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Removal of artifact in bio signal using ECG for QRS detection

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Abstract. This paper proposed a removal of artifacts in bio signal, which is used to improve the signal strength by using Pan Tompkins algorithm for QRS signal detection. This algorithm is compared with different filtering technique such as noise cancellation filter, squaring filter, moving average and differentiator filter. Recorded bio signal and SNR ratio measurement will be shown in simulation result using MATLAB 2018a software tool, this filtering technique data contains noisy input signal with 3 second time delay. The sampling rate of the ECG signal is 200Hz on power line noise from machine power supply, ECG signal wandering after cancellation DC drift and normalization process. Efficacy of the filters for removing the artifact and generate the effect on the ECG waveform, in terms of accuracy rate, the SNR ratio of ECG in pipeline architecture has 93% of efficiency is achieved.

Keywords: bio signal, digital filter, pan-tompkins algorithm, least mean square algorithm, adaptive filtering, noise reduction SNR ratio.

1. Introduction

In primary step the development of physiological sensor as soon as it became a reality started exploration to find the use of acquired signal it was found most of the signal added in noise and suffer from interference [1]. Many signals are not readily comprehensible auditable by human visual or auditory system, it consists of physiological subsystem most of the physiological subsystem associated with some signal and this change with the health of the constant physiological health system [2]. It is used to finding physiological health monitoring in outside. To explore large scale optimization process is an emerging technique for today's digital signal processing [3]. In low power optimization VLSI has play a major role for reduction of power, area and delay. Many devices are depending on the primary source of hardware which is implanted with the secondary source of software for real time electronics as well as by using this so many medical and technological parameters such ECG, EMG, PCG, EOG etc., measurement will be taken [4]. The low power adaptive filtering algorithm was used for error reduction

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in bio signal. It is an efficient way to reduce the error by suing LMS algorithm, it is nonlinear and filtering technique is easy to remove the noise in effective manner [5]. Various algorithm and architecture design was compared and the efficiency was calculated using least mean square algorithm in adaptive filtering method [6]. It is used to detect the bio signal, in this let us consider ECG signal recording setup. QRS detection is a crucial factor for the heart monitoring system like arrhythmia monitoring system, cardio vascular system, cardiac output measurement, flicks method, thermal dilution method impedance matching method etc., adaptive filtering technique is used for QRS detection, one important analytical reason is reduction of noise while monitoring the heart function by using bio signal parameters such as pacemaker, defibrillator etc [7].

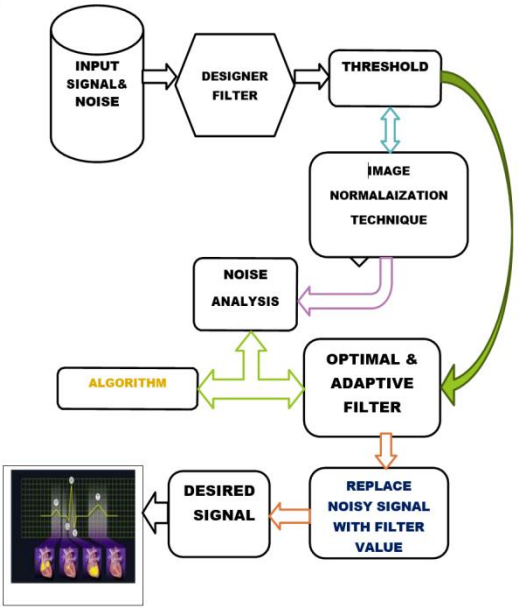

Figure 1. Block diagram of noisy signal analysis.

Basically, every input waveform consists of some noise. The ECG input signal with noise is combined and passed into a designer filter, the filter is used to remove the noise in the input signal and the particular range is selected using threshold, [8] then the signal is normalized using image normalization technique. Further the noise is analysed with the help of noise analysis block by using algorithm and filters. Here we are using two types of filters i.e., optimal filter and Adaptive filter. Figure 1. illustrates the basic block diagram of noisy signal computation [9].

