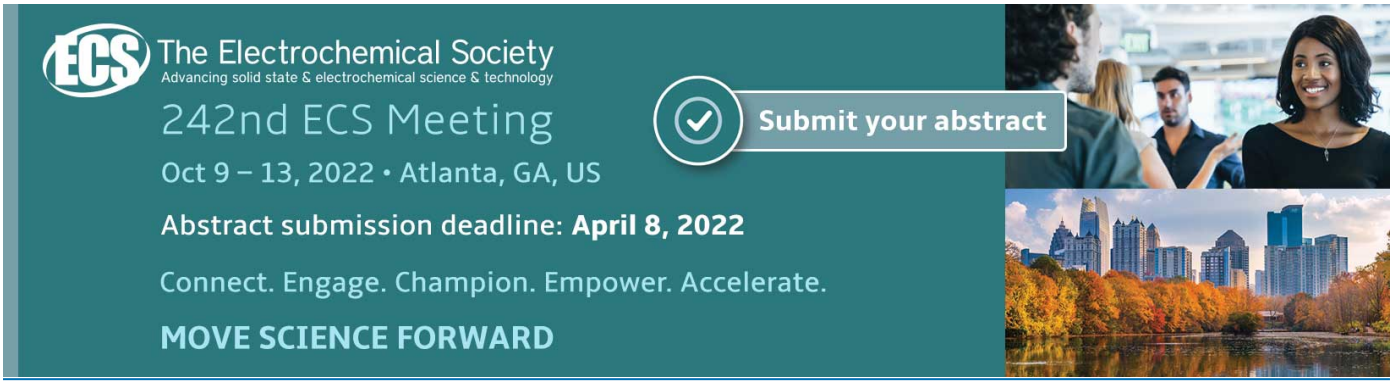
An Early Prediction of Parkinson's Disease Using Facial Emotional Recognition



AN EARLY PREDICTION OF PARKINSON'S DISEASE USING FACIAL EMOTIONAL RECOGNITION

Anusri U[1], Dhatchayani G[2], Princely Angelinal Y[3], Dr. S. Kamalraj[4]
[1,2,3] Students, Department of Biomedical Engineering, Karpagam Academy of Higher Education, Coimbatore.
[4] Professor and Head, Department of Biomedical Engineering, Karpagam Academy of Higher Education, Coimbatore.
Email: kamalrajece@gmail.com

Abstract* — *Parkinson's disease (PD) is a neurodegenerative disorder which challenges the population due to its uncertainty in prediction of the disease. It is a progressive disorder of the nervous system marked by tremor, muscular rigidity and slow, imprecise movement, chiefly affecting middle-aged and elderly people. In our proposed work, we utilize the facial emotions of PD patients and normal person to identify their facial emotions like sad, happy, anger, and depression. For this predictive analysis, the datasets are acquired from Parkinson's Progression Markers Initiative (PPMI) which consists of 188 PD patients and 50 normal people for testing and training process. By utilize this dataset, we applying the CNN architecture of Alex Net, and Vgg 16 to achieve their performance in terms of accuracy, sensitivity, specificity, F1 score and area under curve. Finally, it proven that Vgg 16 gives 10% more accurate results than Alex Net. This research outcome will be very useful in diagnosis of early-stage Parkinson's disease in healthcare.

Keywords: *Parkinson's disease, Convolutional Neural Network, Alex Net, Vgg - 16*

