Chapter 17
Human Voice Waveform Analysis for Categorization of Healthy and Parkinson Subjects

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ABSTRACT

Parkinson disease is a neurological disorder. In this disease control over body muscles get disturbed. In almost 90% of the cases, people suffering from Parkinson disease (PD) have speech disorders. The goal of the paper is to differentiate healthy and PD affected persons using voice analysis. There are no well-developed lab techniques available for Parkinson detection. Parkinson detection using voice analysis is a noninvasive, reliable and economic method. Using this technique patient need not to visit the clinic. In this paper the authors have recorded 155 phonations from 25 healthy and 22 PD affected persons. Classification is done using two proposed parameters: Local angular frequency and instantaneous deviation in the waveform. Support vector machine is used as a classifier. Maximum 86.8% classification accuracy is achieved using linear kernel function.

INTRODUCTION

Parkinson disease is explained and named first by James Parkinson in 1817. He gave Parkinson characteristics as resting tremor, reduced muscle strength and an unusual posture. Later Konstantin Nikolaevitch Tretiakoff described the degeneration of substantia nigra in Parkinson. A Swedish scientist Aruel Carlson in 2000 was awarded Nobel Prize for his work with dopamine and its affect in Parkinson disease. He explained that in Parkinson, dopamine level falls and causes loss of movement. The dopamine neurons

DOI: 10.4018/978-1-5225-3158-6.ch017

present in the substantia nigra part of brain is a neuro-transmitter which sends message to the brain. It controls coordination and movements of body. As the dopamine level reduces the movements become unbalance. The primary symptoms of Parkinson disease are tremor in hands, arms, legs, jaw and face, stiffness of the limbs, slowness of movement and impaired balance. As disease progresses, condition becomes more worse and even patients have difficulty in walking, talking and in daily routine activities. Parkinson usually affects the persons after the age of 50. However in 4% to 5% cases, it appears in younger age and is known as young onset Parkinson disease. Male has 50% higher risk of developing Parkinson than female. In USA one million people are living with Parkinson disease and annually 60,000 persons are diagnosed with it. No blood test or laboratory test is available for its detection. The diagnosis is based on medical history and neurological examination.There is no cure at present, instead some medications are available which provide some relief. Lavodapa combined with carkidopa delays the conversion of levodopa into dopamine until it reaches the brain. Nerve cells use levodopa to make dopamine and replenish the brain dwinding supply. Anticholinergics control tremor and rigidity. Parkinson patients have voice problem because of disorder in laryngeal, respiratory and articulatory functions. These functional disorders are because of inadequate muscle activation. Parkinson patient voices are characterized by reduced loudness, monopitch, monoloudness, reduced stress, breathy, hoarse voice quality, imprecise articulation and dysfluent speech. The reduced ability to communicate is the most difficult aspect of Parkinson disease. The vocal sound pressure level is reduced by approx 2-4 decibel. Reduced frequency range is observed for the patients. Control on voice onset and offset system gets disturbed. LSVT loud treatment is done to remove voice disorders in Parkinson patients (Ramig, Fox & Sapir, 2008).

Parkinson detection using voice analysis is very reliable and non-invasive method. Also in this patients need not to visit the clinic frequently. It reduces the discomfort and expenditure of patients. As Parkinson patients feel it difficult in walking etc in daily routine activities. Many researchers found some relevant voice characteristics which differentiate healthy and Parkinson persons. Skodda (2015) recorded the vowel 'a', syllable /pa/ and /pa-ti/ of 32 Parkinson patients. In one single breath how long vowel can be produced is vowel keeping time (VKT). VKT value reduces for Parkinson patients. Maximum syllabe repetition rate (maxsylrep) is how fast participant can reiterate the syllable. The time intervals between onsets of one vocalization until the following vocalization is known as Interval Duration (IntDur).These two are not significant one. The coefficient of variation (COV) is significant one and is defined as stability of pace of utterance. Tahakhan (2014) did the clinical rating of Parkinson patients as 0, 1, 2 based on UPDRS and used three running texts with different difficulty level. He found the correlation of feature value according to UPDRS and second correlation according to the text difficulty level. The phonatory, articulatory and prosodic features are calculated. The phonatory symptoms were strongly correlated with the clinical rating and this correlation improves with text difficulty. In articulatory features 7^{th}, 8^{th}, 9^{th}, 10^{th} mel frequency cepstrum coefficients (MFCC) were strongly correlated where as 1^{st}, 2^{nd}, 5^{th}, 6^{th} are not strongly correlated with the clinical rating. Phonation parameters are those which are related to vibrations of the vocal folds to create sound. The articulatory parameters are dependent on shape and position of speech organs. Prosody parameters are the variation in loudness and pitch. Prosody parameters are the most significant one; in 61% cases prosodic parameters get affected. Articulation and phonation parameters changes in 39% and 26% cases respectively (Rusz, Cmejla, Ruzickova, & Ruzicka, 2011).

With the prosody, phonation and articulation; one more parameter is combined that is respiratory parameter known as sound pressure level decline (SPLD). 85.02% classification score is obtained with support vector machine (SVM) (Rusz, Cmejla, Ruzickova, Klempir, Majerova, Picmausova, & Ruziicka,