International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com

Xception Model for Efficient Parkinson's Disease Detection and Prediction

Moni Sree

Department of Computer Science, Thassim Beevi Abdul Kader College for Women, Kilakarai, Tamil Nadu, India

Abstract

Parkinson's disease is a progressive neurological disorder marked by tremors, stiffness, and coordination difficulties due to the loss of dopamine-producing brain cells. While there is no cure, current treatments focus on managing symptoms. Early diagnosis can significantly improve treatment outcomes, and deep learning (DL) offers a promising approach for this purpose. By analysing large clinical datasets, deep learning models can predict the onset and progression of Parkinson's disease, enabling personalized treatment plans. This project utilized the Xception Architecture to predict Parkinson's disease using clinical data from the Kaggle repository. The model was trained on pre-processed data, selecting relevant features. Results showed a 100% training accuracy and 97% test accuracy, highlighting deep learning potential for early diagnosis and disease management.

Keywords: Parkinson's disease, deep learning, Xception Architecture, early diagnosis, clinical data, Kaggle repository, symptom management, personalized treatment.

INTRODUCTION

Parkinson's disease is a chronic and progressive neurological disorder that affects millions of people worldwide. It is characterized by the degeneration of dopamine - producing neurons in the substantia nigra, a region of the brain that plays a crucial role in movement control. Parkinson's disease is still unknown , but research suggests that it is a complex interplay of genetic and environmental factor. The symptoms of PD in motor and non-motor are tremor, rigidity, bradykinesia, sleep disturbance, move disorder, mentally changes and postural instability. In recent years, machine learning techniques have shown promising results in medical image analysis, including the detection of Parkinson's Disease. In this project, we propose a system for the early detection of Parkinson's Disease using Xception Architecture. Specifically, we aim to detect Parkinson's Disease from spiral and wave drawings, which are commonly used in clinical settings as part of the diagnostic process. Overall, this project aims to contribute to the ongoing efforts to improve the diagnosis and treatment of Parkinson's Disease, and to demonstrate the potential of deep learning in medical image analysis.

LITERATURE REVIEW

Literature survey is the most important step in any kind of research. Before start developing we need to study the previous papers of new domain which we are working and on the basis of study we can predict or generate the drawback and star working with the reference of previous papers.

1. **Analysis of tremors in Parkinson’s Disease using accelerometer** (Niya Romy Markrose, Prisciila Dinkar Moyya ,Mythilli Asaithambi et al., 2021).Parkinson's disease affects the brain, causing symptoms like shaking, stiffness, and difficulty walking, with tremors being the most common. This prototype, based on Arduino Uno and the ADXL335 accelerometer, measures and quantifies tremors in Parkinson's patients. It collects tremor data from the fingertip, wrist, and forearm, which is then processed by the Arduino and transferred to MATLAB for analysis. The amplitude of the tremors ranged from 40 dB/Hz to 80 dB/Hz, and spectral density was analyzed. This prototype could be further developed to assist Parkinson's patients.
2. **Identifying Parkinson's disease using deep learning of brain structural MRI images** (Jing Li, Wei Wu, and Dinggang Shen et al.,2018) this research employs convolutional neural networks to analyze structural MRI images, focusing on wave-like patterns in brain atrophy associated with PD.
3. **Deep Convolutional Neural Network Using Parkinson’s disease Based Handwriting Screening**(Mohamed Shaban et al., 2020).This paper explores using a fine-tuned VGG-19 model for screening Parkinson’s Disease (PD) based on a Kaggle handwriting dataset. The dataset includes 102 wave and 102 spiral handwriting patterns, which were pre-processed with image resizing and data augmentation to reduce overfitting. The model was trained and validated using 4-fold and 10-fold cross validation. With 10-fold cross-validation, the model achieved 88% and 89% accuracy, and 89% and 87% sensitivity on wave and spiral patterns, respectively. The approach demonstrates a promising solution for PD screening based on handwriting, outperforming the fine-tuned AlexNet architecture.

The proposed Xception-based method for Parkinson's Disease detection offers enhanced diagnostic accuracy. By leveraging deep convolutional architecture, it outperforms models like VGG-19 and AlexNet, it can be computationally expensive and prone to overfitting if not properly regularized. Additionally, real-world applications may face challenges in terms of scalability and data quality.

