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Epilepsy Neurological Problem: Prediction Using Machine Learning Techniques

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Abstract: *Neurological problems are very common and have a serious impact on human beings both in adults and children. The seizure affects the routine work of the patient. Here discussed, an overview of one of the common neurological problems seizure. With the latest emerging technologies like data mining and machine learning algorithms, the prediction of nervous problems in the earlier stage is possible, with the help of EEG (Electroencephalograms) signals. So, the relevant treatments are given to those nerves related problems.*

Key Words: *Machine Learning, Seizure, Epilepsy, SVM, CNN.*

1. INTRODUCTION:

The nervous system is an organized group of cells that are used to send the electrochemical stimuli and response in the network through the sensory receptors. The thin fibers which are nerves help us to transfer important messages from the brain and body vice versa. The nervous system has two parts they are Central Nervous System which comprises the brain and spinal cord and the Peripheral Nervous System which have the rest of the nerves in the human. Neurological disorders are the diseases of the brain, spine, and nerves that connect them. The seizure occurrence is not always due to epilepsy. About 10% of people on this earth have a seizure at least once in their lifetime due to some other reasons. Some of the seizures occur due to accidents, burns, and head injuries. Nervous problems can be divided into the following types based on the serious condition, disease and injuries are blood supply problems, injuries that occur to the head and the spinal cord and lastly the problems that occur during the time of birth.

Neurological issue epilepsy is described by the event of incessant seizures with the symptoms, for example, some portion of the body or the entire body influenced by the automatic developments and misfortune the cognizance. These will greatly affect the standard routine work of individuals. Out of 100% of patients, 70% are appropriate with the restorative treatment and the staying 30% require elective ways to deal with leave the seizure. EEG (Electroencephalograms) and iEEG (intracranial EEG) are the apparatuses that are utilized in the facility to recognize epilepsy. On the scalp, the terminals are put and the sign delivered by the cerebrum are recorded for the examination. The finding of the seizure from the EEG signals is made physically. The data gave by the patient's family member and the seriousness of the seizure is not applicable. Consequently, with the most recent developing advances like AI machine learning techniques which helps in the expectation and mechanization of the anxious issues well in the previous stage.

2. LITERATURE REVIEW

Sudden uncontrolled electrical disturbance in the brain is seizure. It changes the behavior, movements or feelings and in the levels of consciousness. Occurrence of seizure more than once or it has the tendency to have recurrent then it is called epilepsy. The seizure can be broadly classified into two types depending on the type of behavior and the brain activity. They are generalized and partial. Physician prognosis based on the seizure type. Generalized seizures which are generating the electrical impulses from the whole part of the brain, on the other hand, partial seizures are generating electrical impulse from a part of the brain. Epilepsy is due to uncontrolled seizures occurring in the central nervous system[1].

In this case, the normal neuronal network is completely turned into a hyper excitable network abnormality. The other types the non-epileptic seizure are the stroke, dementia, head injuries and tumor. The epileptic seizure leads to the malfunctioning of the electrophysiological system of the brain so that sudden excessive electrical discharge in a group of brain cells present in the cerebral cortex. Since the cerebral cortex is affected which leads to the deformity of the motor functions like jerks, spasms of muscles and joints.

Many Kinds of research detect the seizure at the preictal state using the EEG signals. Preprocessing the EEG signal by removing the noise from the signals and feature extraction play a vital role in the prediction of epileptic seizure [1]. Epilepsy is the disease caused by the functionality disorder [2]. Seizures are not cured completely so it will have the impact on the active life of the patient. Preictal state appearance can be detected. In the supervised training, input

features are formed by 132 dimensions with the target output [3]. From the EEG signals, signal preprocessing, features extraction, EEG signal acquisition and finally classification between different seizure states are included in the Machine Learning models [5]. There should be enough time for the prediction of preictal state. The non-linear features are motivated by the higher-order spectra (HOS) would be the best way to differentiate between normal, background (pre- ictal) and epileptic EEG Signals**.**

3. METHODOLOGY:

The EEG is taken with Baseline, eyes open and eyes closed position. Task 1, the left or right fist is open or close state. Task 2, the both fists or the both feet open and close. The five spectrum sub bands in the EEG signal are responsible for the identification of Seizure. They are delta (0-4 Hz), theta (4- 8 Hz), alpha (8-16 Hz), beta (16- 32 Hz) and gamma waves (32-64 Hz). The EEG signal with high frequency than the specified range and the fluctuation between low and high frequency are identified as the abnormalities in the brain state and lead to seizure. There are three stages in the EEG data, interictal, ictal and preictal. The waves before the occurrence of the seizure are preictal it contains occasion waveforms and isolated spikes, spike trains where as the ictal EEG data has the continuous waveforms with variations in the frequency, spikes are very complex. Interictal is the period between the seizures. Post ictal stage after the seizure the brain state is analyzed. The fig.1 shows the normal and seizure EEG signals. Fig.2 shows the ictal, interictal and preictal waveforms.

