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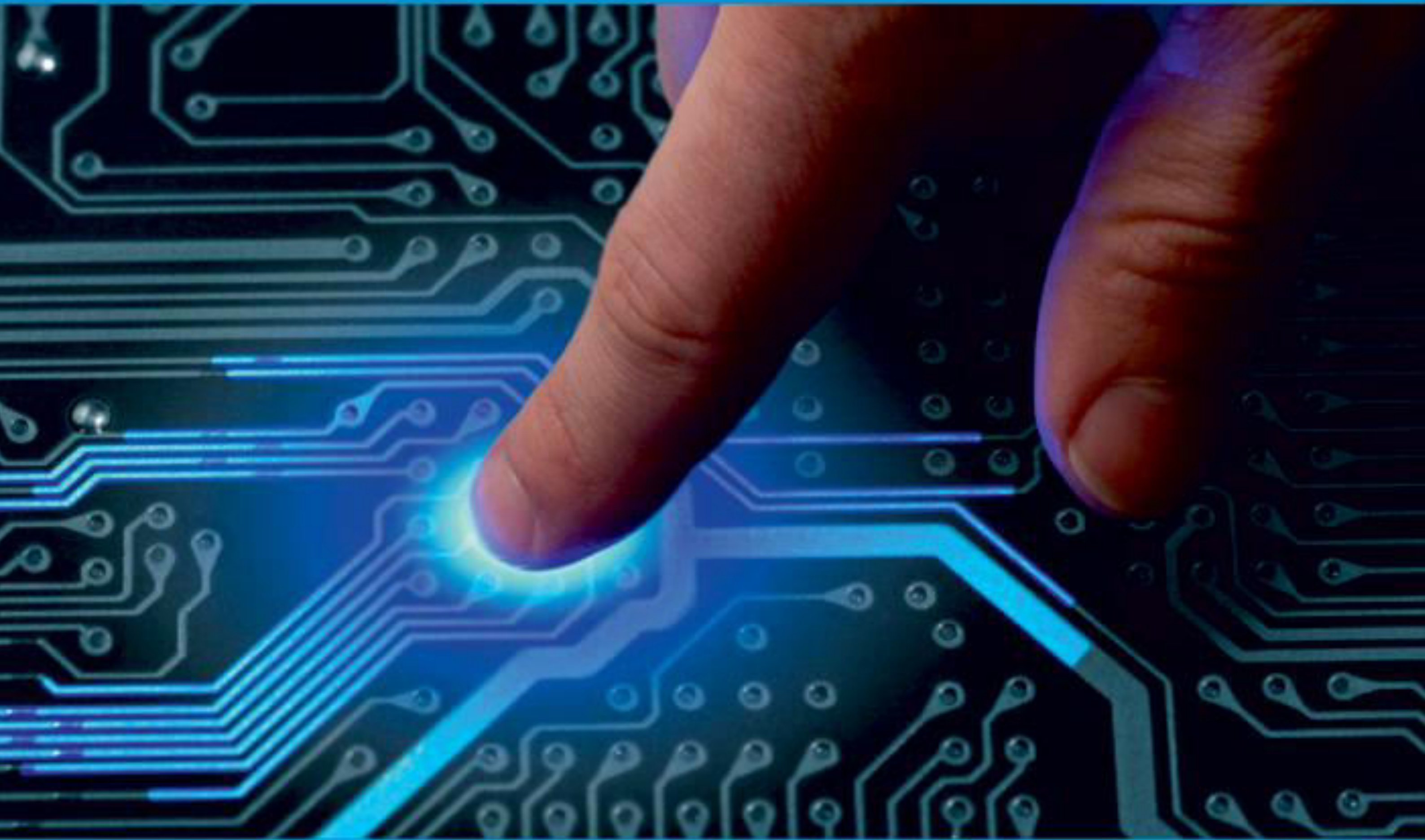

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Parkinson’s Disease Detection using Deep Learning Approach

