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

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ABSTRACT

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. Electroencephalograms (EEG) are signal records of electrical activity of brain neurons. It can easily display wave patterns like alpha, beta, delta, etc according to human behavior. Prediction of EEG signals has core issues on EEG based brain mapping analysis. EEG, which is a compulsive tool, used for diagnosing neurological diseases such as epilepsy, besides of techniques such as magnetic resonance and brain tomography (BT) that are used for diagnosing structural brain disorders.EG 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. This paper describes a novel approach for forecasting epileptic seizure activity, by classifying these EEG signals. The decision making consists of two stages; initially the signal features are extracted by applying wavelet transform (WT) and then an artificial neural network (ANN) model, which is a supervised learning-based algorithm classifier, used for signal classification.[3]

Wavelet transform is the effective method for time frequency representation signal analysis. The classification of EEG signals has been performed using features extracted from EEG signals. The performance of the Artificial neural network is used for signal classification and tests carried out by hidden layer.

Keywords—Electroencephalography, EEG signal, Dwt , ANN Feature Analysis, Prediction of EEG

I. Introduction

EEG is the most useful and cost effective and successful tool in neuroscience to diagnose diseases and neurological disorders which is caused due to the electrical activity within brain. Epilepsy is one of the most serious neurological disorders. About 50 million people world-wide are suffering from epilepsy and each year, 2.4million new cases are estimated to occur globally. In most of the adult patients, it occurs in the mesial temporal structures such as hippocampus, amygdale, and parahippocampal gyrus. It is characterized by recurrent seizures, transient impairments of sensation, thinking, and motor control, caused by sudden excessive electrical discharges in a group of brain cells.

The electrical activity of active nerve cells in the brain produces currents spreading. These currents reach the scalp surface, and resulting voltage differences on the scalp can be recorded as the electroencephalogram. Thus it is the recording of electrical activity along the scalp produced by the firing of neurons within the brain. The EEG records can easily display these electrical discharges as a rapid change in potential differences. Thus, neurologists invariably use EEG records to investigate suspected seizure phenomena.[7]

Epileptic seizures are sudden abnormal function of the body, with loss of consciousness, an increase in muscular activity or an abnormal sensation. There is use of wavelet based features for the classification between normal and seizure EEG signals.

Thus neurologists invariably use EEG records to investigate suspected seizure phenomena ejection of a seizure attack. EEG input signals are in stationary and non stationary form. There are various comparison and classification techniques are used to measure irregularities present to predict EEG signals. The detection of epilepsy is possible by analyzing EEG signals. [4]

II. Data Description

Data collection is a process of gathering information from a variety of sources. In this paper data from EEG signal of approximately 40 to 50 patients is collected and used to train Ann network model. Each EEG signal consists of 309000 data points. This data points are further divided with set of 154 each contains 2000 data points. The energy is extracted from these data packets for further analysis.

METHODOLOGY

Signals originated due to muscle movements are another artifact. The first step is to preprocess the data to remove artifact slow and high frequency components. 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.

