Chapter 68
Parkinson's Disease Detection with Gait Recognition using Soft Computing Techniques

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ABSTRACT

Parkinson's disease is a degenerative disorder of the central nervous system which occurs as a result of dopamine loss, a chemical mediator that is responsible for body's ability to control the movements. It's a very common disease among elder population effecting approx 6.3 million people worldwide across all genders, races and cultures. In this chapter, authors have proposed an automated classification system based on Artificial Neural Network using Feed Forward Back-propagation Algorithm for Parkinson's disease diagnosis by analyzing gait of a person. The system is trained, tested and validated by a gait dataset consisting data of Parkinson's disease patients and healthy persons. The system is evaluated based on several measuring parameters like sensitivity, specificity, and classification accuracy. For the proposed system observed classification accuracy is 97.11% using 19 features of gait, and 95.55% using 10 prominent features of gait selected by Genetic Algorithm.

INTRODUCTION

Aging is a process of becoming older; in humans aging refers multidimensional changes in various aspects of life like physical, psychological and social changes over a period of time. Population aging can be defined as country's population distribution movement towards older ages which is caused mainly by

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reductions in mortality followed by reductions in birth rate. Demographics reveal that population aging is widespread across the world and number of elder persons is growing very fast; according to United Nations, Department of Economic and Social Affairs, Population Division 'World Population Aging' report (2013) number of elder persons aged 60 years or more were approx. 202 million in 1950, 841 million in 2013, and it is expected to get triple by 2050. Biologically aging can be defined as senescence, in humans which causes declining ability to respond to stress, and increased risk of several diseases like Parkinson's disease, depression, diabetes, Alzheimer's disease, breathing problems, arthritis, osteoporosis, coronary heart disease, cancer, eye problems, etc. (Population Aging, n.d.).

Parkinson's disease is a very common disease among elder population effecting approx. 6.3 million people worldwide across all genders, races and cultures (Medtronic Inc., 2010). In the UK, approx. 127 thousand people have Parkinson's disease with majority of the cases in people aged 50 years or over (Age UK Group, 2015). In the Australia, approx. 80 thousand people have Parkinson's disease (Parkinson's AUSTRALIA, 2015). In the USA, approx. 1 million people have Parkinson's disease and approx. 60 thousand new cases get diagnosed each year excluding the thousands of cases that get undiagnosed. In the USA, the disease has been rated as 14th leading cause of death by Center for Disease Control. The disease becomes more common with growing age; out of thousand people around 5 over the age of 60 years and around 40 over the age of 80 years are likely to have the disease (Age UK Group, 2015; American Parkinson Disease Association, 2015; National Parkinson Foundation, 2015).

As the disease progresses motor, non-motor complexities and disability increase which reduces quality of life of the patients. It increases economic burden not only on the patients but also on healthcare system of the country. Economical impact of the disease varies from country to country; in the UK it is estimated between 0.449 to 3.3 billion pounds annually, while in the USA, it is estimated approx. 23 billion dollars annually. The economical impact is mainly caused by inpatient care with small contribution of medication cost (Findley, 2007; Parkinson's disease, n.d.). Currently there is no cure available for the disease, but, its symptoms can be controlled and quality of life can be improved in Patients with Parkinson's disease (PwP) by taking various treatments available today. So, it's very important to get diagnose Parkinson's disease as soon as possible and start taking preferred treatments to maintain a good quality of life.

Although, there's no precise test available today to diagnose Parkinson's disease, but, doctors attempt to diagnose it based on the disease symptoms, medical history and the results of some simple exercises performed by the person. Some tests like magnetic resonance imaging (MRI) scan, single photon emission computed tomography (SPECT) scan, PET scan, computed tomography (CT) scan are helpful in diagnosing Parkinson's disease. Soft computing techniques like support vector machine (SVM), artificial neural network (ANN), fuzzy inference system (FIS), adaptive neuro-fuzzy inference system (ANFIS), genetic algorithms (GA), clustering techniques, hybrid soft computing methods also play a crucial role in diagnosing Parkinson's disease based on various symptoms of the disease, and characteristics of voice, gait and hand writing patterns of the person.

In the chapter, an automated classification system based on ANN has been proposed to diagnose Parkinson's disease by analyzing persons' gait patterns. The system instrumented with GA to reduce gait feature-set utilizes Feed Forward Back Propagation algorithm (a model of ANN) in its core to classify diseased and normal persons. The proposed system yields high sensitivity, high specificity, low false positive (FP) rate and low false negative (FN) rate in diagnosing Parkinson's disease.