Epilepsy seizure detection using EEG signals

Zakareya Lasefr, Raghavendra Sai Shiva Ayyalasomayajula Venkata , Khaled Elleithy
Department of Computer Science and Engineering, University of Bridgeport, CT.

Abstract

EEG signal processing involves multiple algorithms in which epileptic data is received in the MATLAB environment and needs to be processed in order to obtain a perfectly filtered waveform and process it in both the time and frequency domain. In our work we have shown the EEG signal in the frequency domain using Fast Fourier Transform and its absolute value. Using Wavelet decomposition technique we divide the EEG signal into different sub-level bands then the lowest frequency sub-band was selected to perform feature extraction. Discrete Wavelet Transform (DWT) was applied and Vector Analysis was used for feature extraction and then we have used Inverse Discrete Fourier Transform to transform from frequency to time domain so that frequency analysis of the feature extracted EEG signal could fetch the best results. We have used the lowest frequency band possible between 1 and 3.45 Hz which could be the smallest possible in order to either classify a signal or to apply threshold and compare the results. In order to verify our work, we are comparing our results with some of the mostly used classifiers results even though classifiers do not show frequency analysis.

Introduction

Epilepsy is a kind of crucial neurological disease or a disorder of the central nervous system characterized by the loss of consciousness and convulsions. The patients of this disease are subject to epileptic seizure caused by abnormal electrical discharges which can lead to uncountable movements, convulsions and the loss of conscious. Epilepsy seizure is the result of the transient and unexpected electrical disturbance of the brain. EEG or Electroencephalograph is a clinical tool that can be used to take images of the brain of a human being while it is performing a cognitive task.

Wavelet decomposition uses the concept of Multilevel one-dimensional wavelet synthesis which it either uses high pass, low pass filter and down sampler or a specific wavelet function. It decomposes the signal at a level of N which contains a vector C which is used for decomposition and L is used for spectrum keeping.

A Discrete wavelet transform (DWT) is a type of wavelet transform which are individually sampled and captures the features of the signal which gives rise to detect different signal properties of the image or a signal. It captures all the information about the frequency and location. There are variable techniques in wavelets namely wavelet series, wavelet transform, wavelet compression etc.

Classifier will be used as a means of clustering for the detection of random bio signals which will gives us an approximation of those signals. These are also called as non supervised procedure based on the measure of some distances . These classifiers are various types like Support vector machine, Artificial neural network, etc.

Proposed Algorithm

We start the processing of the epilepsy signal with its implementation and its frequency analysis of the signal and sample the signal to a time period of 40.97 sec as shown in figure 1.

