Thresholding based R-Peak Detection in ECG Signals

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Abstract

R-Peak detection in ECG signals have been a crucial topic in biomedical. The current R-peak detectors cope up with the unstable QRS morphology and noise during detection. Also, the detection rate is of equal importance. To overcome all these issues a new technique has been proposed in this paper for the R-peak detection at a very good detection rate. The proposed detector was tested on MIT-BITH database to prove its worth. The experimental analysis over MATLAB shows the superiority of the proposed detector over the current detectors.

Keywords: Arrhythmia Detection, ECG, R-Peak, QRS

I. INTRODUCTION

Automatic detection of the R-peaks in a long-term electrocardiogram (ECG) signal is the most important step for diagnosis of cardiac disorders, heart-rate variability analysis, biometric, and ECG coding systems. The performance of these systems heavily relies on the accuracy of the R-peak detector. Many methods based on the derivatives, digital filters, linear prediction, wavelet transform, mathematical morphology, and empirical mode decomposition (EMD), geometrical matching, neural networks and hybrid approach have been developed for the detection of R-peaks. Methods based on the filtering techniques and decision rules are computationally efficient and hence ideal for any automatic ECG analysis. Most of the methods include a preprocessing or feature extraction stage and a decision stage. Generally, preprocessing stage applies various signal processing techniques to accentuate the QRS complex and suppress noises but most of them have some drawbacks. The WT-based QRS detector has the choice problem of mother wavelet and scales to obtain QRS events. Although the EMD-based approach in can overcome the choice problem of basis function, selection of a set of intrinsic mode functions (IMFs) is very difficult under noisy environments. The performance can be improved by designing more effective filtering and better threshold adjustment procedures. However, it is hard to design a single comprehensive preprocessing technique for achieving simultaneous QRS enhancement and noise reduction effectively in practice. Therefore, most of the works paid attention on constructing suitable decision rules based on the preprocessing results.

II. PROPOSED METHODOLOGY

Fig. 1: Block Diagram for Proposed R-Peak Detection Methodology
Fig. 1 shows the proposed scheme for the R-Peak detection. It consists of three stages, namely, digital filtering, Shannon energy envelope extraction, and true R-peak locator. The first stage of the proposed algorithm includes a bandpass filter, an amplitude normalization and first-order forward difference operation to emphasize the QRS complex and to remove the noise in ECG signal. In the second stage, Shannon energy estimation and zero-phase filtering are applied to obtain a smooth Shannon energy (SE) envelope that plays the most critical role in the proposed algorithm. We can observe that major local maxima in the SE envelope represent approximate locations of the R-peaks in ECG signal. Finally, locations of the local maxima are used as guides to find accurate locations of the R-peaks in ECG signals.

III. SHANNON ENERGY AND SMOOTH ENVELOPE EXTRACTION

After differentiation, the dECG signal is passed through a nonlinear transformation to obtain positive peaks regardless of polarity of QRS complexes. The main objective of transformation is to use single-sided threshold mechanism and to enhance the QRS complexes. In literature, the squaring transformation is widely used but it considerably diminishes the magnitude of the candidate Rpeaks of low-amplitude QRS complexes and wide QRS complexes. Here, we study the performance of different nonlinear transformation techniques using the low-amplitude QRS complexes, wider QRS complexes, and noisy ECG signals.

IV. THRESHOLDING

The earlier used method to detect R-Peak was using Hilbert transform conceding more time as compared to thresholding. Experimental results show that the time lapsed for the detection of R-peaks using thresholding is very much less as compared to detection using Hilbert transform.

V. R-PEAK DETECTION

Experiments show that the locations of candidate R-peaks differ slightly from the time instants of true R-peaks in an original ECG signal. Therefore, a simple true R-peak locator is incorporated.

VI. RESULTS

![Fig. 2: Detected R-Peaks in ECG signal](image-url)
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A thresholding based R-peak detection method in ECG signals have been proposed in the paper. The detection rate reduces to significant values as compared to other R-peak detectors. The comparison table shows the time lapsed for the detection of true R-peaks.

VII. CONCLUSION

REFERENCES


