PARKINSON'S DISEASE PREDICTION AND PREVENTION USING MACHINE LEARNING

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Abstract

Machine learning algorithms is used to predict the onset of the Parkinson's Disease by analyzing the data which is demographic information, symptoms, and the medical history. This can help doctors diagnose and treat the disease more accurately and quickly. Machine learning algorithms use statistical methods to analyse the large amounts of data and there by we can identify patterns that can be used to make predictions and prevention. By analysing data from patients suffering from Parkinson's disease, these algorithms can learn to identify the patterns that associated with the onset of the Parkinson's disease. Machine learning algorithms can be used to find diagnose Parkinson's disease. They can analyze data from patient records and medical imaging scans to identify the early signs of the disease, such as tremor, slowness of movement, balance and coordination problems, and rigidity. We are currently using ML-based diagnostic tools such as EEGs, CT scans, and MRI scans to detect PD in its early stages. ML can also be used to track the progression of the disease and predict potential treatments. We believe that if we can identify and address the disease in its early stages, we can eventually eradicate it.

I. INTRODUCTION

The NEURONE, or nerve cells, is the essential part of the neurological systems. There are various kind of neurones, including the motor neuron that get signals from the brain and spinal cord to control muscle contractions. Parkinson's disease is a persistent and progressive state affecting approximately more than10 million peoples worldwide. It is characterized as a motion disorder caused by the failure of specific neurones in the midbrain region called the substantial nigra. These neurones produce dopamine, a substance responsible for transmitting signals from the substantial nigra to other parts of the brain and the body. The brain also produces acetylcholine, a neurotransmitter that works alongside dopamine. The balance between dopamine and acetylcholine levels is crucial for smooth motor function. As the neurons in the midbrain age, this balance is disrupted, leading to improper muscle contractions and symptoms such as jerking movements or rigidity in patients.

II. Literature Survey

[1] As previously mentioned, PD presents with a variety of symptoms. Numerous researchers are actively investigating these symptoms and seeking effective treatments. One common symptom experienced by many patients is speech disorder. This disorder can be attributed to factors such as hypotonia, which involves changes in frequency, and hypertonia, characterized by voice tremors. Our study suggests that one potential approach to address this symptom is through Cepstral analysis. Cepstral analysis involves using raw signals to obtain a spectrum, which provides information about the periodicity of the signal. By examining the prevalence of frequency spacings in the spectrum, we can gain insights into this type of symptom. It is important to note that the initial symptoms of speech disorder may often go unnoticed, making it challenging to accurately predict the onset of the disease in many cases.

[2]One of the crucial indications in motor skills is Bradykinesia, which is characterized by a gradual decrease in the body's responsiveness to signals send by neurones that control movement. While Parkinson's disease is not fully curable, it can be managed with medication. Levodopa is commonly used to treat PD as it stimulates the brain to produce dopamine. Dopamine is a crucial neurotransmitter and hormone responsible for various bodily functions such as movement, memory, and motivation. In the case of Parkinson's disease, sensors are employed to monitor patients. These sensors are directly attached to the skin and capture real-time bio-signals during normal activities. By analyzing these signals, we can track the sufferer's progress and daily improvements. However, a challenge arises in ensuring that the sensors remain securely attached to the body without causing any discomfort, as they need to be resistant to sweat and avoid delivering any shocks.

[3] Impulse Control Disorder (ICDs) is a condition characterized by the inability to regulate impulsive thoughts originating from the brain, resulting in a powerful desire to engage in activities that may not be necessary.Regular

symptoms of ICDs include stammering and overeating. Various gene samples have demonstrated different variations, as well as exposure to Parkinson's disease. By analyzing these genetic variants, doctors can make predictions regarding the likelihood of developing Parkinson's disease..

[4] Various wearable gadget inertial sensors have been employed to measure both short-term and spatial gait metrics. The primary rationale for utilizing these sensors was their cost-effectiveness and affordability compared to traditional gait measures. Traditional gait measures were deemed environmentally unfriendly, prompting the adoption of temporary and spatial gait measures. By employing these 3D sensors, we are able to capture the route of moving feet during various types of motion such as walking or running. However, a limitation of this approach is the necessity for multiple sensors due to their small size and the need to cover a wide area.

