GE-INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH
VOLUME -2, ISSUE -10 (December 2014) IF-3.022 ISSN: (2321-1717)

PREDICTION OF EPILEPTIC SEIZURE FROM EEG SIGNAL BY DWT AND ANN TECHNIQUE- A REVIEW

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ABSTRACT

Prediction of EEG signals has core issues on EEG based brain mapping analysis. Epilepsy is the most common neurological disorder which is characterized by sudden and recurrent neuronal firing in the brain. It can be detected by analyzing EEG of the subject. EEG recorded in the absence of an external stimulus is called spontaneous EEG; EEG generated as a response to external or internal stimulus is called an event-related potential (ERP). The amplitude of EEG of a normal subject in the awake state recorded with the scalp electrodes is 10–100 mV. In case of epilepsy, the EEG amplitudes may increase by almost an order of magnitude. In the cortex, amplitudes are in the range 500–1500 mV. It can easily display wave patterns like alpha, beta, delta, etc according to human behavior. EEG input signals are in stationary and non stationary form. It is very difficult to predict it. Various comparison and classification techniques are used to measure irregularities present in the EEG signals. Wavelet transform is the effective method for time frequency representation signal analysis. Artificial neural network is used for signal classification and tests carried out by hidden layer.

The classification of EEG signals has been performed using features extracted from EEG signals. Electroencephalogram is a medical technique that records the electrical activity in the brain. The EEG signals were decomposed into time–frequency representations using discrete wavelet transform and seizure signals were classified using a linear classifier .

Keywords—Electroencephalography,Epilepticseizure, EEGsignal ,Dwt,Feature Analysis.

I. Introduction

An EEG machine is a recording device connected by wires to electrodes pasted at key points on the patient's head. Electroencephalogram is the recording of electrical activity along the scalp produced by the firing of neurons within the brain. The electrodes pick up signals produced by electrical discharge of neurons in the related areas of the brain. The different electrodes are used to recognize EEG test over the skull. Epileptic seizures are seen as a sudden abnormal function of the body, often with loss of consciousness, an increase in muscular activity or an abnormal sensation. It may occur in the brain locally called as partial seizures, which are seen only in a few channels of the EEG recording, or involving the whole brain called as generalized seizures, which are seen in every channel of the EEG recording. EEG is the most useful and cost effective tool for the study of Epilepsy. There is use of wavelet based features for the classification between normal and seizure EEG signals. EEG has been considered a successful tool in neuroscience to diagnose diseases and disorders.[1]

II. Standards of EEG measurement

EEG is usually registered by means of electrodes placed on the scalp. They can be secured by an adhesive like embedded in a special snug cap. The resistance of the connection should be less than 5KOhms, so the recording site is first cleaned with diluted alcohol, and conductive electrode paste applied to the electrode cup. Knowledge of exact positions of electrodes is very important for both interpretation of a single recording as well as comparison of results, hence the need for standardization. Silva et al. [12] explained electrode system for EEG measurement which has the inter electrode distance of about 4.5 cm corresponds to placing 10-20 electrodes over the head. Gevins and S. L. Bressler [10] indicating sampling with 128 electrodes system which has inter electrode distance 2.25cm corresponds over the head. Electroencephalographic signals recorded according to such a system using a high spatial sampling frequency are called high-resolution EEGs. Several systems use 256 electrodes [12] to obtain a finer sampling of the electrical activity at the scalp. Recordings under these conditions are important for an appropriate application of signal analysis methods.

III. Data description

EEG signals are extracted from sophisticated machines in highly secured and de-noised labs are easily prone to artifacts and several other type of non-separable noise. EEG signal when analyzed has a very low frequency in the range of hertz. These EEG signals can be classified based on their frequency bands. The classification is shown in the Table mentioned bellow, it also mentions the region of brain from where it is extracted.

Type	Frequency	Location
Delta	Up to 4	Frontally in adults, posteriorly in children; high amplitude waves
Theta	4-8	Found in locations not related to task at hand
Alpha	8-13	Posterior regions of head, both sides, higher in amplitude on non-dominant side.
Beta	13-30	Both sides of Brain, symmetrical distribution, most evident frontally; low amplitude waves
Gamma	31-100	Somatosensory cortex

Table 1: Classification of EEG Signals based on their frequency

Also it is very difficult to extract EEG signal from the brain and separate the artifacts, based on the classification of their frequency it generates signals of those frequency and data will be simulated.