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ABSTRACT: Parkinson's disease, a chronic and progressive neurodegenerative disorder, is characterized by the degeneration of dopamine-producing neurons in specific brain regions. This degeneration leads to a range of debilitating symptoms, including difficulties in speech, motor coordination, and daily activities. The severity of these symptoms tends to worsen over time, significantly impacting the quality of life for affected individuals. This project present a methodology for predicting the severity of Parkinson's disease utilizing deep neural networks. This study make use of UCI Parkinson's Telemonitoring speech Data Set, which is a comprehensive set of 42 patients' biological speech measures.These measurements encompass various aspects of voice characteristics and serve as essential features for the severity prediction task. Implementing the predictive model, by using the 'TensorFlow' deep learning library in the Python programming language. The aim of the project is to offer a data-driven solution that enhances understanding of the progression of Parkinson's disease and facilitates better management and care for individuals affected by this condition.

KEYWORDS *: Parkinson’s Disease, Deep Neural Networks, Tensor Flow, UPDRS*

I. INTRODUCTION

1.1 Parkinson’s Disease

Parkinson's disease is a neurological condition that results in unintentional or uncontrollable movements, including stiffness, shaking, and trouble balancing and coordinating. Typically, symptoms start out mildly and get worse with time. People may experience difficulties walking and talking as the condition worsens. In addition, they could have exhaustion, sadness, sleep issues, mental and behavioral disorders, and memory problems. The prime motor symptoms, together, are referred to as "Parkinsonism", or a "Parkinsonian Syndrome". The changes in patients’ voice is one of the common symptoms which can be identified analyzing the patients’ voice data. The more severe the condition, the more the patient's voice stutters and becomes impacted.The primary indications and manifestations of Parkinson's disease arise from the impairment or death of nerve cells within the brain responsible for regulating movement. Normally, dopamine a crucial brain chemical is produced by these neurons, or nerve cells. The disease's mobility issues are brought on by a decrease in dopamine production caused by damaged or dead neurons.Researchers are still unsure of the exact cause of neuronal death.

1.1.1 Major Symptoms

Parkinson's disease is characterized by major symptoms, including tremors, muscle stiffness, slow movements, impaired balance, emotional changes (such as depression), difficulty with speech and swallowing, and skin issues. These symptoms significantly impact the lives of affected individuals. The symptoms of Parkinson’s and the rate of progression differ among individuals. Early symptoms of this disease are subtle and occur gradually. Frequently, the onset of symptoms occurs in one limb or on one side of the body. The illness gradually affects both sides as it worsens. On the other hand, one side may still experience more severe symptoms than the other.

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1.1.2 Treatments

Parkinson's disease has no known cure, however medications, surgery, and other therapy can frequently lessen some of the symptoms. By raising dopamine levels in the brain and influencing other chemicals in the brain such neurotransmitters, which facilitate information flow between brain cells, medications can help manage Parkinson's symptoms including non-movement symptoms. Deep brain stimulation is a treatment that the doctor could suggest for Parkinson's disease patients who don't react well to medicines. An electrical device is implanted in the chest and electrodes are inserted into a portion of the brain by a surgeon during a surgical operation.The tool and electrodes work to block many of the movement-related symptoms of Parkinson's disease by gently stimulating particular brain regions that regulate movement.

1.2 Deep Learning

Deep learning algorithms have achieved striking performances in fields such as computer vision, natural language processing, and speech recognition. Deep learning is also changing other fields such as biology and engineering. Artificial neurons arranged in numerous layers make up the deep learning system. The neurons are information processing modules, which essentially are simple nonlinear transformations of inputs. For the Deep neural network (DNN) considered in this project, when data are fed into the network, the deep neural networks use multiple layers of neurons stacked together to create classification and feature selection models. Usually, training deep learning algorithms needs large amount of data to achieve desired accuracy. It is hard to interpret the trained neural networks. Also, theoretically, it is still hard to understand why and how deep learning achieves good performances. In this project, deep learning is used to analyze voice data of the patient to classify it into "severe" and "not severe" classes. The total and motor UPDRS scores on the UPDRS (Unified Parkinson's Disease Rating Scale) are the evaluation metrics utilized in this study. The patient's motor ability is assessed by the motor UPDRS on a scale of 0-108, whereas the total UPDRS offers a wider score range, ranging from 0-176.

