Brunel University of London

# Contactless Technology for Conveying Light and Fragile Objects

**Dr. Cristinel Mares, CEng, FIMechE**
**Prof. T. Stolarski, L. McLaughlin**

Department of Mechanical and Aerospace Engineering
Brunel University of London, United Kingdom

August 19, 2025

# Acknowledgements

**The research reported in this paper is supported by the Peter Jost Foundation grant "Contactless Technology for Conveying Light and Fragile Objects".**

Brunel University of London

# Project Overview

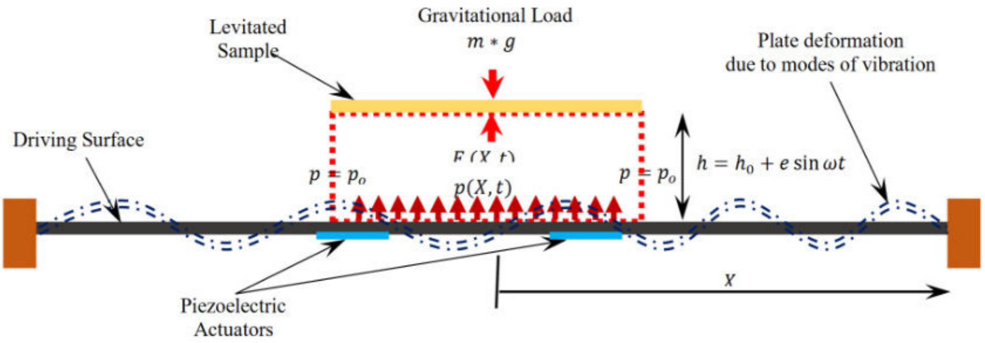
**Project Objective:**

- The proposed research aims to support the realisation of a new non-contact smart conveying technology using squeeze-film phenomenon to levitate and move objects.

**Justification:**

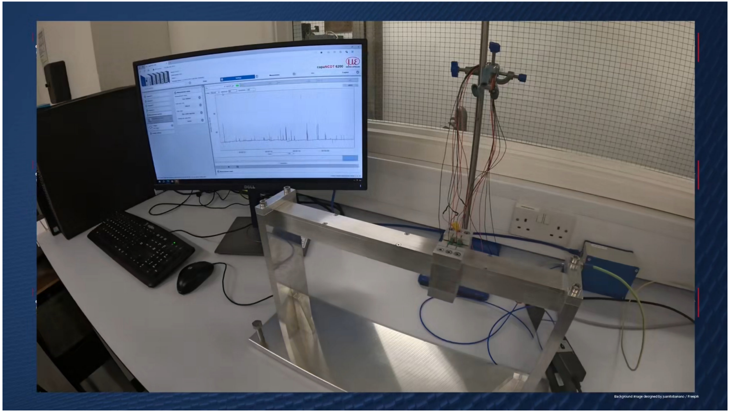
- The development for industrial level applications requires better understanding of the underlying fundamental mechanisms, optimisation of potential effects and control over conveyance.

