Abstract

Organization of the thesis

In this thesis, five different ocular artifact removal methodologies using wavelet transform are proposed and analyzed. Also, the application of wavelet transform on textile and chemical industries are proposed and analyzed. The thesis is organized as follows: Chapter II deals with A Wavelet Based Statistical Method for De-noising of Ocular Artifacts in EEG Signals, using different threshold formulae, threshold function and window size. Here, stationary wavelet transform is applied to the contaminated EEG signal, decomposing it up to eight levels. Two different threshold formulae are proposed with suitable threshold function to fix the wavelet coefficients in a new position. Then, wavelet reconstruction procedure is applied to reconstruct the EEG signal. This gives a better result without any complexity, retains the original information contained in the EEG signal, and can also easily remove the artifacts. In this method, power spectral density plot and correlation plot are used as performance metrics. Further, comparison of the proposed method with other existing methods is discussed. A comparison between the two proposed threshold schemes is also made. Removal of Ocular Artifacts in the EEG through Wavelet Transform without using an EOG Reference Channel is analyzed in Chapter III. It describes a statistical method which directly decomposes the EEG signal using SWT with Symlet (sym3), as a basis function. By using the statistical approach -- the coefficient of variation - the ocular artifact zones are identified and by using a new threshold scheme, the artifacts in EEG recordings, without using EOG reference channel, are removed. First, stationary wavelet transform is applied to the contaminated EEG signals and decomposing it up to eight levels, only 'detail' wavelet coefficients (dj) are taken.

Normally, every spike in contaminated EEG contains three coefficients such as dj_, dj,dj+1. From the number of 'detail' coefficients obtained at each level of wavelet decomposition, the detail coefficients in the form d j>dj_,,d j+, , j = 1,2,3, ...n are selected. Next, spike identification begins with d j+1 treated as d H and checks the next two coefficients. Based on this arrangement, the spikes in the contaminated EEG signals are identified. Using the spike zone coefficients(dH dj,dj+l), the coefficient of variation for every spike zone is calculated. In this study, the larger coefficient of variation values has been selected and the larger value zone is identified as ocular

artifact zone. A threshold formula and threshold function is proposed to remove the artifacts. The results are compared with the other existing research works. This proposed method gives better results without any complexity and also retains the original information contained in the EEG signal. Power Spectral Density and Correlation plots are used as performance metrics. Chapter IV describes the Removal of Artifacts from EEG Signals using Adaptive Filter through Wavelet Transform with LMS Algorithm. The adaptive interference cancellation is a very efficient method to solve the problem when signals and interferences have overlapping spectra. The input signal d(n) is the EEG corrupted with artifacts (EEG + EOG). The reference signal x(n) is an original EOG (without artifact). The output signal from the system function H(z) is y(n) which is estimated from the original EOG. This signal y(n) is subtracted from the corrupted d(n) to produce the error e(n), which is the EEG without artifacts. While applying stationary wavelet transform to the corrupted signal d(n) and reference signal x(n) with symlet (sym3) as a basis function, it decomposes up to eight levels. An adaptive filter based on Least Mean Square (LMS) algorithm with wavelet decomposition is described in order to cancel EOG artifacts. The advantage of adaptive filter over conventional ones is the preservation of components intrinsic to the EEG record. Using the wavelet reconstruction procedure, the EEG signal is reconstructed which is free from artifacts. In the output signal, there are no low frequencies noted to indicate that, the EOG is actually removed. The complexity in this work is the determination of filter order (N) and convergence factor (p). These parameters are very important, because they lead to appropriate filtering and adequate adaptation. If p is too big, the filter becomes unstable, and if it is too small, the adaptation may turn out to be too slow. Several steps are carried out to determine the optimum value for these parameters. Therefore, artifacts were adequately attenuated without removing significant useful information. The adaptive cancellation with the help of wavelet decomposition is a preprocessed work and is an efficient processing technique for improving the quality of EEG signals in biomedical analysis.

In Chapter V, An Adaptive Method to Remove Ocular Artifacts from EEG Signals using Wavelet Transform with RLS Algorithm is discussed. An adaptive filtering method, which makes use of Recursive Least Square (RLS) algorithm for removing ocular artifacts from EEG recordings through wavelet transform, is proposed. This work is similar to adaptive filter with LMS algorithm but, RLS algorithm has higher computational requirement than LMS, and behaves much better in terms of Mean Square Error (MSE) and transient time. The convergence rate is faster than LMS. When it is compared with LMS, the filter order is less. Therefore, an adaptive cancellation using the wavelet decomposition technique with RLS algorithm is an efficient technique for improving the quality of EEG signals. Previous chapters concentrate on applications of wavelet transform on biomedical signal processing. The next chapter deals with application of wavelet transform on textile and chemical industries.

In Chapter VI, A Statistical Approach for Identifying Defects in Fabrics and Ceramic Tiles using Discrete Wavelet Transform is discussed. Using the statistical approach -the coefficient of variation - defective portions of the fabrics and ceramic tile images are identified with the help of wavelet transform technique. The images of defected fabric and ceramic tiles are taken for analysis. The image size is considered in powers of two, say 2J (j=l,2,...). Then, the image is divided into equal number of rows and columns (blocks). Every block contains 2J (j=l,2,...) coefficients. The first level of decomposition is done using DWT technique. Next, considering 2 j_!(j = 1,2,....) approximation coefficients, the DWT technique is again applied. The procedure is repeated until a single approximation wavelet coefficient is obtained. All the single approximation wavelet coefficient corresponding to each block for the image is tabulated into rows and columns. The coefficient of variation for every row and column corresponding to single approximation wavelet coefficient is obtained. The intersection of greater values corresponding to rows and columns is identified as the defective blocks in the image. Varying samples are taken to illustrate the method. The conclusion on the present work and suggestions for future work is presented at the end.