



Surveying & Analysis of Parkinson's disease by Applying ML Algorithms

Swetha K B, R Kruthika, Swathi R, Ranjitha V

Department of Information Science and Engineering, RR Institute of Technology, Bengaluru, Affiliated to VTU,
Belgaum, Karnataka, India

ABSTRACT: Parkinson's disease (PD) is one of the prime health problems in the world. It is recognized that around one million people suffer from Parkinson's disease. Thus, it is necessary to identify Parkinson's disease in an early stage so that early plan for the necessary treatment can be made, to save lives and advice few life style changes for a peaceful and healthier life at low costs. The proposed predictive analytics framework is a cluster of Decision Tree, Support Vector Machine, Naive Bayes Algorithm, Gradient Tress Boosting Algorithm, and Stochastic Gradient Descent which is used to acquire insights from patients. We obtain voice dataset from UCI Machine learning repository as input. The experimental outcome indicates that an early detection of PD will expedite clinical monitoring of elderly folk and increase the chances of their life span and improves lifestyle to lead peaceful life.

KEYWORDS: Parkinson's disease(PD), Decision trees, Naive Bayes Algorithm, Support vector Machine(SVM), Gradient Tree Boosting Algorithm, Stochastic Gradient Descent.

I. INTRODUCTION

PD is a progressive neurodegenerative disorder. It affects certain brain cells that support in controlling the movement and coordination. Dopamine is a hormone and neurotransmitter, a chemical that is generated by brain cell. It is used to transmit signals to other brain cells to control the muscle activity [1].

PD causes, degeneration of dopamine in the brain cell which leads to abnormal muscle activity. It is a common disorder observed in senile person [60years and above] which occurs in 1% of the population.

[1] There are several symptoms that cause PD. Common symptoms in PD are muscular rigidity (limbs and upper half of the body is inflexible), shivering (vibration in upper and lower limbs or jaws, speech problem), expressionless face, Bradykinesia (slow movements), lethargy (unresponsiveness and inactivity), postural instability (depression and emotional changes), involuntary movements, dementia (loss of memory which is a common disorder of Alzheimer's disease), thinking inability and sleeping disorders.

P Certain phases in Parkinson's disease are:

- Primary - Due to unknown reasons
- Secondary - Dopamine deficiency
- Hereditary- Genetic origin
- Multiple system atrophy - Degeneration of parts other than mid brain.

[2] For later stages, surgery is recommended for some people. It does not cure PD, but it may help to ease symptoms. Surgery, Deep Brain Stimulation (DBS) is offered to people with advanced PD. [4] Electrodes can be embedded into specific part of the brain that sends signals to your brain and may reduce the PD symptoms. DBS is a stabilized medication which reduces involuntary movements, tremor and rigidity.

Approximately 15% of people with PD have a family history of the disorder. In a few cases, the disease may be inherited through certain gene changes. PD may occur at the age of 60. [3] Due to technological development in information technology, and healthcare areas resulted in better outcomes and low-cost healthcare delivery that is possibly predicted from the PD patient's analysis. [3] For PD patients, life expectancy is 15 to 20 years and the survival rate is slightly lower than the people of the same age.

II. LITERATURE SURVEY

The accurate diagnosis of PD has been a challenge to date, mainly due to the close relevance of PD to other neurological diseases. These close characteristics are the reasons that cause 25% inaccurate manual diagnosis of PD. In [22], they presented a Convolutional Neural Network (CNN) based automatic diagnosis system which accurately classifies PD and healthy control (HC). Parkinson's Progression Markers Initiative (PPMI) provides publicly available



benchmark T2- weighted Magnetic Resonance Imaging (MRI) for both PD and HC. The mid-brainslices of 500, T2-weighted MRI are selected and aligned using image registration technique.

[23] A general purpose model of Parkinson's disease prognosis based on Markov process is described in this paper. The paper presents the mathematical tool that can be used to generate accurate assessments of Parkinson's disease stage and the DBS effects in time, and can be applicable in medical screening for patients with Parkinson's disease. The Markov chains were used to observe the effect in time of this procedure. Being a minimally invasive procedure, but quite expensive for the patient is helpful to know which area of the brain to be stimulated electrically to relieve symptoms of Parkinson's disease. Using Markov chain is an efficient method to find the features vector for an individual patient at a given time and to predict and identify a stage in Parkinson' disease.

