IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

ELECTROENCEPHALOGRAPHY (EEG) SIGNAL ENHANCEMENT AND ANALYSIS USING WAVELET TRANSFORM

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Abstract

The electroencephalograph (EEG) is technique of recording electrical activity of brain. In this normalized compressed EEG data wavescataloging is done using the Discrete Wavelet Transform (DWT) with Fast Fourier Transform (FFT). The DWT is used to classify the EEG wave's frequencies, while FFT is applied to visualize the EEG waves in multi-resolution of DWT. Various real EEG data sets have been tested and the results recover the validity of the proposed technique.

Keywords: EEG, DWT, FFT

I. INTRODUCTION

Human brain comprises most complicated system having irregular nature. Nowadays several methodsexist to record brain waves and electroencephalography (EEG) is one of them. This is one of the brain signals processing technique that allows gaining the understanding of the complex internalmechanisms of the brain asymmetrical brain waves have shown to be associated with particular brain disorders.

The analysis of brain waves plays a significant role in identification of different brain disorders. The combination of millions of neurons sending signals at once produces an enormous amount of electrical activity in the brain, which can be detected using sensitive medical equipment such as an EEG which measures electrical levels over areas of the scalp. The electroencephalogram (EEG) recording is a useful tool for studying the functional state of the brain and for diagnosing certain disorders. The combination of electrical activity of the brain is commonly called a Brainwave pattern because of its wave-like nature.

Electroencephalographic (EEG) signals are the realizations of brain electrical activities recorded from multiple electrodes located on the scalp. Analysis ofEEG signals has led to an interdisciplinary field of research called EEG signal processing.

EEG signals are the marks of neural activities. There have been many procedures developed so far for processing EEG signals. The application of these algorithms to analysis of the normal and abnormal EEGs.

II. LITERATURE REVIEW

The exposure of neurophysiological features by means of electroencephalogram (EEG) is one of the most regular medical exams to be performed on human beings. As it is noticed, EEG trials are not always enough to deliver a clear and accurate diagnosis for numerous pathologies. Hence it must be combined with other exams. But we can use all additional instrumental exams to recover the quality of the diagnosis since there are other constraints, namely, financial, medical and individual. This work presents an originalapplication of EEG signal processing. [2]

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ISSN (O) 2319 - 8354
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Various state of mind and the cause of the cerebral cortex in different locations reflect the different EEG. Therefore, the electro-encephalogram contains plentiful physical, psychological andpathological information, analyzing and processing of EEG both in the clinical diagnosis of some brain diseases and treatments in cognitive science research field are very important. [4]

A wavelet is a minor waveform which has its energy intense in time. Wavelet Transforms [8] are used to convert a signal into a series of wavelets. The wavelet transform is asignificant method for analysis of EEG signals. One of the main advantage of the wavelet transform is that it is limited in both time and frequency, whereas other classical methods like the Fourier transform are limited in frequency, only.DWT (Discrete Wavelet Transform), being non-redundant, is a very dominant method for many non-stationary Signal Processing applications. The vital point is that it gives a better estimate than the discrete wavelet transform (DWT) since, it is redundant, linear and shift invariant. [8]

Applying Static wavelet transforms to the contaminated EEG signals and decomposes it up to six levels as a basis function. The de-noising system is applied at thisStage is sure by fixing anedge value and thresholding function. The last stage is to obtain the de-noised EEG signal. Apply inverse static wavelet transform to the threshold wavelet coefficients to obtain the de-noised EEG signal. [8]

