Design of Expert System for Diagnosis of Epilepsy using Wavelet Transform and SCGA Based Neural Network

Veenu Sharma[1] Monotosh Manna[2.]

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Abstract—*Epilepsy is a neurological disease caused by a chronic abnormality of brain discharge. Epilepsy is a neurological disease. The incidence rate accounts for about 1-2% of the global population. Monitoring brain activity by electroencephalography (EEG) has become an important tool for the diagnosis of epilepsy. EEG recordings of patients with epilepsy revealed two types of abnormal activity: abnormal signals recorded during seizures; and seizures, activities recorded during seizures. The main goal of our research is to use signal processing tools (such as wavelet transforms) to analyze the collected EEG signals and classify them into different categories. The characteristics of the EEG signal are extracted by statistical analysis of the parameters obtained by the wavelet transform analysis of 300 cases of EEG data. These data are divided into three categories, namely, normal patient categories, epilepsy patients, and epilepsy patients in non-seizure regions. To this end, we applied a neural network classifier based on reverse classification. The second goal after feature extraction is to improve the accuracy of the classification. The feature extraction and classification of each group of 100 subjects was analyzed, and the data was divided into training, testing and verification of the proposed algorithm*.

Index Terms—EEG, Epilepsy, Wavelet transform, Neural network

I. INTRODUCTION

EEG signal is a current between the dendrites of nerve cells in the brain measured Brain regions during their synaptic excitation. This current is made up of the electric field through the electroencephalogram (EEG) apparatus and a magnetic field quantitative detection EMG (EMG) device [4]. As the system for recording, outside the scalp the degree of attenuation head soft tissue caused by a skull in recent times. Such signal amplitude is very low, the greater the number of neurons in the excited state produced only by the scalp electrode system recordable potential.So the amplifier is used for added signal for subsequent processing level [5]. Large brain structure is split into three regions, the brain, cerebellum and brain stem. Since the current flowing between brain cells in the cerebral cortex regions of the brain in the EEG signal is generated. When neurons are activated, current flows between dendrites to their synaptic excitability. This current produces a magnetic field and a secondary current field. Magnetic field can be measured by electromyography (EMG) machine and an electric motor Field measured at the scalp EEG system.

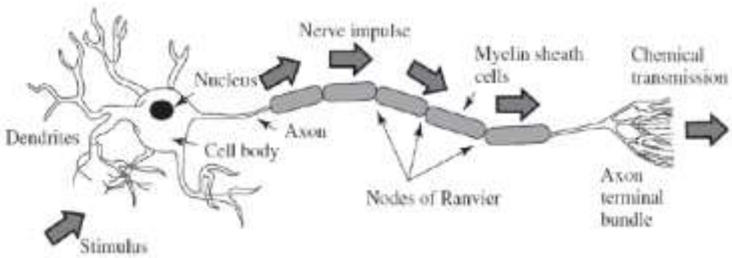

Figure 1.1.Computation process of DWT

1.1 Wavelet Transform-

Discrete Wavelet Transform (DWT) is a very effective signal time-frequency analysis tool. A wavelet transform can be defined as a spectral estimation technique in which any general function can be represented as the sum of an infinite wavelet sequence. In DWT, signal time can be achieved by digital filtering techniques. The multi resolution decomposition method of the signal x(n) is shown in Figure 1.2. The DWT is calculated by continuously performing low pass and high pass filtering on the signal x(n). Each step includes two digital filters and two down samplers. The high pass filter g [] is a discrete mother wavelet, while the low pass filter h [.] is its mirrored version. At each stage, the down sampled output of the high pass filter produces a detail coefficient, while the output of the low pass filter gives an approximation factor. Further decompose the approximation coefficients and the program continues, as shown in Figure 1.2.