[5] When there is a failure of certain crucial neurones placed in the substania nigra to respond, it indicates that the individual is experiencing Parkinson's Disease (PD). Treatment for the patient can be determined by considering their medical history and utilizing various techniques such as pin rolling and the UPDRS - Unified Parkinson's Disease Rating Scale, which employs scientific methods. In this technique, sensors are utilized to capture hand movements, which are then inputted into software to predict whether the presence of Parkinson's disease is there or not.

[6] Research has indicated that there are more than 90% of sufferers with Parkinson's disease (PD) exhibit symptoms of dysphonia. Dysphonia is a condition characterized by a lower or shaky voice, or the inability to produce speech when needed. Studies have demonstrated that employing various vocal measurements can help in the prevention of dysphonia. Support Vector Machine (SVM) is one such technique.

[7] Deep Learning, in conjunction with ML, has demonstrated its effectiveness in diagnosing PD. Various machine learning techniques, including Bayes Classification, Decision Trees, and Self-Organising Map, are combined with deep learning technique like Deep Neural Networks, Convolutional Neural Networks, and Recurrent Neural Networks to address the challenges posed by PD.

[8]Artificial intelligence (AI) is playing a significant role in the foretelling of PD. By utilizing a non-linear selection algorithm and training a dataset of brain signals, it becomes possible to predict the occurrence of Parkinson's disease. The techniques employed in this study yielded an accuracy rate of 97%, and further advancements are expected to enhance the performance of these methods in the future.

[9] Electroencephalogram (EEG) signals are obtained from the brain to assess brain activity. Recent research has shown that stimulation of deep brain and the implantation of an electrode can provide electrical stimulation and help analyze iEEG signal patterns. By analyzing both EEG signals and body movements, doctors can better manage Parkinson's disease (PD) and potentially predict its progression based on the presence of additional symptoms.

[10] Hierarchical clustering is a technique used to organize data in a hierarchical manner and present it in the form of a dendrogram, which represents a tree-like diagram. This clustering technique calculates distances between words and groups similar ones together.

[11] PD is a neurological disorder characterised by a reduction in dopamine-producing neurons, leading to various symptoms. This study proposes an eye blink analysis method using image processing in MATLAB. Changes in blink rate and nonmotor symptoms can indicate the presence of PD. This method could serve as a cost-effective alternative to other analysis approaches. The study utilizes a digital camera,matlab, Computer Vision Toolbox, matlab Image Processing Toolkit, and MATLAB Video Processing Toolbox

[12] This research primarily focuses on motor symptoms, particularly freezing of gait (FOG), which can result in falls and nursing home admissions, significantly impacting patients' quality of life. The study employs Decision Trees (DT) and Support Vector Machines with Polynomial Kernels to predict FOG events. The method involves dimensionality reduction, feature selection, and feature extraction from accelerometer signals.

[13] Voice data collection: Researchers collect voice recordings from individuals with Parkinson's disease, as well as healthy individuals for comparison. These recordings can be obtained using various techniques, such as phone calls, microphone recordings, or specialized devices., the technique achieves an accuracy of 81. 5%. The study compares the performance of this approach with other methods, including neural networks and support vector machines. The technique utilizes six different types of dysphonia parameters, totaling 26 characteristics, such as pitch parameters, voicing, harmonicity, pulse frequency (jitter), and amplitude (shimmer). These parameters are chosen based on the irregular vocal fold vibrations observed in diseased cases compared to periodic vibrations in healthy voice samples.

[14] Freezing of gait (FoG) is a common and potentially dangerous symptom experienced by individuals with Parkinson's disease. It refers to a sudden and temporary inability to initiate or continue walking, resulting in a feeling of being "frozen" to the ground. FoG episodes typically last for a few seconds to minutes and can significantly impact a person's mobility and quality of life.

[15] While this study explores numerous symptoms, it primarily focuses on difficulties in speaking, writing, walking, and completing simple tasks, which occur due to the damage or death of dopamine-producing neurons in specific areas of the brain. The severity of the disease worsens with these symptoms. The study proposes a strategy for predicting the severity of Parkinson's disease using deep neural networks. Additionally, a machine learning model is developed to identify the condition, and a neural network is used to forecast

disease severity. Parkinson's disease is categorized using a neural network and a random forest classifier.

