International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2020 IJSRCSEIT | Volume 6 | Issue 2 | ISSN : 2456-3307
DOI : https://doi.org/10.32628/CSEIT2062105

Deep Learning Based Diagnosis of Parkinson's Disease Using CNN

[1]Dr. Shubhangi D C, [2]Pooja Gundagurti

[1]Chairman & Professor, Department of Studies in Computer Science and Engineering, VTU, CPGS, Kalaburagi, Karnataka, India

[2]Student, Department of Studies in Computer Science and Engineering, VTU, CPGS, Kalaburagi, Karnataka, India

ABSTRACT

Parkinson's disease is the degenerative disease caused by loss of dopamine producing neurons. PD is characterized by gradual degradation of motor function in the brain. In this, deep learning is used to diagnose the PD patients by means of Convolutional Neural Networks (CNN). The CNN architecture ALexNet is used to refine the diagnosis of Parkinson's disease. The MR images are trained by the transfer learned network along with the KNN algorithm to give the accuracy measures.

Keywords : Parkinson's disease, MRI, Deep learning, Convolutional neural networks, AlexNet

I. INTRODUCTION

Parkinson's disease (PD) is a chronic, progressive, multilesion and neurodegenerative disease caused by the loss of a neurotransmitter called dopamine. Hence, as neurons die, with age, the amount of dopamine produced in the brain decreases. When the dopamine levels starts dropping with age, the neurological condition starts slowing down, influenced by the various communication modes in the brain. In Parkinson's disease, high level of reactive oxygen species produced by dopamine metabolism result in an increased level of iron content which is liable to damage the cell components affecting the neuronal functions. Parkinson is a very complex problem and there is no proper scale to predict the severity of PD. The striatal dopamine deficiency is seen in 2-3% of the population in the age group of greater than 65 years.

Usually, PD is more common in the elderly population, producing alterations in gait and posture that may increase the risk of falls and lead to mobility disabilities. As such, it impacts daily activities and reduces the quality of life concerning patients and their families. The depletion of dopaminergic neurons creates a manifold of motor and non motor symptoms. Some of the well-known drugs can help coping with the disease in early stages, and their usage along the years might hasten neurodegeneration.

The primary symptoms of this disease are shaking, difficulty in movement, behavioural problems, dementia and depression. Deep learning is a popular technique that is effectively used for analyzing and diagnosing the unstructured datasets, and the disease better that, provide patients with the best treatment. Deep neural networks use multiple layers of neurons stacked together to create classification and feature selection models.

WHOs records show that PD has affected around 10 million people across the world till Feb 2020. In this work, analysis of PD brain images of healthy control and PD subjects is attempted using CNN model. A transfer learned AlexNet model and the KNN algorithm is used to classify these images, and the performance measures are evaluated.

II. LITERATURE SURVEY

In this paper, an attempt has been made to classify the MR images of healthy control and Parkinson's disease subjects using deep learning neural networks. The CNN architecture AlexNet is used to refine the diagnosis of PD. The MR images are trained by the transfer learned network to give an accuracy of 88.9%. An AUC value of 0.9618 is reported from the ROC curve that shows a better discriminative proficiency [1]. The creators of this paper introduced two neural network based models namely, VGFR Spectrogram Detector and Voice Impairment Classifier that help doctors in diagnosing disease at an early stage. The CNNs have been implemented on large scale image classification of gait signals, converted to spectrogram images and deep dense ANNs on the voice recordings. The classification accuracy on VGFR Spectrogram Detector is recorded as 88.71%, while Voice Impairment Classifier has shown 89.15% accuracy [2]. In this work, an automated 13 layer CNN model to diagnose PD using EEG signals is proposed. The developed model has achieved a promising performance of 88.25% accuracy, 84.71% sensitivity, and 91.77% specificity. The presented model may be able to serve as a trusted and long-term tool to assist clinicians in PD diagnosis [3]. In this, a methodology is proposed using DNN on UCI's Parkinson's Telemonitoring Voice Data Set of Patients. A 'TensorFlow' deep learning library of python is used. The accuracy obtained for PD Severity prediction on the basis of Total UPDRS score is 94.4422% and 62.7335% for train and test dataset respectively. For PD Severity prediction on the basis of Motor UPDRS score the accuracy obtained is 83.367% and 81.6667% for train and test dataset respectively [4]. They proposed, an automatic identification of PD is rectified with the help of a CNN, which aims at learning features from a signal extracted during the individual's exam by means of a smart pen composed of a series of sensors that can extract information from handwritten dynamics. The OPF over the raw data obtained better results, and the accurate result is 83.77% with 64x64 images using 50% of the dataset for training purpose [5].

