International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 6 ǁ June 2023 ǁ PP. 52-59

Review on Parkinson's Disease Diagnosis using AI based Methods

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Abstract—*Background and Objective: Parkinson's disease (PD) is a critical neurological ailment which affects millions of population worldwide.An accurate diagnosis of Parkinson's disease is required for an effective treatment. Deep learning (DL) algorithms are based on various diagnostic methodologies that have been developed to detect PD and resolve the related diagnostic issues. This research study offers a thorough assessment of published surveys and DL-based diagnosis methodologies for PD recognition.*
Methods :*Various methods for diagnosing PD include Convolutional Neural Network(CNN), Recurrent Neural Network(RNN),Convolutional Recurrent Neural Network(CRNN),Deep Belief Network(DBN), Deep Neural Network(DNN) and CNN-BLSTM.*
Result: Deep hybrid network with EEG signals and deep neural network with handwritten patterns outperforms the existing technologies in terms of classification accuracy of 99.2% and with the computational resources of approximately 24% for PD diagnosis.
Conclusion: The reviewed papers indicates many disadvantages in current techniques which in turn may result in very low accuracy of classification of data.Almostevey existing algorithm will rely on either single or multiple features.Accuracy may be further increased by varying several parameters like the characteristics that need to be considered, improving the classification techniques such as multi-level classifiers and increasing the efficiency of noise cancellation.
Keywords: *Parkinson's disease, CNN, Deep learning, voice data, EEG , handwritten patterns , MRI, gait features.*

Date of Submission: 22-05-2023 Date of acceptance: 03-06-2023

I. INTRODUCTION

Parkinson's Disease (PD) is the second most common neurodegenerative disorder[1] worldwide.This disease was discovered by Dr. James Parkinson, initially called 'Shaking Palsy', dopamine deterioration in different regions of the brain, especially in 'Substantia nigra' affects the movements in patients. The symptoms of PD can be either motor or non-motor. Movement related symptoms include dyskinesia (where the limbs move uncontrollably), bradykinesia or slowness of movement and vocal disorders such as dysphonia. The non-motor symptoms include depression, sleep disorders and intellectual disability.

One percent of adults over the age group of 60 have PD and it affects 1-2 of every 1,000 people

(Tysnes and Storstein, 2017).From 1990 to 2016 most of the global population affected by PD and the rate has doubled.(from 2.5 million to 6.1 million)Due to this more number of elderly people were affected and age- standardized prevalence rates (Dorsey et al., 2018).Though women have a lower survival rate and a faster rate of illness development, men are twice as likely to have PD.

The existing methodologies are neuroimaging techniques such as MRI, PET are used to visually assess and determine the loss of neurons in different lobes of the brain for the past two decades in hospitals. MRI was preferred for the past decade because of its non-invasiveness and high spatial resolution. Machine Learning algorithms such as PPMI, Boosting, Support Vector Machine (SVM),artificial neural networks (ANN), K Nearest Neighbor (KNN), Linear regression and Resilient backpropagation are used for PD detection in recent years.

Supervised machine learning algorithm which is based on PCA was used as a feature extraction method. Multilayer Perceptron, SVM and KNN are used for the purpose of classification. These classifiers are applied to the voice dataset which is taken from UCI machine learning repository. Classifiers are evaluated in terms of ROC (Receiver Operating Characteristic) curve. The limitation of the existing SVM algorithm is that it is not suitable when data sets are large and the target classes are overlapping. Other methods like KNN also do not work well with large datasets and high count of dimensions and it is the need of the hour for developing models with high efficiency.

Various metrics used for evaluating algorithms include precision, accuracy,sensitivity, specificity. A higher accuracy value is achieved, which means a better prediction performance. Currently,there is no conclusive test for detecting Parkinson's disease in its early stages where the symptoms are subtle and poorly characterized.This leads to a high misdiagnosis rate. The goal is to find the effective indicator for detection.Several Deep learning algorithms were implemented with voice, speech, handwritten patterns, movement,MRI image dataset, PPMI and gait pattern were used.

