Identification of Disorder in Human Brain on the Basis of EEG using Techniques of Deep Neural Network

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Km Ikra*, [1], Salman Khursheed Ahmad*, Prem Kumari Verma^ and Dr. Nagendra Pratap Singh^

Abstract – *The widely popular Networks of neurons has great applications in many areas and in most of the scenarios, the classification related being bundled up and made available with major techniques of the widespread area of deep learning. The study deals with the popular algorithms like Decision Tree, K nearest neighbor, Gaussian NB and other classifiers in order to categories the signals of EEG.An electroencephalogram (EEG) used widely in order to diagnose many of the disorders related with medical perspectives. Some of the regions or portions of the brain were impacted by the epilepsy which is partial,and the EEG being recorded from those of the areas are termed as the Focal-EEG, while from rest of the areas are termed as Non-Focal EEG, So, it's being area or region centric. Whenever a patient comes up with the drug-resistant epilepsy, the Focal identification of EEG assists the doctors in order to locate the epileptogenic focus and, asa consequence, the doctor recommends the method of removal of those of the regions of the brain as per the diagnosis so performed by means of surgical measures. The methodology used over here helps in categorization of both of the non-focal and focal. In latest time it has been observed that a rise in the utilization of interface through computer for the brain has made a lot of the potential in order to investigate the brain's control mechanism using the EEG signal. Recurrence plot CNN are supported the address issue of the EEG signal process of categorization. To increase the amount of intensity of the signal during the interval of workout, EEG signals were firstly pre-processed. To build the mode of feature of the recurrence plot, features in domain of the time and frequency are extracted, respectively.*

Keywords – Neural Network, EEG, Recurrence Plot, Focal EEG and Non-Focal EEG.

1. INTRODUCTION

This EEG signal is being used in order to detect the diseases which are related with that of the brain. It is known to be one of the cheapest instruments so being used widely in order to perform analysis with the occurrence of the activity going on inside the brain, activity being captured with some of the electrodes which were being placed on the scalp very safely with appropriate handling so as to avoid the discomfort and the harm, signal so obtained through this kind of the procedure is referred as the EEG Signal. The Neural specialist examines the visually passed signals to ascertain the initials of the problem of epilepsy. No doubt, to properly analyses the EEG signal is a time taking process and at most of the time frequently results in incorrect alarms detection of the epilepsy. A person with the problem of epilepsy known to be majorly suffering from the seizures which are sudden and causes convulsions in their musclesand, in some of the cases, even may cause them to lose their state of the consciousness. The work shown here tries to classify the signals using some of recurrence plot for showing each moment and instance in different timestamps. Feature Extraction has been carried out through EfficientNet. EfficientNet is a method known as a scaling method often used to scale the dimensions of viz. Depth or Width or Resolution related things. It's a widely popular Convolutional Neural Network. The purpose of classification is being carried out by different classifiers viz. Random Forest, K nearest neighbor etc.

2. DESCRIPTION OF EEG SIGNAL

2.1 Delta Signal and Alpha Signal

The Delta signal has a frequency of not more than that of 3Hz, it has the largest amplitude and it moves slowly. The Alpha Signal spans from 7.5-13Hz.It occurs when one shuts eyes and then relaxes, and it disappears when someone open them or are aroused by some of the other method (thinking, calculating etc).

2.2 Beta Signal and Theta Signal

The Beta Signal oscillates at 14 Hz or higher. By the both ends, it is typical dispersed very equally, however the front makes it clearer sedative-hypnotic medications, particularly a "diazepam" and the sleeping aids, amplify it. Theta is slow activity and it ranges from 3.5 to 7.5Hz.

3. USES OF EEG

An EEG signal has proven to have a great caliber of detecting the minute differences in the brain activity while diagnosing the various brain diseases, Mostly the epilepsy or the other seizure-based syndromes. For

*Galgotias University, Greater Noida, Uttar Pradesh, India.

^Dr. B.R. Ambedkar National Institute of Technology, Punjab, India.

