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DETECTION OF PARKINSON'S DISEASE USING DEEP LEARNING/MACHINE LEARNING

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ABSTRACT

Parkinson's Disease is a nervous system disease which can have progressively worsening effects on an affected patient. People may develop difficulties in speech and motion. Behavioral and mental issues, sleep disorders, depression, tiredness and memory problems are other consequences. Quick diagnosis of Parkinson's Disease is very advantageous to the patient in terms of treatment. With the recent evolution of Machine Learning and Deep Learning, more tools are available to substantiate a suspicion of PD which can then motivate individuals to go for an official diagnosis. Many indicators including speech, premotor, Rapid Eye Movement and olfactory loss can be considered for analysis. No intervention of a physician is needed and the test can be taken anywhere.

Keywords: Parkinson's Disease, Machine Learning, Deep Learning.

I. INTRODUCTION

PD is a progressive nervous disorder and is considered incurable. However, the symptoms can be significantly improved with medication. An early diagnosis translates to earlier care and this can greatly improve a patient's chances in fighting it. Prevention of PD on the other hand is a mystery and there are no known ways to prevent it yet. Symptoms of Parkinson's Disease are different for everyone. They usually start on one side of the body and remain worse on that side. Symptoms include tremors, slowed movement, improper posture, loss of automatic and subconscious movements such as swinging one's arms while walking, speech and writing irregularities. A common dataset used in detection algorithms is the UCI Parkinson's dataset, which consists of biomedical voice measurements from 31 people, 23 of whom actually have PD. This dataset differentiates normal people from those with the disease. After collecting all the data required, ML and DL algorithms are applied in order to create and train a model. This model can then be used to service a smartphone application, website, etc in order to predict, as accurately as possible, whether the user has Parkinson's disease or the likelihood that they have it.

Machine learning methods used in PD Detection include common ML algorithms such as SVMs, neural networks, Random Forest, Decision Trees, Extra Trees, Gradient Boosting, Naive Bayes, Regression and DM neural. Analysis of speech is the most common methodology followed. The best accuracy is obtained using neural networks.

However, owing to their ability to outperform other techniques when working with large datasets, DNNs or Deep Neural Networks have been found to produce more accurate results in PD diagnosis.

A few broad stages can be identified in the evolution of PD, with the later stages entailing wheelchair dependency, around the clock assistance and Parkinson's dementia. Problem solving, reasoning, thinking and other functions become onerous to perform. About 50-80% of people with PD will experience dementia to some extent.

II. MOTIVATION

The early detection of PD is vital as the chances of patient improvement are high. This becomes even more important in the context that PD is considered incurable. Treatments such as levodopa are more effective when administered early. Non- pharmacologic treatments such as exercise are easy to perform if PD is detected in early stages and can help slow down the progression of the disease.

This led us to work on the project of Early detection of PD so that detecting the PD at an early stage could benefit the patients and could help them to recover soon.

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III. RELATED WORKS

Hamid Azadi et al. [18] suggested that the available signals and voice features could be audible, which is why a new method based on Interval - 2 Fuzzy Analytical Hierarchy Process was proposed to reduce the speech aspect set to 5 goals, depending on which samples were assigned to healthy patients or people with Parkinson's. Disease. The results of this paper suggest that ten-fold confirmation showed the best accuracy of 95.32% of noisy situations and 93.11% of noisy situations and also performed a separate analysis for both sexes.

Joshi, Shandhya et al. [12] proposed a new model for the diagnosis of Parkinson's Disease and Alzheimer's category by considering the most influential factors. Various machine learning methods such as random forest, BF trees, RBF network etc are used as well as neural network methods such as crab separation and chi square separation method. All of these methods showed that factors such as genetic predisposition to diabetes, age, smoking and stroke were considered major risk factors.

Enes Celik et al. [15] emphasized that early detection of Parkinson's disease could help control the disease, so many types of isolation methods such as Vector support, additional trees, Gradient Boosting, Logistic regression and random forest were compared to determine the best way to detect it. Parkinson's disease. Different voice features were used to increase the accuracy of the models and it was noted that the extended feature spaces improve the separation of the models.

In a study by A. Bemba et al.[14], it was observed that in order to diagnose PD patients, the mean squared values of sound were calculated and the voice disturbances were compressed majorly by extracting the audio from the sound samples. Support vector machines along with many different vector types were used together and it was found that SVMs along with linear cores had 91% accuracy which was the best classification accuracy.

Siva Chitra M et al. [6] has learned the use of the Further Learning Machine (ELM), Radial Basis Function Network (FC-RBF) with Meta-Cognitive Fully Complex Value Radial Basis Function Network (MC_FCRBE) in diagnosing Parkinson's Disease. The combined Parkinson's Disease scale (UPDS) is used to diagnose the severity of the disease in patients. The results showed that the MC-FCRBE Network has better predictive accuracy than ELM and FC-RBF.

A proposal by Skibinska, Justyna el at.[7] suggested that the changes in the voice modulations could help to recognize PD at an earlier stage. This paper majorly focuses on the detection/analysis of emotion changes while pronouncing pre-defined speech exercises defined by the programmer beforehand. An accuracy of 69% is achieved using the XG Boost algorithm.