The objective of this study is

- To identify the characteristics of voice disorders which were affected by Parkinson's disease and to accurately classify the disease condition of the patient by using deep learning methods.

- To diagnose and to treat PD before an irreversible destructive change occurs.

- To attain an accuracy greater than the existing methodologies for disease detection.

II.DATASETS

A. VOICE DATASET

a) Convolutional-Neural-Network-Bidirectional-long--short-term-memory(CNN-BLSTM)

The dynamic and static features of speech are used for detecting if a person has Parkinson disease.Thearticulation transitions and the trend of the fundamental frequency curve are quite different for the healthy and for the patients affected by the disease.The long-short term memory (LSTM) model helps us to capture the dynamic features of speech signal similar to the time-series features used for detection of PD.During the transition of voice signal from unvoiced to voiced ,that is the onset and the offset and vice versa segments,the dynamic speech features are measured.The method which is adopted here is the long-short term memory (LSTM) model which is used for capturing the time-series dynamic features of a speech signal for the PD detection. It has an accuracy of nearly 89% but however it takes more computation time for a single epoch than the CNN method and other machine learning approaches.

b) *Support vector machine(SVM)*

The voice based dataset uses the voice recordings from five different datasets,that is from the gender based dataset,balanced dataset and from the unbalanced dataset which are all derived for Parkinson disease detection from the largest public dataset.It mostly consists of applying the technique of feature subset selection. This work mainly contributes to the voice-based PD detection since it has a high detection capacity. The selected features were mainly fed to four different types of classifiers, such as the support vector machine (SVM), multi-layer perceptron (MLP), K-nearest neighbors (KNN), and random forest (RF) [4].It is an improvement over the previous research works on voice based Parkinson disease detection over the dataset.It has a classification accuracy of 95.9% with low economic cost and non-intrusiveness.

c) Convolutional neural network(CNN)

Voice based detection is the foremost important technique for the detection of the disease.CNN (Convolution Neural Network) is used for classifying the disease using vocal features.TheCNN_based_networks_have two frameworks.Combining the different features before given to the nine layered CNN as inputs[7].The second framework will pass all the features directly to the classified parallel input layers and then these will be directly connected to the various convolution layers.The research works show that the second framework is very promising since it can learn and analyze the deep features from each feature set by parallel convolution layers.These models are trained with dataset taken from UCI machine learning repository.The discriminative powers of the classifiers increases and makes it easier for the researchers to distinguish between the normal and the affected Parkinson disease patients.These classifiers resulted the performances up to 98.6% of the precision rate using these features.It mainly achieves better performance for detection(with very low computational complexity) than the various research works done previously.

B. HANDWRITTEN PATTERNS

a) Convolutional neural network- VGG(Visual Geometry Group)

Handwritten patterns taken from the Kaggle repository were used in VGG-19 method for the detection of PD. One hundred-two forms of each spiral and wave pattern were taken as datasets. They were pre-processed to reduce overfitting. Images from the datasets were resized and picture rotation-based data augmentation method was used. After training the pre-processed dataset, a Four-fold and ten-fold cross validation method was used to verify the Convolutional Neural Network (CNN) model. From 10-fold cross validation the accuracy of 88% for wave and 89% for spiral pattern were obtained. Training the large baseline CNN is very difficult due to limited data size.

b) Convolutional-Neural-Network (CNN-BLSTM)

The CNN-BLSTM method combines both CNN and BLSTMs for feature extraction and sequence prediction respectively. One of the two deep learning model feeds a CNN with 2D time series representations and the second model feeds the integrated time variation into CNN- Bidirectional Long-Short-Term Memory Networks (CNN-BLSTM). The complete raw time series is used as input rather than converting them into images. The output of the CNN is a series of 32-pixel vectors with a length of n/4, where n is the length of the time series which is fed as input to BLSTM. CNN-BLSTM was superior against SVM and CNN with an accuracy of 97.62%. As this Network is trained with a short dataset, it may memorize every training sample, which may negatively impact its performance on a holdout dataset.