[1] Corresponding author;
E-mail: ikrahasan6398@gmail.com

the purpose of observing the following.

1. Sleep aponia
2. Brain damage due to head injury
3. Accidental scenarios that lead to brain dysfunction (encephalopathy)
4. Dementia
5. Encephalitis (Inflamed tissues of brain)
6. Various kinds of strokes

4. METHODOLOGY

Here, an attempt was made in order to automatically classify "focal and non- focal classified" seizure kind of data.

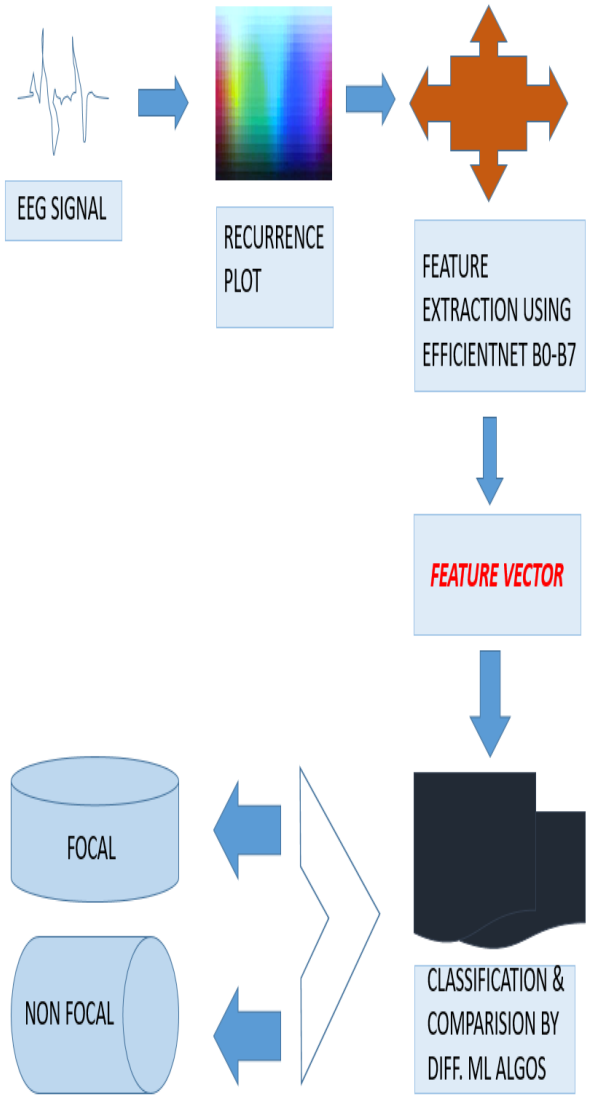

Fig. 1. Proposed methodology flow diagram.

The overall flow of the methodology so undergone has been represented in the Fig 1 as shown above, At every step of the flow a better care of the things has been taken care of so that a better and precise accuracy in results can be obtained.

Data

A data collection is performed using Set of Eight peoples with that of temporal lobe epilepsy being used in order to collect the EEG data.

Pre-Processing

It is used in order to perform conversion of the data in row-by-row form and after that perform the conversion as the data into that of image using recurrence plot.

Recurrence Plot

A recurrence plot is a very adequate way of analysis of the data which is irregular and is use as RP in various ways.

Combination of the recurrence plot with that of the Convolutional Neural Network, a novel method has been developed in order to classify the signals.

A convolution neural network is a very popular network and is a type of Network which is also known as the CNN. It is an algorithm of the vast domain of Deep Learning where the images were given as input, the assignment of some of the weights and the biases to its various aspects in the image is performed and has a great tendency of pointing out the difference between them one from that of the other one for a better understanding.

EfficientNet model has been trained on the dataset named ImageNet, this dataset comprises of the two thousand classes and near to 14 million images. EfficientNet has different versions ranging from B0 to B7 i.e, from the lowest to that of the highest, the difference is in the parameter number and that of the accuracy, it is proven a better one then that of the other older models.

