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Parkinson Disease Prediction Using Deep Learning Algorithm

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***Abstract*—Parkinson's is a neurological disorder that worsens over time. People have trouble communicating, writing, walking, or doing other basic activities once dopamine-producing neurons in specific regions of the brain are damaged or die. Over time, these symptoms worsen the seriousness of the patients' situation. Using Parkinson's Visual Large Dataset from UCI patient populations, which would be dependent on healthy as well as unhealthy of spiral and wave data, we present a technique in this study for determining the prevalence of Parkinson's disease. We have designed a neural network to detect the disorder and predict the severity of the condition. Here, we identify Parkinson's disease using two deep learning models: the convolution neural network and the Alex net. Additionally, this project seeks to investigate how to recognize the Parkinson patient using image data such as healthy and unhealthy spiral and wave data since various databases may record various aspects of this disease. Here, we employ a five-step process that includes data gathering, pre-processing, model application, classification, and estimation based on user-selected input data. Results of the experiments demonstrated the system's improved efficiency. Finally, we compare the classification report and model accuracy score to demonstrate which algorithm is optimal for the system's prediction.**

Keywords—Artificial Intelligence, Deep Learning, Convolution Neural Network, Alex net Algorithm, Parkinson Disease Prediction, Medical Diagnosis, Image Processing, Computer Vision, Python Programming Language, Juypter Notebook Tool.

I. Introduction

According to a recent World Health Organization study, Parkinson's disease patients are becoming more numerous and have a greater health burden. This illness is spreading so quickly in China that it may affect half the population within the next ten years, according to estimates. In the medical industry, classification algorithms are primarily used to divide data into various groups based on a variety of

Characteristics. Anxiety, breathing issues, depression, lack of smell, and speech changes are some of the non-motor signs. If the individual exhibits any of the aforementioned symptoms, the information is recorded. Disease prediction is an important step in early disease diagnosis in the contemporary, overpopulated world. The prediction has gotten much easier thanks to the development of different deep learning algorithms. A precision of the algorithm is, however, significantly impacted by the complexity and choice of the best deep learning method for the provided dataset. [1] The alteration in voice and speaking is one of the traits of PD. The United Parkinson's Disease Symptom Rating System (UPDRS), which measures the frequency and severity of symptoms, is used to monitor the development of PD symptoms. The UPDRS is regarded as the most popular clinical rating system and a reliable test for evaluating Parkinson's patients. [2]

Our body is primarily controlled by the brain. As a result, any harm to this delicate area of a human body will have a negative impact but in the other organs. The condition Parkinson's disease is one of these adverse consequences. Disease (PD) is a long-term, progressive neurodegenerative condition that starts with damage to a specific part of the brain. Particularly in the early phases of these diseases, essential tremor and normal ageing both share symptoms with Parkinson's disease (PD). To ensure that the patient receives the proper care, it is crucial to distinguish among PD and other illnesses. Another of the disorders that develops when cells in the substantial area of the brain stop functioning correctly or are damaged is PD. According to the reports, this condition is generally referred to as a persistent, progressive neurodegenerative illness. People all over the globe suffer from PD, particularly in nations where the median age of the populace is high. Approximately 10 million people globally, including 1 million Americans, have PD, according to the Parkinson's Disease Foundation (2015) [3].

A recent development in the area of neural networks is deep learning. It is a subset of machine learning that works with unstructured (hierarchical) data types like text, voice, and images. A deep system is the human neural system as well. A subset of machine learning called "Deep Learning" works with algorithms that are modeled after the structure and operation of the human mind. With the system's unorganized data, deep learning is mostly used. A machine learning method is deep learning. It trains a computer how to classify and predict information by layering filters over inputs. The way the human mind filters information is the source of motivation for deep learning. Its goal is to imitate how well the human brain functions to perform some true wizardry. There are approximately one hundred billion synapses in the human brain. About 100,000 of each neuron's partners are connected to it[4]. That is how a deep learning system works! You incorporate your feedback into one layer after gathering input from observation. The output of that layer serves as the stimulus for the subsequent layer, and so forth. This keeps happening until you get your ultimate output signal. A transmission or signals are received by the neuron (node) and travel through the neuron. The output signal is sent out by that cell.[5].

