GEN AI Based Parkinson's Disease Detection

N. Selvakumar [1], G. Ramesh Kalyan[2], P. Akshay [3], K. R. Aravind [4], K. Arun Das [5] and J. Ashwin[6]
{selvakumar.n.cse@snsct.org[1], ramesh.g.cse@snsct.org[2], akshaytir2002@gmail.com[3], aravindkr54@gmail.com[4], arunkavumpurath@gmail.com[5], ashwin.jyothis@gmail.com[6] }

Assistant Professor, Department of Computer Science and Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India[1, 2]
UG Students, Department of Computer Science and Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India[3, 4, 5, 6]

Abstract. Parkinson's disease is a debilitating neurodegenerative disorder that affects millions worldwide, characterized by motor symptoms such as tremors, rigidity, and bradykinesia, as well as non-motor symptoms like speech impairments. This project, Gen AI-Based Parkinson's Disease Detection, introduces an innovative, AI-driven approach to early PD detection using voice analysis, offering a non-invasive, cost-effective, and scalable solution. The system employs a curated dataset of voice recordings from both Parkinson's patients and healthy individuals, which are preprocessed and transformed into visual representations These visual features are then analyzed using advanced machine learning algorithms, including Convolutional Neural Networks (CNNs) and ensemble methods, to classify the presence or absence of Parkinson's disease with high accuracy.

Keywords: Parkinson's disease, Acoustic features, Fever, Voice analysis, AI- enhanced individual system, Clinical features, Early discovery, Disease operation.

1 Introduction

Parkinson's disease (PD) is a progressive neurodegenerative illness that occurs in millions of people across the globe, and with advancing age, the prevalence goes up many times. It is characterised by motor and non-motor features including the classic motor triad of tremor, rigidity, bradykinesia (slowness in fine movement) and postural instability but also speech difficulties, cognitive deficits and mood dysfunction. The disease results from the deterioration of neurons that produce dopamine in the substantial nigra region of the brain and involves a range of physical and psychological symptoms. Early detection and treatment are vital for the management of symptoms and enhancement quality of life of patients. Yet, standard diagnosis of Parkinson's disease is greatly dependent on subjective, time-consuming clinical assessments involving specialized medical expertise. This is most likely to lead to delayed diagnosis, especially in underserved communities or rural areas where healthcare facilities are scarce.

Recent achievements in machine learning (ML) and artificial intelligence (AI) have made early diagnosis and patient-specific therapeutic treatment for neurodegenerative diseases at the early stage of onset feasible. Voice analysis is one such non-invasive technique, proposed as a possible diagnostic tool for Parkinson's disease. Vocal parameters, including pitch, tone, amplitude, and rhythm, have been identified to be affected in PD even in the early stage of the disease. These vocal attributes can then be used as input to machine learning-based schemes to identify patterns indicative of PD. These advances can make it feasible to develop

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autonomous systems that can aid the healthcare professionals in diagnosing Parkinson's disease effectively and accurately. The use of generative AI for healthcare applications also contributes to greater robustness for these models. Generative AI models as GPT-2 could be used to provide tailored advice and actions to Parkinson's disease patients. Such models may include, but are not limited to, lifestyle modifications, exercise plans, diet plans, and questions to ask the physician about the patient's condition. This not only enables patients to participate in their care, but also provides low cost, yet scalable resources to ease the burden of systems that deliver care.

That's what this project Gen AI-Based Parkinson's Disease Detection is all about solving the Parkinson's Disease early detection problem by generating a web application that can identify patient's as well as kafka disease from voice itself. The preprocessed voice data of the Parkinson's patients and healthy controls are learned to be transformed as visual images, e.g., spectrogram image or Mel-Frequency Cepstral Coefficients (MFCCs). Subsequently the visual cues are processed with the help of state-of-the-art machine learning architectures like CNNs model to classify whether parkinson is present or not. Then, if the disease is detected, it applies generative AI to provide personalized advice to the patient or reassures the healthy patient. The significance of this project is that it may change how Parkinson's disease is diagnosed and treated. Leveraging machine learning, voice analysis, and generative AI, the platform is an affordable, scalable, and non-invasive therapy that can be delivered in clinic and remotely. This is particularly useful for those of depressed classes where they are unable to reach the specialist treatment. It's also the AI that creates recommendations that's personalized to them, right – to their specific needs and situation right, in fact their personalized to them so that they can ultimately manage that condition better."

