Comparative Study of Denoising Electroencephalogram Signal Using Window and Wavelet Methods

Gurdeep Singh, Er.Gautam kaushal

***Abstract*— Electroencephalogram (eeg) is a biological signal that basically tells us about the electrical activity of our brain. There are low voltage signals that are corrupted by many noises which are known as artifacts.The noise which is present in the eeg signals take out many important features of the eeg signals . as we know these signals cure various types of brain diseases like sleep , apneasyndrome ,insomnia etc.It is very important to remove this noise if we have to detect the diseases and proper output of eeg signal. In this paper we studied different methods of denoising EEG signal i.e window method and wavelet transform method. In it wavelet method is much better than the window method to denoise EEG signal.**

***Index Terms*— EEGsignal, Artifact, EOG, EMG, DWT, Wavelet Transform.**

I. INTRODUCTION

Electroencephalogram is a electric field signal recorded from the neural currents present in the brain and are measured by putting the electrodes on the persons scalp.The measurements of dipoles change by eye blinks and movement of eyes which tends to produce a signal known as electrooculogram(EOG). Only minute number of EOGs disturb the electrical activity of the brain and these potentials which are disturbed are known as ocular artifacts(OA).One more common artifact which is generally observed by contracting our muscles and is measured in our body is Eletromyogram(EMG).This artifact is generally felt when the person is in awake mode and mainly observed during swallowing,grimacing,jawclenching,chewing, talking and sucking.These artifacts are called as muscle artifacts.These are mainly in order of milli -volts and they effect the signals which are in order of milli-volts.The freq range of EEG signal is 0 to 64Hz and OA occurs in the range of 0 to 16Hz i.e they overlap.Therefore finding a method for successfull OA removal from EEG is still a major problem.EEG signal takes lots of time and can be easily corrupted by various other noises and are very weak.That is why many artifacts are constructed during the recording of a EEG signal.OA are those noises which bring lots of difficulty in processing of a EEG signal and its analysis and recognition.In this paper we have discussed many techniques which can be used to remove noise present in EEG signal by the name of artifact.All older techniques like PCA, ICA as well as improved wavelet based techniques using adaptive Thresholding and HAAR waveket has been discussed in this paper[1,2,3].

Manuscript received July 20, 2014.

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II. METHOD FOR EEG SIGNAL DENOISING:

The different methods of denoising an EEG signal that can be implemented for removal of noise available in the EEG signals are discussed below:-

A. Window method(Using Hamming Window):

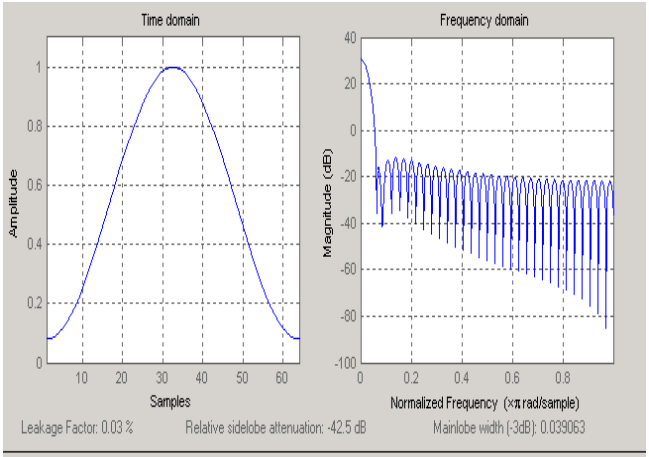
We have used hamming window method. It is most commonly used window in speech processing, this windows also has bell like shape. It's first and last samples are not zero.

Formula for hamming window:

$$W_H(n)= \begin{cases} 0.54 - 0.46 \cos\frac{2\pi N}{M-1} \\ 0 \end{cases}$$ for

n=0,1.....M-1.....[4,5]

Hamming window has reduced side lobes but slightly increased main lobe but the side lobes of the hamming window are higher than the blackmann window.



(a)Time domain graph (b) magnitude response graph.[4,5]

B. Wavelet method:

Wavelet transform is a time frequency analysis method on the basis of fourier transforms. The main function of the wavelet transform is that it can reflect both time and frequency domain in order of a signal.Therefore, wavelet transform is vastly used in the processing of biomedical signal, mainly suitable for the non stationary one such as EEG.The calculation and computational speed of the discrete wavelet transform (DWT) is very fast as compared to many other transform methods,and it is very much needed for the real time artifact present in the EEG.Therefore,the practical signals that are needed to be processed are discrete after sampling process,that is why discrete wavelet transform is widely used.

a) ***Wavelets****: Wavelets are the mainly mathematically functions which breaks up the data into different frequency*

components and then we study each apparatus with a resolution matched to its scale.It is called the wavelets.

