S., Zhao H., 'The effects of exhaust gas recirculation on diesel combustion and emissions', Int. J. Engine Research, 1 (1999) 107. (Ladommatos N., Abdehalim S., Zhao H.,1999)
- McWilliam, L., Megaritis, T. & Zhao, H., 2008. 'Experimental Investigation of the Effects of Combined Hydrogen and Diesel Combustion on the Emissions of a HSDI Diesel Engine'. Shanghai, SAE International. (McWilliam, L., Megaritis.2008)
- Murari Mohon Roy, Eiji Tomita, Nobuyuki Kawahara , Yuji Harada , Atsushi Sakane., 'An experimental investigation on engine performance and emissions of a supercharged H<sub>2</sub>-diesel dual-fuel enginee', Rajshahi University of Engineering & Technology. 2009
- Poola, R. B, 2000. 'Membrane-Based Nitrogen-Enriched Air for NOx Reduction in Ligh-Duty Diesel Engines'. Michigan, SAE International. (Poola, R. B,2000)
- Tsolakis A., Megaritis A. 'Partially premixed charge compression ignition engine with on-board H<sub>2</sub> production by exhaust gas fuel reforming of diesel and biodiesel', Int. Journal of Hydrogen Energy, Vol.30 (7), PP. 731-745, 2005 (Tsolakis A., Megaritis,2005)

## Plasma Assisted Decomposition of Gaseous Propane to Produce CO<sub>x</sub> Free Hydrogen

*Irma Aleknaviciute, Tassos Karayiannis, Michael Collins*

**Keywords:** propane decomposition, hydrogen production, non-thermal plasma

**Introduction:** Hydrogen plays an important role in many industrial processes and hydrogen production is considered to play a key role in the future energy security and the conservation of the environment [1, 2]. Conventional hydrogen production methods, such as steam reforming, are well developed; however, the use of catalyst in the system presents a major disadvantage of catalyst deactivation [3]. Plasma assisted hydrogen production from hydrocarbons has been successfully investigated for different types of plasmas, mainly non-thermal discharges [4, 5]. Non-thermal plasma systems can provide extremely high concentrations of energetic and chemically active species, keeping bulk temperatures as low as room temperature [6]. A corona discharge reactor operating under atmospheric pressure has been developed and a series of experiments have been carried out to investigate CO<sub>x</sub> free hydrogen production from propane.

### **Design/Methodology/Approach:**

Propane is subjected to corona discharge in a pin-to-plate electrode configuration with argon as the working gas. The plasma chamber consists of two 316 stainless steel disks, a stainless steel pin electrode, borosilicate glass cylinder, high voltage power supply, vacuum pump, pressure gauge and data logging system for temperature and pressure. High voltage is supplied via a 3.14 MΩ resistor, which is used to start off and stabilize the plasma; therefore, due to the voltage drop, the power consumed by the plasma is much lower than the power input into the system and is defined as the discharge power. The results for propane conversion and hydrogen selectivity are compared against the discharge power, as it is the power available for the chemical reactions. Energy conversion efficiency will be shown for both, input and discharge power to investigate the efficiency of the system and the plasma unit respectively.

The amount of propane and argon entering the system is measured by volume, using a pressure gauge. High voltage DC power is supplied to the pin electrode initiating electrical break down of the argon gas and hence generating active plasma species such as electrons and ions. Gaseous samples are analysed on the GC-MS before and after each experiment to determine accurate propane conversion. After each experiment a second gaseous sample is analysed on the Chromopack GC to determine accurate hydrogen generation.

We adapted an approach of dividing the parametric testing in sets for positive and negative corona discharges, with the aim to determine the effects of inter-electrode distance (10, 15 and 20mm), discharge power (19 - 35 W) and residence time (60 – 320 s). Within each, set two of the parameters are kept constant and one parameter is varied. The results presented in the next section are for a positive corona discharge at 15 mm inter-electrode distance; discharge power and residence time were varied from 19 – 35 W and 60 – 303 s, respectively.

### **Results and discussion:**

Higher discharge powers and higher residence times both lead to higher propane conversion and hydrogen selectivities. The energy deposited on propane molecules increases with increasing total discharge power (discharge power times the residence time); hence, higher conversion rates are achieved. However, there is a diminishing effect for hydrogen selectivity with discharge power at 120 s residence time, i.e. the increase in discharge power from 24 to 34 W has no substantial effect on hydrogen selectivity.

Energy conversion efficiency (ECE) of the plasma increases with the discharge power and the residence time. ECE values follow the pattern of hydrogen selectivity very closely, also with a diminishing effect of discharge power at 120 s residence time. ECE of the system follows a very different pattern when compared to the ECE of the discharge. The ECE of the system decreases with power input after 65 W at residence times of 60 and 120 s. At higher power inputs, the current of the system is higher causing a higher voltage drop at the resistor and a higher energy loss. Therefore, this pattern is attributed to the efficiency of the power supply system rather than the plasma unit itself.

The optimal conditions for this set are at 35 W discharge power (95 W input power) and 303s residence time, with propane conversion and hydrogen selectivity at 48 and 33 % respectively, and energy conversion efficiency of 11 %.

### **Conclusions:**

Non-thermal plasma reforming unit operating at atmospheric pressure has been developed for converting gaseous hydrocarbons to CO<sub>x</sub> free hydrogen. A series of experiments have been performed for positive corona discharge at 15 mm inter-electrode distance to study the effects discharge power and residence time. The results analysis shows that both, the discharge power and the residence time, have a positive influence on propane conversion, hydrogen selectivity and energy conversion efficiency. Propane conversion and hydrogen selectivity are both highest at the largest discharge power of 35 W and the longest residence time of 303s.

### **Future plans/Directions**

Our main objectives are to determine the parameters that allow the development of an energy efficient hydrogen generation process. Therefore, future work consists of the continuation of parametric study on propane decomposition and an experimental study on methane decomposition to generate COx free hydrogen. The experimental work has been carefully planned for the timely completion of the project.

### **References**

- [1] Balat, M. (2008). vol. 33, p. 4013.
- [2] Ahmed, S., Krumpelt, M. (2001). vol. 26, p. 291.
- [3] Luche, J., Aubury, O., Khacef, A., Cormier, J-M. (2009). vol. 149, p. 35.
- [4] Deminsky, M., Jivotov, V., Potapkin, B., Rusanov, Y. (2002). vol. 74 p. 413.
- [5] Holladay, J.D., Hu, J., King, D. L., Wang, W. (2009). vol. 139, p 244.
- [6] Fridman, A. (2008). Plasma Chemistry. Cambridge: Cambridge University Press.

## Integrated Energy Demand Matching with Multi-Functional Solar Panels

James Allan, Zahir Dehouche, Sinisa Stankovic\*

\*BDSP Partnership

**Keywords:** solar-energy, building-integration, sustainability, energy generation

### Introduction:

The Hottel Whillier Bliss (HWB) Equation (Hottel and Whillier, 1955) is the most extensively used equation in the analysis of solar thermal collectors; however it makes many assumptions and as a result is not applicable to all designs of solar collector (Duffie, Beckman and Worek, 1991). Despite the exponential growth of the solar industry over the last decade, there are still many barriers to the implementation of solar technology. Addressing these and becoming independent of financial support will require the design of non-standard solar collectors. This study investigates the validity of using the HWB equation to design and assess the performance of non-standard solar collectors.

The barriers that exist to solar technology are cost, poor efficiency and intermittent supply. It is envisioned that the future of the solar industry will depend on multi-functional, photovoltaic thermal (PVT) panels that will maximise efficiency through the production of both electricity and thermal energy. It has been shown that these hybrid devices are able to produce more energy per m<sup>2</sup> than conventional technologies installed side by side (Zondag *et al.*, 2005).

There are currently a number of commercially available PVT technologies that closely resemble standard solar collectors. The success of this technology in the future will therefore depend on how well it can adjust to the solar industries trend of moving towards building integration; innovation in design is required if these technologies are to have an impact on the solar energy landscape. As a result the need for models to develop and design such systems is of utmost important.

**Approach:** A study of 1D, 2D and 3D models has shown that, in the interest of time, the empirical HWB equations are adequate for the performance assessment of standard solar collectors (Zondag *et al.*, 2002); and as a result these models are of use in programs such as TRNSYS that can simulate the performance of a PVT system under any given climate. However these empirical models are based on standard header-riser collectors, with parallel tubes running the length of the absorber. In these models a number of assumptions such as zero heat transfer between the pipes are made. As we are extending collector design into applications such as building integration, non-standard collector designs may be required to improve heat transfer in the interest of available space. In a recent project, a non-standard design of solar collector with a spiral arrangement of the pipes was manufactured (Couch *et al.*, 2012). This was identified as being one of the most promising arrangements for a solar collector (Ibrahim *et al.*, 2009); however these predictions were based on the HWB model and therefore their reliability needs to be investigated.

In addition to the novel PVT collector design, an experimental facility has been constructed (Couch *et al.*, 2012) and will be used to validate the numerical modelling. Modified HWB equations (Florschuetz, 1979) will be used as standard, but the findings will be compared to the results from experiments and computational fluid dynamic (CFD) modelling. This will be used to determine the influencing factors, such as internal heat transfer coefficient that are not currently addressed in the HWB models.

**Findings :** The heat removal factor ( $F_R$ ) derived from the experimental results was found to be 0.88 with an overall heat loss coefficient ( $U_L$ ) of  $9.28\text{W/m}^2\text{K}$ . Inputting the experimental value of  $U_L$  into the numerical HWB, the new  $F_R$  for the collector is calculated at 0.92. This suggests that there may be a disagreement between the experimental findings and the collector efficiency factor ( $F'$ ). If this is the case then the HWB model is unsuitable for the collector design under investigation.

**Discussion:** To determine the level of agreement between the experimental and numerical findings we need to understand the experimental limitations. It is not yet possible to control the environmental conditions as required by EN 12975-2; however once these are fully established it will be possible to derive conclusions about the validity of the HWB at assessing non-standard solar collectors. Difficulties associated with modelling irradiation have slowed down progress on the CFD analysis.

**Future Work:** The focus is on enhancing the reliability of the experimental investigation. The experimental element needs to be compliant with the standards as set out by EN12975-2 before we can draw any well founded conclusions. The development of CFD models will occur in the short term and this will enable parametric investigation of new designs of building integrated PVT collector.

## References

- Couch, W., Cook, N., Borton, J. and Mustapha, R. (2012) Development of an optimised solar hybrid PV-T technology for the simultaneous production of electricity and thermal energy, Brunel University, London.
- Duffie, J.A., Beckman, W.A. and Worek, W. (1991) Solar engineering of thermal processes, Wiley New York.
- Florschuetz, L. (1979) "Extension of the Hottel-Whillier model to the analysis of combined photovoltaic/thermal flat plate collectors", Solar Energy, vol. 22, no. 4, pp. 361-366.
- Hottel, H. and Whillier, A. (1955) "Evaluation of flat-plate solar collector performance", Trans. Conf. Use of Solar Energy
- Ibrahim, A., Othman, M., Ruslan, M., Alghoul, M., Yahya, M., Zaharim, A. and Sopian, K. (2009) "Performance of photovoltaic thermal collector (PVT) with different absorbers design", WSEAS Transactions on Environment and Development, vol. 5, no. 3, pp. 321-330.
- Zondag, H.A., De Vries, D.W., Van Helden, W.G.J., Van Zolingen, R.J.C. and Van Steenhoven, A.A. (2002) "The thermal and electrical yield of a PV-thermal collector", Solar Energy, vol. 72, no. 2, pp. 113-128.

## Mixing and Cooling of Exhaust with Dilution gas for Measurement of Particulates arising from Engines and Flames

*Nehemiah S. I. Aliozie, Lionel Ganippa*

*Centre for Advanced Power Train and Fuels Research*

**Keywords:** Engines, Particulates, Cooling and Dilution effects

### Introduction

Particulate emission from internal combustion engines and flames is now a focused area of research due to associated health effects. By 'Particulates' we mean all particles suspended in the exhaust gas stream (aerosol), which include soot, ash, condensates of water vapor, acids and unburnt hydrocarbon.

With reference to Diesel Engines, trend events in terms of formation, composition and location are phenomenal [1]. These trigger lots of complications in the study of particulate properties like the nature, types, size, shape, transport, transformation and deposition in the course of evolving within the engine, within the exhaust and ultimately to the atmosphere. Irrespective of the researcher's focus, the approach to aerosol sampling prior to measurement has become an established criteria for evaluating the validity of results obtained [2]. The stability (or otherwise) of particulates in a dilution tunnel are primarily influenced by - the temperature, which dictates the state of volatile fractions as they nucleate homogeneously; the dilution ratio, which is also linked to temperature, determines how the partial pressures of the volatile fractions are reached at the sampling point; the relative humidity; and the residence time, which indicates time spent by particle in the measurement path [3].

Given the interplay between these factors, a curious effort is being made to investigate the effect of cooling and mixing of aerosol prior to particle size measurement. The aim is to offer a vista for better understanding of the complex transformations of particulates within the exhaust pipe and the atmosphere as the exhaust gas mixes and cools with air. This will offer automotive engine designers further insights on better strategies to abate particulate emissions.

### Design/Methodology/Approach

The Electrical Mobility spectrometer (EMS VIE 11) is used to measure particulate sizes [4]. It consists of a Flow Control Unit (FCU) which conditions the dilution gas, the Differential Mobility Analyzer (DMA) which separates charged aerosol particle sizes according to their electrical mobility and the Faraday Cup Electrometer (FCE) which counts the particles of classified size range.

Preliminary investigations to check the effect of dilution ratio and temperature were done for low and high engine loads using variable injection timings. Exhaust gas from a four cylinder, high speed direct injection (HSDI) Ford's Duratorq (Puma) diesel engine burning ultra low sulphur diesel (ULSD) fuel was used. Nitrogen at 300 °C was used as dilution gas.

The aim is to check repeatability of results from the EMS VIE 11 by using similar conditions of an earlier researcher [5] and also to compare with other similar measurement devices [2].

### **Findings/Results**

Results obtained consistently showed high concentration of nucleation mode particles in all engine operating conditions and dilution ratios. Although having consistent trend in the accumulation mode, deviations in the trend of nucleation mode particles when compared to other results, gave much concern. This led to various investigations and checks on the device. It was finally observed that there was damage on the DMA screen which affected the central electrode due to humidity effect. The DMA was sent to the manufacturers for repairs and re-calibration.

### **Discussion**

The preliminary results have shown the confusion that could emanate from uncontrolled mixing due to temperature and humidity effects. From the opening on the screen, the aerosol sample was further diluted and cooled beyond that which was experimentally measured. This gave rise to nucleation of water vapour particles thereby increasing the nucleation mode values. This has indirectly strengthened the objective of our experimental design.

This development has led to modification of our approach to aerosol dilution in on-going experiments: (i) EMS dilution control is being mimicked by use of a flow meter and the dilution gas (nitrogen) is heated on-line prior to mixing. (ii) A diffusion dryer is incorporated on the line to remove aerosol humidity before the DMA. (iii) Volatile organic fractions are tactically removed by use of a hydrocarbon stripper in order to get a clearer picture of real soot particle sizes.

### **References:**

1. Peter Eastwood; ‘Particulate Emissions from Vehicles’ Wiley-Professional Engineering Publishing Series. John Wiley and Sons Ltd, England. 2008
2. David B Kittelson, Megan Arnold and Winthrop F Watts Jr.; ‘Review of Diesel particulate Matter Sampling Methods’ University of Minnesota, CDR, MN. 1999
3. Markus Kasper; ‘The Number Concentration of Non-Volatile Particles’. SAE 2004-01-0960.
4. Operating Instructions; ‘Electrical Mobility Spectrometer [EMS VIE- 11]’ Tapcon and Analysesysteme gmbh. 2008 .Rev.23
5. Lukasz Labecki; ‘Combustion and Emission characteristics of biodiesels in diesel engine’ PhD Thesis, SEED, Brunel University London. September 2010.

## Build up a new simulation platform for SI Engine

*Yang Bai, Jie Chen*

**Keywords:** Model Based Control, Engine Control

### Introduction

At present the engine control development a lot of kinds of models, for engine dynamic modeling commonly use based on Time-based Mean value Engine Model (MVEM) and Event-based Cylinder-by-Cylinder Engine Model (CCEM). MVEM has neglected in each operating cycle when the different crankshaft Angle various cylinders difference, to average various cylinders status difference, the key point is simulate the engine dynamic characteristic. CCEM is consider the crankshaft Angle timing to take into independent variable, considered the difference various cylinders in each operating cycle process, cylinder control is based on the engine crankshaft Angle.

### Design/Methodology/Approach

The approach of this project starts from numerical analysis. Mass flow rate throttle body, the model is suitable for the majority spark ignition engine, this model has been confirmation by the reality machine that possible to use in the engine control system development, simulation and control.

The mass air flow rate through the throttle including the discharge coefficient can be written as below.

$$\dot{m}_{at} = \begin{cases} C_d A(\theta) \frac{\rho_0}{\sqrt{RT_0}} \left( \frac{\rho}{\rho_0} \right)^{\frac{1}{k}} \left\{ \frac{2k}{k-1} \left[ 1 - \left( \frac{\rho}{\rho_0} \right) \right]^{\frac{k-1}{k}} \right\}^{\frac{1}{2}} & \frac{\rho}{\rho_0} > \left( \frac{2}{k+1} \right)^{\frac{k}{k-1}} \\ C_d A(\theta) \frac{\rho_0}{\sqrt{RT_0}} k^{\frac{1}{2}} \left( \frac{2}{k+1} \right)^{\frac{k}{2(k-1)}} & \frac{\rho}{\rho_0} \leq \left( \frac{2}{k+1} \right)^{\frac{k}{k-1}} \end{cases}$$

The simulation of SI engine system modeling is based on engine dynamic formula. The simulation of engine dynamic system has four main parts; firstly the input model system will be introduced. Second, engine model will be introduced. The third section is to explain the engine controller simulation model. The output simulation model will be explained at next chapter,

The input model is considered: Throttle angle; Spark Timing; Load torque. The engine model has five parts: Throttle body model; intake manifold dynamic model; fuel film dynamic model; engine rotational dynamic model and torque production model. Engine controller model will be joined up by more then four parts: idle speed control; AFR control; EGR control; turbine control, etc.

## **Findings/Results**

The output of Engine System Simulation variables are Air-Port Flow Rate, Fuel-Cylinder Flow Rate, Torque, Lambda, Air-throttle Flow Rate, Manifold Pressure, Air-Fuel Ratio, Injection Time, Throttle Open Angle, etc.

## **Conclusion / Discussion**

This project has proven that the simulation of engine system can be modified to a smaller scale, which can still produce high quality.

## **Future plans / directions**

Engine model uses gasoline engine; it can be further improved by diesel engine and hybrid engine.

Engine controller model only with AFR control, it will be improved in the future.

Design a new graphical user interface for the system to improve the operation to be more friendly.

## **References**

Heywood, J. B (1989) Internal Combustion Engine Fundamentals. McGraw-Hill International editions.

Bosch (2011) Automotive Handbook, 8th Edition. Robert Bosch Gmbh, Stuttgart.

## The impact of the High Prevalence of Expatriate Doctors in the Saudi Arabia Healthcare System on Patient Safety culture

*Faisal Basahl, Susan Grant*

**Introduction:** Purpose, scope and aim of the research, including its originality. Saudi Arabia is the largest country in the Arab world with one of the largest economy due to its huge oil deposits. It is also the cradle of Islam where all the nationals are conservative Muslims. Politically, the country is a constitutional monarchy and most political decisions are through decrees issued by the king. Before oil was discovered a few decades ago, the country had some of the poorest infrastructures in the world. There was widespread lack of adequate social amenities like schools and hospitals leading to only few citizens getting the benefit of decent education and health care. The highly conservative social-religious paternalistic culture of the citizens prevented many people, especially women, from pursuing good education. However, after the discovery of oil, revenues accruing from trade in this important global commodity led to an exponential population growth due to increasing household wealth levels and improved health care. The low levels of well-trained local health professionals led to an increased demand for foreign health workers to satisfy the demand increasing demand . For this reason, the health sector in Saudi Arabia is currently composed of nearly 83 percent of foreign skilled workers.

Thesis statement: This aim of this research is to investigate the patient safety culture in Saudi Arabia hospitals. This includes the effect of expatriate work force towards attaining this safety and ways through which it can be improved.

**Design/Methodology/Approach:** The methodology applied involved the development of a gap analysis that will help in creating the research question. This helped in defining the problem levels against the expected standards. Having done this, a survey questionnaire was prepared and a pilot test instrument developed. The information gathered during the pilot testing was used to finalize the survey questionnaire and the final survey conducted. This was followed by data analysis and a compilation of the research results and conclusions. Among the resources used is the available literature on the matter. This helped in offering an in-depth knowledge on the subject matter and formed part of the secondary research. The literature was instrumental in developing the questionnaire and during the formulation of the survey process. Among the essential resources utilized included the personnel involved in the research question formulation, data collection and analysis, physical attributes like vehicles, computers, printers, stationary, phones and an office. The research involved both qualitative and quantitative aspects. A literature review helped substantially help in understanding the situation better while the quantitative research was aimed at helping to develop the primary knowledge on the issue.

**Findings/ results:** The Saudi Arabian hospitals have a large expatriate work force from different countries in the world that include India, Philippines, Canada, Britain and the United States of America. Their diverse cultural backgrounds differ significantly from those of Saudi Arabian nationals. This has a big effect on the safety of patients in the hospitals due to differences in language, religion, culture and perceptions. Language barriers highly limit the level and quality of communication between the professionals and their patients or among the professionals. Patient safety is largely determined by effective communication that enhances flow of information and understanding. When this is not effective in a hospital setting, patient safety may get compromised (Motacki *et al*, 2011).

The diverse cultural backgrounds from where the professionals come are often in conflict with the Saudi Arabian cultural-religious beliefs. This is because Saudi is a extremely conservative country with many social limitations including a law that prohibits unrelated men and women from mixing. This becomes a serious problem to expatriate hospital professionals who may be limited in the extents they should go in assisting their patients (Wachter, 2008). For example, a male doctor may find it difficult to undertake certain medical examinations to female patients and vice versa. This complicates the ability to achieve patient safety in the hospitals effectively.

On the other hand, effecting patient safety in hospitals is a process that gets perfected with time. However, most expatriates working in Saudi Arabia are there for a limited duration of time. This means that the hospitals have a high turnover of professionals, and, this affects perfection of these standards. Permanent staff would be more likely to help achieve these standards than the contract expatriates. In order to effect patient safety standards more successfully, the hospitals need to have enough financial resources to undertake training and implementation. However, with a highly increasing population in the country, the government's budgetary allocations are not adequate to run all the required programs satisfactorily (Bayers, 2004). This has in turn affected provision of patient safety standards in the hospitals.

**Findings, discussion and conclusion:** Provision of adequate health care is a fundamental human right in many countries including Saudi Arabia. However, it is a costly undertaking that requires enormous financial and human resources. The Saudi Arabian government needs to allocate enough money to training and implementation of the right patient safety standards (Schwendimann, 2006). Training will help in developing the right pool of local professionals who can be relied on to promote the achievement of the standards more effectively in comparison with foreigners. To realize faster implementation of the standards, the conservative cultural attitudes of the locals in medical care matters need to change. More nationals should be encouraged to train as health workers to help reduce over-reliance on expatriate labor. There should also be a more adoptive approach towards the implementation of the standards involving all the stakeholders.

