Automatic Electrocardiogram Delineator Based on the Phasor Transform of Single Lead Recordings

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The surface electrocardiogram (ECG) provides a widely used and comfortable way to study the heart function, being a conventional tool for the diagnosis of cardiac diseases. Given that most of the clinically useful information in the ECG is found within the intervals and amplitudes determined by its fiducial points, the development of accurate and robust methods for automatic ECG delineation is a very interesting challenge. The present work introduces a new ECG delineator which is able to operate in single lead recordings, based on the Phasor Transform, which is characterized by its robustness, low computational cost and mathematical simplicity.

The method converts each instantaneous ECG sample into a phasor, thus being able to deal very precisely with P and T waves, which are of notably lower amplitude than the QRS complex. Initially, the method relies on the detection of R peaks and, next, onset and offset of the QRS complex are identified. Finally, taking the QRS as a reference, P and T waves are detected and delineated.

This delineator was validated with the QT database, which is available in Physionet, providing average values of sensitivity higher than 98.60% for the detection of all the significant ECG waves and fiducial points. Concretely, sensitivity for the P wave was 98.65% for the onset, peak and offset. The QRS onset and end achieved a sensitivity of 99.85% and, finally, the T wave provided a sensitivity of 99.20% both for its peak and offset. Additionally, the average maximum time delineation error was lower than 6 ms and its standard deviation was in agreement with the accepted tolerances for expert physicians in the onset and offset identification for QRS, P and T waves. As a consequence, this new algorithm is able to achieve a performance similar to the top rated ECG delineators, but with notably lower computational cost.