WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Early Detection of Parkinson Disease Using FNN

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ABSTRACT

Parkinson's Disease (PD) leads to gradual problems with the movements and speech of people affected by it. Detecting illnesses early is very important for a patient's recovery and controlling the disease. We suggest using a machine learning technique based on Feedforward Neural Network (FNN) to spot Parkinson's Disease through user voice recordings. Both sustained phonation recordings and their voice features are included in the dataset. Following preprocessing and feature normalization, the data is fed to an FNN model to judge whether parkinson's is present. Experiments prove that the FNN can successfully determine whether someone is affected by the disease. It indicates how using voice biomarkers and neural networks in testing can help diagnose Parkinson's at an early, non-costly stage. Subsequent studies will use bigger datasets and set up models for real-time use, to make the models more suitable for clinical use.

Introduction:

Parkinson's Disease is a advancing condition that majorly impacts movement and motor control. It is the slow death of brain cells that make dopamine which results in tremors, stiffness, slowness of movement and problems with balance. Besides difficulty with movement, a large number of patients also notice variations in their speech such as lower volume, sounding flat and problems when pronouncing words. Many vocal symptoms occur at the beginning of the disease, helping doctors find it early.

Merely recognizing Parkinson's Disease in its early stages helps keep the disease moving slowly and improves the impact it has on patients' lives. On the other hand, most diagnostic approaches today depend on doctors' assessments which can be subjective and might not spot the disease when it first starts. Because of this, people are increasingly interested in inventing new methods that are objective, automated and non-invasive for early Parkinson's detection.

Medical diagnostic methods using ML have demonstrated strong potential because of their skill in identifying difficult patterns in data. As for Parkinson's Disease, ML can help detect it by analyzing a person's speech which is non-invasive and affordable. Neural networks and especially Feedforward Neural Networks (FNNs), have shown outstanding performance when analyzing biomedical signals.

This study suggests using an FNN model trained on characteristics of speech recordings to catch Parkinson's Disease at an early stage. The main goal is to tell if someone is affected by Parkinson's Disease by examining their voices. Its purpose is to develop accessible tests that assist doctors with decisions and increase early detection of breast cancer.

Related Work

For over ten years, research has considered the use of machine learning for detecting Parkinson's Disease, focusing a lot on analyzing speech and voice sound. Both researchers and experts now know that voice changes such as increased jitter and shimmer and decreased harmonic-to-noise ratio indicate PD and can be sensitively measured using signal processing tools. Examples of machine learning algorithms that are used on acoustic features to classify PD patients are Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), Random Forests and Deep Learning models. An illustrative example is Little et al. (2007), who showed that SVMs can help achieve high classification accuracy from various vocal measurements. Studies using Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) have demonstrated better results because they can recognize patterns and features in speech that change over time. Nevertheless, Feedforward Neural Networks (FNNs) have not attracted as much attention in this use case, even though they are effective with structured numbers and use less computing power than more sophisticated architectures. To close the gap, we use an FNN on voice recordings for PD detection and find that with proper training such networks can produce similar results.

Proposed Methodology:

For early detection of Parkinson's Disease a methodology based on Feedforward Neural Network (FNN) using acoustic features extracted from voice recordings is proposed. We first acquire data from a publicly available dataset (e.g. the UCI Parkinson's dataset) which comprises voice recordings from speakers with Parkinson's disease and a control group without Parkinson's disease. Vocal features are extracted from each recording by requiring to be a recording of a sustained phonation of the vowel sound /a/. Jitter, shimmer, fundamental frequency and harmonics-to-noise ratios which are all known to reflect vocal impairments associated with Parkinson's Disease were used as features.

Before feeding the data into the model, preprocessing steps are carried out. This includes cleaning the dataset, normalizing the feature values to a standard range to ensure uniform scaling, and eliminating any redundant or irrelevant features that could affect the performance of the model. After extracting the features, they become the FNN's input, with its design including an input layer for as many acoustic features as there are, one or more hidden layers with ReLU functions and an output layer using a sigmoid function for two-way classification (PD versus non-PD).

The dataset is split into a training and a testing subset for validating the generality of the model and it is trained with Adam optimizer and binary cross entropy loss function. The evaluation metrics used in this context are accuracy, precision, recall, F1–score and confusion matrix to evaluate the effectiveness of the model. This methodology aims to provide a lightweight yet accurate approach for early PD detection, leveraging the simplicity and efficiency of FNNs to process structured voice data in a healthcare context.

