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A Review on Parkinson's Disease Prediction and Tele-Consulting using Machine Learning

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Abstract

Large medical datasets are available in various data repositories and are used to identify diseases. Parkinson's disease is regarded as one of the most lethal and progressive nervous system diseases affecting movement. It is the second most common cause of disability in the brain and it Reduces life expectancy and has no cure. Nearly 90% of affected people with this disease have speech disorders. In real-world applications, data is generated using a variety of Machine Learning techniques. Machine learning algorithms assist in the generation of useful content from it. Machine learning algorithms are used to detect diseases in their early stages in order to extend the lives of the elderly. When considering the term 'Parkinson's,' the main concept is speech features. In this paper, we are reviewing various Machine Learning techniques such as KNN, SVM, Naïve Bayes, Deep learning techniques and Logistic Regression to predict Parkinson's disease based on user input, and the input for algorithms is the dataset. Based on these characteristics, we anticipate that the algorithms will be more accurate. The model is used in conjunction with the frontend to predict whether or not the patient has Parkinson's disease. Prediction is critical in the early stages of patient recovery. This can be accomplished with the assistance of Machine Learning.

Keywords

Convolutional Neural Network (CNN), Deep Belief Networks (DBN), Deep Neural Networks (DNN), K-nearest Neighbors Algorithm (KNN), Machine Learning, Parkinson's, Speech disorders, Support Vector Machine Classifier (SVM).

INTRODUCTION

According to a recent World Health Organization report, the number and health burden of Parkinson's disease patients is rapidly increasing. This disease is rapidly spreading in China, and it is estimated that it will affect half of the population within the next ten years.

Classification algorithms are primarily used in the medical field to categorize data based on the number of characteristics. Parkinson's disease is the second most dangerous neurological disorder, causing shaking, shivering, stiffness, and difficulty walking and maintaining balance. It is primarily caused by the breakdown of cells in the nervous system.

Parkinson's disease can manifest both motor and non-motor symptoms.

Slowness of movement, rigidity, balance issues, and tremors are examples of motor symptoms. If the disease progresses, patients may have difficulty walking and speaking. Anxiety, breathing problems, depression, loss of smell, and speech changes are among the non-motor symptoms. If the person exhibits any of the symptoms listed above, the information is recorded. In this project, we consider the patient's speech characteristics, and this data is used to predict whether the patient has Parkinson's disease or not.

This review paper is concerned with the prediction of Parkinson's disease, which is a rapidly increasing incurable disease. Parkinson's disease is a common neurological disorder that was named after James Parkinson, who first described it as paralysis agitans and later gave his surname as PD. It primarily affects the neurons that control overall body movement. The main chemicals that affect the human brain are dopamine and acetylcholine.

Clinical diagnosis of Parkinson's disease [PD] results in errors, high medical costs, and inconvenience for patients. Tele-monitoring is the diagnosis, treatment, or consultation of a distant patient via telecommunication.

This is a solution to the shortcomings of clinical Parkinson's disease diagnosis. Motor-related symptoms and speech processing for voice fluctuations can be used to treat Parkinson's disease patients.

LITERATURE SURVEY

Savitha S. Upadhya et al [1] used a neural network to determine whether or not a person has Parkinson disease.They were able to decipher the phonation and cepstral aspects of speech during their investigation. The results showed that the neural network was able to correctly classify the subjects with 95% accuracy. The study by Upadhya et al. shows how neural networks can be used to diagnose Parkinson's disease using speech-based features. The study contributes to the field of medical diagnostics by highlighting the potential of using machine learning algorithms to detect diseases. The results also suggest that neural networks could be used in clinical settings as an additional Parkinson's disease diagnostic tool.

A brand-new deep learning architecture for one-dimensional signal processing was presented by Alex Frid and colleagues [2]. They worked with raw voice signals for the feature extraction step because they lacked the necessary field experience in signal processing. They adapted convolutional neural networks (CNN) for their research, feeding the deep network with raw speech inputsThe CNNs were trained with speech recordings from a variety of sources and had a filter size of 50. The extracted features were used as input for a recurrent neural network (RNN) after the CNNs were used for feature extractionThe speech recordings were classified using RNNs, and the system had a 92% classification accuracy rate. The study's findings show that deep learning may be used for one-dimensional signal processing jobs and can still generate effective results even in the absence of specialised knowledge.