The different version of EfficientNet so discussed above are observed to be the around eight times smaller and considered to be the best and around six times faster than that of the best of the other pre-trained models.

EfficientNet is used basically so as to alter the changes in three of the dimensions (D, W and R, respectively) where D is for the depth, W is taken for the width, and R is taken for the resolution, all of these are being at a particular fixed rate. It is seen that if there is some kind of changes or say variation in any of the one dimension, it will lead to have a huge impact in that of the performance of the networks; Thus, it gives an insight of the limitation of the scaling which is being one dimensional.

The important building block of the EfficientNet is MBConv, taken as an inverted convolution "bottleneck", it's the basic & the version at initial point instance used in the MobileNetV2. It creates a link between the initial and that of the termination of the convolution block. Convolution point expands the feature maps and then contracts process as afterwards.

The layers being very narrower are connected via the shortcut of the links, while the broader ones are connected between the links were skipped.

As a result, the number of the computations required were decreased by 'k' square compared with that of the layers before.

Where the 'k' shows the height and width respectively of the two-dimensional convolution window and is referred as a kernel.

Using such a nice and novel network, there's also one aspect to be kept in mind and i.e. The EEG signal one important thing is that the EEG signals are the time-series

signal, and there help of recursive graphs has been taken too.

The signals were converted to recurrence plot (Images) and then fed to the CNN (EfficientNet bo-b7 used here) and we obtain a Feature Vector whose length is 315.

The feature vector is being classified using various classification algorithm like svm, random forest etc.

All the results were compared with respect to the respective versions of the EfficientNet.

However, it is not new to say that the small portion of the EEG signal will affect the precision.

5. RESULT

With respect to the EfficientNet ranging from B0 to B7 version, the results obtained so far are described here as below.

The following figures are represented here in order to show the signals as Focal and Non-Focal signals basically the two signals as discussed earlier.

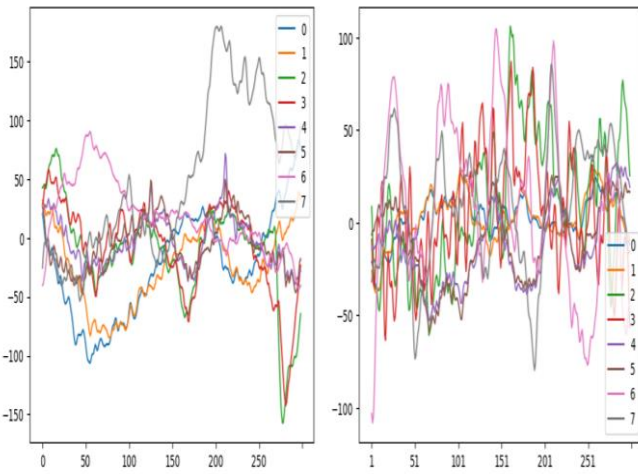

Fig 2. Focal and non-focal signals.

Focal Signal

Focal Signals are basically that kinds of signals of EEG which were being acquired from the region of brains where the first changes are being observed.

Non-Focal Signal

Non-Focal Signals are those kinds of signals of EEG which were being acquired from the region of brains which are not part of seizure onset or we can say which do not contribute to the seizure onset.

The Focal Signals discussed above are also termed as the “F” Signals while the other kind of signal which is termed as non-focal ones are termed as the “NF” Signals as well.

It has been observed that both of the Focal & Non-Focal signals were having the lack of seizure segments.

