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DETECTION OF PEAK AND BOUNDARIES OF P AND T WAVES IN ECG SIGNALS

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Abstract- The ECG elimination is a vital tool for physiologist in detecting and classifying arrhythmia among human beings. One of the major challenges in ECG analysis is the delineation of ECG segments, that is P and T waves detection and delineation of an ECG waveform. Here we presents a new approach to address this problem, where delineation and detection can be done simultaneously. The proposed methodology shows accurate detection of P and T wave peaks and boundaries and enables precise calculations of waveforms for each analysis window.

Keywords- detection, delineation, ECG-electrocardiogram, arrhythmia, P and T waves

I. INTRODUCTION

For reliable detection and discrimination of atypical beats in electrocardiogram, ECG signal pre-processing is mainly used. Different classes of algorithms used for the pre-processing of ECG signals. They are filtering techniques, basis expansion techniques and classification and pattern recognition methods. The filtering techniques involve adaptive filtering [1], low pass differentiation LPD [2] and nested median filtering [3]. The basis expansion techniques include discrete Fourier transform [4], discrete cosine transforms [5] and wavelet transform (WT) [6], [7]. The classification and pattern recognition techniques include fuzzy theory [8], artificial neural networks [9], pattern grammars [10] and hidden Markov model [11]. We first detected the QRS complexes and then detecting and identifying the peaks of individual waves, as well as the onset and end points can performed by using Wavelet transform technique. For recording the electrical activity of heart, ECG signals can used. There are different types of noises like baseline wander noise; power line interference noise, motion artifact, etc are included in ECG signals.

The purpose of pre-processing is to remove all these noise and makes ECG for proper functioning. The shape and pattern of waves in ECG signals are differing from each other. The main category of waves includes P-waves, QRS complex and T-waves. The QRS complex is the most characteristic waveform of the ECG signals. The QRS duration indicates how fast the ventricles depolarize. The normal QRS is < 0.10 seconds.

The P wave is the result of the atrial depolarization. This depolarization starts in the SA (sinoatrial) node. The sinus node (SA) is situated at the top of the right atrium. It is the fastest physiological pacemaker. The average of the depolarization of the inner and outer cardiomyocytes is called as QRS complex. The amplitude of QRS wave is about 1mv. P- and T-wave delineation remains a complicated task because of the low slope and low magnitude of P- and T-waves and due to the lack of a universal rule to locate the beginning and the end of wave components. So our aim is to develop a new algorithm that simultaneously solves P and T-wave delineation task. We propose to resort to Markov chain Monte Carlo (MCMC) methods to alleviate numerical problems related to the posterior associated to the P- and T-wave delineation task. Because of the Markovian nature of the ECG signal, its current state depends only on the previous state

II. METHODOLOGY

ECG is the combination of QRS complexes and non-QRS regions. The interval between QRS offset region and QRS onset region constitutes a non-QRS region. For processing we first detect the QRS region because of the high amplitude it is easy to detect compared to other waves. Thus the QRS region will become the reference for finding the P and T-wave search blocks. The left side of the QRS region consists of P-wave search region and the right side consists of P-wave search region. Once we have obtained the P- and T-wave locations, the corresponding wave amplitudes can estimated. The pre-processing procedure as follows:

1) QRS detection: The QRS detection can be done by using Pan Tompkins algorithm. It consists of low pass filter, high pass filter followed by derivative, squaring and integration part. From derivative stage we got is information about the slope of the wave. The squaring process is done for intensifies the derivative output. This makes all data point positive. The information about both the width and slope of the wave is obtained from the output of the moving integration stage.

2) *Linear filters*: It is used to eliminate unnecessary frequencies from an input signal or to select desired frequencies among many others. For the purpose of linear filtering we design a filter of having window size 1.2. Usually hidden Markov model uses Kalman filter for this process. Thus there is no additional filtering is not needed before the delineation of P and T wave.