c) Deep neural network(DNN)

This method involves four different handwriting datasets (PaHaW dataset, HandPD dataset, NewHandPD dataset, and Parkinson's Drawing Dataset). Data augmentation methods such as flipping, thresholding, illumination, and contrast were applied to increase the diversity of handwritten samples. Different features from handwritten images were extracted with help of multi-scale CNN architectures (Alex Net, Google Net), which were a part of transfer learning network architecture. Then by batch normalization, the distributions of output vector are controlled thus reducing internal covariate shift. To predict the possibility of a subject having PD ,a fully connected layer with the ReLU activation function is employed. Previously learned features are retrained(fine-tuned) using ImageNet for converging the model to handwritten samples with help of a training set. After that PD identification performance is evaluated using a test set.Thereby through fine tuning of previously trained parameters the classification accuracy of 99.22% is obtained.

C. EEG SIGNALS

a) Convolutional Neural Network-CNN

EEG signal samples of 20 patients affected by PD were taken as a dataset for diagnosis. These signal samples are then processed and subjected to CNN model with 13 layers. Python language-Keras is used for designing CNN network and implemented on a system having configuration of 24 GB RAM and two Intel Xeon 2.40 GHz processors. Method named stratified tenfold cross validation was used for splitting the initial data into 10 uniform parts. To find the effectiveness of training at each epoch end, 20% of training data is used for testing the model. Brute force technique is one which tries all possible combinations to find solutions for a particular problem. This technique is used for estimating the size of kernel and filter number.88.25% accuracy is achieved using the method. The main disadvantage is the consideration of a dataset of limited patients and expensive in comparison to other machine learning models.

b) Convolutional-Recurrent_NeuralNetwork(CRNN)

EEG samples of 20 patients diagnosed with PD were taken for study. These signals are then pre-processed to remove artifacts and fed into CRNN model architecture. This model extracts the spatial and temporal features from EEG epochs. Among these two features, spatial features are derived from two layered-CNN model. The output of this CNN model is fed as input to the RNN with LSTM.Temporal features are derived from the second RNN-LSTM model. The final output layer is the fully connected layer which converts and transforms the features for appropriate classification. 96.9% is the classification accuracy obtained through this method.

c) Deep Hybrid Network

PRED-CT data repository is used for collecting the EEG signals dataset(PRED-Parkinson Rests Project).The dataset involves two categories- on and off levodopa medication EEG signals of around 28 patients with PD.EEG signals of PD patients are characterized by abnormal βpatterns in the dopamine producing regions of brain. Individual component analysis-ICA is a technique applied to segregate the EEG channels having this abnormal pattern. They are then dynamically analyzed to find the values of m and τ. Hybrid network is a combination of convolutional network which processes the input data in both spatial,temporal domains and LSTM which further processes the data temporally. Input data can be split into two types-intra patient(EEG signals of same patient) and inter patient(EEG signals of different patients).Since EEG waves are not simple and specific to individual patient, performance of intra patient classification is more when compared to other.This hybrid network outperforms the previously proposed works on EEG signals with classification accuracy of 99.2%.

D. GAIT PATTERNS

a) Support vector machine (SVM)

Gait characteristics were used for diagnosing PD and it can also differentiate it with other neurological diseases. Support Vector Machine (SVM) is used in diagnosing PD with the help of gait characteristics obtained from 15 affected people and 16 healthy controls. In order to analyze, the gait dataset obtained from PD affected patients and from healthy control subjects . This dataset contains 12 features of gait patterns which shows foot movement and hand movement to complete one full oscillatory motion and one complete swing of hand movements. To analyze these features of gait patterns a non-linear SVM classifier is used and a hyper plane with maximum separation with nearest training data.[26] The advantage of using SVM as it works relatively well when the classes have clear margin of separation. SVM is effective for samples with high dimensional space. But the limitation is that It does not execute well when the dataset has more classes in it i.e.when target classes are overlapping. Despite this SVM achieves a good accuracy of 83.33% with gait patterns.

