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ECG Signals De-Noising using Adaptive Filter

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Abstract: *Electrocardiogram (ECG) is a tool which is used for measuring the electrical activities of heart. One of the major problem in biomedical field is the separation of the noise-less ECG signal from the noisy signals caused by power line interference, electromagnetic fields, movement of the body and respiration. Different types of digital filters are used to remove the signal components from unwanted signals. It is difficult to apply filters with fixed coefficients to reduce the noises in ECG signals because human activities are not exactly known with respect to time. This problem can be overcome by an adaptive filter technique. In this paper, adaptive filters are considered to reduce the high and low frequency noise in ECG signals. Simulations and experimental results are presented using MATLAB.*

Keywords: *ECG Signal, Adaptive filter, Noise, Least mean square, Noise measurement, Noise reduction, MAT lab.*

INTRODUCTION

The analysis of various accurate noisy Electrocardiogram (ECG) signal is a very interesting challenge. The weak non-stationary ECG biomedical signal is affected by various noises: power line interference, electromyography interference and sensor contact noise. Due to the presence of these artifacts, the ECG signals are difficult to analyse. The elimination of undesirable artifacts is required to ensure correct analysis and diagnosis. The main goal of ECG signal enhancement is to separate the noisy signal from the valid signal component, so as to present an ECG that facilitates accurate interpretation [1]. Here we are using an adaptive filter whose coefficients are adjusted according to problem specification when compared to others. It computes the desired output by adjusting its filter coefficients in an iterative manner. Adaptive filter is considered as noise canceller filter (ANC) and it has two types of algorithm like LMS(Least Mean Square) and RLS(Recursive Least Square).Compared to RLS algorithm, LMS algorithm is simple and it does not require correlation function calculation as well as Produces the robust and stable performance against different conditions.

Literature Review

Noise reduction and lossy compression in ECG signal is based on kalman filter. De-noising is done by SNR improvement, while for compression, we have chosen the compression ratio (CR). For a hybrid system the proposed framework is more suitable, that integrates these algorithmic approaches for clean and original ECG signal [2].

Wiener filter is used to reduce the high frequency noise in the ECG signal. This can be done by comparing the received signal with a estimation of a desired noiseless signal [3].Before implementation of the filter it is assumed that the spectral properties of the original signal noise is known to the user. Spectral properties like the power functions for both the original signal and noise. And the desired resultant signal is as close to the original signal.

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FIR filter with Kaiser window for removal of noises present on ECG signal. They have designed kaiser window based low pass filter for removing high frequency noise, high pass filter for removing high frequency noise and Notch filter for removing power line frequency in ECG signal [4].FIR filter sometimes have a disadvantage that they require more memory.

Analytical Report

The vector equation is given by,

$$w(n+1)=w(n)+1/2\mu[-\nabla(E\{e2(n)\})]$$

Where μ is the step-size parameter and it controls the convergence characteristics of the LMS algorithm;e 2 (n) is the mean square error between the output y(n) and the reference signal which is given in the following equation,

$$e2(n) = [d*(n) - w h x(n)]2$$

The gradient vector in the above equation can be computed as

$$\nabla w(E\{e2(n)\}) = -2r + 2Rw(n)$$

In this method the major problem in finding the values of r and R matrices .The LMS algorithm which is also used to simplify this by using the instantaneous values of covariance matrices r and R instead of their actual values.

$$R(n) = x(n)x h(n)$$
$$r(n) = d*(n)x(n)$$

Therefore,

$$w(n+1)=w(n)+\mu x(n)[d*(n)-x h(n)w(n)]$$

$$= w(n) + \mu x(n)e*(n)$$

The initial arbitrary value w (0) of LMS algorithm at n=0.

Therefore,

Output, $y(n)= w h x(n)$

Error, $e(n) = d*(n) - y(n)$

Weight, $w(n+1) = w(n) + \mu x(n)e*(n)$

Simulation & Results

To de-noise the ECG data with LMS Adaptive filtering algorithm,the ECG signal is generated in MATLAB fig(1).The high and low frequency noise generated in the MATLAB fig(2).The ECG signal along with the noise signal is given in the fig(3).The filtered ECG signal from the high and low frequency noise is given in the fig(4).

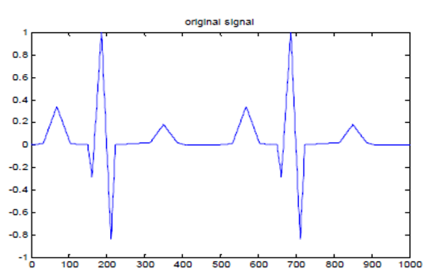

Fig (1)

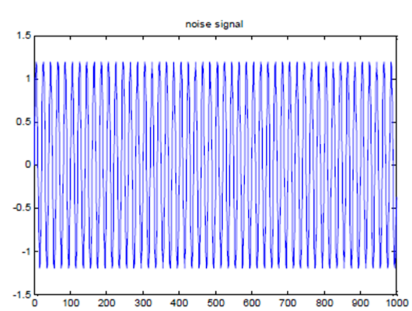

Fig (2)

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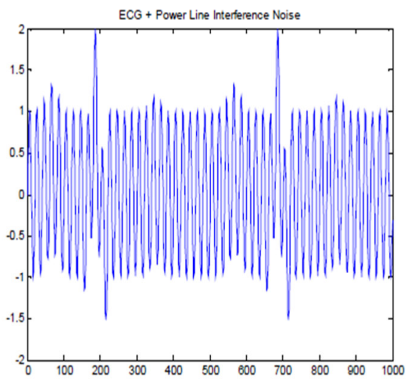

Fig (3)

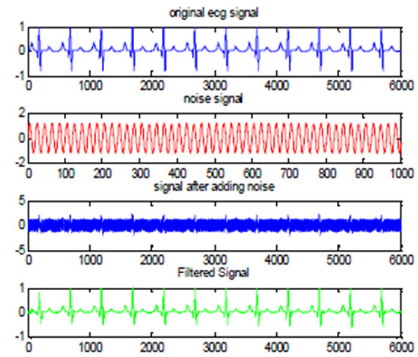

Fig (4)

Conclusion & Future Work

In this paper, the ECG signal contaminated with low frequency and high frequency artifacts is de-noised with Least Mean Square (LMS) adaptive algorithm. This ECG signal contaminated with noise is then filtered using Least Mean Square (LMS) adaptive algorithm. The de-noised ECG signal is then recovered .The LMS algorithm is simple, robust and easy to implement. In Future algorithm with fast convergence can be developed for de-noising of ECG signal since the LMS Adaptive algorithm has low convergence

Reference

1. Respiration wander removal from cardiac signals using an optimized adaptive noise canceller sowmya. I, canadian journal.
2. Reduction of ECG signal noise using extended kalman filter Mohammad Bagher Shamsollahi, Member, IEEE
3. Wavelet domain signal de-noising by thresholding and wiener filtering. Kazubek, M.Signal processing letters, IEEE, volume:10, Issue:11,Nov.2003 265 vol.3.
4. Mbachu C.B.,Onoh G.N.,Idigo V.E.,Ifeagwu E.N.,Nnebe S.U "Processing ECG signal with kaiser window-Based FIR Digital filters" International journal of engineering science and technology,Vol.3 No.8 August 2011 Pg No: 6775-6783

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