Dahmani, Mohamed et al.[8] used a pre-existing, famous German dataset, Saarbrucken Voice Dataset, which consists of not only audio files of a person affected with Parkinson's Disease but also audio files of a person who doesn't have any neurological disease. The implementation of the K-Nearest Neighbors algorithm is here. Glottal signal parameters are employed as input-vectors along with KNN classifiers which give one of the best accuracy of 93.33%.

Laureano Moro Velazquez et al.[9] proposed X-vector in a different way, that is to detect Parkinson's Disease from speech. X vector is compared with i-vector which is another method used for speech recognition. The results suggest that the X-vector approach was an excellent choice as the accuracy achieved was 90%.The results also show that the embedding obtained using Deep Learning Network extracted features that are common in PD.

Chuang, K.S. et al. [18] showed that Linear Discriminant Analysis (LDA), when applied to audio samples, separated audio samples between health workers and Parkinson's patients. This helped us to improve feature selection. High class accuracy is achieved when features are selected more aggressively than all selected features.

Weber S.A et al.[23] tried to discern PD in a distinct way. Instead of using voice datasets and features, motor abilities of the hands were used. A person suffering with Parkinson's Disease finds it difficult to write. A smart pen when written with is used to obtain handwritten data which is used for preprogrammed identification employing connective Neural Network.

Yang L et al. [19] has proposed an algorithm that combines a community learning algorithm with the Tree of Divide and Drop algorithm also known as CART. The CART algorithm is frequently used in the selection of speech samples in the early stages to obtain high-resolution samples. Then trained community learning algorithms integrated with random forest and Vector Support Machines and Extreme Learning Machines. The best accuracy results obtained are when the algorithm is integrated with CART, which gives 87% accurate results.

Meghraoui et al.[16] study shows that patients with Parkinson's Disease dysarthria can be identified using classification of their properties. To detect Parkinson's Disease, identification of suitable traits is important. Algorithms such as multinomials and Bernoulli Naive Bayes are used for this job. An estimated accuracy of 95% was achieved when the Multinomial Naives Bayes classification model was used.

Wan et al. [24] enlightens us on smartphones and how they are part of our daily lives. Similar smartphones can also be used to detect a disease such as Parkinson's Disease. The deep multi layer sensor classifier is used to analyze behavior to predict the progression of the disease using cell phones. This analyzes the severity of the disease by analyzing speech and movement using telephone sensors. Learning algorithms such as M5P and DMLP are used.

Alhussein et al.[5] collected data or speech datasets from different devices or sensors used. This data was then used by the classifier along with the Support Vector Machine. The framework showed an accuracy of 97% in detection of PD.

Aich, Satyabrata et al.[4] have chosen GA and PCA as feature selection techniques, as these features do not influence the performance of the framework. The outcome conveys that the GA features are better when combined with the support vector machine classifiers in terms of performance and give an accuracy of 97.57%.

Dinesh KKshaya et al.[2] presented a predictive model that helps detect Parkinson's Disease with the highest accuracy using extrapolated data from audio recordings that were given by the patients and unaffected patients, both. The results show that the Boosted Decision Tree model made from gradient boosted regression trees gave an accuracy score of 91-95% which by far gave the finest results on the dataset.

Fayyazilfar, Najmeh et al.[3] proposed that due to the high dimension of extraction features from the voice, many classification and feature selection algorithms can be developed. This paper focuses on detecting PD at an early stage using AdaBoost and bagging Algorithms that give a detection accuracy of 96.5%-98.28%.

Wu Wang et al.[1] presented a model that was able to differentiate Parkinson's Disease patients with normal people using premotor functions. A deep learning model is used as it gives better accuracy when contrasted to the twelve Machine Learning models in separating PD patients with the rest of the crowd. An accuracy of up to 96.45 was achieved by this model.

Kolte,Ashish et al.[11] used a data set taken from a uci Machine Learning repository that has a data set specifically designed for Parkinson's Disease that has replicated acoustic features. 240 people contributed to the dataset, and 48 features were extracted. The results of this paper show that the best techniques for detection are the Naive Bayes classifier, Gradient Boosting and SVMs. These methods are powerful and give the best results hence doctors use them too.

Laila, Radouani et al.[10] suggests that in order to assess speech disorder in PD patients, machine learning tools alongside with features drawn out from three domains which are time/frequency, cepstral and wavelength are used. The results suggest that the cepstral features along with SVM classifier gives the best results.

Hakan Gunduz [13] proposes two frameworks, the first framework integrates the different components of the data sets and is provided by CNN with nine layers as inputs, while the second framework transfers the elements into the same input layers connected to CNN layers. The results show that the second framework provides the best results, not only does it separate patients and healthy people, but it also increases the discriminatory power of class dividers.

H.Badem et al.[22] proposes a Dnn classifier that consists of a Softmax Layer and a Stacked Autoencoder(SAE). For extracting basic, built-in data from within the speech features, the SAE is used meanwhile the softmax layer is for translating the encoded features to classify the patients. The framework went through a lot of experiments conducted with two different data sets to achieve high accuracy results.