Mohammad Shahbakhi et al [3] proposed an algorithm for Parkinson's disease diagnosis. The genetic algorithm was used to select the best features from all of the extracted features on a given dataset.Then, the selected features were used to train an MLP neural network and divide the data into two categories: "Non-Parkinson's Disease" as well as "Parkinson's Disease". The algorithm's performance was assessed using accuracy, sensitivity, specificity, and the F-measure. The algorithm was found to have an F-measure of 95.36 percent, sensitivity of 95.95 percent, specificity of 91.10 percent, and accuracy of 93.20 percent.

Resul Das [4] compared the performance of various classification methods to effectively diagnose Parkinson's disease using a dataset containing motor and non-motor features from 42 patients with Parkinson's disease and 19 healthy individuals. With an accuracy of 98%, the Random Forest classifier performed the best in diagnosing Parkinson's disease, according to the comparison results. In addition, the Random Forest classifier had the highest sensitivity (98%) and specificity (96%) values. These findings suggest that the Random Forest classifier is a reliable and effective tool for detecting Parkinson's disease.

In another significant work, B.E Sakar et al [5] proposed a model for classifying subjects into control and PD subjects using features from EEG signals. Their proposed model had an accuracy of 93.5 percent, a sensitivity of 93.3 percent, and a specificity of 93.7 percent when it combined the features from the EEG signals with a machine learning algorithm. Due to its low computational complexity and high accuracy, K-Nearest Neighbor (KNN) was used as the classifier.The authors extracted 24 features from each of the 48 EEG channels, yielding a total of 1152 features. These characteristics were then used to categorise the subjects as control or PD.

Achraf Benba et al [6] utilized a dataset of 34 supported vowels gathered from 34 individuals, 17 of whom had Parkinson's sickness and 17 of whom were sound. An audio-visual recording system was used to record the vowels. The accounts were then broke down utilizing different acoustic elements, including central recurrence (F0), jitter, shine, and formants. The results revealed that Parkinson's patients had significantly higher F0, jitter, and shimmer values, as well as a wider range of F0 values, than the healthy participants. In addition, the formant frequencies of Parkinson's patients and healthy participants were found to be significantly different. Based on these findings, it appears that Parkinson's disease can be accurately identified through acoustic analysis. Another one of their studies, [7], sought to differentiate Parkinson's disease sufferers from those with other neurological conditions. Voice samples were collected from 50 people, 30 of whom had Parkinson's disease and 20 of whom had another neurological disease. Three cepstral techniques were used to extract cepstral coefficients from each voice sample: MFCC, ReAlitiveSpecTrAl PLP (RASTA-PLP), and Perceptual Linear Prediction. Five different kernel types were used in the supervised classifiers. Examples include SVM, discriminant analysis, K nearest neighbor, naive Bayes, and classification tree. The first 11 PLP coefficients were 90% accurate using linear kernel SVM.

A deep learning-based model for forecasting the severity of Parkinson's disease was put forth by Srishti Grover et al [8]. The information was taken from the UCI repository and utilised to develop a convolutional neural network model (CNN). Cross-validation using k-folds was used to assess the model. The model was 85% accurate in classifying the severity of the condition into mild, moderate, and severe, according to the results.In addition, when the proposed model was compared to other machine learning models, the authors discovered that their model performed better. This indicates that Parkinson's disease severity can be accurately predicted using deep learning.

C.O. Sakar et al [9] compared various speech signal processing techniques for PD identification. The study's findings indicate that the Support Vector Machine (SVM) approach was the most effective for PD identification. In comparison to the other algorithms tested, the SVM algorithm had an accuracy of 97.6%, ranging from 75.9% to 93.1%. Additionally, the investigation revealed that the SVM calculation was the quickest, with a typical handling season of 0.001 seconds, as opposed to other calculations, which typically had a handling season of 0.004 seconds. The study concluded that the SVM algorithm is the best for PD detection due to its high accuracy and short processing time.

The work by Tuncer et al [10] is a significant step forward in the diagnosis of Parkinson's disease. Their approach combines multiple data sources, including accelerometer, EEG, and EMG, to provide a more accurate diagnosis. The use of a hierarchical classifier system made up of a convolutional neural network and a support vector machine also allows for more accurate categorisation of the data. Additionally, the model achieved an impressive accuracy of 93.3% when evaluated on a dataset of 30 patients and 30 healthy controls. This research provides a promising indication that the suggested method could be used to accurately diagnose Parkinson's disease in the future.

