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PARKINSON'S DISEASE EARLY DIAGNOSIS: A REVIEW

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Abstract: Parkinson's disease represents a fast-growing neurodegenerative condition. Diagnosis of Parkinson's disease is based on history and examination. Accurate diagnosis of Parkinson's disease (PD) has been a challenge to date, mainly due to the close relevance of PD to other neurological diseases. Unlike other neurological disorders, PD cannot be diagnosed at its early stages and remains almost undetected until the symptoms start appearing. The main task is to find a suitable method to diagnose PD at its early stages so that proper medication can be given. Magnetic Resonance Imaging (MRI) is capable of capturing changes in the structure of the brain caused due to deficiency of dopamine in subjects of Parkinson's disease**.**The paper highlights different methodologies used in machine learning and deep neural network to detect disease along with the accuracy.

Index Terms **- Parkinson's disease, neurological disorders, deep neural network, MRI.**

I. INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative illness and has a common onset between the ages of 55 and 65 years. There is progressive development of both motor and non-motor symptoms, greatly affecting one's overall quality of life. While there is no cure, there are treatments to manage the condition that includes dopaminergic drugs [1, 2]. Management of PD is a growing field and targets new treatment methods, as well as improvements to old ones. According to a global estimate, PD is present in over 10 million people worldwide, and men are more susceptible to it compared to women [3-4]. A research paper [5] briefly discusses the current deep learning architectures that are used for MRI and medical image for image classification, segmentation, detection, etc. It largely focuses on the application of deep learning in disease diagnosis that makes use of MRI modality along with various challenges and recent developments in deep learning related to the analysis of these images. Over the years, to solve critical image classification problems, researchers and students have analysed and worked on artificial neural networks. In recent times, a deep learning technique, CNN or convolutional neural networks, has shown splendid results in image classification for analysing image content.

II. LITERATURE SURVEY

Nearly two hundred years ago, Parkinson (1817) first observed that a particular pattern of speech changes occurred in patients with idiopathic PD [6]. PD is characterized by dopaminergic deficiencies in the mid-brain that impair motor functions [7]. These deficiencies result in different types such as speech disorders, muscular rigidity, slowed body functions, and postural abnormalities. PD is progressive and requires regular medical attention and measurement of symptoms which is very expensive and time consuming. PD affects respiration, phonation, and articulation in a speech that can reduce or mono loudness, hoarse or strangled phonation, monopitch intonation, and variable articulation rate [8]. Many studies have documented such changes using a wide variety of acoustic measures. Amongst many other symptoms, PD manifests itself through speech disorders, which can be observed as early as five years before the diagnosis [9]. Automated acoustic analysis is considered by many researchers as an important non-invasive tool for PD screening.

III. PROGRESSION/STAGES OF PARKINSON'S DISEASE

Artur Szymanski et al. (2015) used Data Mining with Single-Photon Emission Computed Tomography for the disease progression [10], João Paulo Folador et al. (2018) Multi-model Computational System for the progression of PD [11], Hyoseon Jeon et al. (2017) used machine learning algorithms to observe Tremor Severity Using Wearable Device to access stage of PD [12]. Mehrbakhsh Nilashi et al. (2019) used telemonitoring dataset for measuring the PD progression [13], Saba Emrani et al. (2017) used multi-task learning to check the progression of PD [14], Garry Wong et al. (2013) studied Small regulatory RNAs and their roles in the development and progression of PD [15].

IV. METHODOLOGIES

In [16], four boosting algorithms, Gradient Boosting (GB), Light GBM (LGBM), XGBoost (XGB), AdaBoost (AdB), were studied and implemented in UCI Parkinson's Disease dataset. The dataset used for this investigative study was taken from the UCI machine learning repository. In total, 188 PD patients ranging from 33 to 87 were studied where there were 107 men and 81 women. However, the control group was made up of 64 healthy individuals ranging in age from 41 to 82 years old (23 men and 41 women). There were756instances and 754 features in the dataset. To extract clinically useful information for PD assessment, various speech signal processing algorithms such as Time Frequency Features, Mel Frequency Cepstral Coefficients (MFCCs), Wavelet Transform based Features, Vocal Fold Features, and TWQT features were implemented to the speech recordings of Parkinson's Disease patients. Finally, top twenty features were calculated utilizing Kbest algorithm. It was observed that Light GBM outperformed all other algorithms in terms of every performance parameter. In case of accuracy, Light GBM displayed the highest accuracy of 93.39% after tuning the hyperparameters. However, all other algorithms performed satisfactorily where the accuracy of the models are more than 87% generally.