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I. Main Contribution Of Our Project

Our project's primary contribution is the use of deep learning algorithms, CNN, and Alex net, to estimate the patient condition in both normal and Parkinson's disease using two sets of images: the spiral and wave dataset. Follow the steps in our instructions to propose our system model.

- Dataset collection is the first stage; here, we gather data in image format for Parkinson categories depending on normal as well as abnormal.
- The data pre-processing phase is the second step, and image data-generator method is used here.
- The model implementation step comes next. To train and evaluate the model, we use deep learning models like CNN and Alex net.
- The following stage is classification and prediction, which divides the data into normal and abnormal PD patients. The user chooses any form of output image in the prediction section based on the normal and abnormal behavior of PD patients.
- Finally, we calculate performance measures such as accuracy and classification report estimates using the CNN and Alex net algorithms. Which algorithm is the best to predict in terms of the system's accuracy.
- The outcome of this paper showed that our system is composed of five chapters: the introduction, the literature review, the proposed methodology, the results and discussion, and the conclusion.

III. Literature Review

Wingate, J et al., "Unified deep learning method for Parkinson's disease prediction". The research offers a novel method for using medical imaging to diagnose Parkinson's disease that is based on deep learning. The method involves the analysis and application of information gleaned from deep convolution as well as recurrent neural networks trained on medical images like dopamine transporter scans and magnetic resonance images. Interior representations of the learned DNNs make up the extracted knowledge that is applied via learning algorithms and domain adaptation to produce a coherent framework for Parkinson's disease prognosis across various healthcare settings. A sizable experimental study is given to demonstrate how the suggested method can accurately predict Parkinson's disease using various medical image sets taken in actual settings [6].

Boutet, A et al., "Utilizing fully functioning MRI and machine learning to forecast the best deep neural stimulation parameters for Parkinson's illness ". Deep brain stimulation (DBS), which is frequently used to treat Parkinson's disease (PD), delivers notable therapeutic advantages when optimized. However, it takes multiple clinic appointments to evaluate the wide range of stimulation settings (i.e., programming). Here, we investigate the possibility of predicting the most effective stimulation parameters for specific individuals using functional mri (fMRI). In previously unseen datasets of both clinically optimized and stimulation-unaware PD patients, the model forecasts the ideal stimulation settings. We suggest that an empirical biomarker of clinical reaction could be found in the MRI brain activation to DBS treatment in PD patients. These results may pave the way for cognitive imaging-assisted DBS programming after further confirmation with additional research [7].

Wang, W et al., "Transfer learning as well as machine learning for early Parkinson's disease diagnosis ". In order to stop the progression of Parkinson's disease (PD) and give people access to disease-modifying therapy, accurate early detection of PD is unquestionably essential. The premotor period in Parkinson should be closely watched in order to achieve this goal. An innovative deep-learning method is presented to quickly determine whether a person has Parkinson or not based on premotor characteristics. A contrast between the suggested deep learning model with twelve learning algorithms and ensemble learning techniques using only a small sample size of 183 healthy subjects and 401 early PD patients demonstrates the designed model's superior detection performance, which averages the highest accuracy of 96.45%.[8]

Chintalapudi, N et al., "Cascaded Deep Learning Frameworks in Contribution to the Detection of Parkinson’s Disease". The precision of illness predictions has increased since computer vision (ML) algorithms have been used in medical diagnoses. In this research, the accuracy of PD diagnosis was evaluated using recurrent neural networks (RNN), multi-layer perception (MLP), and cascaded long-short-term memory (LSTM), which models of neural networks based on audible speech features of PD patients. A database of speech biomarkers from the participants was used to compare the outcomes among the two 3 models. Experimental findings show that the LSTM model outperforms the competitors with 99% accuracy.[9]