# Acoustic levitation - Overview

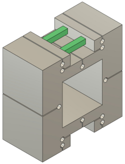


Brunel University of London

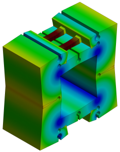
# Demonstration video



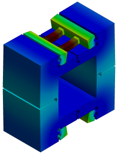
# Modal Analysis - Finite Element



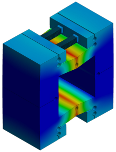
(a) LBv1



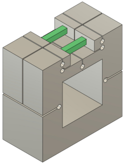
(b) LBv1 Mode 2 @ 3600Hz



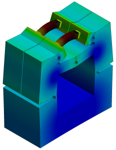
(c) LBv1 Mode 6 @ 8750Hz



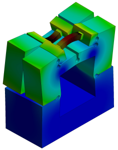
(d) LBv1 Mode 12 @ 12,500Hz



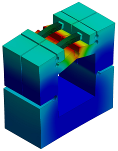
(a) LBv2



(b) LBv2 Mode 6 @ 5450Hz



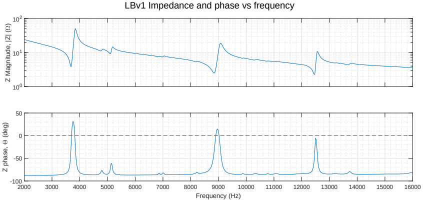
(c) LBv2 Mode 14 @ 9880Hz



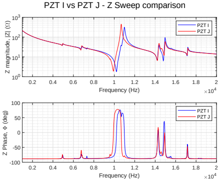
(d) LBv2 Mode 17 @ 11,600Hz

# Distributed Impedance analyses – LBv1 & LBv2

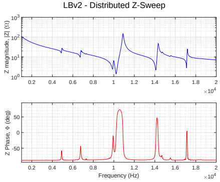
- We present the idea of utilising an in-situ impedance (Z) analysis to determine forced excitation patterns.
- Approach is similar to how the resonant frequency of actuators are determined.
  - Resonance occurs when the deformation of the actuators is primarily in the Z-axis.
- The geometry of the device results in the desired deformation in the linear bearing.
  - Hinging of the bearing in the plane of actuator deformation is imperative to achieving efficient deformation and desired patterns.
- LBv1 shows clear resonance frequencies at 3700Hz, 8850Hz, and 12,500Hz.
- LBv2 shows similar peaks at 4850Hz, 6750Hz, and a main peak at 10,250Hz.
  - These frequencies make up the initial test parameters.




(a)




(b)

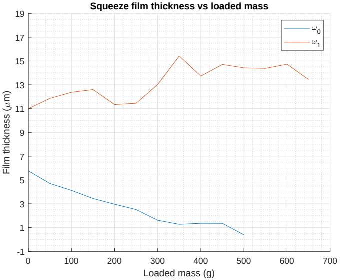


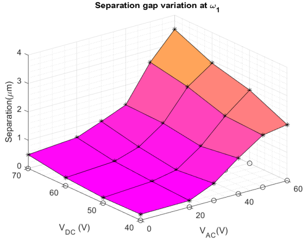

(c)

Brunel University of London

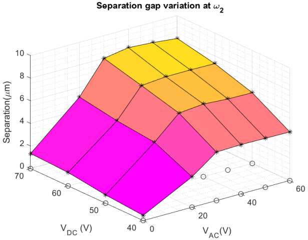
# Levitation Testing

$$V(t) = V_{DC} + V_{AC} \cdot \sin(\omega t + \phi)$$



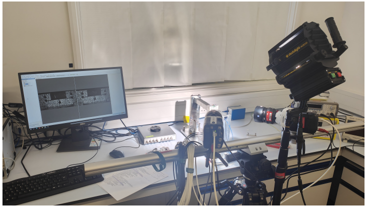

(a)



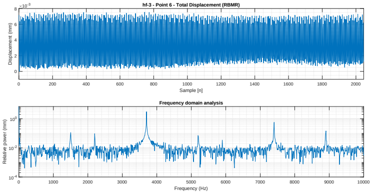

(b)

# Digital Image Correlation

- Digital Image Correlation (DIC) used to confirm forced excitation patterns.
- Setup in (a) used to carry out testing.
  - 2x HS cameras at a shallow relative angle.
  - Low flicker light source.
  - External DAQ device for camera synchronisation.
- 50,000FPS @ 448 * 184 px
  - Resolution reduced to isolate ROI.
- Data collected using correlation of point data at PZT boundary and central deformation point.
- Results show good correlation with those from both FEA and displacement sensor.
  - Demonstrating strong support for the forced excitation results.
- Additional frequency response peak at $2f_s$ will need further investigation.



