Journal of Advances and Scholarly Researches in Allied Education
Vol. 16, Issue No. 5, April-2019, ISSN 2230-7540

An Approach to Compress EEG Signal Using Wavelet Based MSPCA Algorithm

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Abstract – "The Main objective of this paper work is based on implementing a technique to compress the EEG signal using multiscale PCA algorithm with wavelet." This paper is focuses on the technique providing expansive coverage of algorithm and tools from the field of digital signal processing. This concept motivated to develop a method which compress the EEG signal without degradation to accuracy and without loss of data." The motivation for this research is the large amount of low amplitude data involved in collecting EEG information which requires storage space and high bandwidth for transmission."

Keywords: PCA, Wavelet Transform, SVD

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1. INTRODUCTION

Electroencephalography (EEG) signal is the recording of spontaneous electrical activity of the brain. The term EEG refers that the brain activity emits the signal from head and being drawn. It is produced by bombardment of neurons within the brain. It is measured for a short duration of 20-40 minutes with the help of placing multiple electrodes over the scalp. These signals indicate the brain function and status of whole body. Therefore EEG signal provides valuable information of the brain function and neurobiological disorders as it provides a visual display of the recorded waveform and allows computer aided signal processing techniques to characterize them. This gives a prime motivation to apply the advanced digital signal processing techniques for analysis of EEG signals. EEG signal obtainment follows a non-interfering procedure and proper signal processing and pattern recognition tools can emerge an important device for automated system to recognize electroencephalographic changes. However, automated classification of EEG signals is a challenging problem as the morphological and temporal characteristics of EEG signals show significant variations for different patients and under different temporal and physical conditions. This ability motivates us to apply the advanced digital signal processing techniques on the EEG signals.

2. PROPOSED METHOD

A. Problem Definition

Electroencephalogram is the scalp surface recording of electrical activities within the brain and contains a large amount of neural activity information. As it contains large amount of information the analysis of the EEG signals are must require. In practice, EEG signal is generally time varying, non-stationary sometimes transient and usually corrupted by noise. The key issues were how to improve EEG signal. Using wavelet transform, it provides simultaneous information on frequency and time location of the signal in to different detail components or various frequency bands. The goal is to compress the large amount of information signal and remove the noise without loss of (data) information and reconstruct the signal.

B. Proposed Work

The wavelet based multiscale PCA algorithm is proposed and demonstrated to enhance the classification performance in identifying EEG signal. The signal decomposition is done using wavelet transform followed by the de-correlation using PCA to achieve maximum compression while simultaneously preserving the dominant modes of the signal and bad data rejection. The proposed algorithm employing multiscale PCA computes the principle components of the wavelet coefficient at each scale. The wavelet coefficient of a particular

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scale corresponding to the dominant eigen values are retained for signal compression. This result in effectively compresses the EEG signals while preserving the model information of the signal.In PCA, data characteristics remain unchanged during whole processes and behavior of data should be same as original data. The aim of multiscale PCA is to reconstruct simplified multi variance signal, using a simple representation at each resolution level. PCA, is performed on the co-efficient matrix in the wavelet domain as well as on the final reconstructed matrix.

C. Algorithm Steps:

1) Wavelet decomposition:

First we will perform the db2 wavelet decomposition up to level 6 of the signal. This step produces seven matrices D 1. . . . . D6 which contains the detailed coefficients , at level 1 to 6 and A6 containing approximate coefficients (SCs).

2) Multi scale PCA:

This step further divided into two steps:

a) In this we will perform the multi scale PCA on matrices of approximation coefficients, WCs D1 to D6 and SCs A6 simultaneously.

b) After performing PCA we will construct the final signal matrix.

3) Number of Principal components to retain:

In this step we will compute SVD which means singular value decomposition of final matrix and we will get the eigen values A1…....A6 corresponding to each detail from 1 to 6. The dominant eigen values are keep back for signal compression. If p eigen values are made low means dropped, then all components of corresponding Dp scale matrices are not considered for signal compression. Similarly, if q eigen values are made high, then all principal components of Dq scale matrices are preserved for signal construction.

4) Signal reconstruction:

This is the final step in which the individual matrices Dq are obtained from the principal components which are stored and retain all the Dq scale matrices. Then use them to reconstruct the signal.