The results are indicative of the sorry state of patient safety in most hospitals. The findings offer a chance for a second research that should now focus on investigating the best approach in filling the gaps established in this research. This should form the second phase of the research. It should explore such topics as why the locals are indifferent towards taking hospital jobs. Certain social policy exemptions should be encouraged on health matters to promote patient safety (Newhouse, 2005) . It is not clear if apathy towards the medical profession by Saudi nationals is due to religious-cultural reasons. This needs to be probed further.

The above can be completed within the next three years. However, this will require availability of all the requisite resources and time necessary. A good research is time consuming and finance-draining while acquiring the relevant material takes time.

## **References:**

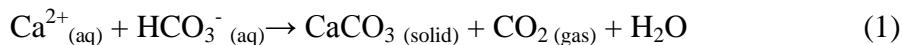
- Byers, J. F., & White, S. V. (2004). *Patient safety: principles and practice*. New York, NY: Springer.
- Motacki, K., & Burke, K. (2011). *Nursing delegation and management of patient care*. St. Louis, Mo.: Mosby/Elsevier.
- Newhouse, R. P., & Poe, S. (2005). *Measuring patient safety*. Sudbury, Mass.: Jones and Bartlett Publishers.
- Schwendimann, R. (2006). *Patient falls: a key issue in patient safety in hospitals*. S.l.: [s.n.]
- Wachter, R. M. (2008). *Understanding patient safety*. New York: McGraw-Hill Medical.

## Removal of Cristal fouling from metallic surfaces using ultrasonic vibration

*Ignacio Garcia de Carellan , Ray Kirby*

**Keywords:** Ultrasounds, Cavitation, Fouling, Pipe Lines, Calcite

**Introduction:** Fouling deposits in metallic surfaces are difficult to avoid, and pose a significant problem to chemical plants, ship hulls, heat-transfer, solar panels among other examples. Scaling or precipitation fouling involves the crystallization of solid salts from solution and the most important is the equilibrium between the readily soluble calcium bicarbonate (always existing in natural water) and the poorly soluble calcium carbonate [1]:



A multitude of cleaning methods exists, reflecting the wide variety of fouling scenarios. Some of these techniques are reliable and extend the equipments life, but most of them require the production/utilization to be stopped and present environmental problems due to the waste products generated [2]. Thus it is necessary to develop a novel technology which addresses all of these problems at the same time. Long range ultrasonic cleaning promises to answer some of these issues [3,4]. At the moment these long range ultrasounds are used for large structures inspection [5] but maybe could be used for cleaning, this document explains a method that will break down bonds between deposits and the metallic surface with ultrasonic waves, what would reduce the time and energy required in existing techniques, or at best present itself as a new cleaning method in its own right.

**Design/Methodology/Approach:** The first approach to the problem has been to clean the metallic surface of a carbon stainless steel covered with a Calcite fouling. The fouling has to be Calcite because other polymorphs of the Calcium Carbonate do not produce a scale, just a precipitation. It has been done both with a heating deposition and electrochemical reaction which lead to the reaction (1).

Once the fouling has been created, a high power transducer has been glued and clamped to the plate, where an impedance analysis and a vibration study have been done in order to find the best frequencies to apply. The highest displacements of the plate match with the minimums in the impedance analysis.

The vibration analysis has been done with a laser vibrometer based on the Doppler effect, and the impedance analysis has been done with impedance analyzer.

Using the results from both experiments, the frequency with the highest displacement was applied with the high power transducer. The experiments have been done in wet and in dry conditions for a different periods from 5 to 60 minutes.

It is known that a compressional wave traveling through a liquid generates small bubbles called cavitations which can implode on the surface of the fouling generating temperatures of 5000 C and pressures of 300 atm. This phenomena can be used for the cleaning propose.

**Findings/Results:** The results of both the impedance analysis and the vibration has been compared visually with graphs and has been demonstrate that the impedance analysis gives the information necessary to apply the best frequencies to each situation.

The fouling was removed from the plates when the frequency from the first minimum in the impedance was applied in wet conditions. The cleaning process starts from the very beginning of the ultrasound vibration and works only in the areas with high displacement which are also the areas with the highest velocities and accelerations.

This cleaning process occurs because the cavitations phenomena, and it has been produced on the surface of the plate. In this case the wave travels along the metallic sample and is transfer trough the water far away of the vibration source what is the different with the conventional ultrasonic cleaning.

**Conclusion / Discussion:** It is possible to remove Calcite fouling from a metallic surface far away from the vibration source in wet conditions.

The impedance and vibrometer analysis can be used to know the best frequencies to apply in the samples and will be used in further experiments to calculate the minimum displacement, velocity, acceleration that will produce the cavitations to remove the fouling. Once know this, that information will transfer to the long range ultrasonic propagation for cleaning large structures such as pipe lines, ship hulls, solar panels, etcetera.

**Future plans / directions:** It looks like it can be done in the three years with the knowledge found this year, but the studes has to focus in a specific area.

The goal to be presented is to find the link between the amplitude of the oscillation and the removal of the fouling. Once know this relation, it will be possible to transfer the idea to the long range ultrasonic propagation and try to clean large surfaces.

**References:** [1] - Dalas, E. & G. Koutsoukos 1989. Calcium carbonate scale formation on heat metal surfaces. *Geothermic*, Vol. 18, No. 1/2, (1989) pp. 83-88.

[2] -De Carellan, I.G., Catton, P., Selcuk, C., Gan, T.-H. 2012. Methods for detection and cleaning of fouling in pipelines. *Emerging Technologies in Non-Destructive Testing*. Ioannina, Greece. pp. 231-236.

[3] -Noritoshi, N., Masaya, F., Chaoqun, W.U., Jun, S. 2006. Removal of fouling inside pipes using ultrasonic waves. *JSME International Journal* C49: 713-718.

[4] -Benzinger, W., Schygulla, U., Jäger, M. & Chubert K. 2005. Antifouling investigation with ultrasound in microstructure heat exchanger. *Engineering Conferences International*, Kloster Isee, Germany, June 5-10, 2005.

[5] -Lohr, K.R & Rose, J.L. 2003. Ultraosnic Guided Wave and Acoustic Impact Methods for Pipe Fouling detection. *Journal-of-Food-Engineering* 56(4): 315-324.

## Combustion With Simultaneous Hydrogen And Nitrogen Enrichment

*Fanos Christodoulou, Thanos Megaritis*

**Keywords:** Hydrogen, Nitrogen, Diesel, Internal Combustion Engines

### Introduction

The current research is aiming in the reduction of exhaust emissions from diesel engines with much effort being put to mediate the tradeoff between nitrogen oxides (NOx) and particulate matters (PM). The project will also provide guidelines for the development of an integrated engine-reformer system that will deliver the required H<sub>2</sub>/N<sub>2</sub> gas mixtures. Part-substitution of diesel with hydrogen has been proven to reduce PM, CO and THC since hydrogen produces no carbon or soot emissions when burnt, in the expense of NOx increase. Enrichment of intake air charge with nitrogen lowers down NOx but favours PM, CO and THC emissions. Although the effect of separate hydrogen and nitrogen, dilution gas, addition has been investigated extensively there are no published papers examining the effect of simultaneous hydrogen and nitrogen addition.

### Design/Methodology/Approach

The experiments are performed on a prototype 2.0 liters Ford HSDI diesel engine. The engine is equipped with a high pressure common rail injection system, a variable geometry turbine, EGR valve and pressure sensor. Two exhaust sample lines fitted after the exhaust manifold direct the exhaust gas to the analyzers, Horiba MEXA 7170 and MultiGas 2030 FTIR Continuous Gas Analyzer. The Horiba analyzer measures NOx, total unburnt hydrocarbons (THC), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>) (McWilliam, 2008). It also calculates EGR percentage, lambda and air/fuel ratio. Apart from the regulated emissions given by Horiba, FTIR can measure, among other emissions, urea, ammonia, formaldehyde and ethane. Hydrogen burning percentage is measured by Gas Chromatography with TCD detector. After calibrating the machines described above, a separate investigation on the effects of hydrogen-diesel blend and nitrogen enriched air-diesel on emissions and fuel efficiency has been performed.

### Findings/Results

The results obtained so far reinforce current knowledge. The findings follow the same trends as those obtained by other researchers, the results of whom are discussed in this paragraph. Hydrogen induction in a diesel engine increases NOx emissions but decreases CO emissions (McWilliam, et al., 2008; SinghYadav, et al., 2012). (Nemser , et al., 2003) claimed 50% NOx emission reductions by supplying nitrogen enriched air on a number of commercial engine platforms. NOx reductions were also reported by inducting membrane-based nitrogen enriched air in a diesel engine (Poola, et al., 2000). Diluent gas induction reduces NOx emissions at the expense of BSN (Tsolakis, et al., 2004; Ladommatos, et al., 1996).

Apart from the findings, the research period helped to gain knowledge and advanced skills that subsequently will be used to extent current knowledge by simultaneously inducting

hydrogen and nitrogen in the engine. All the data and calculations are performed using an integrated software platform built in house.

### **Conclusion / Discussion**

An experimental investigation was carried out to study the effects of diesel-hydrogen blend and nitrogen enriched air-diesel on emissions and fuel efficiency. As the percentage of hydrogen increased, NOx increased with simultaneous decrease of PM and CO emissions. THC emissions decreased at low load independent of engine speed. At high load-high speed THC showed minor changes towards higher values compared to those emitted without hydrogen addition. At high load-low speeds the general trend is that hydrogen did not cause any significant changes in THC emissions. Finally, engine efficiency increased by increasing hydrogen.

Dilution of the cylinder charge with nitrogen decreased NOx emissions at the expense of PM and CO. Depending on the percentage of nitrogen inducted in the engine THC vary, however, only minor changes observed. The addition of nitrogen did not incur any fuel penalties. From the results presented above the competing effects on emissions when adding one or the other gas are obvious. The results so far give an obvious direction for the next step, which is simultaneous hydrogen and nitrogen addition.

### **Future plans / directions**

A considerable amount of the work required to obtain the PhD degree has been completed and the researcher is very optimistic that the PhD will be completed in time. A couple of papers will be published, which will be possibly a good addition to the existing knowledge. Further, experiments inducting simultaneously hydrogen and nitrogen in the engine will be performed.

### **References**

- Ladommatos, N., Abdelhalim, S. M., Zhao, H. & Hu, Z., 1996. *Part 1: Effect of Reducing Inlet Charge Oxygen*. Michigan, SAE International.
- McWilliam, L., 2008. London, Brunel University.
- McWilliam, L., Megaritis, T. & Zhao, H., 2008. Shanghai, SAE International.
- Nemser , S., Stookey, D. & Nelson, J., 2003. Ann Arbor, American Filtration and Separation Society.
- Poola, R. B. et al., 2000. *Membrane-Based Nitrogen-Enriched Air for NOx Reduction in Light-Duty Diesel Engines*. Michigan, SAE International.
- SinghYadav, V., Soni, S. L. & Sharma, D., 2012. *Performance and Emissions Studies of Direct Injection C.I. Engine in dual fuel mode (hydrogen-diesel) with EGR*. International Journal of Hydrogen Energy, 37(4), pp. 3807-3817.
- Tsolakis, A., Megaritis, T. & Wyszynski, M. L., 2004. *Low Temperature Exhaust Gas Fuel Reforming of Diesel Fuel*. Fuel, Volume 83, pp. 1837-1845.

## Simulating the Road Profile in six degree of freedom by the Stewart Platform

*Keyvan Dayyani, Ibrahim Esat*

**Keywords:** suspension system, active control, actuator

### Introduction

Now a day due to huge commercial demand for comfortable and quite cars, reducing and cancelling the unwanted vibration become very important, one of the reasons of vibration is unbalancing.

Controlling vibration in suspension systems is very important for reducing energy wasting and noise in vehicles. Several ways have been developed to control the vibration. For isolating engines and suspension rubbers and hydro mount are very common to use in the cars.

### Design/Methodology/Approach

Vibration controls are divided in 2 different methods, passive and active controls. In a passive system, controlling is based on off-line design techniques and no feedback controlling is used. In recent years active control systems have been of popular interest. For using active controlling, input data should be modified and sent back to the system.

In this experiment an active control applied to the quarter car suspension system.

Quarter car suspension is includes: spring, damper and wheel of a specific car, which is fixed to a Stewart platform, (6 pneumatic actuators are connected to the platform for moving the suspension up and down).

These are all controlling by Compact Rio. For controlling the suspension there are several methods like PID controller PI and....

In this experiment PID controller was found as a best choice. While the platform is running accelerometers are giving a voltage signal, and the signal will go to Compact Rio. By modifying that signal and send it back to the 7<sup>th</sup> actuator, that actuator will start working and it will shake in opposite way of the platform, the force that it can produce will reduce the vibration.

### Findings/Results

This experiment has been done with different loads on top of the suspension, and different PID controller parameters, the results were different in different frequency. By assembling the 7th actuator in different places different results were found.

### Conclusion / Discussion

In this experiment reducing the vibration is strongly based on the place of the shaker and different resonance frequency has different direction they maybe angular or vertical .so the shaker should be in an optimum point or several shakers may needed. Adding shakers have some limitation like the size and the power of them.

### **Future plans / directions**

This project is on track within the three years' time and hopefully will finish by the next academic year.

### **References**

- [1] W H Liao<sup>1</sup> and C Y Lai (2002) Harmonic analysis of a magnetorheological damper for vibration control
- [2] Ferdinand Svaricek<sup>1</sup>, Tobias Fueger<sup>1</sup>, Hans-Juergen Karkosch<sup>2</sup>, Peter Marienfeld<sup>2</sup> and Christian Bohn<sup>3</sup> (2004) Automotive Applications of Active Vibration Control

## Defect Sizing Using Higher Order Guided Ultrasonic Wavemodes in Pipelines

*Matthew Deere, Luiz Wrobel*

*Brunel University & TWI Ltd*

**Keywords:** Ultrasonic guided waves, Pipeline, Defect sizing, Torsional wavemodes

**Introductions:** Long range ultrasonic testing (LRUT) is a relatively new development within in the non-destructive testing sector and uses fundamental ultrasonic guided waves to identify defects in pipelines. Guided waves are governed by their boundary conditions and in this case the pipe acts as the waveguide that can deliver ultrasonic screening tens of metres away from one location [1]. Currently, commercial equipment used in the field operates at low frequencies with the capability of locating and identifying the cross-sectional area of a defect [2-6]. The concern with this type of analysis is that there is no clear indication of the severity of a defect. For example, if two defects had the same cross-sectional area but one has penetrated more through the thickness of the pipe wall this is considered to be the most serious case because the pipe is more likely to rupture in this condition. Therefore, the ability to size a defect with respect to depth of penetration would provide clear benefits to the oil and gas industry. This paper shows developments in a technique to identify the depth of defects in pipeline walls using higher frequencies. Operating at higher frequencies in comparison to the current frequency range used may improve defect sensitivity in signal responses, but can introduce higher order wavemodes adding complexity to signal responses [7]. The purpose of this research is to separate the multimode signal responses and investigate each wavemode with respect to in depth defect size.

**Design/Methodology/Approach:** In order to develop a technique for in depth defect sizing in pipes the characteristics of the fundamental and higher order wavemodes that exist were researched. This led the study towards the fundamental and higher order torsional wavemodes due to their unique through thickness displacement patterns [8]. To analyse the torsional wavemodes a pipe of 168.3mm diameter and 7.11mm wall thickness was used for this case study. Finite Element Analysis was used to model the pipe and design the experimental conditions based on the current commercially available system. This included 24 excitation points around the circumference of the pipe which is currently used to inspect a pipe of these dimensions. To validate the model an initial analysis was conducted at a frequency where the fundamental torsional wavemode was predominant to prove the input conditions were producing the correct results. Expected arrival times of pulses were calculated and compared to the signals generated from the model. The next step is to model the pipe at higher frequencies to introduce each higher order wavemode in stages. The choice of frequency depends on dispersion which is when a wavemode's velocity depends on frequency. A highly dispersive signal occurs when a wavemode's velocity is highly dependent on frequency which causes signal spreading and an undesired signal response. Therefore it is important to choose a centre frequency that has

minimal dispersion in an area where velocity is less susceptible to frequency change because each wavemode's pulse contains a frequency bandwidth. Once results have been gathered at chosen frequencies a technique will be used to separate the first and second order torsional wavemodes.

**Findings/Results:** The results showed that operating at high frequencies (above 165kHz) and using the initial conditions of 24 excitation points produced unexpected responses. This led to analysing the dispersion curves which showed that it is possible for unwanted flexural wavemodes (non-axisymmetric modes) to be excited under these conditions. A trend on the dispersion curve was used to estimate the number of excitation points needed at certain frequencies in order to eliminate the unwanted flexural wavemodes. Therefore, by increasing the number of excitation points around the circumference suppressed the flexural wavemodes providing strong responses for the first and second order torsional wavemodes. The initial experiment was conducted at 200kHz where the second order torsional wavemode is highly dispersive, which provided a combined signal response with the first order wavemode. Applying a technique for separating the torsional wavemodes based on their displacement patterns provided a response for each individual wavemode. The results showed a clear signal for the non-dispersive first order wavemode once the dispersive second order wavemode was removed.

**Conclusions/Discussions:** Initial testing showed that the first and second order torsional wavemodes can be clearly separated using the technique based on their displacement patterns for non-defective pipes. The technique must be developed to analyse each wavemode with respect to defect size because these signals will respond with added complexity from combined wavemodes and possible wavemode conversion.

### Future plans/directions

1. Separate each wavemode with clear pulses on non-defective pipes
2. Separate each wavemode and analyse their responses on defective pipes
3. Develop a technique for identifying in depth defect sizes based on each wavemode
4. Validate modelling results experimentally

### References:

- [1] Rose, J.L., 1999. Ultrasonic waves in solid media, Cambridge University Press. Available at: <http://books.google.co.uk/books?id=pTB1QgAACAAJ>.
- [2] Lowe MJS, Alleyne DN, Cawley P. Defect detection in pipes using guided waves. Ultrasonics 1998;36:147-54.
- [3] Luo W, Rose JL, Kwun H. Circumferential shear horizontal wave axial-crack sizing in pipes. Res. Nondestr. Eval. 2005;15:149-71.
- [4] Catton P. Long Range Ultrasonic Guided Waves for the Quantitive Inspection of Pipelines. EngD, Brunel University, 2009.
- [5] Teletest LRUT Operator Level 1 Training Manual Notes, Plant Integrity, 2007.
- [6] Liu Z, He C, Wu B, Wang X, Yang S. Circumferential and longitudinal defect detection using  $T(0,1)$  mode excited by thickness shear mode piezoelectric elements. Ultrasonics 2006;44:e1135-8.
- [7] Rose J. A baseline and vision of ultrasonic guided wave inspection potential. Journal of pressure vessel Technology, 124(3): 273-282, 2002.
- [8] Pavalakovic B, Lowe MJS, Alleyne D, Crawley P. Disperse: A program for creating dispersion curves and wavemode characteristics.

## The Effect of Next Generation Lubricants and Fuels on Combustion in Future Spark Ignition Engines

*Simon Dingle, Alasdair Cairns*

*Centre for Advanced Powertrains and Fuels Research (CAPF)*

**Keywords:** Lubricants, Fuels, Shadowgraph, Abnormal Combustion, Downsized, Super-knock

### Introduction

The global increase in oil prices and a growing concern over the environmental impact of rising Carbon Dioxide emissions are leading automotive engine manufacturers to aim for ever lower fuel consumption. Demand from both consumers and government legislation has been growing steadily over the last two decades and downsized engines are widely seen as the next step in improving efficiency and subsequently reducing fuel consumption and Carbon Dioxide emissions in spark ignition engines. However, with in-cylinder pressures and temperatures increasing, pre-ignition and knock are becoming ever greater obstacles to engine efficiency.

The purpose of the research is to establish how lubricants interacting with the fuel-air mixture in future spark ignition engines affect combustion. Particular focus will be placed upon the link between lubricants and abnormal combustion; especially pre-ignition and knock.

Previous authors <sup>[1,2,3]</sup> have proposed links between lubricants and abnormal combustion in gasoline, however as yet previous work has been limited to thermodynamic analysis only. Equally many of the parameters investigated were secondary parameters that have many effects other than the ingress of lubricants into the combustion chamber. These limitations make it difficult to conclude cause and effect between lubricants and the abnormal combustion observed. Therefore, this research will provide optical data in addition to thermodynamic data to better establish the link between lubricants, their chemical composition and the different forms of abnormal combustion.

While there has been much research into next generation fuels and their impact on performance (including combustion quality <sup>[4,5]</sup>) and emissions in both current and proposed spark ignition engine designs, there has been no published research into their interaction with lubricants in terms of combustion quality. This research will attempt to analyse the effect of both gasoline and gasoline/ethanol blends on lubricant induced abnormal combustion.

### Methodology

A specifically designed engine has been used to investigate the influence of lubricant and fuel composition on combustion. This engine incorporates full-bore optical access through the use of an over-head mounted window, while retaining a traditional 4-valve valvetrain arrangement. The engine is based on, and retains the bottom-end from, a Lister-Petter TS1 stationary diesel generator. The top-end has been replaced with a new cylinder head to convert to spark ignition and include all necessary features for the research, including direct injection, port-fuel injection, in-cylinder pressure measuring, oil-droplet delivery, inlet air heating and boosting and water-

cooling. A suite of camshafts and adjustable cam-phasing allows for a variety of cam-timings to be tested and the engine is capable of running at real-world speeds (up to 2000rpm).

Combustion imaging is achieved through the shadowgraph technique, where changes in charge density cause a change in the refractive index of the imaged light, resulting in a monochromatic image of the high-density flame-front. Uniform light is provided by a 40mW 635nm Copper-Neon LASER. Images are taken at up to 10,000 frames per second (approximately one frame per crank angle at maximum engine speed) in order to record individual combustion events.

## **Results**

As yet, results are limited to engine characterisation. A variety of stable engine running conditions have been found including 2.62bar BMEP at 1500rpm,  $0.87\lambda$ ,  $1\lambda$  and  $1.13\lambda$  (COV 4.2%, 2.5% and 5.2% respectively). Additionally, initial natural light images have been recorded at 700rpm, 3bar BMEP,  $0.91\lambda$ , 5000fps.

## **Future Plans**

It is expected that the majority of the data will be collected by September 2012 and that analysis of this data will be completed by the end of 2012. The expected submission date of the thesis is September 2013.