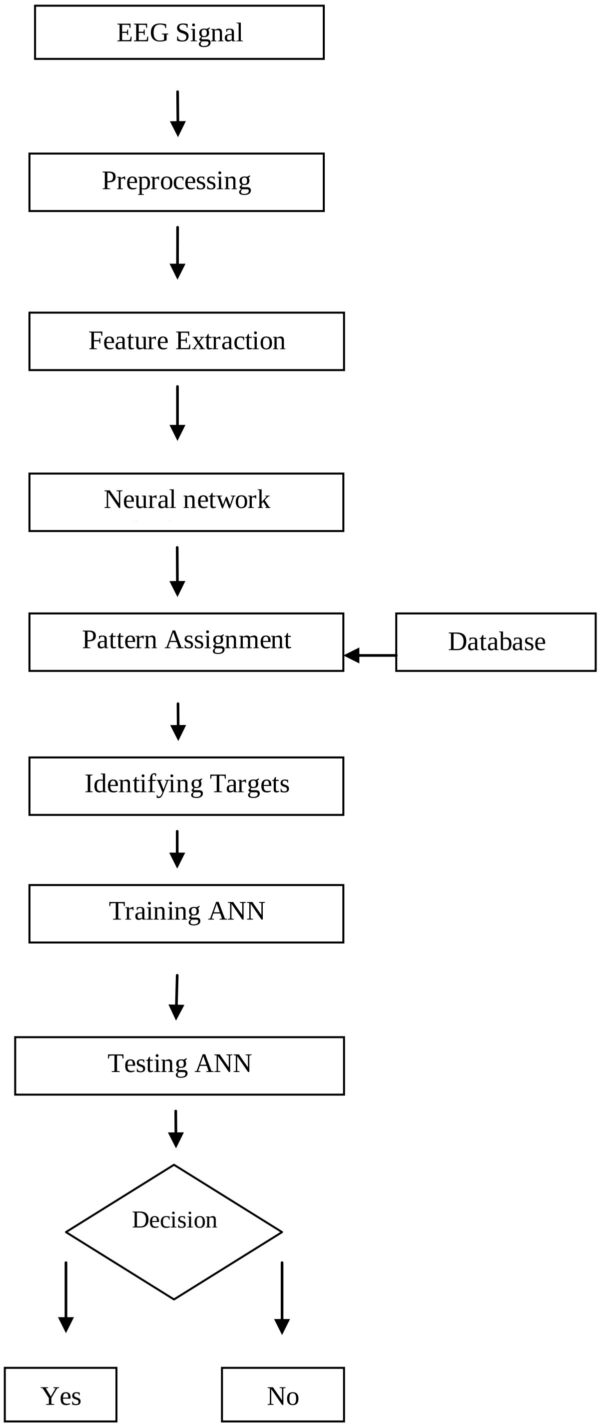

Fig 1 : Functional Modulus of EEG Preprocessing System

Preprocessing:

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. In this stage detailed frequency content is obtained by NFFT (Nyquist Fast Fourier Transform) which is considered in EEG Signal. The high frequency components are removed from the EEG signal and low frequency signals are allowed to pass. The Low Pass Filter is designed according to the Specification and Parameters. At the end of preprocessing stage we obtained new filtered signals.

III. Design and Implementation

Wavelet Transform (WT)

The wavelet transform (WT) is designed to address the problem of non-stationary signals. The main advantage of the WT is that it has a varying window size, being broad at low frequencies and narrow at high frequencies.

Spike parameters extracted from the EEG signal, such as slope and sharpness, are presented to the ANNs for training and testing. The selection of the parameters is very important task for success of such types of system. The EEG signals, consisting of many data points, can be compressed into a few features by performing spectral analysis of the signals with the WT. These features characterize the behavior of the EEG signals. Using a smaller number of features to represent the EEG signals is particularly important for recognition and diagnostic purposes. The window size of 20 points (100 ms) produced successful results [8-10]. Later, this window was extended to 30 points (150 ms) for further improving detection accuracy.[4]

Feature Extraction

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. 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.

Selection of appropriate wavelet and the number of decomposition levels is very important in analysis of signals using the WT. The number of decomposition levels is chosen based on the dominant frequency components of the signal. Thus, the EEG signals were decomposed into details D1–D4 and one final approximation, A4. The smoothing feature of the Daubechies wavelet of order 6 made it more suitable to detect changes of the EEG signals [2].Therefore, the wavelet coefficients were computed using DB 6.

The computed detail and approximation wavelet Coefficients of the EEG signals were used as the feature vectors representing the signals. The EEG signals were decomposed into time–frequency representations using discrete wavelet transform and statistical features were calculated[4].

In this stage filtered signal is Selected for feature extraction and DB6 level, applied to extract the feature on selected signal. Wavelet Energy is recorded after summing of detail coefficients. Then we can plot three subplots for detail, approximate and moving window number.