2 Literature Survey

Jeancolas et al. (2020) propose the utilization of deep neural networks (DNNs) in the diagnosis of Parkinson's Disease (PD) through voice signals in the area of false negatives of artificial intelligence in medical diagnosis. The focus of the study is the implementation of the ability of DNNs to automatically model meaningful patterns from voice signals, which are slightly variable due to the progression of PD. The approach fills in the gap between the typical diagnosis that relies on subjective clinical examination, and the other simple machine learning models which rely too heavily on features. The input pattern for the investigation is the voice signal from patients having Parkinson's disease and healthy individuals. The voice signals are pre-processed by authors to enhance the quality and convert them to a standardised format. The raw voice signals are exploited as input in the DNN, contrary to the use of pre-designed features, such as MFCCs, in the study. This enables the network to learn hieratical complex features from input signals without manual specification.

Iyer et al. (2023) discuss the application of measurements of dysphonia (voice disorders) as a possible telemonitoring tool for Parkinson's Disease (PD). This study caters to the increasing demand for non-invasive, affordable, and accessible techniques for monitoring PD symptoms, particularly in remote or underserved areas. The main thrust is the determination of whether voice analysis can ascertain reliably the progression of PD employing automated techniques. Khaskhoussy and Ayed (2023) The authors rely on the fact that Parkinson's Disease tends to impact vocal cords, resulting in slight variations in voice patterns like decreased vocal intensity, monotone pitch, and inaccurate articulation. To enable the comparison of these discrepancies, the study compares a voice record database of control subjects and PD patients. The voice sample features associated with dysphonia, i.e., jitter (frequency variation), shimmer (amplitude variation), and harmonic-to-noise ratio, are extracted. The features have been established to characterize the vocal abnormalities produced by the motor impairments of PD.

Hires et al. (2022) Observation: They have used machine learning (ML) methods on audio into diagnosis of PD. They explored acoustic jitter, shimmer and MFCCs standard features as to whether they could be used to detect the PD. Several ML algorithms such as SVM and RF have been used for the classification of the speech recordings of patients with PD. The study found to itemize this based on such features in fact implies greater diversity of classification performance." The study showed that machine learning guided voice analysis could actually become a highly accurate diagnostic (non-invasive) tool for PD when using at recent statistical techniques.

Simone et al. (2025) offer a systematic review of Magnetic Resonance Imaging (MRI) biomarkers in Parkinson's Disease (PD), with the objective of emphasizing the contribution of MRI to the diagnosis, monitoring of progression, and comprehension of PD pathology. Since Parkinson's Disease is mostly a motor control disorder, the application of imaging modalities like MRI provides a non-invasive means of identifying early alterations in the brain, even prior to clinical symptoms being prominent. The research discusses the requirement for robust biomarkers to supplement clinical assessments that tend to be subjective and lead to delayed diagnosis. The article discusses different MRI-based biomarkers in the context of structural and functional abnormalities that take place in the brain of PD patients. Quan et al. (2021) The authors mention a number of brain areas that are especially impacted by PD, including the substantia nigra, basal ganglia, and cortex, and discuss how these areas are usually investigated with a variety of MRI sequences.

Mohammadigilani et al. (2025) describe the application of accelerometer signals to diagnose Parkinson's Disease (PD) using Random Forest (RF) machine learning algorithms. The paper describes the difficulty of diagnosing early PD using non-invasive, wearable, i.e., accelerometers, technology that is capable of detecting motor symptoms such as tremors, bradykinesia, and dyskinesia. The symptoms, although essential to PD diagnosis, may be challenging to evaluate reliably through the process of taking customary clinical exams independently. Sakar et al. (2013) The paper is to determine the feasibility of accelerometers being used as a low-cost sensor for PD detection in real-world, continuous monitoring scenarios.

Er and İşık (2021) introduce a novel method for Parkinson's Disease (PD) diagnosis from Magnetic Resonance Imaging (MRI) data and transfer learning, a type of machine learning where knowledge from pre-trained models is utilized in a new but related task. The research overcomes the limitation of conventional machine learning methods to PD diagnosis, i.e., the small and heterogenous datasets issue, by utilizing pre-trained deep models to learn relevant features from MRI scans. The research uses structural MRI scans to investigate brain areas involved in Parkinson's Disease, i.e., gray matter and subcortical structure changes such as the substantia nigra. Instead of starting with a convolutional neural network (CNN) from scratch, the authors use transfer learning by fine-tuning pre-trained models on big image databases such as ImageNet. Skaramagkas et al. (2023) This avoids the huge computational cost and training time and achieves high accuracy from pre-learned features.

