International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 03 | Mar -2017 www.irjet.net p-ISSN: 2395-0072

EPILEPTIC SEIZURE DETECTION USING AN EEG SENSOR

Prof. Sandhya Shinde[1], Shradha Chavan[2]

[1]Assistant Professor, E&TC, Dr. D.Y Patil Institute of Engg, Management and Research, Pune, Maharashtra, India.
[2]Student, E&TC, Dr. D.Y Patil Institute of Engg, Management and Research, Pune, Maharashtra, India.

---***---

Abstract - *Epilepsy is an inveterate neurological disorder which is caused by unusual nerve cell activity in the brain and is characterized by consecutive unexpected seizures. Precisely indentifying and enumerating the seizures in patients with epilepsy is essential for diagnosis, selecting the treatment and estimating the effects of the therapy. Epilepsy detection done just by physically anatomizing a person's body is a very arduous job. The brain involves peculiar nerve cell activity which can be analyzed with the help of an EEG sensor to detect epileptic seizure in a subject as it measures the voltage fluctuations resulting from ionic current within the neurons of the brain. This paper presents an approach to analyze the brain signal using an EEG sensor and perform various signal processing techniques on it in MATLAB, detect its high frequency components by wavelet analysis and compare it with the database signal to detect and classify the seizure with the help of SVM.*

***Key Words*: Epilepsy, EEG (Electroencephalogram), seizure, SVM classifier, DWT.**

1. INTRODUCTION

The brain is one of the crucial organs of the human body. Epilepsy is a non-contagious, chronic neurological disorder of the cerebral nervous system (brain) that affects people of all ages with over 50 million patients worldwide. Globally, each year an estimated of about 2.4 million people are diagnosed with epilepsy [1]. The chronic peculiar bursts of electrical discharge in the brain causes a severe disorder of the cerebral nervous system resulting in recurrent, unprovoked epileptic seizures. During an epileptic seizure, the patient may be struck by numerous symptoms such as loss of consciousness, involuntary movements, uncontrollable twitching. Some epileptic seizures can be milder than the others, but even minor seizures can be perilous if occurred during activities like swimming or driving. The seizures are classified based on the part of the brain affected. Focal (partial) seizures and generalized seizures are the two main types of seizures, in a partial seizure the epileptic activity affects only one part of the brain whereas in a generalized seizure the entire brain is affected during the epileptic activity [2]. The classification of the epileptic seizure is as shown in Fig -1.

Epileptic seizures can be efficiently controlled by the use of appropriate medications but about 30% of the patients do not have seizure control at the proper time.

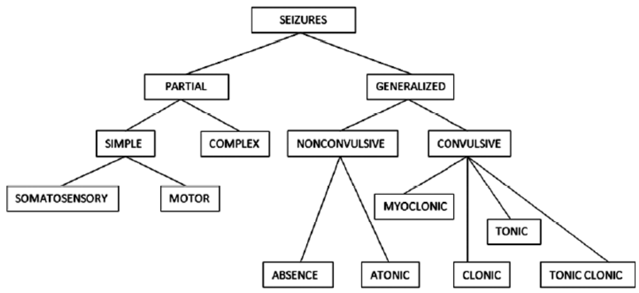

Fig -1: Classification of Epileptic Seizure.

Also the exact type of seizure should be recognized for apt diagnosis. Prediction of epileptic seizures at an initial stage increases the effect of medication and more patients can be treated accordingly thus improving the quality of life of the patients. For the proper treatment, doctors need to know if and when the seizure occurs as many medical decisions depend on detailed information about the seizure type and its origin in the brain. EEG monitoring is the golden standard for the diagnosis of epilepsy, it aids in the appropriate classification and detection of the seizure. An EEG investigation provides the aforementioned information about the continuous unusual nerve cell activity in the brain and a detailed seizure characterization in order to resolve therapeutic options, particularly in the absence of a response to medication. During an EEG investigation, the physicians place electrodes on the scalp which sense and record the impulsive electrical motion taking place in your brain which is then examined to find unusual activity, which may signal epilepsy. The Fig-2 shows a typical EEG recording setup wherein the electrodes are placed on the scalp.