## **References**

1. Dahnz, C. et al., 2010. *Investigations on Pre-Ignition in Highly Supercharged SI Engines*. Warrendale, PA: SAE
2. Attard, W. P. et al., 2010. *Abnormal Combustion including Mega Knock in a 60% Downsized Highly Turbocharged PFI Engine*. Warrendale, PA: SAE
3. Zahdeh, A. et al., 2011. *Fundamental Approach to Investigate Pre-Ignition in Boosted SI Engines*. Warrendale, PA: SAE
4. Hamilton, L. J., Rosetedt, M. G., Caton, P. A. and Cowart, J. S., 2008. *Pre-Ignition Characteristics of Ethanol and E85 in a Spark Ignition Engine*. Warrendale, PA: SAE
5. Bradley, D., *Combustion and the Design of Future Engine Fuels*. London, UK: IMechE

# Numerical Study of a Integrated Gasification Fuel Cell Combined Cycle fuelled by Municipal Solid Waste

*Tygue Doyle, Zahir Dehouche, Alan Harries*

*Environmental Technology*

**Keywords:** Fuel Cells, SOFC, Gasification, Syngas, MSW, Modelling

## Introduction

The system being studied transforms the problem of waste disposal, especially Municipal Solid Waste (MSW), into a commercially viable business which recovers the embodied energy content whilst using highly efficient approaches to electricity generation for maximum return. Exploiting MSW as a principal source of energy can be used to mitigate the environmental impacts associated with landfill disposal and incineration.

This study analyses a decentralized fuel cell power system running on synthesis gas (syngas), derived from a plasma gasification process, where solid oxide fuel cells (SOFCs) have shown to achieve 45% electricity generation efficiency (and combined heat and power efficiency expected >70% LHV). SOFCs allow minor impurities to be tolerated, thus avoiding the expensive gas cleaning associated with PEM fuel cells, although effects from gas composition fluctuations need to be studied and understood.

Results from modelling go on to determine an appropriate strategy for heat recovery for various end-user scenarios, either using district heating or by using a heat engine to improve local electrical efficiency (this reduces retrofitting costs and promotes the uptake of future electrical applications such as vehicles). As a means for coping with load fluctuations a scenario that includes hydrogen production and storage will be implemented in order to study the feasibility of using hydrogen to store energy during periods of excess energy supply. This will not only protect the fuel cell from part load operation but will also facilitate further penetration of renewable energy coming from wind and photovoltaics. A store of onsite hydrogen may also serve to mitigate the effects of fluctuations in the syngas through enrichment and will serve to promote the hydrogen economy.

## Methodology and Approach

Currently work is being done to develop a dynamic numerical model using Simulink®. Due to the complexity of the system being modelled isolated components will be looked at in varying detail. The component of most concern will be that of the fuel cell and its response to a varying fuel composition which fluctuates according to the composition of the MSW being gasified. For this purpose a micro-scale analysis is being performed and a construction of difference and differential equations derived from physical laws is being developed. Physical, chemical and electrochemical equations being looked at are:

### 1. Conservation and Constitutive Laws

- a. Mass conservation (Fick's law, Maxwell-Stefan, Dusty-gas)

- b. Momentum conservation (Darcy's law)
  - c. Charge conservation
  - d. Energy conservation (Gibbs free energy)
2. Chemical and Electrochemical Reaction Kinetics
- a. Hydrocarbon reforming
  - b. Water-gas shift
  - c. Oxidation and reduction

Experimental work being done in the laboratory will be used to define specific characteristics of the SOFC materials being used, and will also assist in validating the results particular to the simulation of the fuel cell. Initial studies using SEM and X-Ray diffraction have already been carried out and from these studies we have learnt more about the surface conditions of the electrodes as well as the crystal structure produced within the electrolyte. Further progress is required in laboratory in order to reduce the NiO to Ni at the anode. In the true application of this material at the electrode Ni alone is used as a conductor and catalyst, and the reduction of O also plays a major role in the diffusion characteristics of the electrode.

Other components of the system such as the plasma gasification, heat engine, electrolyser, and hydrogen storage will be modelled at a macro-scale level where equations derived from practical results will be used to study the mass and energy flows throughout the system.

### **Findings and Discussion**

Developing on a steady state SOFC-GT model where approximations have been made to account for losses at the fuel cell I am now concentrating on modelling the diffusion flux at the triple-phase boundary region of the electrodes. Results thus far have shown a good relationship between temperature and diffusion (normal and Knudsen). The successful simulation of binary diffusion will play an important role in modelling the diffusion flux by using either, Fick's Law, the Maxwell-Stefan model or the Dusty-gas model. Each of these approaches has been applied in the modelling of SOFCs and each have their advantages and only after careful comparison will one be selected for use, although this will require the simulation of further processes.

### **Future plans**

As an EngD student working from the location of my industrial sponsor in Paddington it has been difficult to find consistent periods of research without getting involved with commercial projects. A vast amount of time has also been spent attending modules and completing assignments as well as in the coordination of COST and FP7 proposals, and although related to my project these activities do not allow for specific time for modelling. This has been highlighted between all parties concerned and good progression of my work has begun as an outcome. I expect to complete my studies within the allotted four year period.

## Finite Element Analysis Of The Foot With Hallux Valgus Deformity

*Saba Eshraghi, Ibrahim Esat*

**Keywords:** Hallux valgus, contact pressure, shoe design

### Introduction

Toe deformities compromise foot function leading to mechanical instability. As a consequence, stability during the weight-bearing and push-off phases of gait, or when in situations requiring corrective steps to maintain balance, will be affected [1].

“Hallux valgus (HV) is lateral angulation of the big toe at the metatarsophalangeal joint. When the angulation of the Hallux becomes more than 15 degrees this deformity happens [7]. Hallux valgus is more common in women [2] and subjects with joint hypermobility, and cultures who wear shoes. The prominent median eminence of the first metatarsal head (bunion) looks unsightly and rubs on the inside of the shoe, and incongruent first metatarsophalangeal joint sometimes aches” [3]. The HV deformity occurs primarily in shod populations [4]. There is also evidence that there are pressure differences beneath the hallux between boys and girls, suggesting a functional cause for certain pathology in females, such as juvenile hallux valgus [6].

Some experiment showed that people with hallux valgus had more peak pressure on their first and second metatarsal's regions [1]. Large values of contact pressure can generate pain or pathologies due to the obstruction of blood circulation in areas with peak values of pressure [5]. The purpose of this study is to compare Normal foot with the foot with Hallux Valgus deformity to find out the relation between different foot structures and the pressure distribution over the whole foot among normal and abnormal people to find out the causes of this disease. This study is going to investigate a foot with bone deformities through three-dimensional finite element modelling to identify the causes of the deformity.

### Methodology

MIMICS software (Materialise NV) was used to generate the surface mesh of a three-dimensional (3D) model of the foot bone from CT images of patients. In this software the 2D images converted to 3D structure. Then, the surface mesh was then exported to ABAQUS software (Simulia Dassault Systems) to create a finite element (FE) model which is suitable for contact analysis.

The mechanical property of the bones and soft tissues was defined and a boundary condition was introduced to address the foot at the assumed position. The hallux valgus angle was calculated and the load was applied to the first metatarsal head region and on the great toe region. The reaction of the applied loads was investigated and compared the the normal foot pressure distribution. So the possible solution toward treatment of the problem was proposed.

To obtain reliable results from 3D modelling, the analysis results should be validated with experimental values of the pressure distribution on the sole of the foot in different conditions. In

order to achieve a normal foot and a foot with Hallux Valgus deformity are to be studied and compared.

### **Findings/Result**

Conducting FEA analysis on different foot structures showed different distribution of pressure depending on the existence of HV. The foot with HV deformity the most pressure is on the first metatarsal head and also on proximal and distal phalanx of the great toe. Furthermore, the usage of tight shoe in the toe box can effect the severity of the pressure accelerating the disease probably causing the increase of pain in patients.

It was found that in the normal foot the most pressure was on the calcaneus and tibia in the standing position.

### **Conclusion**

1. The foot structure has an effect on the pressure distribution
2. This gives indirect evidence that wearing shoe habit plays an essential role in increasing the HV disease.
3. Furthermore, by wearing unsuitable footwear diminishes the function of the foot arches which has the function of absorbing the shock to the sole of the foot coming from the ground reaction force.

### **Future planes**

Further substantiate the findings, the dimension of the arch height of the six volunteers will be measured, three of them with Hallux Valgus deformity and the rest without. The In-shoe sensor (Tekscan) will be used to get the pressure on the side of the foot in metatarsal joints in shod and unshod condition. Then there will be comparison between feet with different arches and the influences of the arch height related to HV deformity will be analysed. Finally, the experimental in the lab will be compared to 3D investigations in Abaqus software to see how similar the results are.

### **References**

- 1] Mickle,K. Munro,B.Lord,S.Menz,H.Steele,J.(2011),*Gait, balance and plantar pressures in older people with toe deformities*, Gait & Posture ,Vol 34,pp.347-351
- 2] Videl,C.Sole,M.Antich,J.(2007),*Hallux Valgus Inheritance: Pedigree Research In 350 Patients With Bunion Deformity*,Foot &Ankle Surgery, Vol 46(3),pp.149-154
- 3] Milner,S.(2010),*Common disorders of the foot and ankle*, Orthopaedic surgery, pp.514-517
- 4] Yu,J. Cheung,J.Fan,Y.Zhang,Y.Leung,A.Zhang ,M.(2008),*Development of a finite element model of female foot for high-heeled shoe design*, Clinical Biomechanics,Vol 23,pp.31-38
- 5] Antunes,P.Dias,G.Coelho,A.Rebelo,F.Pereira,T.(2008),*Non-Linear Finite Element Modelling Of Anatomically Detailed 3D Foot Model*,pp.1-11
- 6] lowery, N. DPM.Walkich,K.(2009), *Adolescent Hallux Valgus :Evaluation and Treatment*, Operative Techniques in Orthopaedics,Vol 19,PP.52-57
- 7] guyen,U.Hillstorm,H.li,W.Dufour,A.Kiel,D.Gray,E.Gagnon,M.Hannan,M.(2009),*Factors Associated with Hallux Valgus In Population – Based Study of Older Women and Men: The MOBILIZE Boston Study*, Osteoarthritis Cartilage, Vol 18,pp.1-11

## CFD Modelling of a Closed Two-Phase Thermosyphon

B. Fadhl, L. C. Wrobel

**Keywords:** Thermosyphon, CFD, Multiphase flow, Phase change material (PCM)

### Introduction:

Interest in the use of heat pipe technology for heat recovery and energy saving in a vast range of engineering applications has been on the rise in recent years. A heat pipe is a two-phase heat transfer device with a highly effective thermal conductivity that transfers heat through evaporating and condensing a fluid that is circulating in a sealed container (Parand & Rashidian 2009; ESDU 80013 1980).

Heat pipe heat exchanger (HPHX) is playing a more important role in almost all industrial applications. In particular, it has been used in improving the thermal performance of heat exchangers and increasing economy savings in commercial HVAC systems (Jouhara & Merchant 2012).

Recently, computational fluid dynamics (CFD) has been used to reveal details of two-phase flow phenomena during the operation of a heat pipe, that otherwise could not be visualized by empirical work. Furthermore, CFD has the ability to accurately model the heat and mass transfer processes inside the heat pipe. These include evaporation, condensation and phase change material. Therefore, the central objective of this study is to establish a comprehensive CFD modelling to cover details of the two-phase flow and heat transfer phenomena during the operation of straight wickless heat pipe.

A wickless heat pipe or thermosyphon relies on gravitational forces to return the working fluid to the evaporator. This is different from a wick heat pipe, where the working fluid is returned from the condenser by capillary forces (ESDU 80013 1980).

### Description of the model:

The commercial code ANSYS FLUENT 13.0 and the Volume of Fluid (VOF) method have been applied for the modelling of a closed two-phase thermosyphon. In particular, for the two-phase simulation, FLUENT's capability has been tested to model the evaporation and condensation phenomena inside the heat pipe. The predicted CFD results have been compared with the results presented by Alizadehdakhel et al. (2010).

In a thermosyphon, heat is added to the evaporator where a liquid pool exists, changing the liquid into vapour. The high temperature and pressure cause the vapour to flow and pass through the adiabatic section toward the condenser. The vapour adjacent to the condenser's wall gives up its latent heat. The condensed liquid is then transported back to the evaporator due to gravity (Legierski et al. 2006).

FLUENT does not have the ability to simulate the phase change material during the evaporation and condensation processes. In order to circumvent this problem, a user-defined function (UDF) has been used to complete the existing FLUENT code. This UDF is essentially required to calculate the mass and heat transfer between the liquid and gas phases during the evaporation and condensation processes. The mass and heat transfer is determined by the source terms in the continuity and energy equations. In order to construct a UDF, applicable mass and energy sources need to be derived. Source terms proposed by De Schepper et al. (2009) have been used to calculate the mass and energy transfer.

A total length of 100 cm of a closed copper tube was used as the thermosyphon geometry, with 1.9 and 1.75 cm for outer and inner diameters, respectively. This includes two 40 cm long sections for the evaporator and

condenser, with an adiabatic section between them. The model considered water as the working fluid, heat flux of 20941.5 W/m<sup>2</sup> as heat input and 0.5 FR as fill ration (the ratio of initial liquid volume per total volume of evaporator in the thermosyphon). According to the steam table at  $T_{sat} = 350K$ , the operating pressure for the thermosyphon was set at  $P_r = 42041$  Pascal.

**Results :**

The CFD results of this work showed that FLUENT with the VOF method can successfully model the complex phenomena inside the thermosyphon. The predicted results of evaporation and condensation showed similar behaviour to the results presented by Alizadehdakhel et al. (2010).

The liquid pool, initially filling half of the evaporator, was heated by imposing a constant heat flux of  $q = 20941.5$  W/m<sup>2</sup> as boundary condition. At positions where the liquid reached the boiling temperature of  $T_{sat} = 350K$ , the liquid starts to evaporate and phase change occurred. This continuous evaporation of liquid results in a decrease of the liquid volume fraction and an increase of the vapour volume fraction. Therefore, the mass and energy sources for evaporation should be calculated in the continuity and energy equations. At those positions where the liquid evaporated, bubbles begin to form which are transported toward the top region of the liquid pool.

Following the above process, saturated vapour is transported upward to the condenser. As the vapour reaches the condenser's wall, where the temperature is lower than the saturation temperature of  $T_{sat} = 350K$ , vapour starts condensing forming filmwise condensation. Accordingly, the vapour volume fraction decreases and the liquid volume fraction increases. Depending on the above process, mass and energy sources for condensation are also calculated.

**Conclusion and future work:**

Heat pipes are currently still under development, and new system are being invented as reported by Robinson & Jouhara (2010). However, there are limited studies on the validation of modelling predictions for a heat pipes by using a commercial CFD technique.

The main goal of the presented work is the development of a complex model that allows simulation of the evaporation and condensation processes in a thermosyphon.

For future works, a range of different sets of thermosyphon parameters will be tested and compared with experimental results. Specifically, an investigation will be carried out to understand the effect of different parameters such as heat flux, fill ratio and working fluid on the performance of heat pipe.

**References:**

- Alizadehdakhel, A., Rahimi, M. & Alsairafi, A.A., 2010., 37(3), pp.312-318.
- ESDU 80013, E., 1980. Heat pipes – general information on their use, operation and design 1. , 80013.
- Jouhara, H. & Merchant, H., 2012. Experimental investigation of a thermosyphon based heat exchanger used in energy efficient air handling units. Energy, 39(1), pp.82-89.
- Legierski, J., Wiecek, B. & de Mey, G., 2006. Measurements and simulations of transient characteristics of heat pipes. Microelectronics Reliability, 46(1), pp.109-115.
- Parand, R. & Rashidian, B., 2009. Available at: <http://en.scientificcommons.org/45633579> [Accessed March 8, 2012].

## Large Eddy Simulation of Stagnation Region Heat Transfer Augmentation

*Matthew Fleetwood, Jan Wissink*

**Keywords:** LES, turbulence simulation, heat transfer, stagnation

**Introduction:** The main limiting factor for the performance and efficiency of gas turbines is the turbine stage inlet temperature. In the stagnation region of the turbine blade the flow is strongly accelerating and as a result will not undergo transition to turbulence even when a significant amount of free-stream turbulence (FST) is present. However, the heat transfer in this region - referred to as “laminar heat transfer” (LHT) - can be significantly augmented by free-stream fluctuations. To better understand this phenomenon, direct numerical simulations (DNS) [1] were performed of flow in the stagnation region of a circular cylinder as a model of the stagnation regions of a turbine blade. The augmentation in LHT observed in the DNS was found to closely match the correlation curve produced by Dullenkopf & Mayle (DM) [2]. One of the problems in simulations of flow around a circular cylinder is that the location of stagnation tends to oscillate as a result of the periodic vortex shedding behind the cylinder. To mitigate this effect in the DNS [1], a short splitter plate was placed behind the cylinder.

DNS-s are computationally very expensive, therefore in this work three-dimensional LES-s with an incoming wakes have been performed in the same geometry used in the DNS calculation. To assess the suitability of LES to accurately predict LHT augmentation the results of these simulations will be compared to the DNS results and the DM correlation curve.

**Numerical Setup:** The circular cylinder of diameter  $D$  has a temperature of  $T/T_0=1$ . At the inlet a turbulent wake is introduced which corresponds to the wake of a smaller cylinder of diameter  $d=D/4$ , mounted  $6D$  upstream of the stagnation line of the larger cylinder. The incoming wake corresponds to the wake-data generated in a precursor DNS by Wissink and Rodi [3] and is superposed on a uniform inflow field  $(1,0,0)U_0$  with an initial temperature of  $T/T_0=0.7$ . A Reynolds number of  $Re=13,200$  is used, which is based on the length-scale,  $D$ , and the free-stream velocity  $U_0$ .

To perform the simulations, the incompressible Navier-Stokes solver “LESOCC”, developed at the Institute for Hydromechanics (IfH) of the Karlsruhe Institute of Technology (KIT), was employed. The LESOCC solver discretises the Navier-Stokes equations on a curvi-linear mesh and uses a second-order accurate central method for the spatial discretisation, while the time-integration is performed using a three-stage Runge-Kutta method.

Three simulations are discussed in this paper; two simulations with FST have been completed, one with a SGS model (*Sim\_A*), one without (*Sim\_B*) and a third simulation without FST (*Sim\_C*).

**Results:** The heat transfer is represented by the local Nusselt number ( $Nu$ ),

$$Nu = \frac{-1}{1-\beta} \frac{\partial(\bar{T}/T_0)}{\partial(r/D)}$$

based on the cylinder diameter ( $D$ ), where  $\beta$  is the ratio of the temperature of free stream flow to the cylinder wall and  $r$  is the distance from the cylinders' surface to the first grid line. The augmentation of the heat transfer by the free-stream turbulence can be observed with a plot of  $Nu$  along the cylinder. The inclusion of FST, in *Sim\_A* and *Sim\_B* results in a higher  $Nu$  compared *Sim\_C* without. Though there is a definite increase in the heat transfer, the augmentation shown in the results of the DNS[1] is still higher, which is probably due to the coarser mesh and the dissipative effect of the SGS model (as used in *Sim\_A*). The effect that the SGS model has on  $Nu$  can be seen by comparing the results of simulations *Sim\_A* and *Sim\_B*. The inclusion of the model causes a lower stagnation  $Nu$ , but results in slightly elevated  $Nu$  levels further downstream. In the future it is hoped to improve the agreement between the LES and DNS results with the inclusion of a Heat Transfer Model (HTM).

The Dullenkopf and Mayle correlation is based on  $Re_D$  and the non-dimensional free-stream strain rate,  $a_1$ , defined by  $a_1 = aD/U_0$ , where the free-stream strain rate,  $a$ , is calculated from the circumferential velocity immediately upstream of stagnation, i.e.  $a = U_c/\alpha$ . Using these terms, a modified Nusselt number,  $Nu_a = Nu/\sqrt{a_1 Re_D}$ , and a modified turbulence level,  $Tu_a = Tu_0\sqrt{Re_D/a_1}$ , are calculated and used in the correlation,

$$Nu_a Pr^{-0.37} = 0.571 + 0.0125 Tu_a \left( 1 + \frac{1.8}{1 + (Tu_a 20)^3} \right)$$

where the Prandtl number is  $Pr = 0.71$ . The values of  $a_1$  determined for the simulations were  $a_1 = 2.45$  and  $a_1 = 2.61$  for simulation *Sim\_A* and *Sim\_B* respectively. The turbulence level was identified with the minimum  $Tu$  along  $y/D = 0$  giving  $Tu_a = 11.49\%$  and  $Tu_a = 10.02\%$  for simulations *Sim\_A* and *Sim\_B* respectively. The DNS values are  $a_1 = 2.38$  and  $Tu_a = 10.57\%$ . By calculating the  $Nu_a$  and  $Tu_a$  for these results and plotting the results on the correlation curve it can be seen that the results of *Sim\_A* and *Sim\_B* show the correct trend but are located below the correlation curve. Compared to *Sim\_B*, the inclusion of the SGS model in *Sim\_A* results in a slightly higher  $Tu_a$ -level which is closer to the level obtained in the DNS. Note that the DNS result also lies somewhat below the correlation curve.

## References:

1. Wissink, J. G. and Rodi, W. G. *Direct Numerical Simulation of Heat Transfer from the Stagnation Region of a Heated Cylinder affected by an Impinging Wake*. Journal of Fluid Mechanics, pp. 64-89. 2011
2. Dullenkopf, K. and Mayle, R. E. *An Account of Free-Stream Turbulence Length Scale on Laminar Heat Transfer*. Journal of Turbomachinery, pp. 401-406. 1995
3. Wissink, J. G. and Rodi, W. G. *Numerical Study of the near wake of a circular cylinder*.: International Journal of Heat and Fluid Flow, 29, pp. 1060-1070 2008
4. Lilly, D. K. *A Proposed modification of the Germano subgrid-scale closure method*.: *Phys. Fluids A*, Vol. 4, No. 3, March 1992

## Fundamentals of Two-Phase Flow in Domestic Central Heating Systems

*Andrew Fsadni, Yunting Ge*

**Keywords:** Central Heating; Bubble formation; Dissolved Gasses

An emerging trend in the building services industry is the installation of passive deaerators on the flow line of domestic wet central heating systems. To date, no data and theoretical models predicting the two-phase flow characteristics in domestic wet central heating systems are available in the open literature. This gap in literature has prevented essential design improvements to passive deaerators thus impeding the efficiency enhancement of such devices. Hence, the current study is aimed at assisting designers of deaeration devices by providing fundamental data and model correlations with respect to the two-phase flow characteristics typical in a wet domestic central heating system.

For this purpose an experimental research project was adopted and several studies were carried out, including; (1) a comprehensive review to understand the background of the phenomena, (2) the design and construction of an experimental test rig to conduct the necessary investigations into the phenomenon of two-phase flow in domestic wet central heating systems, (3) the development of a reliable image capture and analysis technique, (4) the completion of a number of experiments to investigate typical bubble sizes, volumetric void fractions, bubble distributions and nucleation and dissolution rates, (5) the correlation of the data gathered as part of the present study with existing bubble size, nucleation and dissolution prediction models.

This research has, for the first time, provided an in depth analysis into the two-phase flow characteristics in wet domestic central heating systems through the use of a high speed camera and image analysis techniques. The two-phase phenomenon finds its origins in high dissolved gas concentrations present in the water flowing through the closed loop system, thus resulting in super saturation conditions at the primary heat exchange wall conditions. Bubble sizes at the boiler flow line were found to be dependent on the bulk fluid velocity, heat flux and pressure, with a measured mean diameter in the range of 0.13 mm to 0.39 mm. The Winterton (1972a) force balance model for bubble size prediction was in reasonable agreement with the experimental results. This model was further improved through the correlation of our data with the inclusion of dimensionless groups. Bubble nucleation rates have been calculated in the range of 0.3 to 4 bubbles / cm<sup>2</sup> s with total system bubble production rates measured in the range of 784 to 6920 bubbles per second. Bubble nucleation rates have been calculated through the consideration of the heat exchanger surface under super saturation conditions. A correlation for the model by Hepworth et al. (2003) for non-classical heterogeneous nucleation is proposed based on the experimental data gathered during the present study.