IV. Seizure detection

The seizure detection problem is basically a classification between normal and seizure EEG signals. Y.U. Khan and O. Farooq, 2009 [8] explained the preprocessing system of EEG signal. This processing system can generally be subdivided to three functional parts preprocessing, feature extraction and classification. Normally the EEG data is corrupted by the artifacts which are electrical signals that are picked up by the scalp electrodes that do not originate from cortical neurons. There are various sources of articraft, one of the most common causes of artifacts is eye movement and blinking. Strong signals from A/C power supplies with 50Hz line frequency is another source of artifact. Signals originated due to muscle movements are another artifact. So the first step is to preprocess the data to remove these artifacts. The next step is to process the filtered signal and extract features that represent or describe the status and conditions of the system. Such features are expected to distinguish between normal and seizure.

Data Collection: Data collection is a process of gathering information from a variety of sources to get and accurate picture. The collection of data from surveys, independent or networked locations via data capture, data entry.

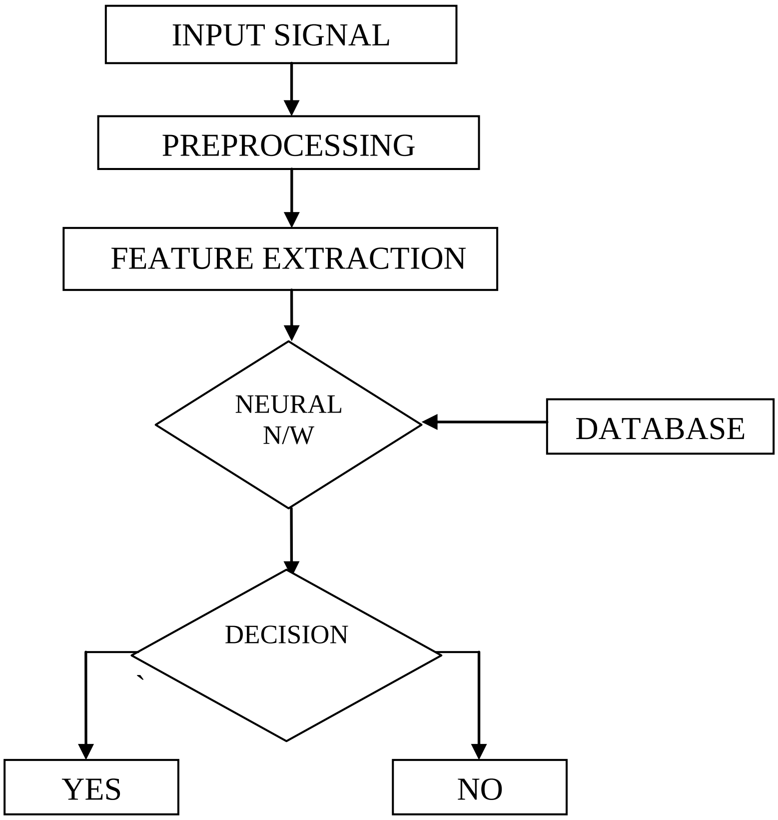

Figure1: EEG Preprocessing System

Preprocessing: It describes any type of processing performed on raw data to prepare it for another processing procedure. Data preprocessing transforms the data into a format that will be more easily and effectively processed for the purpose of the user. There are a number of different tools and methods used for preprocessing such as sampling, de-noising, filtration, normalization etc.

Feature Extraction: Features are functions of the original measurement variables that are useful for classification or pattern recognition. Feature extraction is the process of defining a set of features, or image characteristics, which will most efficiently or represent the information that is important for analysis and classification. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases a neural network is an adaptive system changing its structure during a learning phase. Neural networks are used for modeling complex relationships between inputs and outputs or to find patterns in data.

The last step is the classification and diagnostics. In this step, all the extracted features are submitted to a classifier that distinguishes among different classes of samples, for example, normal and abnormal. In the seizure detection problem this step is the classification between normal and seizure EEG signals.