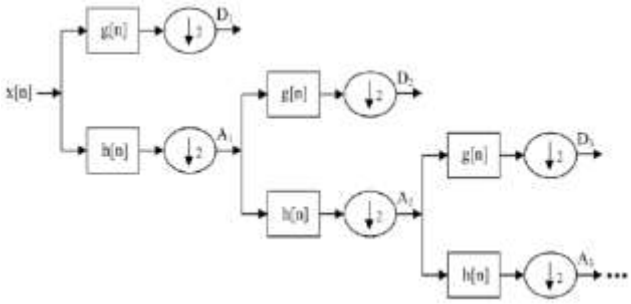

Figure 2.2. Computation process of DWT

The standard equation of Discrete Wavelet Transform is given as-

$$w_{m,n} = \langle x(t), \psi_{m,n} \rangle = a_0^{m/2} \int f(t)\psi(a_0^m(t) - nb_0)dt$$
(1.1)

Where sub wavelets is given by-

$$\psi_{m,n}(t) = a_0^{m/2}\psi(a_0^m(t) - nb_0) \qquad m, n \in Z$$
(1.2)

The DWT decomposition can be described as

$a\;k\;\;l\; = x\;k * \varphi k,l\;(n)$

$d\;k\;\;l\; = x\;k * \psi k,l\;(n)$

where $a(k)(l)$ and $d(k)(l)$ are the approximation coefficients and the detail coefficients at resolution k, respectively.

Wavelet transform gives us a multi-resolution description of the signal. It solves the problem of non-stationary signals, and is especially suitable for EEG feature extraction [2]. The initial EEG signal came from the University of Bonn. This signal consists of a total of 5 sets of (category) data (SET A, SET B, SET C, SET D and SET E) corresponding to five different pathologies and normal cases. This work selects three data sets from five data sets. These three types of data represent three types of EEG signals (SET A contains a blink record in healthy volunteers, SET D contains a record of the epileptic area during the seizure interval, and SET E contains seizures in patients with epilepsy). All records use the standard electrode placement protocol, also known as the International 10-20 system. Each data set contains 100 mono recordings. The length of each single channel record is 26.3 seconds. Each channel uses a 128 channel amplifier [3]. The data is sampled at a rate of 173.61 samples per second using a 12-bit ADC. Therefore, the total sample in a single channel record is almost equal to 4097 samples (173.61 x 23.6). The band pass filter is fixed at 0.53-40 Hz (12dB / octave) [4].

II. METHODOLOGIES

DWT successfully analyzed multi-resolution signals in different frequency bands and decomposed the signals into approximate and detailed information. The band separation method for epilepsy detection is implemented in MATLAB 2013a. The proposed flow chart shows the method of detecting epilepsy data from normal data. Epilepsy testing using EEG requires extracting features from the acquired signals over a specific frequency range of δ, θ, α, β, and γ. Although some researchers have already mentioned DWT decomposition to obtain these bands, the methods given are not sufficient to achieve this goal. First, the study clearly describes a method for up sampling and recombining multiple decomposed sub bands to obtain the desired frequency. First, the data is preprocessed by removing the DC component of the signal, so that each 4096 sampled signals are subjected to different levels of decomposition at a sampling frequency of 173.6 Hz on the Daubechiesorder-2 wavelet. The whole process can be explained by the following flow chart.

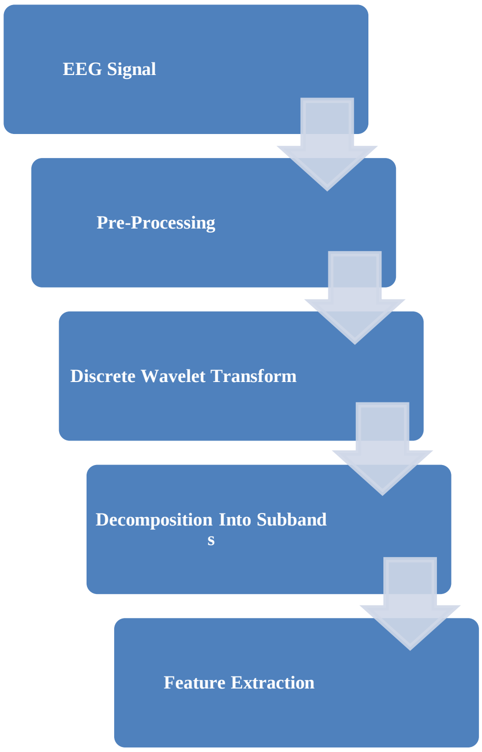

Fig2.1Steps of Detection of Epilepsy Using EEG

III. FEATURE EXTRACTIONS

A rectangular window of 256 discrete data lengths is selected from the data of [9] to form a single EEG segment. It is important to analyze the signal using wavelet transform to select the appropriate wavelet and decomposition level. Wavelet coefficients are calculated using second-order daubechies wavelets because their smoothing features are more suitable for detecting changes in EEG signals. In this study, the EEG signal was decomposed into details D1-D5 and approximately A5. After calculating the coefficients, we can use statistical analysis of the coefficients to calculate various features. –