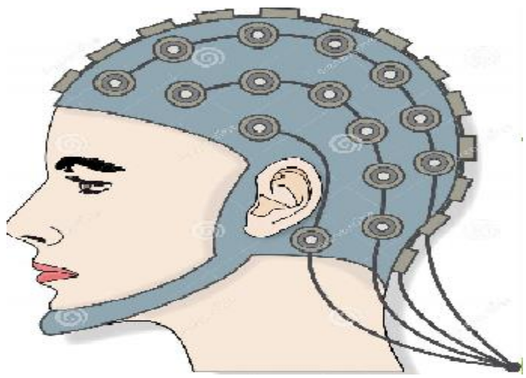

Fig -2: EEG Electrodes placed on scalp.

1.1 Electroencephalogram:

The brain is the most multifaceted of all the other organs of the human body, producing electrical signals to run the entire body directly or indirectly. The electrical activity is generated in the brain by millions of neurons which are recorded by an Electroencephalogram. EEG is a good, non-invasive diagnostic tool that can be digitally anatomized to detect the disorder. The EEG sensor encompassed in the EEG headset is used as a Brain-Computer Interface (BCI) tool that reports the wearer's mental state, along with raw waves and information about the brainwave frequency bands. Two electrodes are placed on the scalp to form an EEG channel which measures the potential difference between the electrodes and then records the summed potential of neurons. A patient suffering from a seizure has a distinctly different EEG as compared to that of the normal ones. Thus by processing the raw waves acquired from the EEG headset with the help of MATLAB, we can classify and detect the epileptic seizure. The first five seconds of EEG data segments from three different groups of data sets (normal EEG data – healthy subject, interictal EEG data – epileptic subject during seizure free interval, ictal EEG data – epileptic subject during a seizure) are as shown in Fig-3.

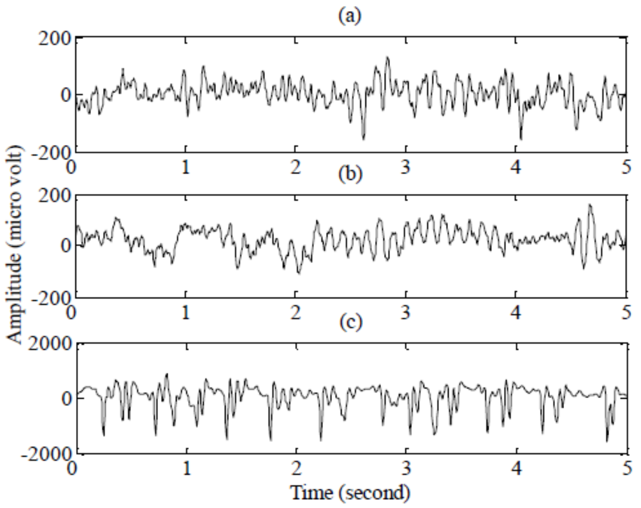

Fig -3: Segments of EEG data: (a) Normal, (b) Interictal, (c) Ictal.

1.2 Objective of the project:

The main objective of our project is to build a lucrative and consumer affable system that will assist doctors, patients and parents in supervising the epileptic seizures. This system will detect the epilepsy even when the patient is not having a seizure at that instance but have had it in the past.

2. Proposed work:

The proposed plan of action of this project is to use an EEG headset comprised of EEG sensors to detect the raw data from the brain waves and process these raw waves using signal processing techniques, extract features and classify them into seizure and seizure-free sets using SVM classifier in MATLAB. The block diagram consisting of the hardware and software part is as shown in the Fig-4. The hardware part consists of the EEG headset which will detect the high frequency components of the brain waves in the form of raw data and further send those signals for processing; the signal processing comes under the software part. The signal processing techniques involves the basic steps of filtering these raw waves in order to remove noise and artifacts associated with the irrelevant physiological activity [3]. These techniques involve the use of low pass filter and a notch filter. These processed signals are further sent for feature extraction to the DWT.

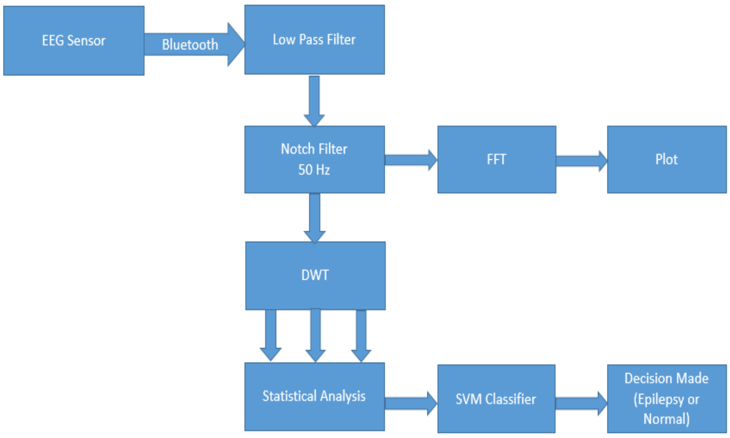

Fig -4: Block Diagram.