Experimental results have shown dissolution rates for the bubble size ratio in the range of 0.4 to 12 % per second with system conditions. A modification for the model developed by Epstein and Plesset (1950) for stationary bubble dissolution is proposed with the inclusion of the Sherwood number to capture the effects of turbulent diffusion. The volumetric void fraction distribution in vertical pipes was found to be quasi-homogenous across the pipe section while being strongly dependent on gravitational and turbulence effects in horizontal pipe bubbly flow. A CFD simulation predicted the volumetric void fraction distribution with reasonable accuracy.

## Thermal Performance of PCM Clay Boards in the Built Environment

Baboo Gowreesunker, Savvas Tassou

Centre for Energy and Built Environment Research (CEBER)

**Keywords:** Phase change materials (PCM); CFD modelling; Thermal comfort.

### Introduction

The use of air-conditioning accounts for a large proportion of the energy consumption and CO<sub>2</sub> emissions of buildings. Due to the growing trend of architects to design buildings with maximum exposure to the outdoor environment, buildings are becoming thermally less massive, leading to higher energy consumption. In spaces without air-conditioning, this leads to overheating and thermal discomfort.

The use of phase change materials (PCM) has been identified as a method to limit excessive temperatures, and to reduce energy consumption. PCMs are materials have enhanced heat storage capabilities in a specific temperature range (phase change temperature) relative to conventional building materials due to their latent heat capacity. Thus, as the temperatures of the building space changes across the phase change temperature of the PCM, the PCM will absorb or release 'extra' energy to the space, maintaining a satisfactory temperature level. However, in order for PCM systems to work successfully, the absorbed energy from the space during operation must be released during the unoccupied period so that the initial energy state of the PCM is restored.

Various studies [1,2] have reported on the effectiveness of PCM in lightweight structures to prevent overheating during summer. However, the focus has been on the global performance of the PCM, and did not consider application to large spaces where thermal stratification and localised temperature distributions are important. The present study will evaluate the performance of clay boards impregnated with PCM in relation to indoor thermal environment control and thermal comfort, using computational fluid dynamics(CFD) modelling and experimentation.

### Methodology

To obtain an appropriate investigation of PCM boards, the following are essential criteria: (i) the heat transfer and storage properties of the PCM must be adequately evaluated; (ii) appropriate air-flow models must be used, and (iii) the models must be validated from experiments. As a result, the methodology employed involves the experimental investigation of PCM Clay boards in a test cell placed in an environmental chamber. The test cell was built according to the Building Regulations Part L to mimic a realistic large glazed space. The environmental chamber is used to simulate outside environmental conditions.

In essence, a building and its external thermal surrounding has been reproduced at model scale in the laboratory and the results from this experimental setup are used to validate numerical models. The thermal properties of the PCM were established through the Differential Scanning Calorimetry (DSC) thermal analysis technique.

As the main mechanism being investigated is the phase change process of the PCM, the default enthalpy-porosity formulation, described in [3] and used in commercial software packages is considered to be too idealised for PCM with phase change hysteresis and non-linear enthalpy-temperature relations. Thus a new method has been developed [4] that integrates the hysteresis effect and the enthalpy-temperature relation curvature through the use of heat sources and sinks in the governing energy equation.

The temperature of the chamber is controlled to mimic the outdoor temperature variation. The internal air/surface temperatures are monitored, and used to validate the CFD models. The use of CFD allows a localised analysis of comfort distribution in the domain, and therefore enables a detailed quantification of the performance of the PCM boards.

### **Results and Discussion**

The validation process of the newly developed phase change simulation method produced an error of 0.9%, compared to 9.3% for the default enthalpy-porosity method. These errors become important as cyclic simulations of buildings are performed. Furthermore, applying this method to the validation of the experimental test cell, an average error of 1.3 – 1.9 °C is obtained for 27 thermocouples, which is satisfactory to confirm validation of the CFD model.

Using the validated model, it was found that a peak temperature reduction of 4 °C was possible through the application of the PCM board relative to conventional gypsum plasterboards, implying that the cooling demand of the building can be reduced and demonstrating the energy saving potential of the PCM boards.

It was also found that charging the PCM during the night was inefficient in a closed cell. Charging is essential to ensure that the cooling potential of the PCM is restored for the following day. Hence, the use of ‘night’ ventilation will be further investigated to improve the overall performance of the boards.

### **Conclusion**

This paper shows the preliminary experimental and numerical validations essential to extrapolate the results of the study to real case scenarios. The reduction in peak space temperatures from the use of the clay PCM boards further confirms that improvements in thermal comfort are possible with the use of PCM boards. Future studies will consider design considerations for real building applications and will quantify the benefit of the application of PCMs in terms of thermal comfort and energy savings.

### **References:**

- [1] L. Shilei, F. Guohui, Z. Neng, D. Li, Experimental study and evaluation of latent heat storage in phase change materials wallboards, Energy and Buildings 39(2007): pp 1088 -1091
- [2] F. Kuznik, J. Virgone, Jean Noel, Optimization of a phase change material wallboard for building use, Applied Thermal Engineering 29(2008): pp 1291-1298
- [3] G. Susman, Z. Dehouche, T. Cheechern, S. Craig, Tests of prototype PCM ‘sails’ for office cooling, Applied Thermal Engineering 31(2010): pp 717-726
- [4] B.L. Gowreesunker, S.A. Tassou, M. Kolokotroni, Improved simulation of phase change processes in applications where conduction is the dominant heat transfer mode, Energy and Buildings 47 (2012): pp 353–359

## The effect of a H<sub>2</sub>/CO mixture at varying ratios on the diesel particulate filter regeneration process: towards an optimised fuel reformer design

*Stephen Hemmings, Thanos Megaritis*

*Centre for Advanced Powertrain and Fuels*

**Keywords:** Hydrogen, carbon monoxide, diesel particulate filter, exhaust aftertreatment, regeneration, mixture ratio

### **Introduction:**

The addition of hydrogen can significantly enhance the performance of a number of diesel aftertreatment devices including; catalytic converters, diesel particulate filters and NOx traps [1,2]. This has led to the development of the exhaust gas fuel reforming process, a technique that allows for production of hydrogen rich reformate ‘on board’ a vehicle. An exhaust gas fuel reformer can generate both H<sub>2</sub> and CO. The impact of H<sub>2</sub>/CO mixture addition on the DPF regeneration process has been researched previously, at a mixture ratio of 60% H<sub>2</sub> (v/v) balanced with CO [3]. The present study takes this further by varying the H<sub>2</sub>/CO mixture ratios that are introduced to the DPF regeneration process in an attempt to identify an optimised mixture ratio. Such research may prove beneficial for future research into optimising the design of an exhaust gas fuel reformer for DPF regeneration applications.

### **Design/Methodology/Approach:**

Exhaust gas was sampled directly from the exhaust manifold and fed to the inlet of a reactor via a heated feed line which was set to the same temperature as that measured at the exhaust manifold. The sample flow rate was fixed at 70l/m, achieved by throttling the suction side of an inline blower via a ball valve. A SiC- mini diesel particulate filter was located inside the reactor. The reactor was housed within a tubular vertically mounted furnace that allowed for exhaust gas temperatures up to 1000°C to be simulated. Three K-type thermocouples were located along the central axis of the DPF situated at the top, middle and bottom. A further two thermocouples were situated at the inlet and outlet of the reactor. In addition, two pressure transducers were also located at the inlet and outlet of the reactor. This allowed for the pressure difference across the DPF to be calculated. Both the pressure and temperature readings were monitored in real time, sampled at a rate of once per minute.

Following a standardised blocking procedure, the filter was regenerated using 6% (v/v) H<sub>2</sub>/CO mixture at varying ratios. The ratios tested began at 100% H<sub>2</sub>, 0% CO through to 100% CO, 0% H<sub>2</sub> at increments of 20% CO balanced with the necessary H<sub>2</sub>. During the regeneration process, the engine load and speed remained at 4.4 bar BMEP and 1500 rpm respectively. The mean filter temperature was set to approximately 440°C before introducing the supporting mixture at the required H<sub>2</sub>/CO ratio. Emission measurements were recorded both pre and post DPF for a period of 5 minutes each. A Horiba 7170 DEGR exhaust gas analyser was adopted to

measure O<sub>2</sub> content while a FTIR analyser was used for all other exhaust emission measurements.

### **Findings/Results:**

The effect of the various mixture ratios on the DPF temperature and the regeneration rate has been investigated. The highest DPF temperature was achieved using the 50/50 mixture ratio while the lowest was attained using 100% CO. This variance in the filter temperature is generally reflected in the regeneration profiles, where a higher temperature results in increased proficiency of regeneration. The results also demonstrate the impact of the various mixture ratios on CO, CO<sub>2</sub>, NOx and THC as well as a variety of unlegislated emissions. It is evident from this data that the extent of the impact on these chemical species is heavily dependent on the mixture ratio adopted.

### **Conclusion / Discussion**

Following initial analysis of the results it is apparent that the closer the mixture ratio is to a 50/50 balance, the higher the filter temperature. Due to a general trend being evident between peak temperature and quality of regeneration, the 50/50 mixture ratio also demonstrated one of the most proficient regeneration profiles.

The emission measurements demonstrated that by increasing the CO content in the introduced mixture the resultant CO<sub>2</sub> produced post filter was increased proportionally. In addition, all the mixture ratios tested besides 100% CO resulted in a significant increase in the formation of NOx post filter. Furthermore, it is apparent that the addition of a reformate that features a mixture of both H<sub>2</sub> and CO results in the reduction of CH<sub>4</sub>, ethylene, propylene and acetylene post filter.

### **Future plans / directions:**

In addition to the completion of this study, the final stage of the PhD thesis would benefit from further research into the size and number of diesel particulates generated during the DPF regeneration process when such a process is supported by H<sub>2</sub>/CO mixture. The project plan aims for completion of the PhD thesis within the three year time scale.

### **References**

- [1] Abu-Jrai, A., Tsolakis, A., Theinnoi, K., Megaritis, A., Golunski, S.E., 2008. *Diesel exhaust-gas reforming for H<sub>2</sub> addition to an aftertreatment unit*. Chemical Engineering Journal. 141. pp 290-297.
- [2] Bromberg, L., Cohn, D.R., Hadidi, K., Heywood, J.B., Rabinovich, A., 2004. *Plasmatron fuel reformer development and internal combustion engine vehicle applications*. Massachusetts Institute of Technology. Paper presented at the Diesel Engine Emission Reduction (DEER) workshop: August 29<sup>th</sup>-September 2<sup>nd</sup> 2004. No: PSFC-JA-05-22.
- [3] Hemmings, S., Megaritis, A., 2012. *Periodically regenerating diesel particulate filter with a hydrogen/carbon monoxide mixture addition*. Int J Hydrogen Energy. Vol. 37, Issue. 4, pp. 3573-3584.

## Modeling bone anchor pull-out in cancellous bone using finite element models

*Chris Hughes, Chris Brown*

*Bio-mechanical Engineering / School of Engineering and Design*

**Keywords:** F.E.A, Cancellous Bone, Cortical Bone, CT Data, Bone Anchors, Osteopenia

### Introduction

- This paper describes a modelling process of anchor pullout using the finite element method.
- A spiralled anchor was used with a maximum external thread diameter of 5mm
- Two apparent densities of cancellous bone were used; 18.5% and 9% apparent density
- The effect of increasing cortical thickness was examined when the anchor was not engaged with the cortical shell
- The result of an anchor engaging with 0.5 mm and 1.5 mm thick cortical shells and cancellous bone was also observed

### Design / Methodology / Approach

- A piece of bone was extracted from distal femur. Understood that bone geometry will vary and location and proximity to cortical shell will alter properties.
- In this case a 10 x 10 x 10 mm volume was taken of cancellous bone, with the top side of the bone being closer to the cortical shell resulting in the upper half having a higher apparent density than the lower half.
- From the original piece of bone two densities of bone were created; one by wrapping the geometry of the original bone, the other by eroding the original geometry giving an “aged bone” effect. This method was chosen instead of finding two pieces of bone with naturally different apparent densities as it allowed for a comparison between two homomorphic structures
- The eroded model had an overall apparent density of 8.95%, with the upper half being 12.3% and the lower half being 5.65%
- The wrapped model had an overall apparent density of 18.5%, with the upper half being 22% and the lower half being 14.9%
- A cortical shell was created using CAD and is an idealised body i.e. there is no graduated change in apparent density
- In total 8 different bone geometries were explored for each apparent density; one with no cortical layer, five with a non-engaged cortical layer at thicknesses of 0.25, 0.5, 1.0, 1.5

and 2.0 mm, and two with engaged anchors at 0.5 mm and 1.5 mm, resulting in a total of 16 meshes

- The anchor had a maximum diameter of 5mm, a thread length of 12 mm, a thread pitch of 3.3mm and a taper of 12°.
- The anchor was inserted vertically in the centre of the bone, and had the same position and orientation for each analysis
- Meshing was carried out in Materialise's 3matic software. Due to the inherent architecture of the bone and software capabilities finishing touches on the mesh had to be carried out by hand
- Ansys Workbench was used to carry out all F.E.A
- A frictional contact was chosen for the interface between the bone and anchor over bonded, previous experience has showed the results to be more appropriate to physical studies. This is because under bonded contact no contact shear stress occurs meaning that no sliding occurs between the surfaces resulting in a stiffer structure
- A bonded contact was used between the cancellous bone and the idealised cortical layer

## **Findings / Results**

- Contact characteristics are important
- Size of element and contact (need some detailed pictures)
- Area in contact: over the period of displacement the number of elements in contact always decreased
- Type of material in contact
- Apparent density
- Then the final result shows that stiffness is matching with mechanical test.
- The effect of a tapered screw

## **Conclusion / Discussion**

- Engaging with the cortical layer increases the stiffness of the structure dramatically, leading to an increase in pull-out force.
- Contact characteristics are important, bonded contact creates an artificially stiffer contact

## **References**

C.H. Turner, J. Rho, Y.Takano, T.Y. Tsui & G.M. Pharr. The elastic properties of trabecular and cortical bone tissues are similar: results from two microscopic measurement techniques. Journal of biomechanics 32: 437-441, 1999.

## A Study of Current and Future Energy Use of Hotels in Greece

*Ifigenia Farrou, Maria, Kolokotroni, Mat Santamouris*

**Keywords:** Hotel sector, climate change, energy consumption, clustering, benchmark

**Introduction:** The residential and commercial buildings are responsible for almost 40% of the total energy consumption in the developing countries. The rapid population growth in conjunction with the industrial and urban development and the demand of better comfort levels inside the buildings predict an increase of the future energy use in the building sector. For this reason, energy efficient measures comprise a primary scope of the current building design. In Greece, hospitals, hotels and offices are the most energy consuming buildings with energy consumption 406.8 kWh/m<sup>2</sup>/year, 273 kWh/m<sup>2</sup>/year and 152 kWh/m<sup>2</sup>/year respectively(Pérez-Lombard, Ortiz, καὶ Pout 2008; Santamouris et al 1996). Concerning the hotel sector, there is no sufficient information on the energy breakdown as very few hotels monitor their sub-systems. Additionally, due to large differences between hotels, it is difficult to arrive at general consumption figures.

This research reviews the current energy use of the hotel sector in Greece. The aim of this research project is to propose guidelines for energy efficiency improvements in hotels currently and using future climatic projections aiming at a nearly ‘zero’ energy hotel building. The originality of this research project lies in the collection of operational energy consumption data in the hotel sector, the classification of hotels according to their operation and energy consumption and the consideration of climate projections to assess the effectiveness of energy efficiency strategies in future hotels, new and refurbished.

**Design/Methodology/Approach:** The research is split into 3 parts:

- A review of the existing hotel stock in the Mediterranean area. The aim of this part is to understand the energy flows of a hotel unit and rank the ‘Greek’ hotel sector within the European stock. The review is based on the existing literature.
- Energy data of 90 hotels all around Greece was collected using questionnaires and visits on site. The average thermal and electrical consumption is calculated and further studied with the frequency distribution analysis. Given the fact that in Greece there are not official benchmarks for the building stock, a need derives to classify the energy data of the hotels. The classification is made using the *k-means* algorithm, being one of the most used clustering methods (Ahmad and Dey 2007), within the MATLAB environment(Todd, M Toth, and Busa-Fekete 2009).
- Use a demonstration hotel in order to investigate the impact of the future climate change on its energy consumption. The investigation is made through simulations using the TRNSYS software. Three climatic files will be simulated covering the periods: the reference period 1961-1990 and the future periods 2021-2050 and 2071-2100.

**Findings/Results:** From the literature research it is concluded that electricity is the main fuel used in the hotel sector. Gas, oil, lpg and natural gas follow and are used mainly for space and water heating.

The average energy consumption of the 90 hotels is calculated in: 202 kWh/m<sup>2</sup>/year for hotels with annual operation and: 159 kWh/m<sup>2</sup>/year for hotels with seasonal operation (April-October).

According to their annual **electricity** consumption the hotels are classified in:

- **5 clusters** (annual operation) with average consumption: 38 kWh/m<sup>2</sup>/year, 131 kWh/m<sup>2</sup>/year, 225 kWh/m<sup>2</sup>/year, 369 kWh/m<sup>2</sup>/year, and 1045 for clusters 1, 2, 3, 4, and 5 respectively.
- **4 clusters** (seasonal operation) with average consumption: 37 kWh/m<sup>2</sup>/year, 117 kWh/m<sup>2</sup>/year, 252 kWh/m<sup>2</sup>/year, 746 kWh/m<sup>2</sup>/year for clusters 1, 2, 3 and 4 respectively.

Currently, simulations are carried out for the demonstration hotel for the real case – reference (year 2007).

**Conclusion / Discussion:** The analysis of the energy consumption data has led to a classification of hotels in Greece according to their operation and energy use. Based on this, a typical hotel from the sample was chosen as representative to carry out detailed energy analysis.

The demonstration hotel comprises a ‘typical’ hotel of cluster 1. Thermal simulations were carried out to compare these results with actual energy data. The simulation results have a small declination (4%) from the real situation. Based on these results, further simulations will be carried out to improve the energy performance of this demonstration hotel using current weather data and also weather data based on future climate projections. The results to date indicate that this is possible as sources for climate projections have been identified together with appropriate energy efficiency measures for the hotel and integration of renewable systems.

**Future plans / directions:** Prepare the future climatic weather files based on the morphing procedure (Belcher, Hacker, and Powell 2005; Giannakidis et al 2011)

- Simulate the impact of the different weather files on the energy consumption of the demonstration hotel
- Investigate energy efficiency measures for the demonstration hotel so that a nearly zero building is achieved
- Investigate the effectiveness of proposed measures in hotels located in different climatic regions in Greece using the developed weather files.

## **References**

- Ahmad, Amir, and Lipika Dey. 2007. ‘A k-mean clustering algorithm for mixed numeric and categorical data’. *Data & Knowledge Engineering* 63 (2): 503–527. doi:10.16/j.datak.2007.03.016.
- Belcher, SE, JN Hacker, and DS Powell. 2005. ‘Constructing design weather data for future climates’. *BUILDING SERV ENG RES TECHNOL* 26:49. doi:10.1191/0143624405bt112oa.
- Giannakidis, G., D.A. Asimakopoulos, M Santamouris, I. Farrou, M. Laskari, M. Saliari, G. Zanis, et al 2011. ‘Modelling the energy demand projection of the building sector in Greece in the 21st century’. *In Press*.
- Pérez-Lombard, Luis, José Ortiz, and Chris Pout. 2008. ‘A review on buildings energy consumption information’. *Energy and Buildings* 40 (3): 394–398. doi:10.1016/j.enbuild.2007.03.007.
- Santamouris, M., C.A. Balaras, E. Dascalaki, A. Argiriou, and A. Gaglia. 1996. ‘Energy conservation and retrofitting potential in Hellenic hotels’. *Energy and Buildings* 24 (1): 65–75. doi:10.1016/0378-7788(95)00963-9.
- Todd, Clifford S., Tivadar M Toth, and Róbert Busa-Fekete. 2009. ‘GraphClus, a MATLAB program for cluster analysis using graph theory’. *Computers & Geosciences* 35 (6): 1205–1213. doi:10.1016/j.cageo.2008.05.007.

## **The Effects of Wing and Tail Vortices on a Spinning Aircraft**

*Rein I. Hoff, Guy B. Gratton*

*Brunel Flight Safety Laboratory*

**Keywords:** Aircraft, Spin, Flight Test Safety

### **Introduction**

Predicting an aircraft's spin characteristics, and in particular its spin recovery characteristics, before a flight test programme is very difficult. Several prototype aircraft have been lost due to unrecoverable spins. In several cases the test pilot had to bail out of the aircraft and parachute to safety. Due to the lack of a reliable spin recovery prediction method, the test pilot is basically left with a careful, incremental, but hazardous spin testing method.

A spin flight-testing programme of a light, amateur-built aircraft in Norway, with one of the authors (Hoff) as test pilot, became the background for a spin research programme at Brunel Flight Safety Laboratory (BFSL). While searching for a spin recovery prediction method, being relevant due to a modified tail on the aircraft, it became clear that several spin research questions should be addressed. In particular the effectiveness of rudder and elevator for spin recovery and also the unsteady aerodynamic flow over wing and tail areas should be better understood before a spin prediction method would become a future reality.

### **Design/Methodology/Approach**

A full-scale experimental spin research programme was thus launched using a military type trainer as the research aircraft. The first stage in this research programme was capturing the spin motion using a vision-based state estimation approach. The aerodynamic flow over wings and empennage has been studied using wool tufts and smoke for flow visualisation. To check if the aerodynamic flow structure observed was unique for the research aircraft, full-scale research flights have also been flown using other aircraft types and the results compared.

### **Findings/Results**

The tufts revealed a vortex forming on top of the outside wing during the spin. This Upper Surface Vortex (USV) formed and moved outwards as the spin developed and moved inwards again during the spin recovery. The movement of the USV has been related to the spin motion data from the vision-based state estimation. Furthermore, a Leading Edge Vortex (LEV) was observed on top of the horizontal tail. These research results have been reported earlier at the 4th European Flight Test Safety Workshop and details will be published in The Aeronautical Journal.

A smoke source mounted forward of the wing revealed temporary USV wake impingement on the tail surfaces. The smoke source also revealed the low-pressure suction created by the USV on top of the outside wing. Flight test data indicate a reduction in tail effectiveness during the time frames where the wake hits the tail. The formation of the LEV on the horizontal tail corresponds with the instant lightening in back-stick force felt by the pilot, thus explaining the increase in stick force experienced during spin recovery.

