VARIOUS APPROACHES OF DETECTING PARKINSON DISEASE USING SPEECH SIGNALS AND DRAWING PATTERN

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Abstract
Over millions of people are suffering from Parkinson's disease (PD), which is one of the most common neuro-degenerative disease. Unfortunately, this disease is just hard to predict. One way to identify PD is by listening to the patient's voice, since they experience several vocal degradations. As a result, voice data is effective for diagnosing disease. Some of the patients who are affected and suffering from PD, it has been observed that handwriting impacts of patients is straight forwardly proportional to the seriousness of PD. Those affected by Parkinson's disease tends to write slower and use less pressure while sketching or writing something. A better clinical diagnosis will be possible with the accurate and precise identification of such biomarkers at the onset of the disease. The purpose of this paper is to present a system design for analyzing voice impairments, spiral drawings and wave drawings in persons those are affected by Parkinson's disease (PD) as well as healthy subjects. In this research paper, two different CNN are used for analyzing patterns of both spiral and wave drawings respectively and a system using artificial neural network for analyzing voice impairments is also implemented. The complete model will be trained on the parkinsons disease voice and pattern data.

Keywords:
Parkinson's Disease, Artificial Neural Networks, Convolutional Neural Networks, Deep Learning, Machine Learning

1. INTRODUCTION

To Parkinson disorder is the world's major disorder, often occurring in elderly aged people over age 60. Its cause remains unclear, although symptoms can be relieved once the disease is detected in its early stages. The greater part of the trials saw that the vast majority of the patients with PD display side effects of voice hindrances. Thus, voice information can be utilized for conclusion of PD. The neurodegenerative problem is the after effect of moderate tearing and nerve cell misfortune in a few spaces of the sensory system. Nerve cells are the practical units of the mind. A good sound looking nerve cell has an expansion known as dendrites or axons, a cell body and a core that contain our deoxyribonucleic corrosive. When a neuron becomes ill, it loses its expansion and henceforth its capacity to impart which isn't useful for itself as well as its digestion turns out to be low so it begins to collect garbage which prompts PD.

There are several other movement related symptoms that are commonly seen in PD patients at different stages, which includes rigidity, instable in posture, and tremors. It's compulsory to recognize PD in the beginning stages in order to avoid the severe cause on PD patients. Perhaps the most widely recognized effect that are effectively observed in the PD affected people and utilized more generally in beginning phase of conclusion is been tracking down the difference in handwritten and sketch-able ability. The no-obtrusive measure, for example, drawing shapes like twisting, wave drawing, and sometimes written in form of texts can be effortlessly recognized starting with one individual then onto the next individual just as an individual with PD and individual without PD. To detect anything in real-time today, it makes more sense to automate the system, thereby saving us both time and being able to perform the same operation more accurately. Machine learning-ML techniques have shown greater effectiveness in this regard, showing a high degree of potential for application in real-life situations. This paper sorts out the various methods and algorithm used for predicting PD and detecting the disease. This paper subjected to various DL techniques and ML techniques, ensemble method is discussed in parkinson's disease prediction and detection process.

2. LITERATURE SURVEY

An analysis of continuous speech is utilized to detect unreasonable speech disorders. With spectrogram as an input feature, a hybrid long-short—term-memory (LSTM) auto-encoder is proposed with multi-task function learning for speech exploitation. Three datasets were analyzed to test the proposed DL structure. An LSTM and an auto-encoder are implemented as part of the DL architecture. A training, validation, and test set was created for each database and split into train-set, validation-set, and test-set. With ten-fold cross-validation (stratified), ten preparation sets was created. In this study, early stopping was determined by the minimum cross-entropy of the disease classification. During the training epochs, a maximum of 1000 patience steps were used to prevent early stopping. Adam optimizer was used during training. Evaluation metrics included accuracy, sensitivity, and specificity. As a result, only 76.7% of the test-sets is classified more efficiently as good-health or diseased [1].