2. Analysis of ECG from various techniques

Electrocardiography is mainly used to study the electrical activity of the heart muscle. Electrocardiogram is the recorded wave pattern. It reflects the rhythmic electrical depolarization and repolarization of myocardium associated with contraction of atria and ventricles [10][11]. The heart has four valves namely tricuspid valve, bicuspid valve, pulmonary valve and aortic valve. The human heart basically consists of three layers, (i) Pericardium: it is an outer layer of human heart it prevents friction between inner heart muscles and outer heart muscles. (ii) Endocardium: it an inner layer of heart and helps to have a smooth blood flow through valves, (iii) Myocardium: it is a middle layer and act as a main muscle Heart consist of three blood vessels namely arteries, veins and capillaries. Artery is a thick valve vessel which carries pure oxygenated blood to various organ of the body, Vein which is a smaller blood vessel that carries impure blood from various organ of the body to the heart. Figure 2. Represents the various steps for QRS wave detection in ECG. In systematic circulation it takes place from left atrium to left ventricular and passed to aorta and then it passes through all the body of the parts from the heart

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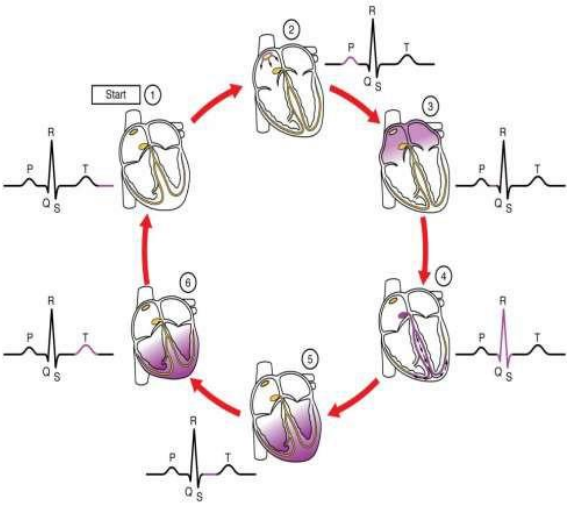

Figure 2. Steps for QRS wave detection in ECG.

2.1. QRS waveform detection

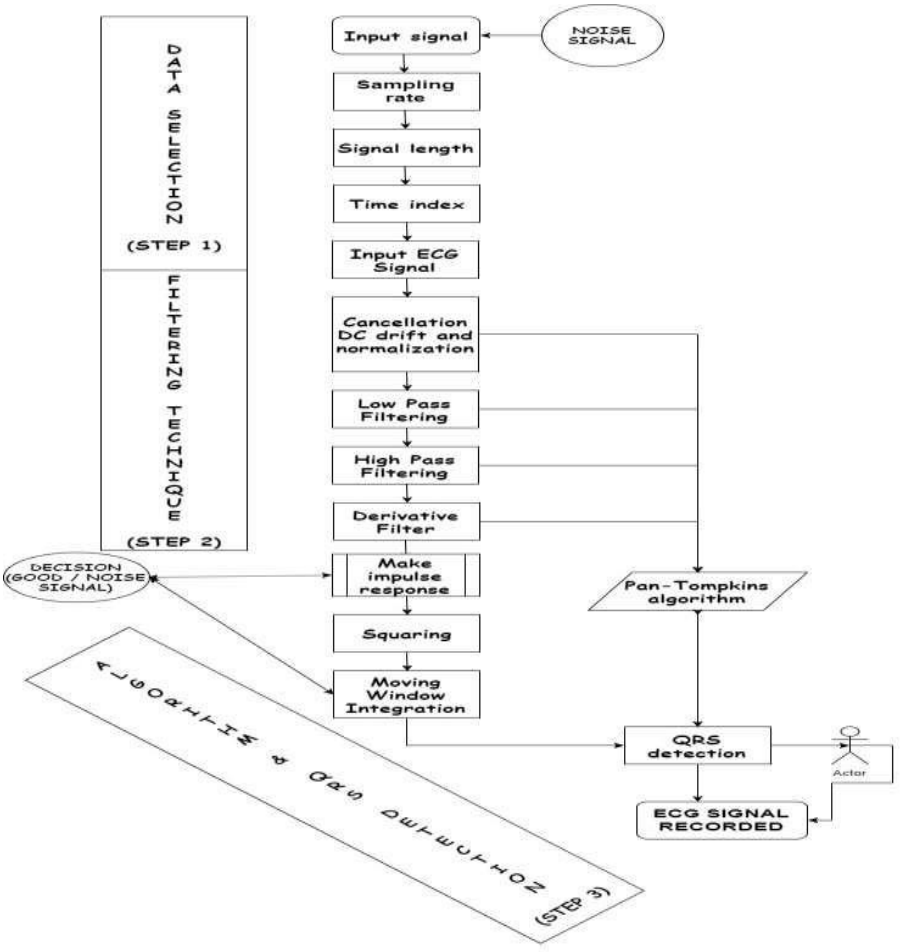

Figure 3. Flowchart of noise analysis.