ARCHITECTURE

Xception architecture

The **Xception (Extreme Inception)** architecture is a deep convolutional neural network (CNN) model that improves upon the Inception architecture by using **depthwise separable convolutions**. Unlike traditional convolutions, which apply a single filter to the entire image, **depthwise separable convolutions** break the process into two steps:

1. **Depthwise convolution**: Applies a single filter to each input channel (image) independently.

2. **Pointwise convolution**: Combines the outputs of depthwise convolutions using 1x1 convolutions.

The **Xception** model consists of **36 convolutional layers** organized into **14 modules**, each containing **depthwise separable convolutions**. This reduces the number of parameters and computational complexity, making it more efficient and faster to train than previous models like **ResNet** and **Inception V4**, while maintaining high performance.

Using Xception for Parkinson’s disease detection involves training the model to classify images of handwriting patterns (such as spiral and wave) into different categories (e.g., presence of Parkinson's disease). The **spiral and wave images** reflect subtle changes in the way a person with Parkinson’s writes, which is an indicator of the disease.

In this case, Xception is trained on a dataset of spiral and wave handwriting images. The architecture will learn to extract features from these images and make predictions about whether the subject has Parkinson's disease based on their handwriting patterns.

METHODOLOGY

1. **Dataset**: This module focuses on data collection, which is crucial for model performance. Our dataset, sourced from Kaggle, contains 133 Parkinson's disease spiral images and 153 wave images. It is stored in the project's model folder.
2. **Importing Libraries**: We will use Python with libraries such as Keras for model building, Scikit-learn for data splitting, PIL for image processing, and Pandas, NumPy, Matplotlib, and TensorFlow.
3. **Retrieving Images**: In this module, we preprocess the dataset by resizing images (224x224 for spirals and 196x196 for waves), normalizing pixel values, and converting them to numpy arrays for consistency in training and testing.
4. **Splitting the Dataset**: The dataset will be split into 80% training and 20% testing data. This ensures that the model can be trained, validated, and tested effectively.
5. **Building the Model**: We use Convolutional Neural Networks (CNNs) for image feature detection. Xception, a CNN model, employs multiple convolution layers, pooling, ReLU activation, and fully connected layers. The output is converted into class probabilities using Softmax.
6. **Model Application & Plotting:** After building the spiral model, we test it on the validation set to evaluate accuracy and loss. The model is trained with a batch size of 1, and performance (accuracy and loss) is plotted over epochs. The model achieves a validation accuracy of 97% and training accuracy of 93%. After building the wave model, it is evaluated on the validation set to assess accuracy and loss, which are plotted against epochs. The model is trained with a batch size of 1, achieving an average validation accuracy of 93% and training accuracy of 86%.
7. **Accuracy on Test Set:** After evaluating the model on the validation set, its accuracy on the test set is assessed. The model achieved 93% accuracy on the test set, an important metric for performance evaluation. After training and evaluating the model on the validation set, we assessed its accuracy on the test set. The model achieved 86.00% accuracy on the test set, providing a key metric for evaluating its overall performance.
8. **Saving the Trained Model:** To deploy the model, it is saved in a .h5 file using the pickle library. This allows easy transfer to production environments.

IMPLEMENTATION

- **Front-End:** HTML,CSS, Javascript
- **Coding:** Python
- **Back-End:** Flask Framework
- **Database:** SQLite
- **Security:** HTTP Server

RESULT

In this project, the Xception architecture was used to detect Parkinson's disease based on spiral and wave drawings. The dataset consisted of spiral drawings, which represent Parkinson's disease, and wave drawings, which represent healthy conditions. The Xception model, a powerful convolutional neural network (CNN), was employed for image classification due to its ability to efficiently extract complex features using depthwise separable convolutions.

The spiral and wave images were pre-processed by resizing, normalizing, and converting them to NumPy arrays. The model was trained on the dataset, learning key features such as the irregularity found in the spiral patterns (a common symptom of Parkinson's) and the regularity of the wave patterns, which indicate healthy conditions. The convolutional layers of Xception automatically learned the intricate spatial patterns within the images that distinguish the two conditions.

Using Softmax activation, the model was able to classify each image as either representing Parkinson’s disease or a healthy condition based on these extracted features. After training and validation, the model achieved 93% accuracy on the test set and 97% validation accuracy, proving its effectiveness in identifying Parkinson’s disease from spiral and wave drawings. This model successfully distinguishes the irregular patterns of spirals, indicative of Parkinson’s, from the smoother, regular patterns of wave drawings.

