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Voice Data Analysis for Early Detection of Parkinson's Diseaseusing Deep Learning Algorithms over Big Data

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***Abstract*—**Parkinson's Disease (PD) is chronic and progressive movement disorder that affects the millions of people. It can grow continuously to halt the neural activities of PD affected people. The various researchers are designed prediction models to predict disease at early stage by analyzing various symptoms such as tremor, bradykinesia, postural instability and rigidity. These models are focused mainly on data analysis effectively to predict the disease in the initial stage to increase the patient life period using Machine Learning techniques. But, the present systems are not predicting the disease in time rigid by attaining multiple attributes on voice data set. The proposed system must be equipped with more characteristics for attaining multi-attribute Parkinson's symptoms analysis. In the proposed system, the Deep Speech Data Analysis (DSDA) is developed using Deep Learning algorithms. The DSDA based PD system can help to predict symptoms of PD effectively than the existing systems. The DSDA system includes the subsystems such as Deep Neural Network (DNN), Deep Recurrent Neural Network (DRNN), and Deep Convolutional Neural Network (DCNN). The DSDA is compared with existing works and showed better performance.

Keywords—Parkinson's Disease; Machine Learning; Deep Speech Data Analysis; Deep Learning;Deep Neural Network; Deep Recurrent Neural Network; Deep Convolutional Neural Network

I. INTRODUCTION

Parkinson's Disease (PD) is neural disorder disease which can damage health of different age group people around the world. PD is classified as various types which are based on different abnormalities. It mostly damages the activities of neurons and body movements [1]. To predict PD symptoms in the initial stage, the medical research work is collaborated with computational intelligence techniques. The researchers are evolved their research on PD using Machine Learning (ML) approach to predict PD at early stage in the recent years [2]. The research work is conducted on various medical observations such as body movements, voice levels, brain signal variations, handwriting variations and protein aggregations. By using different medical apparatuses, the medical observations are measured. The various devices such as ultrasonic, wearable, acoustic and motion sensors and also Electro Encephalogram [3],are used to measure the PD symptoms.

The various researchers are encouraged to analyze the medical data set using ML techniques. It is required to produce reliable and accurate results using detection mechanisms. The effective ML approaches are used to achieve the requirements and adaptable for the data features [4]. From various data sets, the PD

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symptoms are identified by conducting research work. The earlier research works were focused mainly on limit number of PD features. Some researchers are used ML based PD detection techniques with real-time sensor data sets. But, these techniques are limited to certain range of observations. These problems are resolved [5].

Many researchers are developed PD prediction systems based on various types of data sets. The data sets are included images, text, video and audio content of PD patients. These data sets are diagnosed and used by appropriate feature detection methods [6]. The researchers can deal with sensor data, motion detection, vocal data and pictorial data. Many researchers were concentrated ML based prediction techniques to predict PD on these data sets only but not on multi-type data set [7].

To present PD abnormalities, the researchers can use any type of data set. In the proposed research work, the multiple types of audio samples are analyzed to create integrated data set. This novel data set is placed for Deep Learning analysis. Mainly, this work is focused on voice attribute based PD. To resolve these issues, the proposed system is useddeep learning techniques on huge PD data set for solving those issues [8].

II. Related Work

By using medical and computational biology techniques, the various researches have been researched on PD prediction techniques.

R.M. Sadeket al [9] proposed an approach using Back Propagation and Artificial Neural Network (ANN) techniques for predicting PD in the early period. These techniques are used to identify continuous patient movements. To get optimal disease evaluation, the patterns of patient activities are registered and trained. The authors were tested and analyzed PD results that have got acceptable on homogeneous medical features. It has shown better performance.

James Wingate et al [10] proposed an approach for predicting PD using Convolutional Recurrent Network in the initial stage of disease. This approach includes analysis that extracts the data such as dopamine transporters scans and magnetic resonance images. The unified framework is created to predict PD across the various medical environments. The authors were presented the experimental study that illustrates the approach for predicting PD effectively using medical image data sets of real environments. The domain adaption methodology was integrated in proposed approach to introduce an error criterion that can train with DaTscans and MRIs effectively.

