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Performance Analysis ECG Signals Noise Removal Techniques: A Review

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Abstract
Heart problems are a source of danger to human life, so it is necessary to conduct an ECG to avoid the threat to our lives. The result is recorded in the form of a signal or waves through the technique of ECG, but faces the problem of artifacts, basic roaming and noise, It should be removed from the original signal. There are many methods used to remove noise in the medical field such as neural retina and wavelet transformation. In this paper we have studied literature on the development of advanced technology and algorithm and performed an analysis of the advantages and disadvantages.
Keywords*: ECG, Neural Network, Wavelet transform, Noise, Wander baseline*

I. Introduction

Heart disease is a concern for humans and getting rid of this anxiety is the main issue. Signal processing in the field of bioengineering is very important. The field of bio-signal processing has entered the application phase in pattern analysis and signal processing for use in improved diagnosis, rehabilitation and monitoring of patients in critical situations via the Internet. The first step for heart patients is an electrocardiogram. The techniques used to record the electrocardiogram of the heart are EKG and ECG. Here we must mention what the Dutch scientist Willem Einthoven proposed in 1990 the technique (EKG) of the original term electrocardiogram, the ECG signal represents the activity of the heart in a detailed and graphical form, which is used to detect abnormalities of the heart and its various diseases. This signal consists of a complex QRS, P wave and T wave In addition to heart abnormalities, Fig. 1. shows the standard ECG signal.

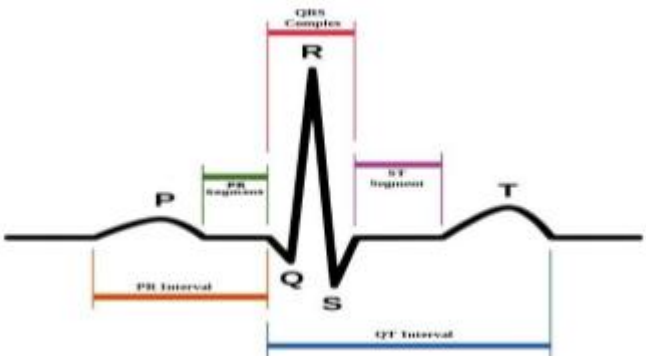

Fig. 1. Standard waveform ECG (Google Images)

Note that the ECG is based on the English version, which is the word "electrocardiogram" as we see today is the most preferred version of medical staff as well as still used by EKG and many people regularly, for reasons that may be a common method or They may be in order to circumvent confusion with similar sounding EEG from the brain . In the future you will decide to use ECG or with a section of EKG or both. The current work includes the ECG signal The biomedical and technical signal proposed for different filtration is FIR or IIR filter It should be noted here that the frequency of the ECG signal is between (0.5 - 100) Hz, the damage to the ECG is due to artifacts [1,2].

1. Electrical cable impedance
2. Electrical contact clamor
3. Movement ancient rarities
4. Muscle withdrawal
5. Standard float
6. Instrumentation clamor created by electronic

Gadgets. Because of this combined noise alone, the ECG signal is damaged and the diagnosis is wrong. To address such errors, digital filters of interest are used in the treatment of biomedical signals, this noise is also eliminated by the use of analog filters. But analog filters are less accurate than digital filters because the nonlinear phase is converted [3,4,5]. There are two types of digital filters the first is the (FIR) Finite-impulse-response, while the second is the (IIR) infinite-impulse-response.

II. Literature Review

Mbachu C.B. He used the Kaiser window with the FIR filter to accomplish the task of removing noise from the ECG signal. This method was based mainly on the design of a low filter based on the Kaiser window. In order to remove high-frequency noise like in EEG, the focus is on the use of a high-pass filter to eliminate noise that is inherently low-frequency, such as a notch filter and basic roaming. To achieve noise removal, the power line that is present with the ECG signal is followed by a sampling frequency that has a frequency of 1000 Hz, they also used a filter for 100, these filters are all designed for a cascade [6].

Chinchkhede K.D. et.al Breed has an idea to remove ECG noise by developing a FIR filter using multiple windows, of which: Blackman Window, Kaiser Window, Gaussian Window and Blackman Harris Window, the results were then compared in terms of performance and efficiency based on correlation and SNR [7].

Bhumika C. et. al. This researcher was characterized by unique opinions where he proposed a Review on noise through techniques to remove noise from the ECG, where he concluded that the Kaiser window with the filter FIR is able to remove artifacts from signal ECG, note that there is a slight modulation in the wave.

Mahes S Chavan et.al In order to minimize interference to the ECG signal the researchers used rectangular window with fir filter through the use of two types of scroll filters high and low look be kind of first class with a waterfall three. They concluded their work by comparing the results of the interference of the power line of the tire such as Hanning window and Kaiser Window, Rectangular window, Hamming window, with the result of reducing basic roaming. By doing so, they were able to complete the development of an elliptical digital filter used to rid the ECG signal of noise reduction.

VAN ALSTE J. A. et.al In developing the FIR filter, the researcher relied on characteristics in the linear phase, where he was able to remove the interference of the power line and roam the baseline, depending on the characteristic of the calculations that are common in digital filters [8].

