Electrocardiogram (ECG) Signal and Interference Filtering for Clinical Diagnostic Support

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Abstract **- Signal processing for electrocardiogram (ECG) records cardiac activity to unveil any abnormality in the heart through electrocardiograph. The pictorial representation comes in graph to indicate electric potential changes occurring between electrodes when patients' cardiovascular state is being examined. The electrical functioning of the heart is translated into a waveform, being utilized to find the heart condition. An ECG signal tracks heart diseases, such as poor blood flow to the heart and structural abnormalities. Analysis of ECG signal and removal of interference for clinical diagnosis in presented in this paper.**

Keywords: **Electrocardiogram (ECG), Graph, Signal, Cardiac, Diagnosis, Interference**

I. INTRODUCTION

Cardiac ailment is the worst of all health related diseases because it is associated with the heart of every living organism, and if not taken serious could lead to death [1]. Electrocardiographic signals may be recorded on a long timescale (i.e., several days) for the purpose of identifying intermittently occurring disturbances in heart rhythm [2]. Therefore, the produced ECG recording amounts to huge data sizes that quickly fill up available storage space. Data compression is an essential operation and, consequently, represents yet another objective of ECG signal processing [3]. Signal processing has significant contribution to a new understanding of the ECG and its dynamic properties as expressed by changes in rhythm and beat morphology [5]. Techniques have been developed that characterize oscillations related to the cardiovascular system and reflected by subtle variations in heart rate. The detection of low-level, alternating changes in T wave amplitude is another instance of oscillatory behavior that has been established as an indicator of increased risk for sudden, life-threatening arrhythmias [4]. The electrocardiogram (ECG) signal is one of the diagnosing approaches to detect heart disease. ECG signals provide evident information about heart functional conditions and circulation system. By placing the electrodes on body surface, the electrical activity of the heart muscles is measured [6]. The electrical activity of the signal is represented by electrocardiogram (ECG) [7].

However, recording of ECG suffers from different kinds of noise and interference such as power-line interference, respiration baseline wander and electrode motion artifacts, and hence the resulting distortion in the recorded ECG signal makes automatic clinical diagnosis difficult without prior reduction of noise so the preprocessing of the corrupted ECG signal is required in order to extract its essential features. ECG records are often corrupted by various kinds of noise such as power line interference, motion artifacts and so on.

The noise is generally generated from the used equipment and also from the body's bioelectric activity. Therefore, the extraction of high-resolution ECG signals from recordings contamination is an important issue to investigate.

II. RELATED WORK

In clinical practice ECG is the most frequently used cardiovascular signal because it is low cost method and non-invasive technique which gives diagnostic information [8]. Doctors regularly use ECG in order to find heart related abnormalities; standard tool for clinical diagnosis. Several methods are used for this de-noising purpose such as wavelet transforms, undecimated wavelet transform, discrete wavelet transform, fast Fourier transform, neural networks analysis, digital filter (IIR or FIR) [9]. Adaptive filter is convenient but it amplified the S-peaks in some cases.

Moving averaging filter are used for smoothing out the signal and removing power line noise and these methods can be successfully demonstrated in the MATLAB or LABVIEW environment [11]. The advantage of FIR filter are that it has exact linear phase, always stable, design method is linear and filter start up [10]. Power line interference is a significant source of noise during bio-potential measurements. It degrades the signal quality and overwhelms tiny features that may be critical for clinical diagnosis [12]. Power line interference may severely corrupt a biomedical recording.

III. METHODOLOGY

This raw ECG signal is contaminated with noise. The noise present in the signal is removed by using different types of digital filter such as high pass filter and low pass filter. High pass filter is used to remove low frequency noise from the ECG signal such as baseline drift having a frequency range between 0.15 and 0.3 Hz having cut off frequency of 1 Hz and order 150. Low pass filter is used to remove high frequency noise from the ECG signal if present having cutoff frequency of 150 Hz and order 350.

