De-noising and detection of Left-Right Limb Movement using STFT - Short-Time Fourier Transform and DWT - Discrete Wavelet Transform

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***Abstract*— EEG Electroencephalogram is regarded as a test to evaluate the electrical activity in the brain to detect the potential problems associated with it. Predominantly EEG is widely used to measure the electrical activity of the brain and diagnose the disorders related to brain such as seizure disorders, head injury, encephalitis, brain tumor, encephalopathy, memory problems, sleep disorders and brain stroke etc.Electroencephalographic recordings are often observed with the contamination of several artifacts like powerline interference and baselinenoise etc. The noise should be reduced at the time of recording of data or at the stage of preprocessing of recorded data. In this paper we present Short-Time Fourier Transform (STFT) and Discrete Wavelet Transform (DWT) methods to reduce the noise in the Electroencephalographic recordings of Left-Right Limb movements of the brain.**

Key words: Electroencephalograph – Noise Reduction - Short-Time Fourier Transform - Discrete Wavelet Transform – LRM movements..

I. INTRODUCTION

ELECTROENCEPHALOGRAPHY is predominantly used in the observation and measurement of brain activity. Electroencephalography EEG is rich with excellent time resolution and most economical operational use. While measuring the brain signals through EEG the signals are coupled with wide variety of noise sources. Noise reduction is treated as the predominant activity to get obvious picture about the brain functionality. Hence the quest has begun to reduce the noise of EEG with different methods and methodologies.

The brain activity can be measured with the rhythm and frequency. The frequency can be measured with Hz. Different frequency levels are reserved for different rhythms like Delta, Theta, Alpha, Low Beta, Midrange Beta, High Beta and Gamma. Different rhythms are identified by the range of Frequencies and represents different mental activities. The mental activities should be distinguished through the EEG tool. If the EEG recordings are mingled and composed with different attributes for noise levels, the identification of frequencies will be merged and mismatched. When the frequencies are mismatched automatically the mental activities are distinguished and leads to mis-diagnosis. This mis-diagnosis should be avoided by removing the noise reduction in the EEC waves recorded from the patients (Christos I. Salis, et.al. (2013)).

Wavelet – Based noise removal is regarded as healthy and epileptic. The noise removal on EEG signal can be regarded as the healthy practice with appropriate wavelet functions effectively. The special function available in Wavelet function is Daubechies 8 (db8) is regarded as the potentially good to remove the noise from the EEG signals. The portable biomedical equipment is feasible option for implementing Discrete Wavelet Transform on the signals transmitting from brain state in different circumstances (A.GuruvaReddy et.al (September, 2013)).

Short Time Fourier Transform – STFT is also regarded as the best tool for removing the noise from the EEG signals. The analysis of Spectral or Frequency content of non-stationary signal generated from EEG has to be evaluated by the Short Time Fourier Transform method to reduce the possible noise attributes associated. The frequency content can be examined from the spectrogram in time-frequency output. The signal is generated from the mind with the data acquisition, then it will be transmitted from lowpass and high pass filter. Then it will be filtered by Bandpass filter. Then it should be evaluated through Short Time Fourier Transform – STFT. This process will effectively reduce the noise generated in the processes of data acquisition and pre-processing stages of analysis. The short time fourier analysis can determine the rhythm of the wave whether it is Delta, Theta, Alpha, Low Beta, Midrange Beta, High Beta and Gamma with its spectral contents of the EEG signal. EEG signal is a non-stationary signal.

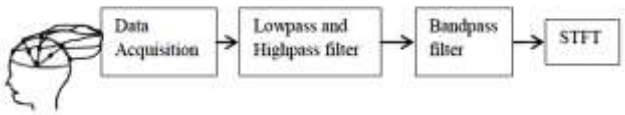

Figure 1

The signals released in the form of EEG format will be analyzed by the STFT in N samples and fragmented into segmented data. The modulation and Translation parameters of the EEG signals are analyzed by the windowing techniques of STFT methods. The important role of the STFT methods are removing the possible noise from the EEG signals and determine obviously the Rhythms of the signals. So that the accurate identification of rhythm reveals the condition and activity of the brain to the clinicians (MriduSahu et.al (2015 September)).

