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# **Parkinson Diagnosis using Neural Network: a Survey**

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**Abstract:** Clinical decisions lead to unwanted biases, errors and excessive medical costs which affect the quality of services provided to patients. Accurate detection is highly essential for treatment planning which can minimize the fatal results. Accurate results can be obtained through Artificial Neural Network. Besides being accurate, these techniques must converge quickly in order to apply them for real time applications. Parkinson's disease (PD) is a common disease of central nervous system among the elderly & its complex symptoms bring up some difficulties for the clinical diagnosis. PD is a progressive neurological disorder characterized by tremor, rigidity & slowness of movements. It is associated with progressive neuronal loss in the substantia nigra & other brain structures. This situation leads towards the need to develop a Decision Support System for PD. This paper presents a comparative analysis to illustrate merits of various available research techniques. The aim of the survey is to introduce for those new to the field, an overview for those working in the field & a reference for those searching for literature on a specific application.

**Keywords:** Parkinson's disease, Decision Support System, Soft computing, Machine Learning

## **I. INTRODUCTION**

Parkinson's disease is one of a larger group of neurological conditions called motor system disorders. Historians have found evidence of the disease as far back as 5000 B.C. It was first described as "the shaking palsy" in 1817 by British doctor James Parkinson. Because of Parkinson's early work in identifying symptoms, the disease came to bear his name. Parkinson's disease is the second most common neurodegenerative action only surpassed by Alzheimer's disease [2]. It is expected to increase in the next decade with accelerating treatment costs. PD is a progressive disorder of the nervous system that affects movement. It develops gradually, often starting with a barely noticeable tremor in just one hand. But while tremor may be the most well-known sign of Parkinson's disease, the disorder also commonly causes a slowing or freezing of movement. In the normal brain, some nerve cells produce the chemical dopamine, which transmits signals within the brain to produce smooth movement of muscles. In Parkinson's patients, 80 percent or more of these dopamine-producing cells are damaged, dead, or otherwise degenerated. This causes the nerve cells to fire wildly, leaving patients unable to control their movements. Though full-blown Parkinson's can be crippling or disabling, experts say early symptoms of the disease may be so subtle and gradual that patients sometimes ignore them or attribute them to the effects of aging. At first, patients may feel overly tired, "down in the dumps," or a little shaky. Their speech may become soft and they may become irritable for no reason [13]. Parkinson's disease influences a large part of worldwide population. About 1% of the population over 55 years of age is affected by this disease [3] Parkinson's disease (PD) is a destroy neuro pathological status, characterized by progressive neuro degeneration of dopamine (DA) neurons in the substantia nigra pars compacta [9]. Two studies draw attention to the difficulties in the diagnosis of the disease in the early stages [11]. Recently, there is no medical treatment of PD, although medication is available offering significant alleviation of symptoms, especially at the early stages of the disease [12]. However, a proper diagnosis at an early stage can result in significant life saving. A system for automated medical diagnosis would enhance the accuracy of the diagnosis and reduce the cost effects. Many of people with Parkinson's disease will therefore be substantially dependent on clinical intervention. The requisite physical visits to the clinic for monitoring and treatment are difficult for many people with Parkinson's disease [8]. Diagnosis depends on the presence of two or more cardinal motor features such as rest tremor, bradykinesia, or rigidity [2]. Having so many factors to analyse to diagnose PD, specialist normally makes decisions by evaluating the current test results of their patients. Moreover, the previous decisions made on other patients with a similar condition are also done by them. These are complex procedures, especially when the number of factors that the specialist has to evaluate is high (high quantity and variety

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of these data). For these reasons, PD diagnosis involves experience and highly skilled specialists [14]. Functional neuro imaging holds the promise of improved diagnosis and allows assessment in early disease.

