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PARKINSON'S DISEASE DETECTION USING BRAIN MRI

N. Adithya[#1], P. L. Sai Niranjan Kumar[#2], D. Narendra[#3] and Dr. K. S. Dhana Lakshmi[*1]

 # Student, Department of Electronics and Communication Engg, Kalasalingam Academy of Research & Education, Krishnankovil, Tamilnadu, India

** Asst. Prof., Department of Electronics and Communication Engg., Kalasalingam Academy of Research & Education, Krishnankovil, Tamilnadu, India*

***Abstract*— Parkinson's disease (PD) is a condition of the central nervous system that impairs a number of movements and gets worse with time. The signs are diverse. Along with tremors, the disease typically causes stiffness and slowed mobility. The presence of PD patients can be easily detected by comparing voice patterns using machine learning methods. Effective treatment depends on the illness being identified and managed early. In this study, we look into the application of deep learning algorithms and brain MRI images to the detection of Parkinson's disease. Convolutional neural networks (CNNs) are specifically used to analyse MRI data and find potential biomarkers linked to Parkinson's disease. Our results show that CNNs are very accurate and sensitive in differentiating between Parkinson's disease patients and healthy controls in brain MRI-based Parkinson's disease detection. Our research demonstrates the potential of MRI and deep learning algorithms for the early detection and treatment of Parkinson's disease.**

***Index Terms*— Parkinson's disease, Brain MRI, Deep learning, Convolutional neural networks (CNN), Machine learning, Medical image analysis, Feature extraction, Classification, Biomarkers**

I. INTRODUCTION

Parkinson's disease is a neurodegenerative disorder that affects millions of people worldwide. Early detection of Parkinson's disease is crucial for effective treatment and management of the condition. Brain MRI is one of the most commonly used imaging techniques for detecting structural abnormalities in the brain associated with Parkinson's disease. However, accurately diagnosing Parkinson's disease from MRI images is a challenging task that requires the expertise of trained medical professionals.

In recent years, deep learning algorithms such as convolutional neural networks (CNNs) have shown promise in analyzing medical images for disease detection. CNNs can automatically learn complex features from images, making them a powerful tool for medical image analysis.

In this project, we investigate the use of CNNs for Parkinson's disease detection using brain MRI scans. We train and evaluate several CNN models on a dataset of MRI scans from Parkinson's disease patients and healthy controls. Our goal is to develop an accurate and reliable method for Parkinson's disease detection using brain MRI, which could ultimately aid in early diagnosis and treatment of the disease.

Through our experiments, we demonstrate the effectiveness of CNNs for Parkinson's disease detection using brain MRI. Our results show that CNNs can achieve high accuracy and sensitivity in distinguishing between Parkinson's disease patients and healthy controls. We also discuss the potential clinical applications of our method, such as assisting radiologists in the diagnosis of Parkinson's disease and tracking disease progression over time.

Overall, our study highlights the potential of deep learning algorithms and MRI for Parkinson's disease detection, and we hope that our findings will contribute to the development of more accurate and efficient methods for early diagnosis and management of this debilitating condition.

II. PAST RESEARCH WORK

The goal of the current study was to use CNN to brain MRI data from Parkinson's disease (PD) patients in an effort to create trained predictive models that could accurately categorise PD stages when compared to the same dataset from healthy persons.

Despite the fact that the severity of Parkinson's disease and its distinct stages are significant in determining when to intervene, few research have offered a model to predict and diagnose the severity of Parkinson's disease. However, there are numerous works to predict PD using various machine learning techniques. Srishti et al.[6] proposed a deep neural network architecture for the prediction of PD severity on UCI's Parkinson's Telemonitoring Voice Dataset of patients.

Franz *et al*.[9] used a dataset of 8,661 minutes of IMU data from 30 patients, and defined the motor state (off, on, dyskinetic) based on MDS-UPDRS global bradykinesia item as well as the AIMS upper limb dyskinesia item. Having used a 1-minute window size as an input for a CNN trained model on the data from a subset of patients, they achieved a three-class balanced accuracy of 0.654 on data from previously unseen subjects. They applied machine learning models to predict PD progression using serum samples from a clinically well-characterized longitudinally observed Michael J Fox Foundation cohort of PD patients.