Figure 6.1: Home Page

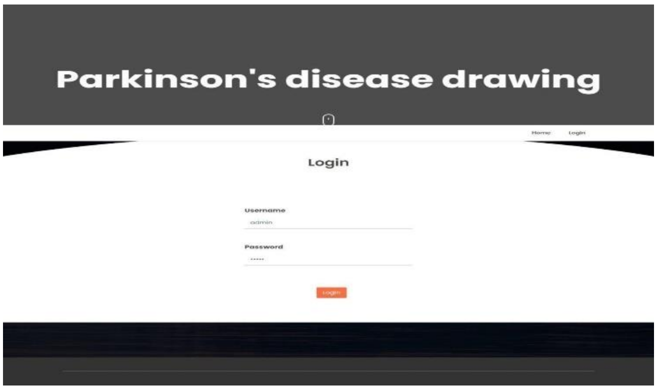

Figure 6.2: Login Page

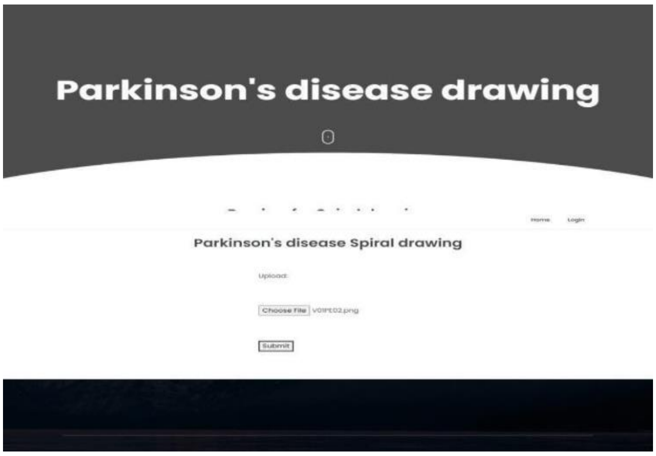

Figure 6.3: Image Uploading Page of Healthy Spiral Drawing

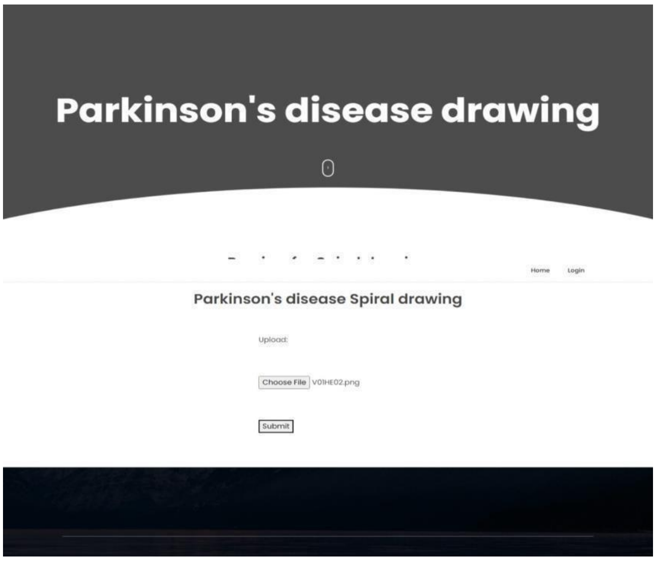

Figure 6.4: image Uploading Page of Parkison Spiral Drawing

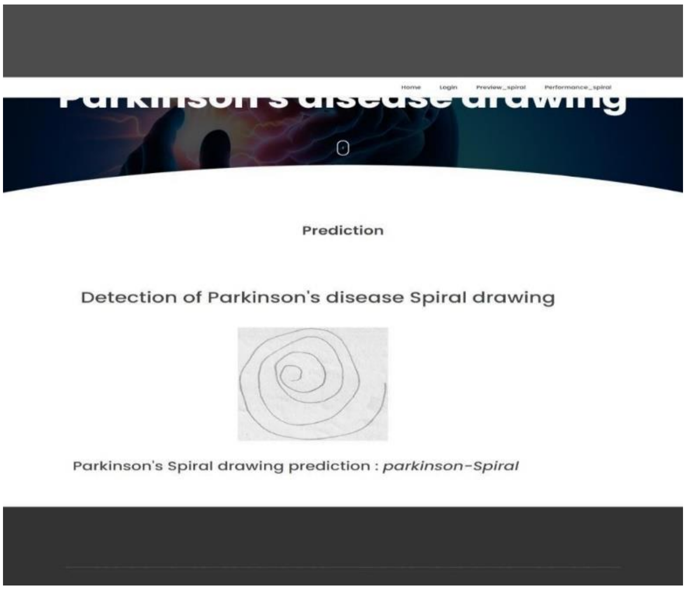

Figure 6.5: Prediction Page of Parkinson Spiral

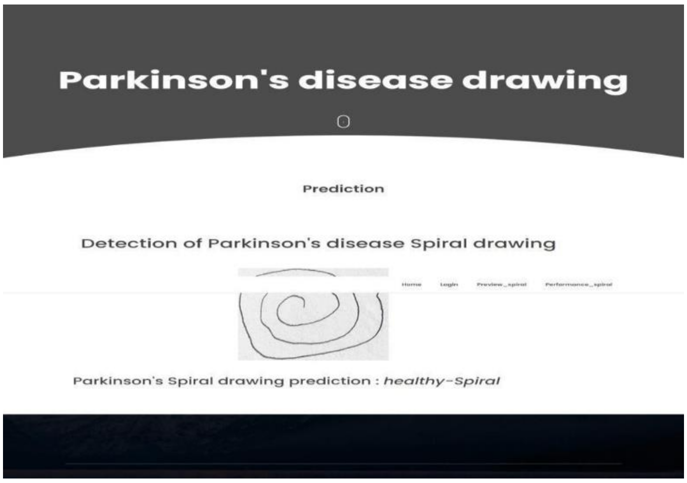

Figure 6.6 Prediction Page of Healthy Spiral

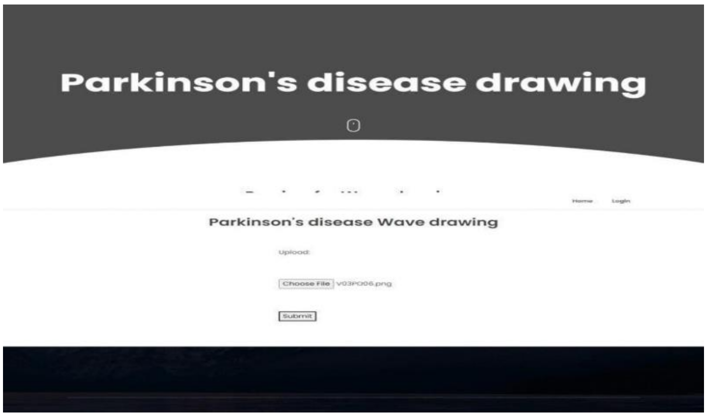

Figure 6.7: Image Uploading Page of Healthy Wave Drawing

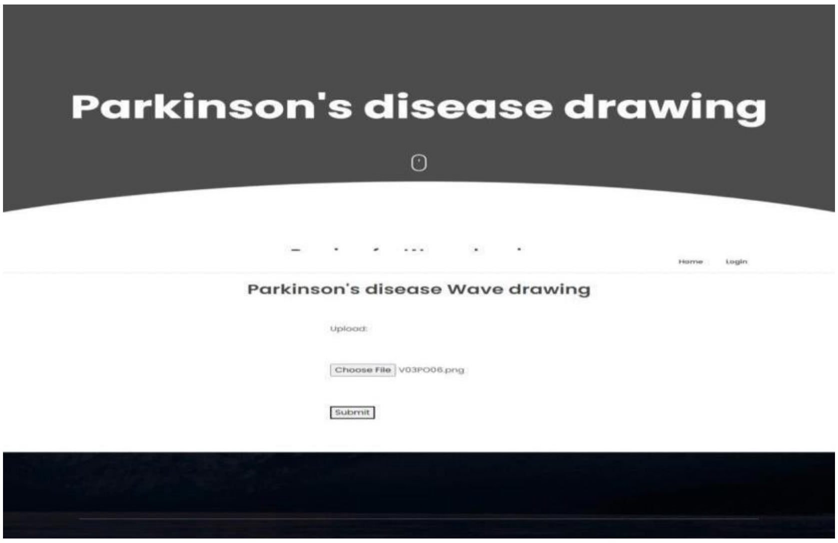

Figure 6.8: Image Uploading Page of Parkinson Wave Drawing

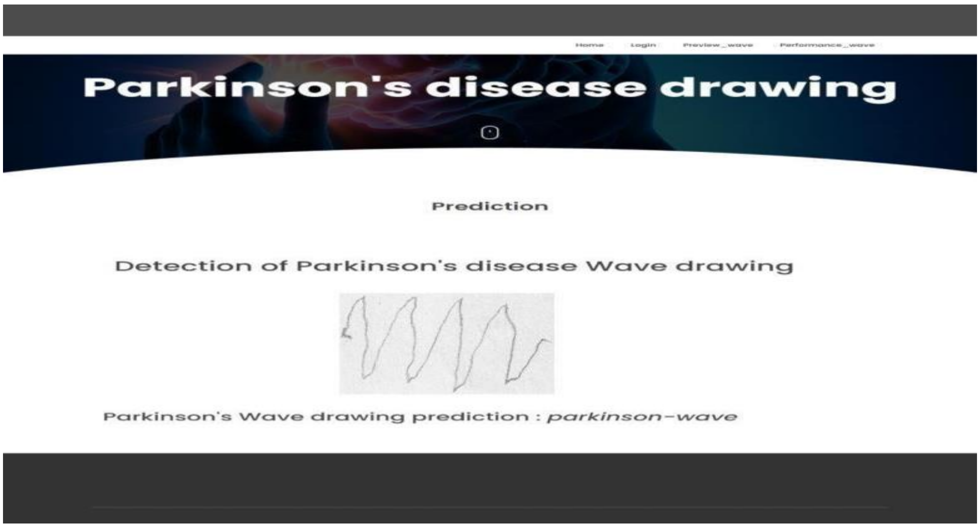

Figure 6.9: Prediction Page of Parkinson Wave Drawing

Figure 6.10: Prediction Page of Healthy Wave drawing

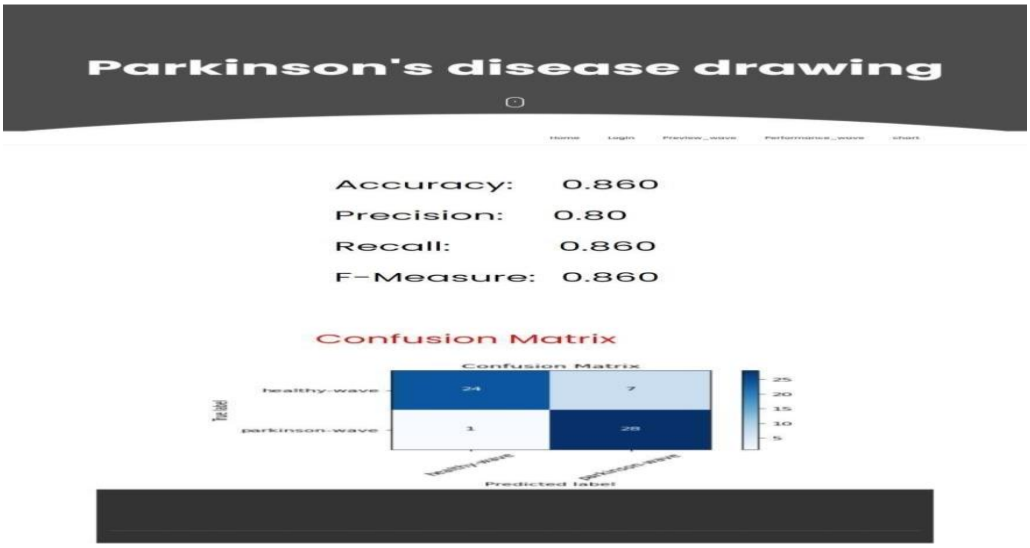

Figure 6.11: Accuracy of Wave Drawing

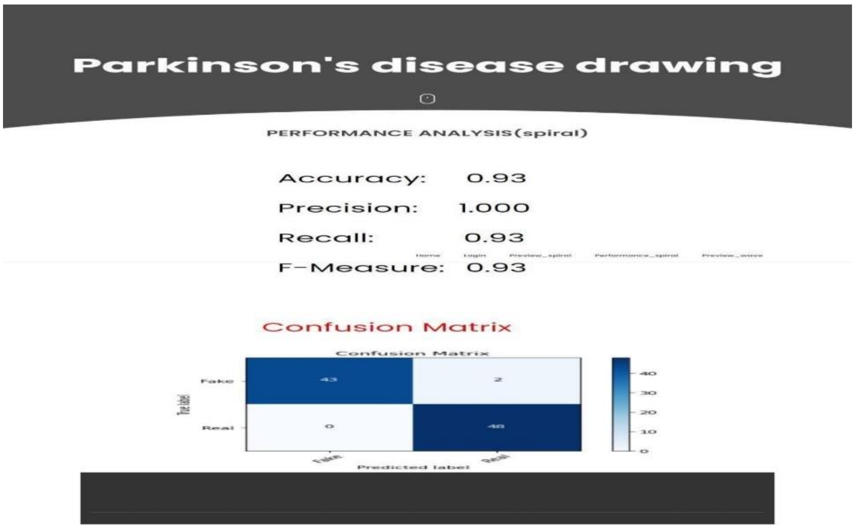

Figure 6.12: Accuracy of Spiral Drawing

FUTURE SCOPE

To enhance the platform further, future developments will include:

- **Incorporating More Data:** While we achieved high accuracy in detecting Parkinson's disease from spiral and wave drawings, incorporating additional datasets could further improve the performance of the model.