The authors in [2] presented a way to deal with Parkinsons disease discovery utilizing vowel sound supported with a Res-Net framework committed initially to picture characterization. To forestall over-fitting the database the time area of the database was strongly augmented. The database comprises of hundred people (fifty are solid/fifty are affected by PD). As part of the auto-encoder, utilized a marginally altered Res-Net design that had 18 layers, and replaced the final straight layer containing a dense network of three layers with the P-ReLU as the enactment capacity and function called dropout that has a probability of 0.5 later the first two layers. Fundamental motivation behind why they chose to utilize Res-Net is the accessibility of Image-Net database which permitted them to utilize a pre-trained model. SVD was used to retrain the entire network by data utilizing the Image-Net pre-training and dense network layers. In this manner, the PD database network was prepared with consistent and significant outcomes. Of 300 voice recordings, the framework correctly grouped 275 of them out of a 10-fold validation set. In general, 85.7% of the recordings were correctly grouped.

The authors in [3] used different classification methods have been compared in order to predict Parkinsons disease, including Logistic Regression-(LR), Support Vector Machines-(SVM), Extra Trees-(ET), XGradient Boosting-(XGboost) and Random Forest-(RF). A total of 40 individuals were analyzed in this review, 20 patients were considered with PD and 20 good-health individuals. A large set of speech samples from Parkinson affected persons is used to classify ML techniques. The number of people with Parkinsons disease were assessed for success rate of ML methods in huge data problems. An accuracy pace of 76.03% is achieved by Logistic Regression with the widest feature space. Meanwhile, the SVM produced the best results at 75.49%. As for the accuracy rates, ET, XGboost, and RT give the best results as they give 73.71 %, 72.18 %, and 71.96 % respectively.

The authors in [4] developed a method involves leveraging deep neural networks to predict the severity of Parkinsons disease using voice data collected from UCI's Parkinson's Tele-monitoring speech Database. A DL method is utilized to analyze speech information of a patient so that it can be put into "extreme" and "not serious" categories. Measures used for assessment in this examination are the total and motor UPDRS scores. There has been pre-processing of the dataset and standardization into a 0-1 scope using min-max using Eq.(1).

$$\text{Normalized worth of } X = x\text{-min}(x)/\text{max}(x)\text{-min}(x) \quad (1)$$

Here, x=column value, min(x) = least incentive for that segment and max(x) = most extreme incentive for that segment.

Each of the three hidden-layers contains ten neurons in first Input layer, 10 neuron from hidden-layer, then 10 neurons in the Input layer. Individually, UPDRS accuracy to train and test datasets is 94.4% and 62.7%. Based on Train and Test datasets separately, Motor UPDRS0's accuracy is 83.3% and 81.6%. This proposed DNN model had a higher accuracy than other existing strategies.

The authors in [5] classified the data for the phonation and discourse tasks, a method was evaluated that used 18 features extraction strategies and four machine learning techniques. Phonation and Speech were the two unique modalities utilized in this study. Motor manifestations unequivocally associated with voice are the key to identifying PD in the proposed approach. Each sound is analyzed separately. Based on its analysis, two classifiers were found to be the most efficient. The AC methodology achieved precision of 94.55% and error rate of 19.01% when utilizing Phonation (P) sound sort, YA extractor, and K1 classifier. The SP methodology offers sound kind (K1) and sound kind (P) extractors along with 93.94 percent EER and 92.94% exactness. Implemented methodology achieved the best result in both AC and SP methodologies. By combining all capabilities with the current approach, the EER for the AC and SP channels were 19.27 percent and 23 percent respectively.