[16] To address Parkinson's disease, this research suggests combining complementary neural networks and stacking generalization. The study utilizes the Parkinson voice dataset from the UCI machine learning repository. Complementary neural networks, trained to anticipate true and false outputs, are combined to form a new input feature. Five sets of machines are trained to provide five features, which are then used as inputs for complementary neural networks created at level 1 of stacked generalization. By employing layered generalization and complementary neural networks together, rather than solely relying on classic neural networks, superior performance can be achieved.

[17] In today's healthcare environment, early diagnosis of Parkinson's disease is crucial for several reasons: Optimal treatment: Early diagnosis allows for the prompt initiation of appropriate treatment strategies. Medications and therapies can be prescribed to manage symptoms effectively, potentially slowing down the progression of the disease and improving quality of life. Improved symptom management: Early intervention provides the opportunity to address symptoms proactively. By managing symptoms from the early stages, healthcare professionals can help individuals with Parkinson's disease maintain their functional abilities, such as mobility, speech, and cognition, for a longer duration. Personalized care planning: Early diagnosis enables healthcare providers to develop personalized care plans tailored to each individual's specific needs. This includes considering factors such as age, overall health, and individual goals and preferences, which can guide treatment decisions and improve outcomes. Access to support and resources: Early diagnosis allows individuals with Parkinson's disease and their families to access support services and resources early on. This includes educational materials, support groups, counseling, and assistance programs that can provide valuable information, emotional support, and practical help. Research participation: Early diagnosis facilitates participation in clinical trials and research studies, which are vital for advancing our understanding of Parkinson's disease, exploring new treatment options, and ultimately finding a cure. Timely enrollment in research studies can contribute to the development of more effective interventions for future generations.

[18] A neurodegenerative condition known as Parkinson's Disease is characterized by both motor and non-motor symptoms. Speech problems are common among PD patients, with about 90% experiencing them as early indicators. To slow down the progression of PD, machine learning techniques can be used to anticipate PD based on speech symptoms. In this study, an ensemble classifier approach is employed using a dataset of speech characteristics obtained from the UCI repository. The dataset consists of 252 subjects, each with three speech feature occurrences. Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) are used to combine the data without losing any information. Ensemble classifiers, such as bagging, adaptive boosting, gradient boosting machine (GBM), and extreme gradient boosting, are used to predict PD. Hyperparameter tuning techniques, including random search and grid search, are utilized to obtain the best parameters for the ensemble classifiers. The performance of the ensemble classifier models is assessed based on measures such as Accuracy, Precision, Recall, F1 score, and Support

[19] The results indicate that PCA outperforms LDA, grid search outperforms random search in terms of hyperparameter tuning, and boosting classifiers outperform bagging classifiers in terms of prediction accuracy.

Freezing of gait (FOG) is a common gait issue in individuals with severe Parkinson's disease. Various models have been proposed to detect FOG, many of which utilize feature learning capabilities and do not require manually created features. However, certain aspects unique to this method have not been thoroughly investigated. In particular, the impact of inadequately labeled pre-FOG data on the development and evaluation of models has not been well understood.

[20]Over the past decade, extensive research has been conducted on automatic detection of Parkinson's disease using wearable sensors. These sensors are inexpensive and lightweight, making them a feasible solution for objective evaluation in both laboratory and home settings. The research in this field has focused on wearable devices that integrate inertial sensors and machine learning techniques to detect FOG episodes in Parkinson's disease.

III. Methodology

i. Obtain the PD database, which includes data for both training and testing.

ii. Data is divided into separate sets for testing and training purposes..

iii. Preprocessing techniques are put in an application for training data, and relevant characteristics are selected.

iv. The training process is conducted, resulting in the creation of a fortelling model.

v. Data pretreating and character selection are also performed on testing data

vi. The foretelling model derived from training data is utilized during the foretelling phase to make accurate predictions.

IV. Detection

The exact cause of Parkinson's disease remains unknown, resulting in a lack of specific detection methods. This paper focuses on studying two datasets: one consisting of healthy subjects and the other comprising persons with Parkinson's disease. The objective is to compare the spiral drawing created by every individual in order to determine the phase of Parkinson's disease.

