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Developing an Adaptive Audio-Visual Cue System for Gait Improvement in Parkinson Disease

P.P.M. Harshani[a], H.A.S.K. Jinaranshi[a], R.P.S. Tharaka[a],
K.D. Pathirana[b], N.W. Prins[a]*

[a] *Department of Electrical and Information Engineering, Faculty of Engineering, University of Ruhuna*
[b] *Department of Medicine, Faculty of Medicine, University of Ruhuna*

*Corresponding Author: *prins@eie.ruh.ac.lk*

ABSTRACT

Freeze of gait (FOG) is a common gait abnormality of Parkinson Disease (PD). The occurrences of FOG negatively affect the Activities of Daily Living (ADL) and quality of life. Physiotherapy-based treatments are more effective in managing the FOG events of the PD, enjoy an active lifestyle and an ordinary life expectancy. The aim of this research is to develop an adaptive audio-visual cue system for gait improvement in PD. The main technological approaches used in this project are a wearable device that has accelerometer sensors and a deep learning (DL) algorithm for real-time FOG detection. The wearable device was implemented using 3 accelerometers which were placed on the ankle, knee and waist of the PD subject and data were recorded. In order to find the optimal DL algorithm for FOG detection, Artificial Neural Network (ANN), Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) were compared using 8000 examples (7000 for training and 1000 for testing). Feature extraction was not necessary for these models. This was similar to data accessed from online database with (Daphnet Freezing of Gait Dataset). Comparison results indicate that DL algorithms are effective tools for FOG with excellent sensitivity and specificity. We conclude that the CNN is the best of the three approaches with sensitivity of 0.93, specificity of 0.96, F1 score of 0.96, and accuracy of 0.96. Even though the system is a simple binary classification, it can be easily modified for complicated tasks. An adaptive audio-visual cue system was used to distract the PD patient from FOG episode and initiate a gait. Through this solution, we anticipate for PD patients to maintain the quality of their lives by reducing the gait abnormalities through adaptive audio-visual cueing and gait improvement.

Keywords: Audio-Visual Cue System, Convolutional Neural Network (CNN), Freeze of Gait (FOG), Parkinson Disease (PD)