International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

SIGNAL DE-NOISING TECHNIQUES-A REVIEW

Miss.Shweta Revankar[1], Mr.Gautam Kulkarni[2], Mrs.Shubhangi Deshmukh[3] , Dr.B.B.Godbole[4]

PG Student, MTech Embedded System, Sanjay Ghodawat University, Kolhapur, Maharashtra.
PG Student, MTech Embedded System, Sanjay Ghodawat University, Kolhapur, Maharashtra.
Assistant Professor, MTech Embedded System, Sanjay Ghodawat University, Kolhapur, Maharashtra.
Associate Professor, Department of Electronics, K.B.P.College of Engineering, Satara, Maharashtra.

Abstract - *The signals that are used in the various fields that includes medical, military, and navy have the various types of noise introduced into it. There are various studies and researches have been done to improve the quality of the signals, there are several methods that are used to de-noise these signals to get a better version of signals. These methods are extremely helpful that they de-noise the signal at the very early stage that all the further proceedings with that signals become convenient. The methods help in developing a corruption free signal or when the signal is already corrupted with noise it helps to de-noise it by removing the unwanted noise from that signal. In this paper, we are studying types of de-noising techniques, signal de-noising of the ECG signal is also discussed.*

Key Words: **De-noising, Wavelet, ECG Signal de-noising, Threshold de-noising, Signal de-noising, Radar life signal; Lifting wave transform.**

1. INTRODUCTION

Signal de-noising is one of the major research contents in the area of signal processing. The traditional de-noising methods include, for example, median filter, Wiener filter and so on. However, there appear deficiencies such as enabling to describe the signals' character of non-stationarity and increasing the entropy after signal transformation. In order to overcome these shortcomings, the domestic and overseas' researchers are all interested in utilizing WT (Wavelet Transform) to solve the signal de-noising in recent years. Compared with the traditional WT, promoting the WT has some advantages such as the higher speed of calculation, additional memory is no longer required for storage and integer to integer wavelet transform can be realized.

This paper includes the study of De-noising techniques like Wavelet Based De-noising, FIR and IIR Filter for ECG Signals, Empirical Mode Decomposition.

2. SIGNAL DENOISING TECHNIQUES:

A} WAVELET BASED TECHNIQUE:

Employing a chosen orthonormal wavelet basis, an orthogonal N × N matrix W is appropriately built[7] which in turn lead to the discrete wavelet transform (DWT)

c = W x

Where, x = [x(1), x(2),..., x(N)] and c = [c1, c2,..., cN] contains the resultant wavelet coefficients. Due to the orthogonality of matrix W , any wavelet coefficient ci follows normal distribution with variance σ and mean the corresponding coefficient value ˉ ci of the DWT of the noiseless signal ˉ x(t). Provided that the signal under consideration is sparse in the wavelet domain, which is actually the case with the most of the signals we are interested in, then the DWT is expected to distribute the total energy of ˉ x(t) in only a few wavelet components lending themselves to high amplitudes. As a result, the amplitude of the most of the wavelet components is attributed to noise only. The fundamental reasoning of wavelet thresholding is to set to zero all the components which are lower than a threshold related to noise level, i.e., T = σC, where C is a constant, and then reconstruct the de-noised signal ˜ x(t)utilizing the high amplitude components only. The hard thresholding operator is defined by

$$\rho_T(y) = \begin{cases} y, & |y| > T \\ 0, & |y| \leq T, \end{cases} \qquad (3)$$

Consequently, the estimated de-noised signal is given by

˜ x = W T ˜ c (4)

Where, ˜ c = [ρT (c1), ρT (c2), ..., ρT (cN)]

And W T denotes transposition of matrix W. Apart from the standard wavelet thresholding described above, a number of modifications are investigated in our simulation results section including translation invariant thresholding and Bayesian-based wavelet thresholding. With respect to the threshold selection, the universal threshold T = σ√2lnN is a popular candidate. Such a threshold guarantees with high probability that all the components attributed to noise will have lower amplitudes. In this paper, multiples of the above thresholds are used and the noise variance is estimated using a robust estimator based on the median of the components. Moreover, it is usually beneficial to apply thresholding after a primary resolution level leaving the coarse scales corresponding to low frequencies unthresholded. This parameter will be taken into account in our study. Fig. 1a,b shows the noise-free estimates of the corrupted by noise signal of Fig.2 using wavelet hard thresholding with the universal threshold and Bayesian-based wavelet thresholding. The numbers on the top left of the figures indicates the SNRs after the de-noising procedure. Note that this performance corresponds to a single arbitrary noise realization[1] .Fig 1 from [1]