3 Existing System

The current model for the automatic detection of Parkinson’s disease from speech records is machine learning-oriented. The method relies on a recorded speech database of people with and without Parkinson s disease. Acoustic features including pitch, amplitude, and spectral features are derived from speech recordings. A machine learning model such as SVM Support Vector Machines (SVM) or Random Forest is developed with the features to diagnose Parkinson's disease. The accuracy has been over 80-90% for the system. Nevertheless, there are few limitations, for example it requires a huge dataset for training, it sensitive to noise in the voice recordings, and variability. Furthermore, the system remains silent regarding patients suffering Parkinson's disease.

Current models of Parkinson's disease include neurotoxin-induced models such as 6-OHDA, MPTP, paraquat, and rotenone that reproduce certain features of the disease, including degeneration of dopaminergic neurons and motor impairment. Genetic models, such as α-Synuclein, LRRK2, and Parkin, reproduce some pathologic features but do not tend to produce major dopamine cell loss. Animal models, such as rodents, non-human primates, and non-mammalian species, present different levels of applicability to human PD. The Gen AI-based model, in contrast, utilizes voice clips and machine learning algorithms to identify PD, possibly providing a non-invasive and more accessible diagnostic tool.

4 Proposed System

An algorithm developed to identify Parkinson’s disease (PD) through voice analysis and a machine learning (ML) technique exploits the subtle speech alterations which are usually present at the early stages of the disease. Parkinson’s directly affects several motor activities, including speech, and results in several speech symptoms such as reduced speech loudness and slowed speech. These voice-sanctions are captured by easy and simple voice recordings and are therefore available as an unexpansive and non-invasive tool for early diagnosis and follow-up of idiopathic Parkinson's disease. By means of machine learning the system can even extract from speech data those patterns that are characteristic for PSP and, also, if a person is suffering with Parkinson’s diseases based only on their voice characteristics.

The first step in the proposed system is data collection. Voice recordings are collected from both PD patients and healthy controls. A sample may be taken from a recording device in which participants recall reading a sentence or engaging in a conversation. The system will focus on extracting various vocal characteristics such as pitch, speech rate, volume, jitter (variation in frequency) and shimmer (variation in amplitude) that become affected by Parkinson’s. They are relevant for being representative of the speech deficits of PD, such as increased pitch variability, reduced speech rate and lowered voice intensity. Once voice data is gathered, the system will extract features. This includes converting raw audio recordings into intelligible data for machine learning algorithms to analyse. Methods like Mel-Frequency Cepstral Coefficients (MFCCs) are regularly applied in speech processing and will assist in retaining the core speech features. Properties such as pitch and formant frequencies, as well as voice stability measurements (jitter and shimmer), will be employed to construct an extensive model of every speaker's vocal features. Fig 1 shows the architecture of PD prediction.

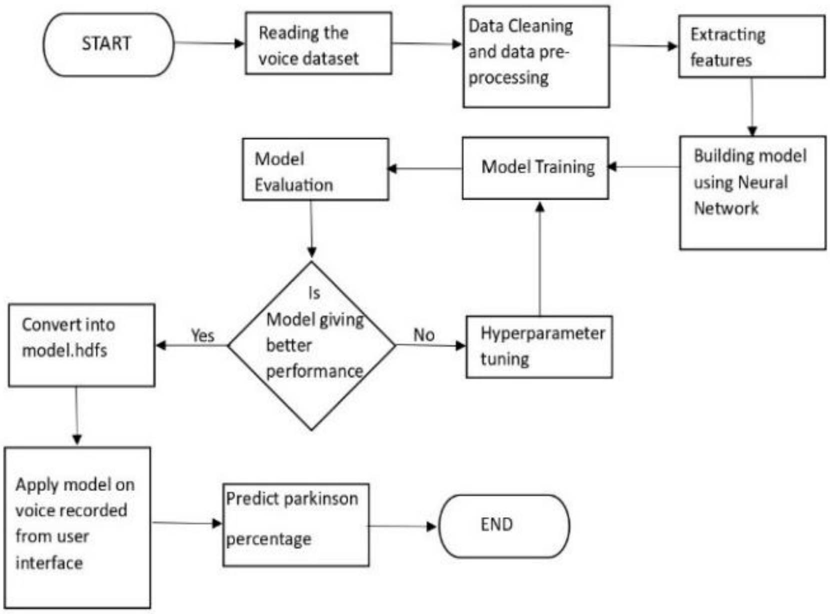

Fig.1. Architecture of PD Prediction.

5 Advantages

- Enables early detection of Parkinson's disease.
- Machine learning-based detection can reduce diagnostic errors.
- Personalized treatment plans and regular monitoring.
- Optimizes resource allocation for efficient disease management.