I. INTRODUCTION

Parkinson's disease (PD) is a chronic disorder; it affects people above the age of 60 [1]. The symptom to be targeted in this diagnosis model is the Motor Symptom. The five stages of symptoms in PD are, first stage include changes in posture, walking and facial expressions, second stage include continuing daily tasks are harder because of tremor, stage three causes loss of balance and slowness of movements, stage four ends up in severe tremor and unable to measure alone and in last stage it is impossible to stand or walk and leads to hallucinations and delusions [2]. Still, there is no proper treatment for PD diagnosis but some treatments are helps to relieve the symptoms and maintain the quality of life. Those treatments are physiotherapy, medication, and surgery. The diagnosis of Parkinson's based on cardinal motor signs of rigidity, tremor, and instability. Since examining this facial expression is more reliable and easier as well as it can be used extensively in telemedicine which gives a greater impact on the patents on the remote places. In our proposed work, we analysis the stages of Parkinson's disease by classifying facial emotions using CNN architecture like Alex Net, Vgg 16. Section 2 gives a detailed description about related works, section 3 gives a detailed information about data's we have collected section 4 explains about the data preparation, section 5 we proposed our methodology, section 6 we compared the results and discussion, section 7 and finally concluded with section 7 .

II. RELATED WORKS

Pir Masoom Shah Et.al has proposed a way of detecting Parkinson disease by using Brain MRI scan and applied CNN for the better performance [3]. Ning Z et al proposed an algorithm combining long short-term memory network and CNN for the purpose of classifying and diagnosing neurodegenerative disease [4]. Adams et.al has predicted the outcome of PD from DAT SPECT images in which they obtained 70.7% accuracy in CNN [5]. Khatamino et.at, has proposed a deep learning CNN based system for Medical Diagnosis from the spiral drawing of PD patients and have achieved 88% accuracy results [6]. Xinjie Shi et.al has proposed an attempt to use hybrid convolutional recurrent neural networks in classifying between PD and normal patients, which is an asset to clinical practice [7]. Shivangi et.al, has introduced two neural network models; VGFR Spectrogram Detector and Voice Impairment Classifier which aim to help doctors in diagnosing disease at an early stage [8] Catherine Taleb et.al, has employed deep learning approach to aid in PD detection.,which led to best performance on spectrogram representation [9]. H-Gunduz et.al has classified the Parkinson disease based on CNN using Vocal Features [10]. J Correia et.al has studied the way of depression in detection of SA disease using DNN [11].

III. DATA COLLECTION

The dataset is acquired from Parkinson's Progression Markers Initiative (PPMI) [12]. The training dataset is the contribution from 188 Parkinson disease patients of which 107 are male and 81 are female PD patients. These subjects aged from 33 to 87 [13]. PD arises with the onset of Motion Retardation symptoms at the beginning stages of the disease.

Fig 1: Without Parkinson's disease

Fig 2: With Parkinson's disease

IV. DATA PREPARATION

The outputs from the database are verified that the shiver in the video is not due to the external disturbance and the medical history of the patients is also checked. It is also mentioned that equipment Canon D Camera is used along with the standard tripod in such a way the experiment is unaffected. Each of the patients from whom the data is collected has an individual patient ID. It contains the Name, Age, Gender, Medical History and any other Neurological problems are present or not. The subjects are made sure to follow the instruction for the data collection [14]. They are intimated to show the possible facial expression as instructed for them. From those clips it is possible to identify the difference between the normal subject to the PD subject. This process cannot be diagnosed manually; it is done with the help of the software developed in this project [15].

V. PROPOSED METHOD

In the proposed method, we utilize CNN architecture for the classification of facial image of Parkinson's patient. CNN does not require human interface for the preprocessing of the imager data. It automatically preprocesses the image for feature extraction. The Vgg 16 classifier has 16 layers of neural network for classifying the PD patients. The PPMI dataset are used for training the algorithm. It is then preprocessed for the purpose of feature extraction. It is then employed under CNN architecture in Vgg 16 classifier to get the classification