GayathriNagasubramanian et al [11] proposed Multi-Variant Stacked Auto Encoder (MVSAE) approach to analyze Parkinson's Disease symptoms accurately and it provides optimal treatment assistantship. In this approach, the four different encoder strategies such as Hyperactive Clustered SAE (HSSAE), Hyperactive Classless SAE (HUSAE), Balanced Multi-SAE for Parkinson Feature Classification (BMSAE) and Deep Variant Multi-SAE (DVSAE) are used to achieve accurate PD classification. The MSAEPD was compared with existing systems UMLBD, GAE and MANN. The MSAEPD produces 5% to 10% better performance than earlier research work.

SukhpalKaur et al [12] proposed an approach which is grid search optimization for predicting Parkinson's Disease at early stage. It is optimized deep learning model that it sets and tunes to evaluate the multiple hyper parameters. This framework consists of various stages such as DLM topology optimization, the hyper parameters and model performance. The model was evaluated using voice samples of healthy individuals and PD patients. In this testing process, the results are proved the average classification accuracy of 91.69% and testing accuracy of 89.23%.

AfzalHussainShahid et al [13] proposed an approach using Principal Component Analysis (PCA) based Deep Neural Network (DNN) model for extracting the features in a multivariate analysis on data set which consists of a huge set correlated variables. The PCA addresses multicollinearity problems in the dataset and reduces the dimension of input feature space. The performance of model is tested by conducting several experiments and the result is compared with the earlier works on the same data set. The accuracy of prediction is measured using various metrics such as Mean Absolute Error, Root Mean Squared Error, and

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Coefficient of determination. The proposed method is predicted PD in efficient manner.

Shivangi et al [14] proposed an approach VGFR Spectrogram Detector and Voice Impairment Classifier based on neural network. It is more useful for doctors for diagnosing PD in early period. In this approach, the Convolutional Neural Networks (CNN) is implemented on large scale image and the voice recordings data set is used to predict PD using deep dense Artificial Neural Networks (ANN). The proposed models were outperformed the performance. The VGFR Spectrogram Detector classification accuracy is recorded as 88.1% while Voice Impairment Classifier has shown 89.15%.

Chaithra B.R et al [15] proposed a PDDS (Parkinson's Disease Detection System) to predict disease at early stage. The proposed system includes the deep learning techniques such as Deep Neural Networks (DNN) and Artificial Neural Networks (ANN). The authors were implemented and tested the system with the PD subjects that produce the promising preliminary results.

Srishti Grover et al [16] proposed DNN PD prediction model to diagnose the severity of PD using deep neural networks on UCI's Parkinson's Tele-monitoring voice data set. For predicting the severity of PD, the 'TensorFlow' deep learning library of python is used for implementing deep learning network. The results are produced accurately and compared with the accuracies of earlier research work. The authors stated that as classification based on motor UPDRS score is better than classification based on total UPDRS score.

Karunanithi.D et al [17] proposed a method using Feed Forward Back Propagation (FFBP) and Trainlm function to analyze the PD in the early stage. The authors are chosen four classifications for comparing the various accuracies of different methods. The trainlm function is used in the experiment to produce more accurate results which can help for classifying the people that who affected with PD and healthy. The experimental result is shown that the highest accuracy of training of FFBP is 98.53% and testing value is 99.4%.

S. Anita et al [18] proposed an approach based on Artificial Neural Networks (ANN). It is used to predict Gamma-Amino Butyric Acid (GABA) concentration level in PD. To predict GABA concentration level, the model can use multi-layer perception network having 4-30-1 architecture. In this process, the model is trained for predicting the GABA concentration level with optimum level. It is highly encouraged to improve the prediction performance on ANN model. It overcomes the misdiagnosis of earlier PD detection systems. This model is highly reliable in prediction of PD at early stage using artificial neural network.

III. METHODOLOGY

A. Description of Dataset

The voice data set of PD is collected from UCI system. The voice recording measurements of 31 people are composed in this data set. This data set consist 23 PD patients information. A particular voice measure is placed in each column in the table and each row specifies the voice recordings of 195 instances of various people [19]. This data set aim discriminates PD people from healthy people and the status of healthy people is set as 0 and status of PD people is set as 1. The attributes are defined in Table1.