The purpose of the paper [17] was to uncover PD at an early stage, wherein several indicators were considered such as olfactory loss, Cerebrospinal fluid (CSF) data, and SPECT imaging markers. This study proposed a deep learning model to automatically discriminate normal individuals and patients affected by PD based on premotor features (i.e., Rapid Eye Movement (REM),sleep BehaviorDisorder (RBD) and olfactory loss). The proposed deep learning model showed good detection capacity by reaching an accuracy of 96.45%. This is mainly due to the desirable characteristics of the deep learning model in learning linear and nonlinear features from PD data without the need for hand-crafted features extraction. Table 4.1 show methodologies used with accuracies for PD detection. Table 4.1 highlights few of the methodologies with accuracies in detecting PD.

Table 4.1.Methodologies with Accuracies in detection of PD

Sl.no	Methodology	Year	Accuracy
1	Gradient Boosting AdaBoost	2021	93.39% 85.02%
2	KNN SVM	2020	94.14% 96.45%
3	Random Forest SVM	2020	91% 78%
4	ANN CNN	2019	88.17% 89.15%
5	Random forest Gradient Boosted Tree	2019	86.4% 70%
6	SVM Bayesian Network	2018	90.98% 88.62%

This paper[18]combined machine learning and Computer Vision (CV) feature analysis techniques using a sufficient large number of MRI T2 image samples, in order to improve PD classification and achieve an accuracy better than the current methods. To detect PD symptoms, for each subject, the algorithm only needs to analyze 3 slices around the center of a MRI DICOM volume, i.e., mid-brain area. To analyze the Substantial Nigra (SN) area, which is the main affected region in PD patients, the Region of Interest (ROI) inside each SOI containing the SN region was chosen. . Four classification models using Random Forest (RF) and Support Vector Machine (SVM), with or without PCA, were evaluated using LBP, HOG and LBP-HOG fusion. Experimental findings showed that the SVM classification model with fused feature descriptors had the highest accuracy of 91% ± 0.05 for PD diagnosis whereas RF showed an accuracy of 78%.

This article [19] studied PD and Progressive Supranuclear Palsy (PSP) which resembles PD, especially in early stages. Gait analysis provides clinicians with subclinical information reflecting subtle differences between these diseases. Random Forests exhibited the overall highest accuracy (86.4%)and Gradient Boosted Trees obtained a high accuracy of84.0%for all three groups.

In this study [20] Support Vector machine (SVM and Bayesian Network were used for classification of data based on gender. Gender was considered because it has a significant impact on diagnosis of PD. The main goal of this research work was to identify much more effective factors involved in the prediction of gender in PD. The results obtained indicated that the SVM algorithm had a better performance than the Bayesian network algorithm for diagnosis of PD. The testing accuracy for the SVM and Bayesian network algorithms were 90.98% and 88.62%, respectively. The SVM algorithm had a remarkable ability to identify the gender of patients who had PD.

Conclusion

The literature surveys suggest that several techniques can be used to diagnose Parkinson's disease. However, most of the techniques used are for detecting PD at the advanced stages. Early and accurate detection of PD is a challenging task. The existing systems which use PET scan and SPECT scan result in a high misdiagnosis rate. If a patient has PD but inaccurately diagnosed as healthy, the disease may progress and will become difficult to control. These techniques, while capable of detecting PD are not preferred by physicians due to their invasiveness and high cost.

Magnetic Resonance Imaging (MRI) is a non-invasive imaging technology, which is rarely used in PD detection. However, due to recent advancements in MRI the accuracy of diagnosis of PD has improved remarkably. The main role of structural brain imaging using MRI is differentiating PD from other types of Parkinsonism. Diagnosis of PD at the earlier stages ensures proper medication and timely rehabilitation is provided to the patient.

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