b) Deep Neural Network(DNN)

Gait patterns were used as a dataset for diagnosing PD using deep neural network architecture, and this is one of the best methods in Deep learning. In this the dataset were obtained from sensors which are placed on the feet of affected patients and healthy controls for effective progression rate of PD diagnosis. The DNN method is used to differentiate ill patients from healthy controls and to distinguish patients on various degrees of illness. In this method the datasets were classified into classes, binary and multiclass classification.[28] The advantage of using this method is that it has multiple layers and they allow models to become more efficient and it helps in learning complex features and performs more intensive computational tasks by executing many complex operations simultaneously. But the limitation is that DNN requires a very large amount of input data when compared to other methods and it is more expensive to train the models with input data set.it also requires a large number of machines to process the cascaded work. DNN achieves a good accuracy of 98.03% for multiclass severity and 99.07% for binary classification.

c) Sensor technology using gait characteristics with different methods

Gait patterns were used as a dataset as the Human gait, being the most decisive biometric and effective tool for diagnosing. Wearable sensors are used. In this the wearable sensors were placed on the ankles, feet and arms to get the gait patterns and these patterns were very accurate as they are available in form of real-time signal. These wearable sensors are used in shoes and clothes for obtaining gait patterns from the subjects. In some cases non-wearable sensors were also used. For analyzing these gait signals, methods like SVM, Artificial neural networks,RNN and CNN were used. All these methods yield best results and good accuracy. SVM yields accuracy of 81.03%, ANN yields 97.76%, RNN yields 98%, CNN yields 90%, DNN yields 94% and another time frequency analysis was done on the obtained gait signals through wearable sensors. This time frequency analysis yields an accuracy of 97% in which it compares the signals obtained from normal healthy controls and affected patients. Among these methods RNN and time frequency analysis were effective in diagnosing PD with best accuracy.[29]

E. MRI Images

a) Autoencoder based Method

The dataset applied for identifying Parkinson's disease was the Parkinson's Progression Markers Initiative (PPMI). The MRI study concentrates on identifying variations in the shape of brain regions. Autoencoder-based models like spatial autoencoder, spatial variational autoencoder and dense variational autoencoder were developed. From healthy MR images, a model was taken to optimize a loss function and to produce accurate reconstructions. The reconstruction error was utilized as an indicator of abnormality to differentiate between healthy and diseased individuals[11]. Due to the absence of ground truth, it was very difficult to determine which model was the most accurate for the parkinson's detection. The reconstructed image consists primarily of white matter, with accuracy rates of 83%, 80% and 74% for the sAE, sVAE and dVAE respectively.

b) Convolutional Neural Networks (CNN)

The Convolutional Neural Networks (CNN) method was applied on MRI images to differentiate between various stages of Parkinson's disease. The CNN model consisted of five convolutional layers, two fully connected layers and a final output layer. The data was preprocessed and then fed into the deep neural network. The model's accuracy was estimated using cross-validation. The study utilised simple and comprehensive data for both training and validation. As a classifier, it demonstrated adequate capacity to handle MRI data. Thus high accuracy of 94% [28] was obtained with this model to distinguish between healthy and Parkinson diseased.

c) Convolutional Neural Network and Recurrent Neural Networks (CNN-RNNs)

Deep convolutional neural networks with Recurrent neural networks (CNN-RNNs) were developed for the prediction of Parkinson's Disease. In RNNs, loops are used to pass information from one layer to another layer in the network and it consists of a hidden layer to store the information. When this approach was applied to the PPMI dataset, there was no need for a feature selection step as the features were automatically detected and extracted by the method. The models were trained to classify the MRIs into either the Parkinson's Disease (PD) or non-Parkinson's Disease (NPD) category. This approach offers an efficient and clear prediction of PD, and the accuracy achieved using MRI images was 95% [12].