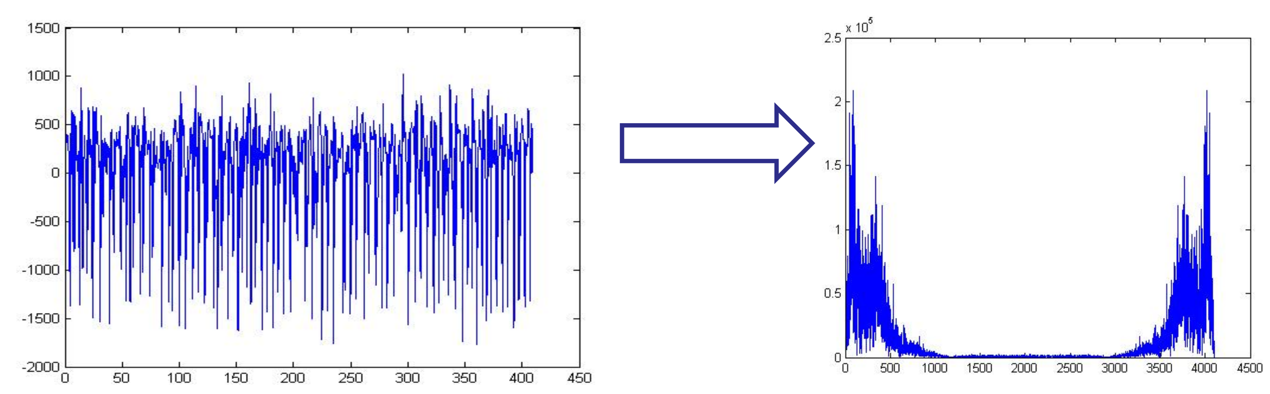

Figure 1

Once the signal is sampled, a Chebyshev filter was used for the finite response filter to achieve maximum spectrum efficiency. Then Wavelet Analysis was applied in order to decompose the EEG signal and thus comprising a frequency analysis of lower frequency band in both the time series and frequency series as we can see in figure 2.

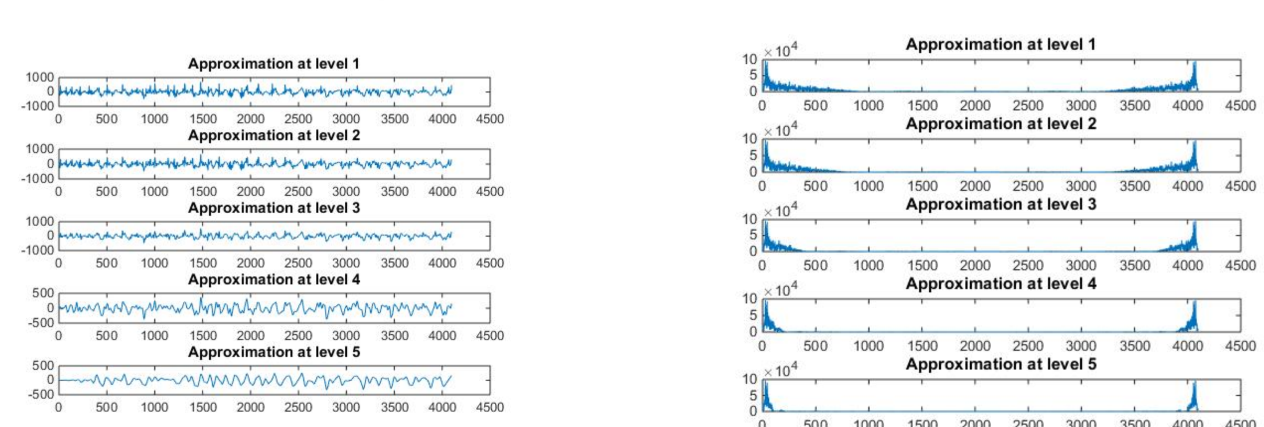

Figure 2

Figure 3 shows feature extraction of the signal where unnecessary components of the signals are removed. Furthermore, Discrete Wavelet Transform was used which for feature extraction in terms of wavelet coefficient vector and in terms of time and frequency analysis using DFT and IDFT process.

