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Implementation of Convolution Neural Network deep learning model for Parkinson's Disease detection

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***Abstract* – Most of the disease can be identified without the help of the professional doctors or can be test through the application of artificial intelligence. Parkinson's disease is one of them, as the early symptoms of the Parkinson disease the patient at the beginning of the disease started to lose the preciseness in writing. This means when a patient is asked to draw some shapes like waves or some spiral shapes, then the patient loses the accuracy and ends up with the distracted drawing. By having these early symptoms as the initiative to identify the Parkinson disease, some methodologies are tried their involvement in the research. But an overall study shows this process still needs improvement in the accuracy of the detection of the Parkinson's disease. Hence, to achieve some good accuracy this research article uses the dataset of spiral and sine wave drawing sample of the patients and non-patients. This dataset is used by the Convolution Neural Network deep learning model and then by decision making technique to identify the writing patterns. The obtained patterns are finally analyzed by Root mean Square Error to provide the best output for Parkinson's disease detection.**

Keywords—*Parkinson disease, Convolution Neural Network, Decision making, Deep learning.*

I. INTRODUCTION

Humans have been on this planet for a very short duration when compared to the lifetime of our planet and the emergence of various species and their eras. But human have made their mark on this planet with the various advancements and technological feats that have been very crucial for the development and survival. This has all been possible due to the ingenuity and the perseverance of the human beings. The humans are different from the other animals on this planet. The humans have an extremely capable and powerful organic computing device in their skulls, Brain.

The Brain is the most useful and important organ in the human body and has been largely been the main reason behind the success and technological advancement of the human race. The humans have been effective in achieving a significant improvement in their lifestyle. The various breakthroughs and largescale improvements have been the most effective in realization of a comfortable life with increased convenience. One of the most significant improvements has been devised in the field of medicine. The improvements in the medical sector over the years have been highly fruitful in eradication of the various diseases and other ailments.

The medical sector has also improved in terms of the immense advances in the diagnosis and treatment of a plethora of disorders and diseases. This change is evident in the reduction of the mortality rate and the increase in the life expectancy of the individuals. The increased life expectancy of the individuals have introduced some novel problems in the populous. These problems are due to the increased number of elderly individuals that have age related problems that have not been encountered at such a large scale before. One such problem is the significant increase in the age related neurological degradation such as Alzheimer's and Parkinson's disease prevalence.

The Parkinson's disease is a degradation of the neurological functions in the brain that is usually detected in individuals that are elderly. This degradation is highly difficult to detect as it is a progressive disease. This disease starts off as a benign malady wherein the individual experiences occasional tremors and other signs of motor incontinence. This are the start stages of the Parkinson's disease that also can be signs of other diseases such as dementia, Alzheimer's or other muscle related problems faced by elderly patients.

The detection of Parkinson's disease is highly difficult to detect through traditional techniques. These techniques are very dependent on the paradigm of analyzing the motor function and coordination of the individual. The most common techniques determine the consistent tremors or shaking in the muscles. This is usually defined as a constant persistence of the neurological signal to the muscles that does not stop or secede. These conditions are highly painful for the individual for the patient to bear and

the diagnosis takes an inordinate amount of time. The diagnosis is also not as accurate which can lead to a lot of false positives which is detrimental to the condition of the patient.

Therefore, there is a need for an effective technique for the purpose of enabling an accurate as well as an effective technique for the timely detection of the Parkinson's disease. The implementation of the machine learning techniques can be of immense assistance in this regard and allow the accurate determination of the Parkinson's disease detection in a timely manner. The methodology proposed in this paper implements Black Widow optimization and Decision tree to effectively classify the Parkinson's disease.

The input provided are the handmade spirals by the patient which are preprocessed and optimized using the Black Widow Optimization approach. The Black Widow algorithm has been derived from the mating process of the Black Widow spiders. This is one of the most effective and efficient approaches that considerably optimizes our training process. This is highly suitable for the implementation as it can reduce the load on the system significantly.

This technique is coupled with the utilization of the Decision Tree approach which performs effective classification of the output that is derived from the image processing of the spiral images. The Decision Tree segregates the output and allows only the most accurate analysis to be represented as the result of the Parkinson's disease detection. The Decision Tree implements the If-then rules for the classification task. This achieves an effective and useful implementation of the approach using machine learning techniques to provide highly accurate Parkinson's Disease detection.