III.SURVEY OF EXISTING LITERATURE ON PD DETECTION

Changqinquan et.al [13] has proposed the various traditional ML models which includes the DT, KNN,MP,GNB and SVM for PD detection.The speech signal is processed by CNN and the bidirectional LSTM.In comparison with the traditional ML models which uses static features, the basic DL models will take less computation time and will also improve the performance.The best results of Accuracy, F-score, and MCC can be achieved by the technique of Bidirectional LSTM model and by using dynamic articulation features on a short sentence recorded from the patient.It has an accuracy of 73.46%.

HakanGunduz et al. [14] proposed two CNN based frameworks inorder to classify Parkinson's Disease (PD) using speech feature sets.There are two frameworks proposed in this study. In the first framework, feature sets are convolved and then fed to CNN model with 9 layers, wherein the second framework feeds the feature sets directly to parallel input layers. These parallel input layers are in direct connection with convolution layer.Accuracy, F-Measure and Matthews Correlation Coefficient are the metrics used for this assessment.The second framework performance is better comparatively as it is capable to learn deep features from each feature set via parallel convolution layers. The proposed CNN model achieves an accuracy of 86.9% and F-Measure and MCC rates are 0.917 and 0.632 respectively.

Shu Lih Oh et al. [5] developed a CAD detection system with CNN for PD diagnosis using electroencephalogram (EEG) signals. The network has a 13-layer CNN architecture and the advantage is there is no need for separate phases to represent the features. There are two phases involved in the process- training and testing phase. The training phase trains the 13 layer model with characteristic features from input EEG signals and the model is tested for correctness in the testing phase. Stratified tenfold cross-validation is used during training, dividing the full data into 10 uniform parts. This model achieves a 88.25% accuracy in diagnosis and with 84.71% sensitivity and 91.77% specificity.

Shixiao Xu et.al. [15] has developed a deep neural network, one of the category/type of ML models and it has numerous applications in various diagnosis processes and in the process of identifying the natural language during recent times. Features of cortical (or subcortical) segments in the brain can be easily detected using the EEG signals and even when the patient has non motor signs of disease,it can easily be detected.The method proposed can give a promising efficiency and with 88.31% precision.

Sivaranjini et.al [16] proposed a methodology which can be extended to the deep fine tuning process of the AlexNet model to obtain an improved performance level. As deep learning architecture grows widely in the clinical world, the diagnosis process of Parkinson's disease will no longer be a laborious and a tedious job for the clinicians in thefuture.An accuracy of 88.90% is achieved for classifying PD patients.

Shivangi et al.[27] aims to create two neural network models, called the VGFR Spectrogram Detector and Voice Impairment Classifier, with the goal of accurately detecting Parkinson's Disease in its early stages. Basically the first method is based on the walking patterns of patients and the second one is based on speech impairments. In this study, CNN were utilized for the image classification of gait signals (walking pattern) and Artificial Neural Networks were applied to voice recordings. This study utilised three Machine learning algorithms: XGBoost, Multi Layer Perceptron, and Support Vector Machine. The accuracy achieved by the VGFR Spectrogram Detector was 88.1% while the accuracy of the Voice Impairment Classifier was 89.15%.

Amin ul Haq et al.[18] proposed techniques based on deep learning for PD recognition. These techniques involve pre-processing the data, extracting and selecting features, and conducting classification. This survey examines the benefits and drawbacks of current surveys in the field of Parkinson's disease diagnosis. The most commonly used method for diagnosis of Parkinson's disease is Convolutional Neural Networks (CNN).