Following is a diagram illustrating the proposed ideas;

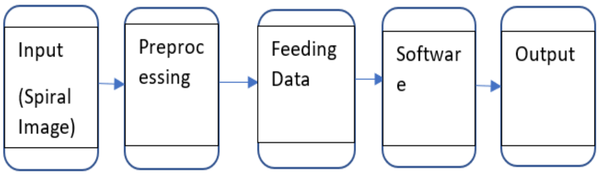
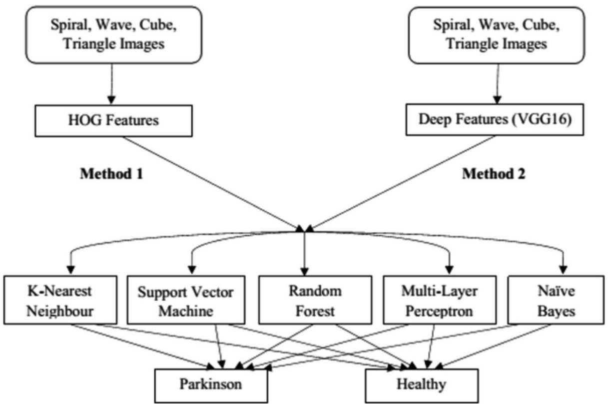


Figure 1

Based on the diagram, the initial step involves obtaining an input image from the user. Subsequently, the image will undergo preprocessing before being inputted into the software. Following this, a printed output will be generated, indicating the stage at which the sufferer is currently situated.

V. Flowchart and Implementation



VI. Algorithm

The chosen algorithm for our application is Convolutional Neural Networks (CNN). It involves three layers: first one is Input layer, second is hidden layer, and finally output layer. These layer allow us to pretreat the images based on the software's input.

VII. Dataset

Dataset utilized in this casestudy is divided into two categories: healthy individuals and individuals diagnosed with Parkinson's disease. The input data consists of spiral and wave images, which are drawn by the Parkinson's disease patients themselves. By analyzing the drawings made during this process, we can make predictions from the stage of Parkinson's disease the patients are in.

VIII.Conclusion

In today's rapidly evolving world of technology, there are opportunities to minimize the risk of disease for patients. Whether through medication or technological advancements, there are solutions available to address the symptoms associated with Parkinson's disease. By attaching various sensors to the body, real-time information about body movement can be obtained. Medications can also be employed to lessen the severity of symptoms prior to the implementation of technology. For instance, in countries like China, electrode implants have been utilized following comprehensive brain stimulation. However, it is important to acknowledge that despite the implementation of these techniques, there are certain limitations, including the possibility of symptom omission, sluggish software response, and the need for algorithm improvement.

IX. Future scope

[21]Improved prediction accuracy: Researchers will continue to explore and refine machine learning algorithms to enhance the accuracy of Parkinson's disease prediction. This involves identifying new features, incorporating multimodal data (such as genetic, imaging, and wearable sensor data), and optimizing model architectures to improve predictive performance.

[22]Early detection and monitoring: Machine learning models can potentially aid in the early detection of Parkinson's disease before noticeable symptoms manifest. By analyzing various data sources, including voice recordings, motor assessments, genetic information, and wearable sensor data, machine learning algorithms can identify patterns and detect subtle changes associated with the onset of Parkinson's disease.

[23]Personalized risk assessment: Machine learning models can be used to assess an individual's risk of developing Parkinson's disease based on their demographic information, genetic markers, and other relevant factors. This can help identify individuals at higher risk who may benefit from proactive monitoring or preventive interventions.

[24]Longitudinal tracking and disease progression: Machine learning can assist in tracking disease progression over time by analyzing longitudinal data from individuals with Parkinson's disease. This can help identify patterns and biomarkers associated with different stages of the disease, enabling personalized treatment plans and predicting future complications.

[25]Remote monitoring and telemedicine: With the advancement of wearable devices and remote monitoring technologies, machine learning models can analyze continuous data streams and provide real-time insights into disease progression and symptom fluctuations. This allows for remote monitoring and personalized interventions, reducing the need for frequent in-person visits.

[26]Integration with clinical decision support systems: Machine learning models can be integrated into clinical decision support systems, providing healthcare professionals with additional tools for accurate diagnosis, treatment planning, and patient management. These models can aid in risk assessment, treatment selection, and monitoring treatment response.

X. Reference

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