Table1. List of attributes for recorded PD voice signals

S.No	Attribute ID	NAME of Attribute	DESCRIPTION of Attribute
1	A1	MDVP: Fo (Hz)	Average Vocal Fundamental Frequency
2	A2	MDVP: Fhi (Hz)	Maximum Vocal Fundamental Frequency

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3	A3	MDVP: Flo(Hz)	Minimum Vocal Fundamental Frequency
4	A4	MDVP: Jitter (%)	Jitter as Percentage
5	A5	MDVP: Jitter(Abs)	Absolute Jitter in Microseconds
6	A6	MDVP: RAP	Relative Amplitude Perturbation
7	A7	MDVP: PPQ	Point Period Perturbation Quotient
8	A8	Jitter: DDP	Average Absolute Difference of Differences Period
9	A9	MDVP: Shimmer	Local Shimmer
10	A10	MDVP: Shimmer(dB)	Local Shimmer in Decibels
11	A11	Shimmer:APQ3	3-Point Amplitude Perturbation Quotient
12	A12	Shimmer:APQ5	5-Point Amplitude Perturbation Quotient
13	A13	MDVP:APQ	11 Point Amplitude Perturbation Quotient
14	A14	Shimmer: DDA	Difference of Differences Amplitude
15	A15	NHR	Noise to Harmonic Ratio
16	A16	HNR	Harmonic to Noise Ratio
17	A17	RPDE	Recurrence Period Density Entropy

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18	A18	D2	Correlation Dimension
19	A19	DFA	De-trended Fluctuation Analysis
20	A20	Spread1, Spread2	Non-Linear measures of Fundamental Frequency variation
21	A21	PPE	Pitch Period Entropy
22	A22	Status	0-Healthy, 1-Parkinson's Disease

B. Architecture of DSDA System

The architecture of DSDA system is designed with a classification framework using the Deep Learning based Vocal Data Analysis System for analyzing the voice data set to predict Parkinson's Disease. In this work, the various deep learning based methods are used in Deep Speech Data Analysis (DSDA). In DSDA model, the speech feature selection algorithm is used to extract the various features and also data sampling manipulation process is applied for sampling the various features for analyzing properly. The system is deployed with various deep learning techniques such as DNN, DRNN, and DCNN. The architecture of the proposed system with deep learning algorithms is designed as shown in Fig1.

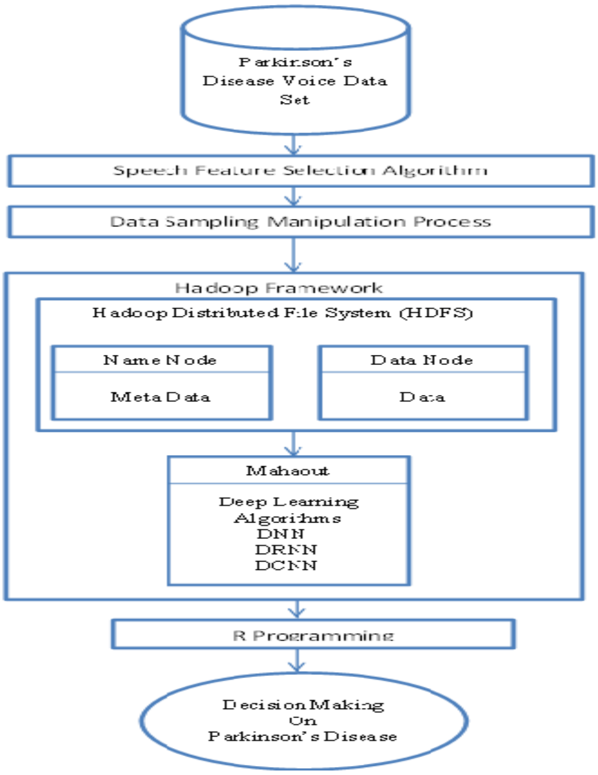

Fig1. Architecture of the Proposed System

The system is received PD data set as input from data source. The system includes the technologies such as Mahaout and R to process the operations on given data to produce the required results. After examining of data set, if there are any stimulating facts, then it discloses those elements. The data is provided to Mahaout

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as input and this data is diagnosed and grouped based on the different type of feature. It process as well structured form and the output is sent to R. The R can analyze the output as statistical form. The output can be represented as graphical pictures with attribute wise.