V. Modeling and characterization of EEG signal:

The impact of EEG signal processing and modeling with respect to inter ictal activity, or epileptiform transients, and thus to the characterization of the irritative zone, can be considered according to two dimensions spatial and temporal. The spatial approach focus on the identification of brain areas responsible for the occurrence of epileptiform transients and their topographic properties .The temporal approach targets on the evolution of the occurrence of these transients.

A. The Equivalent Dipole Source Concept

The most common source model is the dipole layer. The main neuronal sources of epileptiform spikes consist of cortical patches and are capable of producing strong current dipoles, whereas the layer IV spiny stellate and layer III aspiny stellate cell with closed-field configurations produced weaker current dipoles. Baumgartner et al. [3] introduced dipole layers in strong and weak current dipoles.

B. Requirements for Time and Spatial Sampling

In order to apply EEG analytical tools to detect any kind of activity one has to perform a proper sampling both in time and space. These events have high-frequency temporal and spatial components and that their occurrence may involve very limited extent of the cortex. Some spikes may be accounted for a radial dipole localized in the crown of a cortical gyrus. J. Britz et. al 2008 [12] has applied 256 electrodes to obtain a finer sampling of the electrical activity at the scalp to acquire EEG signal. To perform the analysis of sources of various kinds of cortical phenomena, including epileptiform spikes, using high-resolution, EEGs introduced a de-blurring operation, i.e., a method to minimize the blur distortion that takes place in the transfer from the cortical surface to the scalp. The optimal potential distribution the cortical surface that provides the best-fit forward solution to the measured scalp distribution, using an appropriate volume conductor model.

C. From Topographical Maps to Source Modeling

The simplest and most general form of analysis of epileptiform transients is to perform topographical maps of the transients. The case of epileptiform spikes that are characteristic Epilepsy of Childhood that EEG analysis in providing insight into the abnormal neuronal processes underlying these events. In these cases there is a focus of epileptiform transients. G. Huiskamp et. al. 2004 [13] described a single or multiple dipolar sources depend on the nature of the epileptic condition, but is also affected by the analytical methodology applied.

VI. EEG Classification and its Optimization Techniques

P.K. Kulkarni (2013) used improved approximate Entropy hybrid technique for classification EEG signals for identification of epilepsy seizure. The system is combination of multi-wavelet transform and artificial neural network. FFNN is one of the artificial intelligence techniques, which is used for generating training dataset. From the generated dataset, the types of EEG signal classified as normal and epilepsy seizures signal. Approximate Entropy algorithm is enhanced to measure irregularities present in the EEG signals. The technique is implemented, tested and compared with existing method, based on performance indices such as sensitivity, specificity, accuracy parameters. EEG signals are classified as normal and epilepsy seizures with acceptable accuracy [2].

R Harikumar, M. Balasubramani, Saravanan S. (2013) explained implementation of a wavelet neural network (WNN) with learning ability on Field Programmable Gate Array for epilepsy detection. The electro- encephalography (EEG) signals were first pre-processed using discrete wavelet transforms (DWTs). Three different activation functions were used in the hidden nodes of WNNs Gaussian, Mexican Hat, and Morlet wavelets. The best combination to be used was the WNNs that employed Morlet wavelet as the activation function, with Daubechies wavelet of order 4 in the feature extraction stage. A more suitable method is the particle swarm optimization (PSO) that is a population-based optimization algorithm. In the approximation of a nonlinear activation function, there is use of Taylor series and a look-up table (LUT) to achieve a more accurate approximation. [4]

Sang-Hong Lee 2014 stated a method that uses a wavelet transform (WT) and a fuzzy neural network to select the minimum number of features for classifying normal signals and epileptic seizure signals from the electroencephalogram (EEG) signals of people with epileptic symptoms and those of healthy people. WT was used to select the minimum number of features by creating its coefficients. with the highest accuracy. It is obtained by using a non-overlap area distribution measurement method which is based on a neural network with weighted fuzzy membership functions resulted in satisfactory performance in terms of sensitivity, specificity, and accuracy[5].