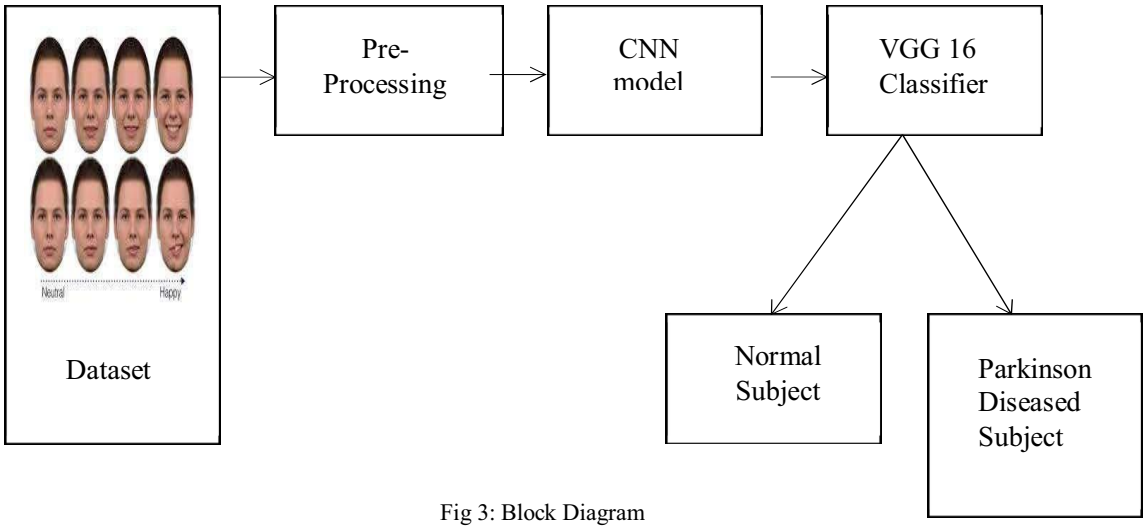


Fig 3: Block Diagram

A. Convolutional Neural Network (CNN)

Convolutional layers are combined to form a network resulting in Convolution Neural Network (CNN). CNN are used for image classification and recognition of its high accuracy. CNN finally gives out results of fully-connected layer where all the neurons are connected to every other and also the output is processed. The main advantage of CNN compared to its predecessors is that it automatically detects the important features with none human supervisions

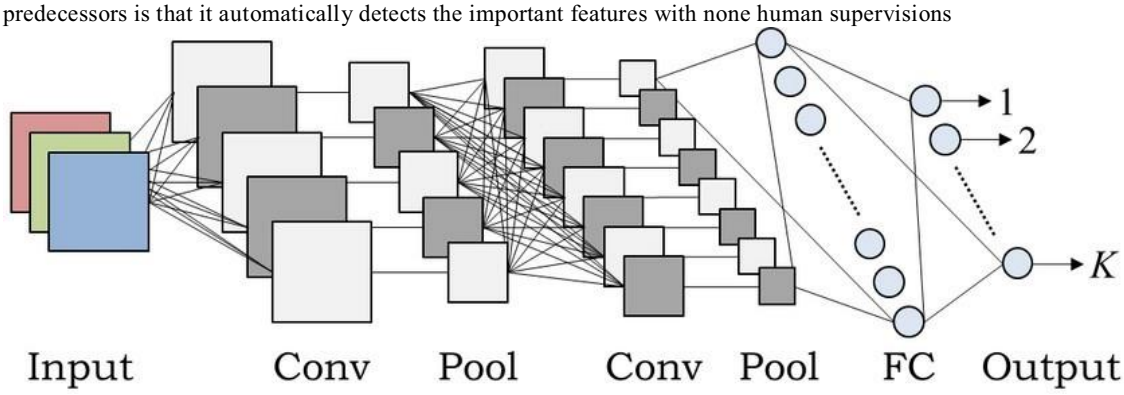


Fig 4: CNN Architecture

CNN used in this system contains a complete number of 16 layers. The orders of those layers are as follows, 5 convolution layers followed by pooling layer and finally with 3 dense layers. The proposed model shows better accuracy in analyzing between PD subjects and Normal subjects.

Preprocessing the image data with the classical method is one of the tedious processes. Thus using Convolution Neural Network will serve as an advantage for the preprocessing methods. It automatically preprocesses the image data and revolves as a highly effective method.