III. METHODOLOGY

A. PD Brain Image dataset and Image Preprocessing

The PD patients brain images are obtained from the own Dataset. The dataset is widely applied to identify the progression biomarkers in PD and access the structures and the function of brain over the course of disease. The dataset used in this work consists of number of Parkinson's disease images.

In the second stage, the input images are normalized to achieve a uniform contrast and intensity range across all the images. The normalized MR images are then subjected to filtering operation for noise reduction with the help of 2D Gaussian filter.

B. Convolutional Neural Networks

The CNN analyzed in this work is depicted in Fig. 1. The CNN is organized into 2 parts. The first part is composed of two convolutional layers, considering 16filters with dimensions 1 x 5. The Maxpooling layer is included between the convolutional ones. This part tries to extract the main features from the inputs. The second part consists of 3 fully connected layers for classification. After convolutional and fully connected layers, Dropout layers are included to avoid over fitting. This architecture is a simplification of the AlexNet CNN. The architecture is used to train the CNN parameters for smaller dataset. The inputs are complied in a 2D matrix with N x 125 dimensions where, N is the number of images considered in the CNN. The last layer has only one output with a sigmoid function to classify between two classes. This output should be close to 1 for PD patients and, the output uses binary cross-entropy as loss metric.

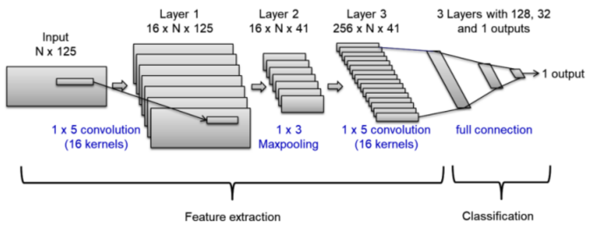

Figure1. Deep learning Structural Model

C. Transfer Learning

Transfer learning in machine learning is the transfer of knowledge from one learned task to a new task. The pre- trained AlexNet model with transfer learning is considered and adapted for classification of dataset images for PD. The output layer following the fine-tuned fully connected layer uses the softmax output unit activation function as

$$y_r(x) = \frac{e^{a_r(x)}}{\sum_{j=1}^{k} e^{a_j(x)}}$$

where $0 \leq y_r \leq 1$ and $\sum_{j=1}^{k} y_j = 1$. The cross entropy function called the log loss evaluates the network by assigning its output a probability value between 0 and 1.

IV. EXPERIMENTAL RESULTS

This section provides the experimental results of the Parkinson's disease database images by, computing the Receiver Operating Characteristic (ROC) for evaluating the performance of the network.

The implementation part initially consists of the home page that is developed through the Mat lab software, as depicted in Fig. 2. This includes buttons such as load dataset, pre-processing of the image, average filtering and the classification through transfer learning.

Figure 2. Home Page

A. Importing dataset and pre-processing

Initially, the images of the PD patients are imported from the dataset as shown in Fig. 3. Then, a 2D Gaussian filter is used for pre-processing the input image as shown in Fig. 4.