Artificial neural networks are inspired by attempts to simulate biological neural systems. The human brain consists primarily of nerve cells called neurons, linked together with other neurons via stand of fibre called axons. Axons are used to transmit nerve impulses from one neuron to another whenever the neurons are stimulated. A neuron is connected to the axons of other neurons via dendrites, which are extensions from the cell body of the neurons. The contact point between a dendrite and an axon is called a synapse. Neural networks provide a very general way of approaching problems. When the output of the network is continuous, such as the appraised value of a home, then it is performing prediction. When the output has discrete values, then it is doing classification. A simple rearrangement of the neurons and the network becomes adept at detecting clusters. The fact that neural networks are so versatile definitely accounts for their popularity. The effort needed to learn how to use them and to learn how to massage data is not wasted, since the knowledge can be applied wherever neural networks would be appropriate [14]. Nowadays, with the development of computer technology, data mining has been widely used in various fields. Clinical decision support systems (CDSSs) form a significant part of the field of clinical knowledge management technologies through their capacity to support the clinical process and use of knowledge, from diagnosis and investigation through treatment and long-term care [13]. The use of classifier systems in medical diagnosis is increasing gradually. Recent advances in the field of artificial intelligence have led to the emergence of expert systems and Decision Support Systems (DSS) for medical applications. Moreover, in the last few decades computational tools have been designed to improve the experiences and abilities of doctors and medical specialists in making decisions about their patients. Without doubt the evaluation of data taken from patients and decisions of experts are still the most important factors in diagnosis. However, expert systems and different Artificial Intelligence (AI) techniques for classification have the potential of being good supportive tools for the expert [1]. Classification systems can help in increasing accuracy and reliability of diagnoses and minimizing possible errors, as well as making the diagnoses more time efficient [14].

## II. OVERVIEW OF ALGORITHM

The main objective of this work is to highlight the position of various automated techniques which can indirectly aid in developing novel techniques for solving the health care problem of the current society. In this review different methods based on Artificial neural network was mentioned for diagnosis of PD. Various PD detection algorithms are proposed in past. Following subsection describes the same.

### A. PD Detection Algorithm

David Gil [15] Presented 3 methods MLP & SVM with the two kernel types have both a high precision level of the confusion matrix regarding the different measurement parameters (accuracy, sensitivity, specificity positive predictive value and negative predictive value). The SVM produces better results than the MLP. Uses a new algorithm for training the SVM: Sequential Minimal Optimization (SMO) which is a faster training method for SVMs. *SVM with* universal Pearson VII function based kernel (puk kernel) improves the accuracy of system. PUK kernel is robust and has an equal or even stronger mapping power as compared to the standard kernel functions leading to an equal or better generalization performance of SVMs.

Mehmet Can [16] developed a parallel networks system which is bound together with a majority voting system in order to further increase the predictive accuracy of a Parkinson's disease data set based on vocal recordings. To identify the presence of Parkinson's disease, a neural network system with back propagation together with a majority voting scheme is used. The designed neural network system is boosted by filtering, and this causes a significant increase of robustness.

Another study by M. Lee et. al. [18] on the imbalanced data problem in biomedical data uses a sampling scheme in collaboration with a naive Bayes classifier to deal with the imbalanced data problem. The sampling pattern starts with a small portion of the data to train the classifier, and then successively to increase the number of training samples regardless of the initial class distribution.

Anchana Khemphila [14] attempt to introduce a classification approach using Multi-Layer Perceptron (MLP) with Back-Propagation learning algorithm and a feature selection using information gain with Parkinson disease patients. In this work, context selection is determined by the weight of each low-level context. Instead of learning weights through a generic algorithm or other machine learning method, uses the information gain of each attribute, as its weight. The basic motivation for this study comes from the power of ANN classification algorithm and it uses the concept of

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information gain as the criterion to select an attribute. IG is usually used for feature set selection so the method applied consists of computing the IG for each field.

## B. Classifiers for recognizing the PD

Resul Das [17] applied various classifiers to recognize the PD by using SAS based software. Four different classifiers are selected and implemented with SAS based software. These are DMNeural, Neural Network, Regression, and Decision tree respectively. For neural networks classifier the back propagation learning algorithm has been used in the feed-forward, single hidden layer. The algorithm used is the Levenberg– Marquardt (LM) algorithms. A tangent sigmoid transfer function has been used for both the hidden layer and the output layer. In regression node, logistic regression was used. Moreover, default values were chosen for both DMneural and Decision tree nodes. Various evaluation schemas were employed for calculating the performance score of the classifiers. The neural network classifier yielded the best score.