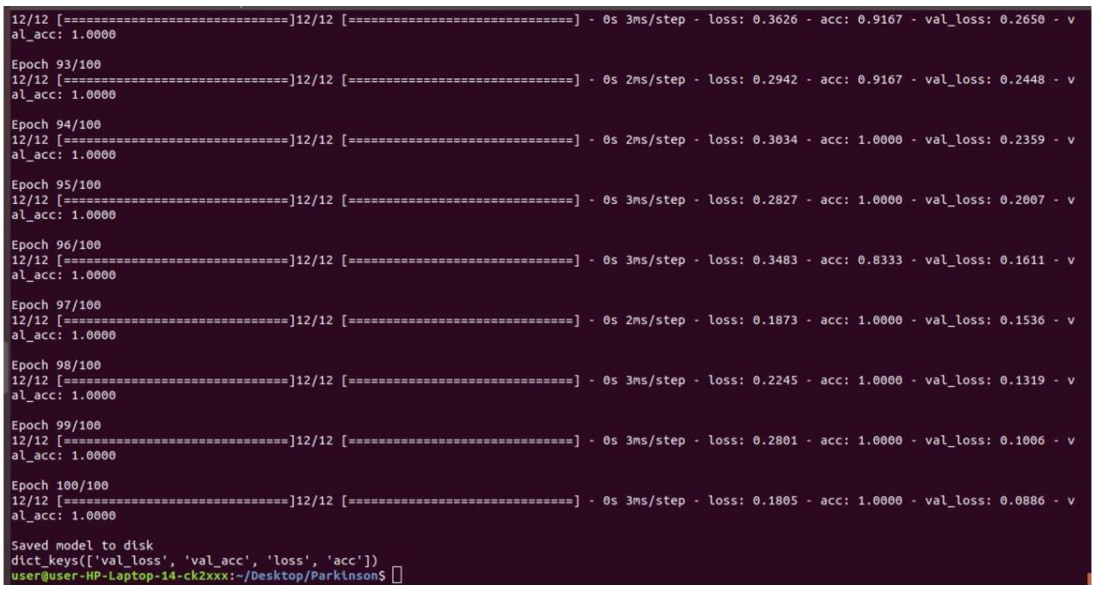


Fig 5: Detecting of the result

B. VGG 16

CNN comprises of many model leveling from basic to advanced level. Out of which Vgg16, Visual Geometry Group is a considered as a suitable model for the face emotion recognition. Its 16 convolution layer makes the extraction of information from the image process perfect. Vgg16 shows 92.7% results in Image recognition.

Fig 6: Vgg16 Architecture

VI. RESULT & DISCUSSION

The main contribution has been the proposal of the image as inputs to a CNN for PD detection from facial expression detection. The CNN includes convolution layers (features learning) and fully connected layers (for PD detection). We evaluated the detection capability of different facial emotions obtaining the most effective results. Employing a public dataset, Parkinson Disease facial emotion dataset, the most effective results obtained during this work showed an accuracy of 96.5% and a section under the curve of 95.3%. This technique represents a non-invasive, reliable method for the detection of Parkinson's disease.

ALGORITHM	ACCURACY	SENSITIVITY	SPECIFICITY	F1 SCORE	AREA OF CURVE
Existing method (Alex Net)	83.2	84.1	82	86	85.2
Proposed Method(Vgg16)	96.5	93	96	97.7	95.3