Section 2 of this paper is used for reviewing the past work on Parkinson's disease detection models. In section 3 proposed methodologies are explained in detail. The obtained results are evaluated using the section 4 and finally section 5 concludes this paper.

II. LITERATURE REVIEW

Q. Ly explains that Parkinson disease is one of the most problematic occurrences that are highly difficult to detect and effectively diagnose for a patient. There are various techniques that are used which require extensive amounts of time and resources for the purpose of diagnosis and detection [1]. Therefore to provide a solution to this problem the authors propose the use of freezing of gait for the purpose Of Parkinson disease detection through the utilization of support vector machines And wavelet transformation. The presented technique approaches effective and promising results.

A. Rueda discusses that there has been an increase in the number of diagnosis of Parkinson disease patients across the world. This increase in the number of patients has been attributed to the improved accuracy of the detections that are being performed [2]. Therefore to further improve the Paradigm and implement an effective and useful diagnosis of Parkinson's disease authors have proposed the utilization of dysphonia speech and its feature analysis for monitoring the growth of the Parkinson disease. Experimental results have been performed on the down sampled signals which has achieved an effective utilization for telemedicine in the future.

S. Aich elaborate on the various Impacts that the Parkinson's disease can have on individual and the countries and economy as the whole. Large number of older individuals formed the larger section of society that is suffering from this debilitating disease. Most of the Pieces of the Parkinson's disease are elderly individuals that have been diagnosed in the later years of their life [3]. Increase in the number of patients and the high cost of detection and Diagnosis of this disease has led to a large impact on the various resources especially the developing countries. The photo authors of proposed an effective text mining technique for identification of the relationship between Parkinson's disease based researches and the gait analysis of the patient.

X. Wu expresses that there has been Lot of innovation that has been targeted towards the diagnosis and detection of Parkinson disease. This disease is highly debilitating and can lead to a lot of psychological as well as physical problems for the patient. Most of the patients are old age individuals that are suffering to this disease [4]. To improve the detection capabilities of The Diagnostic process the authors propose the utilization of a force sensitive Platform to perform gait analysis which has been Evaluated through Extensive experimentation.

Z. Moharkan narrates that there are multiple different types of nervous disorders that affect a lot of individuals all across the world. One of the most problematic out of these occurrences is the Parkinson's disease which effectively reduces the quality of life for that individual significantly. Parkinson disease is highly difficult to detect which makes it really late when it is diagnosed [5]. The authors comment that there has to be an effective Technique that can provide results In a Fast and effective manner. For this purpose the authors have provided an effective classification system For the purpose of classifying the presence and prediction of Parkinson disease in an individual.

R. Guzman-Cabrera explains that Parkinson disease is a highly degenerative nervous disease which is second to only Alzheimer's in terms of severity. Parkinson disease usually affects elderly individuals which is diagnosed pretty late leading to a decreased quality of life for these patients. To significantly improve the process of identification and detection the authors have proposed and effective mechanism for Parkinson disease detection through the Implementation of Image processing [6]. The authors have utilized the database which contains the progression markers for Parkinson's disease Using Magnetic resonance imaging. The authors have implemented segmentation of the texture based on intensity.

R. Viswanathan elaborate on the Neurological Defect or a degenerative disease known as Parkinson's disease. This disease is highly problematic and usually affects the elderly or old population significantly. The disease is highly painful and the effective diagnosis of this disease is very time-consuming and often Results in inaccurate diagnosis [7]. Therefore, to improve the Diagnostic abilities and provide an effective and useful Parameter for the detection of Parkinson's disease the authors have utilized voice-based features. The technique has been Highly Effective In the detection And Diagnosis of the Parkinson's disease through the use of the voice of the patients with very high accuracy.

A. Ranjan discusses the prevalence of Parkinson's disease which is a neurological Disability that affects the central nervous system and results in the loss of motor reflexes for an individual. Which disease is mostly seem to occur in individuals that have aged significantly and Results in Impaired balance and tremors [8]. The Process of diagnosis of Parkinson disease is not as effective and is a time consuming Procedure. Therefore the authors propose an intelligent computing approach for the purpose of identification of Parkinson's disease in an individual. The authors have utilized ANN, KNN and SVM and compared the results for these approaches in machine learning applications.