Mehmet Can [5] presented a parallel distributed neural network with two hidden layers, boosted by the use of filtering, and a majority voting system. In this a case study of Parkinson's disease that some of the difficulties with imbalanced data sets are resolved. The type of network used is the standard feed forward back-propagation neural network, since they have proven useful in biomedical classification tasks.

Mehmet Fatih [6] developed ANFC-LH classifier. It has enough satisfaction with higher accuracy for classification of Parkinson dataset which collected from sustained vowel phonation. Also, ANFC-LH classifier is used for the feature selection. Used completely different features, such as MDVP: F<sub>0</sub>(Hz), RPDE, spread1 and D2. In this work different and novel feature selection and classifying techniques presented, valuable for diagnosing hidden PD in early ages, may give greater accurate solutions.

## C. Decision Support System

A.H. Hadjhamadi [13] compares the accuracy of several machine learning methods including Bayesian Networks, Regression, Classification and Regression Trees (CART), Support Vector Machines (SVM), and Artificial Neural Networks (ANN) for proposing a decision support system for diagnosis of Parkinson's disease. By comparing all the methods the classification and regression tree method is the best classifier. Artificial neural network and support vector machine are the next best classifiers.

## D. Vision-Based Diagnostic System

C.W. Cho [10] proposes a vision-based diagnostic system to aid in recognition of the gait patterns of Parkinson's disease. The proposed system utilizes an algorithm combining principal component analysis (PCA) with linear discriminate analysis (LDA). This scheme not only addresses the high data dimensionality problem during image processing but also distinguishes different gait categories simultaneously. The feasibility of the proposed system for the recognition of PD gait was tested by using gait videos of PD and normal subjects. The efficiency of feature extraction using PCA and LDA coefficients are also compared. The proposed system is a promising aid in identifying the gait of Parkinson's disease patients and can discriminate the gait patterns of PD patients and normal people with a very high classification rate. Seven PD patients and seven normal people from Buddhist Tzu Chi General Hospital in Taiwan were enrolled in this study. All the experiments were conducted in the laboratory of the neurosurgery department of the hospital. Under supervision, the subjects were asked to walk from left to right and then to walk back. A SONY HDR-HC3 camcorder was utilized to capture the motion video of the subjects. All video recordings were then extracted to image clips with a sampling rate of 15 frames/s. Because the subjects walked at different speeds, the lengths of the video sequences varied from person to person.

## III. DISCUSSION

Algorithms based on ANN, effectively compare the performance of various kinds of NNs and choose the best one for the diagnosis. Classification algorithms are widely used in various medical applications. It is not necessary a single best classification tool but instead the best performing algorithm will depend on the features of the dataset to be analyzed ([13], [18], [10]). Some datasets include only laboratory data. In some datasets both laboratory & non laboratory data are included. The data used [5] is a voice recording originally done at University of Oxford by Max Little. It is observed that some neural networks like RBF, MLP are found to have best classification accuracy but takes more time for training. ANN can be investigated by employing various activation functions to get higher classification accuracy [17]. SVM is also found better as a classifier.

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## IV. CONCLUSION

Brain is the most important organs of human body the performance of other body parts depends on brain. Computer-aided detection and diagnosis algorithms have been developed to help radiologists give an accurate diagnosis and to reduce the number of wrong decisions regarding the Parkinson diseases. In this paper, algorithms that are commonly used and the ones recently developed are discussed. Over the years there has been an improvement in the detection algorithms but their performance is still not perfect. Another issue is extracting and selecting appropriate features that will give the best classification results. Furthermore, the choice of a classifier has a great influence on the final result and classifying abnormalities of brain is a difficult task even for expert radiologists. Further developments in each algorithm step are required to improve the overall performance of computer aided detection and diagnosis algorithms.

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