In the present study has taken the Left-Right Movements

of the patients and examined the noise levels of the EEC recordings and removed the noise with the help of STFT - Short-Time Fourier Transform and DWT - Discrete Wavelet Transform. The process would definitely reduce the noise attributes from EEG signals representing the patient mental conditions (Pavithra.A (April 2016)).

II. Literature Review

EEG signals can be analyzed through STFT statistical analysis tool to reduce the noise of the signals. The statistical analysis is done for the non-statistical signals with distinct rhythm. The rhythm is identified by removing combination of attributes associated with the EEG signals. The filtering system implemented by the STFT is predominantly removed the noise of the signals generated from EEG for the brain signals. The computation analysis using STFT algorithm has successfully helped to remove the noise and identification of specific signal frequency (S.S. Hussin et.al. (April 2014)).

Joseph W.Matiko has introduced a method for removing the noice from EEG signals acquired from the brain activity. The brain activity has been taken as an eye blink and measured the frequency of the signal and distinguished its rhythms of the signal. At the same time the researcher has used Short Time Fourier Transform approach to remove the attributed noises to the EEG signals (Jose Antonio Urigüen et.al.(April 2015)). The noise removal has been done with the help of fast computation of the estimation of the signal coefficients using the basis pursuit algorithm. The results have been obtained from the raw EEG signals and Cleaned EEG signals. The variation has been recorded from these two stages of same signal. The experiment has revealed the variation obtained from the raw signal and cleaned signal (Joseph W. Matiko et.al (July 2013)).

Phenomenally Ocular artifact is associated attribute interference in Electroencephalogram recordings. The Ocular Artifact is predominantly influence the obviousness of the EEG signals in distinguishing the Rhythms. Mingai Li et.al have introduced a novel mechanism called DWT Discrete Wavelet Transform. The Discrete Wavelet Transform algorithm is applied for multiple scale coefficients of the waves of EEG which were combined with the Ocular artifact. The method has successfully removed the Ocular artifact from the EEG signals. The raw signals have captured and evaluated the frequency and the cleaned waves have been evaluated the frequency. The difference of the frequency has revealed the power of DWT in removing the noise of the EEG signals (Mingai Li et.al. (March, 2013)).

Methodology

The present experiment is for de-noising and detection of Left-Right Limb Movement using STFT Short-Time Fourier Transform and DWT Discrete Wavelet Transform. This experiment is done for a patient who has been connected with the EEG operates to detect the left-right limb movements. When the patient is created the movement for the Left – Right Limb the EEG recordings have taken and then the readings have taken for the patients when the no movements are done. The EEG recordings have been obtained with the specific frequency. The frequency ranges have revealed the Rhythms of the movements and different Rhythms have been identified for the EEG recordings for without movements.

The methodology is to reveal the variation for the raw data and cleansing data of the Left-Right Limb Movement using STFT Short-Time Fourier Transform and DWT Discrete Wavelet Transform. The raw data frequency has been recorded and evaluated in the results chapter. Then the cleaned data with the STFT and DWT have been recorded and evaluated with the frequency.

The actual raw data has been acquired from the patient through EEG signals when the patient has made a hand movement. The hand movement has created variation of signals and recorded. The signals have recorded when no movement is made by the patient. The raw data when the hand movement is made is compared. The variation is recorded. The variation has been recorded and reserved for the Pre-Processing Filtering mechanism with Bandpass filter for mu and beta range of rhythms. Beta rhythm range is 13-30 Hz is recorded and mu rhythm rang is 8-13 Hz is recorded. This pre-processing EEG signals recordings have been evaluated in a examination chart (GeetaKaushik et.al.(Dec 2013)).