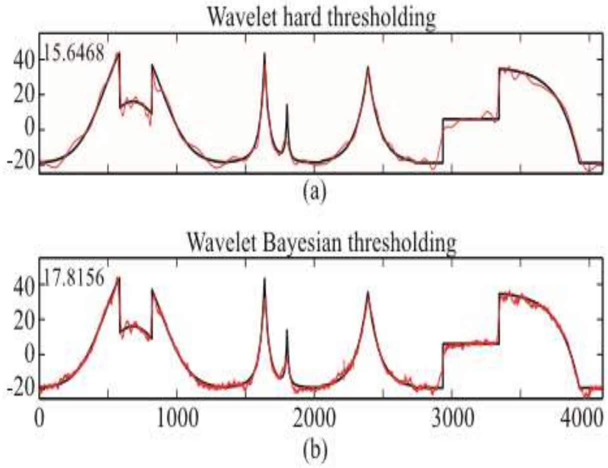

Fig 1. Examples of Wavelet based denoising

B} EMPERICAL MODE COMPOSITION TECHNIQUE :S

One of the most challenging tasks for which EMD could be useful is that of non-parametric signal de-noising, an area in which wavelet thresholding has been the dominant technique for many years. In this paper, the major wavelet thresholding principle is used in the decomposition modes resulting from applying EMD to a signal. We show, that although a direct application of this principle in the EMD case is not feasible, it can appropriately be adapted by exploiting the special characteristics of the EMD decomposition modes. In the same manner, inspired by the translation invariant wavelet thresholding, a similar technique adapted to EMD is developed leading to enhanced de-noising performance[1].

The Empirical mode decomposition (EMD) method is an algorithm for the analysis of multi component signals that works by breaking the signal into a number of amplitude and frequency modulated (AM/FM) zero mean signals, termed intrinsic mode functions (IMFs). In contrast to conventional decomposition methods such as wavelets, which perform the analysis by projecting the signal under consideration onto a number of predefined basis vectors, EMD expresses the signal as an expansion of basic functions which are signal-dependent, and are estimated via an iterative procedure called sifting[1].

Although many attempts have been made to increase the understanding of the way EMD operates and to improve its performance, EMD still lacks a sound mathematical theory and is essentially described by an algorithm. However, partly due to the fact that it is easily and directly applicable and partly because it often results in interesting and useful decomposition outcomes, it has found a vast number of diverse applications such us biomedical watermarking and audio processing to name a few. Apart from the topic specific applications of EMD listed above, a more generalized task in which EMD can be proved useful is signal de-noising. In this paper, inspired by standard wavelet thresholding and translation invariant thresholding, EMD-based de-noising techniques are developed and tested in many different signal scenarios. We show, that although the main principles shared by wavelet and EMD thresholding remain the same, in the case of EMD, the thresholding operation has to be properly adapted in order to be consistent with the special characteristics of the signal modes that result from EMD[1].

Fig. 2 depicts, as an example, the outcome of the application of EMD to a well studied piecewise-regular signal corrupted by white Gaussian noise corresponding to a 5dB signal to noise power ratio (SNR)[1].

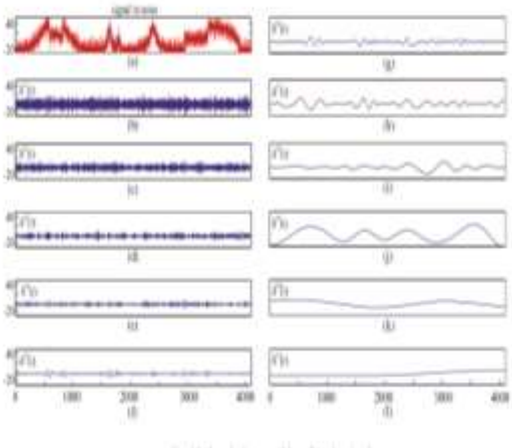

Fig.2. Empirical mode decomposition of a noisy signal

C} FIR AND IIR FILTERS FOR ECG ANALYSIS :

Seema rani et. al. in[4] made a comparative study on the use of FIR and IIR filters for removing baseline noises present in ECG signal. Two parameters considered to evaluate the suppression of baseline noises are Spectral density and average power of signal Based on the obtained implementation results, though FIR and IIR filters both have removed the baseline noises, IIR filters are efficient as there is a phase delay in FIR filtered waveforms. Produced due to large order of FIR filter Also the computational complexity, memory requirement and power dissipation of IIR filter is less than FIR filters which makes IIR filters the better choice for removal of baseline noises[6].