C. Speech Feature Selection (SFS)

The Speech Feature Selection technique is used for extracting the features from the data set [20]. The proposed model DSDA can start with voice signals and sampling all the features. The algorithm1is described the process steps for producing scalar and vector elements of speech determinations. The values of data set are not included any scalar and vector attributes. By separation of attribute nature, it can make up the real-time data of acoustic features. The run time deflection of accuracy rate can reduce by creating absolute magnitudes for all the data items in this model. This technique can make Parkinson Acoustic Model A(M) with the various speech attributes [21].

The speech information is generated by algorithm1 and it is also categorized. It can contain sound velocity, wavelength variations, pressure metric, pitch, and speech frequency variations in multiple pronunciations. The optimal sampling function can get modeled values for enhancing the data processing actions.

Algorithm1: SFS for PD Detection
Step1: Determine patient speech sound pressure S(p), the variations in speech baseline sound pressure (scalar element)
Step2: Determine medium wave particle velocity M (v), the usual velocity of sound particles in the medium (m/s) (vector element)
Step3: Find sound vector S(Q) = UxQx + UyQy + UzQz
Step4: Determine the temporal variations in patient's speech tone using adaptive frequency P(f) = V cos(2ft+a)
Step5: Calculate linear speech attribute variations in S (p), M (v) and P (f) with respect to time 'T'
Step6: Compute the wavelength, yT = 1
Step7: Keep the information in sample.basic.db (basic Parkinson's Features)
Step8: Set other attributes such as pitch variations, spelling delay and others as D(S)
Step9: Set the final speech (attributes) according to designed A (M) for all subjects (people)

D. Data Sampling Manipulation

The sampling technique is used to generate sample data quantities using finite number of data sets. It can help to take data samples from the processed data sets. By increasing the quantity of effective samples, the decision making algorithm performance can be increased. For detecting PD, the processed data samples are used. The sampling rate reflects directly on the detection rate of disease features. The deep learning approaches can use optimized sampled PD data set that can applied on various Deep Learning techniques such as ADNN, ADRNN, and ADCNN. It can help to detect and forecast the symptoms of PD from observed data samples.

E. Deep Neural Network (DNN)

The deep learning (DL) techniques are applied on the processed data values of Parkinson's disease features. The DNN algorithm can utilize the data values and the samples effectively. The DNN's input layer can get the details of acoustic model by DSDA. The hidden layers of DNN can evaluate and weight the attributes to produce the output. More number of complex hidden layers is existed in DNN than the other neural networks. The algorithm2 shows that the DNN can manipulate the input elements in matrix notation. It can help to arrange data in structure form in DNN. To evaluate the maintenance effectively, the data elements are mapped with acoustic model in each matrix. The next DRNN can evaluate the data set features in the next cycle.

Algorithm2: DNN for PD Detection
Step1: Get input samples and form multimodal acoustic data matrix for given attributes
Step2: Initialize S_b as 0, the fractional variance factor for matrix elements
Step3: Initialize weight function Q, Mm-Multimodal acoustic data matrix, attributes and e-matrix elements
Step4: Update the weights in deep hidden layers

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Step5: Apply deep classification on samples
Step6: Determine the number of hidden layer, C-number of classes of observed values
Step7: Set threshold for Q
Step8: Apply redundancy removal and missing values elimination procedures
Step9: Do mapping between A(M) and Mm components
Step10: Execute Hidden Markov Model (HMM) for e(Mm) at T intervals (Time series)
Step11: Match states S(t) and e(Mm)
Step12: Update Parkinson acoustic learning information

F. Deep Recurrent Neural Network (DRNN)

The DSDA system includes the DRNN algorithm which works based on recurrence model. The DRNN can have the functions LSTM-RNN and gate recurrence. In algorithm3, initially it forms the standard RNN and analyzes the acoustic data items of Parkinson's Disease (PD) based on creating LSTM (Long Short-Term Memory) and gate functions. By observing the various states in the estimation of RNN model, the PD features are utilized. To handle PD acoustic elements, the DSDA system develops the multilayer RNN based on RNN functionalities. For the next level inputs, it retrains the neuron from the outcomes. The DRNN statements and procedures are produced by Algorithm2. The basic RNN backbone structure is used in the construction of DRNN.