### **Conclusion / Discussion**

The effects of wing and tail vortices on a spinning aircraft have been studied and documented. These effects, in particular the USV on wing and LEV on top of horizontal tail, are important for the understanding of spin dynamics. A better understanding of the aerodynamic flow may reveal potential hazardous spin conditions and the probable effect of controls for recovery. This research has not resulted in a generic spin prediction method. However, the unfruitfulness of other simplified spin prediction methods, that have been used historically, is now clear. Aeroplane spin recovery models must be based on the physics of the aerodynamic flow.

### **Future plans / directions**

More research flights are planned using flight test instrumentation to further verify the results and get more quantitative data to analyse the spin motion, with particular emphasis on the effects of the USV and LEV flow conditions.

### **References:**

- R.I. Hoff, "The Challenges of Light Aeroplane Spin Testing & Research", 4th European Flight Test Safety Workshop, London, UK, September 28, 2010
- R.I Hoff, G.B. Gratton, "Camera Tracking and Qualitative Airflow Assessment of a 2-turn Erect Spin", The Aeronautical Journal, (accepted November 2011, to be published).

## Direct Numerical Simulation of oxygen transfer across the air-water interface in a convective flow environment

*Boris Kubrak, Jan Wissink*

**Keywords:** DNS, Gas Transfer, Flow Simulation, High Schmidt Number, Air-Water Interface

The gas transfer across the air-water interface plays a vital role for many applications in environmental engineering. For instance oxygen is absorbed by natural water bodies such as lakes. This process, which represents a low diffusivity (High Schmidt-number) scalar transport in a flow field has been simulated by direct numerical simulation. The fourth-order accurate WENO scheme developed by Liu, Osher and Chan [1] has been adapted for usage on a non-uniform mesh. To be able to deal with low diffusivity a dual meshing strategy is adopted, in which the scalar gas concentration field is solved on finer mesh than the flow field. The buoyant convection is modeled using a Boussinesq approximation with a linear relationship between flow temperature and density.

The results show that a relatively coarse mesh is sufficient to accurately describe the fluid flow. The usage of a refined mesh for the scalar gas concentration is found to be beneficial in order to obtain a highly accurate resolution by minimizing numerical diffusion.

### Introduction

The gas transfer across the air water interface is a complicated combination of molecular diffusion and turbulent transport. The characteristic non-dimensional parameter to control the molecular diffusion is the Schmidt-number  $Sc$ . For high Schmidt numbers the diffusion is weak. The Schmidt number for the diffusion of oxygen into water is  $Sc = 500$ . A very thin layer of high oxygen concentration will form beneath the surface by means if diffusion. Another important factor is the flow field beneath the surface which will enhance subsequent mixing of high oxygen level water with the low oxygen level water below it. There are three main mechanisms that drive the flow in natural waters; (a) Wind-Shear, (b) Bottom-shear (in rivers), and (c) natural convection. Substantial research has been done for (a) and (b) [3] but relatively little is known about the weaker influence of buoyant convection. This project investigates the case of naturally convective driven flow where cold water with high oxygen concentration from the surface sinks down and mixes with the less saturated water below.

### Methodology

The flow field was solved using a fourth-order accurate kinetic energy conserving method [2]. The gas concentration field was solved on a finer overlaying submesh using a weighted-non oscillatory scheme (WENO) [1]. The velocities were interpolated onto the finer grid to calculate its transport. A 2-D extensive grid refinement study was carried out where the sub mesh was refined (refinement factor  $R = 2$  and  $3$ ) to achieve high resolution for the gas concentration field.

The mesh has a stretching and is finer near the surface wear steep gradients in the oxygen concentration are expected. The size of the domain is 5x5 cm. The code is parallelized and the numerical simulation were carried out at Leibniz Supercomputing Centre in Munich.

### **Results grid refinement study**

Three different levels of grid refinement for the oxygen field were tested. On a standard 400 x 256 gridpoints mesh the concentration is under-resolved. When an overlying finer sub mesh of 800 x 512 (R=2) and 1200 x 768 (R=3) gridpoints was used the results converged and the concentration was well resolved. The same refinement for the velocity field showed no difference in the flow structure which proves that the flow field is fully resolved, the gas concentration field however requires a finer mesh for accurate resolution.

### **Conclusion**

A sufficient mesh size for the resolution of the diffusion process of oxygen into water was identified in an extensive 2D study. The results have been used for full 3D simulations where. The dual meshing approach by using different meshes for the flow and concentration field saves substantial computational effort. For a refinement of R=2 and above the results converge.

### **References**

- [1] X. Liu, S. Osher and T. Chan, Weighted Essentially Non-oscillatory Schemes, Journal of Computational Physics 115, 200-212, 1994.
- [2] J.G. Wissink, On unconditional conservation of kinetic energy by -difference discretizations of the linear and non-linear convection equation, Computers and Fluids, Vol. 33, No 2, 315-343, 2004.
- [3] S. Banerjee, Modeling of Interphase Turbulent Transport Processes, Ind. Eng. Chem. Res., 2007, 46 (10), pp 3063-3068

## Simultaneous measurements of soot volume fraction, flame temperature and flow velocity using laser diagnostics in flames – Part 1: Flame temperature

*Martin Lawrence, Lionel C Ganippa*

**Keywords:** NOC, soot, 2D-LIP, thermographic phosphors, YAG:Dy

### **Introduction:**

The combustion process produces undesirable particulate emissions including soot and nanoparticles of organic carbon (NOC) which form from incomplete combustion of hydrocarbons. These pollutants are toxic and government measures are constantly being tightened on their production and release into the atmosphere. In order to reduce emissions and improve combustion efficiency, the combustion process must be better understood, down to the smallest and fastest reaction mechanisms. Soot inception and the early soot formation process are especially interesting as they are thought to determine the entire speed in which NOC and soot are formed and the amount produced. If this could be better understood there could be a dramatic reduction in NOC and soot emissions. This would benefit all kinds of domestic and industrial applications, such as transport and power processes which are used worldwide.

The formation and behavior of these particulates are governed by the temperature distribution of the environment they are in. The main aims of this project are to study the early soot formation process and how it is affected by various diluents and fuel additives for different fuels. In order to do this successfully, the flow field and temperature gradients must be well identified throughout the flames studied. Once these parameters are known, investigations into initial combustion reactions such as production of NOC, soot inception and subsequent reaction mechanisms can be accurately carried out, producing well defined results to realise how these pathways are influenced. The objective of the first part of this project is to investigate the temperature distribution throughout fuel lean flames using a novel technique which has been developed over the last year. The flames chosen for examination will also be subjected to varying degrees of dilution from different diluents, such as CO<sub>2</sub>, CO and N<sub>2</sub>, in order to study the effects these have on flame temperature. After this has been completed the technique will be further developed to incorporate flow velocity measurements, simultaneously producing temperature and velocity distributions throughout the chosen flames. The third and final part of the project will examine the soot particle size and number distributions in the same flames. This will allow for an investigation into the strong link between temperature and soot to be carried out, as well as providing information on how velocity, equivalence ratio and dilution effects can influence each other and the early soot formation process.

### **Novel flame temperature measurement technique:**

Two-dimensional laser-induced phosphorescence (2D-LIP) uses thermographic phosphors (TPs) to find the temperature of a system. Phosphors are thermographic if they display variations in their emission characteristics with a change in temperature. The 2D-LIP technique produces an image of the system which can be related, pixel-by-pixel, to temperature via a previously carried out calibration. The technique has been widely used for surface and gas temperature measurement and has been developed for usage in gaseous reacting jets for the first time, leading the way for 2D-LIP flame measurements. There are two methods for carrying out this technique; temporal and spectral, of which the spectral method is used in this study, where key wavelengths vary with temperature and their ratio can be related to temperature. The technique has been demonstrated using YAG:Dy which is considered an ideal TP for combustion measurements and is often used in high temperature studies. A 355 nm Nd:YAG laser, split into a sheet was used to excite the YAG:Dy, seeded within the flame, which subsequently emits a phosphorescence signal, collected by an ICCD camera fitted with an image doubler, through appropriate filters centered around the key wavelengths.

### **Results and discussion:**

The results show some basic temperature relations, proving the technique successful. Results were produced showing the temperature distribution of a sooting turbulent, partially premixed reacting jet with varying degrees of nitrogen dilution. The results reveal the structure of the partially premixed flame which has an inner premixed cone displaying much cooler temperatures than the external diffusion flame. There is a general increase in diffusion flame temperature as the height above burner (H.A.B.) increases. The diffusion part of the flame also shows a general decrease in temperature as more nitrogen is added. The premixed inner cone increases in length as more nitrogen is added. The maximum temperature measuring capabilities of the technique depends on which TP is used, in this case shown to be about 1580 K for YAG:Dy in a sooting flame. The results point to the technique performing better in a laminar flame. Now that the technique has been fully developed, current efforts are being invested in producing temperature relations for well characterised, fully premixed, laminar flames which vary from non-sooting to slightly sooting. Temperature relations for flames of varying equivalence ratio and dilution levels are underway.

### **Future work:**

As previously mentioned, there are three parts to this project, of which the first part is nearly complete. The second part will involve minor modifications to the experimental setup, allowing for another technique to be newly applied to flames; 2D-LIP-PIV which uses phosphorescent signal tracking to calculate the particles velocity, similar to particle image velocimetry (PIV) but with a single laser pulse and a high speed camera. This technique is relatively new and has not been applied to flames before. Finally, the early soot formation process will be explored using laser induced incandescence and fluorescence (LII and LIF) techniques. The overall progress of the project is being completed in good time. Part 2 of the project should be completed during summer, leaving approximately a year to carry out soot testing and completing the project.

## The investigation of gasoline partially premixed combustion based on the optical engine

*Pin Lu, Hua Zhao*

**Key words:** PPC, gasoline, low emission, high efficiency, optical technique

### Introduction

The purpose of this research is to run the high octane number fuel on the compression ignition engine in the PPC (partially premixed combustion) mode so that the high efficiency and low emissions can be achieved. Low NO<sub>x</sub> and soot can be achieved simultaneously when the combustion happens under homogenous (HCCI) or low stratified conditions (PPC). When the engine is running with diesel fuel at the higher load, the compression ratio has to be reduced or amount of EGR need to be added in, so that the start of combustion and the end of injection can be separated resulting in low stratification. High resistance of gasoline can promote the premix process without excess EGR. In this research, high injection pressure and octane number PPC will be running on the optical engine.

### Design/methodology/approach

The PPC work will be carried out in a single cylinder Ricardo Hydra diesel engine. Several optical measurement techniques would be employed to further explain the combustion process in this operation mode. High speed imaging is applied to observe the fuel spray and combustion event; two-colour method is to measure the flame temperature and soot concentration in the combustion chamber; Mie scattering and laser-induced fluorescence (LIF) is for distinct the liquid and gaseous phase during the fuel spray process; shadowgraph and microscope technique can be used to detect the fuel near nozzle spray so that the formation and breakup of spray is investigated clearly.

The diesel PPC would be running on the optical engine initially. On one hand, it can be the practical part to get more understanding of PPC mode. On the other hand, performance and emission comparison between diesel and gasoline will be analyzed. As the optimized strategy is founded on diesel one, the gasoline will be introduced on the PPC mode. The combination of the injection strategy (timing, angle, pressure) and intake, EGR will be tested to run the engine on PPC. In addition, the different octane number fuels will be applied as well.

### Findings/ results

The calibration of two-colour method has been done on a tungsten lamp. The calibration curve was obtained by the setting of F2.4 and 80, 85, 90, 95, 100 of gain number (intensifier). The principle the two-colour method is based on the estimation of flame temperature and KL factor. Two apparent temperatures from two distinct wavelengths generate an auxiliary equation so that the apparent temperatures at their corresponding wavelengths are evaluated. This is achieved by

obtaining the intensity values at each pixel through pixel by pixel analysis on every frame. The system is calibrated so that the intensity value at each pixel can be converted into flame temperature and KL factor.

The in-cylinder data has been collected for the diesel PPC run. Apparent heat release rate is calculated based on the in-cylinder pressure and volume which is a measure of the amount heat added, or subtracted, to the cylinder contents in order to achieve the same in-cylinder pressure.

### **Conclusion/discussion**

The sufficient ignition delay is needed when the engine is running at PPC with either gasoline or diesel. The long ignition delay it has, the more premix of gas mixture can have. That is the key to reduce the NOx and soot emissions. The injection strategy and EGR rate has to be further considered properly to get reasonable ignition delay.

### **Future plans/directions**

More work need to be done in the coming academic year, and time management is crucial to complete the research work in time.

### **References**

1. Kalghatgi, G.T., Risberg, P., and Ångström, H.-E., "Advantages of Fuels with High Resistance to Auto-Ignition in Late-Injection, Low-Temperature, Compression Ignition Combustion," SAE Technical Paper 2006-01-3385, 2006.
2. Kalghatgi, G.T., Risberg, P., and Ångström, H.-E., "Partially Pre-Mixed Auto-Ignition of Gasoline to Attain Low Smoke and Low NOx at High Load in a Compression Ignition Engine and Comparison with a Diesel Fuel," SAE Technical Paper 2007-01-0006, 2007.
3. Manente V., et al., "Half Load Partially Premixed Combustion, PPC, with High Octane Number Fuels. Gasoline and Ethanol Compared with Diesel", ARAI INDIA 295.
4. Manente, V., Johansson, B., Tunestal, P., and Cannella, W., "Effects of Different Type of Gasoline Fuels on Heavy Duty Partially Premixed Combustion," SAE Int. J. Engines 2(2):71-88, 2009.
5. Manente, V., Johansson, B., Tunestal, P., and Cannella, W., "Effects of Different Type of Gasoline Fuels on Heavy Duty Partially Premixed Combustion," SAE Int. J. Engines 2(2):71-88, 2009.

## 2-Stroke Engine Analysis and Design

*Jun Ma, Hua Zhao*

**Keywords:** 2-stroke, uniflow, scavenge, combustion

### Introduction

The primary advantage of 2-stroke engines is doubled firing frequency comparing to 4-stroke engines. With doubled firing frequency, theoretically, the power density is twice as much as the 4-stroke engine for same engine configuration, or for same engine performance, the engine works in a less severe state, the design of the engine can be more simple and downsized. But the conventional two-stroke engines suffer from poor fuel efficiency and generate high emissions.

Compared with the ported two-stroke engines in production, the uniflow 2-stroke engine is characterized with highest scavenging efficiency, high reliability, and can be boosted to produce higher power output. In this project, the in-cylinder flow, mixing and combustion process in a uniflow 2-stroke engine will be studied in a specially designed single cylinder engine by CFD and advanced laser and optical techniques.

### Design/Methodology/Approach

The approach of this project starts from numerical analysis. By simulating the engine working process, a proper engine configuration can be determined. According to the predicted engine configuration, special engine blocks will be designed, manufactured, and commissioned on a single cylinder engine with optical access. Various laser and optical techniques will be employed to study the flow and mixing process in the cylinder.

### Findings/Results

The 3D CFD simulation has been performed on the effect of intake port geometry on gas-exchange performance.,

1D engine simulation is being carried out on the timing events (valve/port timing, injection and combustion etc.),

The test engine block design has been primarily finalised and being machined

### Conclusion / Discussion

The numerical analysis indicates that there is a specific intake port configuration that gives the best gas-exchange performance for a certain engine configuration. The results have been used to determine the engine block design.

### **Future plans / directions**

Based on the numerical analysis result, the engine block design has been primarily determined, the engine assembly can be expected to be finished in 3 to 4 month, further engine experiment will be carried out on time.

### **References**

- [1] Golden P. Blair, The Basic Design of Two-Stroke Engines (Society of Automotive Engineers, Inc, 1990)
- [2] Reinhard Knoll, AVL Two-Stroke Diesel Engine, SAE Paper 981038
- [3] Eduardo C. O. Pepeira, Eurico F. A. Rodrigues, Jorge J. G. Martins, Design of a Fuel Efficiency Uniflow Two Stroke Semi-Direct Injection Engine, SAE Paper 970367
- [4] E. Mattarelli, Virtual Design of a Novel Two-Stroke HSDI Diesel engine, Int. J. Engine Res. Vol. 10
- [5] 'Press information Sirion 2CD'  
<http://www.daihatsu.com/brand/motorshow/frankfurt99/s2cd/index.html>

## A Study Of The Effect Of Vortices In Flow Around The Cylinder With A Rotational Degree Of Freedom

Seyed Hossein Madani, Hamid Bahai

*Fluid-Structural interaction / Computational Mechanics group*

**Key words:** circular cylinder; Vortex-Induced Vibrations, rotational d.o.f.

### **Introduction:**

The study of flows around cylinders has a long history [1, 2]. Although the study of flows around rotating circular cylinders is not new, most of the previous works consider the rotational speed as a parameter that can be used to decrease the effect of vortex shedding on the cylinder. In other words, angular velocity is viewed as a way to reduce the root mean square of the lift force. Forced oscillatory rotation of a circular cylinder has also been investigated numerically as well as experimentally [3]. Etienne and Fontaine [4] studied the effect of vortex shedding on a two dimensional cylinder with two spatial d.o.f. They observed that the cylinder was mainly oscillating transversely and slightly in line with the flow. When they added a rotational degree of freedom, for an arbitrary rotational moment of inertia, the transverse amplitude of oscillation was found to be reduced by a factor of two, while the mean in-line deflection was also found to decrease by a factor between 1.5 to 2. In this study, we evaluate the effect of introducing a rotational degree of freedom, on the flow around a circular cylinder. To achieve this we introduce the rotational angle of the cylinder as an unknown that is affected by friction-induced torque. Numerical simulations of Vortex-Induced Vibrations (VIV) of a circular cylinder in cross flow with a rotational degree of freedom about its axis have been carried out by means of a finite-volume method. The study is performed in two dimensions at a Reynolds number of  $Re_D = 100$ , based on the free stream velocity and the diameter, D, of the cylinder. The effect of the rotational degree of freedom on the cylinder's lift and drag forces are compared with the baseline simulation results of flow around a stationary cylinder.

### **Methodology:**

The cylinder was allowed to rotate about its axis. The rotation was controlled by adding a torsional spring with stiffness K. Because of the low Reynolds number, we were able to model the set up as a two-dimensional flow problem. At the inlet, the flow is assumed to be uniform. A free-slip boundary condition is applied along the upper and lower boundaries while a convective outflow boundary condition is applied at the outlet. At the surface of the cylinder, finally, a no-slip boundary condition is prescribed.

For this simulation the LESOCC flow solver has been used. LESOCC has been developed at the Institute of Hydromechanics at Karlsruhe, Institute of Technology, Germany. LESOCC uses a second-order accurate discretization of the convection and diffusion, combined with a three-stage Runge-Kutta method for the time-integration. It uses a collocated variable arrangement combined with momentum interpolation to avoid a decoupling of the pressure and velocity fields.

### **Result and discussion:**

For the present study, a mesh independency test was carried out and, as a result, a mesh with (360\*126) points in the circumferential and radial direction respectively was chosen. Numerous runs have been

carried out on the computing cluster at Brunel University. To simulate each case using 8 processors it takes nearly 2000 hours for the results to converge.

In this study, the effect of a rotational degree of freedom on vortex shedding and lock-in phenomena was investigated and the results were compared with flow around a stationary cylinder. For high (low) amounts of inertia the frequency decreases (increases) dramatically. In the stationary cylinder; the frequency of the vortex shedding for this case is 0.17. These results exactly match the results of Roshko [5]. Etienne and Fontaine [4] observed that the introduction of a rotational degree of freedom causes a reduction in the vortex-induced vibration in the transverse direction with the flow [4]. It implies that we should expect a lower lift when we have a rotational d.o.f. in combination with spatial degrees of freedom. In the absence of a spatial degree of freedom, our results show a completely different behaviour and predict a significant increase in unsteady lift forces acting on the cylinder due to the Magnus effect.

**Conclusion:**

The introduction of a rotational degree of freedom which allows the cylinder to rotate about its axis has a significant effect on the pattern of vortex shedding at low Reynolds numbers. In all cases considered, the vortex shedding locks-in to the natural frequency of the inertial/spring system. Compared to the baseline simulation of flow around a stationary cylinder, the addition of a rotational degree of freedom to the cylinder was observed to significantly increase unsteady lift forces because of the Magnus effect, while also the drag forces were not diminished. In the near future, we aim to complete the present parametric study of the effects of inertia/spring stiffness on the flow pattern and the lift and drag forces.

**Future work:**

The parametric study for this research needs to be developed for a higher range of the parameters. Due to insufficient computational power the improvement is very slow. To add more value to this research it is recommended to introduce translational degree of freedom to the cylinder as well.

**References:**

- [1] C.H.K. Williamson and R. Govardhan, “ Vortex- Induced Vibration”, Annu. Rev. Fluid Mech.(2004). 36:413-55.
- [2] T.Sarpkaya, “A critical review of the intrinsic nature of vortex-induced vibrations”, Journal of fluids and structure 19 (2004) 389-447.
- [3] Lam K M (2009).Vortex shedding flow behind a slowly rotating circular cylinder. *Journal of Fluids and Structures*, **25**, 245–262,
- [4]S. Etienne, E. Fontaine, “ Effect of Rotational degree of freedom on Vortex-Induced Vibrations of a circular cylinder in Cross-Flow”, Proceedings of the international offshore and polar engineering conference,3,pp. 1089-1093, 2010.
- [5] Roshko, Anatol (1954). On the drag and shedding Frequency of two dimensional bluff bodies, NACA technical note 3169.

## Omnidirectional Shear Wave Transducer

*Hugo Rodrigues Marques, Joe Au*

*TWI & Brunel University*

**Keywords:** Transducers, Long Range Ultrasonic Testing (LRUT)

**Introduction:** The environmental, social and economic impacts of structural failures in the petrochemical, nuclear and aviation industries are severe. In some cases these occur in plate-like structures only partially accessible and are currently difficult to inspect frequently. This provided the author's motivation to embark on a PhD in the field of Long Range Ultrasonic Testing (LRUT) with the objective of developing a novel omnidirectional shear wave transducer.

LRUT is a technique that evolved from the more conventional ultrasonic testing (UT). It operates in the kHz range, and uses the specimen under inspection as wave guide. It is commercially used in the inspection of pipelines. From the literature reviewed, LRUT has been researched to inspect plate-like structures using arrays of transducers [1-4]. In some, Lamb waves are successfully transmitted omnidirectionally from a localized array [2-4]. However, no evidence was found of omnidirectional transmission and reception of shear waves. Omnidirectional transmission allows guided waves to be transmitted in all directions equally, which facilitates full inspection coverage and can lead to defect mapping. The advantage of this type of transmission is evident when inspecting structures with limited access.

The aim of this research is to develop a transducer /array, capable of omnidirectionally transmit and receive the fundamental shear wave mode, SH0, in plates. There are two main advantages in using this wave mode as opposed to Lamb waves. Firstly, this mode (unlike Lamb waves), is entirely non-dispersive (i.e., the velocity is constant for all frequencies). Secondly, it causes purely in-plane particle displacement, allowing investigation of specific scenarios such as storage tanks, without attenuation due to energy leakage into the surrounding fluids.

**Design/Methodology/Approach:** Two test rigs have been designed and built by the author for this research. These will allow the characterisation and development of transducers and localised arrays. One rig comprises a carbon steel plate, similar to the ones found in storage tank floors. The other, comprises an aluminium plate; similar material and thickness is found in aircraft fuselages. Both plates sit vertically on purpose built steel frames. On both plates an array of equally spaced reference piezoelectric Lead Zirconate Titanate (PZT) transducers were permanently attached at the perimeter, which will operate mainly as receivers.