Neeraj k. et.al add a great scientific product by introducing the FIR type –I filter and the Butterworth IIR filter to get the noise removal result from the ECG signal. The FIR filter was used to reduce the interference of the power line with the ECG signal. This filter was used to remove the interference in the 50/60 Hz power line in the ECG signals [9]. In our paper this is used low pass filter, high pass filter with filter reject tape used

III. Theoretical

The filtering techniques proposed in this worksheet include:-

1. FIR-FILTER:- Filters have a response that is in the form of a propulsive response for a specified duration, and is characterized by the fact that it can be implemented without feedback. The FIR filter is used in the performance of some window technologies are:-

A. Rectangular-window: the weighting capacity of a rectangular-window is given by

$$w(n) = \begin{cases} 1, & 0 \le M-1 \\ 0, & otherwise \end{cases} \qquad 1$$

B. Kaiser-window: The purpose of the Kaiser window is to achieve the appropriate mitigation of the stopping band with the maximum stopping bandwidth design, thus minimizing the attenuation of the lateral lobe β dB. The α parameter in the Kaiser window that affects the lateral attenuation property for the Fourier conversion as in equation 2.

$$\alpha = \begin{cases} 0 & ;\le 21 \\ 0.5842(\beta-21); 21 < \beta \le 50 \\ 0.1102(\beta-8.7) & ;> 50 \end{cases} \qquad 2$$

C. Hanning-window: The hamming-window capacity will be communicated by condition

$$w(n) = \begin{cases} 0.5 - 0.5 \ * cos\left\lfloor \frac{2nn}{M-1} \right\rfloor, 0 \le n \le M-1 \\ 0, otherwise \end{cases} \quad 3$$

D. Hamming-window: The hamming-window capacity can be communicated as

$$w(n) = \begin{cases} 0.54 - 0.46 \ * cos\left\lfloor \frac{2nn}{M-1} \right\rfloor, 0 \le 0 \le M-1 \\ 0, otherwise \end{cases} \quad 4$$

E. Blackman-window: Blackman-window:- The Blackman window capacity is given by

$$w(n) = \begin{cases} 0.42 - 0.5 \ * cos\left\lfloor \frac{2nn}{M-1} \right\rfloor, 0 \le n \le M-1 \\ 0, otherwise \end{cases} \quad 5$$

The usefulness of these windows is demonstrated by the design of high-pass filters and low-pass filters with a frequency cut from 0.5 to 100 Hz, to be passed through a loud ECG to noise was removed.

2. IIR-FILTER:- A simple filter has the potential to remove the fixed interference of the power line through the use of a first class filter in case it is a notch filter that has a attenuation degree that is high this will have the ability to remove PLI noise to a very large degree from the ECG signal, It is a filter that has an infinite impulse response rate [10,11,] and is designed using filters such as

A. Butterworth-filter: The greatness reaction of Butterworth low-pass-filter is given as

$$|H(j\Omega| = \frac{G}{\left[1 + (\frac{\Omega}{\Omega_C})^2\right]^{1/2}} \quad 6$$

Note: In the filter we notice that G means increase and ΩC is 3-dB cut off recurrence.

B. Chebyshev-filter: The greatness reaction is given by

$$|H(j\Omega| = \frac{G}{\left[1 + \varepsilon^2 C_N^2(\frac{\Omega}{\Omega_C})^2\right]^{1/2}} \quad 7$$

Note: In the filter we notice that G means increase and ΩC is 3-dB cut off recurrence. And the constant here is $\varepsilon \, also \, C_N(x)$ pointing to a Chebyshev-polynomial of N[th] order [12].

IV. Signal To Noise Improvement (Snr)

The SNR means the signal-to-noise ratio which represents the power-to-noise ratio, as for other signals, SNR should be positive, except ECG signal will be negative SNR, The ECG signal is noise-free the more the negative signal-to-noise ratio, and the SNR is calculated through the equation

$$SNR = \frac{\sum_{n=0}^{N-1}\{y[n]\}^2}{\sum_{n=0}^{N-1}(x[n] - y[n]^2)} \quad 8$$

Note: N is the number of points required for sampling in ECG-signal. SNR Large means high ability to reject noise [13].

V. Simulation Results

This is to evaluate the performance of different techniques used to reduce ECG signal noise, using FIR and IIR filters as well as MATLAB (R2011a). Through the Physionet-MIT-BIH database, ECG samples are selected and this will lead to arrhythmias and this is avoided by artificial noise. The statistical comparison was done by designing the filter algorithms and comparing them in terms of signal to error ratio, noise and accuracy. Matlab code is a highly efficient digital filter that is a digital filter used in converting to VHDL and then simulating Modelsim and thus the algorithms are implemented on Sparton-6-FPGA.

The results showed that When we look at many papers and compare them with some it is clear that the digital filter FIR with Kaiser window is very effective in removing artifacts from ECG including a little modification in the wave, this summarizes the results of this number of different papers in the table 1.

Table 1. Result of reduction in SNR using different windows.

Type of Filter	Signal power before filtration in dB	Signal power after Filtration in Db	Effect on PQRST Waveform
Rectangular Window	-27.18	-29.58	More Distortion
Hanning Window	-27.18	-28.77	Less Variation
Hamming Window	-27.18	-29.18	Less Variation
Kaiser Window	-27.18	-29.59	Less Variation

Butterworth	-27	-100	Not modified
Chebyshev	-30.93	-52	Not modified

Table 2 SNR comparison with customary technique and proposed strategy

Method	SNR
Traditional Method	-9.7438 dB
Proposed Method	-10.290 dB

The SNR results obtained from the proposed method and the traditional method are shown in Table 2, which shows how to obtain the appropriate SNR in the proposed method and then compare with the proposed method. To add a smooth effect on the ECG signal in this work an additional medium filter was used, porefer FIR filters over IIR filters with the following features:-

1. FIR filter are constantly steady as they have non-recursive structure.
2. They gave the definite straight stage.
3. Efficiently achievable in hardware.
4. The filter reaction is of limited length.

In this manner clamor the result obtained using FIR advanced filter is better alternative in examination with IIR computerized filter

VI. Conclusions

This paper refers to the method used to remove noise from the ECG is an efficient and much more effective method than conventional middle filter technique.

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