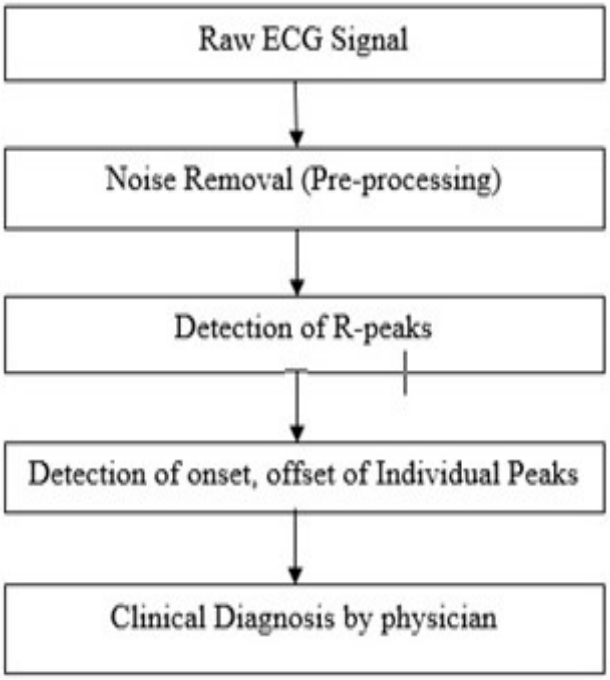

Fig. 1: Filtering Phase for ECG Interference

IV. EXPERIMENT AND RESULTS

Signal processing for ECG filtering experiments were performed in MATLAB with simulink capability. The coefficients were obtained with the IIR using comb function of the Filter Design, and the additive white noise generator was observed with the awgn function of the Communications, while unwanted ECG components are suppressed.