2.1 Discrete Wavelet Transform (DWT):

There is a considerable trade-off between the time and frequency resolutions in the traditional methods of Fourier analysis, thus leading to show more accurate results with increased sensitivity and specificity in the wavelet decomposition (wavelet transform). The wavelet decomposition allows the best possible selection of decomposition levels with least amount of entropy values, high power spectral density, pertaining to epileptic waveform [3]. The DWT decomposes the signal into mutually orthogonal set of wavelets meaning that the wavelets are sampled discretely. The EEG signal is decomposed into its sub-bands by discrete wavelet transform to extract features from the theta, alpha and beta bands i.e. it is used to split the signal into five frequency bands. Various features such as the Energy, Zero Crossing Rate (ZCR), Variance and Fractal dimensions can be extracted from the sub-bands. The values of these features are fed to a Support Vector Machine to separate the classes into epileptic and non-epileptic seizures after performing statistical analysis on it. Statistical analysis and SVM classifier are used for the computation of datasets that are too vast to be stored in the memory. The statistical toolbox aids us to identify variables and features by providing feature choice, stepwise reversion, principal component analysis (PCA), formalization and additional dimensionality reduction methods.

2.2 Support Vector Machine (SVM):

The Support Vector Machine is used for the classification of the EEG signals, it must be able to differentiate between the electrical activity of a healthy subject and an epileptic one. In SVM, we plot each data item as a point in n-dimensional space with the value of each feature being the value of a specific coordinate, and then the classification is done. The SVM primarily consists of constructing an optimum hyperplane that maximizes the margin of separation amid two different classes. To do so a kernel is used to transform the input data to a higher dimensional space followed by an optimization step for the construction of an optimum hyperplane [4]. Since we are using raw data from the brain waves we will have non-linearly separable data, for which we will create non-linear decision boundaries using kernel. A kernel is basically a function which converts non-separable problem to a separable problem by simply transforming low dimensional input space to a higher dimensional input space. The main motive behind the kernel is to map the data into different feature space in order to construct linear or non-linear classifiers in the original space. It does some extremely complex data transformations and then finds out the process to segregate the data based on the labels or outputs we have defined. The classifier will thus be able to classify the seizure precisely and at the same time be robust with respect to EEG signal variations across assorted mental states and subjects. The SVM classifier used for the epileptic seizure detection should be trained, cross validated and tested with the extracted features using DWT of the EEG signals obtained from healthy (non-epileptic) and epileptic subjects comprised in our database.

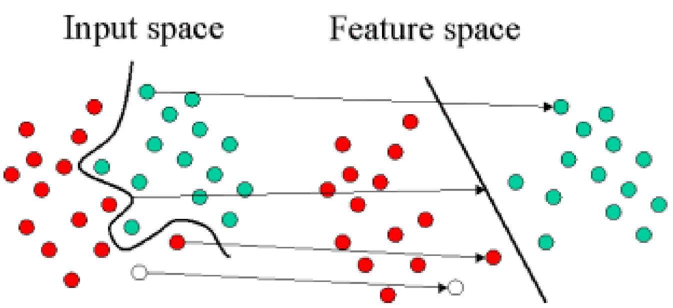

Fig -5: Classification of EEG from Nonlinear into a Linear.

3. Flowchart:

The work flow of the project is as shown in Fig -6.