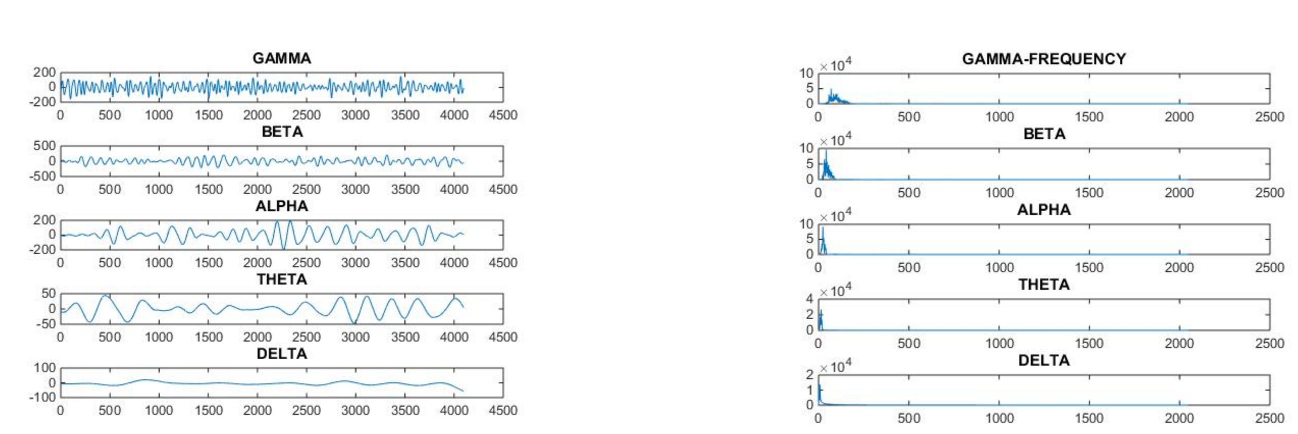

Figure 3

From the spectrum analysis of Discrete Wavelet Analysis ; we can establish that the frequency spectrum is at 11 Hz, 25 Hz , 46 Hz and 85 Hz respectively according to the decomposition of the EEG signal.

Comparison of Different Classifier Simulation Results

Figure 4 shows the process of classification with the use of Support Vector Machine. It defines the signal through the SVM classify function in MATLAB environment.

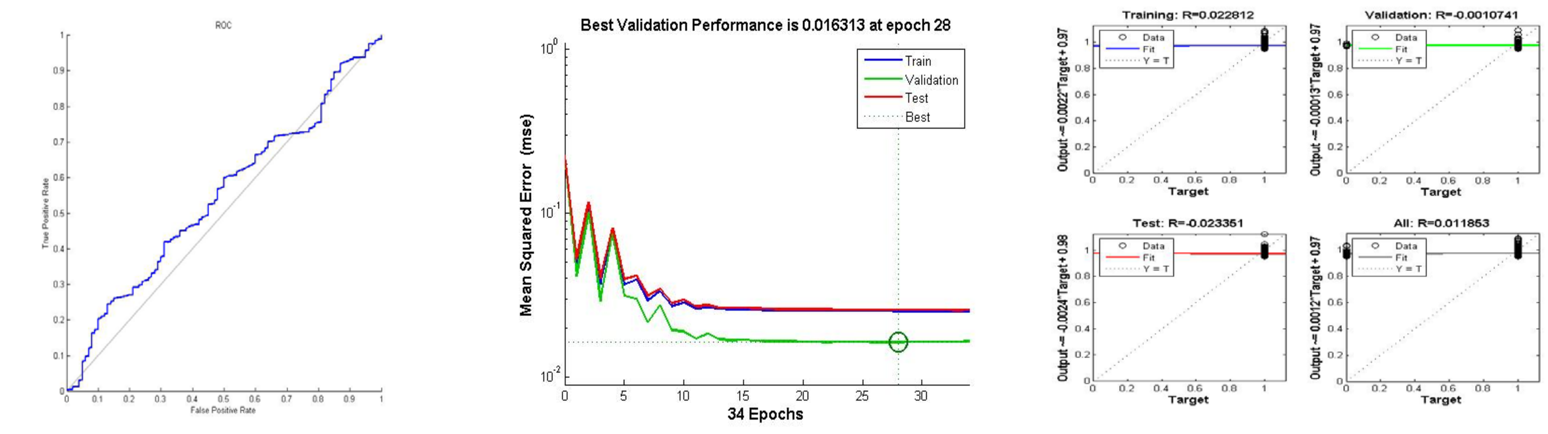

Figure 4

In figure 5, Artificial neural network was applied using feed forward clustering technique and the comparison between the mentioned classifiers is done using a simple looping system and calculated as

