# Detection of Epileptic Seizure Using EEG Sensor

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***Abstract*****—**The epileptic seizure is a disease of central nervous system. Its detection by the physical analysis of the person's body is very difficult. So, the appropriate detection of the seizure is very crucial in diagnosis of the person with seizure. The person with epileptic seizure which affects the brain signal can be detected by analyzing the brain signals using EEG sensor. The electroencephalogram (EEG) signal is very essential in the diagnosis of epilepsy.

Long-term EEG recordings of an epileptic patient contain a huge amount of EEG data. The detection of epileptic activity is, therefore, a very demanding process that needs a detailed analysis of the entire length of the EEG data, usually performed by an expert. This paper describes an automated classification of EEG signals for detecting epileptic seizures using wavelet transform and statistical analysis. The decision making process is comprised of three different stages: (1) filtering of EEG signals given as input (2) feature extraction based on wavelet transform, and (3) classification by SVM classifier. The signal from brain given as an input to EEG sensor is analyzed using MATLAB by signal processing technique.

**Keywords**-*Epilepsy, seizure, SVM classifier, EEG sensors*

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## I. INTRODUCTION

Epilepsy is a very common brain disorder that, according to an estimate of the World Health Organization, affects almost 60 million people around the world. Approximately one in every 100 persons will combat a seizure at some time in their life. [1]. Epilepsy is defined by the recurrent and sudden incidence of epileptic seizures which can lead to dangerous and possibly life-threatening situations [2]. Epilepsy seizure may cause many injuries such as fractures, submersion, burns, motor vehicle accidents and even death. It is highly possible to avert these unwanted situations if we can predict and/or detect electrical changes in brain that occur prior to incipience of actual seizure. When building a prediction model, the goal should be to make a model that precisely classifies pre-ictal period (prior to a seizure onset) from inter-ictal (period amidst seizures when non-seizure syndrome is observed) period. Onthe hand, for the detection we need to make a model that can distinguish between ictal (actual seizure period) from non-ictal/inter-ictal period.

Seizure is simply the medical condition or neurological disorder in which huge number of neurons are excited in the same time induced by brain injury or by an imbalance of chemical in the brain that is characterized predominately by unpredictable interruptions of normal brain function. During the seizure period the brain cannot perform normal task, consequently people may experience anomalous activities in movement, sensation, awareness, or behavior. There are 1% of total population in the worldwide perturbed by epileptic seizure (Netoff et al., 2009). The detection of epileptic seizure plays eminent role for medical diagnosis of epilepsy. EEG recordings are very incorrupt in the diagnosis of epilepsy. EEG signals from an epileptic patient can be split into five periods (a) non-seizure period– no epileptic syndrome is visible, (b) ictal period–actual seizure period, normally the duration is 1 to 3 minutes (c) pre-ictal period– 30 minutes to 60 minutes afore ictal period, (d) post-ictal period– 30 – 60 minutes after ictal period, and (e) inter-ictal period– period amid post-ictal period to pre-ictal period of the next ictal. Some quantum of the inter-ictal period, which does not have any epileptic syndrome, can be described as a non-seizure period. Prediction and detection of seizures by scrutinizing ictal, pre-ictal, and inter-ictal could alarm a patient of the next seizure and also could lead to fitter treatment and safety [2].

Electroencephalography (EEG) mensurates electrical brain waves. EEG has two lucid advantages for brain research, first being the characteristic of any electrical recording system—high precision time measurements. Mutation in the brain's electrical activity occur instantaneously, and extremely high time resolution is vital for determining the precise moments at which these electrical events take place. Today's EEG technology can precisely detect brain activity at a resolution of a single millisecond (and even less). Unlike other electrical recording devices that need inserting electrodes into the brain, EEG electrodes are merely stuck onto the scalp. It is thus a non-invasive procedure that allows researchers clear approach to a healthy human brain (which they would not probe inside to explore, of course). In addition, EEG sensors are relatively

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inexpensive compared with other devices and simple to operate [3].