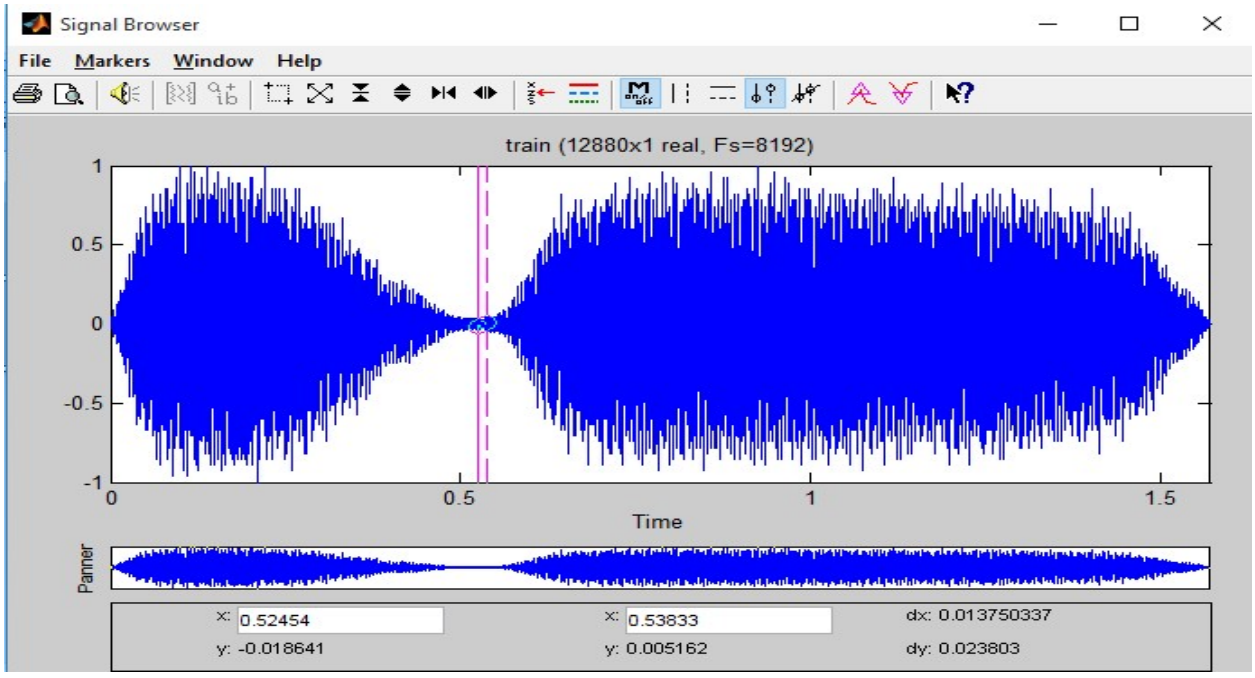

Fig. 2: Training Sequence for ECG samples

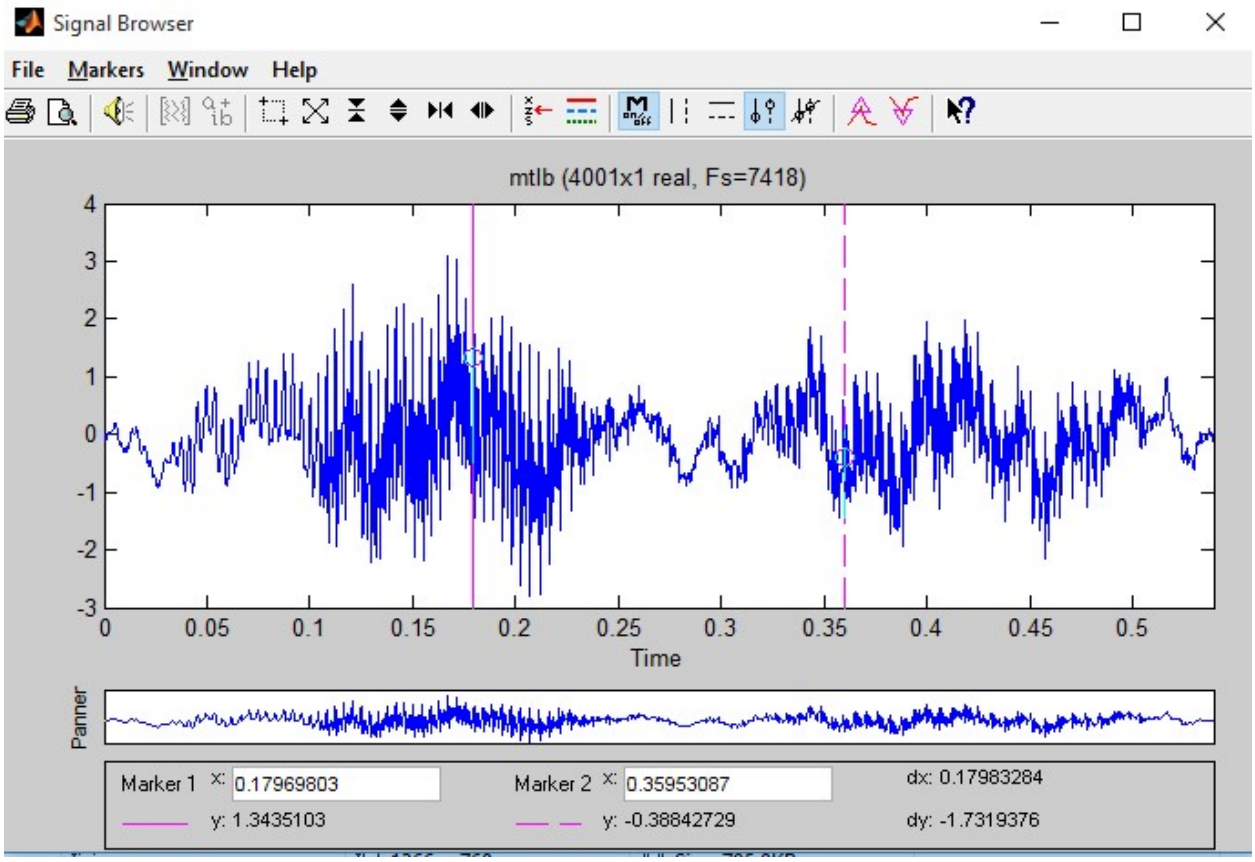

Fig. 3: Timing Sequence for ECG signals

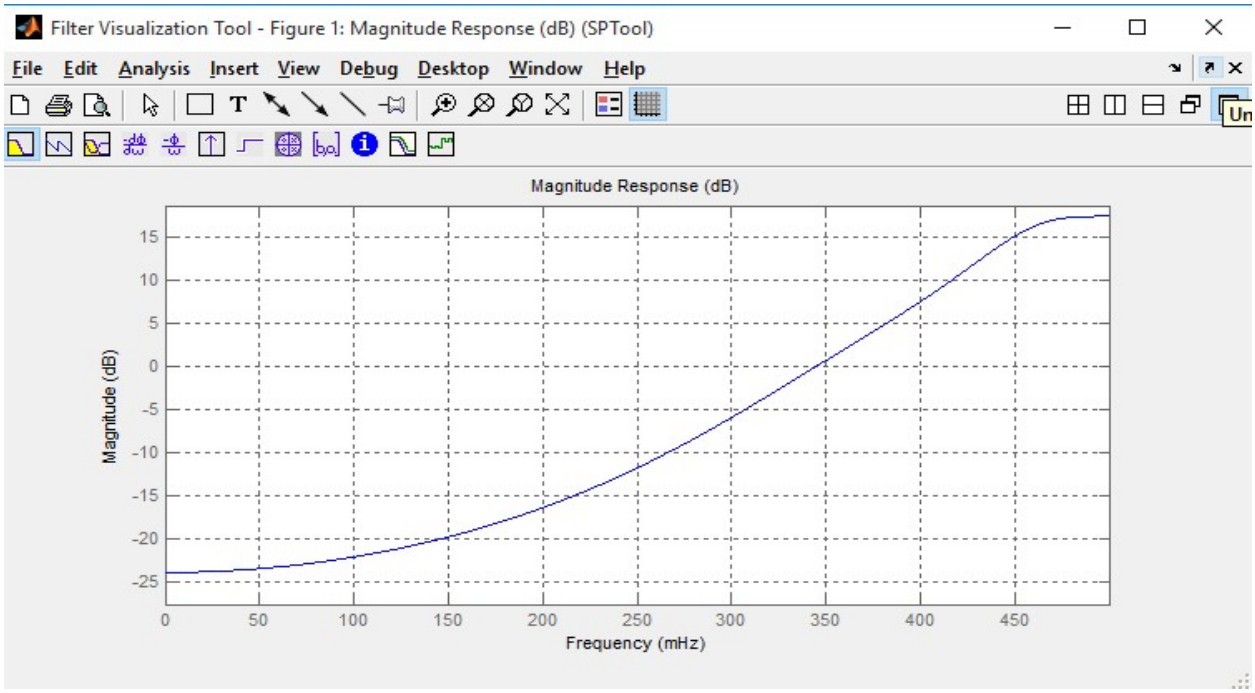

Fig. 4: Magnitude Response for ECG sample Processing

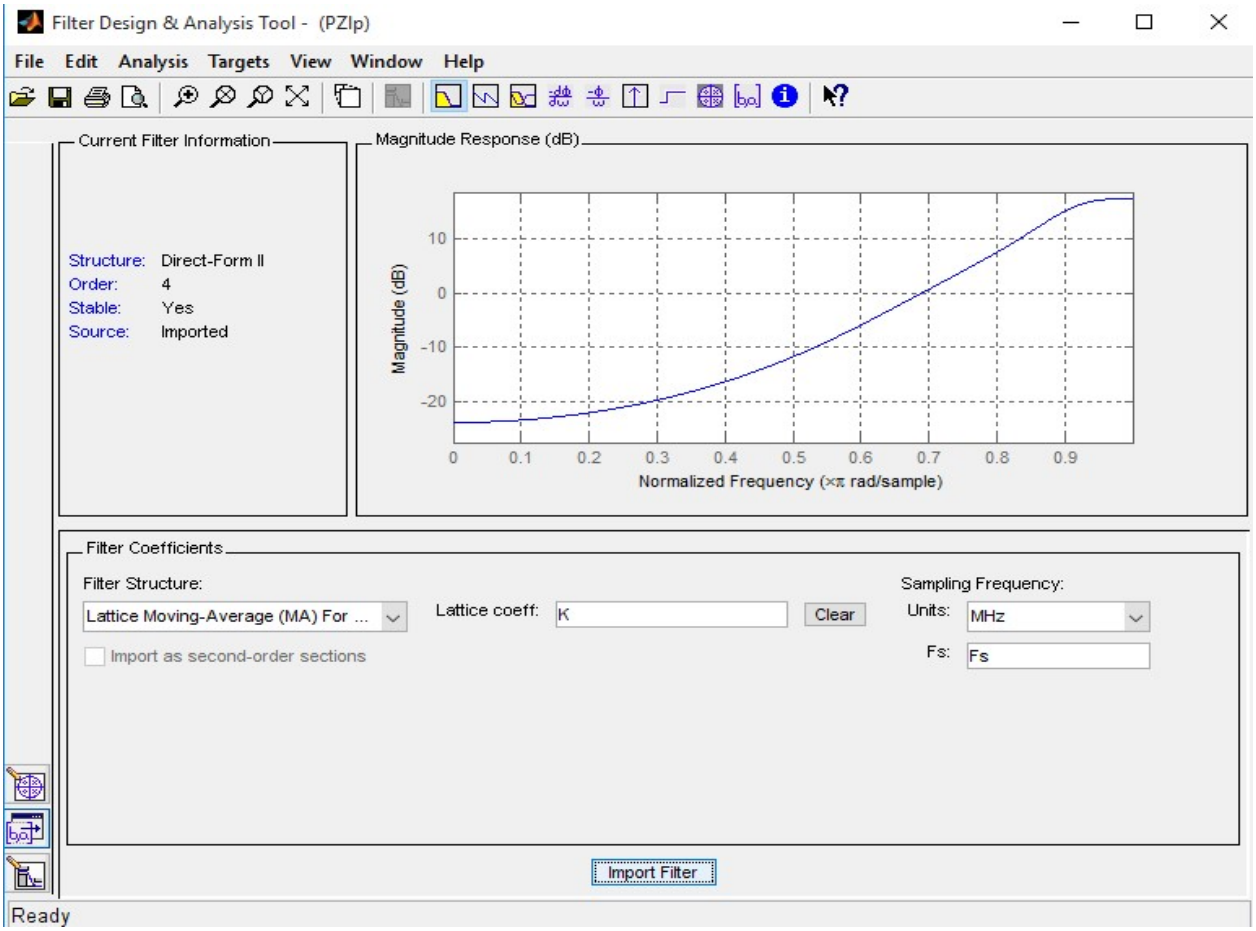

Fig. 5: Magnitude for Normalized Frequency after Filtering

V. CONCLUSION

The noise free ECG signal obtained from filter circuit is used as input for ECG analysis to find various intervals and peaks in MATLAB environment. Many works are done in the field of ECG analysis and they involve complicated calculations and hence difficult to design. The computational algorithm used is of importance, should be efficient and simple, so it can be easily implemented on ECG signal. In some cases, the waveform can be divided into positive and negative parts and each section will be analysed separately. Various peaks are detected by finding local maxima and minima of the signal and setting minimum threshold limit for them.

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