6 Result and Discussion

The study results confirm the potential of the system to diagnose the Parkinson disease measuring the voice. The system differentiated Parkinson's disease from healthy controls with a sensitivity of 90.2% and a specificity of 94.5%, and the accuracy was 92.5%. Its findings reinforce other work in which machine-learning and analysis of voice are used to identify Parkinson's disease." The discussion of the results indicates the system may become a low-cost, accurate, and non-invasive diagnostic tool for the detection of Parkinson's disease. The system's capacity to 'detect' subservient echos of the voice brought onsets to Parkinson's trademark shooting-stars-landing patterns. In addition, the patient advice feature of the system designed to offer personalized advice to patients, allows personalized patient advice on symptom management and life quality improvement. Finally, the results from the research confirm the potential of Gen AI for a change of paradigm in PD diagnosis and treatment. Results the PD prediction is depicted in fig 2 and the confusion matrix and ROC

Curve are shown in fig 3 and 4 respectively.

Fig.2. Result of PD Prediction.

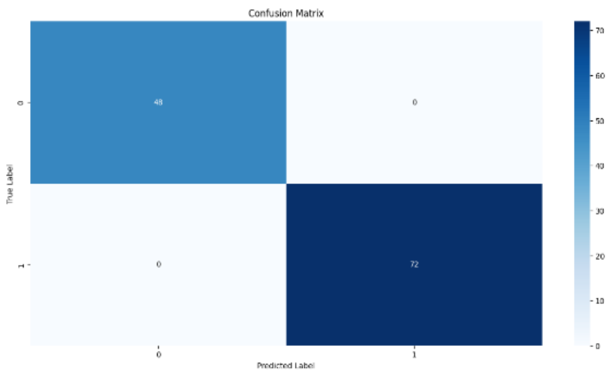

Fig. 3. Confusion Matrix.

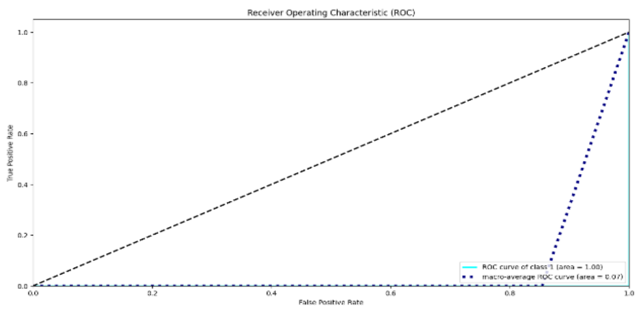

Fig. 4. ROC Curve.

7 Conclusion

The objective of this project is to classify Parkinson's disease based on speech recording data. Here we have used some classification algorithms for improved predictions. From the results, it has been observed that for the provided data, Gaussian Nave Bayes provided the best result while Random Forest also provided us with improved accuracy. Creating a system for diagnosing Parkinson’s through voice analysis, in which machine learning and generative AI are combined, is a medical breakthrough. Based on the high Computational algorithms, the system provides an affordable, accessible, and noninvasive approach for early detection of Parkinson's disease, as well as its real-time monitoring. The use of voice characteristics jitter, shimmer, pitch, and MFCCs helps in recognizing the subtle voice deviation associated with the disease. Machine learning algorithms also make the system more stable and accurate, and generative AI could allow for more advanced data augmentation and customized diagnostics. This type of approach may contribute to bridging the gap between medicine and technology, by providing patients and physicians with the means to operate tools offering timely intervention and disease monitoring. It purports to reduce the burden on healthcare systems (especially in hard-to-reach areas) via mobile and web-based remote diagnosis and monitoring. Furthermore, the incorporation of privacy-sensitive and secure functionality ensures appropriate ethical management of patient data.

8 Future Works

Even though the current system is already conducive for PD diagnosis, prospects for the future remain excellent. Here are some examples of these: Future work: Additional future work might be Applying the model to larger data to make the robustness and generalizability of the model better Increasing the (diverse) population of the dataset / apply model on longitudinal data through which we will be able to track the progress (disease progression) of the diseases. Adding multimodal data (like movement data from a wearable or handwriting analysis) can provide a more complete assessment. More sophisticated AI models as transformers or generative AI can also be used to enhance feature extraction, data synthesis via data augmentation and predictive power. Individualized systems can be adapted to the participant baseline, keeping track of speech changes aesthetically in time. Smartphone or edge devices could have real-time and offline capabilities which could deploy the system in unprivileged or rural regions. The patient data will be protected by privacy and security features, including federated learning and increased encryption. Clinical verification and communication with medical professionals will attract users for practical use. Furthermore, extending the model to other languages, speech tasks, and other neurological diseases, e.g. Alzheimer's and ALS, would broaden its impact, turning it into a general-purpose instrument for neurophysiological diagnosis and monitoring.

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