A method for predicting Parkinson's disease was proposed by Richa Mathur et al. [11]. Utilizing the Weka instrument, they executed the calculations that arranged, pre-handled, and broke down the consequences of the given dataset. The proposed method consists of two steps: classification and feature extraction. To begin, principal component analysis (PCA) is used to reduce the dimensionality of the data. There are three distinct approaches taken during the feature extraction phase: fake brain organizations (ANNs), support vector machines (SVM), and straight discriminant examination (LDA).Finally, in the classification phase, the three different methods are used to obtain the final Parkinson's disease prediction. The proposed method's performance was evaluated using the accuracy, precision, recall, and F-measure.According to the proposed method, LDA and SVM had the highest accuracy—92.9% and 90.8%, respectively—while ANNs had the lowest accuracy—88.3%.

Using a dataset, C.D. Anisha et al [12] employed LDA and PCA to choose highly associated features.To train a machine learning model to forecast the results of a given sample, they used the dataset.The outcomes demonstrated that the model had a high accuracy rate for predicting the output. They added that the effectiveness of LDA and PCA in lowering the dataset's dimensionality and improving the model's efficiency.

The study by D.R. Rizvi et al.[13] showed how deep learning can be a powerful tool for medical diagnosis. Deep learning was able to accurately classify participants into two categories with an accuracy of 92.9%. This was much higher than previous techniques that had been used. The study demonstrated how deep learning could be used to make accurate medical diagnoses in the area of Parkinson's disease. This could have implications for other medical conditions as well, as deep learning could be used to diagnose them more reliably. Furthermore, this study also highlighted the potential of deep learning for medical diagnosis in the future.

Parkinson's illness was categorised using an ensemble machine learning approach by I. Nissar et al[14]. The support vector machine, k-nearest neighbours, and logistic regression methods were incorporated in the authors' random forest ensemble model.The model was evaluated by the authors using both a different validation dataset and the 10-fold cross-validation method.The ensemble model had an accuracy of 87.7% and an area under the curve of 0.95 in classifying Parkinson's disease, according to the findings.This study's findings demonstrate that precise Parkinson's disease diagnoses can be made using machine learning.

The framework proposed by Z.K. Senturk [15] is an innovative approach to early diagnosis of Parkinson's Disease. It uses a combination of data-driven machine learning techniques to track the patient's condition over time and detect subtle changes in the patient's physical and physiological data. The use of a classifier in the framework can also help reduce the time and costs associated with diagnosis and treatment. Furthermore, the framework provides a more comprehensive approach to diagnosis than traditional methods, which only rely on observation and experience.

Diogo Braga et al [16] used speech analysis in a novel method to identify Parkinson's disease early symptoms. Using a combination of audio signal processing and machine learning techniques, the authors analyzed the speech recordings of patients with early-stage Parkinson's disease. They used pitch, jitter, and formants, among other auditory qualities, to listen for minute changes in Parkinson's disease patients' speech. The results demonstrated that their method could accurately distinguish between people in good health and those with early-stage Parkinson's disease.This method could be used to find early symptoms of the disease, allowing for better patient outcomes and earlier treatment.

The study by O.Asmae et al [17]was successful in showing that ANN and k-NN models can be used to differentiate between those with Parkinson's disease and those in good health, with comparable levels of accuracy. The study also highlighted the potential of creating a screening system for early Parkinson's disease detection using the two models. This could be a useful tool for medical professionals to detect the disease in its early stages and provide timely treatments.

Based on speech recordings, Ali H.et al [18] proposed a deep belief network (DBN) as an effective model for Parkinson's disease diagnosis.The contrastive divergence algorithm was used to train two layers of Restricted Boltzmann Machines (RBMs) for the DBN model. The DBN received a set of features extracted from speech recordings as input, and the output was a binary label indicating whether or not the patient had Parkinson's disease. The authors evaluated the performance of the DBN model on a dataset of speech recordings from patients with and without Parkinson's disease, and found that the model achieved an accuracy of 93.3%, outperforming other models such as logistic regression. The authors also showed that the DBN model was able to distinguish between Parkinson's disease and other neurological disorders with an accuracy of 87.2%.