The authors in [6] proposed a new method based on the elements acquired from the discourse signals for the detection of Parkinsons disease. Various phases of hybrid machine learning are proposed in this paper: i) data cleaning (oversampling); ii) categorization. The database (PD database) is composed of 2 classes and was extracted from the uci ML database. The study proposes the novel method for identifying an imbalanced distribution of classes in the PD database by using SMOTE and Random Forest classifiers. A hold-out technique has been used in the training and testing stages of the Random Forests classifier with a fifty-fifty(half) training and testing segregation and ten-fold validation. Using SMOTE and Random-Forests classifiers for classification, this method classified Parkinson disease datasets. The suggested hybrid strategy (combination of SMOTE and RT classifier) achieved a 94.89% classification success rate in the characterization of the PD dataset, while the random forest classifier made 86.03% in the characterization of the parkinsons dataset.

The authors in [7] detected PD through time series classification, they investigated the use of different DL algorithms, specifically the CNN and the CNN-BLSTM. There is a publicly accessible set of handwriting datasets called HandPDMultiMC here. There are two primary parts to a CNN model, the feature extractor and the classifier. Each of the feature extraction layers consists of two convolution layers each consist of two pooling layers and an activation function (ReLu). CNN layers are utilized for extraction along with BLSTMs for helping to predict successions in the CNN-BLSTM architecture. On the database, CNNBLSTM models prepared with Jittering and Synthetic data augmentation approaches produce the best results for early PD recognition of 97.62% success rate.

The authors in [8] identified patients who suffer from Parkinsons disease and good health subjects are compared with the spiral drawings and wave drawings of the network architecture. Two different types of CNNs were used in this methodology in order to break down the patterns of both spirals and waves individually. Here, Kaggle's data archive was used to gather data. A framework is offered here to investigate spirals drawings and waves drawings in patients who are affected by Parkinsons disorder, and how they identify PD. CNN and ensemble classifiers were incorporated into the framework as a means of developing 2-D convolutional neural networks. To provide weighted outcome from both the spirals and waves sketches, expectation probability is trained through a classifier related to ensemble voting. A total of 55 patients were used to train the entire model, achieving an success rate of 93.3 percent, recall rate of 94 percent, precision around 93 percent, and f-1 score is of 93.4 percent.

The authors in [9] developed Feed-forward artificial neural networks (ANNs) to forecast parkinsons disease (PD) based on 26 different voice tests, each representing an extricated feature, that are unique to each subject. They have utilized point selection methods based on principal component analysis, Pearson's correlation coefficient, self-organising maps and Kendall's correlation coefficient has been utilized to aid in the calculation process and for data reduction. Parkinson database was retrieved from UCI Machine Learning Repository to be utilized in the study. A neural network that has been trained can change the weights associated with a neuron productively. This is accomplished via a scalable conjugate gradient backpropagation method. The method for forestalling over-fitting in this application is terminated early on the grounds that this is effective when applied to a gradient back-propagation algorithm of scaled form. There have been 89.43%, 87.51%, 100%, and 100% training accuracy for A-MCFS (adjusted), Kendall's ANN, PCA-ANN, and self-organising maps-ANN respectively. For determining PD without maximizing component choice methodology, various ANNs together have proven to be the most effective categorization technique. It was finally possible to achieve an accuracy of 86.47% for the test using the neural network.

The initial analysis of the framework proposed for Parkinsons diseases determination is based on speech signals. This was done by trying multiple association of feature selecting concepts and classifier algorithm, then planning the classification by the best combinations. For the analysis of various combinations, three methodological techniques, followed as extra trees, information gain, and genetic algorithms, as well as three classification techniques, such as naiive bayes, random forest (RF), and knearest-neighbor(kNN) are been utilized. Various combinations have been categorized using the speech dataset found at UCI's machine learning repository. The synthetic minority oversampling procedure (SMOTE) solves the class balancing issue in the dataset given its unusual imbalance. By using all features and selected subsets of reduced features using feature selection methods, the naive bayes classifier was able to achieve a success rate of 84.67%. In an analysis of every feature and decreased subsets of features selected by concept called feature selection methods, the kNN classifier performed with an accuracy of 91.45%. A random forest classifier outperforms with a 95.58% accuracy rate when applied to each and every feature and decreased feature subsets is been selected [10].