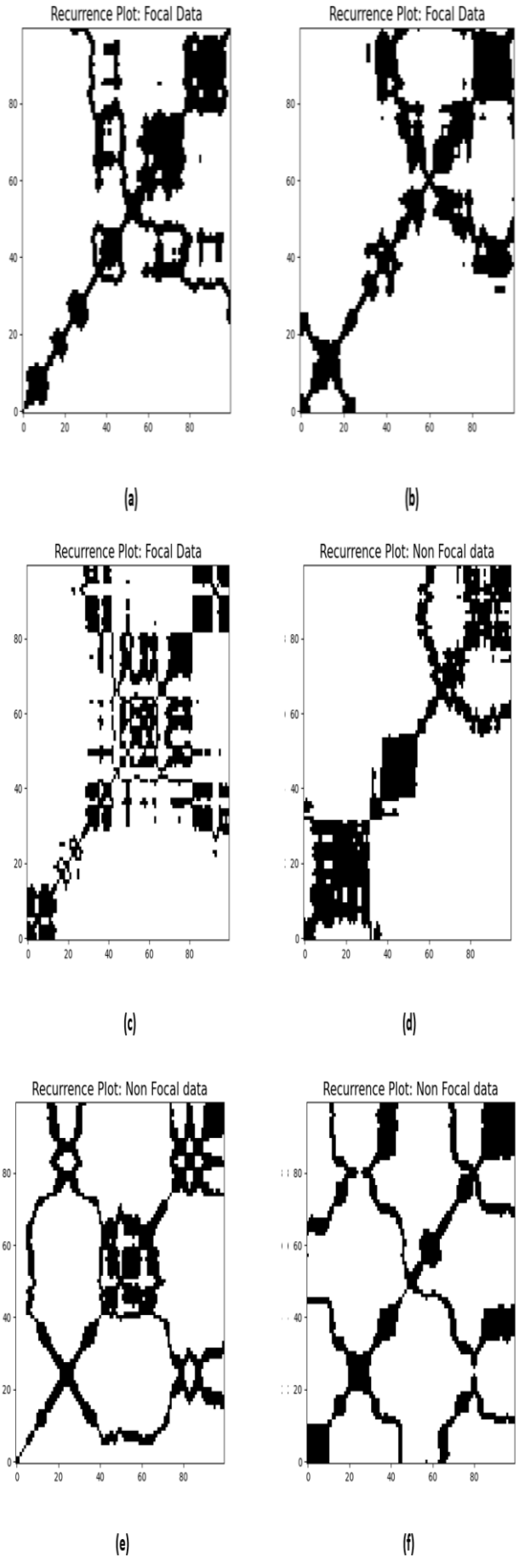

Fig 3. Recurrence plot of focal and non focal signals daigram.

The different values of accuracy for different classification algorithms are described under the table in Fig. 4.

The different versions of EfficientNet from B0- B7 are taken all together so as to provide the better insights and to make a better comparision among them all which would yield a clearer comparative insights.

It was seen that the accuracy in different of versions in different kind of classification algorithms were some times getting a very closer accuracy value inrespect to each others value while some time getting a far apart.

The table shown in Fig 4. clearly helps in drawing a better conclusion insight from the results obtained so far.

VERSIONS OF EFFICIENT NET	RANDOM FOREST	KNN	GAUSSIAN NB	SVC	DECISION TREE
B0	61.76	57.56	59.06	60.26	81.9
B1	58.8	55	58.4	59.66	59.33
B2	60.58	53.33	58.43	59.66	53.83
B3	60.5	57.03	60.60	60.7	53.46
B4	59.5	58.33	56.1	60.46	54.2
B5	59.76	55.93	54.66	60.13	52.1
B6	60.36	57.8	58	60.3	52.33
B7	59.10	54.86	54.66	59.56	52.56

Fig 4: Results on Different Classifiers On Versions of EfficientNet

The remarkable properties of an EfficientNet are clearly visible on seeing the accuracy on the different classifiers of Machine Learning and Deep Learning in Fig.4.

6. CONCLUSION AND FUTURE WORK

In this work, the main focus is to examine the signals of EEG with various techniques of Learning which were used. Python Programming language is used to implement the traditional SVM and logistic regression methods in keras, coupled with a normal simple neural network, in order to evaluate the performance. For the higher performance of 95% percent accuracy in the EEG classification, SVM and enhanced NN are recommended.

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