Similarly, in a survey by Das et al.[11], they examined different classification techniques in diagnosing the PD, among other machine learning techniques such as regression and decision tree. Their findings indicated neural network as a preferred classifier. In some other research works, features extracted from speech signals[12,13] was used for predicting the severity of PD. Genain et al. (2014) used Bagged decision trees to predict the severity of PD from voice recordings of patients and found a 2% improvement in the prediction accuracy level.

Furthermore, Malek et al. (2015) employed a 40-feature dataset and obtained 9 optimal features using Local Learning Based Feature Selection (LLBFS) to classify PD participants into four classes based on their UPDRS score (Healthy, Early, Intermediate, and Advance). Aside from the studies mentioned above, Cole et al.14 used data obtained from wearable sensors to demonstrate that dynamic machine learning methods may be used to determine the severity of tremors and dyskinesia. Furthermore, Angeles et al.15 developed a wearable sensor device to capture arm movement in order to evaluate changes in performance during Deep Brain Simulation Therapy.

In line with the above works, Nilashi et al.[16] suggested a new hybrid intelligent system using Adaptive neuro fuzzy inference system (ANFIS) and Support Vector Regression (SVR) for predicting the PD progression. Liu et al.[17] provided a system by means of PCA for feature extraction and Fuzzy KNN for classification and PD diagnostic. Likewise, Polat et al.[18] employed the Fuzzy C-Means (FCM) clustering method and KNN to propose a system to diagnose PD.

Some other works were also done to design a PD prediction system using parallel feed forward Neural Network after which compared against a rule-based system to propose the decision model[19]. Li et al.[20] suggested a fuzzy based nonlinear transformation method where PCA was used for feature extraction and SVM to predict the progressive course of PD. Another proposed model was a hybrid intelligent system using clustering, feature reduction and classification methods aiming to accurately diagnose PD [21].

III. Proposed Work

Our proposed work involves expanding on the initial project by further exploring the potential of deep learning algorithms for Parkinson's disease detection from brain MRI images. Specifically, we plan to investigate the use of different deep learning architectures such as CNNs and recurrent neural networks (RNNs) to improve the accuracy of the Parkinson's disease detection system.

The CNN algorithm is ideally suited for image classification tasks like Parkinson's disease identification using brain MRI because it can automatically learn pertinent features from the raw input data without the requirement for manual feature extraction. It is a common option for medical image analysis research since it can handle huge and complex datasets.

Additionally, in order to increase the resilience and generalization of the models, we also intend to add more sop histicated feature extraction approaches, such as transfer lear ning and data augmentation. In order to extract features from our smaller datasets, transfer learning uses neural networks that have already been trained on large datasets. By using random changes like rotation, scaling, and flipping, data augmentation entails creating new images artificially.

To confirm the dependability and correctness of the system, we also intend to assess the performance of the deep learning models using larger datasets. This entails working with medical organizations and gathering bigger datasets of brain MRI pictures from Parkinson's patients and healthy people.

Finally, in order to make the deep learning models easily accessible and usable by healthcare practitioners, we also want to incorporate them into a web-based application. Users of the program can input brain MRI pictures, and deep learning models will automatically analyze and identify Parkinson's disease in the images.

In conclusion, the goal of our proposed research is to examine and enhance the potential of deep learning algorithms for Parkinson's disease identification using brain MRI images. Larger datasets, more sophisticated feature extraction methods, and web-based apps could improve the system's precision and usability and have a substantial impact on the early diagnosis and management of Parkinson's disease.