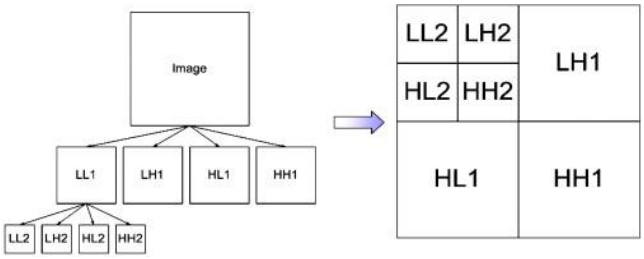
There are many types of wavelets in the family of wavelets.

But we have used the two types of the wavelets:-

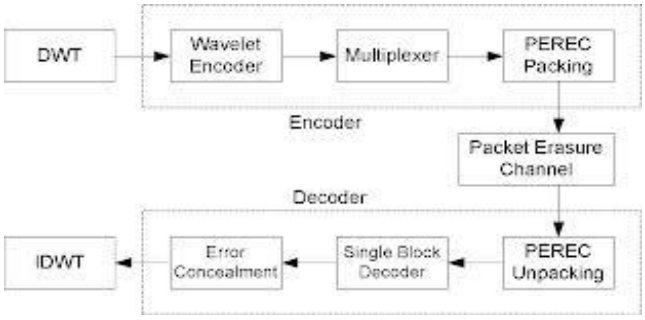
1. DWT (Discrete Wavelet Transform).

2. IDWT (Inverse Discrete Wavelet Transform).

b) ***DWT(DiscreteWavelet Transform):*** *DWT is Discrete Wavelet Transform. It is a type of wavelet. There are some denoising techniques to decrease the speckle noise with using the wavelets. Wavelet noising filtering: we will use the wavelet noise thresholding which is Discrete Wavelet Transform (DWT). In the case of DWT first the image is divided into the four parts HH, HL, LH, and LL and the further the approximation part is divided into two sub-bands. Approximation part is LL. And the other part is detailed part in which we have all three parts HH, HL and LH. We will work on the detailed part because the noise will occur on the high frequency part which is detailed part.*



c) ***IDWT(Inverse Discrete Wavelet Transform):****IDWT is Inverse Discrete Transform. It is also a wavelet. It is perfectly the inverse of the DWT technique.*



IDWT is the inverse of the process of DWT or you can say that it is the reverse process of the process DWT.In this case first it decodes the image and then it encodes the image and then it converts it into the first perfect noise free image which will be clear and clean. It makes the two sub bands in to the one then and at the end it makes only the perfect one image which will be noise free image.[6][7].

III. STEPS OF PROPOSED METHODOLOGY:

1.Load noisy eeg signal of sampling frquency 4 msec.
2.Then apply dwt (discrete wavelet transform)which decompose the signal into various parts.
3.Apply DWT (Discrete wavelet transform) on z^(x, y) =log f(x, y) +logɳ(x, y) to decomposed the signal into detail part + approximation part using equations.
4.Then approximation part gives us the lowest frequency components of the noisy eeg signal.Then these approximation low frequency coefficients of noisy signals will be ploted.
5.Then we plot the approximation high frequency coefficients of the noisy eeg signals.These detailed high frequency coefficients of noisy signal are ploted.
6.Then we recontructed the original signal using approximation coefficients because the length of the approximation coefficients is unequal,so to make their length equal we do reconstruction,and we have done reconstruction up to the third level(A1,A2,A3).Then third level are give us the denoised eeg signal.
7. Finally calculate its SNR value of denoised signal by the following formula.

$$MSE=\frac{1}{MN}\left[\sum\sum\left(f(x,y-f(x',y))\right)\right]$$

$$SNR=10\log\left[\frac{\sum_{I-1}^{N}x(I^2)}{\sum_{I-1}^{N}\left(x(I)-\bar{x}(I)\right)}\right]$$

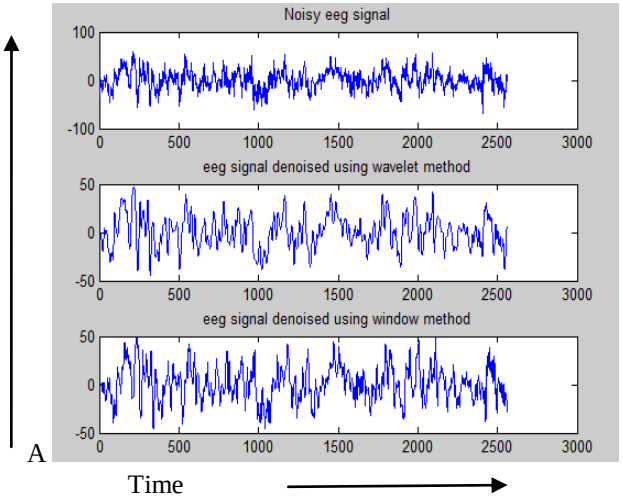
IV. RESULT AND CONCLUSIONS:

Signals → / Methods ↓	P_7O_1	C_3P_3	C_4P_4
Window method	0.6021	0.2512	0.2777
Wavelet method	0.8415	0.4183	0.4762

In the above given table it is shown that the wavelet method is much better than the window method. In this table we took three different noisy eeg signals respectively p_7O_1, C_3P_3, C_4P_4 from the physiobank mih database. In the above table it is shown that the SNR values of the wavelet method with signals P_7O_1, C_3P_3, C_4P_4 is much better than the SNR values of the window method. SNR values of wavelet method are: 0.8415, 0.4183 , 0.4162 and the SNR values of the window method are: 0.6021, 0.2512, 0.2777.