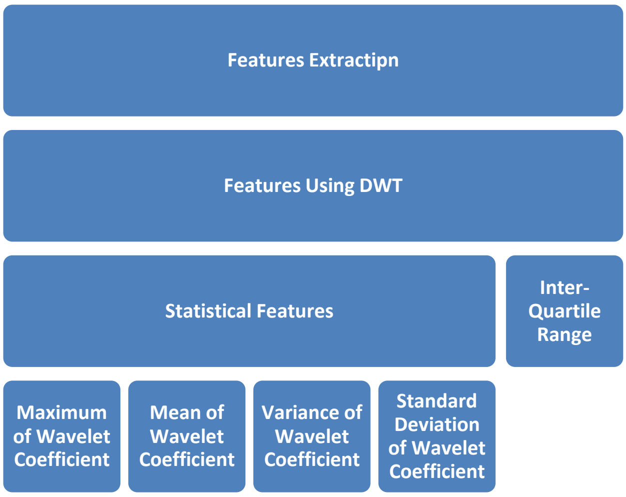

Fig 3.1 Feature Extraction using DWT

A rectangular window having 256 discrete sample lengths is selected from each channel to form a single EEG segment. The total number of time series present in each class is 100, and each single channel time series contains 16 EEG signal segments. Therefore, each class produces a total of 1600 EEG image segments. As a result, a total of 4,800 EEG image segments were obtained from these three categories. A rectangular window having 256 discrete sample lengths is selected from each channel to form a single EEG segment. The total number of time series present in each class is 100, and each single channel time series contains 16 EEG signal segments. Therefore, each class produces a total of 1600 EEG image segments. As a result, a total of 4,800 EEG image segments were obtained from these three categories. The 4800 EEG is divided into training and test data sets. The test was performed using 2400 EEG signal segments (800 vectors from each category) and trained using 2400 EEG signal segments (800 segments from each category). [5] Figures 3.2 show the raw EEG signal diagram for a given data set. These signals are analyzed using matlab, using db2 as the parent wavelet, with a decomposition level of 5, using DWT for decomposition.

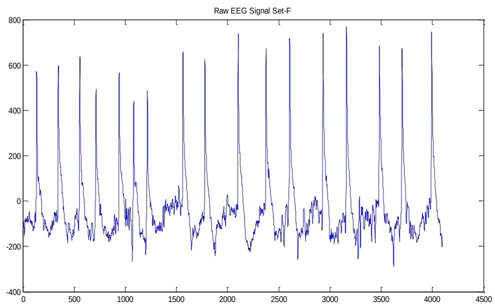

Figure 3.2 Raw EEG Signal

IV.RESULTS

In our work, we have achieved classification of epilepsy EEGs by means of a scaled conjugate backpropagation neural network with a hidden layer equal to 10 and an initial weight assumed to be zero. In order to classify features using neural networks, we need two important predefined parameters, as shown below: In our study, feature vectors are implemented as input vectors. The input vector consists of a matrix of size 25X300, so the row indicates the feature and the column indicates the number of samples. This column indicates the number of samples to test. The global classification is done using the input vector and the target vector of the back propagation neural network based on the scaled conjugate gradient.

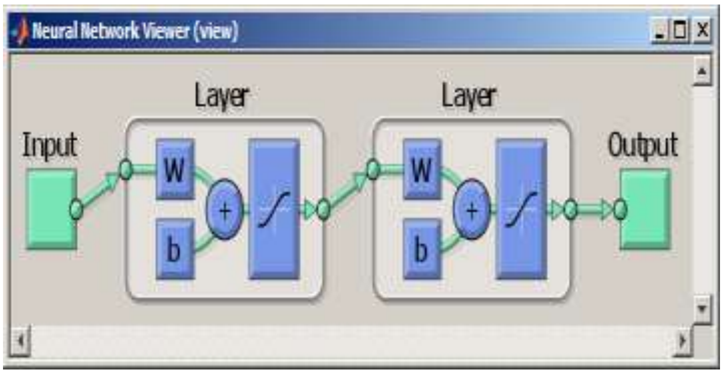

Figure 4.1.Model of Neural Network

The overall samples are divided into three categories training Data-70 % of total 240 samples, testing Data- 15 % of 240 samples, validation Data- 15 % of 240 samples and unknown testing Data-20 samples from each class of EEG samples. (Total 60 samples)