A speech-signal-based classification system for patients is described in the article. The decision trees were generated in the R studio interface using algorithms decision tree (DT) classifier, Classification and Regression Trees (CART) and Random Forest (RT) classifier. To further classify those patients, cut-off value was applied for individual attributes. Data from 40 individuals were used in this article, of whom half suffered from Parkinson's disease. Several records were stored for each individual, containing their permanent vowel pronunciations, words, numbers, and sentences. To create the best accurate classifier model, a DT based on the types of voice signal has been utilized. A cross-validation analysis was conducted to assess how well the models performed. The relatively higher average success rate of 66.5 percent was achieved when individuals pronounced the numbers themselves [11].

In order to implement a deep learning-DL framework that can predict occurrence of parkinsons disease in the beginning stage, an optimization framework for grid-search is proposed, which is set with multiple hyper parameters and tunes them for evaluation of the DL model. Three optimization steps are involved in optimizing the grid search: the topology of the DL model, hyper parameters, and finally the performance. Data utilized here is obtained through UCI machine learning archive is used in the computation through the grid search. The developed concept is assessed by comparing the voice samples of PD patients with those people of with good health. This improved classification precision has been achieved with 89.23% overall and 91.69% mean for the DL model with grid-search hyper-parameter tuning. A method is presented here that can predict parkinsons disease at beginning stage [12].

Using voice data collected from individuals with parkinsons disease(PD) and from good health people, cepstral features can be extracted and analyzed to detect PD. It is suggested that linear discriminant analysis utilize support vector machines classifier as a classification algorithm to bring down the dimensionality in the extracted features. The developed method was also validated through the development of ten different machine learning techniques. Accordingly, in the developed method, there is an AUC of around 88 percent, a specificity of 84 percent and a sensitivity of 73.33 percent. As an additional step, public databases that include many types of voices were used to simulate the proposed intelligent system. Patients from both within and outside the state were surveyed. The public database has provided promising results compared to previous studies [13].

An analysis of the logistic regression (LR) model was used to determine whether people with parkinsons disease experience gait freezing (FoG). During this study, patients were first fitted with acceleration sensors to collect data. In addition, features have been extracted from these acceleration signals using the Fast Fourier Transform (FFT). The FFT concept provides coefficient frequency calculated from these acceleration signals. In order to reduce the number of features, these signals have been statistically gone through to determine standard variance, max form of amplitude, min form of amplitude, max form of energy, and min form of energy. The following five parameters were extracted for each class (three for FoG and three for non-FoG). The dataset contains 8 patients with PD disorder. Logistic regression modeling was utilized to identify the gait frozen cases based on the extracted features of the dataset. Based on acceleration signals, an accuracy of 81.30 percent was achieved when classifying FoG cases. As well as logistic regression, four other classifiers were also used to classify FoG cases. The proposed method was demonstrated to be effective in detecting and identifying parkinsons disease based on study results [14].

A wearable device for measuring tremor has been developed using the accelerometer device, which can detect tremor. By using accelerometers and gyroscopes, a list of the detected tremors is collected. The extreme gradient boosting algorithm is used to train, analyze, and detect the seriousness of disease (PD). With this algorithm, a decision tree is used as the base learner. In addition to KNN (k-nearest neighbors), Naive Bayes classification was also used in this study. A 94.87% accurate result is produced by this model, which allows a patient to contact the hospital if he or she experiences tremor. KNN (k-nearest neighbors) produces an outcome of 90%, whereas Naive Bayes produces an outcome of 91% [15].