The DRNN has input, output and state transition forms. The DRNN consist discrete nonlinear Parkinson acoustic element functions Q and F for determining input and output. The RNN model has two units such as LSTM and Gate recurrent. These two units are denoting the RNN gating functions such as input, forget, output and inner functions.

By using trainable parameters, the current PD features are determined with RNN gating functions. The gate unit functions and parameters are illustrated in Algorithm2. To provide optimal PD detection rate, the DRNN can analyze the PD samples with different perspectives. Finally, the PD symptoms are predicted by DCNN.

Algorithm3: DRNN for PD Detection
Step1: Get input samples for attributes
Step2: Find discrete samples and determine basic RNN function
Step3: Form Conventional RNN
Step4: Create and manipulate LSTM and GR unit for U
Step5: RNN has acoustic trainable parameters such as
Step6: LSTM RNN and Gate Recurrent unit analyze the acoustic samples.
Step7: Data Prediction in time series
Step8: Collect and update PD data items for decision making
Step9: Detect anomalies in acoustic items.

G. Deep Convolutional Neural Network (DCNN)

The DCNN algorithm is used to diagnose data variances of PD, classify effectively and forecast PD symptoms. For evaluating the acoustic values at different time interval, it has max pooling and rectified linear unit techniques. For resolving disease prediction disorders, these functions were implemented. It manipulates various filters and layers of convolution procedures. The algorithm4 describes that the data elements are fed into DCNN's hidden layer. It can help for classifying the Parkinson symptoms ranges.

Algorithm4: DCNN for PD Detection
Step1: Collect and extract acoustic features from DD(R), SS (q)
Step2: Samples of DD(R) have 1040 of data set elements
Step3: Samples of BB(R) from SS (q)
Step4: Frame ConvNet filters at various ranges
Step5: Apply Filtering for acoustic features w.r.t time series
Step6: Determine convolutional weight function
Step7: Apply ReLu and Max pooling functions
Step8: Compute sampling and scoring functions
Step9: Create score based Parkinson's Disease symptoms
Step10: Redo for all data elements of DD(R) and BB(R)

IV. RESULTS AND DISCUSSION

A. Experimental Setup

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For carryout the experiment, the Hadoop framework environment is used to store, process and analyze the data set. The HDFS is used to store the data and required items are used for analysis purpose. The main aim of using the UCI Parkinson's disease dataset is to identify PD symptoms such as voice variations and motor symptoms. The implementation has been done using Mahaout framework is used for executing DL algorithms and R is used for generating visual graphs for analyzing PD. The open source tools are Mahaout and R and these are used for DL implementation and data preprocessing respectively. The Mahaout tool is used to implement the operations such as speech model creation, data sampling, DNN, DRNN and DCNN techniques apart from data preprocessing section. By applying preprocessing techniques on dataset, the redundant values, missing values and other improper values are eliminated. The dataset is divided as testing and training datasets. Before detecting the disease symptoms, the DSDA can take latency in milliseconds in learning phase. The dataset can use in DSDA evaluation process. The improvement of disease detection rate describes with comparison. The features of data set are determined, modeled and prepared by speech processing techniques. The deep learning algorithms are received the sound records as either vector or scalar data from preprocessed data. To find out the PD voice symptoms, the DNN, RDNN and DCNN algorithms are processed either scalar or vector data. The performance of proposed approach is measured using the following metrics to predict PD at early stage.