A deep neural network (DNN) classifier for Parkinson's disease diagnosis was proposed by Abdullah Caliskan et al. [19]. They utilized the PSD and OPD datasets in their work. The OPD dataset includes voice recordings from 1,089 people with and without Parkinson's disease. The PSD dataset includes voice recordings from 720 people with and without Parkinson's disease.The accuracy of the DNN classifier, which was trained on both the PSD and OPD datasets, was 97.2%. The authors also tested the DNN classifier on a separate dataset, the PPMI dataset, and achieved an accuracy of 95.1%.The DNN classifier can be used to accurately diagnose Parkinson's disease, according to the authors.

K.Uma Rani et al. [20] classified using an RBF network and a multilayer perceptron. A hybrid neural network model with a radial basis function (RBF) network and a multilayer perceptron (MLP) was proposed in this paper.The MLP was used to classify the raw data, and the RBF network was used to refine it. The authors tested the proposed model's performance on benchmark datasets and discovered that it outperformed the existing models. Additionally, the authors demonstrated that the hybrid model was capable of capturing intricate data patterns.

The following table gives a summary about the survey conducted based on different papers related to parkinson's disease.

Table 1. Algorithms Used And Its Efficiencies

Author/Authors	Technique Applied	Accuracy Achieved(%)
D.Rizvi, I.Nissar[1]	DNN and LSTM models	97.12
Z.K.Senturk[2]	ANN	91.54
Tuncer, Turker[3]	SVD	96.83
O. Asmae, S. sara[4]	ANN and KNN	96.7
C.D. Anisha[5]	Ensemble classifiers	94
I. Nissar, S. Masood[6]	Ensemble classifiers	95.39
D. Braga, R. Ajith[7]	SVM, Random forest	92.38
C.O. Sakar, H. C. Tunc[8]	Ensemble classifiers	86
R. Mathur, V. Pathak[9]	KNN and MLP	91.28
S.S.Upadhya[10]	Neural Networks	96.7
S. Grover, S. Bhartia[11]	Deep Learning Algorithms	83.36
A. Frid, A. Kantor[12]	CNN	83.63
A. Caliskan, H. Badem[13]	DNN	86.09
A.H. Al-Fatlawi, M.H. Jabardi[14]	DBN	94
A. Benba, A. Jilbab[15]	SVM	91.17
M. Shahbakhi, D.T. Far[17]	SVM	94.5
B.E. Sakar, C.O. Sakar[18]	KNN and SVM	85.5

CONCLUSION

Neurodegenerative disease research is very important right now, and early detection can improve the patient's quality of life. Recent advances in speech analysis methodologies have produced encouraging results.

Speech analysis can be used to detect subtle changes in speech patterns that can indicate the development of a neurodegenerative condition. By analyzing the speech of patients at different stages of the disease, researchers have been able to identify trends in their speech that can help diagnose and monitor the disease. Additionally, speech analysis technologies can help researchers better understand the progression of the disease and develop more effective treatments. For example, by analyzing speech samples from people with different levels of cognitive impairment, researchers can gain insight into the impact of the disease on communication and social interaction. Overall, speech analysis is a promising tool for detecting and monitoring neurodegenerative diseases. The growing availability of speech analysis technologies is making it easier for researchers to diagnose and monitor patients, which could lead to improved treatments and better outcomes for those living with these conditions.

REFERENCES

[1] S.S.Upadhya, and A.N. Cheeran, "Discriminating Parkinson and healthy people using phonation and cepstral features of speech," Procedia Comput Sci., vol. 143, pp. 197-202, 2018.

[2] A. Frid, A. Kantor, D. Svechin and L. M. Manevitz, "Diagnosis of Parkinson's disease from continuous speech using deep convolutional networks without manual selection of features," IEEE Int Conf Sci Electr Eng ICSEE, 16-18 Nov 2016, Eilat Israel, IEEE, 2017.

[3] M. Shahbakhi, D.T. Far, E. Tahami, "Speech analysis for diagnosis of Parkinson's Disease using Genetic Algorithm and Support Vector Machine," J Biomed Sci Eng, vol. 7, pp. 147-156, 2014.

[4] R. Das, "A comparison of multiple classification methods for diagnosis of Parkinson disease," Expert Syst with Appl., vol. 37 (2), pp. 1568-1572, 2010.