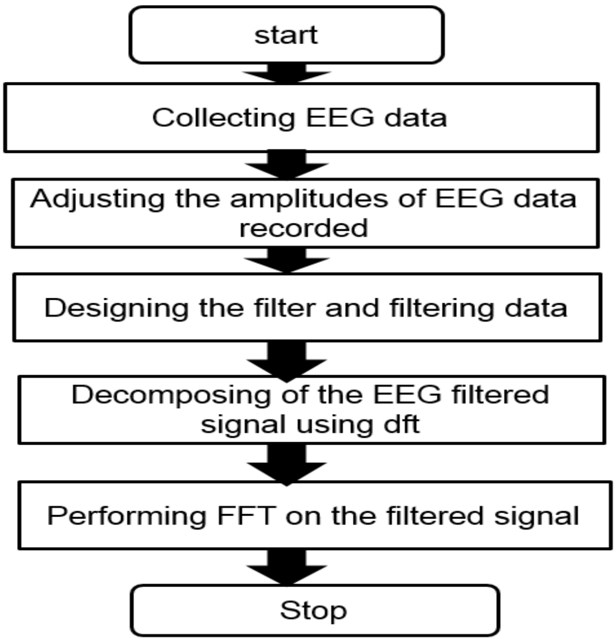
III.OBJECTIVES

1. To advance the power of EEG signals using wavelet transform.

2.To provide visualising, analysis and handling for EEG signals.

3.Classify the EEG signals based on the frequency range.

IV. FLOWCHART



V.METHODOLOGY

The methodology followed in the study is concise below. It consists of three sequentially performed algorithm.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 04, April 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
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5.1 Data collection

The data which is provided by health center is in the form of Microsoft access format. For importing these data we link database file into matlab by converting it into .mat format. It is shown in Fig.1 as below.

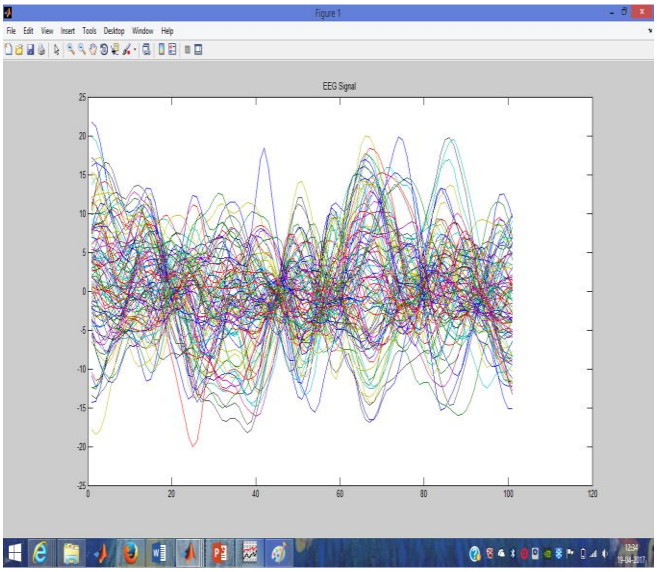

Fig 1:Input file

5.2 Waveform Transformation

We carried out decomposition of EEG signals with the help of Doubechies and Har filter .After that finding detail information about the coefficient at level N from wavelet decomposition structure.Transformed signals are shown in Fig.2.

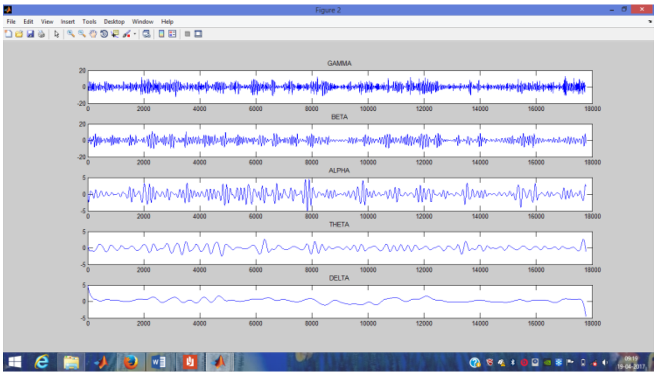

Fig 2:Transformed signals

5.3 Data Compression

Data compression is done with the help of approximation technique. Also by avoiding continuities in the signals.

5.4 Signal Reconstruction

For reconstruction of signal inverse Fourier transform is used. It is shown in Fig 3**.**

International Journal of Advance Research in Science and Engineering
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www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
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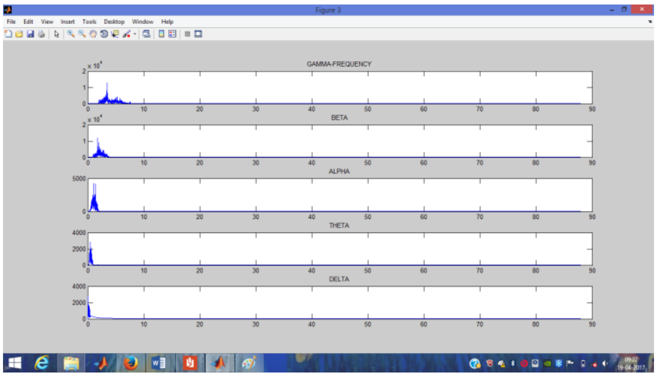