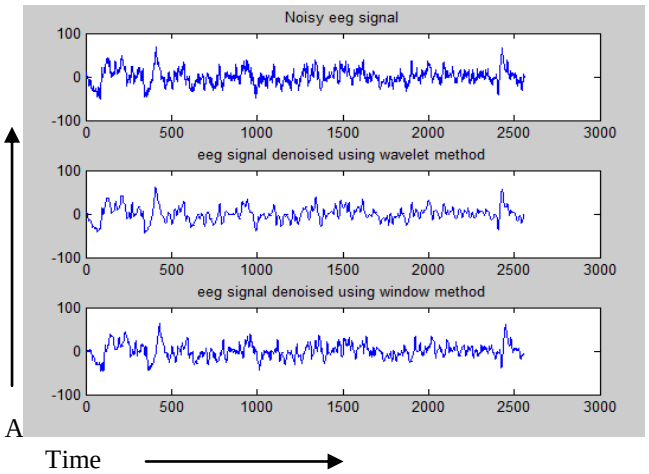
A. Image results for window and wavelet methods:

a) *Image result for window and wavelet methods with signal P_7O_1 :*



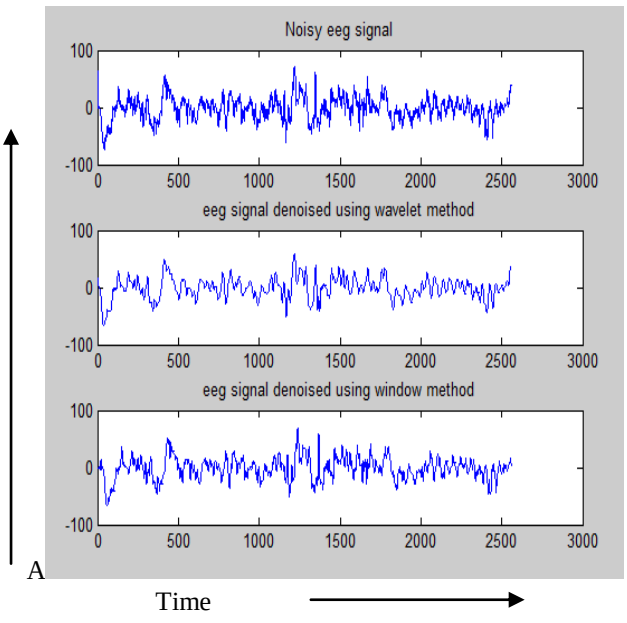
The above figure shows that the wavelet method is much better than the window method because wavelet method denoises the EEG signal better as compared to the window method which is clearly shown in the above figure and also the SNR (signal to noise ratio) of the wavelt method is 0.8415 whereas the SNR value of the window method is 0.6021 which is clearly less as compared to the wavelet method . hence the wavelet method is much better than the window method for denoising a EEG signal

b) Image result for window and wavelet methods with signal C_3P_3 :



In this given figure which is shown above that the wavelet method is way better than the window method which is able to denoise the EEG signal better than the window method we can justify it by comparing their SNRs . the SNR(signal to noise ratio) of the wavelet method is: 0.4183 whereas the SNR of the window method is 0.2512 which is very clearly less than the wavelet method SNR value and hence shows that the wavelet method is better than the window method.

c) Image result for window and wavelet methods with signal C_4P_4 :



In this give figure shown above it is clear that the wavelet method is much better than the window method and able to denoise the EEG signal much better as compared to the window method and we can easily justify our statement by comparing their SNRs. The SNR(signal to noise ratio) value of the wavelet method is 0.4762 and the SNR value of the window method is : 0.2777 which is clearly less as compared to the wavelet method and hence the wavelet method is much better than the window method.

V. CONCLUSION

This has been discussed many denoising EEG signal techniques which are specially used to denoise the eeg signals using various methods such as PCA, HAAR wavelet, ICA. These methods are basically used to denoise the EEG signals. Wavelet transform has the most better results to denoisse the EEG signal and we have shown that by using wavelet transform along with daubechies wavelets. In this we have compared it with the window method technique and wavelet filter is giving the superior results as shown above. It gives the better value of SNR (signal to noise ratio) and also gives the better quality of signals as clearly stated above in all of our figures. Therefore wavelets with daubechies show that their result is far better than as compared to other techniques such as window method.

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