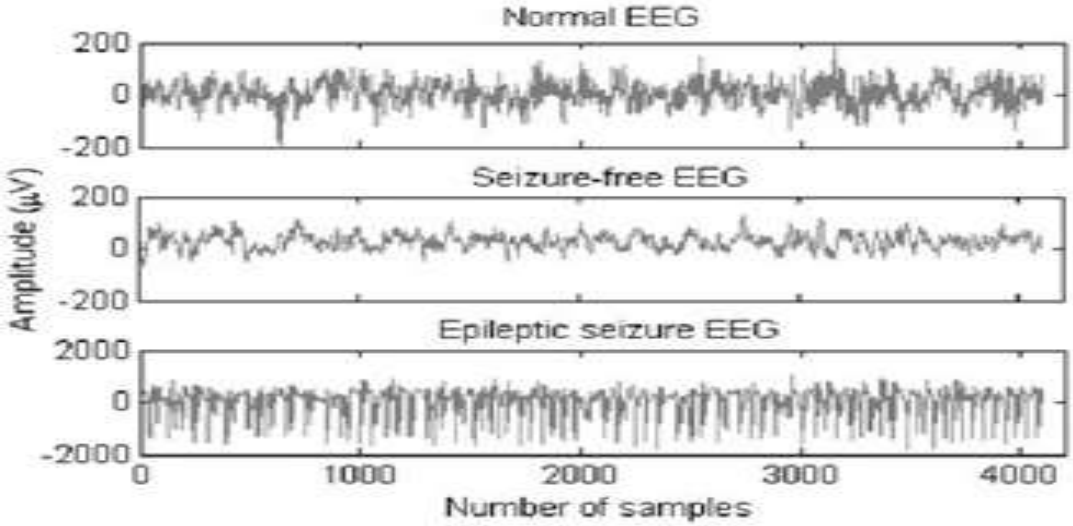

Figure 1. Sample EEG

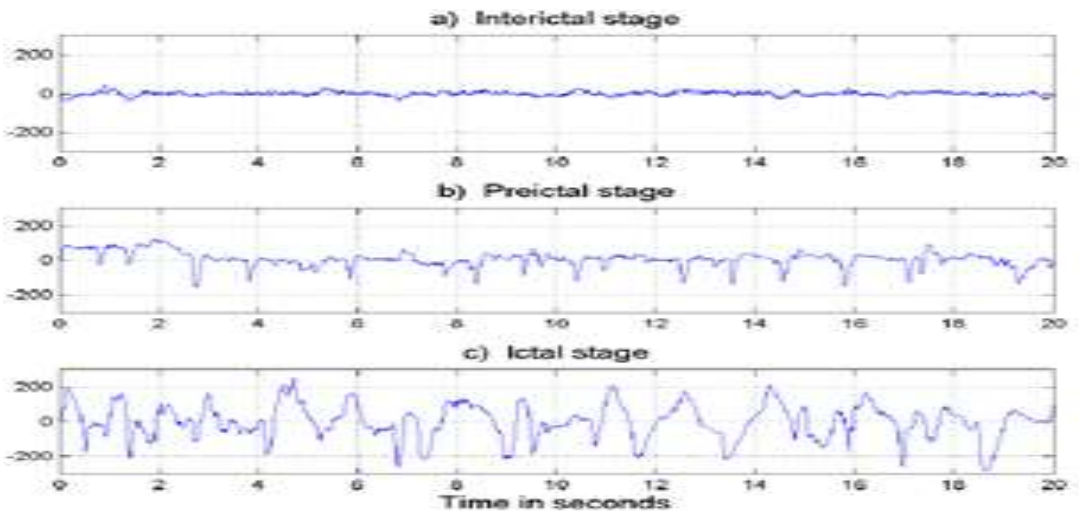

Figure 2. EEG ictal, preictal and interictal state

The fig. 3 shows the sub brands of EEg signals like alpha, beta, gama, theta and delta frequncy wave forms.