Veronica Munoz Ramirez et al.[11] developed three distinct types of autoencoders to detect early-stage anomalies in Parkinson's Disease patients through the analysis of MRI images. These models were trained to reconstruct healthy diffusion MR scans. Spatial autoencoder (sAE), spatial variational autoencoder(sVAE) and dense variational autoencoder (dVAE) are the models used for detection. In this study, the errors in the reconstruction of each structure were utilised to differentiate between patients from healthy individuals. Amongst these three, dVAE model detected the biggest reconstruction errors.

Shahid, A. H., & Singh, M. P. et al.[19] PCA is used to handle the multicollinearity issues in the dataset. The first PCA has the most variability, and the least significant Principle Components can be deleted to minimise the dataset's dimensionality while keeping the most relevant aspects of each variable. Artificial neural networks with numerous layers known as deep neural networks (DNN) can be taught using a lot of data. There are numerous deep learning subtypes. The training data set has two parts and the first part consists of various attributes related to various domains and the second part consists of concerned information. Dataset includes real world public
dataset acquired from the repositories and predominantly consist of voice measurement.

Caliskan, Abdullah, et al. [20] Proposed Parkinson's disease can be diagnosed through interpretation of vocal and speech dataset. For this diagnosis, Deep Neural Network classifiers such as stacked auto-encoder and Softmax classifier are used.Studies show 90% of people with Parkinson's disease have vocal and speech impairments such as dysphonia, monotone, hypophonia and dysarthria.Major steps involved in diagnosis are preprocessing, Feature extraction and classification . Deep neural network combines the activities of auto-encoder and softmax classifier in diagnosing Parkinson's disease.

Jefferson S. Almeida et al.[21] worked on processing voice signals for detecting Parkinson's disease.Foranalyzing classification performance, this method compares employment of four machine learning approaches and 18 feature extraction strategies to categorize data obtained from sustained phonation and speech activities. The classification performance is examined using Area Under Curve (AUC),Equal Error Rate (EER), ,Receiver Operating Characteristic curves, Accuracy,Specificity,and Sensitivity. The accuracy, AUC, and EER values for the AC channel's best performance were 94.55%, 0.87, and 19.01%, respectively. Employing the SP channel Accuracy, AUC, and EER values of 92.94%,0.92,14.15 % are obtained.

Ali H. Al-Fatlawi et al. [5] developed a Deep Belief Network-DBN for PD disease diagnosis. Speech signals are used as biomarkers for indication of PD. DBN consists of one output layer and two stacked Restricted Boltzmann Machines (RBM).The parameters of the networks are optimized by applying two stages of learning. Unsupervised learning is the first stage where RBM is used toovercomeproblemsthatcanariseduetorandomvaluesofinitialweights.Tool used for supervisedlearning and for finetuning isthebackpropagationalgorithm.The overall testing accuracy of the proposed system is 94% which outperforms all other approaches in comparison.

Gabriel Solana-Lavalle et.al. [23] employed a voice-based PD detection, the best results were obtained by using the techniques of support vector machine (SVM), random forest (RF), K-nearest neighbors (KNN), or hybrid algorithms.Parkinson speech datasets will have multiple types of recordings.It shows that different factors are associated with the PD detection according to gender,that is high-frequency voice content is the most significant functional information in order to assist PD detection in women, while the low-frequency content will assist PD detection in men.The accuracy which is obtained by the k nearest neighbor (KNN) classifier algorithm improves considerably from the previous works, and is approximately up to 95.9%.

Hongyoon Choi et al.[24]worked on improving the imaging diagnosis of Parkinson's disease and a FP-CIT SPECT interpretation system based on deep learning was designed.It was trained so that it results in high accuracy using SPECT images of normal and affected individuals. In addition,for SWEDD the design provided objective patient group classification , so in future it could aid in the identification of uncertain PD conditions. PD Net has a 96.0% overall accuracy rate for detecting PD.