[24] Provides approaches to quantify the motor symptoms of Parkinson's disease with wearable devices, and the quantification was developed with four paradigm maneuvers. The quantification parameters included tremor frequency, amplitude of hands movement, and speed of foot-tapping and turning duration. The approach provided quantitative measures for the tremor, bradykinesia and gait symptoms, which could be useful for optimization of drug or deep brain stimulation treatments.

[23] A study of the frontal and temporal EEG of Parkinson's disease patients using MATLAB platform. Lyapunov exponent and inverse Lyapunov exponent for both PD and healthy subjects were calculated within a given time frame. It was found that for PD subjects, the Lyapunov exponent for the temporal part of the brain is less than that of the frontal while the inverse Lyapunov exponent is reverse order of the brain.

Many researchers have conducted several studies using voice recordings to produce an accurate PD diagnosis system. One unique promising way to use the speech disorder as a helping factor to predict PD is by using machine learning techniques [26] they used NNge classification algorithms to analyze voice recordings for PD classification. NNge classification is known to be an efficient algorithm for analyzing voice signals but has not been explored in details in this area. Then, an experiment using NNge classification algorithm to classify people into healthy people and PD patients was performed. The parameters of the NNge algorithm were optimized. Moreover, SMOTE algorithm was used to balance the data. Finally, NNge and ensemble algorithms specifically, AdaBoostM1 was implemented on the balanced data. The final implementation of NNge using AdaBoost ensemble classifier had an accuracy of 96.30%.

The literature shows that a sizable number of researchers have used data mining to classify people correctly as either PD patients or healthy people based on a set of voice recording values. In 2011, feature selection was performed on the Oxford Parkinson's Disease Detection (OPD) dataset from Data Mining Repository of the University of California, Irvine (UCI) and the accuracies of several classifiers were compared [27].

As the PD progresses slowly in most people. Therefore, it is difficult to be identified in the earlier stage. It resides for many years with only minor symptoms. The symptoms differ in various stages of the disease, but they mainly involve tremors, rigidity, bradykinesia, flatfacial expression, and speech disorder. Since speech disorder is one of main PD symptom, recording voice signals and analyzing it automatically is the easiest and most reasonable way to identify the disease in its initial stages [28].

An attempt was been made to distinguish PD group from the healthy control group based on voice recordings with selected features and different classification techniques such as linear classifiers, nonlinear classifiers and Probabilistic classifiers. They used recursive feature elimination algorithm (RFE) for selection of important features [29].

III.EXISTING APPROACH

In this section, we review some existing machine learning techniques for diagnoses of Parkinson Disease. Olanrewaju et al. in the article [30], proposed machine learning based technique for diagnosis of PD and developed Multilayer Feed Forward Neural Network (MLFNN). They used a data set, available in Oxford Parkinson disease datasets. The dataset consists of voice measurements of 31 people with 23 patients. They used 8 attributes which are based on frequency (tremor). They used a total of 8 input and 10 hidden nodes. For classification, they used the k-mean algorithm. The simulation result showed that they achieved a sensitivity of 83.3%, specificity of 63.6% and accuracy up to 80%. However, this method is not validated on real data.

Das et al has done a comparison based on different classification method on speech signals for effective diagnosis of PD. He used four classification methods such as neural networks, regression, for effective diagnosis of PD. He used



four different classification methods such as Neural networks, Regression, DM neural, and Decision tree and found that neural network is the best among the four classifier with accuracy of 92.9%.

Prashanth et al. in the article [31], worked on nonmotor features for PD diagnosis. The non-motor features consist of Rapid Eye Movement (REM), sleep behavior disorder, and olfactory loss. In this study, they used nonmotor features in combination with cerebrospinal fluid measurement and dopaminergic imaging markers features. The dataset was obtained from (PPMI) database. This dataset consists of 183 normal and 401 patients of Parkinson disease. They used Naïve Bayes, SVM, Boosted Tree and Random Forest for classification. The simulation result showed 96.4% accuracy rate of SVM. It was found that the combination of different non-motor features yielded better results. However, data contained imbalanced class distribution.

Al-fatlawi et al. in the article [32], proposed Deep Belief Network (DBN) for diagnosis of PD. In this work, a data set PDD was obtained from the UCI data repository that contains 195 voice recordings of 31 people and 16 attributes. The proposed DBN yielded 94% accuracy. However, this work didn't calculate harming probability.

IV. PROPOSED APPROACH

In this proposed system, we follow a similar approach, however we try to use different machine learning algorithms that can help in improving the performance of model and also play a vital role in making in early prediction of PD which in turn will help us to initiate neuro protective therapies at the right time.