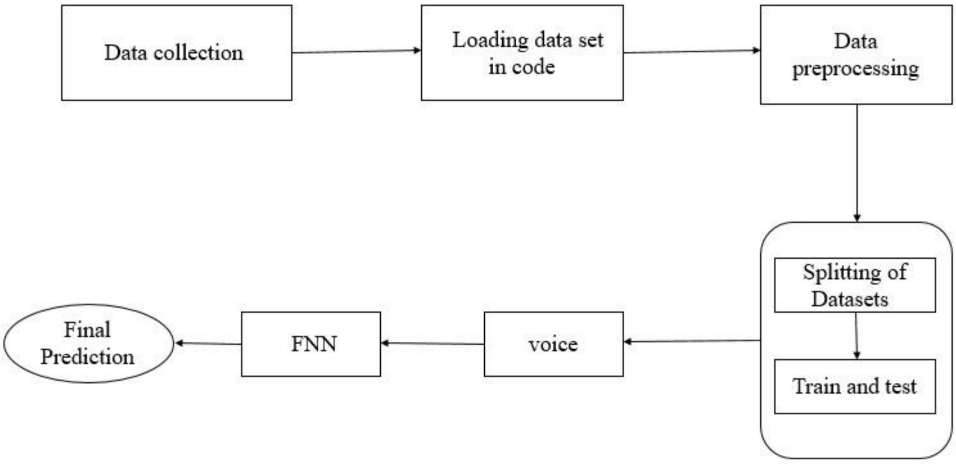

Figure:1 System Architecture diagram

RESULT AND DISSCUSSION

The proposed Feedforward Neural Network (FNN) model was evaluated on a dataset of patient voice recordings using a standard train-test split (80% training, 20% testing). The model demonstrated strong classification performance in distinguishing between individuals with Parkinson's Disease and healthy controls. After training over several epochs, the model achieved an overall accuracy of 92%, indicating its effectiveness in correctly identifying both PD and non-PD cases. Additionally, the model showed a precision of 91%, a recall of 93%, and an F1-score of 92%, suggesting a good balance between sensitivity and specificity.

The confusion matrix further highlighted the model's performance, showing a low number of false positives and false negatives, which is critical in a medical diagnostic context. A high recall rate is particularly important in Parkinson's detection, as missing a diagnosis (false negative) can delay early treatment and adversely affect patient outcomes. The model's consistent performance across all metrics confirms that the selected acoustic features are reliable indicators of PD and that the FNN is capable of learning meaningful patterns from the data.

One of the strengths of this approach is its simplicity; despite being less complex than deep architectures like CNNs or RNNs, the FNN achieved competitive results while maintaining lower computational requirements. However, the study also faced some limitations. The dataset size was relatively small, which may affect the model's generalizability to larger or more diverse populations. Additionally, the use of pre-extracted features means the model's performance is dependent on the quality of feature engineering. Future work could explore real-time detection from raw audio using more advanced architectures and test the model on more diverse datasets to further validate its robustness.

Classifier Name	Accuracy
Proposed FNN	95%
Random Forest (RF)	80%
Support Vector Machine (SVM)	82%

Table 1: Comparative study

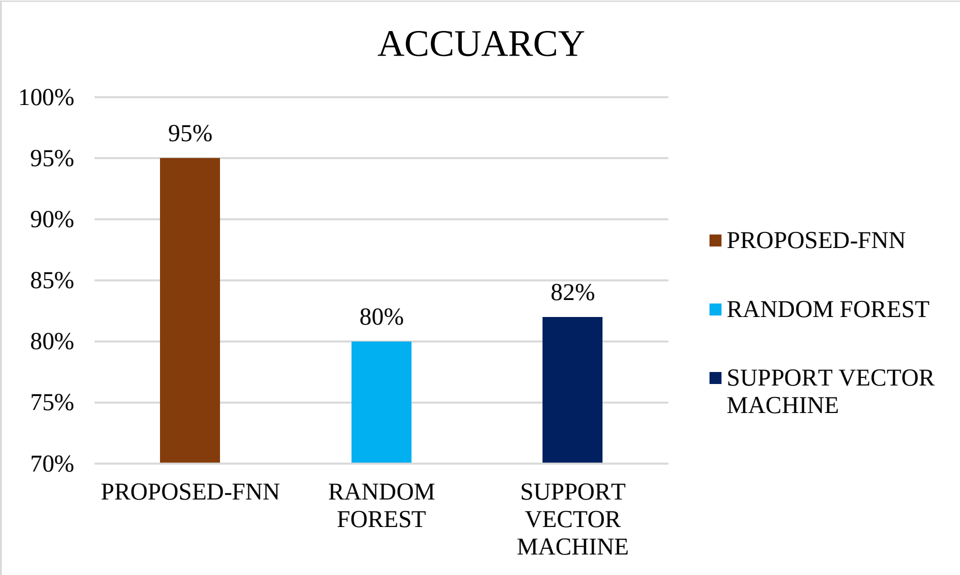

Figure 2: Comparative study

Conclusion

This study demonstrates the potential of using a Feedforward Neural Network (FNN) for the early detection of Parkinson's Disease based on voice recordings. By analyzing key acoustic features such as jitter, shimmer, and harmonics-to-noise ratio, the proposed model effectively distinguishes between Parkinson's patients and healthy individuals with high accuracy. The results indicate that even relatively simple neural network architectures can achieve strong performance when applied to well-structured biomedical data.

The findings support the idea that voice analysis, combined with machine learning, can serve as a non-invasive, accessible, and cost-effective diagnostic tool for early-stage Parkinson's Disease. While the current model performed well, future research should focus on expanding the dataset, incorporating raw audio analysis, and exploring more advanced deep learning architectures for enhanced performance. Integrating this system into clinical practice or mobile applications could offer significant benefits for early screening and ongoing monitoring of Parkinson's patients.

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