Modi, H et al., " PET imaging data for deep learning-based classification of Parkinson illness ". Previously, the PSD was identified by manually examining its signs. Numerous automatic methods to identify the PSD have been developed by researchers around the world. The majority of previous solutions focused less on the PET diagnostic dataset and more on the conventional MRI but also SPECT databases for PSD recognition. Current PET scan dataset-based solutions require human feature extraction and use machine learning methods like SVM and linear regression. We suggested a VGG16-based convolutional neural net (Neural) system to identify the PSD as a result of these. The collection of PET scan images, which is gathered from the PPMI source, is automatically processed to extract features. Selectivity, accurate, sensitivity, and precision are used to assess the proposed system's performance; these metrics yield results of 97% and 84%, 70%, as well as 96.7%, accordingly.[10]

Sahu, L et al., " Effective Parkinson's disease diagnosis using deep learning methods over medical data ". In this study, the illness is accurately diagnosed by probability estimation using the combination of two neural network tools, RA and ANN. In RA, data preprocessing and likelihood estimation are carried out. The second method currently in use compares a patient's PD status to a neuron's

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predetermined cutoff value. The estimation is done using a collection of data that includes people's pulse rates, iron contents, and speech recognition. The suggested method is contrasted with other methods, such as SVM as well as k-NN classifier. The calculated outcome shows that the suggested algorithm is superior with 93.46% accuracy.[11]

Vyas, T et al., "Parkinson's illness diagnosis using deep learning". We have used MRI (magnetic resonance imaging) brain images for this reason. With these goals in mind, we have introduced two cutting-edge deep learning (DL) methods. MRI scans in the axial plane are used to teach both two-dimensional and three-dimensional convolution neural networks (CNN). A two-dimensional CNN as well as a three-dimensional CNN model were trained and tested on an entire set of 318 MRI images. Using various evaluation metrics, including reliability, damage, matrix of confusion, we have evaluated the performance of the models. As a result, it can be seen that the three-dimensional model is more precise and trustworthy than the two-dimensional model [12].

Roobini, M. S et al., “Machine Learning for the Detection of Parkinson's disease”. This method investigates the categorization of acoustic input characteristic dataset to identify Parkinson's disease (PD). The classifiers we like to utilize in this system are from machine learning. Parkinson's disease patients typically include low-volume noise with such a monotone quality. The audio features data from of the UCI dataset repository, as well as provision training and XGboost classifiers, are typically used in our approach. The Mathews parametric statistics (MCC) of 89% and the height correctness of 96% produced by XGBoost allowed the algorithm to determine the health of the palladium patient remains healthy.[13]

Pramanik, M et al., “Parkinson's disease detection utilizing acoustic features and machine learning”. In order to identify people with Parkinson's disease in its earliest stages, this article addresses proposed Parkinson's disease detection algorithm. Starting out, the suggested method chooses 24 voice attributes based on how relevant they are to the target detector. A streamlined model of something like the gradient boosting system was used as the target detector to carry out the discrimination task. The proposed method has an accuracy of 83.23%, a sensitivity of 78.57%, and a specificity of 87.95% in detecting Parkinson's disease [14].

Sharma, S et al., “Parkinson's disease detection using automated means”. Hence, for the sick person, symptom tracking is expensive and logistically challenging. Here, for the first time, we have developed a system that could quickly and clinically accurately identify PD by conducting speech, tremor, and handwriting tests, and so further forecast the stage of the disease. This model will serve as a building block for telemonitoring frameworks that will transform extensive medical studies into quick PD treatments. In order to create an automated technique to extract the required biomarkers that will aid in the diagnosis and classification of Parkinson's disease into stages, our study will concentrate on identifying the optimum model.[15]