The clinical Parkinson dataset consists of 195 instances and 22 attributes with one class without any missing values. The data set is collected from speech sounds produced during standard speech tests records using a microphone and there recorded speech signals are analyzed using part software [10] to eliminate noise and characterize unique properties in signals. The classifier models are trained with 66 percent of the sample and tested them over the rest of it. Sufficient care has been taken such that the testing is not done over the same instances. Also the data set is standardized such that the overall standard deviation & mean is equal to 1 and 0 respectively using relation given by $P(j) = \frac{(k-n)}{SD}$ where $P(j)$ is the standardized data, k is the data to be standardized, n is the mean of the population and SD is the standard deviation. Data cleaning methods are applied for dimension reduction horizontally as well as vertically. The appropriate features are selected for the models and also the outliers from the dataset are removed based on the quantile information obtained statistically beyond 10 % and 90%.

The flow chart of the proposed methodologies is shown in the figure 1. The original data collected from the dataset composed of voice measurements from 31 people out of which 23 were diagnosed with PD. We have used Random Forest-Recursive Feature Elimination (RF-RFE) algorithm on the original feature sets. Feature reduction removes multicollinearity resulting in improvement of the model in use. Feature reduction is used to decrease the number of dimensions, making the data less sparse. We have used nonlinear classifier with decision tree for classification of groups are as follows Bagging classification and Regression tree, Random Forest and Boosted C5.0 and probabilistic classifier as Naïve Bayes method, and linear classifier as SVM Support vector machine is used for voiceprint analysis of Parkinson's disease patients.

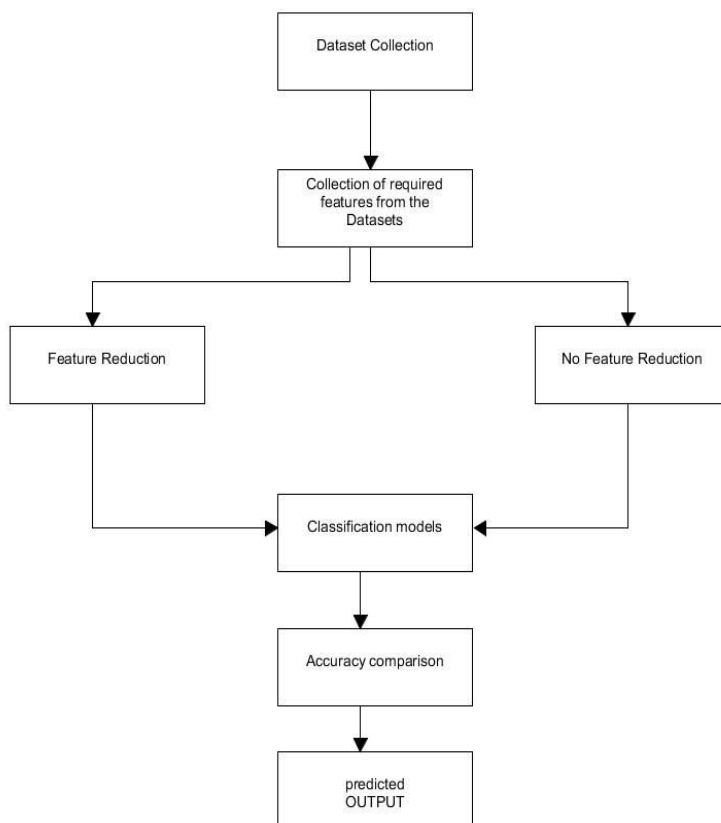


Fig 1: Flow chart of proposed method

For time series acquired from subjects specified, we applied the linear and nonlinear dynamics analysis, using specific parameters for the tremor symptom diagnosis. To characterize the tremor signal we used the following parameters: frequency, amplitude, type of tremor, spectral character.

V. CONCLUSION

In this paper we have implemented different algorithms such as Decision Tree, Support Vector Machine, Naive Bayes Algorithm, Gradient Tress Boosting Algorithm, and Stochastic Gradient Descent to classify the PD. We found SVM has performed well in terms of accuracy, sensitivity, and specificity. It was presented how to use different algorithms to generate accurate assessments of Parkinson's disease at various levels. Using SVM one can attain accuracy up to 87.74% and it's been an efficient method to find the features vector for an individual patient at a given time and to predict and identify a stage in Parkinson's disease. It can be concluded that these neurophysiological measurements are most helpful for early diagnosis of PD.

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