J. Chatterjee states that the development of Parkinson disease takes a very long and inordinate amount of time. During this time the disease is often undetected and can be very hard to diagnose for the individual. The problematic occurrence for this Parkinson's analysis is the Time taken for performing the diagnosis which can be the factor and the survival of the patient [9]. Therefore there is a need for an accurate and timely Implementation of the diagnosis of the patient. Therefore the authors of proposed utilization of image processing approaches to be utilized on the brain CT scan images for automatic and highly accurate detection of Parkinson's disease.

K. Polat narrates that it is highly complex and difficult for the categorization and classification of Parkinson disease effectively. This is highly difficult For the purpose of providing timely treatment to the patient as it can take a very long time to detect the disease and provide Effective treatment. Therefore the traditional techniques need to be improved and effectively implemented in a fast manner for the treatment to be formed as soon as possible [10]. For this purpose the authors have proposed Synthetic Minority quota sampling technique along with random forest classification for the purpose of classifying speech signal to detect the presence of Parkinson's disease.

G. Kiss explains that there has been largescale advances in the paradigm of processing the information that is conveyed non-verbally. One of the most effective and predominant approaches for non-verbal communication has been the speech signals for the humans. The cognitive responses can also be effectively identified and correlated using the speech signals from the particular subject [11]. The authors have explained that the speech analysis can be vital to achieve an effective diagnosis for the purpose of classification of the Parkinson's disease effectively. The authors have proposed the use of Ration of transient parts for the purpose of Parkinson disease classification.

A. Dewanjee elaborates on the topic of Parkinson's disease which is a highly problematic and can lead to further complications if not detected and treated on time. The Parkinson's Disorder is usually noticed with increased frequency in individuals with advanced age. The age factor severely limits the mobility and can lead to increased tremors and shaky hands. The problems can be difficult to gauge and identify for the purpose of diagnosis [12]. To provide a solution to this problem, the authors have proposed the use of Gait Analysis for performing the diagnosis of the ailment. The researchers have utilized the length of the strides and the steps for their classification and achieved effective accuracy. The main drawback of this approach is the lack of a prediction based approach for the detection purposes.

J. Goyal states that the process of detection of a serious neurological ailment such as Parkinson's is a convoluted and a complex procedure. The diagnosis takes a lot of time to process and results in a diagnosis with a low accuracy rate. This is an undesirable circumstance as the timely and prompt treatment of Parkinson's is necessary to ensure the survival and pain free life for the patient [13]. Therefore, there is a need for an effective technique for the identification and classification of the Parkinson's disease. The main drawback noticed in this approach is the lack of a technique to reduce the class imbalance effectively.

III. PROPOSED WORK

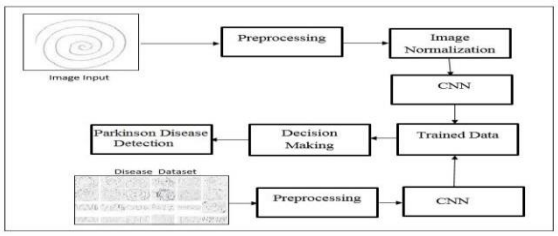

Figure 1: The Proposed System model overview

The proposed methodology for the Parkinson's disease detection is depicted in the above figure 1. The steps that are carried out in this process are explained in the below mentioned steps.

Step 1: Preprocessing – The proposed model for Parkinson's disease detection utilized a dataset downloaded from the URL: https://www.kaggle.com/kmader/parkinsons-drawings?. This dataset consists of testing and training images, which are obtained by the patients and non-patient subjects. The dataset contains spiral and wave structure specimen drawn by both types of the subjects. The Proposed model uses 866 Train images and 399 test images of spiral images for the process of training the model using the convolution neural network. Model also uses 464 Train images and 288 test images of Wave images for the process of training the model using the convolution neural network.

Step 2: Image Segmentation – Before beginning of the training, the spiral images are resized to the dimension of 150 X 150. Whereas the wave images are resized to the dimension of 170 X 170.

Here in this step of the proposed model a Image Data Generator object is created from the library tensorflow and keras using the ratio 1/255 for the in-depth analysis of the images. This process is done for both training and testing of spiral images and as well as wave images. The Image Data Generator object is segmented by assigning some parameters like training and testing directory paths, image dimensions, batch size of 64, color mode of " grayscale" and with the class mode of " Categorical".