II. LITERATURE REVIEW

A part of investigate has been done to anticipate Parkinson's illness in a persistent, but less work has been detailed to anticipate its seriousness. These works have utilized different machine learning strategies. In a overview by Das et al. [1] on the application of different classification strategies in diagnosing the Parkinson's disease(PD), neural arrange was found as the superior classifier compared to relapse and choice tree. In most of the detailed inquire about, the highlights extricated from discourse signals [6][7][15] are utilized for anticipating the seriousness of PD.Genain et al. [2] utilized Packed away choice trees to foresee the PD seriousness from voice recordings of patients and found an advancement of 2% precision. Maleket al.[3] utilized 40-features dataset and recognized 9 best highlights utilizing Neighborhood Learning Based Include Determination (LLBFS) to classify PD subjects into four classes (Healthy, Early, Middle of& the based on their UPDRS score. Cole et al.[4] investigated the utilize of energetic machine learning calculations for distinguishing the seriousness of tremors and Dyskinesia from the information collected from wearable sensors. Angeles et al.[5] created a sensor framework to record motor information from the arm in arrange to survey side effect seriousness changes amid Profound Brain Reenactment Treatment. Nilashiet al.[8] proposed a unused crossover brilliantly framework utilizing Versatile neuro fluffy deduction system(ANFIS) and Bolster Vector Regression(SVR) for foreseeing the PD movement. Chen et al.[9] proposed a PD demonstrative framework utilizing PCA for include extraction and Fluffy KNN for classification . Polat[10] proposed a show utilizing Fluffy C-Means (FCM) clustering and KNN to analyze the PD. Åström and Koker[11] outlined a PD expectation framework utilizing parallel bolster forward Neural Arrange and after that yield is compared against a rule-based framework for making the ultimate choice. Li et al.[12], proposed a fluffy based nonlinear change strategy where PCA is utilized for include extraction and SVM for PD expectation. Hariharanet al.[13] proposed a crossover brilliantly framework utilizing clustering, highlight lessening and classification strategies for precise PD determination.

III. METHODOLOGY

The proposed system aims to predict the severity of Parkinson's disease by leveraging deep learning techniques for analysis of biomedical voice data. Collect voice data from Parkinson's disease patients, including attributes such as

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subject number, age, gender, time interval, Motor UPDRS, Total UPDRS, and 16 biomedical voice measures. Normalize the collected data using min-max normalization, scaling the values within a range of 0 to 1.Construct a DNN comprising a input layerwith number of neurons matches the number of attributes in the input data, hidden layers which is a customized layers for feature learning and output layer which contains two neurons representing the classes 'severe' and 'non-severe,' facilitating the categorization of disease severity. Train the DNN with the normalized data, iteratively adjusting network parameters to enhance prediction accuracy. Test the DNN's ability to accurately classify disease severity based on unseen data.

- Objective Disease Severity Assessment: It provides an objective and data-driven method for assessing the severity of Parkinson's disease, reducing subjectivity in diagnosis and monitoring.

- Early Detection: The system can potentially detect changes in disease severity at an earlier stage, enabling timely interventions and treatment adjustments.

- Non-Invasive: It relies on voice data, which is non-invasive and easily collected, making it a patient-friendly approach.

- Personalized Care: By accurately predicting disease severity, it can facilitate personalized care plans for individuals based on their specific needs.