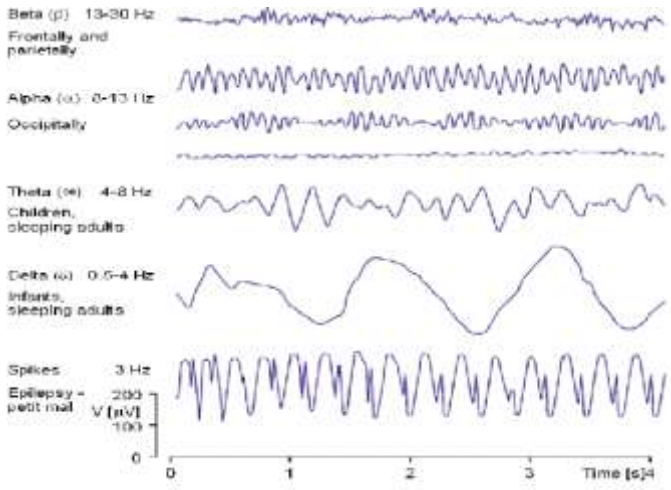

Figure 3 EEG with sub bands Alpha, Beta, Gama and Delta Frequency

The seizure is predicted with the Machine Learning algorithms such as SVM and CNN are discussed here.

3.1. Convolution Neural Network Classifier:

Convolution Neural Network has used in this work with convolution blocks. Each convolution block has batch of normalization, a convolution layer with a rectified linear unit activation function and a max-pooling layer. The batch normalization confines there zero means and unit variance. Machine learning techniques and computational techniques used in the prediction of the seizure from EEG (Electroencephalograms) signals [6]. This algorithm suits well across all the datasets and an efficient method to preprocess the raw EEG signals. Short term Fourier transform (STFT) used for the conversion of EEG signals into matrix of 2D with the frequency domain and time domain. Effective featureThis algorithm will create effective features of each patient. The engineering model built for both ictal and preictal states and is pretty much helpful in identifying the epileptic seizure well in advance. Preprocessing the EEG signals eliminate all the noise data present in the signals. Identifying the preictal state is very important than ictal because it occurs before. So diagnosing the preictal state with the help of EEG reports available we have enough time to take medication and avoid seizure. A new method has been formulated and names as k-of-n in which an alarm is set is the k predictions out last n were identified positive. For example consider the value of k=8 and n=10, will have good prediction of seizure. Among 300s, 240s will be the positive result in the prediction of seizure, after that the alarm is set. The Common practice is by spilting the dataset in 80:20 ratio, 80% training 20% test data. Each and every time the validation has to be set for the accurate result. Below fig. 5 shows the result for the sample datasets for ictal, interictal and pretictal stages.

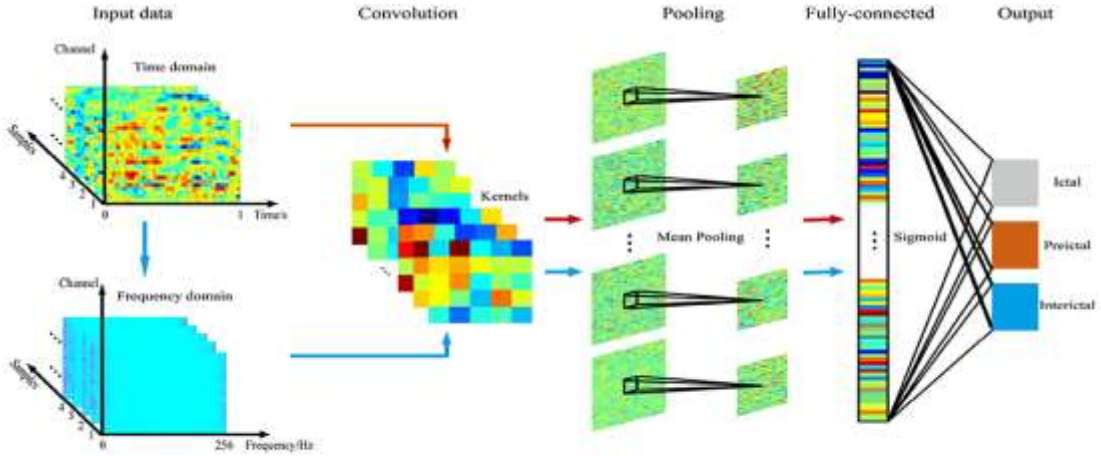

Figure 4. seizure prediction with CNN

The seizure prediction horizon (SPH)[7] and seizure occurrence period (SOP) is set for the performances metrics. The time interval where the seizure is expected to occur is SOP. The duration between the alarm and SOP is SFP. If the prediction is correct the seizure onset should occur after SPH and within SOP. Likewise, for the false alarm,

the prediction occurs but no seizure within the SOP. Sensitivity is defined as the percentage of seizures correctly predicted divided by the total number of seizures. Using this, the occurrence of the seizure is identified during preictal state. Thus the CNN method used the technique to get more sensitivity than other models.