IV. Proposed Methodology

The suggested methodology covered how our system would be implemented. In our proposed approach, we develop a deep learning method to identify Parkinson's disease and predict the disease's severity. The field of study for Parkinson's disease is important because systemic health of patients can be enhanced by early diagnosis. Here, depending on the patient's healthy and unhealthy conditions, we use the five modules to predict the disease. The first module is a dataset gathering founded on spiral as well as wave images of system patients who are healthy and unwell. The data preprocessing stage in the second module uses an image data generator technique. The deep learning algorithm's model implementation is covered in the third section. Here, CNN and Alex net are the two algorithms we use. The classification model, which is the module after that, uses the system's healthy and unhealthy conditions to forecast disease. The system's accuracy score is used to compute the performance metrics. In order to determine which algorithm is optimal to employ in terms of the accurate measure we can estimate for our system, we first evaluate both computational intelligence accuracy scores. Results of the experiments demonstrated the system's improved efficiency. Here, we use a few key components in our suggested approach to build our system. The components include,

- **MODULE 1:** Dataset collection
- **MODULE 2:** Data preprocessing
- **MODULE 3:** Splitting of dataset
- **MODULE 4**: Model implementation
- **MODULE 5:** Classification
- **MODULE 6:** Prediction

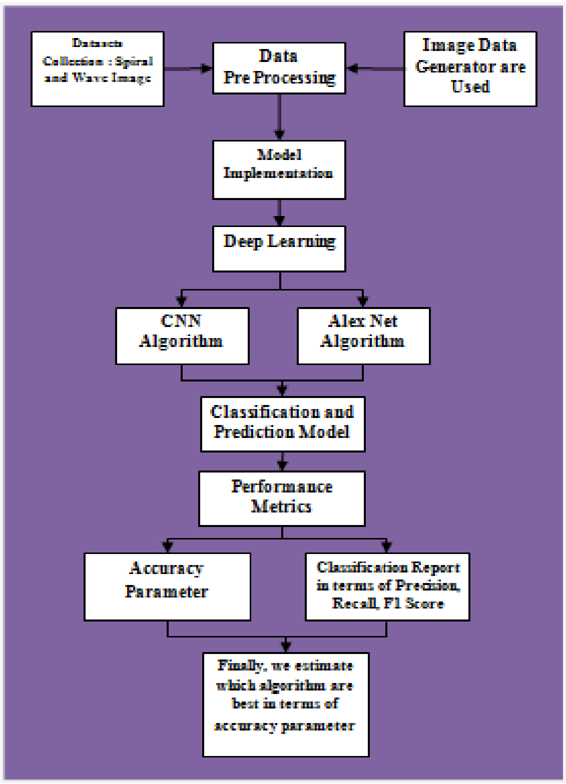

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Fig. 1. Architecture Diagram of our Proposed method

Explanation

Dataset Collection: In order to use analysis of information to discover recurring patterns, data collection enables you to record a record of prior occurrences. You can create forecasting models using deep neural network algorithms that search for trends and forecast future changes based on those patterns. Here, we employ Pictures as a dataset for this assignment. In the context of Category 0 and Category 1, there are two categories of data. A wave collection of healthy as well as unhealthy data is explained for mode 0. The spiral collection of the system's both positive and negative data is explained for Mode 1. The system's Parkinson patient data can be used to create either Model 0 as well as Model 1 databases.

Data preprocessing: Information pre-processing, which entails transforming unorganized data into a more organized structure, may be a part of information mining. Data pre-processing is a technique used in information extraction to transform unusable data into something useful and practical. The method known as the Image Database Generator technique is employed here.In the field of real-time data augmentation, Picture Data Generator is used to create groups that contain data from tensor images. By giving the appropriate settings and the necessary input to the Picture Data Generator resize class, we can use it. To modify the values of pixels from a possible range of 0 to 255 to the range 0-1 recommended for neural network models, use the Image Dataset Generator class. Normalization is the term used to describe scaling data to a 0–1 range.

