ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 3, November 2022

Parkinson Disease Detection from Spiral and Wave Drawings using Machine Learning Algorithm

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Abstract: *Research in biometrics has grown substantially in recent years with an increasing number of applications. One of the most important applications is healthcare. Identification of the appropriate biomarkers with respect to particular fitness problems and detection of the same is of paramount significance for the improvement of medical decision assistance systems. For the sufferers laid low with Parkinson's Disease (PD), it's been duly found that impairment in the handwriting is directly proportional to the severity of the sickness. Also, the velocity and pressure implemented to the pen while sketching or writing something also are much lower in sufferers affected by Parkinson's disorder. Therefore, successfully figuring out such biomarkers accurately and precisely at the onset of the disorder will result in a better medical diagnosis. Therefore, a system is designed for studying Spiral drawing patterns and wave drawing patterns in sufferers affected by Parkinson's disease. With the help of various Machine Learning Algorithms, we will be able to analyse the spiral pattern and wave pattern and check whether the person is suffering from Parkinson's Disease or not.*

Keywords: Parkinson's Disease, Patterns, Spiral and Wave, Machine Learning

I. INTRODUCTION

Parkinson's Disease is a disease that causes the muscles to become weak, the arms and legs to shake and that gets worse over a period of time. Parkinson's disease is a neurodegenerative disease with a prevalence rate of 1% in the population above 60 years old. The global population affected by Parkinson's Disease has almost doubled from 1990 to 2016 (from 2.5 million to 5.1 million). Parkinson's Disease affects Quality of life (QoL) severely. Traditional tests are not much effective in diagnosis of Parkinson's disease. Machine learning techniques and algorithms are being increasingly used in the healthcare sector. For the diagnosis of Parkinson's Disease, machine learning models have been applied to a large number of data modalities, including handwritten patterns.

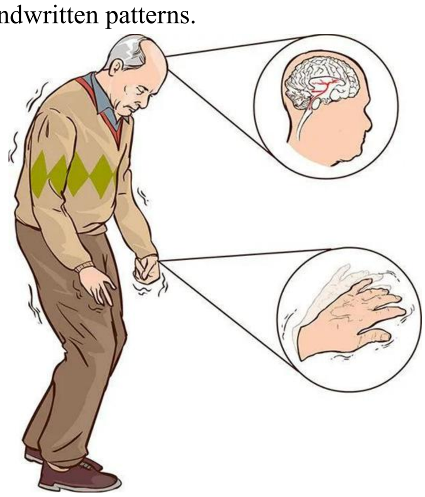

Figure 1: Parkinson's Disease Symptom

DOI: 10.48175/IJARSCT-7631

As a result of medical interest and medical indicators, along with the description of motor signs and symptoms, Parkinson's disease (PD) is generally diagnosed. Due to the fact that they depend upon the assessment of motions that are regularly subtle to human sight and hence hard to identify, conventional diagnostic techniques can be vulnerable to subjectivity and misclassification. As a result, those symptoms are typically ignored, making the early analysis of Parkinson's disease hard to achieve. Machine Learning tactics were used for the categorization of PD and healthy controls or patients with similar medical presentations so as to overcome those problems and enhance the diagnostic and evaluation processes of PD.

II. LITERATURE REVIEW

In the paper [1], published by Anastasia Moskova, Andrey Samorodov, Natalia Voinova, Alexander Volkov, Ekaterina Ivanova, Ekaterina Fedotova, they created a system in which they detected Parkinson Disease by capturing hand movements of the patients by using Leap Motion Sensor. They applied KNN, SVM, Random Forest, Decision Tree on the data obtained and got an overall accuracy of 95.3%.

In the paper [2], published by Shrihari K Kulkarni, K R Sumana, they used machine learning algorithms such as XGBoost, CNN, ANN, Logistic Regression, Random Forest, SVM, Boosted Trees, RNN on the data to detect Parkinson disease. They got an overall accuracy of 94.5%.