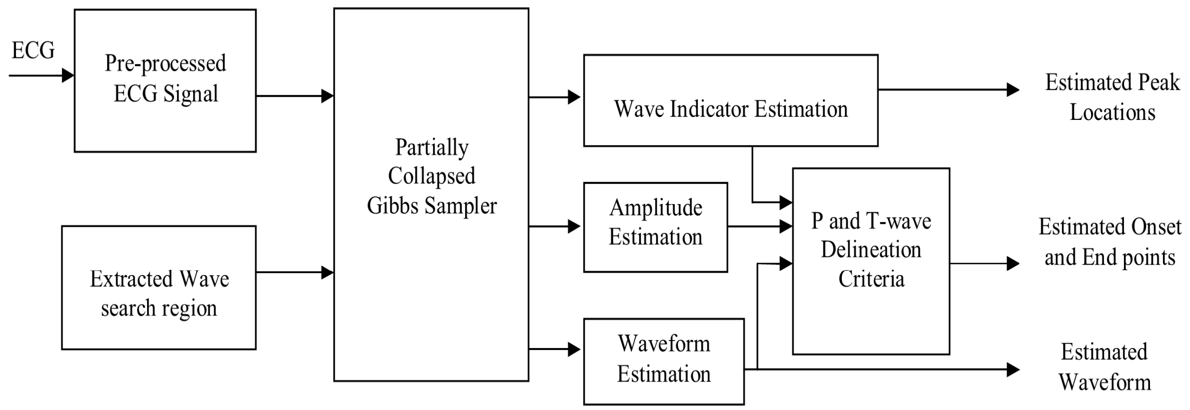

Figure 1.General block diagram for P and T wave delineation algorithm

3) *Removal of baseline drift:* Baseline wander can caused by perspiration, respiration and body movements. Baseline drift causes inefficient waveform estimation results. In order to minimize changes in beat morphology, removal of baseline wander is required. Baseline wander is a low frequency activity. The frequency of baseline wander is usually in the range below 0.5 Hz. In order to remove baseline drift we subtract the median value of samples from the average value of samples. According to statistics and probability theory, median is the numerical value separating the higher half of sample from the lower half. Median is generally used for skewed distribution. The general block diagram of the proposed P- and T- wave delineation algorithm is shown in figure1.

The block diagram explained as follows: the pre-processing includes linear filtering, global baseline wandering and QRS detection. The input ECG signal is first applied for linear filtering. The filtered output is then applied to both the global baseline cancellation and QRS detection block. The output of QRS detection block is then applied as input for Global baseline cancellation block. From the output of the QRS detection block extracted wave search region can be obtained. The pre-processed ECG signal and the extracted wave search region are then applied to the partially collapsed Gibbs sampler.

To determine P and T-waves from collapsing samples we use Partially Collapsed Gibbs Sampler (PCGS). The output of PCGS is then applied to Wave Indicator Estimation, amplitude estimation and amplitude estimation block. The wave indicator is done by using Local Map A Posteriori (MAP) method. The amplitude estimation is done by using fuzzy theory. The waveform estimation is done by using neural network. Estimated onset and end points are obtained from the P and T-wave delineation block. The estimation of noise variance of the wave is done by using MMSE method.

III. SIMULATION RESULTS

A. Experimental Environment

In this paper we used MIT–BIH arrhythmia database (MITBIH) for the experimental setup. The simulation tool used for this purpose is MATLAB on a 3.0-GHz Pentium IV processor. Matlab can solve technical computing problems faster than with other programming languages.

B. *Result Analysis*

The data and results are explained in this section. The input ECG signal is applied to linear filtering. The normal ECG signal from the database is shown in figure2. This ECG signal is used as the input for pre-processing. The filtered ECG signal obtained from the output of the linear filter is shown in figure 3. The filtered ECG signal is then used as the input for global baseline cancellation and QRS detection block.