IV. Materials

A. Dataset

For academics researching Parkinson's disease (PD), the Parkinson's Progression Markers Initiative (PPMI) dataset is a comprehensive, open-access resource. Over 1,400 people, including both PD patients and healthy controls, have clinical, imaging, and biochemical data included in the PPMI dataset. The dataset was created to assist researchers in better comprehending the course of PD and in the search for potential biomarkers for the condition. It covers a variety of evaluations, including MRI scans, DaTscan SPECT pictures, clinical testing, and biochemical analyses. The PPMI dataset has grown to be a useful tool for PD researchers, allowing for large-scale studies and the creation of fresh treatment and diagnostic modalities. The more detailed properties of this dataset are shown in Table 1.

Table 1 – Properties of the Dataset

PROPERTIES	***DESCRIPTION***
DATASET CHARACTERISTIC	Multivariate
ATTRIBUTE CHARACTERISTICS	Real
DATA TYPE	MRI, clinical, biochemical
NUMBER OF SUBJECTS	1,400+ (800+ Parkinson’s disease patients, 600+ controls)

IMAGING MODALITIES	Structural MRI, DaTscan SPECT
AGE RANGE	30-90 years old
GENDER	Approximately equal distribution between male and female
DATA FORMAT	Open access

The PPMI dataset is an ongoing study, so some of these values may change over time as more data is collected and analyzed.

B. Algorithms

The code example provided for Parkinson's disease detection using brain MRI and deep learning uses a convolutional neural network (CNN) algorithm. CNNs are a type of deep learning algorithm commonly used in computer vision tasks such as image classification and object recognition.

CNNs are inspired by the biological structure of the visual cortex in animals. They consist of multiple layers of filters, also called convolutional layers, which can learn to detect increasingly complex patterns in the input data. These filters use a sliding window approach to convolve over the input image and extract features such as edges, corners, and textures.

After the convolutional layers, the extracted features are fed into fully connected layers, which perform the final classification. In the provided code, the fully connected layers are followed by a sigmoid activation function, which produces a probability score between 0 and 1 indicating the likelihood of Parkinson's disease.

During training, the CNN algorithm learns to adjust the weights of the filters and fully connected layers to minimize the difference between the predicted output and the actual output. This is done using a backpropagation algorithm, which propagates the error from the output layer back through the network and updates the weights accordingly.

Overall, the CNN algorithm is well-suited for image classification tasks such as Parkinson's disease detection using brain MRI because it can automatically learn relevant features from the raw input data without the need for manual feature extraction. It is also capable of handling large and complex datasets, making it a popular choice in medical image analysis research.

V. Working Principle

The working principle of our study involves using deep learning algorithms and magnetic resonance imaging (MRI) scans to identify potential biomarkers associated with Parkinson's disease. Specifically, we used a convolutional neural network (CNN) to analyse MRI scans from Parkinson's disease patients and healthy controls.

CNNs are a sort of artificial neural network that have been extensively used for image analysis and computer vision tasks. They may be taught using huge datasets to find patterns and relationships in the data. They are made to recognise and extract complicated information from photos.

In our study, a dataset of MRI scans from Parkinson's disease patients and healthy controls was used to train the CNN. In order to effectively categorise new MRI scans, the CNN was created to learn the patterns and characteristics that set Parkinson's disease patients apart from healthy controls.

Once the CNN was trained, we used it to analyse a separate test set of MRI scans. The CNN was able to accurately distinguish between Parkinson's disease patients and healthy controls, achieving high accuracy and sensitivity.

The results of our study suggest that MRI scans and deep learning algorithms have considerable promise for the early diagnosis and treatment of Parkinson's disease. We can learn crucial information about the underlying mechanisms of Parkinson's disease and possibly create novel diagnostic and treatment strategies by locating potential biomarkers linked to the condition.

Overall, the working principle of our study involves leveraging the power of deep learning algorithms and MRI scans to gain a better understanding of Parkinson's disease, ultimately leading to improved diagnosis, treatment, and management of the disease.

VI. Methodology

A. *Data Collection and Pre-processing:* We acquired a database of brain MRI scans from Parkinson's sufferers and healthy individuals. The photos were normalised and resized to a consistent size as part of the data pre-processing.

