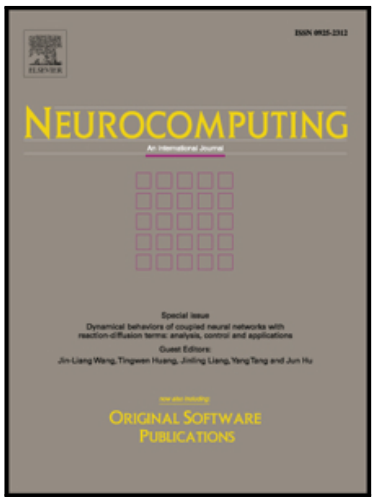

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Pedro Gómez-Vilda , Daniel Palacios-Alonso ,
Victoria Rodellar-Biarge , Agustín Álvarez-Marquina ,
Víctor Nieto-Lluis , Rafael Martínez-Olalla

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Pedro Gómez-Vilda, Daniel Palacios-Alonso, Victoria Rodellar-Biarge, Agustín Álvarez-Marquina, Víctor Nieto-Lluis, Rafael Martínez-Olalla

Biomedical Technology Center, Universidad Politécnica de Madrid, Campus de Montegancedo, s/n, 28223 Pozuelo de Alarcón, Madrid, Spain

Corresponding Author: Pedro Gómez-Vilda (pedro@fi.upm.es)

Abstract:

Patients suffering from Parkinson's Disease (PD), may be successfully treated pharmacologically and surgically to preserve and even improve their life quality and health conditions. Although the progress of the disease cannot be stopped, at least mitigation of the most handicapping symptoms can be achieved. But both pharmacological and surgical treatments require the adequate monitoring of the disease stage of progress and the effects of treatment. Several techniques have been proposed for PD evolution monitoring, ranging from subjective auto-evaluation by questionnaires, or from gait and handwriting examination by specialists. Nevertheless, these techniques present certain difficulties, which make frequent evaluation impractical. On the other hand, it is known that speech acoustic analysis may estimate indicators of patient's conditions, and can be implemented for a frequent evaluation protocol; and under minimal help, it can be carried out at distance using communication technologies. The acoustic analysis, may be based on mel-cepstral coefficients, distortion features as *jitter*, *shimmer*, harmonic-to-noise contents, or pitch-perturbation estimates, among others. Phonation biomechanical parameter and tremor estimates are also good markers of PD. The present work proposes a combination of biomechanical features to predict PD progress using Bayesian likelihood estimation. This methodology proves to be very sensitive and allows a three-band based comparison: pre-treatment vs post-treatment in reference to a control subject or a normative population. Results from a study are presented, including eight patients recorded on a four-week separation interval, meanwhile they were treated with medication, physical exercising and speech therapy. The conclusions show that certain distortion, biomechanical and tremor features are of special relevance to monitor PD phonation, and that they can be used as evolution markers.

Keywords: neuro-motor diseases; neurodegenerative speech; phonation dyskinesia, age and well-being; e-health systems, speech processing.

1. Introduction

Parkinson's Disease (PD) is a neurodegenerative disorder, consequential to the deterioration of *substantia nigra* in midbrain, with increasing prevalence and incidence rates. It is expected that PD prevalence will double in 2030 with respect to 2005 [1, 2]. It is well known that PD affects voice and speech even at an early stage, when other symptoms are not yet evident [3-5]. The present study is motivated by this fact. Speech can be used as a hallmark to monitor PD in the sense that there is "compelling evidence to suggest that speech can help quantify not only motor symptoms ... but generalized diverse symptoms in PD" [6]. Speech is a convenient signal to monitor PD evolution subsequent to surgical, pharmacological or rehabilitative treatment. Therefore, speech features have been used to detect, assess and monitor PD by clinicians during the last two decades [7-10]. Historically, the PD grading scale of Hoehn and Yahr (H&Y) [11] has been the standard to evaluate the severity of this disease in five levels (1-5), although it does not take into account specifically how speech is affected by the disease. On the contrary, the Unified PD Rating Scale (UPDRS) often used in PD clinical evaluation [6, 9, 10], assigns a normalized score in the interval 0-4 on 50 items [12], evaluating concepts such as cognition, speech, swallowing, handwriting, gait, posture and numbness, among others. Circumstantially, only two specific items are explicitly devoted to evaluate speech-related symptoms, and those refer only to intelligibility (under *Activities of Daily Living* and *Motor Exam*). Nevertheless, other items have to see with symptoms which may also be correlated to anomalies in language, speech or phonation, as *Cognitive Impairment, Depressed Mood, Anxious Mood, Apathy, Pain and Other Sensations, Fatigue, Handwriting, Facial Expression, Rigidity, or Hand Movements (tremor)*. Recently, intensive research in PD evaluation and grading based on correlates of phonation, prosody or fluency have been produced [13, 14]. Phonation correlates are based in distortion measurements as *jitter*, *shimmer*, harmonic-noise-ratios (HNR), pitch period entropy (PPE) or mel-frequency cepstral coefficients (MFCC's), among others [6]. The problem in using only these correlates is that they do not convey semantics about possible underlying phenomena explaining pathology development and evolution, although they may be very accurate in predicting affection levels [10, 15]. This loss of semantics implies too large a penalty, hampering further research. The present approach is aiming to advance in the grading of PD whilst maintaining the