Tabe-1 (Compilation of Results)

Type of Data Set	*Analysis of Accuracy*	
	Testing with 70 Samples of each class	**Testing with 70 Unknown Samples of each class**
Epileptic Patients without Seizures	99%	100 %
Epileptic Patient with Seizures	100 %	100 %
Healthy Patient	97 %	91 %
Overall Accuracy	**98.6 %**	**97%**

V. CONCLUSION

In our research work, 300 data sets were analyzed using wavelet-based statistical features. In the given table given below, we summarize the accuracy of the two eigenvector classifications as a basis for comparing their effectiveness. The classification process can be implemented on a large data set to improve accuracy. The neural network classifier can be replaced by an optimized hybrid classifier. Pre-rectal epilepsy data can be analyzed to develop an effective epilepsy prediction system.

VI REFERENCES

[1]Automated Epileptic Seizure Detection Methods: A Review Study,Alexandros T. Tzallas, Markos G. Tsipouras, Dimitrios G. Tsalikakis, Evaggelos C. Karvounis, LoukasAstrakas, SpirosKonitsiotis and Margaret TzaphlidouDepartment of Medical Physics, Medical School, University of Ioannina, Ioannina, Greece,2011

[2] ElifDeryaÜbeyli,(2009), ―Statistics over Features: EEG signals analysis‖, Computers in Biology and Medicine, Vol. 39, Issue 8, 733-741

[3]I. Daubechies, "The wavelet transform, time-frequency localization and signal analysis,"IEEE Trans. on Information Th eory, vol. 36, no.5, pp. 961-1005, 1990.

[4] Adaptiveneuro-fuzzy inference system for classification of EEG signals using wavelet coefficientsInanGuler,ElifDeryaUbeyli Journal of Neuroscience Methods Elsevir (2005)

[5]] E. D. U beyli, "Wavelet/mixture of experts network structure for EEG signals classifi- cation," Expert Systems with Applications, vol. 34, pp. 1954-1962, 2008.

[6]E. D. U beyli, "Least squares support vector machine employing model-based methods coefficients for analysis of EEG signals," Expert Systems with Applications, vol. 37, pp. 233-239, 2010.

[7] Raj, Ashish, Mangesh S. Tomar AkankshaDeo, and Manoj Kumar Bandil. "Analysing the Inclusion of Soft Computing Techniques in Denoising EEG Signal." International Journal of Soft Computing and Engineering 2.

[8] Raj, A., Deo, A., Kumari, M., & Tripathi, S. A review on automated detection, classification and clustering of epileptic EEG using wavelet transform & soft computing techniques. IJIRSE) International Journal of Innovative Research in Science & Engineering, ISSN, 2347-320.

[9] S. Haykin, Neural Networks: A Comprehensive Foundation, New York: Macmillan, 1994.

[10]Spectral Analysis of sEMG Signals to Investigate Skeletal Muscle FatigueParmod Kumar, Anish Sebastian,2011 50thIEEE Conference on Decision and Control andEuropean Control Conference (CDC-ECC)Orlando, FL, USA, December 12-15, 2011

[11] Raj, Ashish, Akanksha Deo, and Manoj Kumar Bandil. "Canvassing Various Techniques for Removal of Biological Artifact in EEG." International Journal of Recent Technology and Engineering (IJRTE) 1.3 (2012): 149-154..

[12] spectral analysis ofSignalsPetreStoica and Randolph MosesPRENTICE HALL, 2004

[13] Automated detection of pd resting tremor using psd with recurrent neural network classifier.http://www.ukessays.co.uk/essays/engineering/diagnosis-of-parkinsons-disease.php. 2011

[14]I. Daubechies, "The wavelet transform, time-frequency localization and signal analysis,"IEEE Trans. on Information T heory, vol. 36, no.5, pp. 961-1005, 1990.

[15] Adaptiveneuro-fuzzy inference system for classificationof EEG signals using wavelet coefficientsInanGuler,ElifDeryaUbeyli Journal of Neuroscience Methods Elsevir (2005)