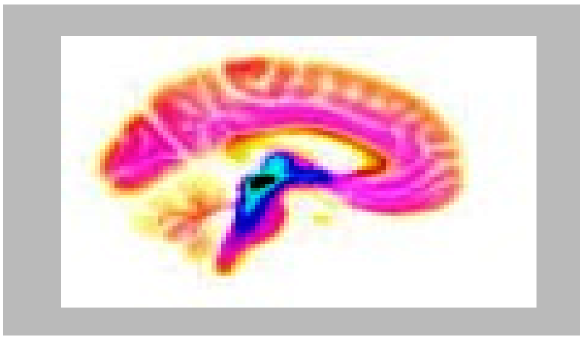

Figure 3. Original Image

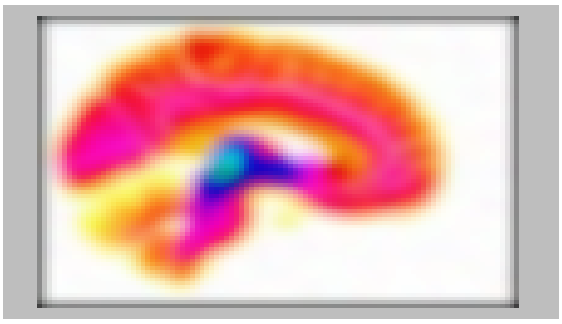

Figure4. Blurred image (Gaussian filter)

B. Average Filtering

The average filtering is a method used for smoothing of images by reducing the amount of intensity variation between neighbouring pixels. A smoothing kernel of size 5 x 5 is used (Fig. 5) to smoothen and thus reduce the intensity in homogeneities from the images to be used for further processing.

Figure5. Average filtered image

C. Results

The proposed transfer learned AlexNet architecture is able to exhibit the sensitivity and specificity values of 78.89% and 88.20% respectively. Without complicated image feature extraction and selection, the model is able to classify the images with better accuracy of 84.00%.

The Receiver Operating Characteristic (ROC) curve is computed to evaluate the performance of the network. The area under the curve (AUC) is calculated to be 1.00 from the ROC curve as given in Fig. 6.

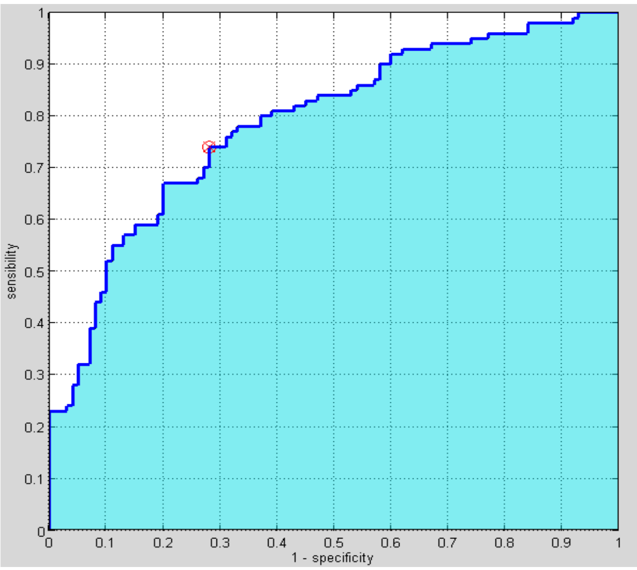

Figure 6. ROC Curve

V. CONCLUSION

A simplified AlexNet CNN model is proposed to diagnose PD patients using brain images. This study is implemented using the deep learning concept to diagnose the PD using MR images. We have obtained an accuracy of 84.00%, sensitivity of 78.89%, and specificity of 88.20% with the small number of dataset. An AUC value of 1.00 is reported from the ROC curve, which shows a better discriminative proficiency of the proposed deep learning model.

Although we have used a smaller dataset of PD patients brain instances, the accuracy of this approach can be further improved by implementing it on a larger dataset, having more number of MR images as well as other attributes like gait and handwriting.