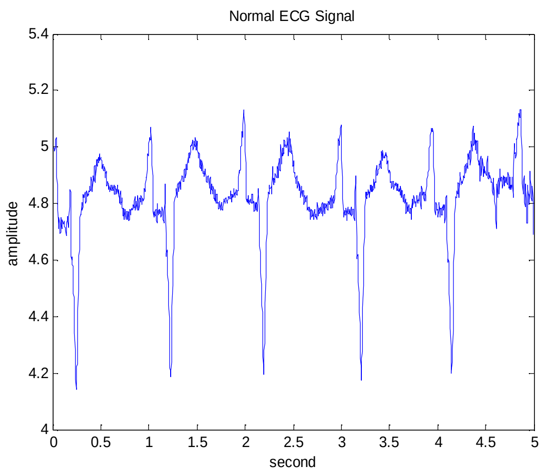

Figure 2.Normal ECG signal

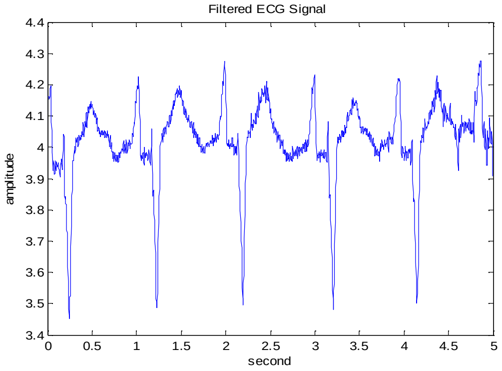

Figure 3.Filtered ECG signal

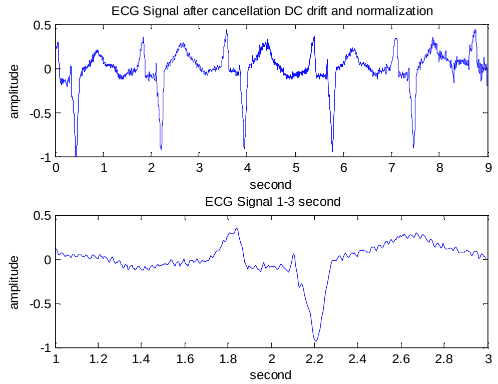

Figure 4.ECG signal after cancellation of DC drift

Figure 4 shows the ECG signal after cancellation of DC drift. This is used as the input for QRS detection algorithm.

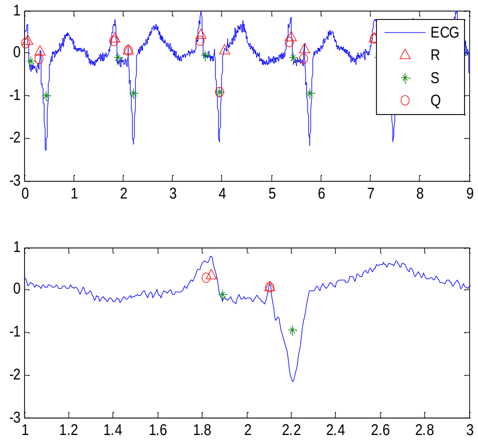

Figure 5. ECG signal after applying Pan Tompkins algorithm

The above figure shows the output obtained after applying Pan Tompkins algorithm. The algorithm consists of LPF, HPF, differentiator, squaring and integrator. The Pan Tompkins algorithm is used for the detection of QRS complex. Figure 6 is obtained by subtracting median value of samples from the average value of samples. The output of P and T-wave delineation criteria is shown in figure7. The Waveform estimation is shown in figure 8.