The EEG signals transmitted from the patient with no movement has been cleaned with the help of STFT filtering and DWT filtering mechanism have been recorded. Similarly the hand movement of the patient has been recorded with the EEG signals and cleaned with the help of STFT filtering and DWT filtering. The reading has been recorded and distinguished the rhythms.

Taking reading for TPR and FPR readings is predominant in this methodology. The present project is simulated in the Matlab Simulink software. The TPR readings will be obtained when the limb movement or any action is taken place in the brain. The activation of brain cell when the activity of the body is stimulated by the brain.

The FPR readings will record the brain cells signals when no action is taken by the body. The stable state of the mind will be recorded first from the EEG signals recordings.

The efficiency can be calculated from the difference between the recordings taken from the EEG signals when no action is taken and when the action is performed by the body.

The efficiency = TPR – FPR

Block Diagram

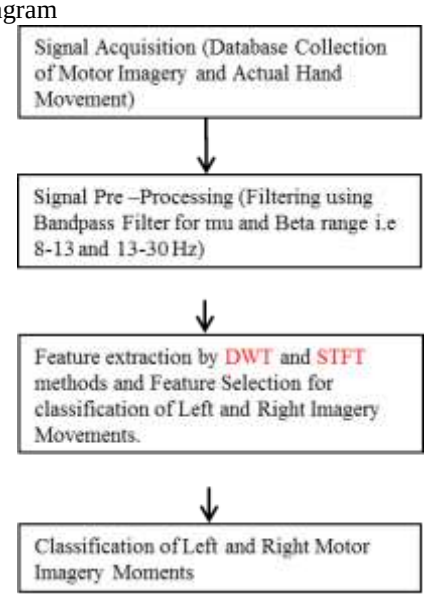

Figure 2

The following results have been obtained from the simulation software Matlab Simulink. The results have revealed the significance of the cleaning of the data with the help of STFT and DWT algorithms.

Results

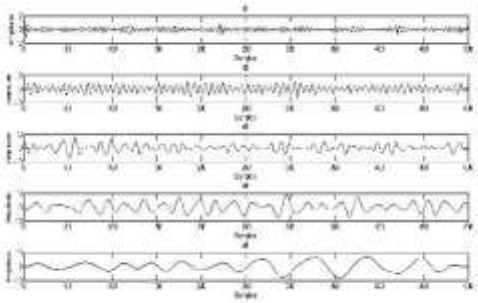

Figure 3

The above picture demonstrate the RAW EEG signal data before the pre-processing

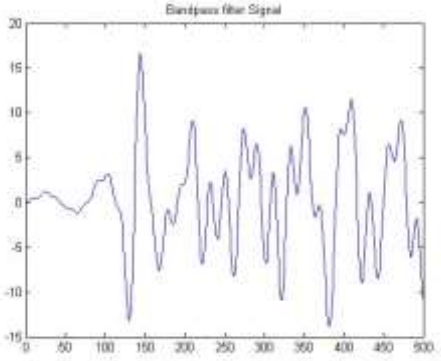

Figure 4

The above diagram demonstrate the Bandpass filter signal processing for the EEG signals.

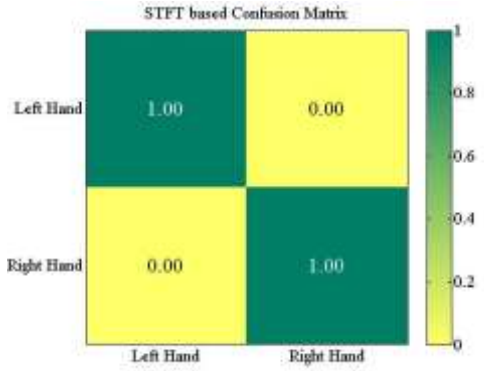

Figure 5

The above picture demonstrate the obvious results obtained after cleaning the EEG signals with STFT methodology.