VI. REFERENCES

[1]. S. Sivaranjini, C. M. Sujatha "Deep learning based diagnosis of Parkinson's disease using convolutional neural network" Dept. of E&CE, Anna University, Chennai, March 21, 2019

[2]. Shivangi, Anubhav Johri, Ashish Tripathi "Parkinson Disease Detection Using Deep Neural Networks" Dept. of Computer Science, Jaypee Institute of IT, Noida, 2019

[3]. Shu Lih Oh, Yuki Hagiwara, U. Raghavendra, Rajamanickam Yuvaraj, N. Arunkumar, M. Murugappan, U. Rajendra Acharya "A deep learning approach for Parkinson's disease diagnosis from EEG signals" Dept. of Electronics and Computer Engineering, Ngee Ann Polytechnic, Singapore, 30 August 2018

[4]. Srishti Gover, Saloni Bhartia, Akshama, Abhilasha Yadav, Seeja K. R "Predicting Severity Of Parkinson's Disease Using Deep Learning" Dept. of CSE, Indira Gandhi Delhi Technical University foe Women, Delhi, 2018

[5]. Clayton R. Pereira, Sike A. T. Weber, Christian Hook, Gustavo H. Rosa, Joao Papa "Deep

Learning-aided Parkinson's Disease Diagnosis from Handwritten Dynamics" Dept. of Computing, Federal University of Sao Carlos, Brazil, June 2016

[6]. Ram Deepak Gottapu, Cihan H Dagli "Analysis of Parkinson's Disease Data" Missouri University of Science and Technology, USA, November 2018

[7]. Dag Aarsland "Cognitive impairement in Parkinson's disease and dementia with Lewy bodies" Karolinsha Institutet, Dept NVS, Center for Alzheimer Research, Sweden, January 2016

[8]. Chaudhari KR, Healy DG, Schapira "Non-motor symptoms of Parkinson's disease: diagnosis and management" National Institute for Clinical Excellence, March 2006

[9]. Ozkan Cigdem, Arif Yilmaz, Iman Beheshti, Hasan Demirel "Comparing the performances of PDF and PCA on Parkinson's disease classification using structural MRI images" Dept. of E&EE, Eastern Mediterranean University, Turkey, May 1, 2018

[10]. Cheng HC, Christina M Ulane, Robert E Burke "Clinical progression in Parkinson's disease and the neurobiology of axons" Annals of neurobiology, June 2010

[11]. Dan Long, Jinwei Wang, Min Xuan, Quanquan Gu, Xiaojun Xu, Dexing Kong, Minming Zhang " Automatic Classification of Early Parkinson's Disease with Multi-Modal MR Imaging" Dept. of Radiology, Zhejiang University School of Medicine, China, November 9, 2012

[12]. Xingfeng Li, Yue Xing, Stefan T Schwarz, Dorothee P. Auer "Limbic Grey Matter Changes in Early Parkinson's Disease" Radiological Sciences, University of Nottingham, Queen's Medical Centre, United Kingdom, 2017

[13]. Athanasios Tagaris, Dimitrios Kollias, Andreas Stafylopatis "Assessment of Parkinson's Disease Based on Deep Neural Networks" School of Electrical & Computer Engineering, National Technical University of Athens, Greece, August 2, 2017

[14]. C. Salvatore, A. Cerasa, I. Castiglioni, F. Gallivanone, A. Augimeri, M. Lopez, G. Arabia, M. Morelli, M. C. Gilardi, A. Quattrone "Machine Learning on Brain MRI data for differential diagnosis of Parkinson's disease and Progressive Supranuclear Palsy" Dept. of Physics, University of Milan Bicocca, Italy, January 30, 2014

[15]. Tamara Pringsheim, Nathalie Jette, Alexandra Frolkies, Thomas D. L. Steeves "The prevalence of Parkinson's disease: a systematic review and meta-analysis", The University of Calgary, Canada, November 2014

Cite this article as :

Dr. Shubhangi D C, Pooja Gundagurti, "Deep Learning Based Diagnosis of Parkinson's Disease Using CNN", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 6 Issue 2, pp. 351-355, March-April 2020. Available at doi : https://doi.org/10.32628/CSEIT2062105
Journal URL : http://ijsrcseit.com/CSEIT2062105