Step 3: Training with Convolutional Neural network : A sequential neural network model is set by using the Sequential class of the tensorflow library. Once it is done then a convolution layer with 32 kernel with size 3 X 3 is added with "Relu" activation function as the First layer of the Neural Network for the respective dimension of the images. Following this a second Convolution layer is added with 64 kernels with size 3 X 3 with " Relu" activation function. A max pooling layer is added with size 2 X 2 with a dropout percentage of 25%.

A third layer of Convolution is added with 128 kernels with size 3 X 3 with "Relu" activation function along with a max pooling layer with size 2 X 2 . Finally a 4th Convolution layer is added with 128 kernels with size 3 X 3 with " Relu" activation function. Then a max pooling layer is added with size 2 X 2 with a dropout percentage of 25%.

Finally the neural network is stopped using the flatten function with a dense layer of size 1024 with " Relu" activation function. At the end of the convolution neural network a dropout ercantage of 50 is set with 2 Dense layer along with " softmax" Activation Function.

During the training process the Adam oprimizer is used to enhance the result with 800 Epochs for Spiral and Wave images. After the training the trained data is stored in a H5 file which is further used by the model while testing. The architecture of the convolutional Neural network can be seen in the below figure 2.

Layer	Activation
CONV 2D 32 X 3 X 3	Relu
CONV 2D 64 X 3 X 3	Relu
MaxPooling2D 2 X 2	
Dropout 0.25	
CONV 2D 128 X 3 X 3	Relu
MaxPooling2D 2 X 2	
CONV 2D 128 X 3 X 3	Relu
MaxPooling2D 2 X 2	
Dropout 0.25	
Flatten	
Dense 1024	Relu
Dropout 0.25	
Dense 7	Softmax
Adam Optimizer	

Figure 2: Convolution Neural Network Architecture

Step 4: Testing through Decision Making- In the process of testing the stored trained model data in h5 file format is read into the testing image neural network object. This data is used to predict the classes in an integer form. The dictionary of classes identifies the presence of Parkinson disease based on the integer index to display to the user.

IV. RESULTS AND DISCUSSIONS

The proposed methodology for Parkinson's disease detection is coded on a Windows operating system based machine based using python programming language. For the purpose of coding this approach, the Spyder IDE is utilized. The machine for deployment is made up of an Intel Core i5 processor, 6GB of RAM and 500GB hard drive.

The performance of the Parkinson Disease Detection needs to be assessed for the achieving an effective implementation of the Convolution neural Network. This approach takes an image as input consisting of spirals and sine waves drawn by the patient. To identify the performance of the Parkinson Disease Detection, the performance metric of RMSE is utilized effectively. The experimental evaluation is discussed in the section given below.

Performance Evaluation through Root Mean Square Error

Root mean square error (RMSE) is measured to achieve an accurate assessment of the error rate of the presented technique. Here in this experimentation, RMSE is used to measure the Error rate attained between the proper Parkinson Disease Detection achieved and Expected Parkinson Disease Detection through the CNN module. The equation 1 given below depicts the RMSE approach.

$$\mathrm{RMSE}_{fo} = [\sum_{i=1}^{N} (z_{f_i} - z_{o_i})^2 / N]^{1/2}$$

Where

$\sum$ - Summation.

$(Z_{fi} - Z_{oi})^2$ - Differences Squared for the Parkinson Disease Detection.

N - Number of Images.

The purpose of calculation of the Error rate of the approach through the use of RMSE, the Mean Square Error or MSE needs to be calculated first. The MSE is the difference between the proper Detection of Parkinson Disease achieved and Expected Detection of Parkinson Disease. This method is experimented on with an increasing number of trails and the resultant data is tabulated in the table 1 given below. The values obtained are utilized for the purpose of plotting the graph given in the figure 3 below.