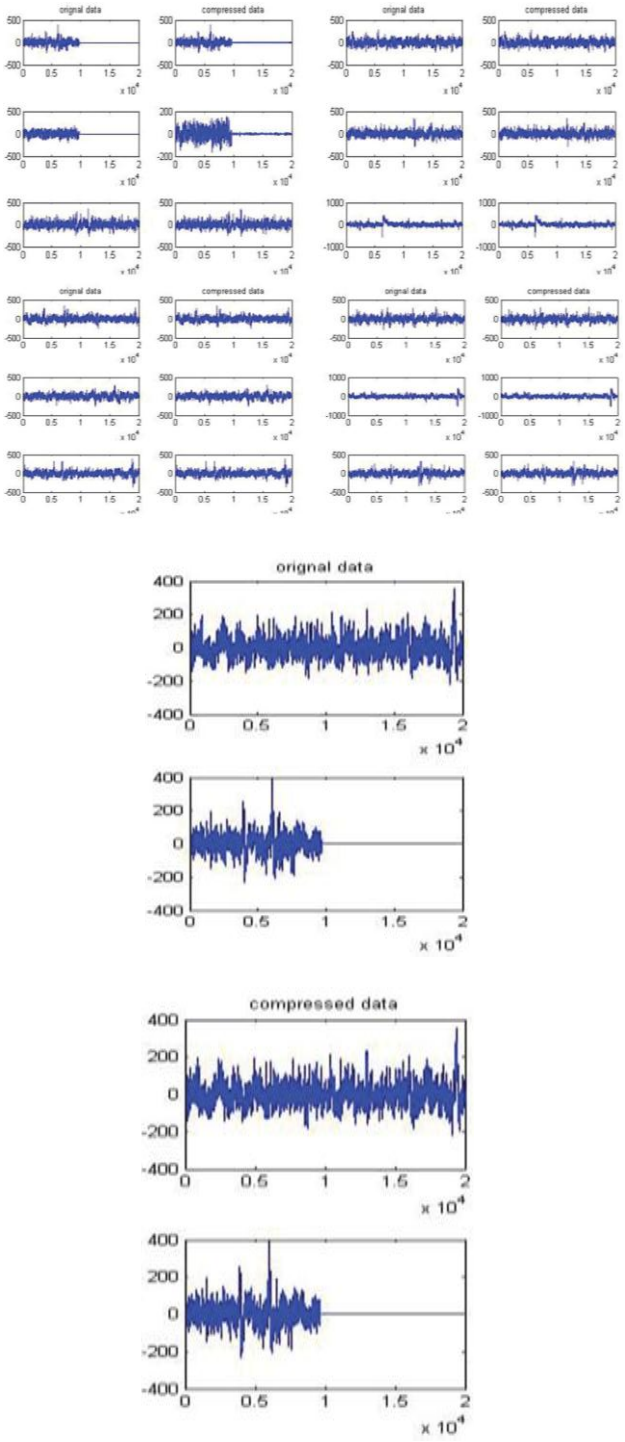

Fig.2. Signal After and Before Compression

CONCLUSION

We have reviewed the wavelet based multiscale PCA algorithm to improve the EEG signals. “This method is a new multi resolution time frequency analysis method.” This possesses well localization feature both in time and frequency domains. “It acts as a group of band-pass filters to decompose mixed signal into signals at different frequency bands”. The main advantage of this method is to provide simultaneous information on frequency and time location of the signal. EEG, as a noninvasive testing method, plays a key role in the diagnosing

diseases, and is useful for both physiological research and medical applications.

By using wavelet transform with Multi Scale PCA, EEG can be differentiates into different detail components or various frequency bands, and the noise also can be rejected without loss of data effectively according to the different behavior of Wavelet Transform coefficients of signal and noise. PHYSICIAN may use those detail components and denoised EEG for further clinical analysis of the paitent. “It indicates that it provides a promising method to characterize the EEG and remove the noise from the signal and compress the signal without loss of data.”

Using this technique a new data compression algorithm has been successfully verified for EEG signal data. From above experiment obtained results showed better match between the original signal and reconstructed signal over the previously reported work. “For signal compression and signal reconstruction of EEG signal, DB2 is found to be the appropriate wavelet.”

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