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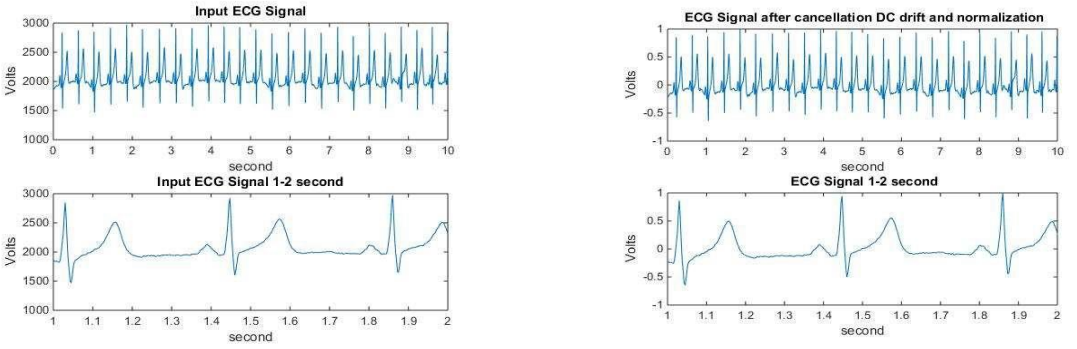
P Wave: P wave is originated due to atrial depolarization or contraction. It has the amplitude of 0.25mV and has the duration of 0.12 to 0.22sec. Q wave: Q wave is originated in the early ventricular depolarization. Depolarization is the process of moving the electric charge from the resting potential to the action potential. R Wave: R Wave is originated due to repolarization of the atria and the depolarization of the ventricles. It has the amplitude of 1.60mV and has the duration of 0.07 to 0.1 sec. S wave: S wave it occurs due to ventricular contraction. T Wave: T Wave is originated due to ventricular repolarization (relaxation of myocardium). It has amplitude of 0.1 to 0.5mV and has the duration of 0.05 to 0.15 sec. Repolarization is the process of moving the action potential to the resting potential. Figure 3. depicts the noise analysis flowchart. Figure 4, illustrates the input and cancellation of DC drift and normalization signal. Figure 5, represents the simulation of result of LPF and HPF signals. Figure 6, depicts the simulation of result of derivative and squaring signals. Figure 7, represents simulation of result of average and moving average ECG signals.

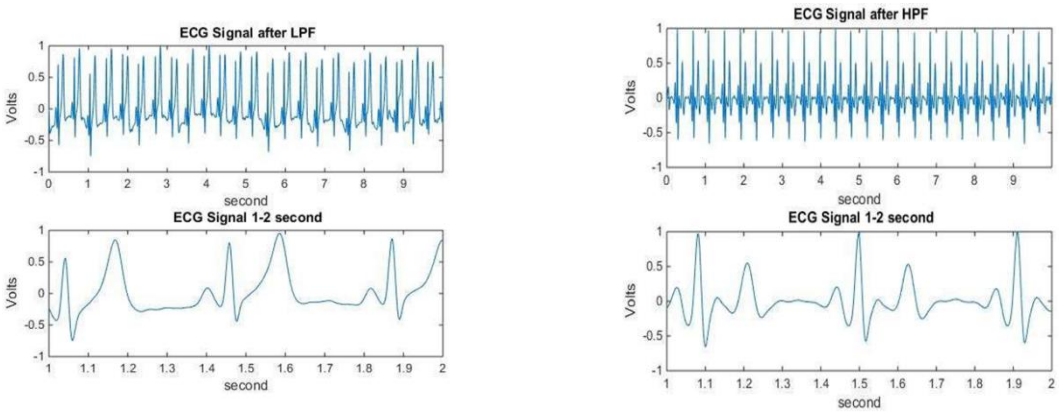
3. Simulation result for bio-signal using filters

The data file contains an ECG signal, sampled at 200 Hz, with a significant amount of 60Hz power line artifact. Hence different filter is applied to find the useful information. The frequency range between 1000 Hz to 3000 Hz is used to reduce the interference.



(a) (b)

Figure 4. (a) input ECG signal; (b) cancellation DC drift and normalization ECG signal.



(a) (b)

Figure 5. (a) Simulation result of LPF signal; (b) Simulation result of HPF signal.