Table 1: Result of Detection using Standard Facial Expressions

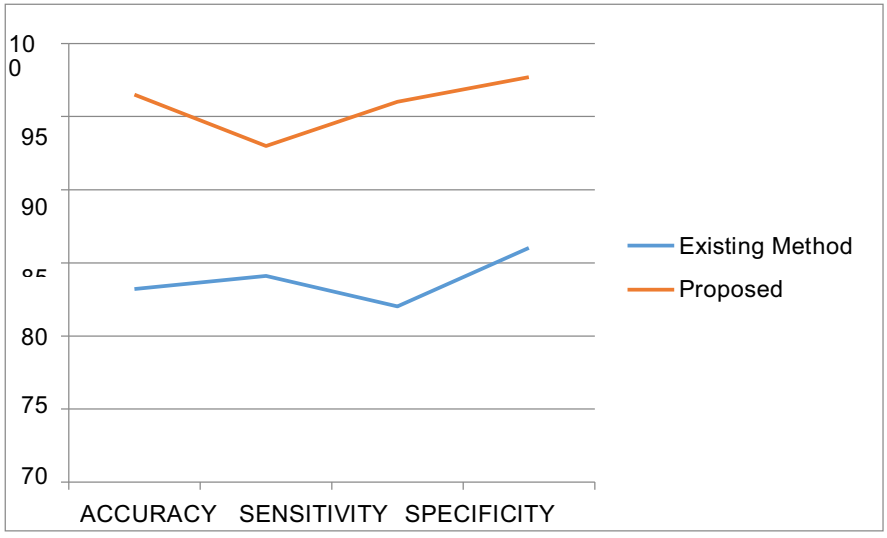


Fig 7: Comparison of the result

VII. CONCLUSION

Parkinson's disease (PD) is a neurodegenerative disorder which challenges the population due to its uncertainty in prediction of the disease. In our proposed work, we utilize the facial emotions of PD patients and normal person to identify their facial emotions like sad, happy, anger, and depression. For this predictive analysis, the datasets are acquired from Parkinson's Progression Markers Initiative (PPMI) which consists of 188 PD patients and 50 normal people for testing and training process. By utilize this dataset, we applying the CNN architecture of Alex Net, and Vgg 16 to achieve their performance in terms of accuracy, sensitivity, specificity, F1 score and area under curve. Hence, it is proven that Vgg 16 gives 10% more accurate results than Alex Net. Thus the performance results show that the proposed VGG 16 architectureachieved accuracy of 96.5%, sensitivity of 93%, specificity of 96%, F1 score 97.7%, and area of curve 95.3% compared to that of Alex Net research outcome will be very useful in diagnosis of early-stage Parkinson's disease in healthcare.

VIII. REFERENCE

[1] Abdulhay, Enas, et.al, "Gait and tremor investigation using machine learning techniques for the diagnosis of Parkinson disease." Future Generation Computer Systems 83 (2018): 366-373.

[2] [2]. Sivaranjini, S., et.al, "Analysis of Parkinson's Disease 34 SPECT Images Using Geometric Measures and Orthogonal Moments." In 2018 Fourth International Conference on Biosignals, Images and Instrumentation (ICBSII), pp. 206-212. IEEE, 2018.

[3] [3] Pir Masoom et.al, "Detection of Parkinson Disease in Brain MRI using Convolutional Neural Network." 24th International Conference on Automation and Computing (ICAC), pp. 1-6. IEEE, 2018.

[4] [4]. Ning, et.at, "Classification of neurodegenerative diseases based on CNN and LSTM." 9th International Conference on Information Technology in Medicine and Education (ITME), pp. 82-85. IEEE, 2018.

[5] [5]. Adams et.a, "Prediction of outcome in Parkinson's disease patients from DAT SPECT images using a convolutional neural network." IEEE Nuclear Science Symposium and Medical Imaging Conference Proceedings (NSS/MIC), pp. 1-4. IEEE, 2018.

[6] [6]. Khatamino et.al, "A Deep learning-CNN based system for medical diagnosis: an application on Parkinson's disease handwriting drawings." 6th International Conference on Control Engineering & Information Technology (CEIT), pp. 1-6. IEEE, 2018.

[7] [7]. Shi, Xinjie, et.al, "Hybrid Convolutional Recurrent Neural Networks Outperform CNN and RNN in Task-state EEG Detection for Parkinson's Disease." In 2019 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC), pp. 939-944. IEEE, 2019.

[8] [8]. Johri, et.al, "Parkinson Disease Detection Using Deep Neural Networks." In 2019 Twelfth International Conference on Contemporary Computing (IC3), pp. 1-4. IEEE, 2019.