- **Developing a Mobile Application:** Developing a mobile application that integrates the proposed system could enable patients to easily and quickly perform the drawing tests from home, making it easier to detect and monitor Parkinson's Disease.
- **Multi-Modal Diagnosis:** Combining multiple diagnostic techniques, such as speech and gait analysis, with the proposed system could provide a more comprehensive and accurate diagnosis of Parkinson's Disease.
- **Clinical Validation:** Validating the performance of the proposed system in a clinical setting could help demonstrate the clinical utility of the system and its potential for widespread use in healthcare.
- **Real-Time Monitoring:** Developing a real-time monitoring system that integrates the proposed system could enable healthcare professionals to monitor patients in real- time, providing timely intervention and improving patient outcomes.

CONCLUSION

In conclusion, the proposed system for Parkinson's disease Detection using Xception architecture has shown promising results. By leveraging state-of-the-art deep learning techniques, specifically the Xception architecture, we were able to achieve high accuracy in detecting Parkinson's disease from spiral and wave drawings. The proposed system has several advantages, including improved accuracy, robustness to noise and artifacts, faster training, interpretability and transparency, and better patient outcomes. These advantages make the proposed system a promising approach for Parkinson's disease diagnosis and treatment.

Furthermore, the Xception architecture has several advantages, including improved efficiency, better generalization, reduced overfitting, state-of-the-art performance, and adaptability, which make it a reliable and effective architecture for image classification tasks. Overall, this project has demonstrated the potential for using deep learning and Xception architecture in the early detection of Parkinson's disease, which could lead to better patient outcomes and quality of life. Further research and development in this area could have significant implications for the diagnosis and treatment of Parkinson's disease.

REFERENCE

1. Niya Romy Markose, Priscilla Dinkar Moyya, Mythili Asaithambi, “Analysis of tremors in Parkinson’s Disease using accelerometer,” IEEE,4th July 2021.