In the research paper [3], published by Jaichandran R, Leelavathy S, Usha Kiruthika S, Goutham Krishna, Mevin John Mathew, Jomon Baiju in European Journal of Molecular and Clinical medicine, they used K Mean Clustering and Decision Tree algorithms to detect the Parkinson Disease and obtained an overall accuracy of 85%.

In the paper [4], published by Sabyasachi Chakraborty, Satyabrata Aich, Jong-Seong-Sim, Eunyoung Han, Jinse Park, Hee-Cheol Kim in ICACT Journal, they analysed the spiral and wave drawings of healthy and Parkinson affected patients and applied Logistic Regression, Random Forest Classifier, CNN algorithm on it. From this they got an overall accuracy of 93.3%.

In the paper [5], published by Ferdib-Al-Islam and Laboni Akter in IEEE Journal, they used hand drawn images of healthy and affected people and applied various machine learning algorithm such as Decision Tree, Gradient Boosting, KNN, Random Forest, HOG feature descriptor, Logistic Regression an obtained an overall accuracy of 89.33%.

In the paper [6], published by Md. Sakibur Rahman Sajal, Md. Tanvir Ehsan, Ravi Vaidyanathan, Shouyan Wang, Tipu Aziz, Khondaker Abdullah Al Mamun in the Brain Informatics Journal, they worked on the Tremor and voice analysis of Parkinson affected people and applied KNN, SVM, Naïve Bayes, MRMR Feature Selection algorithms on it. They got an overall accuracy of 99.8%.

In the paper [7], published by Priyadharshini, Gowtham, Harshavardhan Bhoopathi, Reshma, Tamilarasi, Nandhini in the ETJRI Journal, they analyzed the voiced of parkinson affected patients and applied XGBoost algorithm on it. With that they got an accuracy of 92.76%.

In the paper [8], published by Basil K Varghese, Geraldine Bessie Amali D, Uma Devi K S in the Research Journal of Pharmacy and Technology, they applied machine learning techniques such as SVR, Decision Tree Regression, Linear Regression, SVM on the speech dataset. They obtained an overall accuracy of 92.9%.

In the paper [9], published by Timothy Wroge, Yasin Ozkanca, Cenk Demiroglu, Dong Si, David Atkins, Reza Hosseini Ghomi in the IEEE Journal they worked on the voice dataset of healthy and parkinson affected peoples. They used CNN, SVM, Decision Trees, Random Forest, Artificial Neural Network to detect parkinson disease. From this they got an overall accuracy of 86%.

III. METHODOLOGY

3.1 Data Collection

The data was taken from a Kaggle repository which was originally published in the paper [10] by: Zham P, Kumar DK, Dabnichki P, Poosapadi Arjunan S and Raghav S (2017). This data collection process was performed at RMIT University Human Research Ethics Committee. All participants were informed about the experiment and gave oral and written informed consent prior to the start of the experiment.

All subjects were given two tests i.e Spiral test and Wave Test. These tests were conducted on A3 sized paper and an ink pen was used for drawing. Below is the figure of collected data sample.