[9] [9]. Taleb, Catherine, et.al, "Visual Representation of Online Handwriting Time Series for Deep Learning Parkinson's Disease Detection." In 2019 International Conference on Document Analysis and Recognition Workshops (ICDARW), vol. 6, pp. 25-30. IEEE, 2019.

[10] [10] Gunduz, H, et.al, "Deep learning-based Parkinson's disease classification using vocal feature sets". IEEE Access, 7, pp.115540-115551., 2019.

[11] [11] Correia, J., et.al, December. In-the-Wild End-to-End Detection of Speech Affecting Diseases. In 2019 IEEE Automatic Speech Recognition and Understanding Workshop (ASRU) (pp. 734-741). IEEE, 2019.

[12] [12]. Wan, Jinting, et.al, "EEG Sub-band Abnormality of Early-stage Parkinson's Disease with Mild Cognitive Impairment." In 2020 39th Chinese Control Conference (CCC), pp. 2856- 2861. IEEE, 2020.

[13] [13]. Andrei, et.al, "Parkinson's Disease Detection from Gait Patterns." In 2019 EHealth and Bioengineering Conference (EHB), pp. 1-4. IEEE, 2019.

[14] [14]. Shinde, et.al, "Facial Features Based Prediction of Parkinson's Disease." In 2018 3rd International Conference for Convergence in Technology (I2CT), pp. 1-5. IEEE, 2018.

[15] [15]. Neehal, et.al, "Prediction of Parkinson's Disease by Analyzing fMRI Data and using Supervised Learning." In 2020 IEEE Region 10 Symposium (TENSYMP), pp. 362-365. IEEE, 2020.

[16] [16]. Rao, et.al, "Parkinson's Disease Detection Using Voice and Spiral Drawing Dataset." In 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT), pp. 787-791. IEEE, 2020.

[17] [17]. Kumar, et.al, "Advanced And Effective Classification of Parkinson's Disease Using Enhanced Neural Networks." In 2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS), pp. 801-807. IEEE, 2020.

[18] [18]. Karan, et.al, "Stacked auto-encoder based Time-frequency features of Speech signal for Parkinson disease prediction." In 2020 International Conference on Artificial Intelligence and Signal Processing (AISP), pp. 1-4. IEEE, 2020.

[19] [19]. Mabrouk, et.al, "Machine learning based classification using clinical and DaTSCAN SPECT imaging features: a study on Parkinson's disease and 33 SWEDD." IEEE Transactions on Radiation and Plasma Medical Sciences 3, no. 2 (2018): 170-177.

[20] [20]. Oh, Shu Lih, et.al, "A deep learning approach for Parkinson's disease diagnosis from EEG signals." Neural Computing and Applications (2018): 1-7.

[21] [21]. Alaskar, et.al, "Prediction of Parkinson disease using gait signals." In 2018 11th International Conference on Developments in eSystems Engineering (DeSE), pp. 23-26. IEEE, 2018.

[22] [22]. Aich, Satyabrata, et.al, "A nonlinear decision tree based classification approach to predict the Parkinson's disease using different feature sets of voice data." In 2018 20th International Conference on Advanced Communication Technology (ICACT), pp. 638-642. IEEE, 2018.

[23] [23]. Johri, et.al, "Parkinson Disease Detection Using Deep Neural Networks." In 2019 Twelfth International Conference on Contemporary Computing (IC3), pp. 1-4. IEEE, 2019.

[24] [24]. Xiong, et.al, "Deep Feature Extraction from the Vocal Vectors Using Sparse Autoencoders for Parkinson's Classification." IEEE Access 8 (2020): 27821-27830.

[25] [25]. Sajal, Md Sakibur Rahman, et.al, "Telemonitoring Parkinson's disease using machine learning by combining tremor and voice analysis." Brain Informatics 7, no. 1 (2020): 1-11.

[26] [26]. Haq, Amin Ul, et.al, "Comparative analysis of the classification performance of machine learning classifiers and deep neural network classifier for prediction of Parkinson disease." In 2018 15th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP), pp. 101-106. IEEE, 2018.