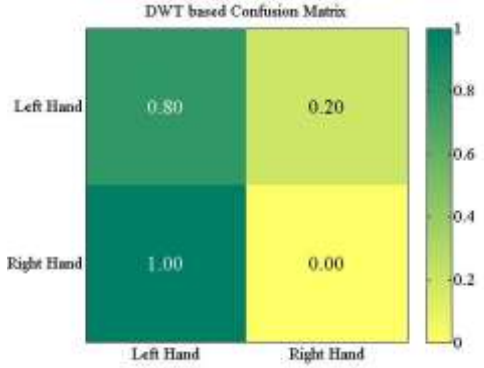

Figure 6

The above figure shows the Cleansing data for the left hand and right hand movements obtained from DWT based cleansing confusion matrix.

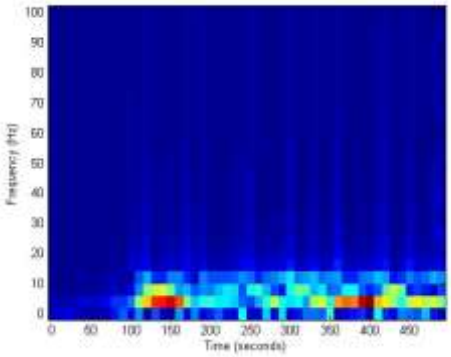

Figure 6

The above figure illustrate the final signal frequency and time in seconds graph

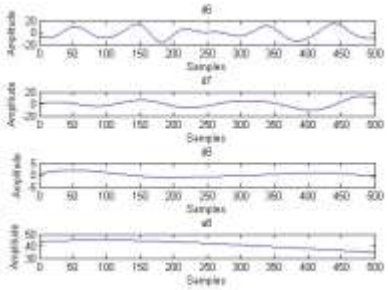

Figure 7

The above figure illustrates the amplitude readings for different samples

Figure 6

The above results have revealed the prominent noise reduction in the Left hand and right hand movement EEC recordings by using Short-Time Fourier Transform (STFT) and Discrete Wavelet Transform (DWT) methods

The following results have been obtained from the DWT and STFT cleaning implementation for the raw signals of EEG. The results of efficiency rating have been demonstrated in the tables with the percentage.

Method	TPR	FPR	Efficiency
DWT	1.4452	0.1564	90.2322
STFT	1.4530	0.1451	90.9193

Left hand movement

TPR represents the average rate of control events being detected by the asynchronous mechanism. The values have been obtained for FPR. FPR represents the average rate of false control events detected during a subject's noncontrol state.

When DWT filtering mechanism is used the stable state represent the FPR values of 0.1564

When the left hand movement is activated the TPR readings have been taken the readings have recorded with 1.4452.

The difference between the FPR and TPR is calculated and the result is 90.2322 percent efficiency is recorded.

Similarly for STFT filtering mechanism the movement less state is recorded and it is 0.1451 and registered in FPR methods.

When the left hand movement is recorded with TPR readings of 1.4530. Hence the difference between the movement less state and left hand movement state is being calculated and recorded the efficiency of 90.9193.

The pre processed signals have been sent to DWT filters and obtained the results. The results demonstrated the 90.2322 efficiency for DWT filtering mechanism.

The pre processed signals has been sent to exclusively to STFT filtering mechanism. The efficiency has been recorded with 90.9193 per cent. Hence comparatively STFT filtering is making more efficiency than DWT filtering mechanism.

Conclusion

The implementation of STFT and DWT methods to remove the noise of the EEG signals is proven good. The EEG sample data has been taken and processed in the specified two methods simultaneously. The extracted data has been examined and evaluated for checking the rhythms of the EEG signals. The proposed topic is recording the Right-Left Limb movements of the children of different health conditions. The results extracted from the EEG are evaluated properly and found the obviousness of the signals to reveal the rhythms of the patients. EEG signals are non-statistical signals. The experiment has been done with the combination of Discrete Wavelet Transform analysis and Short Time Fourier Transforms analysis to remove the noise from the signals with the help of duel filtering system.

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