Wu Wang et al. [25] proposed a deep-learning technique for PD detection based on premotor features.This study has taken into account a number of signs, including dopaminergic imaging markers, cerebrospinal fluid data, rapid eye movement, and olfactory loss. Twelve machine learning and ensemble learning techniques were compared to the suggested deep learning model.The developed model achieves the highest accuracy, 96.45% on average. In addition to identifying PD, the boosting method-based PD detection technique and feature importance are also provided.

Catherine Taleb et al. [3] looked into the use of CNN and CNN-BLSTM as well as other Deep Learning architectures for PD detection through time series classification. For the CNN model, other techniques like spectrogram for encoding the pen-based signal to images were employed. Different data augmentation methodologies for pen-based signals are suggested for training the algorithms on a big scale.Combining CNN-BLSTM models with Jittering and Synthetic data augmentation techniques outperforms PD detection with an accuracy of 97.62%.

Syed Aamir Ali Shah et al. [8] developed a Dynamical System generated hybrid network which is a derived category of deep neural network. PD disease induces some characteristic changes in dynamic properties of EEG signals. Embedding reconstruction is a tool that highlights these changes.ICA(Individual component analysis) is applied to segregate the EEG channels having this abnormal pattern. In PD patients, strong synchronization is observed between β wave amplitude and phase components. This hybrid network outperforms the previously proposed works on EEG signals with classification accuracy of 99.2%.

James Wingate et al.[12] analysed several medical images, including magnetic resonance images (MRIs) and dopamine transporters scans (DaTscans), for the purpose of diagnosing Parkinson's disease. The analysis of MRI centres on the detection of morphological variations in brain area. DaTscans are utilised to detect degeneration of dopaminergic neurons. A deep CNN-RNN network was used and trained to classify the DaTscans and MRI Images for the prediction of Parkinson's disease. The accuracy obtained using MRI Images and DatScanswas 93% and 97.9% respectively.

Zhang, R., Jia, J., & Zhang, R. et al. [26] Proposed Deep learning techniques and time frequency analysis to detect PD. Datasets for the diagnosis of PD have been taken from the handwritten patterns, gait patterns and the EEG signal obtained during the REM sleep, and the diagnosis have been done by splitting the process by splitting them into various subcategories of 2-class, 3-class and 4-class classification. Methods such as time frequency analysis and deep learning methods are used to extract the wavelet energy and entropy of that wavelet energy used to freeze the EEG for effective diagnosis. Convolutional neural network is used to diagnose PD in which the signal is obtained from handwritten dynamics. Signal processing methods including fast Fourier transform and short time Fourier transform have been used. Tunable Q- factor methods have been used to adjust the oscillations in the EEG signal by dividing the time scale plane more finely. It provides 99.92%, 92.59% and 93.79% in 2,3 and 4 classification accuracy and for sound recording dataset is 68.05%.

IV. CONCLUSION

The deep neural network with handwritten patterns and deep hybrid network with EEG signals that was undertaken in this research outperforms the other methods and technologies with classification accuracy of 99.2% which is approximately 24% of the computational resources for PD diagnosis.It is preferred over the machine learning technologies as the training time is very less.Also,it has a good self-feature selection capacity.Voice recording data sets itself were enough for diagnosing PD as it has high accuracy of about 98% and it is also of low cost. With further future advancements the accuracy rates can be increased and enhanced and this can outperform all other methods because of its very low computation complexity.The convolution neural network as such has a low accuracy and a high computational complexity. However combining it with recent technologies like BLSTM architecture ,it can facilitate sequence prediction with high accuracy and a better detection rate. CNN technology can be integrated with RNN(recurrent neural network) as it provides higher accuracy through fine tuning of previously trained parameters like drawing and handwriting datasets which were used for the PD detection.In terms of the gait analysis for PD detection the RNN method has the highest accuracy and the time frequency analysis were also effective in early detection and diagnosis of PD. Despite all these methods, the deep hybrid methods outperforms the previously proposed works on EEG signals like the Convolutional Recurrent Neural Network(CRNN)with an accuracy of 99.2%.

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