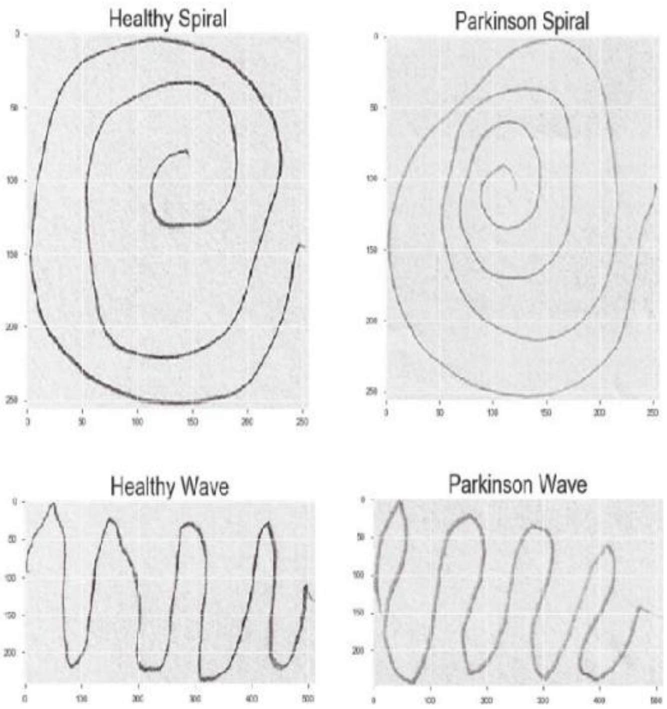

Figure 2: Spiral test and Wave Test

3.2 Data Augmentation

Data augmentation is a method used in Deep learning to artificially increase the amount of data by increasing the data points. These augmented images are derived from original images with some geometric changes such as Flipping, Rotation, etc. of images.

The accuracy of deep learning models is highly dependent on the quality, quantity, and contextual importance of training data. However, lack of data is one of the most common challenges when building deep learning models. In operational use cases, collecting such data can be costly and time consuming.

Hence, we are using data augmentation for Improving our quantity of data and Quality of our CNN Model.

3.3 Model Creation

We are going to use CNN (Convolutional Neural Network) for training of our model. It is a deep learning neural network used for processing various types of data. CNN are very useful in picking up various designs such as lines and gradients from input images.

In Parkinson's patients there are various biomarkers from which we can detect the disease. One of such biomarkers is the Spiral/ Wave Drawing. A Parkinson's patient cannot draw a smooth or proper spiral/wave diagram. Our model will be trained by both healthy and Parkinson drawings. For this there are a total of 72 Spiral/Wave Drawings for training and 30 Spiral/Wave Drawings for testing. These number of drawings will be increased in data augmentation. The model can run directly on an underdone image and do not need any pre-processing.

The model will consist of n numbers of neural layers for prediction of the result.