Brain cells communicate with the help of these small electrical impulses. In an EEG, electrodes are sited on the scalp over multiple areas of the brain, as shown in figure 1. These electrodes help insensing and recording patterns of electrical

Figure 1: A subject wearing an EEG cap fitted with electrodes.

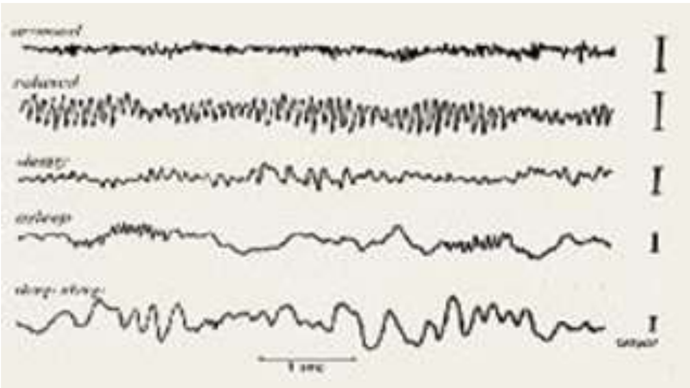

Figure 2: EEG readings with different levels of alertness

activity. Figure 2 gives an insight of EEG readings of a patient at different levels of awareness [4].

Assessing brain activity has many applications, from clinical use to research. An EEG can articulate if there is abnormal electrical activity in the brain and, in some cases, the different types of seizures you might be going through. One of the most common EEG application is to indicate the type and location of the activity in the brain during a seizure. This information can then be used for producing the right diagnosis.

## II. METHOD

In this paper, we are using a simple technique for the detection of epileptic seizure using EEG sensors. The block diagram given below, consists of Hardware and a Software Part. The Hardware comprises of the EEG Headset which contains EEG sensors which monitor method to record electrical activity of the brain. It is non-invasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used in particular applications. EEG measures voltage fluctuations resulting from ionic current within neurons of the brain. In clinical context, EEG refers to recording of the brain’sspontaneous electrical activity over period of time, as recorded from multiple electrodes placed on the scalp. These signals are then processed using the signal processing techniques which comes under the software part. It is compared with the signal database available and compared using the wavelet analysis with the help of MATLAB.

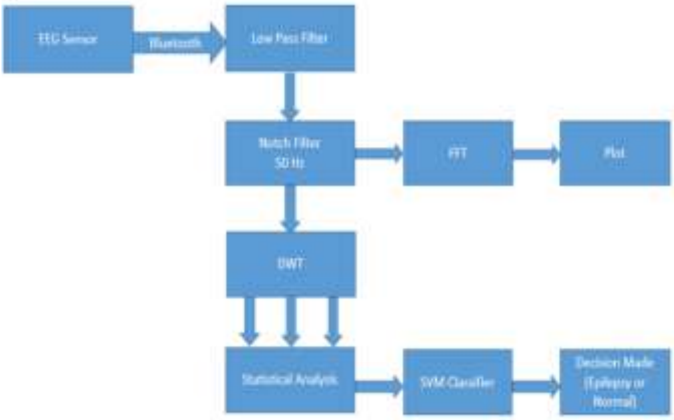


Figure 3: Block Diagram

### A. *EEG Sensor*

It consists of the EEG Headset and EEG electrode. It is typically non-invasive with the electrodes placed along the scalp. EEG electrodes measure voltage fluctuations resulting from ionic current within the neurons of the brain. In clinical context, EEG electrode record the spontaneous electrical activity of the brain. In this configuration an op-amp produces an output potential (relative to circuit ground) which is typically hundreds of thousands of times larger than the potential difference between its input terminals [5].

### B. *Filtering*

In order to confine the EEG signals within the preferred frequency band & remove distortion caused by noise due to electric supply, we carry out filtering of the input signals. The low pass filter can be used to eliminate the noise spikes and unwanted signals from other part of device. The notch filter fixed at 50Hz is used to remove the electric supply interference in the EEG signal.

