Pre-processing of ECG Signals Using Filters

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Abstract—The ECG signal is abruptly changing and continuous in nature. The heart disease such as paroxysmal of heart, arrhythmia diagnosing, are related with the intelligent health care decision this ECG signal need to be pre-process accurately for further action on it such as extracting the features, wavelet decomposition, distribution of QRS complexes in ECG recordings and related information such as heart rate and RR interval, classification of the signal by using various classifiers etc. Filters plays very important role in analyzing the low frequency components in ECG signal. The biomedical signals are of low frequency, the removal of power line interference and baseline wander is a very important step at the pre-processing stage of ECG. In these paper we deal with the study of Median filtering and FIR(Finite Impulse Response)filtering of ECG signals under noisy condition.

***Keywords*— ECG, FIR filter, Median filter, Pre-processing**

I. INTRODUCTION

Electrocardiography is a transthoracic interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the outer surface of the skin and recorded by a device external to the body [1].ECG is used to measure the rate and regularity of heartbeats ,the position and size of chambers, the effect of drugs or devices, the presence of any damage to the heart, and the effects of drugs or devices used to regulate the heart, such as a pacemaker.

Fig.1 shows an ECG Waveform which consist of P wave, QRS complex, T wave And various intervals. Importantly, the R-R interval represents one heartbeat.

The ECG signal gets corrupted due to different types of artifacts and interferences such as Electrode contact noise, Power line interference, Motion artifacts, contraction, Base line drift, Instrumentation noise generated by electronic devices and Electrosurgical noise.

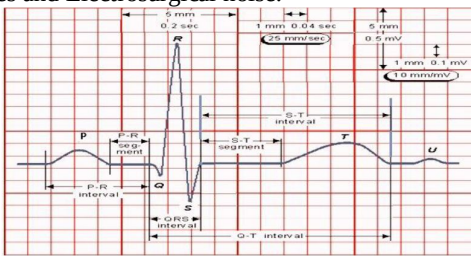

Fig.1 ECG Waveform

For accurate detection steps have to be taken to filter all these noise sources. The base line wandering, a low frequency fluctuation is due to the rhythmic depolarization and repolarization during respiration [9]. Hence, FIR and Median filters are discussed in this paper and how they can be applied in combination on vital signal of human body that is ECG for heart care is depicted. Section 2 discusses Material samples of ECG used for the experiments.FIR and Median filters are described in section3. Section 4 depicts how these filters can be applied on ECG signal for pre-processing and some of the results after applying filters. Section 5 represents Conclusion.

II. MATERIAL

The ECG signals samples are used to study the different cases of the patient. these ECG signals are taken from MIT-BIH database .these ECG signals are easy to analyze in MATLAB. The number of samples is not enough for a complete research concerning the effects of age, gender, weight, etc. Because the purpose of this study focuses only on the pre-processing of ECG signal, these factors, such as age, gender, and weight, etc. are not concern factors for sampling.

III. FILTERS

The Pre-processing of an ECG signal is performed for the removal of noise associated with the ECG signal. While acquisition of ECG, it gets corrupted due to different types of artifacts and interferences such as Power line interference, Electrode contact noise, Motion artifacts, Muscle contraction, Base line drift, Instrumentation noise generated by electronic devices and Electrosurgical noise. For the meaningful and accurate detection, steps have to be taken to filter out all these noise sources. In the project, for noise removal a function of Matlab called smooth() is used.

Z = SMOOTH (Y, SPAN)

This function smooth data Y using SPAN as the number of points used to compute each element of Z. *smooth()* uses the Moving Average filter and FIR (Finite Impulse Response) Filter for smoothing the ECG signal.

A. *Smoothing via Moving Average Filter*

In order to eliminate the effect of high frequency ripples on the obtained signal, the ECG trace is smoothed down using a moving average filter which performs local regression with the weighted linear least square and the 2nd degree polynomial model. The method assigns lower weight to outliers in the regression and zero weight to data outside six mean absolute deviations.

B. *FIR Filter*

FIR filters are digital filters with finite impulse response. They are also known as non-recursive digital filters as they do not have the feedback (a recursive part of a filter), even though recursive algorithms can be used for FIR filter realization. FIR filters can be designed using different methods, but most of them are based on ideal filter approximation. The objective is not to achieve ideal characteristics, as it is impossible anyway, but to achieve sufficiently good characteristics of a filter. The transfer function of FIR filter approaches the ideal as the filter order increases, thus increasing the complexity and amount of time needed for processing input samples of a signal being filtered.