VII. Conclusion

Electrode measurement systems are used to acquire EEG signal. The EEG signal is classified between normal and seizure EEG signal. In order to apply EEG analytical tools to detect any kind of activity, there is need to perform a proper sampling in time and space. Epilepsy can be described by a single or multiple dipolar sources depend on the nature of the epileptic condition. Field Programmable Gate Array implements classifiers to solve the statistical, identification and control problems and requires hardware implementation. To detect irregularities there is use of improved approximate Entropy hybrid technique for classification of EEG signals and for identification of epilepsy seizure. WT is used to select the minimum number of features by creating its coefficients with the highest accuracy. It is obtained by using a non-overlap area distribution measurement method. In the future, a recurrent wavelet neural network will be proposed for solving identification and control problems.

References

[1]S. M. Shafiul Alam and M. I. H. Bhuiyan, "Detection of Seizure and Epilepsy Using Higher Order Statistics in the EMD Domain", IEEE Journal Of Biomedical And Health Informatics, vol. 17, No. 2, March 2013.

[2]Sharanreddy, P.K. Kulkarni “EEG signal classification for Epilepsy Seizure Detection using Improved Approximate Entropy”, vol. 2, No. 1, March 2013.

[3]C. Baumgartner,M. Graf, A. Doppelbauer,W. Serles, G. indinger, A.Olbrich, J. Bacher, E. Pataraia, E. Almer, and A. Lischka, “The functional organization of the interictal spike complex in benign Rolandic epilepsy,” Epilepsia, vol.37, pp. 1164–1174, 1996.

[4]Dr. R Harikumar, M. Balasubramani, Saravanan S. “ FPGA Implementation of Wavelet Neural Network for Epilepsy Detection ”, vol. 2, Issue 9, March 2013.

[5]Sang-Hong Lee and Joon S. Lim **“**Minimum Feature Selection for Epileptic Seizure Classification using Wavelet-based Feature Extraction and a Fuzzy Neural Network” ,Applied. Mathematics Information Science an International Journal 8, No. 3, 1295-1300 2014.

[6] Nandish.M , Stafford Michahial, Hemanth Kumar P, Faizan Ahmed “Feature Extraction and Classification of EEG Signal Using Neural Network Based Techniques”, vol. 2, Issue 4, October 2012.

[7] Alexandros T. Tzallas, Markos G. Tsipouras, and Dimitrios I. Fotiadis, “Epileptic Seizure Detection in EEGs Using Time–Frequency Analysis”, IEEE Transcations On Information Technology , vol. 13, No. 5, September 2009.

[8]Y. U. Khan and O. Farooq, “Autoregressive features based on classification for seizure detection using neural network in scalp electroencephalogram”, International Journal of Biomedical Engineering and Technology,vol. 2, No. 4, pp.370-381, 2009.

[9] Z.L. Gaing, “A particle swarm optimization approach for optimum design of PID controller in AVR system”, IEEE Transactions on Energy Conversion 19 (2) (2004)

[10]A. S. Gevins and S. L. Bressler, “Functional topography of the human brain,” in Functional Brain Imaging, G. Pfurtscheller and F. H. Lopes da Silva, Eds. Toronto, pp. 99–116, 1988.

[11]F.H.Lopes da Silva,“EEG analysis:Theory and practice,”in Electroencephalography, Basic Principles, Clinical Applications and Related Fields,, pp. 1097–1123, 1993

[12] Britz, T. Landis, and C. M. Michel, “Right parietal brain activity precedes perceptual alternation of bistable stimuli,” in Cereb. Cortex,Apr. 18, 2008.

[13]G. Huiskamp, W. van Der Meij, A. van Huffelen, and O. van

Nieuwenhuizen, "High resolution spatio-temporal EEG-MEG analysis of Rolandic spikes," J. Clin. Neurophysiol., vol. 21, No. 2, pp.84–95, Mar.-Apr. 2004.

[14] Nandish.M, Stafford Michahial, Hemanth Kumar P, Faizan Ahmed," Feature Extraction and Classification of EEG Signal Using Neural Network Based Techniques" International Journal of Engineering and Innovative Technology (IJEIT) vol.2, Issue 4, October 2012.