

ABSTRACT

Machine Learning and Deep Learning are promising technologies that have the potential to assist and support clinicians in providing an objective and reliable diagnosis. These technologies play a crucial role in analyzing vocal features for the early detection and monitoring of Parkinson's disease. The advancements in these fields aim to furnish objective and quantitative measures of vocal impairments, thereby offering valuable insights for both diagnosis and the evaluation of treatment outcomes.

Parkinson's disease (PD) is a progressive neurodegenerative disorder that primarily affects movement and is characterized by a range of motor and non-motor symptoms. One notable non-motor symptom is vocal impairment, which can significantly impact communication and quality of life for individuals with PD. The manifestation of vocal impairments in Parkinson's disease is commonly referred to as hypokinetic dysarthria. Vocal features are increasingly recognized as important diagnostic markers for Parkinson's disease. Assessment of vocal impairments, along with other motor and non-motor symptoms, contributes to a comprehensive diagnosis.

The main goal of this research work is to develop an accurate and robust classification model for Parkinson's disease (PD) by employing deep learning techniques, specifically focusing on vocal features. The study aims to achieve the objectives through Feature extraction, Dimensionality reduction & feature ranking, Feature Selection using optimisation techniques, Ensemble feature selection methods and Ensemble Deep Learning classifiers.

Initially, feature extraction technique is implemented to extract Vocal fold, TQWT, WT, MFCC, Time frequency and baseline features were extracted from dataset. Dimensions are reduced by introducing Kernel based Principal Component Analysis

(KPCA). It attempts to find a linear subspace of lower dimensionality than the original sound recording feature space, where the new sound recording features of PD have the largest variance. Minimum Redundancy Maximum Relevance (mRMR) technique is introduced for selecting informative features. High relevance score based on class label are selected and redundant features are eliminated. Finally, Fuzzy Convolution Long Short-Term Memory based Convolutional Neural Network (FCLSTM-CNN) classifier is introduced for PD classification. Here, triangular membership function is used for burning bias and weight values. In the mRMR algorithm, NP-hard problems will occur and it can be solved by using the Swarm Intelligence methods.

In the second phase of the study, the Fuzzy Monarch Butterfly Optimization Algorithm (FMBOA) is implemented to effectively select crucial features from the dataset, thereby improving the Parkinson's Disease (PD) detection rate. In this phase, the weight value plays a crucial role in the quest for optimal features within the dimensionality-reduced feature set. The computation of the weight value involves the use of the Gaussian fuzzy membership function, contributing to the algorithm's enhanced performance. Various classification algorithms are employed to evaluate different feature sets derived from FMBOA, each exhibiting distinct combinations. The proposed Fuzzy Convolution Bi-Directional Long Short-Term Memory (FCBi-LSTM) classifier is introduced for PD classification. This innovative classifier amalgamates multiple speech feature types at the feature level, facilitating the identification of individuals with PD in contrast to those without. Furthermore, there is potential for extending this work to incorporate the Ensemble Feature Selection algorithm to enhance overall accuracy.

In the third phase, Optimization Based Ensemble Feature Selection (OBEFS) algorithm has been proposed to select features based on the consensus. OBEFS algorithm

is introduced to combine three methods such as Fuzzy Monarch Butterfly Optimization Algorithm (FMBOA), Levy Flight Cuckoo Search Algorithm (LFCSA), and Adaptive Firefly Algorithm (AFA). Correlation function is introduced to combine the results of methods in order to select the optimal features. The proposed OBEFS algorithm yields better results for three feature subsets than other combinations of feature sets. The optimal features selected through OBEFS algorithm is used to train a Fuzzy Convolutional Bi-Directional Long Short-Term Memory (FCBi-LSTM) classifier. This can be extended to ensemble learning. Ensemble learning evaluates a variety of approaches instead of single classification algorithms, and final results are generated by merging outputs of classifiers.

In the final phase, Ensemble Deep Learning (EDL) classifiers are considered for the classification of Parkinson's disease. EDL include FCBi-LSTM, Contractive Auto-encoder (CAE), and Sparse Auto-encoder (SAE). CAEs represent robust adaptations of standard autoencoders, demonstrating an ability to acquire reduced sensitivity to minor variations in data. SAEs play a pivotal role in training Neural Network (NN) classifiers aimed at identifying Parkinson's Disease (PD) within datasets. The amalgamation of results from Deep Learning classifiers is achieved through the application of stacked generalization. Enhanced predictive performance is observed in comparison to utilizing a single model when employing Ensemble Deep Learning (EDL) techniques. The proposed classifier undergoes experimentation and evaluation using a dataset sourced from the University of California-Irvine (UCI) Machine Learning repository.