The test transducer/array under characterisation is positioned at the centre of the plate. A pulse/receiver unit provides the required kHz frequency range and pulse. The mechanical waves transmitted through the plate are then received by the permanent transducers and by the test transducer/array itself when in pulse-echo mode. The data collected is then analysed by numerical computing software such as Matlab. As shear waves do not propagate in gases or liquids, coupling fluids could not be used. Therefore a force loading device to enable mechanical coupling was designed and built. The device includes a digital load

cell to measure the applied load so it could be included as a variable to study. Another variable accounted for is temperature.

Type T thermocouples were installed, providing logs of the plates temperatures. Teletest® is the selected pulse/receiver unit. A Polytec PSV-400 1D scanning laser vibrometer is also being used. This equipment can provide confirmation of results obtained from the permanent transducers. To optimise the vibrometer use it was essential to apply a reflective coating on the steel and aluminium plates. New coatings and methods were developed by the author and evaluated against commercially available coatings. The evaluation parameters were the reflectivity of the coating when perpendicularly exposed to an artificial bright light in line with the observer eye, and also the signal-to-noise ratio of the signal captured by the vibrometer.

**Findings/Results:** Initial experimental transducer characterisation tests on the aluminium plate revealed the need for an optimum reception distance from the point of source to the determined, in order to optimise the characterisations using the vibrometer. At such distance no mode superposition occurs, allowing reception with a clear separation of wave modes. The results from the reflective coating evaluation showed that the coatings presenting a high level of brightness when exposed to bright artificial light were also the ones presenting the higher signal-to-noise ratio when analysed with the vibrometer. Some of the new coatings created were equally comparable in performance with the best commercially available, but many times cheaper, with the latter being cost prohibitive for large applications, as the specimen plates.

**Conclusion / Discussion** Initial experimental tests reveal that the rigs setup, together with the loading devices and reflective coating, provide a solid baseline for the characterisation and development of transducers and localised arrays. The newly created reflective coating allows for optimised and cost efficient vibrometry of large areas. The loading device enables a constant coupling of the transducers and the upright plates.

**Future plans / directions** The research is on track to be complete within the three year time scale. The initial experimental tests are being concluded. The next step is the characterisation of selected off-the-shelf transducers, followed by the development, manufacturing and characterisation of an omnidirectional shear wave transducer.

## References

- [1] - Diamanti K. , Soutis C., Hodgkinson J. M., "Piezoelectric transducer arrangement for the inspection of large composite structures" in Composites Part A: Applied Science and Manufacturing, Vol. 38, issue 4, pp 1121-1130, 2007.
- [2] – Wilcox P. D., Lowe M., Cawley P., "Omnidirectional Guided Wave Inspection of Large Metallic Plate Structures Using an EMAT array" IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Vol. 52, no. 4, pp. 653-665, 2005.
- [3] – Wilcox P. D., " Omni-directional guided wave transducer arrays for rapid inspection of large areas of plate structures," IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Vol. 50, no. 6,pp 699-709, 2003.
- [4] – Wilcox P. D., Lowe M., Cawley P., "Lamb and SH Wave transducer Arrays for the Inspection of large Areas of Thick Plates" in Review of Progress in Quantitative Non-destructive Evaluation, Vol. 19, D.O. Thompson and D. E. Chimenti, Eds. New York: AIP Conf. Proc., 2000, 1049-1056.

## Analysis of Vortices Passing through Curved Environments

Feven Mebrahtu, Reza Mokhtarzadeh

**Keywords:** Longitudinal vortices; Curvature; Pressure gradient; Shear layers; turbulent boundary layers; Hot-wire anemometry

**Introduction:** Stream-wise vortices occur in many turbulent flows in practical complex geometries. For example two major issues arising in S-ducts and other curved duct diffusers used for air intake systems are the flow separation due to their short length and high degrees of centreline curvature and secondly, the cross-stream pressure gradients which produce significant secondary flows. The most common technique to control separation and secondary flows in practice are by re-energising of the boundary layer via passive vane-type vortex generators. The flow phenomena to be investigate deals with three-dimensionality, curvature and pressure gradients which are a severe challenge for numerical models. The development of reliable turbulent models relies on the accuracy and validity of assumptions made (i.e. the validity of the universal law of the wall) therefore experimental data are vital for setting up reliable and accurate models.

The purpose of this project is to gather experimental data behind a row of vortex generators (VGs) located in the test section of a wind tunnel, ahead of a 90° curved duct to investigate the effect of curvature on the stream-wise development of artificially introduced vortices. The study first examines the flow in the wake of the vortex generators mounted ahead of a concave wall, a convex wall and in the free-shear. Review of literature has revealed that no experimental data currently exist for the longitudinal development of embedded vortices on convex surfaces or for the free-shear layer.

**Design/Methodology/Approach:** Experimental data was gathered via hot-wire anemometry techniques (StreamWare software package and StreamLine hardware with a calibration unit). The nature of flow to be examined is highly three-dimensional and requires all three components of velocity and Reynolds stresses ( $\bar{u'v'}$ ,  $\bar{u'w'}$ ,  $\bar{u'^2v'}$ ,  $\bar{u'v'^2}$ ,  $\bar{u'^2w'}$  and  $\bar{u'w'^2}$ ) to be measured and calculated. Both 55P63 (UV) probe and 55P64 (UV) probe are used to obtain three components of velocity, the root-mean-square, turbulence intensities and Reynolds stresses. The vortices are generated via half-delta wing passive vortex generators mounted in the free-shear layer and in the boundary layers along the top (convex) and bottom (concave) walls of the test-section.

Gathering detailed results at stations 1 to 5 and comparing with previous data was of primary importance in order to acquire the baseline/reference case data. Detailed measurements were obtained at stations 1-5 in both *cross-* and *span-wise* directions. The experiments were conducted at a free-stream of  $U_0=15\text{m/s}$ , using a sampling frequency of 10 kHz, 150,000 samples and a time interval of 15s. Comparison with previous studies (refs [1-2]) showed that the results are in good agreement with only small variations in the measured quantities. Further, flat plate boundary layer characteristics were tested and compared to well-established data to confirm that a good level of accuracy was being practiced.

The vortex generators (5mm x 20mm) were initially installed on the bottom wall in the straight section, 90mm from station 1 in order to determine the extent of flow distortion due to the presence of these vortices. Measurements were then carried out in the straight section at different stream-wise positions to track the development of the vortices ahead of the bend ( 10 and 55 vane heights) followed by measurements in the

curved region using increments of 1mm in the Z direction. The vortex generators were then installed on the bottom followed by the top wall 60mm ahead of the start of the curvature and measurements were conducted within the curvature. And finally two sets of vortex generators were inserted in the free-shear layer at the same stream-wise location. Initial tests were first carried out in the free-shear layer at station 3 using the large vanes (10mm x 40mm) to study the flow behind the flat plate with and without vanes. It was important to firstly establish the effect of the wake of the plate on the development of the vortices so both vertical and horizontal data were obtained for various pitch angles within the range of  $\pm 12^\circ$ , followed by the small vanes (5mm x 20mm). Detailed experimental data has been collected both the large the flat plate with vanes and without at an angle of  $-4^\circ$ .

**Findings/Results:** The analysis of results was performed via Matlab and Excel. The results in the straight section showed that at 10 and 55 vane heights downstream of the VGs the flow had been significantly distorted close to the wall and weakly further away from the wall and no wavy patterns were evident beyond 15mm above the wall. The means quantities showed that his distortion was not amplified as was expected in the curved portion although shear stress profiles show some redistribution of the turbulent structures had occurred. In the second case where the VGs are positioned at 60mm ahead of the curvature showed clear modifications to the flow occurred due to the presence of the vortices both on the concave and convex walls. The results in the boundary layer have shown that the concave and convex walls have opposite effects on the development of the vortices.

Investigations in the free-shear layer with the large vanes (10mm x 40mm) into the effect of the angle of inclination of the flat plate on vortex development showed an angle of  $-4^\circ$  as the optimum angle. A detailed set of experimental data was then obtained for the case of the large flat plate with and without vanes at an angle of  $-4^\circ$  using two different free-stream velocities. In order to associate the experiments on the concave and convex wall with the free-shear a detailed set of experimental data has also been obtained for the small vanes (5mm x 20mm) at the optimum angle of  $-4^\circ$ . The results in the free-shear layer have shown some interesting features which occurred within the flow that suggest the development of the vortex structures and the wake of the plate are significantly influenced by the inclination of the plate with respects to the flow.

**Future plans / directions:** The nature of the work demands an extensive number of hours in the laboratory in order to collect the necessary data and each case must also be carried out twice using two different probes in order to obtain all there components of velocity. This project is largely dependent on experimental data and so far only one station of four has been fully investigated. Therefore for the project to be meaningful and conclusive the remaining three stations must be completed over the next five months.

## References

- [1] Yuan Y.M (1991) An experimental study of coherent structures in turbulent boundary layers. PhD thesis, Brunel University, UK, 1991
- [2] Piradeepan N. (2002) An experimental and numerical investigation of a turbulent airfoil wake in a  $90^\circ$  curved duct. Ph.D. thesis Brunel University, UK, (2002).

## Friction factor and heat transfer in microchannels with three different hydraulic diameters

*Mirmanto Mirmanto, Tassos Karayiannis*

**Keywords:** Microchannel, friction factor, Nusselt number

### Introduction:

Microchannels are promising devices and have been studied in recent decades due to their capability to remove very high heat fluxes [1]. They also have been used in many industrial applications such as in cooling systems for computer processors [2], electronics, laser diode, gas turbine blades, bearing and cutting tools. The advantages of these microscale devices, in addition to size, include, less material needed, low weight, smaller amount of coolant and high overall system efficiency. Thus microscale devices offer long term benefits of resource conservation and environmental protection. However, the fundamental knowledge of fluid flow (friction factor) and heat transfer (Nusselt number) in microchannels are still required to be explored further because of the difficulties of accurate measurements at small scale. In addition, there is a wide disagreement in the published results [3].

### Experimental facility and methodology:

To explore the flow in microchannels, an experimental facility was used for conducting some series of experiments on friction factor and heat transfer. The working fluid, de-ionized water, was circulated from the main boiler through the entire loop by using a gear pump model O/C GA-T23 PFSB. The pump speed can be adjusted with the micro pump speed regulator “ISMATEC REGLO ZS digital drive”, so that the desired mass flow rate of working fluid can be achieved. A coriolis flowmeter (model Elite MF010 micro motion) was used to measure the mass flow rate and two pre-heaters were employed to get the temperature of the fluid to rise up to a certain required degree. The heat source for the pre-heaters is an AC power controlled by using a PID, whilst for the test section, the heat source is provided using a cartridge heater model CIR-1029/240V 225 W. The cartridge heater was operated by means of a variac 280 V. A cooling system is also connected to the test rig to cool several parts on it. The system uses a refrigerant R22 with a capacity of approximately 3 kW. Chilled water glycol is used as the working fluid to remove the heat from the test rig and carry it to the cooling system.

There are three test sections used in the experiments with a constant depth of 0.39 mm, widths of 0.5 mm, 1 mm and 1.71 mm. All test section lengths are 62 mm and they are made of cooper block. The channel was grooved on the top of the copper block by using micro milling machine HSPC KERN 2216 with a speed rotation of 10000 RPM, feed rates of 100 mm/min and cut of depth of 0.24 mm (at first cut) to 0.08 mm (at finishing). The width of the test sections was measured using SEM technique with an accuracy of  $\pm 2 \mu\text{m}$ , whilst the depth was measure using TSER V200 microscope with an accuracy of  $\pm 2 \mu\text{m}$  and the length was measured using digital vernier caliper with a resolution of 10  $\mu\text{m}$ .

### **Experimental results:**

Experiments were performed to measure the pressure drop, friction factor and the heat transfer coefficients (Nusselt number), and to identify some deviations of flow behavior from conventional passages. The pressure drop was obtained by measuring inlet ( $p_i$ ) and outlet ( $p_o$ ) pressures, and the friction factor can be estimated using Eq. 2.

$$\Delta p_{ch} = p_i - p_o - \Delta p_{loss} \quad (1)$$

$$f_{ch} = \frac{\Delta p_{ch} D_h}{2L\rho \bar{V}_{ch}^2} \quad (2)$$

The heat transfer coefficient and the Nusselt number are calculated using Eq. 3 and 4:

$$\bar{h} = \frac{q''}{\Delta T_{lm}} \quad (3)$$

$$\bar{Nu} = \frac{\bar{h} D_h}{k_l} \quad (4)$$

Experimental friction factors and Nusselt numbers have been obtained for three different hydraulic diameters of microchannels and they are compared with the conventional theory and some correlations such as apparent friction factor ( $f_{app}$ ) for developing flow [4], Dittus-Boelter, Gnielinski [5] and Nusselt number correlation for laminar developing flow [6]. Also, the trends of friction factor and Nusselt number in laminar flow seem to increase with the Reynolds numbers.

### **Conclusion:**

Experimental friction factors and Nusselt numbers are higher than those of conventional theory of fully developed flow, but in reasonable agreement with the developing flow theory of friction factor and Nusselt number. Some correlations used for comparison can predict the experimental data. No effect of hydraulic diameter on friction factor and Nusselt number was found.

The future work includes observation of the flow pattern and the timing synchronised boiling, and measurement of the flow boiling pressure drop and heat transfer coefficient.

### **References:**

- [1] Mudawar I., Assessment of high heat flux thermal management schemes, *Transactions on Components and Packaging Technologies*, 24(2):122-140, 2001.
- [2] Naphon, P., Wiriyasart, S., Liquid cooling in the mini rectangular fin heat sink with and without thermoelectric for CPU, *Int. Communications in Heat and Mass Transfer* 36, pp. 166-171, 2009.
- [3] Morini, G.L., Single phase convective heat transfer in microchannels: a review of experimental results, *Int. J. Thermal Science* 43, pp. 631 – 651, 2004.
- [4] Shah, R.K., A correlation for laminar hydrodynamics entry length solution for circular and non circular ducts, *Journal of Fluids Engineering*, Vol. 100, pp. 177 – 179, June 1978.
- [5] Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S., *Fundamental of heat and mass transfer*, Sixth Edition, John Wiley and Sons, USA, 2006.
- [6] Bejan, A., *Convection heat transfer*, Third Edition, John Wiley and Son, Inc., USA, 2004.

## Error analysis on Apparent Heat Release Rate calculation in HSDI Diesel Engine combustion

*G. Abbaszadeh Mosayebi, Lionel Ganippa*

*Centre for Advanced Powertrain and Fuels Research (CAPF), School of Engineering and Design*

**Keywords:** Diesel, error calculation, Heat release analysis, In-cylinder pressure, specific Heat capacities ratio

### **Introduction**

Induced error on Apparent Heat Release Rate (Ahrr) in respect to in cylinder pressure and Specific Heat capacity ratio ( $\gamma$ ) were studied in this work. It was found that Ahrr was affected more by  $\gamma$  in compare to in -cylinder pressure. By using the Ahrr error function absolute error value was calculated for Ahrr and the location of maximum error on Ahrr was discussed. Also error on cumulative heat release was calculated.

### **Design / Methodology /Approach**

A four cylinder High Speed Direct Injection (HSDI) metal diesel engine was employed to study two bio-Diesels (RME and JME) along with Ultra Low Sulfur Diesel (ULSD) as a reference fuel at wide range of engine conditions.

### **Findings/Results**

It was found that  $\gamma$  can affect Ahrr significantly in compare to in -cylinder pressure. It was also found that in-cylinder pressure linear error cannot affect  $\gamma$  value.

### **Conclusion / Discussion**

1. Ahrr accuracy follows the in-cylinder pressure data accuracy. Using an accurate pressure transducer can provide acceptable values for Ahrr.
2. Specific heat ratio cannot be affected by linear in-cylinder pressure error values.
3. Ahrr values can be affected by error on  $\gamma$  values significantly in compare to in-cylinder pressure.
4. Ahrr absolute error increases by increasing injection pressure.
5. It was found that Diesel fuel has the highest absolute error in respect to  $\gamma$  values and RME has the lowest Ahrr absolute error value.

6. It was found that overestimating of  $\gamma$  value results underestimating of Ahrr values and vice versa.
7. Cumulative heat release can be affected by error on  $\gamma$  value. Cumulative heat release relative error is less than relative error on  $\gamma$  and also less than Ahrr relative error value. It is concluded that error on cumulative heat release due to error on  $\gamma$  is negligible.

### **Future Plans / Directions**

It is planned to improve the paper by finding alternative method to calculate  $\gamma$  value.

It is planned to publish the papers and start writing of the theses.

### **References**

1. Benjamin Robert Brown (2010), combustion Data Acquisition and Analysis, Loughborough University.
2. S Rousseau; B Lemoult and M Tazerout. Proceeding of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering 1999 213: 481.
3. Haywood, J.B. Internal Combustion Engine Fundamentals, 1988 (McGraw-Hill).

## Exhaust Gas Recirculation in Future Spark Ignition Engines

Ben Moxey, Alasdair Cairns

Mechanical Engineering / School of Engineering and Design

**Keywords:** Gasoline, Fuel Economy, Exhaust Gas Recirculation, Controlled Auto-Ignition, Alcohol Fuels, Downsizing

### Introduction

The aim of the project is to improve the fundamental understanding of the optimum use of Exhaust Gas Recirculation (EGR) in future spark-ignition engines (i.e. downsized), in conjunction with future fuels (i.e. ethanol/gasoline blends). This is done in two stages. Firstly, a single cylinder optical engine – the Brunel Optical Research Engine (BORE) - is employed with spark-ignition in the laboratory to gain empirical data with varying EGR volumes inducted into the cylinder and with varying fuel types. This data is then used to complete a reverse mode thermodynamic analysis of the engine and of the EGR/fuel type combination. Much research has been completed and is still on-going regarding the future of SI engines and many OEMs consider downsizing alone to be the method of most reward [1, 2] However in an IMechE paper already published and co-authored by myself [3], it is proved that the fullest fuel economy benefits can be achieved when running an engine larger than 1.4L with Controlled Auto Ignition (CAI) and EGR. This is the second phase of the research which simulates a CAI engine with EGR and future fuels sweeps to analyse the effect these have on combustion speeds in cylinder. CAI engines are considered to have an emissions improvement far beyond anything that an SI engine can achieve [4]. It is hoped that another paper (at least) can be gained from further investigation into this work focussing more on unthrottled work with EGR.

### Design / Methodology / Approach

In the Tower C laboratory is the BORE which is a 631cc engine with a four valve layout, situated laterally in the head. The inlet system is rigged to the SED's wind tunnel compressor to charge the inlet air to a maximum of 2 bar. This feeds into a pressure vessel to iron out pressure waves to ensure a constant supply. It is into this plenum that the EGR will be reintroduced (crucially *after* the throttle so as to minimise pumping losses [5]). Once the air/EGR mixture is as required it is then passed through an in-line heater to maintain a constant desired temperature and the fuel is then injected into the manifold before entering the cylinder. A centrally located spark plug developed in-house for this project by myself and embedded in a silica window will then combust the charge, allowing not only full bore optical access but spark kernel and early flame propagation visualisation.

These images, captured on a MEMRECAM fx-6000 high-speed camera, will be passed through a MATLAB code that will apply a spatial filter to the images and assign a value between 0 and 1 on a contrast scale. At this point, depending on frame rate and brightness values, a filter value can be applied to differentiate between the burnt and fresh charges – this information will supply a flame area for analysis. The images will also be used in conjunction with a FORTRAN code to analyse the mean flame radius, the flame shape and the crossing point frequency of the flame front as studied by Hicks [6] and Gillespie [7] among others.

The reverse mode analysis will be carried out on two differing softwares. The thermodynamic analysis will be conducted using Ricardo WAVE while any fuel economy benefits discovered will be validated using GT-Power to submit the engine not only to a drive-cycle simulation, but to a drive-cycle simulation *with* a vehicle connected to it to account for any road-load losses (mass loads, tyre rolling resistance or excessive coefficient of drag) or gearbox frictions to provide any fuel economy improvement findings with a real world figure to support it.

### **Findings / Results**

So far one paper has been co-authored for the IMechE publication, *Journal of Automotive Engineering* under the title of “Optimising the trade-off between gasoline engine downsizing and controlled auto-ignition combustion” [3]. It is hoped that further analysis of the un-throttled SI engine with internal EGR and Variable Valve Actuation will lead to a second paper at least. As for empirical data and results, due to several set-backs in the lab the engine has only been firing for a period of around 3 months. This has hampered operation but recently we achieved the first flame images while running Natural Light imaging. Over the coming weeks and months the amount of images will grow along with additional images of the flame captured using the more precise double pass shadowgraph method. From this correlations can be drawn and validation can be completed

### **Conclusion / Discussion**

The results obtained so far have already adapted the thesis direction and are shaping the aim and objectives. This natural and organic process is vital for any work and as the results come in, then the thesis will pick up pace and draw to a conclusion for presentation at that stage only. To conclude the project prior to completion would invite error and fault upon the author. Every confidence is that the project will be completed by the October 2013 deadline.

### **References**

- [1] Krebs, R., (2004), *The New Audi 2.0LT-FSI Motor-The first DI Turbo Gasoline Engine at Audi*, 25<sup>th</sup> International Vienna Motor Symposium
- [2] Yi, J. et al, (2009), *Development and Optimization of the Ford 3.5L V6 EcoBoost Combustion System*, SAE Int. J. engines Oct 2009 Vol 2(1) 1388-1407
- [3] Cairns, A., Moxey, B., Ganippa, L. Zhao, H. and Bassett, M. (2012), *Optimising the trade-off between gasoline engine downsizing and controlled auto-ignition combustion*, Journal of Automotive Engineering (Pending)
- [4] Mori, S., Lang, O., Salber, W., Pischinger, S. and Bucker, C. (2006), *Type Analysis of EGR-Strategies for Controlled Auto Ignition (CAI) by Using Numerical Simulations and Optical Measurement*, SAE Paper 2006-01-0630
- [5] Cairns, A., Fraser, N. & Blaxill, H. (2008), *Pre Versus Post Compressor Supply of Cooled EGR for Full Load Fuel Economy in Turbocharged Gasoline Engine*, SAE Paper 2008-01-0425
- [6] Hicks, R. A., Lawes, M., Sheppard, C. G. W. and Whitaker, B. J. (1994), *Multiple Laser Sheet Imaging Investigation of Turbulent Flame Structure in a Spark Ignition Engine*, SAE Paper 941992
- [7] Gillespie, L., Lawes, M. Sheppard, C. G. W. and Woolley, R. (2000), *Aspects of Laminar and Turbulent Burning Velocity Relevant to SI Engines*, SAE Paper 2000-01-0192

## A Novel Viscoelastic Cohesive-Zone Model: Formulation, Validation and Enrichment Through Process-Zone Micromechanics

*Marco Musto, Giulio Alfano*

A novel rate-dependent cohesive zone model combining damage and viscoelasticity is presented. Its formulation is described in the framework of thermodynamics with internal variables and relies on two major assumptions. Firstly the existence of an intrinsic, hence rate-independent, fracture energy is postulated. Secondly, the evolution of the internal variables characterizing the evolving interfacial damage is driven by the current free energy and the intrinsic fracture energy. Phenomenological assumptions supporting the use of ad hoc time – dependent damage evolution laws are avoided.