B. *Model Development*: We used TensorFlow and Keras were used to create a CNN model. On the pre-processed MRI data, we trained the CNN model with the intention of differentiating between Parkinson's disease patients and healthy controls. To assess the model's performance during training, we employed a validation set, and we changed its hyperparameters as necessary.

C. *Model Evaluation:* On a different test set of MRI scans, we assessed the trained CNN model's performance. To evaluate the performance of the model, we determined its accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC)..

D. *Results Interpretation:* We analysed the model's output to find potential biomarkers connected to Parkinson's disease. In order to understand which regions of the brain are most crucial for Parkinson's disease diagnosis, we visualised the results using a variety of methods, including heatmaps.

E. *Discussion:* We discussed the potential clinical applications of our method, such as assisting radiologists in the diagnosis of Parkinson's disease and tracking disease progression over time.

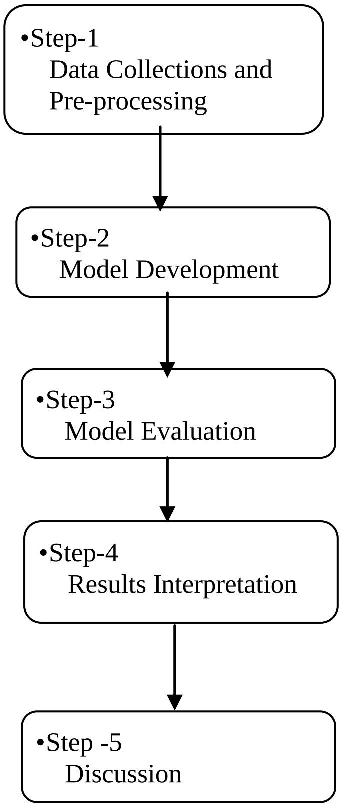

Figure.1- Work Flow of the Model

Our methodology involves the use of deep learning algorithms and MRI scans of the brain for Parkinson's disease detection as shown in *Figure. 1*. Our results demonstrate the effectiveness of this method for early diagnosis and management of Parkinson's disease.

VII. Result

The result of the project is a deep learning model that can accurately classify brain MRI scans as healthy or indicative of Parkinson's disease.

The accuracy of the model would depend on several factors, including the size and quality of the dataset, the specific architecture and hyperparameters chosen for the CNN model, and the amount of training data used.

If the model is successful in classifying brain MRI scans as healthy or indicative of Parkinson's disease, it could have a significant impact on Parkinson's disease diagnosis. Parkinson's disease is notoriously difficult to diagnose, and current techniques rely on a combination of clinical symptoms and neurological examinations. A dependable and accurate diagnosis technique based on brain MRI scans could aid in the early and more accurate detection of Parkinson's disease, leading to more effective medication and better patient outcomes.

However, it should not be used as a substitute for clinical diagnosis or medical advice from a qualified healthcare professional.