2. Oliver Y.chen, Florian lipsmeier, Huy Phan, and John prince, “Building a Machine learning Framework to Remotely Assess Parkinson’s Disease Using Smartphones,” IEEE, May 16th, 2020.
3. Mohamed Shaban, “Deep Convolutional Neural Network for Parkinson’s Disease Based Handwriting Screening,” IEEE, Sep 12th, 2020.
4. Shrinidhi Kulkarni, Neenu George Kalayil, Jinu James, Sneha Parsewar and Revati Shriram, “Detection of Parkinson‟s Disease through Smell Signatures,” IEEE, Sep 10th, 2020.
5. Yuxin Lin, Bingo Wing-Kuen Ling, Nuo Xu, Ringo Lam, and Charlotte Ho,“Effectiveness Analysis of Bio-electronic Stimulation Therapy to Parkinson’s Disease via Discrete Fourier Transform Approach,” IEEE, May 17th, 2021.
6. Yuqi Qiu, “Efficient Pre-diagnosis Approach for Parkinson’s Disease with Machine Learning,” IEEE, Nov 2nd, 2020.
7. Surendrabikram Thapa, Surabhi Adhikari, Awishkar Ghimire, and Anshuman Aditya, “Feature Selection Based Twin-Support Vector Machine for the Diagnosis of Parkinson’s Disease,” IEEE, June 20th, 2021.
8. Dr. Pooja Raundale, Chetan Thosar, Shardul Rane, “Prediction of Parkinson’s disease and severity of the disease using Machine Learning and Deep Learning algorithm,” IEEE, Aug 12th,2021