IV. UML

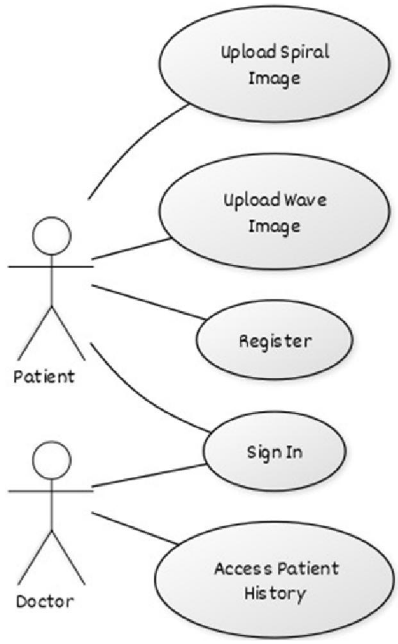

Figure 3: Use Case Diagram

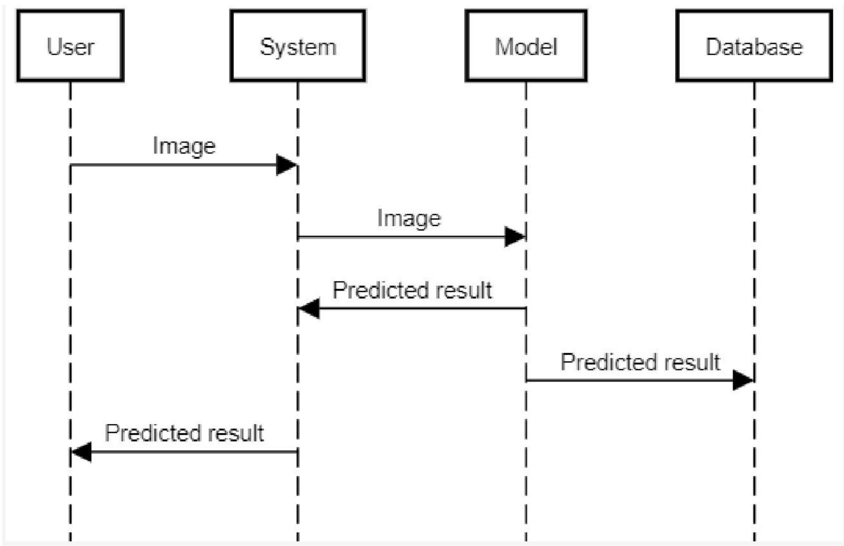

Figure 4: Sequence Diagram

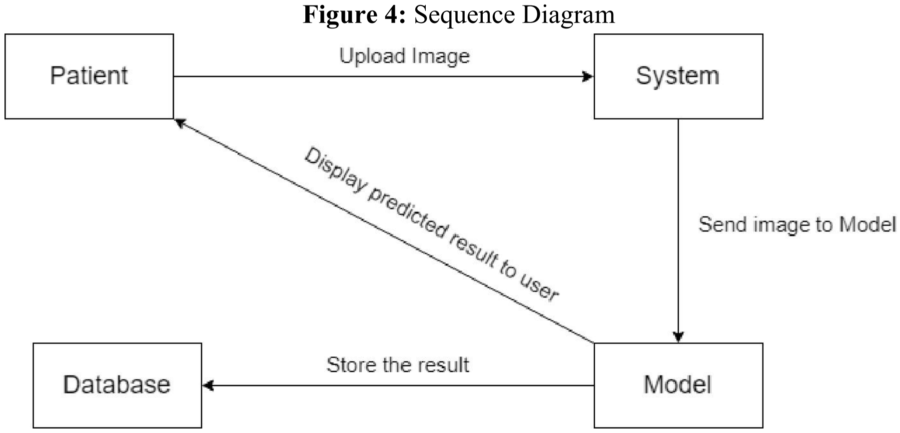

Figure 5: Collaboration Diagram (Parkinson Detection)

IJARSCT
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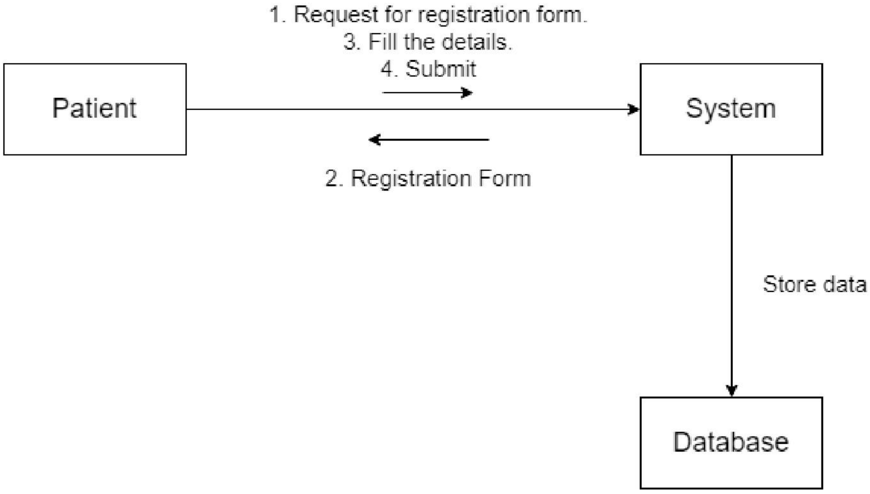

Figure 6: Collaboration Diagram (New Registration)