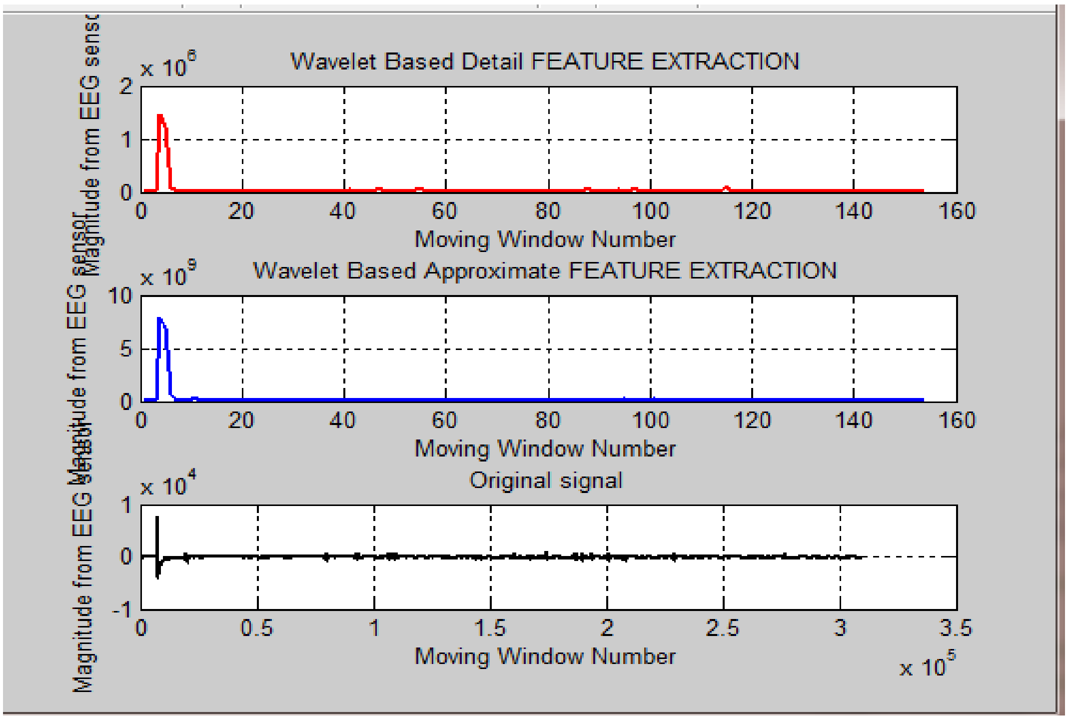

Fig 2 : Detail and approximate feature extraction.

Artificial Neural Network :

A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. Neural networks are used for modeling complex relationships between inputs and outputs or to find patterns in data.

In this ANN approach the neural network is prepared Artificially by training it through giving various Inputs of EEG pattern such as Normal patients, Brain death, slow wave and Epilepsy etc. Neural Network gets trained for these various types of Inputs according to feature extraction, wave pattern and energy values. The trained model is checked tested for its efficiency up to acceptable level and then the completed Model is now can be used for actual testing and reorganization of unknown patients EEG pattern for different types o diseases as mentioned above.[4]

IV. Result

Target Pattern to the ANN model	Answer given by the ANN model at trained stage	Answer as per algorithmic absolute value	Error	Display Remark
1.00 0 0	0.9593 -0.0189 0.0616	1 0 0	0 0 0	Normal
0 1.00 0	-0.0210 0.9763 0.0452	0 1 0	0 0 0	Brain Death
0 0 1.00	0.0415 0.0187 0.9371	0 0 1	0 0 0	General Epilepsy

Table 1: Result of ANN trained data pattern(Classification and Training stage)

Accuracy of Algorithm for Brain death Disease (a)	Accuracy of Algorithm for Normal(b)	Accuracy of Algorithm for General Epilepsy(c)	Accuracy of Algorithm for Slow wave (d)	Accuracy of Algorithm for Focal Epilepsy(e)	Calculated Avg. Accuracy (= $\frac{a+b+c+d+e}{5}$)
100 %	**100 %**	**90 %**	**100 %**	**100 %**	**98.00 %**

