

Using of the Fractal Dimensions for the Analysis of Hyperkinetic Movements in the Parkinson's Disease

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Abstract : Parkinson's disease (PD), which is characterized by the tremor at rest, rigidity, akinesia or bradykinesia and postural instability, affects the quality of life of involved individuals. The concept of a fractal is most often associated with irregular geometric objects that display self-similarity. Fractal dimension (FD) can be used to quantify the complexity and the self-similarity of an object such as tremor. In this work, we are aimed to propose a new method for evaluating hyperkinetic movements such as tremor, by using the FD and other correlated parameters in patients who are suffered from PD. In this study, we used 'the tremor data of Physionet'. The database consists of fourteen participants, diagnosed with PD including six patients with high amplitude tremor and eight patients with low amplitude. We tried to extract features from data, which can distinguish between patients before and after medication. We have selected fractal dimensions, including correlation dimension, box dimension, and information dimension. Lilliefors test has been used for normality test. Paired t-test or Wilcoxon signed rank test were also done to find differences between patients before and after medication, depending on whether the normality is detected or not. In addition, two-way ANOVA was used to investigate the possible association between the therapeutic effects and features extracted from the tremor. Just one of the extracted features showed significant differences between patients before and after medication. According to the results, correlation dimension was significantly different before and after the patient's medication ($p=0.009$). Also, two-way ANOVA demonstrates significant differences just in medication effect ($p=0.033$), and no significant differences were found between subject's differences ($p=0.34$) and interaction ($p=0.97$). The most striking result emerged from the data is that correlation dimension could quantify medication treatment based on tremor. This study has provided a technique to evaluate a non-linear measure for quantifying medication, nominally the correlation dimension. Furthermore, this study supports the idea that fractal dimension analysis yields additional information compared with conventional spectral measures in the detection of poor prognosis patients.

Keywords : correlation dimension, non-linear measure, Parkinson's disease, tremor

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