Trail No	No of Expected Parkinson's Disease Detection	No of Obtained Parkinson's Disease Detection	MSE
1	5	4	1
2	6	6	0
3	8	8	0
4	9	9	0
5	10	9	1
		RMSE	0.632

Table 1: Mean Square Error Measurement

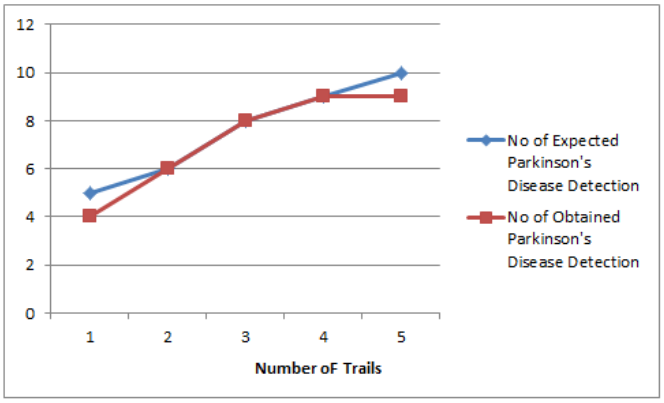

Figure 3: No of proper Expected of scores V/s No of Obtained Scores

The MSE values obtained through the extensive experimentation of the CNN module of the Parkinson's disease detection approach are used to achieve the average MSE. The average MSE is then square rooted to obtain the RMSE value of 0.632. Such a low error rate indicates that the CNN Model has been implemented accurately. This in turn improves the execution accuracy of the Parkinson's disease detection significantly.

V. CONCLUSION AND FUTURE SCOPE

This paper dealt with the early prediction of the Parkinson's disease detection based on the hand written drawing sample of the patients. Basically, these drawing of the patients generally deliver an idea behind applying artificial intelligence based on the smoothness of the drawing. Hence, this paper collects the sample drawing of the patients and then they are rescaled to a specific length and width. These images ultimately feed to the CNN deep learning model to estimate the prediction score of the Parkinson's disease. The obtained scores are used by the Decision making model to estimate the Parkinson Disease. Early evaluation of the system for the Parkinson disease detection using RMSE score indicates the betterment of the system towards the identification of the Parkinson's disease. For the experimental evolution both wave and Spiral Images are considered. The result obtained and discussed in the Result and Discussion Section Clearly indicates that obtaining of the 0.632 Root mean Square Error definitely proves the best deployment of the CNN model for the Parkinson disease detection.

For the future enhancement of this model an interactive API can be developed to use the model by the other developers and researchers.

REFERENCES

[1] Q. Ly et al, "Detection of Gait Initiation Failure in Parkinson's disease based on Wavelet Transform and Support Vector Machine", 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2017.

[2] A. Rueda et al, "Feature Analysis of Dysphonia Speech for Monitoring Parkinson's Disease", 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2017.

[3] S. Aich et al, "A Nonlinear Decision Tree-based Classification Approach to Predict the Parkinson's disease using Different Feature Sets of Voice Data", International Conference on Advanced Communications Technology(ICACT), 2018.

[4] X. Wu et al, "A Study on Gait-based Parkinson's Disease Detection Using a Force Sensitive Platform", IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2017.

[5] Z. Moharkan et al, "A Classification based Parkinson Detection System", International Conference on Smart Technologies for Smart Nation (SmartTechCon), 2017.

[6] R. Guzman-Cabrera et al, "Parkinson´s Disease: Improved Diagnosis using image processing", Photonics North (PN), 2017.

[7] R. Viswanathan et al, "Efficiency of Voice Features based on Consonant for Detection of Parkinson's Disease", IEEE Life Sciences Conference (LSC), 2018.

[8] A. Ranjan et al, "An Intelligent Computing Based Approach for Parkinson Disease Detection", Second International Conference on Advances in Electronics, Computer and Communications, ICAECC-2018.

[9] J. Chatterjee et al, "A computer vision approach to diagnose Parkinson's Disease using Brain CT Images", Proceedings of the Second International Conference on Computing Methodologies and Communication, ICCMC, 2018.

[10] K. Polat, "A Hybrid Approach to Parkinson Disease Classification using speech signal: The combination of SMOTE and Random Forests", Scientific Meeting on Electrical-Electronics & Biomedical Engineering and Computer Science (EBBT), 2019.

[11] P. Sanguansuttigul et al, "Modelling the Concentration Changes of 18F-FDOPA using Compartmental Model in Parkinson Patients", 17th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 2020.

[12] A. Dewanjee et al, "Quantitative Deviation of Spatial Parameters of Gait in Parkinson's Disease", International Conference on Wireless Communications Signal Processing and Networking (WiSPNET), 2019.

[13] J. Goyal et al, "Analysis of Parkinson's disease diagnosis using a combination of Genetic Algorithm and Recursive Feature Elimination", 2020 Fourth World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4), London, United Kingdom, 2020.