Table 2 : Summery of Result / Accuracy of ANN Algorithm

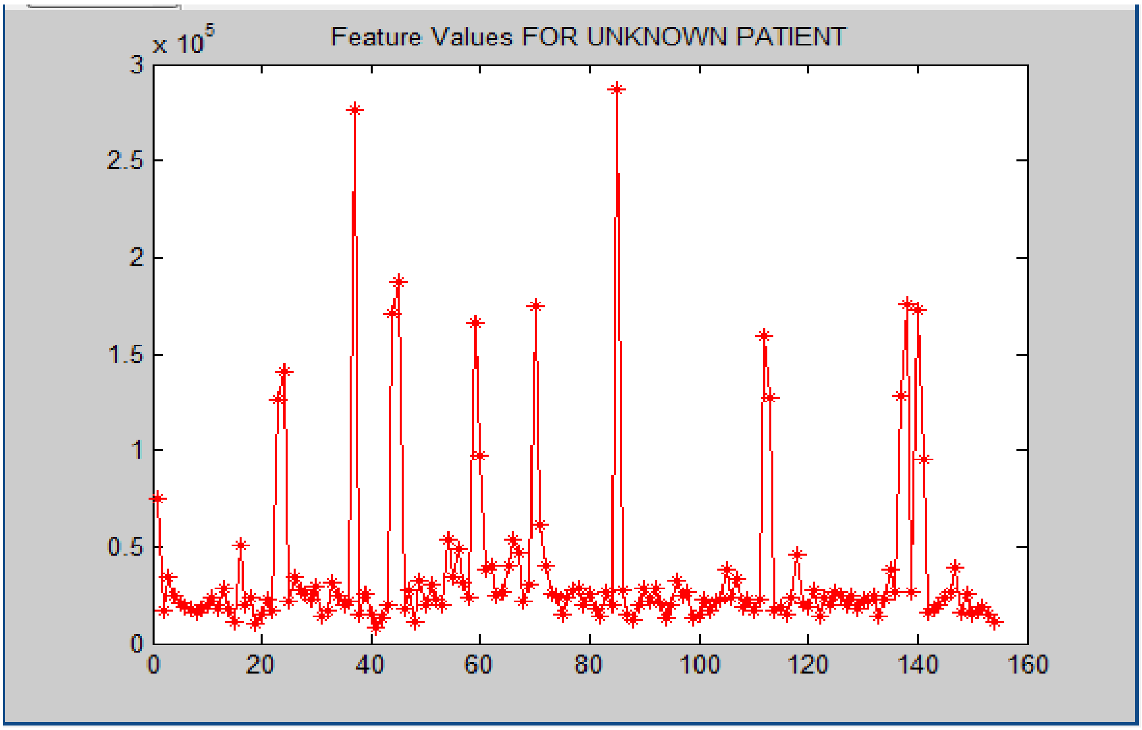

Fig 3 : Energy Values for Patient under test (Disease detection stage)

V. **Conclusion**

This work presents a new method to calculate the features in the wavelet packet space, called as wavelet packet features. The aim is to demonstrate the application of wavelet method to analysis of the segment of spontaneous EEG. This application may turn especially useful for studying EEG synchronization in conditions with certain limitation for long duration records. Thus Wavelet coefficients were used as feature vectors identifying characteristics of the signal. Selection of appropriate wavelet and the number of decomposition levels is very important in analysis of signals using the WT to remove dominant frequency.

Selection of the ANN inputs is the most important component of designing the neural network based on pattern classification since even the best classifier will perform poorly if the inputs are not selected well. Input selection has two meanings: (1) which components of a pattern, or (2) which set of inputs best represent a given pattern [8]. The first-level networks were implemented for the EEG signals classification using the statistical features as inputs. To improve diagnostic accuracy, the second-level networks were trained using the outputs of the first-level networks as input data. Three types of EEG signals recorded from healthy volunteers, epileptic patients, patients with brain death disease were classified. ANNs do not need any specific rules but only examples for training. Thus, ANNs offer an attractive solution to recognition and classification tasks where complete rules cannot written.

VI. Future Scope

Developing algorithms by combining ANN models and Fuzzy logic is another approach in classifying extracted features of EEG signals. Neuro-fuzzy systems are fuzzy systems, which uses the ANNs theory in order to determine their properties (Fuzzy sets and fuzzy rules) by processing data samples. By replacing the extreme values of wavelet coefficients with suitable percentiles, the classifiers gave better classification accuracy. The high overall classification accuracy obtained verified the promising potential of the proposed classifier that could assist clinicians in their decision making process. The task of epileptic seizure prediction [8] is another interesting task where it requires the classifier to differentiate between pre-ictal and inter-ictal data. A major drawback of the existing wavelet neural networks is that their application domain is limited to static problems due to their inherent feed forward network structure. In the future, a recurrent wavelet neural network will be proposed for solving identification and control problems.

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