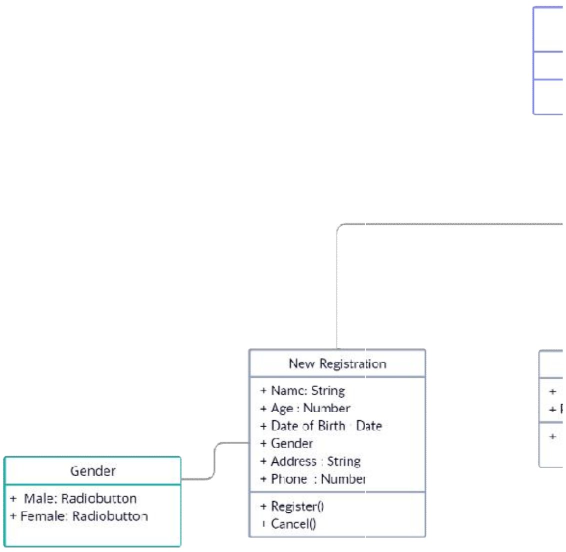

Figure 7: Class Diagram

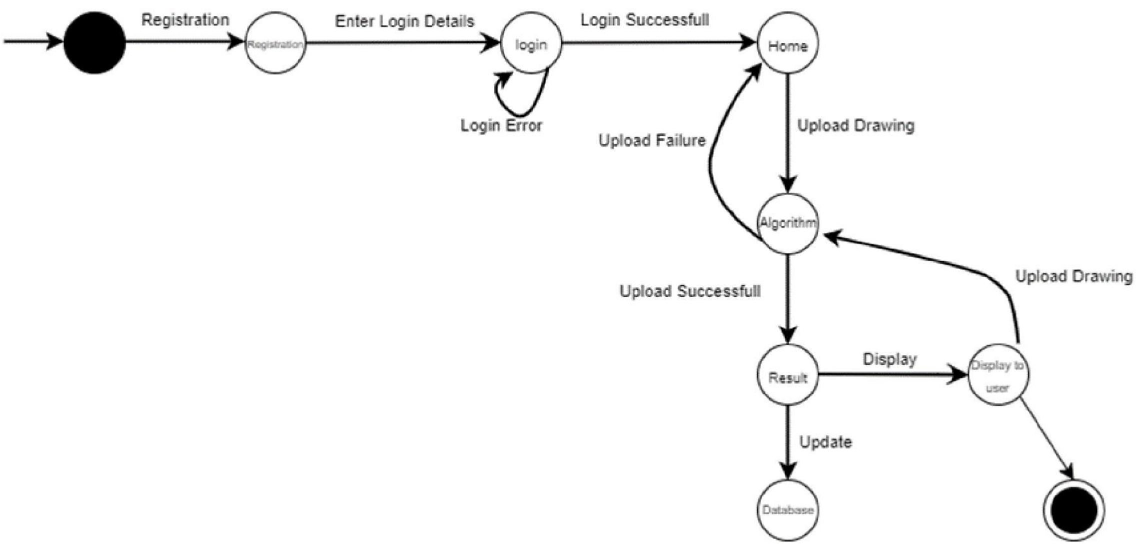

Figure 8: State Diagram- Habit Tracker

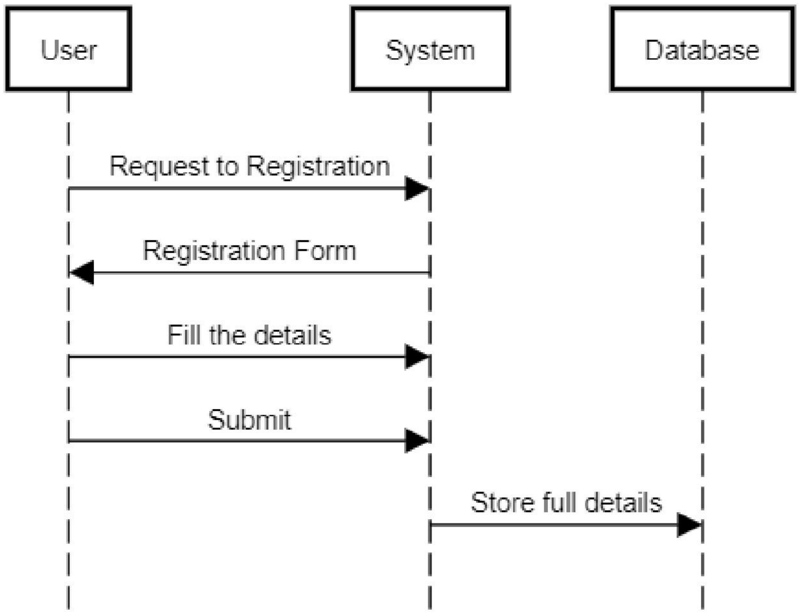

Figure 9: Registration Diagram

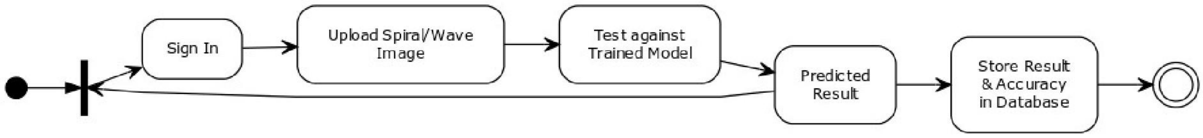

Figure 10: Activity Diagram (New Registration)

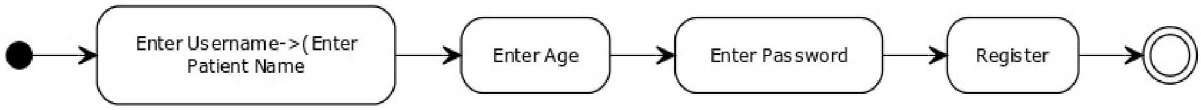