Fig 3:Reconstructed signals

After that we complete the filtering process by applying various filter i.e. Har filter and Doubechies8 filter. After completing filtering process we apply DWT transform by developing effective algorithm for analyzing the EEG signal in frequency and time domain. Classification of EEG signals is takes place with the help of frequency analysis. Signal processing and analyzing will be done with the help of matlab software

The data was available in binary file format with 12 bit resolution and the sampling frequency of 250 samples per second. It was then preprocessed to separate the 20-channel waveform and stored in a separate file for subsequent transformation with wavelets.

Previously work was done support vector machine (SVM) was used in which point to point mapping was not possible and hence it gives low efficiency.[8]

VI. PRACTICAL APPROACH

6.1 Discrete WaveletTransform

Wavelet transform decomposes a signal into set of basic functions. These basic functions are called wavelet. A medical image gives more accuracy without loss of information. The DWT based on time scale representation which provide multiresolution. Wavelet transform is able to provide the time and frequency information simultaneously, hence giving a time-frequency representation of the signal. The basic principle is to factorize the polyphase matrix of wavelet filter into a sequence of alternating upper and lower triangular matrices and a diagonal matrix.

6.2 Filters used in EEG analysis

6.2.1 Haar filter

Haarwavelet is irregular, and look like a step function. It is shown in Fig.4. The Haar Wavelet Transformation is a simple form of compression which contains averaging and differencing terms, storing detail coefficients, eliminating data, and restructuring the matrix such that the resulting matrix is similar to the initial matrix.

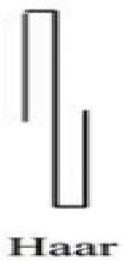

Fig 4: Haarwavelet

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

6.2.2 Daubechiesfilter

The names of the Daubechies family wavelets are written dbN, where N is the order, and db the surname of the wavelet. It is shown in Fig.5. The db1 wavelet, is the same as Haar wavelet. Here is the wavelet purposes psi of the next nine members of the family. Response of Daubechies filter.

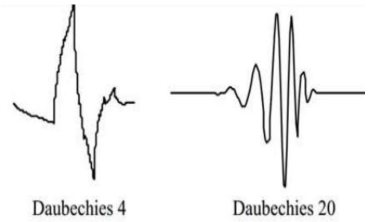

Fig 5: Daubechies 4 &Daubechies 20 wavelet

VII. RESULT

1. The Delta waves which results all the waves in the EEG below 3.5 Hz. They arise in deep sleep, in childhood, and in serious organic brain disease.

2. The Theta waves have frequencies between 4 and 7 Hz. These arise primarily during the childhood, but they also arise during sensitive stress in some adults.

3. The Alpha waves are rhythmic waves occurring at a frequency range between 8 and 13 Hz, which initiate in all normal persons when they are awake in a quiet, resting state of cerebration.

4. The Beta waves are very low amplitude, and high frequency range between 13 and 30 Hz. They are affected by emotional action.Result analysis is tabularized below

Table1: Results

Band	Frequency	Representated Status
Delta	<4 Hz	Show Wave sleep
Theta	4-7 Hz	Inhibition of excited responses
Alpha	8-15 Hz	Relaxed inhibition control
Beta	16-31 Hz	Anxious, active thinking
Gamma	>32 Hz	Cross model, sensory preception

VIII. CONCLUSIONS

The proposed method makes use of both the discrete wavelet transform as well as the discrete Fourier transform.Specially, wavelet transform is used as a classifier of the EEG frequencies. In addition, the filtered EEG data were used as input to the wavelet transform, offers a perfect success in the rejecting undesired frequencies and permits the DWT levels to discriminate the EEG waves only. In this paper the waves are classified according with the frequency range as Delta, Theta, Alpha, Beta, Gamma etc. The status of each wave is discussed in the result section of this paper.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

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