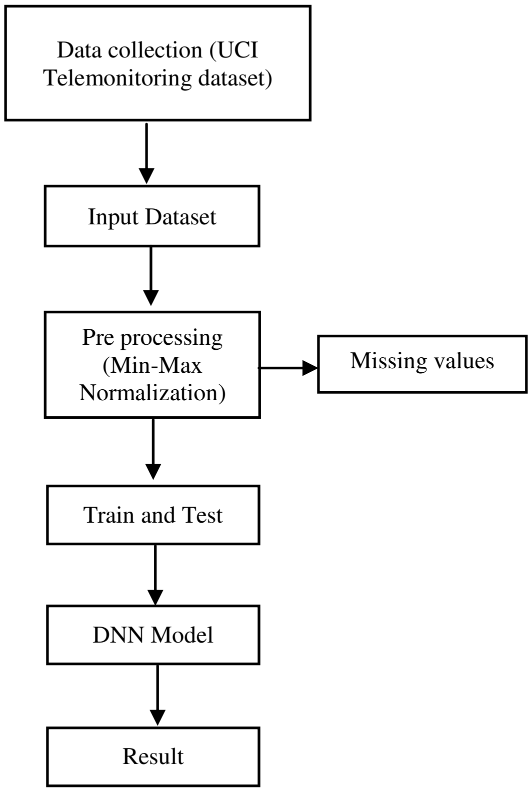

Figure-1 System Architecture

3.1 Data Collection

The project have used Parkinson's Telemonitoring Voice Data Set[15]from UCI Machine Learning Repository. The dataset comprises of biomedical voice measurements of patients. The different attributes of the information are subject

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number, subject age, subject gender, time interval, Motor UPDRS, Total UPDRS and 16 biomedical voice measures. 5,875 voice recordings of these patients are included in the dataset. The data is in ASCII CSV format. On an normal, there are around 200 recordings collected from each patient (identification can be done through the primary attribute - subject number).

3.2 Data Pre-processing

Clean the dataset to address missing values, outliers, and data inconsistencies. Normalize the features to ensure they are on a consistent scale. Encode categorical variables if necessary. This project have normalized the dataset into a range of 0-1 using min-max normalization. The normalization was done column wise utilizing equation (1):

Normalized value of x = x – min(x) / max (x) – min(x) --->(1)

where x= column value, min(x) is the column's minimum value, and max(x) is the column's highest value.

3.3 Data Splitting

The total-UPDRS score in the dataset ranges from a minimum value of 5.0377 to a maximum value of 54.992, while it ranges from minimum of 5.0377 to maximum of 39.511 in case of motor-UPDRS scores. We created the train and test datasets by splitting the normalized dataset into parts of 80% (for train dataset) and 20% (for test dataset). Further, separate train and test datasets were made for both motor UPDRS score and total UPDRS score, keeping each of these scores as the output variable in their comparing records.

3.4 Building the DNN

The features for classification are the normalized values of 16 biomedical voice measures, specifically Jitter (%), Jitter (Abs), Jitter RAP, PPQ5, DDP, Shimmer(dB), Shimmer: APQ3, APQ5, Shimmer: APQ11, Shimmer DDA, NHR, HNR, RPDE, DFA, and PPE. The output classes are 'non-severe' and 'severe'. We have characterized the range for the different measurements for severe and non-severe classes as appeared in Table 1 due to the limitation of values within the dataset.

Table (1).Unified Parkinson's Disease Rating Scale

Metric	Severe	Non-severe
Total-UPDRS	Above 25	0-25
Motor-UPDRS	Above 20	0-20

IV. RESULT AND DISCUSSION

The algorithm takes in the input dataset and makes an input pipeline, and characterizes iterates over it, these are factors which makes a difference in filtering over data set. The defined algorithm also gives the usefulness to rearrange the dataset in order to supply randomness. After defining the input pipeline, the second step is to feed the input data into the training model, this is with the assistance of lambda function. Once the model has the data, it goes through training, evaluating, and predicting. The training is done by characterizing arrays of hidden layer with the pre-initialized weights to the layer, which makes and saves model, within the processing system. And in the conclusion, we perform evaluation of the resultant DNN classifier. The DNN Classifier was built using Tensor Flow with Keras as the backend. Our neural

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network contains 16 units within the Input layer, 10, 20, 10 neurons in each of the 3 hidden layers separately. The network was further trained with1000 and 2000 steps individually.