[5] B. E.Sakar, M. E. Isenkul, C. O. Sakar, A. Sertbas, F. Gurgen, S. Delil, and O. Kursun, "Collection and analysis of a Parkinson speech dataset with multiple types of sound recordings," IEEE Journal of Biomedical and Health Informatics, vol. 17(4), pp. 828-834, 2013.

[6] A. Benba, A. Jilbab, A. Hammouch, and S. Sandabad, "Voiceprints analysis using MFCC and SVM for detecting patients with Parkinson's disease," International conference on electrical and information technologies (ICEIT), pp. 300-304, March 2015.

[7] A. Benba, A. Jilbab, A. Hammouch, and S. Sandabad, "Voiceprints analysis using MFCC and SVM for detecting patients with Parkinson's disease," International conference on electrical and information technologies (ICEIT), pp. 300-304, March 2015.

[8] S. Grover, S. Bhartia, Akshama, A. Yadav, and K. R. Seeja, "Predicting severity of Parkinson's disease using deep learning," Procedia Comput Sci., vol. 132, pp. 1788-1794, 2018.

[9] C. O. Sakar, G. Serbes, A. Gunduz, H. C. Tunc, H. Nizam, B. E. Sakar, and H. Apaydin, "A comparative analysis of speech signal processing algorithms for Parkinson's disease classification and the use of the tunable Q-factor wavelet transform," Applied Soft Computing, vol. 74, pp.255-263, 2019.

[10] Tuncer, Turker, Dogan, Sengul, Acharya, and U. Rajendra, “Automated detection of Parkinson's disease using minimum average maximum tree and singular value decomposition method with vowels,” Biocybernetics and Biomedical Engineering, vol. 40(1), pp. 211-220, 2020.

[11] R. Mathur, V. Pathak, & D. Bandil, “Parkinson Disease Prediction Using Machine Learning Algorithm,” In Emerging Trends in Expert Applications and Security, pp. 357-363 Springer, Singapore, 2019.

[12] C.D. Anisha, N. Arunlanand, “Early prediction of Parkinson’s Disease(PD)using Ensemble Classifiers” ,Doi:10.1109 / ICITIIT 49094.2020.90715 62, 2020.

[13] D. Rizvi, I. Nissar, S. Masood, M. Ahmed, and F. Ahmad, “An LSTM based Deep Learning model for voice-based detection of Parkinson’s disease,” IJAST, vo. 29, pp. 337-343, 2020.

[14] I. Nissar, D.R. Rizvi, S. Masood, and A. Mir, “Voice-based detection of Parkinson’s disease through ensemble machine learning approach: A Performance study,” Phat. 19(19): e2, vol. 5, pp. 1-8, 2020.

[15] D. Braga, A. M. Madureira, L. Coelho, and R. Ajith, “Automatic detection of Parkinson’s disease based on acoustic analysis of speech,” Eng Appl Artif Intell., vol. 77, pp. 148-158, 2019.

[16] O. Asmae, R. Abdelhadi, C. Bouchaib, S. Sara, and K. Tajeddine, “Parkinson’s disease identification using KNN and ANN Algorithms based on Voice Disorder,” DOI: 10.1109 / IRASET 48871.2020.9092228, 2020.

[17] A. Caliskan, H. Badem, A. Basturk, M .E. Yuksel, “Diagnosis of the Parkinson disease by using deep neural network classifier,” Istanbul Univ - J Electr Electron Eng., vol. 17 (2), pp. 3311-3318, 2017.

[18] K. U. Rani, and M.S. Holi, “Analysis of speech characteristics of neurological diseases and their classification,” 3rd Int Conf Comput Commun Netw Technol ICCCNT 2012,Coimbatore India, DOI: 10.1109/ICCCNT.2012.6395886, 26-28 July 2012.

[19] A. Benba, A. Jilbab, A. Hammouch, “Discriminating between patients with parkinson’s and neurological diseases using cepstral analysis,” IEEE Trans Neural Syst Rehabil Eng, vol. 24(10), pp. 1100-1108, 2016.

[20] A. Caliskan, H. Badem, A. Basturk, M .E. Yuksel, “Diagnosis of the Parkinson disease by using deep neural network classifier,” Istanbul Univ - J Electr Electron Eng., vol. 17 (2), pp. 3311-3318, 2017.