3.2. Support Vector Machine Classifier:

Another classifier Support Vector Machine classifies the various states of EEG signals as ictal, preictal and interictal. According to [7], Preprocessing and feature extraction from EEG signals will give a great accuracy for the prediction time. Features are extracted in both time and frequency domains. From the time domain, statistical features have been extracted and other special features have been extracted from the frequency domain. Here three classifiers are compared based on the sensitivity [8]; Support Vector Machine classifier works well and a suitable one. From the time domain, statistical features have been extracted and other special features have been extracted from the frequency domain [9]. The following fig. 4 shows the flowchart for epilepsy prediction.

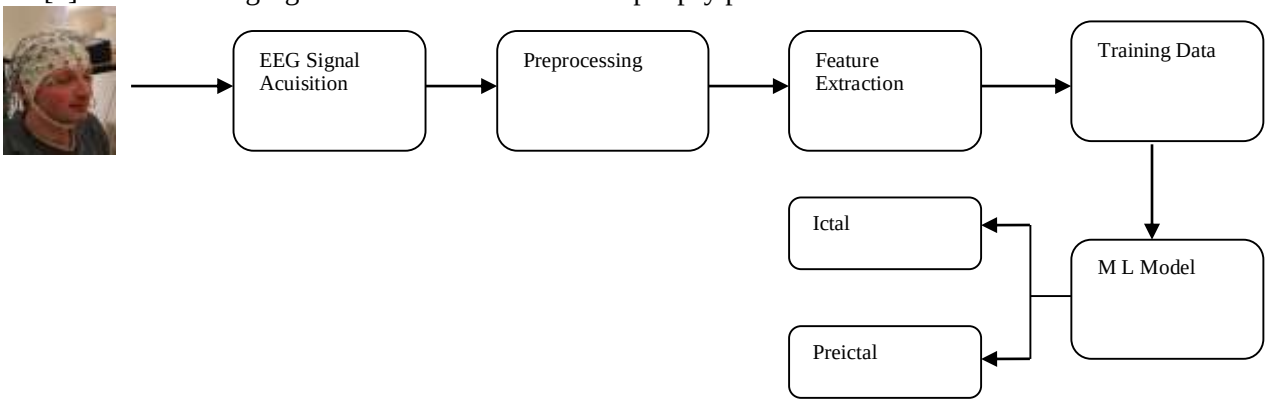

Figure 5. Flowchart for Epilepsy prediction

Frequency components are different after applying the Intrinsic Mode functions (IMF) and Empirical mode decompositions (EMF). The following conditions are must for all IMFs :(1) The of the peak values and number of zero crossing must be same otherwise the difference maximum will be 1 (2) The average envelope value calculated by local maxima and local minima should be zero. The given signal value is assumed to be x(t).

Input: Signal x(t)
Output: Intrinsic Mode Function (IMF)
Process:

- Minima and maxima sample are taken, the el(t) and em(t) are the envelopes generated.
- Local Mean value a(t) is calculated by subtracting minimum envelope from maximum envelopes.
- After that retrieve the value h1(t)=x(t)-a(t)
- Deploy the two conditions till the valid imf value is obtained.
- Continue the process until the accurate IMF is arrived.

Four statistical moments such as standard deviation, skewness, kurtosis and spectral centroid are derived from IMFs are helpful in the classification of the EEG signals. The dataset has the mixture of preictal, interictal and ictal data. Thus this SVM classifier proved accuracy level in seizure classification.

4. CONCLUSION AND FUTURE WORK:

In this discussion, the machine learning classifiers CNN and SVM are applied for EEG reports of the patients and analyzed for the prediction of seizure and processed with the model. CNN showed the higher accuracy than SVM classifier. When we apply this model for the given data set, the seizure will be predicted well in advance. So, the patients have enough time to take proper medication before the occurrence of an epileptic seizure. In future, the hybrid model for preprocessing is applied to get more accuracy.

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