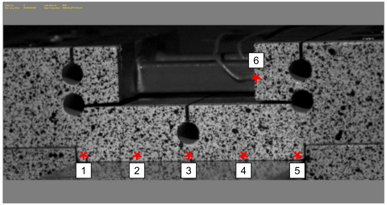
(a)



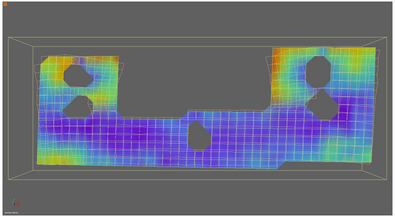

(b)

Brunel University of London

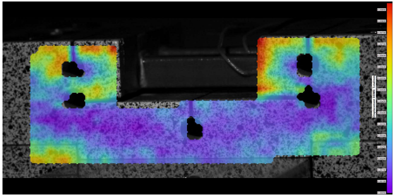
# Digital Image Correlation - Contd.



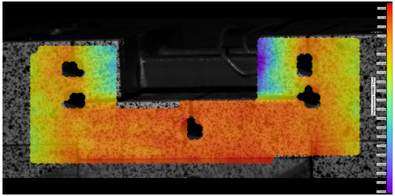

(a)



(b)

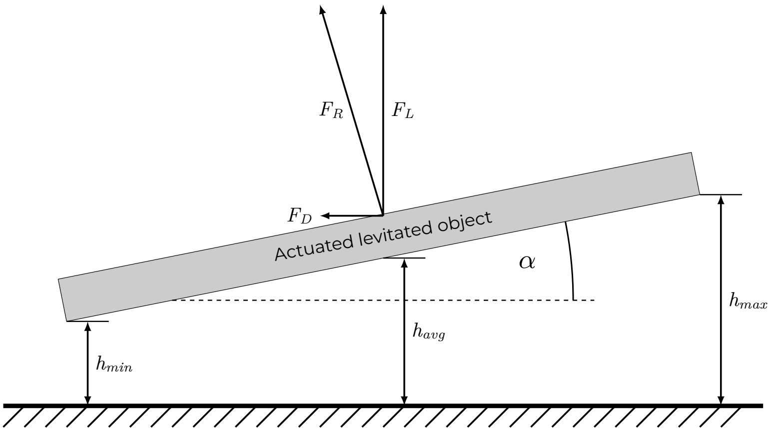


(c)



(d)

# Transportation Approach



# Publications


- C. Mares, L. McLaughlin, and T. Stolarski, ‘3D DIC Operational Modal Analysis for an Acoustic Levitation System’, presented at the International Conference on Vibration Problems & 11th International Conference on Wave Mechanics and Vibrations, Lisbon, Portugal, Sep. 2025.
- L. McLaughlin, C. Mares, and T. Stolarski, ‘Controlled, self-sustained rectilinear motion for levitated objects’, presented at the International Conference on Vibration Problems & 11th International Conference on Wave Mechanics and Vibrations, Lisbon, Portugal, Sep. 2025.
- M. Atherton, C. Mares, and T. Stolarski, ‘Some fundamental aspects of self-levitating sliding contact bearings and their practical implementations’, Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology, vol. 228, no. 9, pp. 916–927, Sep. 2014, doi: 10.1177/1350650113517110.
- R. Ogawa et al., ‘Development of non-contact floating mechanism utilizing squeeze film levitation under vacuum environment’, Proceedings of the Institution of Mechanical Engineers, Part J, vol. 237, no. 12, pp. 2224–2229, Dec. 2023, doi: 10.1177/13506501231211624.
- C. Mares, M. Miyatake, and T. Stolarski, ‘On the role of Poisson’s contraction propagation in the creation of squeeze-film assisted levitation’, Advances in Mechanical Engineering, vol. 15, no. 10, p. 16878132231194277, Oct. 2023, doi: 10.1177/16878132231194277.
- T. A. Stolarski and S. P. Woolliscroft, ‘Performance of a self-lifting linear air contact’, Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, vol. 221, no. 9, pp. 1103–1115, Sep. 2007, doi: 10.1243/09544062JMES623.

Brunel University of London

# Thank you for listening