*Accuracy (%) = (Updated count /200) *100*

And we have achieved an accuracy of 99% using SVM system and 99.35% using ANN

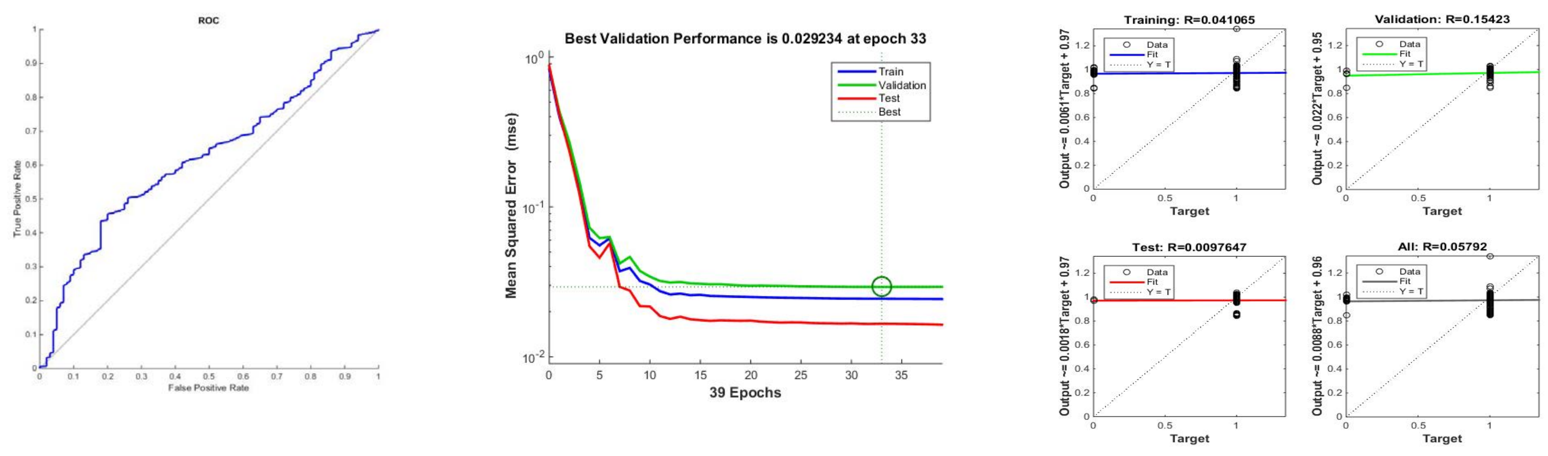

Figure 5

Thresholding Technique for Approximation

Filtering and removing the noise of the signal as well as the images was used for the synthesis of final extraction of the EEG signals by applying Wavelet compression technique. Then Thresholding was applied instead of using classifiers in order to detect the epilepsy seizure and the results were checked using both soft and hard thresholding techniques as shown in figure 6.

