EEG analysis of Freezing of Gait in local-moving experiment

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ABSTRACT

Freezing of gait (FOG) is a motor symptom, which is described as feet that seem to be glued on the floor by patients with Parkinson's disease (PD). Several cueing-strategies, e.g. rhythmic auditory or visual cues, may help PD patients overcome FOG. The on-demand manner cueing (i.e. cueing only occurring when FOG is detected, and preferably predicted) would further improve the feasibility in daily life. Current studies mainly analyze movement patterns (via 3D gyroscopes or accelerometers) to detect FOG. However, these studies are limited by their ability to at best detect, but not predict FOG. The possibility of using electroencephalography (EEG) to predict FOG (detect the transition between normal walking and FOG) was proposed by Handojoseno [1]. In his study, 4-channel EEG data was acquired and analyzed, which is not yet sufficiently accurate for FOG prediction and detection. Our study therefore focuses on real-time detection and prediction of FOG, with not only EEG, but also Electrocardiogram (ECG) and motion sensor data. Ultimately, we aim to develop a 'brainwave' chip, which can monitor the EEG signals of PD patients. An automatic FOG detection/prediction algorithm applied on this chip is under investigation.

This is an explorative observational study. Fifteen patients with idiopathic Parkinson's disease (Hoehn and Yahr scale [2, 4]) at off-medication state were asked to execute three tasks in place (two minutes per task) at each session: stepping, normal half turning, and rapid half turning. The following data were acquired during the sessions: 64-channel EEG data (ActiCap), motion data from 6 accelerometers (TMSi; applied above ankles, knees, and metacarpophalangeal joints) and 8 footswitches (TMSi; 4 per foot), EMG data (TMSi; 1 sensor per forearm), and 3-lead ECG data. The experiment was videotaped, and two independent raters annotated the presence of FOG via the videos. Our results show that rapid half turning especially evokes FOG in Parkinson patients. The EEG signals correlated with the FOG episodes were time-frequency analyzed. Based on our preliminary results, we hypothesize that EEG signals present different patterns during FOG in each condition (task), and each subject bring differences in the patterns.

References

[1] A. M. Ardi Handojoseno, James M. Shine, Moran Gilat, Tuan N. Nguyen, Yvonne Tran, Simon J.G. Lewis, Hung T. Nguyen, Using EEG spatial correlation, cross frequency energy, and wavelet coefficients for the prediction of Freezing of Gait in Parkinson's Disease patients. Engineering in Medicine and Biology Society (EMBC) 2014 36th Annual International Conference of the IEEE, pp. 4119-4122, 2014, ISSN 1557-170X.