F1-Score: It uses for measuring accuracy of the tested data. It refers as harmonic mean of recall and precision. It can be denoted as:

$$F1-score = \frac{2*(\text{Pr}ecision*\text{Re}call)}{(\text{Pr}ecision+\text{Re}call)}$$

Precision: It refers as the no of correct positive results is divided by the number of correct positive results. It can be denoted as:

$$\text{Pr}ecision = \frac{(TruePositive)}{(TruePositive+FalsePositive)}$$

Recall: It refers as the no of correct positive results is divided by the addition of correct positive and incorrect negative results. It can be denoted as:

$$\text{Re}call = \frac{(TruePositive)}{(TruePositive+FalseNegative)}$$

Specificity: It refers as the no of correct negative results is divided by the addition of correct negative and incorrect positive results. It can be denoted as:

$$\text{Specificity} = \frac{(TrueNegative)}{(TrueNegetive+FalsePositive)}$$

Accuracy (Acc):It refers as the total no of correct predictions divided by the total number of predictions and multiply by 100.

$$\text{Accuracy} = \frac{No\ of\ correct\ predictions}{Total\ no\ of\ predictions}*100$$

Mean Absolute Error (MAE): It refers as summarizing the results and can use for understanding the difference between actual values of training data and the average of predicted values.

$$\textbf{MAE} = \frac{1}{N}\sum_{i=1}^{N} |\ yi - yi^\wedge\ |$$

The Table2 is illustrated the various deep learning techniques performance in DSDA on a voice data set. The proposed algorithms such as DNN, DRNN and DCNN are compared with the other existing mechanisms. These techniques are shown collectively 2.6% performance than the earlier methods. The proposed DLtechniques are manipulated the absolute values rather the relative observations. The speech signal model is preprocessed the observations of data set. Before analyzing these features by DL techniques, the PD speech model and voice sampling procedures can use for analyzing the data set features.

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Table2. Comparison of various models on UCI data set

Techniques	Precision	Recall	Specificity	Accuracy	MAE
DNN	98.76	98.73	98.82	98.90	1.06
DRNN	99.08	99.11	99.18	99.21	0.79
DCNN	99.81	99.87	99.79	99.91	0.05
KFPD	98.31	98.12	98.04	98.22	1.78
SPPD	98.25	97.95	98.15	98.23	1.77
CNN	97.61	97.64	97.76	97.83	2.16
RNN	97.26	97.38	97.48	97.57	2.42

The proposed deep learning techniques such as DNN, DRNN and DCNN accuracy rate against increasing samples is illustrated in Fig2. By using data sampling technique, it can change progressively with respect to the effective gathered sample data elements. By considering the filtering technique for attributes, the sampling procedures are produced good accuracy rate than the other methods.

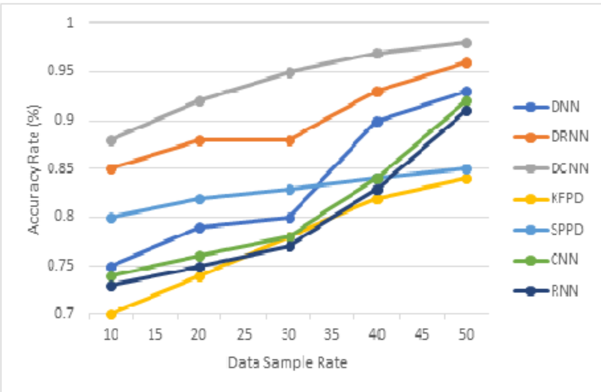

Fig2. Accuracy Rate as increasing samples

In Fig3, **t**he accuracy rate increases as prediction rate increases is illustrated. As data size increases, the progress can improve. In the earlier work, the timeline activities were not performed effectively. To detect and predict the sequential observations of PD symptoms, the Data Sampling Process is used in DSDA. So, it is very useful to take right decision.

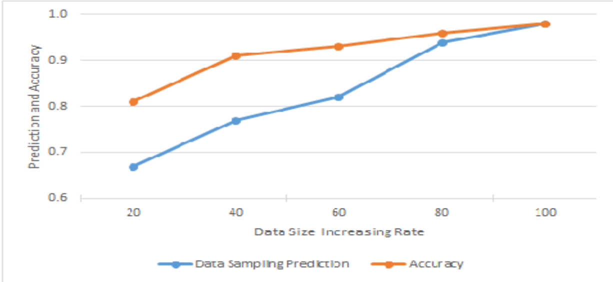

Fig3. Prediction Rate increases as increasing Samples

The DCNN produces the minimal error rate that comparing to conventional CNN and RNN which is shown in Fig4. The MAE is the parameter to differentiate the predicted items and actual disease items. The parameter is used to find out the PD detection deviations.