The physical idea upon which these assumptions are laid is that the energy of the bonds at the micro-level is rate-independent, so that the rate-dependence of the overall crack propagation phenomenon is only the result of viscoelastic dissipation occurring within the process zone and of the presence of two different mechanisms for storing elastic energy. Coherently with the CZM approach, the rate-dependent contribution to the observable fracture energy is lumped on an idealized zero-thickness interface, whose constitutive equation is then naturally derived by assuming that the constitutive law for the bulk material is a valid characterization of the process-zone behavior, after the necessary changes in the used deformation measure are made [1].

The formulation is very general and for the purposes of an experimental validation it is specialized to linear viscoelasticity with one single relaxation time. This decision is motivated by the will to test the fundamental principles the model is built on before proceeding to adopting more refined and suitable constitutive laws capable of accurately characterizing material and geometrical non-linearities.

The results of numerical computations are then presented and compared to a set of experimental data obtained for a DCB specimen with metallic arms bonded through a rubber interface tested at different loading rates in displacement-control. Figure 1 shows that the correlation between experiments and prediction is rather good for displacement rates between 0.1 mm/min to 100 mm/min , which is the expected captured range for continuum problems if a viscoelastic model with one relaxation time only is used. These results strongly support the validity of the adopted modeling strategy, whereby further model refinements are expected to result in an highly effective analysis tool for industrial applications.

In one particular aspect the model can be significantly improved. In the original formulation, whose details are given in [2], the dissipated energy, i.e. the ‘measured’ fracture energy, is monotonically increasing. On the other hand there seems to be experimental evidence of the fact measured fracture energy may not be a monotonic function of crack speed for some material such as rubber [3]. In the authors’ opinion, this discrepancy possibly originates from an insufficient characterization at the mesoscale, because the mechanism of fibrils nucleation is neglected [2]. We will show that the phenomenon can be energetically accounted for using a variational formulation of fracture [4]. Preliminary analytical calculations will then be presented to highlight the potential of the procedure in characterizing “stick-slip” type instabilities [5] and indicate future outlooks.

## **References**

- [1] G. Alfano, E. Sacco, Combining interface damage and friction in a cohesive-zone model. Int. J. Numerical Methods in Engineering 65: 542-582, 2006
- [2] M. Musto, G. Alfano, A novel rate-dependent cohesive-zone model combining damage and visco-elasticity. Submitted to Computers & Structures
- [3] K. Tsunoda, J. J. C. Busfield, C. K. L. Davies and A. G. Thomas, Effect of material variables on the tear behaviour of a non crystallising rubber. J. Materials Science 35: 5187–5198, 2000
- [4] B. Bourdin, G.A. Francfort and J.J. Marigo, The variational approach to fracture, J. Elasticity 91: 5-148
- [5] D. Maugis, Subcritical crack growth, surface energy, fracture toughness, stick-slip and embrittlement. J. Materials Science 20: 3041-3073, 1985

## Effect of substrate geometry on the properties of diamond-like carbon films deposited by PECVD

*Nico Nelson, Richard Rakowski*

**Introduction:** Thin film coatings are being used extensively for tribological applications in order to reduce wear, increase life and improve efficiency of mechanical components. Diamond-like carbon (DLC) is an amorphous carbon thin film containing both graphitic ( $sp^2$ ) and diamond ( $sp^3$ ) bonds as well as a certain amount of hydrogen depending on the deposition process<sup>1</sup>. Hydrogen content and ratio of  $sp^2$  to  $sp^3$  bonding are significant factors in governing the properties of the coating. Many applications require a reliable uniform coating over geometrically complex surfaces. The plasma enhanced chemical vapour deposition (PECVD) method is considered ideal for such applications as it allows for large areas to be relatively uniformly coated at low temperature and minimal cost<sup>1</sup>.

The expected uniformity is due to PECVD being a non-line of sight process in contrast to other methods in which geometrical effects have been studied<sup>2</sup>. For this reason there has been little consideration given to the effects of substrate geometry on PECVD DLC coatings. This study focuses on assessing variations in coating structure, topography and characteristics which occur as a result of substrate geometry. It will also investigate how these variations affect the mechanical properties of the film, particularly in regards to machine tool applications.

**Methodology:** DLC coatings were deposited on 1cm<sup>2</sup> silicon wafer samples. Samples were either placed flat on the cathode plate or were clamped at the base and held vertically. Coating parameters were based on those previously developed for drilling applications<sup>3</sup>. The DLC coatings were initially examined using scanning electron microscopy (SEM) to investigate any variations in surface structure. Coating thickness was also measured on a sectioned sample using SEM. Atomic force microscopy (AFM) was used to quantify any variation in the surface texture of the DLC. Selected areas on the samples were measured in terms of roughness ( $R_a$ ), skewness and kurtosis at scan sizes of 1 and 10μm. X-ray photoelectron spectroscopy (XPS) has been used to determine how composition at the surface may vary in the samples.  $sp^2/sp^3$  ratios have been calculated by deconvolution of the C1s peak using a method described in a previous study<sup>4</sup>. Tribology tests were performed at the National Physical Laboratory using a 20μm radius diamond tip. Friction tests were conducted using forces of 30 and 60μN whilst Scratch tests used a ramped load of 10 to 200μN.

**Results & Discussion:** SEM analysis of the samples revealed clear differences in the DLC coatings. The horizontally positioned samples had no variation in the coating at the surface. The surface structure near the top of the vertically positioned samples, however, shows a greatly altered topography.

AFM investigations highlighted further variations between the vertical and horizontal samples particularly in terms of roughness values. Average roughness of the horizontal samples remained low at just 0.54 and 0.52nm at the middle and edge, over a 10μm area. The roughness of the vertical sample was much greater than the horizontal sample and varied with distance from the top. The top edge had a roughness of 14.6nm, this decreases considerably within the first millimetre, before levelling at 1.8nm. Skewness and kurtosis also show

significant variation between the top 1mm and the middle of the sample. Analysis of the sample sections shows that the coating thickness varies significantly on the vertical sample. The area near the top of the sample has a thicker film of  $1.8\mu\text{m}$  compared to the middle which was  $1.5\mu\text{m}$ . The horizontal sample remained constant at  $1.68\mu\text{m}$ . XPS revealed the horizontal sample to have a constant  $\text{sp}^2/\text{sp}^3$  ratio of 0.65. The top of the vertical sample had a similar ratio whilst the middle was seen to have lower ratio of 0.6.

Tribology tests revealed variations between the samples. Friction coefficients of the horizontal and vertical samples were similar at 0.041 and 0.054 respectively. Critical loads of the horizontal samples were 8.1N whilst the vertical sample failed at 4.3N. Surface structure,  $\text{sp}^2/\text{sp}^3$  ratios and film thickness are related to the energy and density of impinging ions as well as the substrate properties and temperature. The balance of nucleation and growth mechanisms, ion implantation and surface diffusion as well as sputtering and etching from argon and hydrogen in the plasma may be affected by tip enhancement factors and localised heating<sup>4,5</sup>.

**Conclusions:** In contrast to previous literature the DLC coating thickness, roughness and composition have been shown to be significantly affected by the geometry of the substrate. The  $\text{sp}^2/\text{sp}^3$  ratio of the DLC on the vertical plane reduced from 0.65 at the top of sample to 0.6 at the middle. Surface roughness is over 7 times greater at the top of the vertical sample than in the centre and is 30 times greater than that of the horizontal sample. Film thickness varied by  $0.7\mu\text{m}$  (45%) between minimum and maximum points. The critical load of the vertical sample was half that of the horizontal sample.

This variation will have a significant impact on the effectiveness of the coating, particularly with complex substrates such as biomedical devices, mechanical components and high precision machine tools. It is important to understand these effects in order to fully optimize DLC coatings for such applications.

**Future Plans:** Further experiments will be conducted in order to gain an improved understanding of how the coating properties can be affected by the geometry of the substrate being coated. As well as investigating variations based on orientation, samples of varying sizes will be coated. This will aid in the understanding of how the distance from the cathode plate may affect the energies of the impinging ions, which in turn affects the coating characteristics and mechanical properties.

Experiments will also examine various surface orientation angles in regards to the cathode plate. The tip enhancement effect will also be studied further by DLC coating tips of varying radii before analysing the coatings using SEM, AFM, XPS and Raman. Substrate materials may also have a significant impact on how the geometry affects coatings due to variations in surface texture and electrical properties, therefore samples with varying levels of conductivity may be investigated also.

## References

1. J. Robertson; *Mater. Sci. Eng. R* 37 (2002) 129
2. K. Bobzin et al; *Plasma Process. Polym.* 6 (2009) 425
3. M. Zolgarni et al; *Diamond Relat. Mater.* 17 (2008) 1733
4. B.J. Jones et al; *Diamond Relat. Mater.* 20 (2011) 1030
5. X.L. Peng et al. *Surf. Coat. Technol.* 138 (2001) 23

## Simulation of Bending in off-shore Flexible Risers: Deformation of Tendon Layers

Shayan Norouzi, Hamid Bahai, Giulio Alfano

Mechanical Engineering, School of Engineering and Design

**Keywords:** Riser, Tendon, ABAQUS, Finite Element, Bending, Strain

### Introduction

Unbounded and flexible oil risers design and manufacturing technology has over the recent times developed significantly in response to the off-shore oil industry's demands. As the exploration for oil and gas moves to increasing sea depths, the processes of design / installation of extra-long risers are vital [1]. Each flexible riser consists of variety of layers with different performances. These mostly non-metallic layers are essentially held together using helical metallic wires called *Tendons*. There are usually two tendons which are wound in opposite angular positions with each other in order to eliminate the torsion induced in the riser due to the existence of the first tendon.

In this paper, a four layer flexible riser with just one helical tendon (no tensile/ pressure deformation) subjected to a bending load is simulated. The purpose of this simulation, the results of which will be compared to experimental results in the next stage of the project, is to analysis the structural integrity of the riser. Flexible risers usually fail due to fatigue of the tendon members. Accurate analysis of the stresses in the helical tendon is therefore an essential part of the riser design process. Most of previous works of research team members, as well as the works by other researchers, have been focused on tensile/pressure conditions. Flexible risers are usually subjected to significant bending during service and hence the focus of this work will be to consider the effect of bending as well as other modes of loading. In future, the results simulated using a Finite element program will be compared with experimental work.

### Design / Methodology / Approach

First of all, in order to simulate the strain changes in tendon under bending conditions, CAD software is required; for this case SOLIDWORKS was used. All components, which in the future should be tested experimentally, have been designed and dimensioned and then ordered for further experimental lab tests, which means CAD modelling was helpful for both simulating and practical tests. The riser designed in this paper consists of four main layers and some other components. These layers are:

- **Transparent outer layer:** This is the outer cylindrical layer of the specimen. It is made out of clear polycarbonate plastic which covers tendon layer (and all other layers of the riser).
- **Tendon:** This is the red helical layer made of steel wire. Much of the work in this project is focused on assessing the structural integrity of this component.
- **Cylinder:** This is the inner cylindrical layer, which is made of clear polycarbonate plastic. It holds the carcass layer in place, and is covered by tendon.
- **Carcass:** is the darker helical layer with pitches.

The next stage of the project involved modelling the riser assembly by using the finite element analysis (FEA) method. The FEA program adopted was ABAQUS. The material chosen for both simulation and physical test was mild steel CR4 (BS1449) for the tendon layer and clear polycarbonate plastic for the cylinder and the cover layers. It has been assumed that tendon has non-linear elasto-plastic behaviour. The finite element mesh involved the use of hexagonal solid elements and a convergence study was conducted to achieve an optimum mesh. The interface between various layers of the riser was modelled using contact elements. This is an important part of the modelling. The contact algorithm accounts for friction between various layers. For tangential behaviour, Penalty Friction formulation, isotropic directionality, and COF of 0.5 was selected. For the case of normal behaviour, Hard Contact Pressure-Overclosure and Default Constraint Enforcement Method were chosen. In order to define the boundary conditions (BC), two options are possible: to define the areas of both ends of each layer as BC, or to define two initial nodes (called set-points) and connect all areas to those nodes and then assume that those nodes as BC; the first approach is much faster and generate faster results with sufficient accuracy.

## **Results / Discussion**

Under the lower bending load condition, the main critical area is likely to be around the location where contact between the loaded part and the cover takes place. I.e. in the middle of tendon which is at its lower value because of the opposing influence of the external load and the internal pressure. However, the other parts are still dominated by the effect of internal pressure.

By increasing the load, the deformation caused by bending increases and therefore lower strain changes will be seen. The minimum value of strain of less neutralized internal pressure could be even less than the lower strain of the first loading condition.

## **Conclusion / Future Plans / Directions**

From the initial analysis carried out so far it can be seen that the accurate numerical models have a critical role in the design of flexible risers.

The next level is to test the riser experimentally in lab. To conduct bending tests on specimens in the lab, some strain gauges will be attached on the tendon layer at various locations. The results will then be compared with those obtained from the numerical model. Software called SCORPIO will be used for finding the deformations on strain gauges. The next stage of the project will include conducting riser fatigue analysis. This will involve modelling the crack propagation in the riser tendon components. The riser specimen will be subjected to cyclic loading tests using the INSTRON machine which will be controlled by WAVEMATRIX software. An FEA crack propagation software, Zencrack, will be used to simulate and predict crack growth on the specimen.

## **References**

- [1] Bahtui, A., 2008. *Development of a Constitutive Model to Simulate Unbonded Flexible Riser Pipe Elements*. Ph. D. Brunel University London.
- [2] Forrest, P.G., 1962. *Fatigue of Metals*. London: PERGAMON Press LTD.
- [3] National Instrument, 2001. *Measuring Strain with Strain Gages*. [online] Available at: <<http://www.ni.com>> [Accessed 13 Dec 2011].

## Particulate Matter Emission From Different Combustion Modes in a 2/4 Stroke Switchable Direct Injection Gasoline Engine

*Mohammed Ojapah, Hua Zhao, Yan Zhang, Lionel Ganippa*

*Centre for Advanced Powertrain and Fuels*

### Introduction

Direct injection gasoline engines are staging a come-back because of its potential for improved fuel economy through principally the engine down-sizing by boosting or 2-stroke operation, and possibly stratified charge combustion or Controlled Auto Ignition (CAI) at part load operations. Due to the limited time available for complete fuel evaporation and the mixing of fuel and air mixture, locally fuel rich mixture or even liquid fuel can be present during the combustion process. This causes significant increase in Particulate Matter (PM) emissions from direct injection gasoline engines compared to the conventional port fuel injection gasoline engines, which are of major concerns because of its health implications.

### Methodology

#### *Background theory*

The ability of CAI combustion is to burn highly diluted or lean air and fuel mixture, the pumping loss is minimised and the NOx emission is kept at ultra-low levels [1]. Although CAI combustion can be achieved in Port Fuel Injector gasoline engines, GDI brings the additional means of controlling mixture formation and CAI combustion process through flexible in-cylinder injection timing [2]. Direct injection is often used to take advantage of its charge cooling effect for high compression operations without knocking combustion. In addition, in order to achieve highly downsized engine with superior performance, as a member of a consortium, Brunel University has been working with Ricardo UK in developing the 2/4 stroke switchable engine technologies over the last several years. Cleaner and renewable fuel is being introduced worldwide as an alternative transportation fuel for several reasons. The PM emissions results using ethanol/gasoline mixtures E15, E85 and pure gasoline are presented.

#### *Experimental set up*

All experiments were conducted on a unique research single cylinder direct injection gasoline camless engine comprising of the high pressure hydraulic pack for the electro-hydraulic actuators, an AC dynamometer, a supercharger unit, gaseous and particulate emission measurement and analysers, data logging and analysis system.

### Results and Discussions

The results obtained show that the number of particles of 15nm or larger in diameter decreases rapidly when the ethanol content is increased from zero to 15%. However, addition of ethanol

leads to increased number of the smallest particles less than 5nm in diameter. Furthermore, the particle number reaches its minimum value for particles of diameters greater than 18nm. The dominant peak of within 20nm-30nm particulates may be explained by the valve timing and fuel injection timing used. In the case of 4-stroke normal SI operation, fuel is injected into cold intake air during the intake process. During 4-stroke CAI operation with the negative valve overlap, the fuel injection takes place during the negative valve overlap period and fuel is injected into hot burned gases. During the intake and compression processes, some residual gas and fuel mixture can be stratified, causing locally fuel rich combustion and hence the formation of soot particles seen in the peak of the exhaust particle emissions. However, the addition of ethanol removes the peak associated with the soot particles due to the inherent tendency of oxygenates to produce less soot.

### **Conclusion and Further Work**

- The particle emissions from the DI gasoline engine are dominated by smaller particles. The effect of ethanol content on soot reduction becomes saturated when ethanol concentration reaches 15%, irrespective of the combustion modes. Hotter charge and better mixing are the main parameters affecting the soot particles in the exhaust irrespective of the combustion mode.
- Further work will be the expansion of the operational range for low and high loads, low and high speeds of the CAI combustion using various valve timing, injection timing and split injection and iEGR and cooled ext EGR

### **References**

- 1 Zhao H., HCCI and CAI engines for the automotive industry, Woodhead Publishing, Cambridge, 2007.
- 2 Tongroon M., and Zhao H., “Combustion Characteristics of CAI Combustion with Alcohol Fuels”, SAE Paper 2010-01-0843, 2010.

## Investigating the mechanical behavior of the human jawbone under single and cyclic loading

*Pooyan RahmaniVahid, Ibrahim Esat*

**Keywords:** Dental Implants, Biomechanics, Behavior of Jaw bone

A review on mechanical behaviour of the jaw bone using their anatomical and restored structures is provided. It includes a description of involved principles and critical application to published finite element models ranging from three-dimensional reconstructions of jaws to investigations on the behavior of natural and restored teeth, plus basic materials science.

FE analyses can provide precise insight into the mechanical behavior of natural and restored craniofacial structures affected by three-dimensional stress fields which are still difficult to assess.

This study aims to analyze the mechanical behavior of human jawbone affected by single and cyclic loads from teeth and dental implants. The simulation and experimental observations are running in parallel to enable the research to evaluate based on comparing results. The overall purpose is to design an optimized implant to overcome the problems, especially for brittle bones.

### **Introduction:**

Dental implants are fine metal screws, which are inserted into pre-drilled sockets in the jaw bone. The implants hold new crowns, dentures or dental bridges in place and this enables the new tooth to work in exactly the same way as a natural tooth. There is little different type of oral implants, Root form implants is the type which is being used more often nowadays and there is a wide range of design for these kinds of implant comparing to other oral implants. In a process called Osseointegration, Root form implant is screwed to the jaw bone in order to play the role of the missing tooth or teeth.

This project aims at providing a review regarding the mechanical behavior of the jaw bone using their anatomical and restored structures. It includes a description of involved principles and critical application to published finite element models ranging from three-dimensional reconstructions of jaws to investigations on the behavior of natural and restored teeth, plus basic materials science.

FE analyses can provide precise insight into the mechanical behavior of natural and restored craniofacial structures affected by 3-dimensional stress fields which are still difficult to assess.

### **Design/Methodology/Approach:**

In this project it has been tried to analyse the mechanical behaviour of human jawbone affected by single and cyclic loads from teeth and dental implants. The simulation and experimental observations are running in parallel to enable the research to evaluate based on comparing results. The overall purpose is to design an optimized implant to overcome the problems, especially for brittle bones.

This project can be divided to three parallel categories which are run at the same time:

- Biomechanical behaviour and mechanical interaction between human jawbone and dental implants

First of all, there is a need to produce a simulation of human jaw bone and teeth separately, in order to enable the study to analyse the biomechanical behaviour of the bone in simulation environment (MIMICS). Then the created model would be analysed in Abaqus environment.

- Simulation analysis and new design

Second part aims at new design dental implants and analyse the interaction between the bone and the implants by use of Ansys and Abaqus.

- Fabrication of a new shape of implant

And finally, in order to be able to judge whether the new design meet the requirements of the study, they must be experimented in vitro. Therefore, new design of dental implant has been manufactured. In order to integrate and develop with an innovative approach several design features had to be considered:

These were, threaded surface, parallel walled shape, tapered and conical shape

#### **Findings/Results:**

Some artificial blocks similar to the density of human jaw bone have been provided. Then they have been tested the newly fabricated screws in artificial bone blocks. As it has been measured in previous studies, the load on the implants is up to four times bigger than natural teeth, this big difference exist even for the couple which created by dental implants. Since the implant is screwed into the jawbone straightly, this load would be transferred into the human jawbone and fracture might happen.

#### **Future plans / directions:**

While dental implants are considered as a safe alternative for natural teeth, but failure occurs in some cases. This problem is more common in brittle and weak jawbones. As the majority of implants users are adults or old people, their bone density is lower than normal human bone quality. The procedure of dental implant placing into the jawbone includes drilling the bone, screwing the implant, loading the implant root for required time, and placing the crowns and denture. Dental implants basic design has not been changed from their basic shape and form. They are considering as an expensive medical services. The overall aim of this study is analyzing the biomechanical behavior of human jawbone, and by considering the mechanical interaction between the implant and bone, introduces a new design of the implant which is an optimization of the present ones. I am planning to complete my PhD within 3 and half years.

#### **References**

- 1.T.Albresksson et al “The long term efficacy of currently used dental implants: a review and proposed criteria of success” 1997
- 2.PER astrand “ Tapered implants in jaws with soft bone quality: a clinical and radiographic 1 year study of the Branemark system Mark IV fixture”
- 3.Bertil Friberg “One-Year Prospective Three-Center Study Comparing the Outcome of a “Soft Bone Implant” (Prototype Mk IV) and the Standard Branemark Implant”
- Fiberg B et al, “ MKII: the self-tapping Branemark implant: 5-year results of a prospective 3 center study” 1997

## Time-frequency Analysis of Long Range Ultrasonic Signals

*Keith Thornecroft, Cristinel Mares*

**Keywords:** Time-frequency, guided waves, signal processing, long range ultrasonics

### Introduction

Long range ultrasonic testing (LRUT) is a relatively new development within the non-destructive testing sector. Traditionally, conventional ultrasonic testing (UT) is performed at high frequencies, in the MHz range, and is capable of detecting small flaws within a range of millimetres; whereas long range ultrasonic inspection is carried out at lower frequencies, typically between 20 and 100kHz, and is capable of highlighting structural detail and discontinuities tens of meters from a test position. Conventional ultrasonic testing relies on the transmission of bulk waves, the velocities of which are independent of frequency and can usually be predicted easily if the elastic properties of the material under test are known. The dynamics of the plate or guided waves involved in LRUT, however, are dependent upon frequency making the analysis of received data from a specimen complex. This paper will serve as a review of a range of time-frequency techniques which will allow a clearer understanding of the raw signals produced by this inspection process. Currently, LRUT data are assessed in the time or distance domain using the amplitude vs. time ‘A-Scan’, therefore structural features and potential flaws are highlighted on a time-of-flight basis. However, as the data obtained are dynamic in time and frequency (non-stationary), time-frequency distributions could provide a mode identification or de-noising process to deal with the problem of coherent noise. The class of structure examined here is carbon steel pipe; a common material used within industrial refineries and chemical plants worldwide to convey a variety of hazardous and non-hazardous materials. The processed results displayed are obtained from both real field inspections on industrial pipelines and laboratory trials.