Ying -Wen Bai et. al. in[3] made a comparative study of general notch filter, comb notch filter and equiripple notch filter. The performance is measured with respect to mean square error. It is observed that the equiripple notch filter retains the detail of practical signal effectively at the expense of higher filter order while the comb and general notch filters weaken the features of the ECG signal[6].

Mahesh Chavan et. al. in[5] designed a digital FIR equiripple notch filter which remove power line interference from ECG signal. Even though higher order filter is required , this filter reduces powerline interference successfully. The higher order implementation increases the computational complexity and makes it difficult to realize the higher order filter. Also, the delay in response is increased. Reduction in signal power is more in the Equiripple method when compared with the windowing technique. Window method need less number of elements while Equiripple method need more computational elements, thus computational time is the major limiting parameter of the Equiripple type digital filter. A technique is proposed in[3] for the improvement of raw and noisy ECG signals by using window based FIR filters. The performance of de-noising is measured by calculating the SNR of the processed ECG signal and then correlation coefficient was determined to find the degree of mismatch between raw ECG and filtered noisy ECG. The designed FIR filter with Kaiser window works excellent as compared to the Gaussian, Blackman and Blackman-Harris filter in removing baseline wandering and power line interference under different noisy conditions [6].

3. CONCLUSIONS

This survey includes the work by different researchers on signal de-noising techniques, In wavelet based technique and emperical mode decomposition technique we studied that, the basic wavelet thresholding operator was modified in order to suit to the special characteristics of EMD modes. Moreover, inspired by translation invariant wavelet thresholding, an iterative scheme for improved EMD de-noising performance was developed. The new algorithms have been tested with two well studied signals in high noise scenarios and their performance was compared with wavelet thresholding methods. It turned out, that the iterative EMD de-noising method exhibit the best performance in most cases[1].

In ECG Signal de-noising we reviewed that, ECG signal is corrupted by different type of noises like power line interference, channel noise, baseline wander, Electromyogram (EMG) Noise, electrode contact noise, and motion artifacts. Adaptive filtering is the best filtering technique for ECG signal with low frequency SNR. Wavelet technique can be used if signal beat to beat variation is high. EMD can be used to remove high frequency noise[6].

REFERENCES :

[1] EMPIRICAL MODE DECOMPOSITION BASED DENOISING TECHNIQUES Yannis Kopsinis, Stephen (Steve) McLaughlin IDCOM,School of Engineering and Electronics The University of Edinburgh, King's Buildings, EH9 3JL, Edinburgh

[2] Qilian Liang, Biologically-Inspired Target Recognition in Radar Sensor Networks, EURASIP Journal on Wireless Communications and Networking, Paper ID: 523435, vol. 2010.

[3] Ying –Wen Bai, Wen-Yang Chu, Chien-Yu, Yi –Ting , Yi-Ching Tsai and Cheng-Hung Tsai ―Adjustable 60 HZ Noise Reduction by a Notch Filter for ECG signal‖ International and Measurement Technology conference Italy 18-20 May 2004

[4] Seema Rani, Amarpreet kaur, J S Ubhi. ―Comparative study of FIR and IIR filters for the removal of Baseline noises from ECG signal‖ International Journal of Computer Science and Information Technologies Vol 2 (3), 2011.

[5] Mahesh S Chavan, R A Agrawala, M.D. Uplane. ―Design and implementation of Digital FIR Equiripple Notch Filter on ECG Signal for removal of Power line Interference‖ 4th Wseas International Conference on Electronics, Control & Signal Processing, 2005.

[6] ECG DENOISING TECHNIQUES: A SURVEY 1Shamya C, 1Shilpa Unnikrishnan M K, 2Smitha P B 1PG Scholar, 2 Assistant Professor, Dept. of ECE, Thejus College of Engineering.

[7] S. Theodoridis and K. Koutroumbas, Pattern Recognition, Academic press, third edition, 2006.