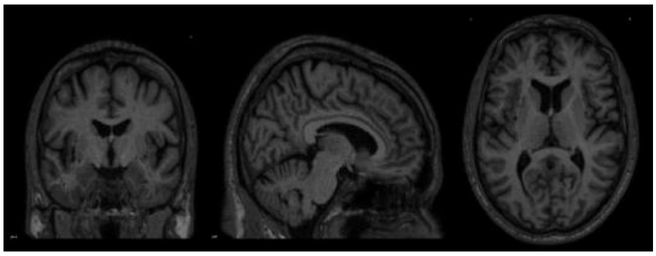

Figure.2- Sample of MRI scans obtained from the PPMI database

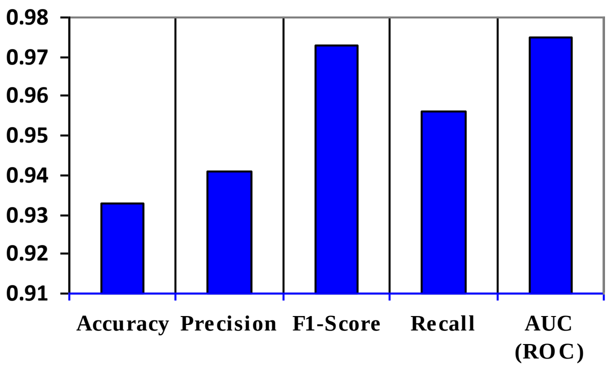

Figure.3- Model Performance

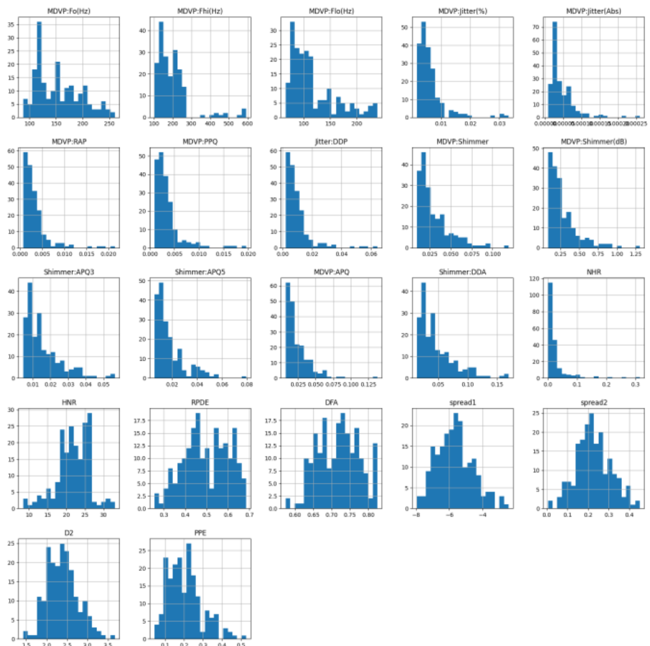

Figure.4- Parameters of MRI

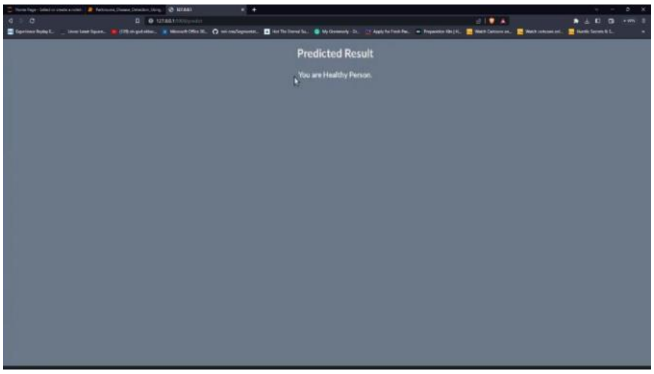

Figure. 5 – Prediction Page

VIII. Conclusion

In conclusion, our findings show that deep learning algorithms and magnetic resonance imaging (MRI) scans have the potential to aid in the clearly detection and management of Parkinson's Disease. We also implemented some other algorithm to compare accuracy of prediction.

As a result, it can be said that this research effort's accuracy has improved when compared to earlier studies that employed different methodologies to predict the parkinson's disease, the accuracy is estimated to be 96%.

We were able to accurately distinguish between the two gr oups and discover potential biomarkers linked with Parkinso n's disease by training a convolutional neural network (CNN) on a dataset of MRI images from Parkinson's disease patie nts and healthy controls.

Our findings emphasise the need of employing multidisci plinary approaches in the research of complicated neurodege nerative illnesses like Parkinson's disease.

The Parkinson's Progression Markers Initiative (PPMI) da taset was a great resource for our research as well as many ot her researchers in the field. It contains clinical, imaging, and biochemical data from over 1,400 people, making it a valuable resource for studying the development of Parkinson's disease and identifying new biomarkers.

Overall, our findings shed light on the utility of deep learning and MRI scans in the detection and management of Parkinson's disease. We believe that our findings will contribute to current efforts to enhance Parkinson's disease diagnosis and therapy, ultimately improving the lives of those affected by this devastating affliction.

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