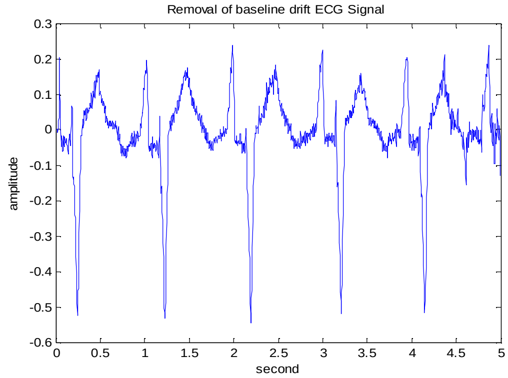

Figure 6. ECG signal after removal of baseline drift

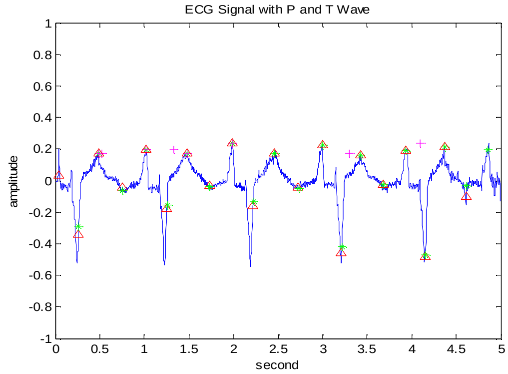

Figure 7. ECG signal with P and T-wave

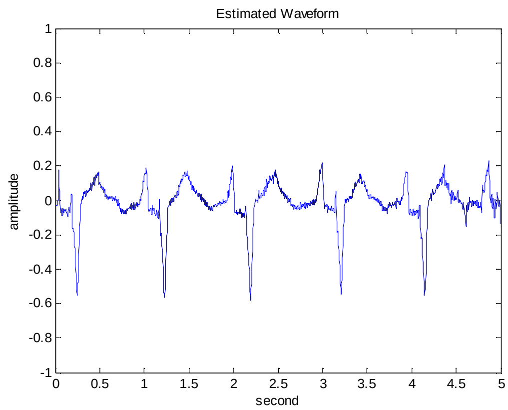

Figure 8. Estimated Waveform

Figure.9 is obtained from wave indicator estimation by using Local MAP block. P and T-wave delineation criteria is shown in figure.10

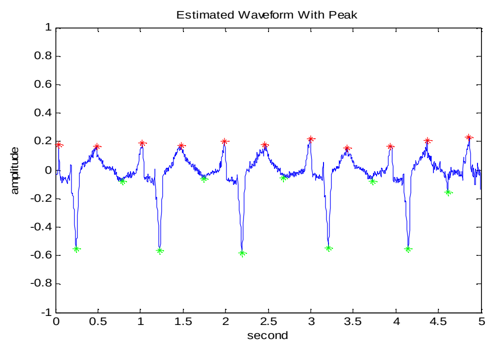

Figure 9. Estimated waveform with peak

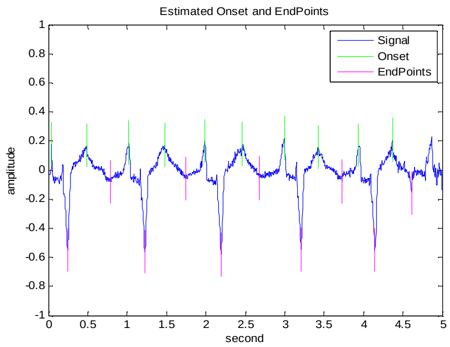

Figure 10. Estimated onset and end points

IV. CONCLUSION

The joint P- and T-wave delineation and waveform estimation are performed by using the proposed algorithm. With the help of PCGS we can overcome the slow convergence problem in the classical GS. The confidence intervals, which provide reliability information about the estimates, are also determined by using PCGS. The simultaneous estimation of the P- and T-wave fiducial points and the P- and T-waveforms are done by using the proposed method. The hierarchical Bayesian model for P and T-wave delineation is based on a modified Bernoulli–Gaussian sequence with minimum distance constraint for the wave locations and amplitudes, and appropriate priors for the wave impulse responses and noise variance.

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