Table (2).Accuracy for UPDRS in DNN model

Accuracy	Metric	ANFIS + SVR	DNN
	Total-UPDRS	47.2	62.733 5
	Motor-UPDRS	44.3	81.666 7

The 16 biological voice features make up the input dataset, and the total UPDRS score is the output variable. For the train and test datasets, the corresponding classification accuracy is 94.4422% and 62.7335%, respectively. By comparing the result with that of the work by Nilashiet al.[8] , since they evaluated their model on the same UCI Parkinson’s Telemonitoring Voice Data set. They used ANFIS and SVR to predict the Parkinson’s disease advancement. Their work produced an average accuracy of 47.2% for the Total UPDRS score. The performance comparison classifiers for Total UPDRS score is shown in Fig.1.

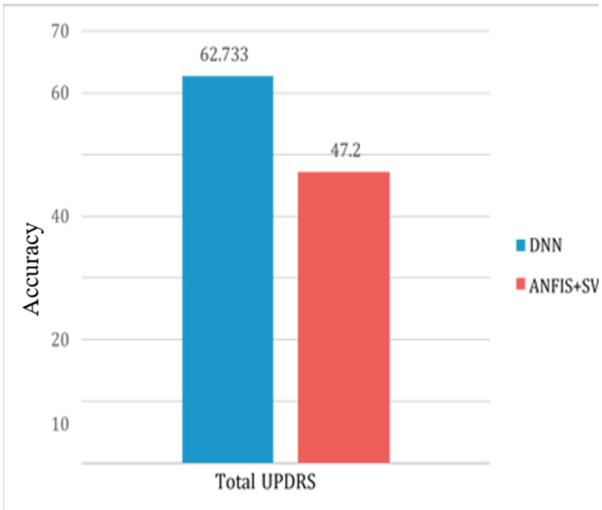

Fig.1.AccuracyComparison forTotal UPDRS Score

In this project, the input dataset is the 16 biomedical voice features and the output variable is Motor UPDRSscore. The classification accuracy obtained is 83.367% and 81.6667% for train and test dataset respectively. Incomparison to this, the methodology proposed by Nilashiet al.[8] produced an average accuracy of 44.3% for theMotorUPDRSscore.TheperformancecomparisonofclassifiersforMotorUPDRSscoreisshownin Fig.2.

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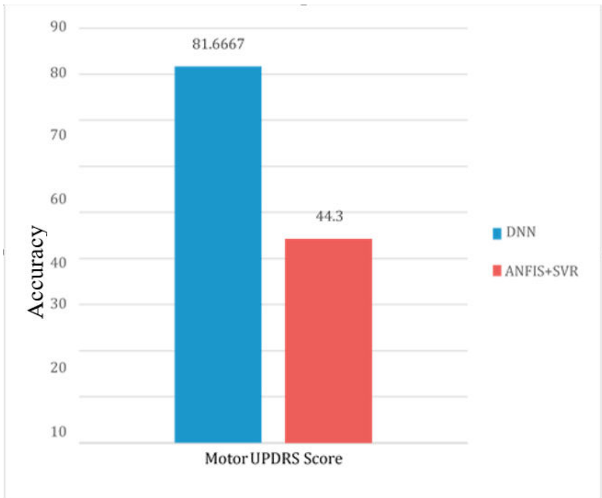

Fig.2.AccuracyComparisonfor Motor UPDRS Score

V. CONCLUSION

In this paper, a deep neural network has been constructed as part of the attempt to predict the severity of Parkinson's disease. In comparison to other methods currently in use, the accuracy of the proposed DNN model was higher. Additionally, it is discovered that the motor UPDRS score classification outperforms the total UPDRS score classification, supporting the idea that this metric is superior for severity prediction. Our approach's accuracy can be further enhanced by applying it to a larger dataset with a greater number of instances of each severity class and to a combined database containing patient attributes such as gait and handwriting features, in addition to the 5875 instances we used in our dataset.

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