Splitting of Dataset: When database is separated into multiple categories, this is known as data splitting. A two-part split usually consists of developing the model in one part and assessing or analyzing the data in the other. Data isolation is an essential component of data science, particularly when creating models from data. The simplest method to divide algorithmic knowledge into sets utilized for testing as well as training is to assign a majority of the information elements to the training collection and the remaining 1/3 to the testing set. As a consequence, we train the algorithm on the training set before deploying the model that was learned on the test set. This enables us to evaluate the performance of our algorithm.

Model implementation: Here, we are utilizing deep learning models for this endeavor. In deep learning, the CNN algorithm and the the Alex net algorithm model are used to forecast the occurrence of Parkinson's disease based on the normal and abnormal states of two datasets, such as the spiral as well as wave datasets of acquired images.

CNN: Convolution neural networks are one of the primary types of neural networks used to classify and recognize images. CNN receives a picture as input from the user, which is then categorized and processed in accordance with our users' needs. The pixel density of the picture affects how the computer interprets it as a collection of pixels. It will perceive as height, width, and dimension, depending on the picture resolution. For instance, a grayscale picture is a four * four * a single matrix array, while a picture with RGB values is a six * six * three- matrix array. The CNN method is used in our project to train and learn our datasets, and at the end for prediction the output is displayed based on the user's Parkinson patient.

Alex Net: Alex Net is an eight-layer convolution neural network. The Image Net database contains a pretrained variant of the network that has been learned on over one million images. With its eight layers and deeper design, Alex Net is more capable to derive characteristics from the user's input data. There are eight learnable levels in the Alex net. Relu activation is used in each of the five layers of the model, with the exception of the output layer, which uses maximal pooling followed by three completely connected layers. The alexnet algorithm is primarily used in our project to train and evaluate our data based on system input from users.

Classification: Here, we categorize the information based on two datasets of spiral as well as wave of Parkinson's disease patients using the CNN and Alex net algorithms. The user can input any type of image and based on the system's healthy and unhealthy conditions for Parkinson's disease, the end output will display which type of patient. It can be obtained from both method outputs based on two datasets, such as the system's spiral along with wave of Parkinson's data.

Prediction: The forecast will be made using the Parkinson disease prognosis of a healthy or unwell patient. Finally, the system's classification report and accuracy score are used to compute the success metrics. As a conclusion to our article, we determined which algorithms are best in regard to accuracy score and evaluated them against the system as a whole.

V. Results and Discussion

The results and discussion section can be viewed as the ultimate output graph that displays all of the system's algorithmic results.

Figure 2 depicts the system's Accuracy Graph for the Wave Dataset.

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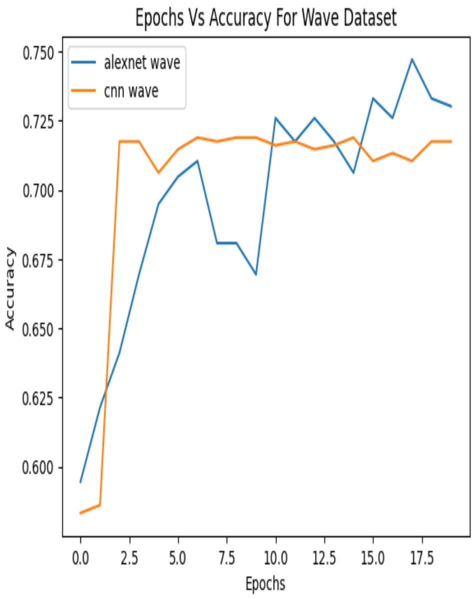

Fig 2 Accuracy Graph of Wave Dataset

Figure 3 depicts the system's Wave Dataset's Loss Graph.