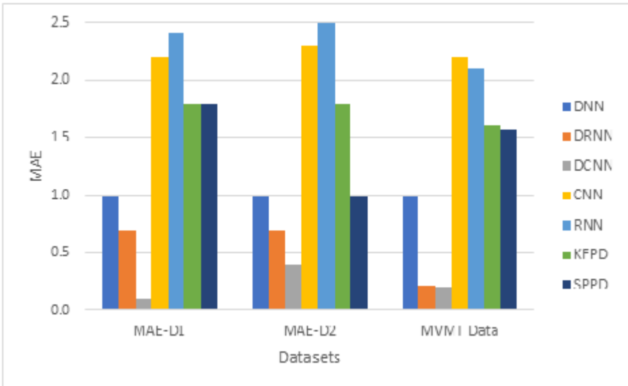

Fig4. Mean Absolute Error

The sensitivity values with ROC curve for the DSDA is illustrated in Fig5. The application performance of DSDA can give growth on voice-based Parkinson disease detection.

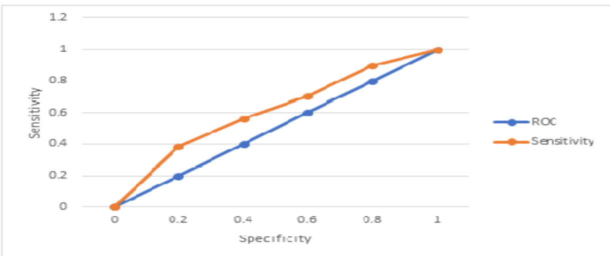

Fig5. ROC analysis

The vocal management system is used in diagnostic centers to keep multiple voice dimensions of each person. To improve the results on PD detection, they can use these techniques. The DSDA delivers moderate PD detection rate than the existing systems throughout the result discussions.

V. CONCLUSION

To detect PD at early stage, a novel model was designed using deep learning techniques. This approach is incorporated with absolute voice processing algorithms for making well-defined data pattern. To improve Parkinson's Disease prediction, the DL techniques such as DNN, RDNN, and DCNN are proposed to support the activities of UCI PD data processing. The optimal data sampling technique in proposed method is used to improve the accuracy rate. This technique can help to get relevant PD disease symptoms. The DSDA performed effectively in the prediction of PD when it is compared to the other techniques. The proposed DSDA model algorithms produced minimal MAE and optimal disease detection rate in performance evaluation. The DCNN showed better performance comparatively than the other techniques because of using convolutional filters. The complex filters are used in DCNN to enhance the system and to increase learning rate by using DNN techniques. In future, our research work will be extended to develop efficient PD detection system on hand writing data set.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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References

[1] Gayathri Nagasubramanian and Muthuramalingam Sankayya, "Multi-Variate vocal data analysis for detection of Parkinson disease using deep learning," Neural Computing and Applications, 2020.

[2] Ramzi M. Sadek, Salah A. Mohammed, Abdul Rahman K. Abunbehan, Abdul Karim H. Abdul Ghattas, Majed R. Badawi, Mohamed N. Mortaja, Bassem S. Abu-Nasser, and Samy S. Abu-Naser, "Parkinson's disease prediction using Artificial Neural Network," International Journal of Academic Health and Medical Research, vol. 3(1), pp. 1-8, 2019.

[3] Manuel Gil-Martín, Juan Manuel Montero and Rubén San-Segundo, "Parkinson's disease detection from drawing movements using Convolutional Neural Networks," MDPI, pp.1-10, 2019.

[4] Lucijano Berus, Simon Klancnik, Miran Brezocnik and Mirko Ficko, "Classifying Parkinson's disease based on acoustic measures using Artificial Neural Networks," MDPI, pp.1-15, 2018.

[5] S. Kanagaraj, M.S. Hema, M. Nageswara Gupta, "Machine learning techniques for prediction of Parkinson's disease using Big Data," International Journal of Innovative Technology and Exploring Engineering, vol. 8(10), pp. 3788- 3791, 2019.