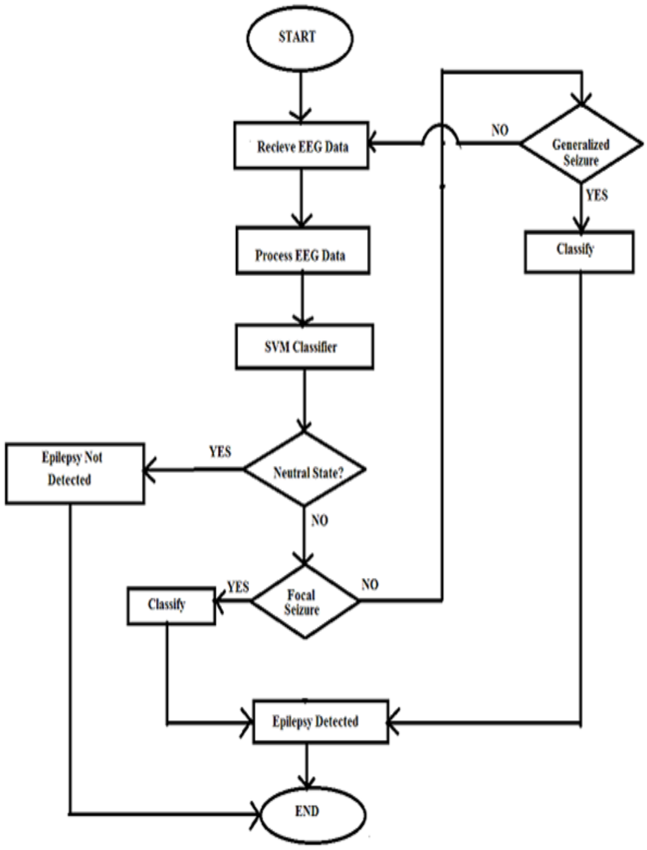

Fig -6: Flow Chart

4. Advantages:

- It is a robust device for tracking brain changes during different phases of life, including evaluating adolescent brain maturation and indicating noteworthy facets of the timing of brain development.
- EEG is tolerant to a relative extent of subject movement and it also includes artefacts for eliminating movement in EEG data.
- It prevents inadequate availability of technologists to provide abrupt care in high traffic hospitals.
- It is a non-invasive technique with high temporal resolution.
- The hardware costs are significantly lower of this system than compared with most of the other techniques available.

5. Disadvantages:

- Relatively many subjects are needed to extract constructive information from EEG and sophisticated data analysis is required since the signal-to-noise ratio is poor.
- EEG requires intense interpretation just to postulate which parts are activated by a specific response.

6. Applications:

- To distinguish between the epileptic seizures and other sorts of spells such as psychogenic non-epileptic seizures, syncope (fainting), sub-cortical movement disorders and migraine variants.
- It serves as an adjunct test of brain death.
- To prognosticate, in certain cases, in patients with coma.
- To decide whether to wean anti-epileptic medications.

7. CONCLUSIONS

This paper presents a system which extracts large number of features from the EEG data after wavelet transformation and performs statistical analysis before sending it to the SVM classifier to make an objective decision about the EEG data processed. This system will be able to efficiently differentiate the epileptic features from the normal EEG signals with high accuracy and the least false rate will influence its ability to correctly predict the onset of the seizure.

REFERENCES

[1] World Health Organization, "Epilepsy." (http://www.who.int/mediacentre/factsheets/fs999/en/).

[2] Kimberly Holland, "Epilepsy by the Numbers: Facts, Statistics and You." (http://www.healthline.com/health/epilepsy/facts-statistics-infographic).

[3] Kavya Devarajan, E. Jyostna, K. Jayasri, "EEG-Based Epilepsy Detection and Prediction", IACSIT International Journal of Engineering and Technology, Vol. 6, No. 3, June 2014.

[4] N. Mammone, F. La Foresta, and F.C Morabito, "Automatic artifact rejection from multichannel scalp EEG by wavelet ICA," IEEE Sensors J., vol. 12, no. 3, pp. 533-542, Mar. 2012.

[5] A. Kumar and M. H. Kolekar, "Machine learning approach for epileptic seizure detection using wavelet analysis of EEG signals," Medical Imaging, m-Health and Emerging Communications Systems (MedCom), 2014 International Conference on, Greater Noida, 2014, pp. 412-416. doi: 10.1109/MedCom.2014.7006043.

[6] S. Sanei and J.A. Chambers, "EEG Signal Processing," Centre of Digital Signal Processing, Cardiff University, UK, John Wiley & Sons, Ltd., 2007.

[7] A. S. Zandi, G. a Dumont, M. Javidan, R. Tafreshi, B. a MacLeod, C. R. Ries, and E. Puil, "A novel wavelet-based index to detect epileptic seizures using scalp EEG signals", Conf. Proc. Engineering in Medicine and Biology Society, vol. 2008, no. 2, (2008), pp. 919–922.

[8] A. Shoeb and J. Guttag, "Application of Machine Learning To Epileptic Seizure Detection", Proceedings of the 27th International Conference on Machine Learning, (2010) pp. 975–982.