Methodology for assessing the proportion of unstable changes with someone with Parkinsons disease is proposed using ML techniques. A dataset has been taken from PPMI. This database is used to test the effects of activities of PD patients on daily basis. For predictions, three algorithms are used: Recurrent neural networks, Logistic Regression, and Principal component analysis. Data pre-processing, data is separated into training sets, and testing sets test data, prediction algorithm implementation and performance assessment followed as accuracy, recall, precision and f1-score calculation are those steps in the above methodology. Logistic regression can predict metamorphic changes with 92% accuracy for the sleep dataset and 95% accuracy for the Olfactory (smell) dataset when compared to PCA Algorithm and RNN Algorithm, which produces an accuracy of 83% and 89% for sleep dataset respectively and for Olfactory(smell) produces an outcome of 80% and 86% [16].

The method in [17] presents a methodology that utilizes a convolutional neural network-(CNN) to process handwriting images end-to-end to diagnose parkinsons disease (PD), without requiring any additional signals. As a consequence, no specialized devices or feature engineering is necessary. To enhance the performance of pre-trained CNN, it was proposed to fine-tune it more than once. For transfer learning to become effective, the source database and target database must be able to bridge the semantic gap. There are two datasets used here. By constructing a CNN ensemble by training multiple fine-tuning methods, weights are constructed with which CNNs are constructed. These weights are then combined to create a CNN ensemble. A proposed architecture uses a combination of multiple-fine-tuned CNNs to detect PD from offline handwriting with 94.7% accuracy.

In order to determine whether PD patients are more likely to develop Parkinson's disease than healthy controls, an ensemble model for learning combined with Principal Component Analysis-(PCA) and Random Forest-(RF) techniques is presented. Six unique RF methods were built from six different handwritten exams in order to obtain the corresponding class probability vectors, and a single prediction result was obtained from a strategy called voting for every RF model. K-fold cross validation of the exam datasets was used to evaluate the classifier's performance. Six handwritten exams can be classified more accurately with the ensemble model than with RF. With multiple handwriting tests, ensemble with RF model's accuracy is 89.4%, its specificity is 93.7%, its sensitivity is 84.5%, and its F1-score is 87.7%. Ensemble models developed using RF tend to outperforms and SVM and Logistic-Regression [18].

A fine-tuned version of the VGG-19 is investigated and also tested for screening Parkinsons Disease (PD) based on a Kaggle handwriting database. The database consists of 102 wave drawing and 102 drawing spiral sketching patterns, and an image augmentation method was utilized in minimizing over-fitting. The pre-processed database was utilized to train the data and to validate a Convolutional Neural Networks-(CNN), with a 4fold and 10fold cross-validation. The CNN architecture obtained 88 percent success rate in the wave drawing pattern, 89 percent success rate in the spiral drwaing pattern, and 87 percent success rate in the 10x cross validation process. The proposed approach for assessing and screening PD based on handwriting patterns offers a promising alternative to the state-of-the-art architecture that uses a finely tuned AlexNet model [19].

Based on the acoustic features of Parkinsons disorder patients' voices; establish a distinction between Parkinson's disease and dysphonic speech disorder. To analyze the voice feature dataset, machine learning techniques including parametric and nonparametric ones were applied. This method evaluates the performance of the various concepts, such as Random Forest-(RT) Naive Bayes, K-Nearest Neighbors-(kNN), and Logistic Regression-(LR) Algorithm, in detecting Parkinsons disease. The machine learning models are fed into pre-processed data based on speech attributes. Performance metrics including precision, recall, and F1 score are calculated for all four ML techniques. With 87.2% and 90.2% accurate, nonparametric models utilizing K-Nearest Neighbors(kNN) and Random Forest-(RF) outperform parametric models in categorization [20].

3. CONCLUSION

The conclusion of this paper, some of most popular classification methods in ML will be used for predicting Parkinsons disease. And Literature review on Parkinson's disease prediction and classification approaches based on different dataset. The goal of this research is to study various DL-deep learning and ML-machine learning techniques to produce a precise outcome in the final results.

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