There are essentially three well-known methods for FIR filter design namely:

1.The window method

2.The frequency sampling technique

3.Optimal filter design methods
The window method uses following functions and parameters.

[b, a] = fir1(N, Wn, varargin)

B = FIR1(N, Wn) designs an N'th order lowpass FIR digital filter and returns the filter coefficients in length N+1 vector B. The cut-off frequency Wn must be between 0 < Wn < 1.0, with 1.0 corresponding to half the sample rate. The filter B is real and has linear phase. The normalized gain of the filter at Wn is -6 dB.

B = FIR1(N,Wn,'high') designs an N'th order highpass filter. We can also use B = FIR1(N,Wn,'low') to design a lowpass filter. If Wn is a two -element vector, Wn = [W1 W2], FIR1 returns an order N bandpass filter with passband W1 < W < W2. We can also specify B = FIR1(N, Wn, 'bandpass'). If Wn = [W1 W2], B = FIR1(N, Wn, 'stop') will design a bandstop filter. For filters with a gain other than zero at Fs/2, e.g., highpass and bandstop filters, N must be even. Otherwise, N will be incremented by one. In this case the window length should be specified as N+2.

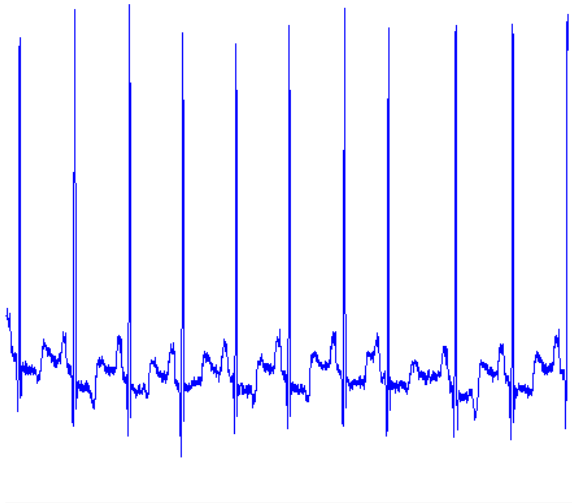

Fig. 2 Original ECG signal.

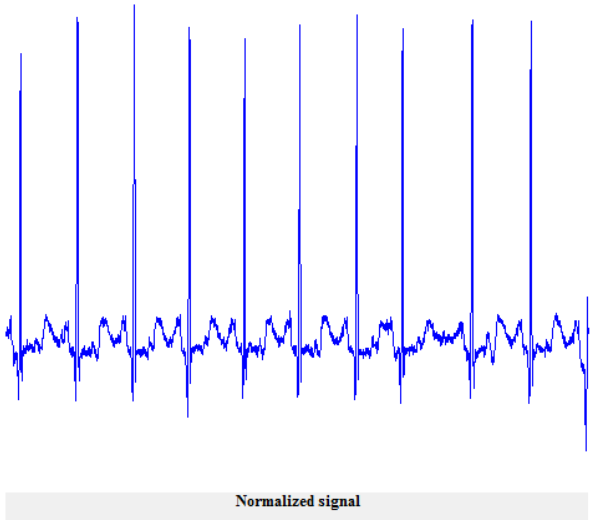

Fig. 3 Pre-processed ECG signal.

IV. RESULT

An objective of a health process is one where patients can stay healthy with the support of expert medical advice when they need it, at any location and any time. An associated aim would be the development of a system which places increased emphasis on preventative measures as a first point of contact with the patient.the ecg signals are continuous in nature and plays a very vital role in human body for predicting health status of a human, and so we are applying the FIR and Median filters for pre-processing on ECG signal.the original ecg signal is shown in fig 2, after applying both the filters on fig 2 we get the pre-processed ECG signal as shown in figure 3.

V. CONCLUSION

In this study our main objective is to demonstrate the combined effect of moving average filter and FIR filter for the pre-processing of an ECG signal which is more significant and very efficient rather than using single filter. This combination of FIR and moving average f filter in pre-processing an ECG signal removes not only baseline drift

(drift refers to the deviation of the signal from one state to another unpredictable state) but also preserves edges while removing noise. Another motivation for this type of work to perform for ECG signal because pre-processing is a vital step for later and better analysis of ECG signal of human being to take accurate decision regarding heart diseases.

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