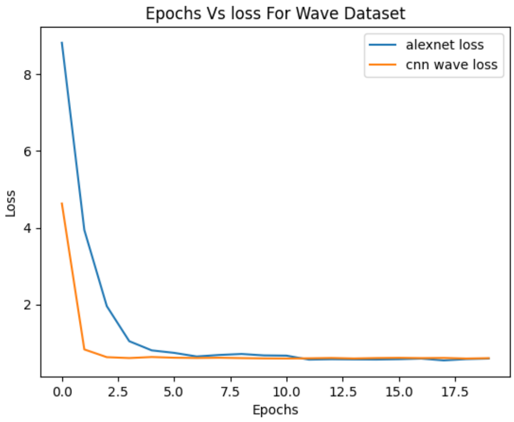

Fig 3 Loss Graph of Spiral Dataset

Figure 4 displays the system's output forecast for the Wave Dataset of Parkinson patient data.

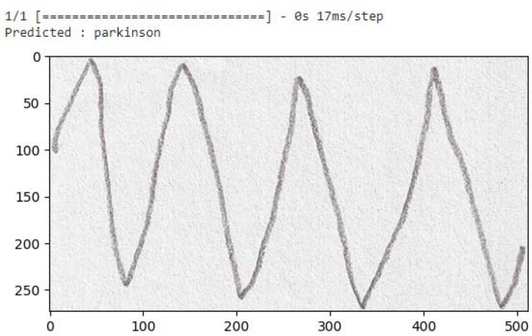

Fig 4 Output Result of Parkinson of Wave

The System Accuracy Curve based on the Spiral Dataset is shown in Figure 5.

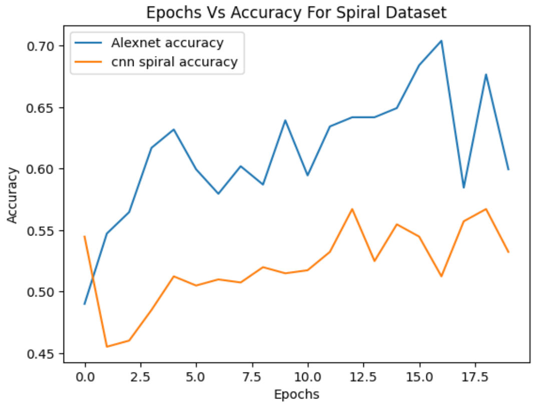

Fig 6 Accuracy Graph of Spiral Dataset

The entire System Spiral Dataset's Loss Diagram is shown in Figure 6.

The output prediction for the Parkinson patient data Spiral Dataset is shown in Figure 7.

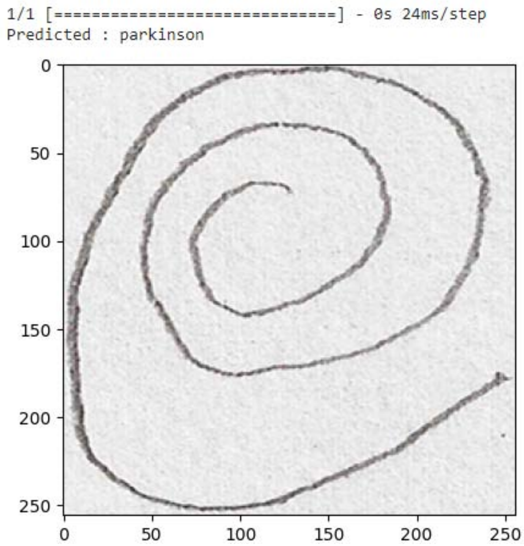

Fig 7. Output result of Spiral Patient

V. Conclusion

In order for predicting the severity of Parkinson's disease, we have employed a network of convolution neural networks in this project. When compared to other methods, the suggested Neural and Alex net models both had higher accuracy. Additionally, the categorization of Parkinson's disease based on two datasets the spiral and wave was discovered. We looked into using deep learning to recognize Parkinson's disease. The simulated workflows were created to examine how well the models trained with deep learning performed on a range of datasets using different deep learning techniques. The processing of some data is the first step in these workflows, which then move on to the classification job and the best results collection. As a result, we came to the conclusion that both algorithm accuracy values were high for the Alexnet algorithm, which demonstrated superior performance and high system performance.

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