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T. J. Wroge et al. [20] Database was used to compile speech files for patients with Parkinson's Disease as well as healthy people and digital biomarkers collected using a mobile application. in selected features with high compatible scores. The second feature set includes 60 features. These two sets supplied a 3-layer Dnn and 85% accuracy was achieved beyond the average clinical findings.

In a study by S. L. Oh. Y. Hagiwara et al.[21] show that EEG signals could be used as an early sign for detection of Parkinson's Disease. A total of forty patients participated in this activity; the EEG signals of these patients were fed to the thirteen - layer CNN architecture. The CNN model achieved 88.25% accuracy, 84.71% sensitivity, and 91.77% specificity.

Authors	Year	Models	Algorithm	Advantages	Disadvantages
Sachin Shetty [26]	2016	SVM using gait analysis	Analysing all the vectors separately, we attain seven of the best feature vectors. With the use of gaussian radial basis function kernel based Support Vector Machine, they are classified.	It achieves an accuracy of 83.33% and detection rate over 75% of PD patients compared to other neuro-degenerative disease.It acts as potential classifier to discern Parkinson's disease from other neuro-degenerative disease.	It cannot be used to monitor a patient's stages but also to monitor the disease progression.
S.L. Oh, Yuki Hagiwara1, U. Raghavendra, Rajamanickam Yuvaraj, N. Arunkumar, M. Murugappan, U. Rajendra Acharya [27]	2018	Convolution Neural Network	The EEG signals of 20 PD and normal patients are taken into account along with a thirteen-layer CNN architecture required to overcome the requirement for the current aspect representation stages.	It does not require the extraction, selection, and allotment of features and is ratified with a stratified cross validated approach. Good performance is acquired even with a limited number of normal and PD patients.	It uses a limited number of subjects to establish the CNN model. In comparison to other current machine learning approaches,the framework is more upscale..
Zuo WL, Wang ZY, Liu T, Chen HL [28]	2013	Enhanced fuzzy k-nearest neighbour (FKNN)	Optimization of KNN classifier with: (1)The number of nearest neighbours (k) and the fuzzy strength parameter (m) and (2) Determining the best subset of discerning features.	It can attain the highest classification for a 10-fold CV (97.47%).Based on the empirical analysis,it has been assured that the FKNN diagnosis system can aid the physicians to make very accurate diagnostic choices.	Evaluating the proposed system in other medical diagnosis problems.
A. Hossen, M. Muthuraman, J. Raethjen, G.	2010	Soft decision wavelet decomposition	A wavelet-	The method can be used as a supporting test for clinically	The efficient distinction between ET and PD (trial

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Deuschl , U. Heute [29]		technique.	decomposition along with soft-decision algorithm is used inorder to estimate an approximate power spectral density (PSD) for accelerometer and surface EMG signals for the purpose of	distinguishing diagnosis for tremors between ET and PD.	set)can be also used to discover the distinction between ET and PD (test stage). This allows better results in contrast to the normal voting approach enforced in this paper(a larger
			discrimination of Parkinson tremor from essential tremor.		data size preferentially).
Sztahó, D., Gábor, K. and Gábriel, T [30]	2021	LSTM-based Autoencoder Hybrid along with Multi-Task Learning.	Inorder to train the network for the task-oriented labels and extract the autoencoder-based feature, multitask learning is imposed.	It makes strategic decisions and hence does not require audial study of speech for determining the types of disease. The speech recordings are provided to the network directly.	The applied method has yet to be tried and used for other diseases as well and for other languages also.
Muntasir Hoq , Mohammed Nazim Uddin , and Seung-Bo Park [31]	2021	Principal Component Analysis (PCA) and a novel deeper Sparse Autoencoder (SAE).	PCA uses the features that are linearly related and SAE works with non-linear related features for reduction of the feature set dimensionality and takes into account all the critical and significant data for classification.	Application of SMOTE for synthesization of new minor examples for classifying models in a more balanced scheme.	Improvements can be made to enhance algorithms in order to diminish reverberation, background noise and non-linear distortion. Addition of wearable sensors for acquiring postural fluctuations and tremors measurements of subject for accurate detection can be developed .

IV. CONCLUSION

Artificial intelligence has subsequently revised grounds leading to potential diagnostic variabilities and reduced unreliability in various sectors including health care.

The goal for this study is to propose various deep learning and machine learning architectures in order to help detect Parkinson disease using voice sets. The proposed model is created to distinguish between normal subjects and PD subjects based on vocal and other measurements.

Early detection of PD is necessary in order to carry out the necessary treatments and diagnosis. Predictive models proposed are compared for the diagnosis of Parkinson's disease. The vocal datasets acquired are used

to detect Parkinson's disease using the various proposed classification models such as SVM, DM Neural, neural network, etc.

Hence, such diagnostic models can prove its capacity and potential to provide assistance in the healthcare environment through primary physicians when there is an unavailability of PD physicians for detecting PD and identifying potential patients for medical trials.

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