Figure 11: Activity Diagram (Check Parkinson Disease)

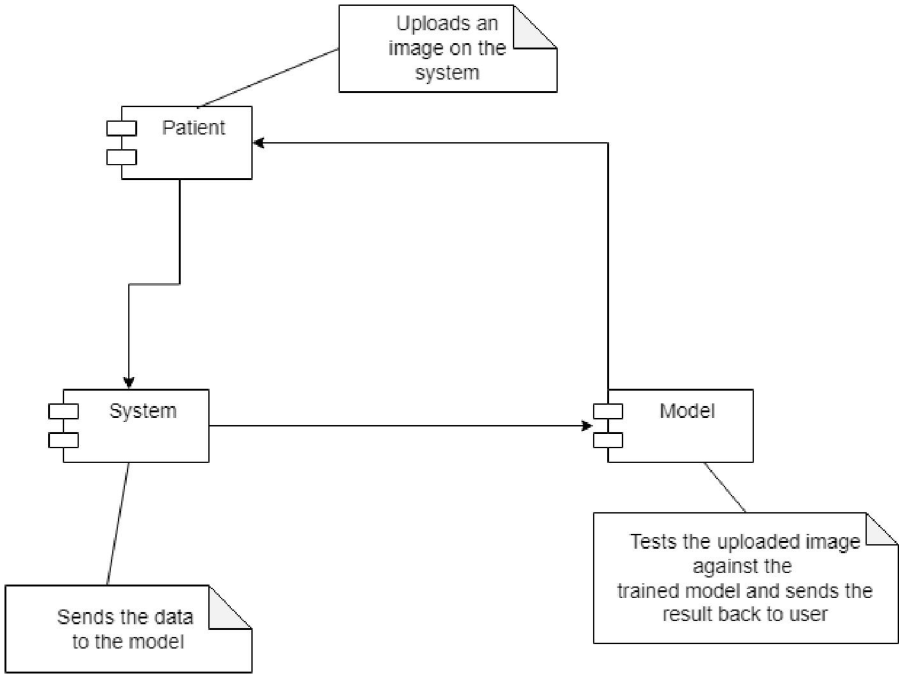

Figure 12: Component Diagram

V. ACKNOWLEDGMENT

I thank our guide Prof. Nitin R. Talhar and HOD Dr. S. V. Athawale for their expertise and assistance throughout all aspects of our study and for their help in writing the manuscript.

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