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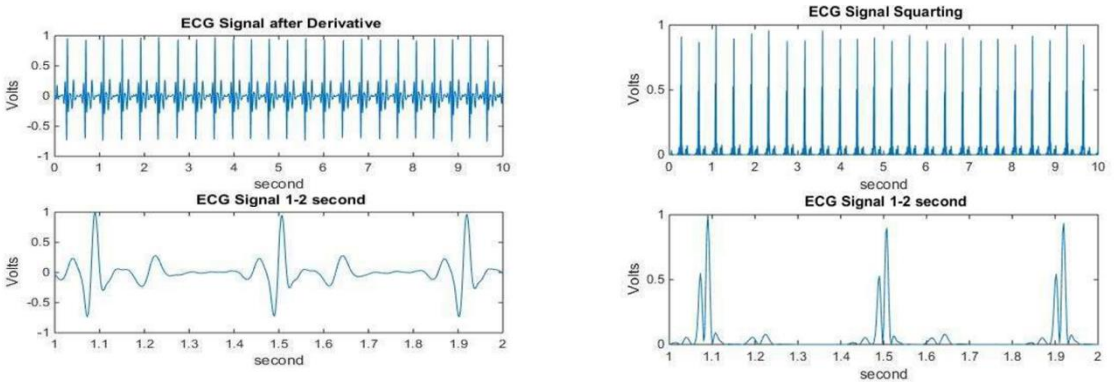
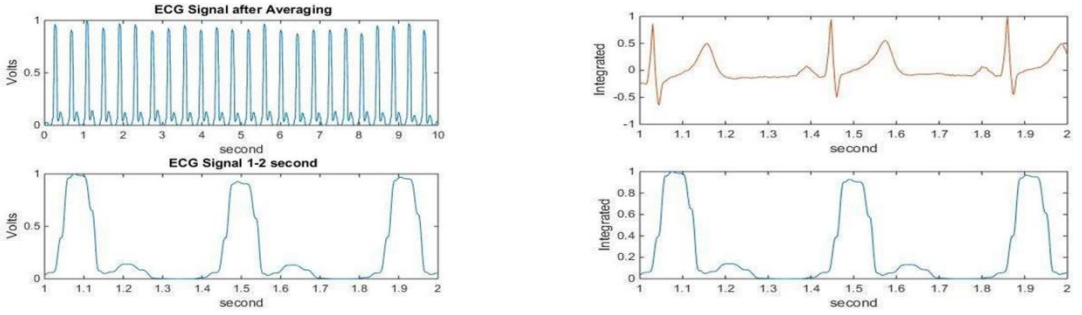


(a) (b)

Figure 6. (a) simulation result of derivative ECG signal; (b) simulation result of squaring ECG signal.



(a) (b)

Figure 7. Simulation result of (a) averaging ECG signal; (b) moving averaging ECG signal.

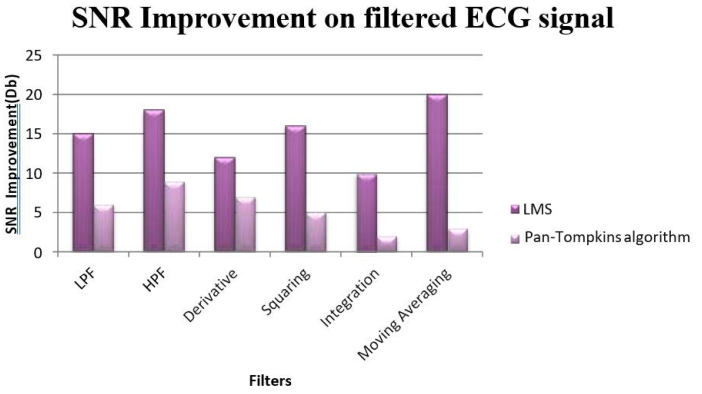


Figure 8. SNR improvement on filtered ECG signal.

To reach this, various digital filters like low pass filter, High Pass filter, derivation, integration, squaring, moving averaging filters are used to implement the various filters in bio signal. Compare the least mean square algorithm with Pan-Tompkins algorithm. Fig shows the efficiency of Pan- Tompkins algorithm.

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4. Conclusion

The experimental result was showed using filtering ECG signal. Even though so many algorithms and filtering technique is available today to remove the noise signal which present in original signal. Some of artifacts are present when the signal transmits and record the information by using some electronics components it's a major issue. Figure 8, illustrates the SNR improvement on filtered ECG signal. At present these cases are analyzed and find the solution using digital filters and power line interference technique. This paper proved that the removal of artifact and QRS detection of ECG signal has observed and analyzed using QRS detection algorithm and filtering technique and efficiency was shown in simulation result obtained 93%, graphical view and data sheet.

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