[6] Neharika D Bala, Anusuya S, "Machine learning algorithms for detection of Parkinson's disease using motor symptoms: speech and tremor," International Journal of Recent Technology and Engineering, vol. 8(6), pp. 47-50, 2020.

[7] Yanhao Xiong 1 And Yaohua Lu, "Deep feature extraction from the vocal vectors using Sparse Autoencoders for Parkinson's classification", IEEEAccess, vol. 8, pp. 27821- 27830, 2020.

[8] Muntasir Hoq 1 , Mohammed Nazim Uddin 1,* and Seung-Bo Park, "VocalfFeature extraction-based Artificial intelligent model for Parkinson's disease detection," MDPI, vol. 11, pp. 1-22, 2021.

[9] R. M. Sadek, S. A. Mohammed, A. R. Abunbehan, A. K. Ghattas, M. R. Badawi, M. N. Mortaja, B. S. Abu-Nasser, and S. S. Abu-Naser, ``Parkinson's disease prediction using artifcial neural network," Int. J. Acad. Health Med. Res., vol. 3(1), pp. 1-8, 2019.

[10] James Wingate, Ilianna Kollia, Luc Bidaut and Stefanos Kollias,"Unified deep learning approach for prediction of Parkinson's disease", The Institution of Engineering and Technology, vol. 14(10), pp. 1980-1989, 2020.

[11] Gayathri Nagasubramanian, Muthuramalingam Sankayya, Fadi Al-Turjman and Georgios Tsaramirsis, "Parkinson's data analysis and prediction aystem using Multi-variant Stacked Auto Encoder", IEEEAccess, vol. 8, pp-127004-127013, 2020.

[12] Sukhpal Kaur, Himanshu Aggarwal and Rinkle Rani, "Hyper-parameter optimization of deep learningmodel for prediction of Parkinson's disease", Machine Vision and Applications, pp. 1-15, 2020.

[13] Afzal Hussain Shahid and Maheshwari Prasad Singh, "A deep learning approach for prediction of Parkinson's disease progression", Biomedical Engineering Letters, pp.1-13, 2020.

[14] Shivangi, Anubhav Johri and Ashish Tripathi, "Parkinson disease detection using Deep Neural Networks", IEEE, pp.1-4, 2019.

[15] Chaithra B.R, Gowthami A.L, Harshitha U, Keerthana N and Asha V.G, "Early stage prediction of Parkinson's disease using Neural Network", International Research Journal of Engineering and Technology, vol. 6(5), pp. 4911- 4916, 2019.

[16] Srishti Grover, Saloni Bhartia, Akshama, Abhilasha Yadav, Seeja K. R, "Predicting severity of Parkinson's disease using Deep Learning", Procedia Computer Science, 132, 2018, pp-1788_1794.

[17] Karunanithi.D, Dr. Paul Rodrigues, "Diagnosis of disease through voice recordings using Artificial Neural Networks", International Journal of Computer Applications Technology and Research, ISSN:-2319–8656, Volume 6–Issue 7, pp-299_305, 2017.

[18] S. Anita, P. Aruna Priya, "Early prediction of Parkinson's disease using Artificial Neural Network", Indian Journal of Science and Technology, ISSN: 0974-5645, Vol- 9, Issue- 36, pp-1_2, September 2016.

[19] Ramzi M. Sadek, Salah A. Mohammed, Abdul Rahman K. Abunbehan, Abdul Karim H. Abdul Ghattas, Majed R. Badawi, Mohamed N. Mortaja, Bassem S. Abu-Nasser and Samy S. Abu-Naser, "Parkinson's disease prediction using Artificial Neural Network," International Journal of Academic Health and Medical Research, vol. 3(1), pp. 1-8, 2019.

[20] A.A. Orunsolu, A.S. Sodiya and A.T. Akinwale. "Apredictive model for phishing detection",Journal of King Saud University – Computerand Information Sciences,vol. 34(2), pp. 233-247, 2019.

[21] N. Prasath, Vigneshwaran Pandi, Sindhuja Manickavasagam and Prabu Ramadoss. "Acomparative and comprehensive study ofprediction of Parkinson's disease", IndonesianJournal of Electrical Engineering andComputer Science, vol. 23(3), pp. 1748-1760, 2021.