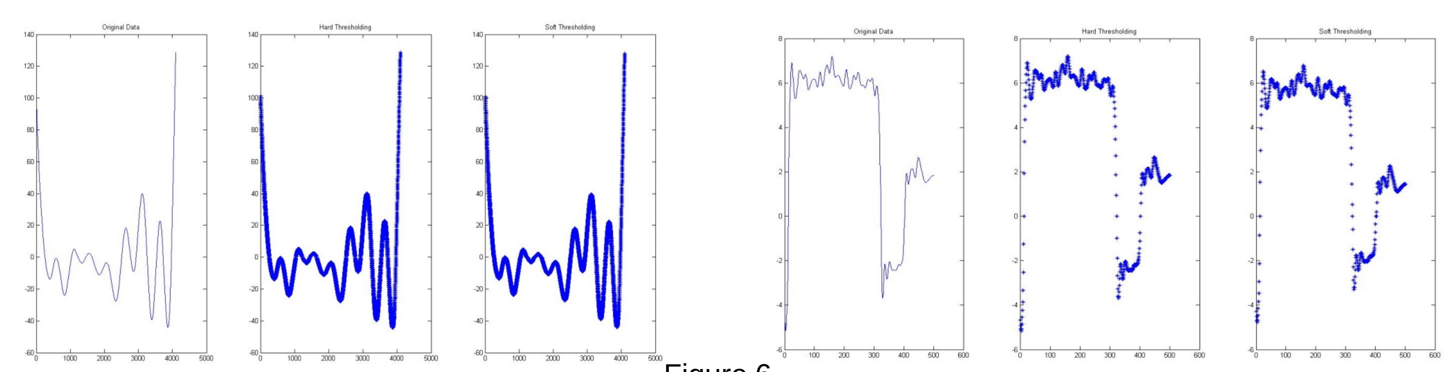

Figure 6

Figure 7 clarifies that Spectrograph is an important step to identify these waveform in the form of colored spectrum and the scalogram shows the representation of the wavelet transform in the increased of brightness in the 3rd axis of the one dimensional representation.

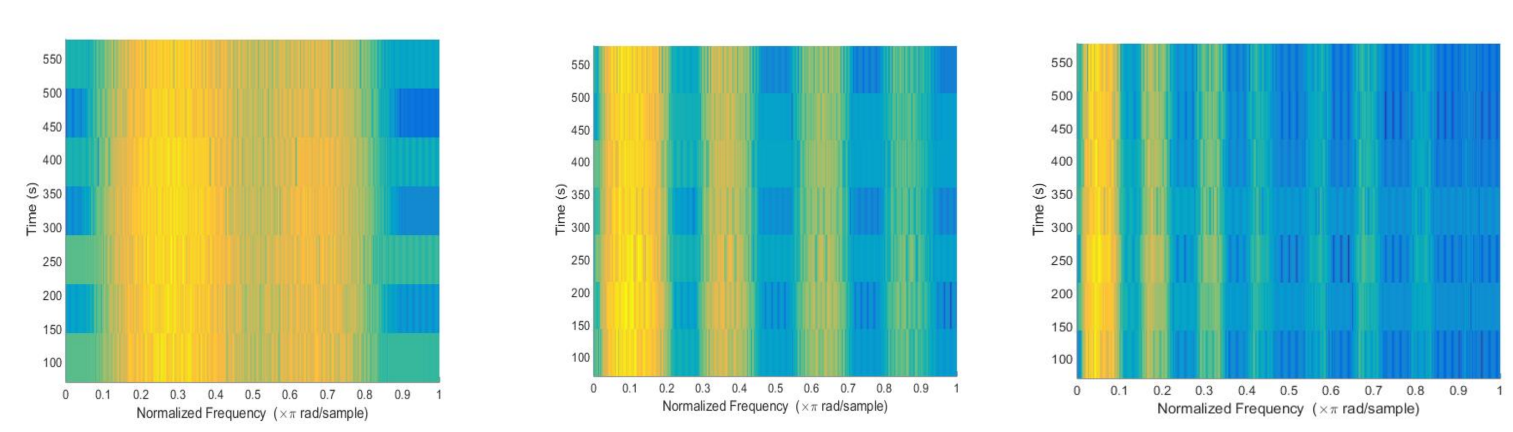

Figure 7

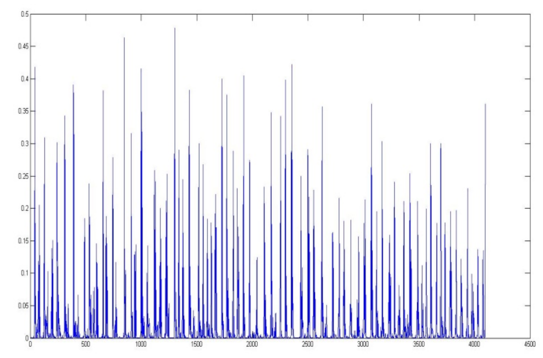

Figure 8

Conclusion

Finally, this research paper gives an important idea of acquiring the data from the EEG signal and the frequency and time responses in various steps at the processing stage. Once the processing is done, a final extraction can be made through a classifier and results are well compared to each other and efficiencies are well explained. Furthermore, the frequency spectrum at each decomposed signals are important to achieve an accuracy to 99%. This can be implemented through the spectrum analyzer which introduces a practical model to a EEG based epilepsy detection.