### Design/Methodology/Approach

Representing and analyzing long range ultrasonic signals using time-frequency techniques is a natural progression from earlier research carried out on the subject of ‘long range ultrasonic testing using broadband excitation’ as the signals are non-stationary i.e. they posses information in both time and frequency. The equipment used to excite the structure is the *Teletest Focus<sup>+</sup>* pulser/receiver which is commercial system used to inspect pipelines out in industry. The received signals are complex and are multi-modal; this can lead to poor resolution. In order to distinguish and break down this complex signal a custom time-frequency toolbox within Matlab was used. Once a display in time and frequency is obtained and optimized each vibrational mode may be identified and isolated.

## **Findings/Results**

It has been found that by using a broadband signal on a pipe, a complex multi-modal signal is obtained. This single time domain signal can be represented in the time-frequency domain and the nature of each mode of vibration within the signal is displayed. The results gained so far are similar to those achieved by *Niethammer, M. et al. [2001]* which is promising.

## **Conclusion / Discussion**

The results gained and displayed using this technique can be analysed further, for example it may be possible to apply a threshold upon the decomposition of a multi-modal signal in order to achieve a higher signal to noise ratio. The signals received using LRUT suffer from coherent noise, i.e. unwanted signals which appear at similar frequencies and amplitudes to that of the desired signals. Each mode has a specific phase and group velocity at a given range of frequencies, this behaviour is known and can be used when decomposing each signal through time-frequency representations.

## **Future plans / directions**

The research seems to be on track and It is believed that once this current study on processing broadband LRUT data using a time-frequency processing technique is complete then the thesis will provide a good platform for a different outlook for the transmission, display and processing of LRUT data.

## **References**

- [1] Lokenath, L., "Wavelets and Signal Processing", *Applied and Numerical Harmonic Analysis*, Birkhäuser, Boston, (2003).
- [2] Flandrin, P., "Time-frequency / Time-scale Analysis", *Wavelet Analysis and its Applications Volume 10*, Academic Press, London, (1999).
- [3] Prosser, W. H., Seale, M. D. and Smith, B. T., "Time-frequency Analysis of the Dispersion of Lamb Modes", *Journal of the Acoustical Society of America*, 105, 2669-2676, (1999).
- [4] Niethammer, M., Jacobs, L. J., Qu, J. and Jarzynski, J., "Time-frequency Representations of Lamb Waves", *Journal of the Acoustical Society of America*, 109, 1841-1847, (2001).

## On the turbulent boundary layer developed on a flat plate with serrated trailing edges

Alexandros Vathylakis, Tze Pei Chong

*Aerospace Engineering / Mechanical Engineering*

**Keywords:** Aeroacoustics, Aerodynamics, Trailing edge Serrations on flat plate

### Introduction

There is renewed interest in using serrated trailing edge geometries for the reduction of airfoil self-noise radiation in the aerospace and wind turbine industries<sup>1-3</sup>. Trailing edge serratation is known to be easy to install and does not require complicated manufacturing processes. Theoretically<sup>4</sup>, significant noise reduction can be achieved when the root-to-tip distance  $2h$  is larger than the local turbulent boundary layer thickness,  $\delta$ , or the serratation wavelength,  $\lambda$  (spanwise distance between the tips of the saw-tooth) is small. More specifically, a serratation angle of less than  $45^\circ$ , or  $\lambda / h < 4$ , should be fulfilled. The above conditions have been verified experimentally and are generally found to be true<sup>1</sup>. However, the significant noise level reduction predicted by the theory<sup>4</sup> has not been confirmed by any experiments to date.

The mechanism by which the serrated trailing edges reduce the radiated self-noise is not yet fully understood. If the dominant noise source is the turbulent eddies at the trailing edge, the use of serratation could affect the acoustical scattering process. More attention should be placed on the turbulent boundary layer developed at the serrated region. This paper attempts to study the characteristics of the turbulent boundary layer at the serrated region using several experimental techniques that will be described in the next section.

### Experimental Setup / Design

The experiment is conducted in an “Air Flow Bench AF10” small-scale wind tunnel. Different Perspex flat plates with serrated trailing edges were fixed to one side of the AF11. The dimensions of the plate are  $295\text{mm} \times 150\text{mm} \times 5\text{mm}$ . The maximum speed inside the test section can reach approximately  $31 \text{ ms}^{-1}$  and open to the atmospheric air at the other end. To ensure a turbulent boundary layer is generated, rough sandpaper is used. The placement of the sandpaper will be chosen at a location that attains Reynolds number based on the displacement thickness greater than 520 to ensure that bypass transition to occur<sup>5</sup>.

A total of ten different trailing edges were designed in the current study:

- 1 sharp TE
- 9 serrated TEs of the followings:  $2h \in \{1, 2, 3\}$  (10mm, 20mm, 30mm)  $\times \epsilon \in \{1, 2, 3\}$  ( $12.5^\circ, 22.5^\circ, 45^\circ$ ).

## **Methodology**

Three different approaches have been used for the current investigation:

- i. Measurements for the investigation of the boundary layer profiles at the saw-tooth region using hot wire anemometry.
- ii. Unsteady wall pressure measurements by direct and remote microphone arrangement<sup>6</sup>, allowing measurements to be taken very close to all of the trailing edge designs.
- iii. Use of temperature-sensitive liquid crystals as the passive tracer to map the heat transfer rate of both the sharp and serrated edges.

## **References**

- [1] Gruber M, Joseph PF, Chong TP. On the mechanism of serrated airfoil trailing edge noise reduction. In: 17th AIAA/CEAS aeroacoustic conference and exhibit, Portland, Oregon. 2011, AIAA Paper 2011-2781.
- [2] Oerlemans S, Fisher M, Maeder T, Korler K. Reduction of wind turbine noise using optimized airfoils and trailing edge serrations. AIAA J 2009;47:1470-81.
- [3] Parchen R, Hoffmans W, Gordner A, Braun K. Reduction of airfoil self-noise at low Mach number with a serrated trailing edge. In: 6th international congress on sound and vibration, Lyngby, Denmark. 1999. p. 1433-40.
- [4] Howe MS. Noise produced by a sawtooth trailing edge. JASA 1991;90:482-7.
- [5] Schlichting H. Boundary Layer Theory. 7th ed., McGraw-Hill, 1979
- [6] Franzoni LP, Elliott CM. An innovative design of a probe-tube attachment for a  $\frac{1}{2}$ -in. Microphone. JASA 1998;104:2903

## Experimental Study of Flow Boiling in Small to Micro Channels

*E. A. Pike-Wilson, T. G. Karayannidis, D. B. R. Kenning*

**Keywords:** Flow boiling, Heat transfer, Micro-channel

**Introduction:** Heat transfer in flow boiling has been studied for many years but it is only in recent years that the attention has turned to smaller diameter channels. The desire for smaller technology is continually increasing and with this, the demand for smaller heat exchangers with smaller diameter channels. This work is part of a larger experimental study on flow boiling within small to micro diameter channels. This work utilises the experimental facility which was designed by X.Huo (2005) and since upgraded by various researchers [1, 2, 3]. The previous work focused on the heat transfer and pressure drop along with flow visualisation and flow pattern mapping. This facility was designed for use with R134a and the research resulted in correlations for small to micro channels based on the results for this fluid [4]. The current aim of this work is to examine further the fundamental aspects of flow boiling in micro channels and develop these correlations by using an alternative refrigerant, R245fa. This study will also include results on the effect of surface characteristics on flow boiling. The aim is also to study the instabilities in the flow and the effects that these have on the heat transfer and pressure drop.

R134a is a popular refrigerant which is used in many domestic and industrial applications, including automotive air conditioning. R134a was developed as a replacement for R12 due to increased environmental awareness [5]. However, due to further environmental restrictions, R134a is being phased out and a new suitable refrigerant must be found, one of these possible future refrigerants is R245fa [6].

**Design/Methodology/Approach:** The experimental facility consists of two systems, the main test rig and the cooling system. The current cooling system uses R22 and will not be changed. The test rig will be adapted to use R245fa as a replacement for the R134a.

The current study will focus on how flow boiling is affected by changes in the channel diameter and surface characteristics, focusing on channels which are within the small to micro range. The channel diameters which will be examined are 4.26mm, 2.88mm, 1.1mm and 0.52mm, which includes small to micro ranges. The effect of surface characteristics will be tested by examining 1.1mm channels of stainless steel, copper, aluminium and brass, as well as welded and seamless stainless steel channels.

For each given channel, the system pressure and mass flux will be varied and the results compared in terms of heat flux as a function of quality. This will allow for comparisons on the effect of diameter, material, system pressure and mass flux.

The study will be enhanced by flow visualisation which will allow comparisons of flow patterns between the two fluids. The new data will be combined with the existing R134a data to help improve the correlations developed at Brunel.

The upgrading of the test facility is now complete and the new refrigerant is in the rig. The current test section is a previously used test section [4]. This allows for comparison of the effect of the refrigerant alone.

**Findings/Results:** Single phase validation of the test rig and all the instrumentation using R245fa has begun. This is required to validate the working of the experimental rig and the two-phase. This data will be compared with data for R134a to allow for preliminary results on the effect of refrigerant.

**Conclusion / Discussion:** Flow within smaller channels presents many difficulties as the current flow correlations for larger channels are not applicable. Research is needed within this area to find the flow patterns and appropriate correlations to allow for the design and safe use of smaller technology to meet the growing international demand for cooling of high heat flux equipment such as high power electronics compact heat exchangers for refrigeration [4].

**Future plans / directions:** The conclusions from the current study on the heat transfer characteristics of refrigerant, R245fa, as compared to R134a will allow for a journal paper to be produced. The results will be used to compare with the current flow correlations and conclusions can be drawn on whether R245fa is a suitable ‘drop-in’ replacement for R134a.

The next stage in this study is to experiment with surface characteristics. This study will allow for conclusions to be drawn on the effect of channel material and manufacturing methods.

## References

1. Huo, X. Experimental study of boiling heat transfer in small diameter tubes, PhD thesis, London South Bank University, London, UK, 2005
2. Chen, L. Flow patterns in upward two-phase flow in small diameter tubes, PhD thesis, Brunel University, UK, 2006.
3. Shiferaw, D. Two phase flow boiling in small- to micro-diameter tubes, PhD thesis, Brunel University, UK, 2008.
4. Mahmoud M, Mohamed M. Flow boiling of R134a in vertical mini-diameter tubes, PhD thesis, Brunel University, Middlesex, UK, 2011
5. Steven Brown, J. Yana-Motta, Samuel F. Domanski, Piotr A. Comparative analysis of an automotive air conditioning systems operating with CO<sub>2</sub> and R134a *International Journal of Refrigeration* Vol. 25 pp. 19-32, 2002
6. Bolaji, B.O. Experimental study of R152a and R32 to replace R134a in a domestic refrigerator. *Energy* Vol. 35 pp. 3793-3798, 2010

## **Electrospinning of Poly(ethylene-co-vinyl alcohol) Nanofibres Encapsulated with Ag Nanoparticles for Skin Wound Healing and its Mechanical strength**

*Chao Xu, Bin Wang*

**Keywords:** nanofibre, electro-spinning, tensile strength, yield

### **Introduction:**

Skin wounds may occur in different format, but all pose as a significant health problem, which affect adversely people's lives with huge societal costs. Each year in the USA alone, more than 1.25 million people have burns and 6.5 million have chronic skin ulcer caused by pressure, venous stasis, or diabetes mellitus. Although treatment of skin wounds has become an increasingly matured subject of study with steady progress, there are few breakthroughs in skin wounds therapies, mainly due to limited capacity to handle large surface area of skin damage which often causes severe fluid loss and inflammation.

Broadly, there are two types of treatment for skin wounds. First is the medication method, in which coating medicines are applied onto a wounded area which is then covered with bandages. Frequent dressing changes are required to clear discharges and replace medicines. Such changes however can cause severe pains and increase the rate of inflammation. The second method is skin transplantation, which is more effective in improving healing and limiting infections. However, this method is associated with restrictions such as shortage of donor skin tissues and high costs. As such, skin dressing is still the most widely used treatment in clinical practice. There is an unmet need for novel treatment method for better availability and effectiveness in skin wound healing.

### **Experimental:**

Dressings are normally applied in sheet formats with various thicknesses. The collectors therefore were designed to produce nanofibre sheets. The thickness of the obtained sheets is controlled by the duration of the fabrication, and also by the fibre diameters and injection speed of the solution. Once the sheet was completed dried, coupon samples were cut to rectangular size of 25mm to 40mm. Tests were conducted on a screw-driven universal test machine (Instron 8500) using a load cell of 1N nominal accuracy. The crosshead extension was used to calculate the engineering stress-strain curve. The fibre diameters were ranged by using three solution densities of EVOH used at 7.5, 10 and 12.5 %. The dry densities of the fibre sheets are yet to be quantified.

### **Results and discussion:**

In this study, we explored new dressing materials with better clinical properties to deal with the problems associated with the existing woven and non-woven dressing materials currently used in skin wound treatment. The advantages of nanofibres network over the traditional dressing materials comes from its large surface/volume ratio. This helps to promote permeation of water molecules through the dressing to regulate the moisture level of wound surface, an important fact to promote cell growth and reduce inflammation. The large fibrous system also allows drugs, *e.g.*, antibacterial or cell growth promoters, to be retained within the structure to control infections and facilitate new growths. The advantages will lead to less frequency in dressing replacement and a better environment for healing. In addition, materials of proven biocompatibility and bio-decomposability can be selected.

This paper is arranged in the following sections: first, the electrospinning fabrication technology and the material used are introduced. The tensile tests on thin sheets made of random fibres are then described, followed by discussions of the test results.

### **Conclusion and future plans:**

Further study is needed on the unloading behaviors of the material and for a broader range of strain rates. In a previous study Ag were added to the fibres to enhance the function of inflammation control for the application of wound dressing. Nano particles of simple pure Ag are formed inside and on the surface of the nanofibres. This “doping” insertion will behave as “defects” and affect the mechanical property of the fibre sheets and need to be quantified as dressing materials will be stretched, pulled, torn and cut when in use. The environmental factor, such as temperature, moisture and aging effect (for prolonged storage) may also need to be examined.

### **References:**

- [1] Brigham PA, M. E., 1996, "Burn incidence and medical care use in the United States: estimate, trends, and data sources," *J Burn Care Rehabil*, vol. 17, p. 12.
- [2] Calif, I., 1997, "U.S. markets for wound management products," *Medical Data International*.
- [3] Domres B., K. D., Rutczynska J, 2007, "INTERMINGLED SKIN GRAFTING: A VALID TRANSPLANTATION METHOD AT LOW COST," *Annals of Burns and Fire Disasters*, vol.10(3), p. 7
- [4] Christine R. Carlisle , C. C., Manoj Namboothiry , David L. Carroll, Roy R. Hantgan, Martin Guthold, 2009, "The mechanical properties of individual, electrospun fibrinogen fibers," *Biomaterials*, vol.30, p. 8.
- [5] Cooley, J. F., 1902, "The process of electro-spinning ", U. S. Patent, ed.USA.

## Does changing the kinematic of motion affect on Femoroacetabular impingement?

*Mahshid Yazdi Far, Ibrahim Esat*

**Keywords:** Hip impingement, kinematic, range of motion

### Introduction

The Femoroacetabular Impingement (FAI) causes pain and reduction of range of motion. FAI also causes abnormal contact stress and potential joint damage around hip. We investigated the kinematics of a hip joint when a FAI occurs. Lots of articles concern the medical concept and the causes of impingements. Also Tannest et.al have studied the biomechanical and range of motion of the femoroacetabular impingement. In this study we are going to answer 2 questions: Does changing the kinematic of motion reduce contact surface/forces? Does changing the kinematic of motion eliminate the need of cutting the bump?

### Methodology

Mimics software was used to read the Digital Imaging and Communications in Medicine (DICOM) files of the subject patient. Segmentation and editing tools allow the manipulation of data to select bone and soft tissue. Theresholding was used to separate the bone from soft tissue. Cavity filling, reducing the sharp edge and enhancing the model was applied in mimics. After generating the 3-D model it was surface meshed using triangular elements. Surface meshing was done in 3matic. Reducing the triangle numbers and improving the mesh quality were applied to the model in 3 matics. The surface mesh was then exported to Abaqus and converted to a volume mesh (tetrahedral elements) prior to post processing. The model was assembled and material properties of bone were defined for the model. Boundary condition, load and interaction were defined for the hip model.

### Findings

7 different models of hip with cam impingement were modelled. Femur and acetabulum distance was reduced 1mm, 2mm and 3 mm for 3 models. Femur and acetabulum distance was increased 1mm, 2mm and 3 mm for 3 models. One model has the normal distance between femur and acetabulum. Adduction, flexion and internal rotation at the contact femur on acetabulum were measured for all of the models. Adduction, flexion and internal rotation decrease with increasing the distance between femur and acetabulum. There is not outstanding changes in the location of impingement. For all of the models impingement was happened in anterosuperior of hip.

## **Conclusion**

Increasing the distance between femur and acetabulum eliminate the needs of cutting the bump in femoroacetabular impingement. Changing the distance between femur and acetabulum affects on the impingement angle contact.

## **Future plans**

I am going to design and set up lab experimental in order to prove the results I have obtained. The design will be a mechanism that will be included the adjustment of the femoral head inside the acetabular socket in 3degree of freedom position. The design also will be measured 3degree of rotation. The device will be developed for hip impingement.

## **References**

1. Ganz R, Leunig M, Leunig-Ganz K, Harris WH (2008) The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clin Orthop Relat Res* 466(2):264-72. doi: 10.1007/s11999-007-0060-z.
2. Ganz R, Parvizi J, Beck M, Leunig M, Notzli H, Siebenrock KA (2003) Femoroacetabular impingement: a cause for osteoarthritis of the hip. *Clin Orthop Relat Res* 417:112–120.
3. Langer Kubiak M, Tannast Moritz, Murphy SB, Siebenrock KA, Langlotz F (2007) Range of Motion in Anterior Femoroacetabular Impingement. *Clinical orthopaedics and related research* 458:117–124. doi:10.1097/BLO.0b013e318031c595
4. Tannast M, Goricki D, Beck M, Murphy SB, Siebenrock KA (2008) Hip Damage Occurs at the Zone of Femoroacetabular Impingement. *Clin Orthop Relat Res* 466:273–280. DOI: 10.1007/s11999-007-0061-y
5. Tannast Moritz, Monika Kubiak-Langer, Frank Langlotz, Marc Puls, Stephen B Murphy, Klaus A Siebenrock (2007) non-invasive three-dimensional assessment of femoroacetabular impingement. *Journal of orthopaedic research*. DOI:10.1002/jor.20309
6. Tannast Moritz, Siebenrock Klaus A, Anderson Suzanne E (2007) Femoroacetabular Impingement: Radiographic Diagnosis—What the Radiologist Should Know. *AJR* 188:1540–1552. DOI:10.2214/AJR.06.0921

## Long Range Ultrasonic Testing of Coated Pipelines

*Zahari Zlatev, Ray Kirby, Peter Mudge*

**Keywords:** Ultrasonic guided waves, Coated pipelines, Ultrasonic attenuation, Viscoelastic materials

### **Introduction:**

Long range ultrasonic testing has been used for over a decade as a screening technique for detection of metal loss in industrial pipelines, [1, 2]. One disadvantage of this technique is its limited test range when it is applied on coated pipelines, [3, 4]. Because of the viscoelastic dynamic behavior of the coating materials, the energy of the incident and reflected signals propagating into the pipeline is usually severely attenuated, [5, 6]. This alone could reduce the test range few times. The aim of this article is to demonstrate how the attenuation into the pipeline affects the test range and the possibilities of reducing its effect.

### **Design/Methodology/Approach:**

The test range of the long range ultrasonic tool has been expressed as function of the attenuation into the pipeline, signal to noise ratio and the energy reflected from defects with different reflectivity. The attenuation curves of T(0,1) and L(0,2) guided wave modes for 6 inch Schedule 40 bitumen coated pipe were calculated by finite element based method. Experimental attenuation measurements of T(0,1) and L(0,2) guided wave modes were also conducted in 6 inch 6 meter long Schedule 40 pipe, coated with 1.3mm thick bitumen material. The material covered 3m of the pipe, starting from the far end of the pipe. The desired guided wave mode was excited into the pipe by Teletest Mark4 tone burst pulser/receiver and 6 inch array of transducers. The array exciting the waveguide was mounted at the close end of the pipe and a second transducer was used in order to monitor the wave propagating into the coated section of the pipe. The frequency range covered was from 20kHz to 100kHz. The frequency dependent attenuation was calculated by comparing the energy of the incident and the energy propagating into the coated section.

### **Findings/Results:**

The test range in lossy waveguides is exponentially dependent on the attenuation into the waveguide. The attenuation in steel pipelines coated with viscoelastic material is not steadily increasing as a function of frequency as it is in plain pipelines. Actually it exhibits minimums and maximums which position on the frequency axis is strongly dependent on the geometry and the acoustic characteristics of the viscoelastic layer. The theoretically calculated attenuation curves based on acoustic properties of bitumen coating material available at the literature are not seen to agree well with the experimental results obtained. Good agreement between the

theoretical predictions and experimental data was achieved after conducting a parametric study to identify more appropriate values for the acoustic properties of the bitumen material used.

**Conclusion / Discussion:**

The attenuation into the waveguide has significant influence on the test range. The test range in coated pipes can be increased by using guided wave modes at frequency range where their attenuation is minimal. Accurate theoretical predictions of the guided wave modes available in given coated pipeline and their attenuation could be done by using the acoustic properties of the particular coating material used as input parameters.

**Future plans / directions**

Development of method for on-site attenuation measurement of T(0,1) guided wave mode in coated pipelines.

Development of method for on-site measurement of the longitudinal acoustic properties in viscoelastic coating materials.

Development of method which can determine the acoustic properties of unknown viscoelastic coating material from the data measured by the methods in p.1 and p.2.

Validation of the methods developed.

The methods described have been developed. Their validation is ongoing process at the moment.

**References:**

1. P. Cawley, M. J. S. Lowe, "Practical Long Range Guided Wave Inspection – Managing Complexity", Rev. Prog. Quant. NDE, 657:22-40, 2006.
2. P.J Mudge, "Practical Enhancements Achievable in Long Range Ultrasonic Testing by Exploiting the Properties of Guided Waves", proceedings of the 16th World Conference on NDT, Montreal, Canada, September 2004.
3. F. Simonetti, "Sound propagation in lossless waveguides coated with attenuative Materials", PhD thesis, Mechanical Engineering Department, Imperial College London, 2003.
4. M.J.S. Lowe, P. Cawley, "Long Range Guided Wave Inspection Usage – Current Commercial Capabilities and Research Directions", Department of Mechanical Engineering, Imperial College London, 2006.
5. J.L. Rose, J. Hua, "Guided Wave Inspection Penetration Power in Viscoelastic Coated Pipes", Insight, Vol 52, No 4, April 2010.

