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ABSTRACT SUBMISSION

Title: Analysis of Surface Electromyography in Parkinson's Disease Using Time-Frequency and Recurrence Quantification Methods

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Abstract

Parkinson's disease affects one to three people in every hundred over 65 years of age. Characterised by muscle rigidity, bradykinetic gait, and severe tremor, Parkinson's disease is the result of a depletion of dopaminergic neurons in the substantia nigra, inhibiting the person from initiating motor movements. Various treatments of this disease include deep brain stimulation, Leva-dopa medication, and pallidectomies. However, biomarkers for early onset detection of the disease still remain elusive. Given that human lifespans are growing, premature detection of Parkinson's disease will have major importance in terms of providing preventative measures and quality of care for elderly citizens.

Recent efforts have been made to identify early stage parkinsonian symptoms from surface electromyography (EMG) signals which depict the electrical activity of muscles. These analyses employ computational methods to extract features of the EMG in order to classify Parkinsonian tremor from regular healthy controls. Time-frequency methods such as Fourier theory and wavelet analysis have been adopted to examine how frequencies of the EMG change with time. These changes in frequency content often reflect physiological events such as motor unit synchronization [1].

Great interest has been shown lately in non-linear time-series analyses, such as recurrence quantification analysis (RQA). RQA has only existed for a couple of decades, but its effectiveness in calculating regularity in non-linear dynamical systems is highly advantageous. Recurrence applies Takens theorem [2] to calculate the difference in phase space between states of a system, to detect how often states recur in the same 'neighbourhood' of each other. Recurrence methods provide parameters such as recurrence rate (REC%), determinism (DET%), and cross recurrence (CRP), which explain the behaviour of non-linear systems like parkinsonian EMG.

Recent work on Parkinsonian EMG using RQA has yielded conflicting results. One reason for this discord could stem from improper selection of the RQA variables like the embedding dimension, the delay parameter, or the threshold radius. As there is no defined method for evaluating these variables, only 'rules of thumb', their selection to date could potentially be flawed. Furthermore, the application of some quantification measures may be unsuitable depending on how one views the system being studied.

In order to resolve these issues, the work presented here aims to establish the optimal RQA variables for the calculation of RQA parameters (REC, DET, JRP, etc.), and to apply these parameters to EMG data of Parkinson's disease patients. Additionally, the cross-correlation of these parameters with time-frequency features will be assessed with the

[1] Conway BA, et al., J of Physiology (1995); 489 (Pt 3): 917-924.

[2] Takens F, et al., Lecture Notes in Mathematics (1981), vol. 898, pp. 366–381

Approval Confirm

Affiliations (1) University College Dublin, Dublin, Ireland
(2) Insight Centre for Data Analytics, SFI, Dublin, Ireland

Authors Matthew Flood (1) (2) Presenting

	Madeleine Lowery (1) (2)
Categories	Biosignals and Biosensors
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Career Stage	Year 1 of Post-graduate study
Award	Yes
Presenter's Email address	matthew.flood@ucdconnect.ie

Contact us if you have a problem or wish to withdraw a submission: Bini2015abstracts@keynotepco.ie