### C. *Discrete Wavelet Transform*

The discrete wavelet transform (DWT) is an implementation of the wavelet transform by using discrete set of wavelet scales and translations following some defined rules. In other words, the discrete wavelet transform is used to

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decompose the signal into mutually orthogonal set of wavelets [5]. In numerical analysis and/or functional analysis, a discrete wavelet transform is any wavelet transform for which the wavelets are sampled discretely. DWT has a key advantage over Fourier Transform-temporal resolution, that is, it captures frequency as well as location information (location in time).

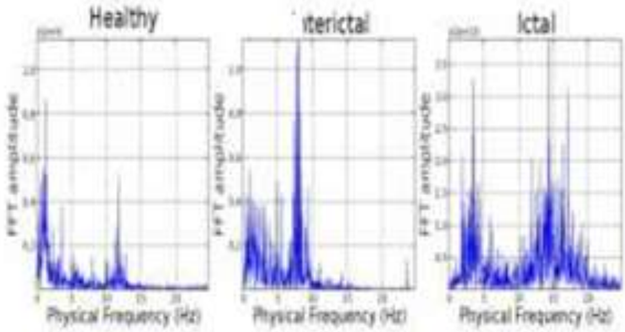


Figure 4: FFT results for 3 EEG fragments

### D. Feature Extraction

Feature extraction is a method of minimizing the resources required to delineate a large set of data. EEG data set is very complex and lengthy. Hence, for a compact representation of the humungous data set, we use statistical analysis, that is, mean and standard deviation representation of EEG signal amplitude.

### E. SVM Classifier

A feature vector is an n-dimensional vector of various features that denote some object. Many algorithms in data analysis require a numerical representation of objects, since such representations aid processing and statistical analysis. When representing EEG data set, the feature values correspond to the voltage and/or frequency of the EEG signals. We classify this feature vector as representative of seizure or non-seizure activity using a support vector machine (SVM).As the seizure and non-seizure classes are often not linearly separable, we create non-linear decision boundaries using an RBF kernel.Support vector machines (SVMs) are used to map input feature vectors into a high dimensional space to comprehend a linear classification system [6], [7]. By providing the algorithm with a set of training data, SVMs can define an optimal hyper-plane that decreases the risks. We first concentrate on the training problem of a class pair. Giving a training set of instance, say, label pairs (x, y) and weighting vector w, where x and y represent the input and output domains respectively, allocate a penalty to errors.

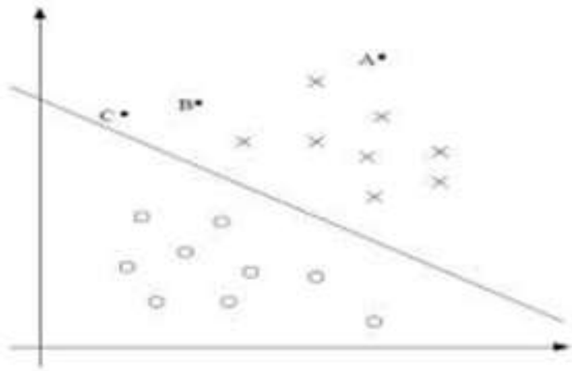


Figure 5: Classification of a Support Vector Machine

Note that it may not be beneficial to achieve high training accuracy (i.e., classifiers precisely predict training data whose class labels are indeed known). Hence, a common way is to distinguish training data by mapping instances into high dimensional domain to form models. After data are mapped into a higher dimensional space, the number of variables becomes very large or infinite. Diagnose the seizure, the total system will expose a new area of patient wearable systems for monitoring and analyzing biological signals to detect seizure [5].

## CONCLUSION

The main objective of this report was to examine the advancement in signal processing algorithms for epileptic seizure detection using digital signal processing of EEG signals [7]. It aimed to blend hardware for sensing EEG signals and computer technology to perform as the processing hub for monitoring the EEG signals. The project also intended to carry out small scale investigation by applying statistical analysis along with direct evolution of the signal. The wavelet transform with the statistical analysis is the finest option for the EEG signal classification and seizure detection [6].

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