A Prototype System Using Microsoft Kinect to Recognize Freezing of Gait in Parkinson's Disease Patients

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***Abstract*— Freezing of Gait (FOG) is a disabling symptom and movement disorder, typically associated with the latter stages of Parkinson's disease. Within this paper, we propose a novel approach that is based on a system for real-time FOG, tremor monitoring and fall detection, consisting of a 3D camera sensor based on the Microsoft Kinect architecture. The system is capable of recognizing freezing episodes (FOG) / tremors and fall incidents; commonly seen in Parkinson's disease patients.**

I. Introduction

Parkinson's disease is a neurological condition in which part of the brain becomes incapacitated over time [1] [2] [3]. Common symptoms may include *tremors*: spontaneous shaking in particular body parts, *rigidity*: muscle stiffness and *bradykinesia*: slow paced physical movements [1].

Kinect sensor is a motion-sensing device that enables users to interact with the Xbox 360 without the need of a conventional controller. It features a depth sensor (3D perspective) and a RGB camera that can be used for different purposes including healthcare and rehabilitations. The proposed project uses the Microsoft Kinect sensor to recognize Parkinson's disease postures with emphasis on FOG.

II. Methodology

A Kinect sensor was placed at a height of 2.2 meters above the floor facing downward. The subjects' average distance from the Kinect sensor was about 2 meters. The joint coordination data were gathered from seven subjects (four males and three females aged between 21-32 years old) with different heights, body types, and walking styles. Being an initial study, fellow researchers simulated freezing/tremor/falling incidents. (Following an ethical approval, real patients will test the system during next stage).

Figure 1 demonstrates the system's ability to detect falling incidents by invoking the falling detection algorithm. During the testing stage, a subject simulated falling/getting up at 63 and 105 secs. where the system picked up the event.

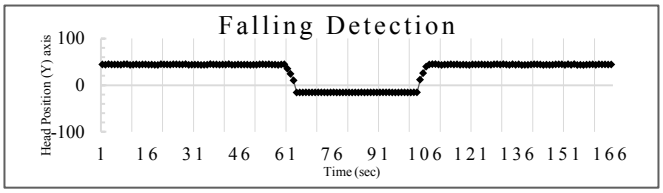

Figure 1. Falling detection

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For the FOG/tremor detection sub-system, a probability chart was created in which the value '1' indicates the detection of a tremor incident (Figure 2).

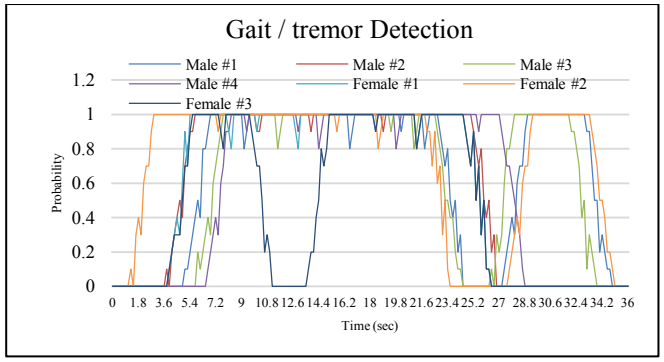

Figure 2. FOG/tremor detection

The system was tested on seven subjects and in 12 events, indicating that this design was able to detect 99% of the falling incidents and 91% of tremor and 92% of the freezing of gait episodes with an average latency of 300 ms. As the falling detection algorithm utilizes the Kinect skeleton feature [4], its performance is irrespective of any subject above 1.5 meter of height.

Conclusively, the system presented here is an accurate and a valuable tool to recognize FOG and falling episodes in Parkinson's disease patients. It requires no on-body sensors; it is non-invasive, easy to setup and has a modest price range. As a next step, this research is geared into coupling the output of this system together with a small projector mounted on the ceiling and using visual and auditory cues to assist the unfreezing of a subject when a FOG episode is detected [5]. This will be further supported with the use of the recently announced new version of Kinect, having a considerably increased accuracy; something vital for recognizing hand tremors.

References

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