

Real-time Heartbeat Classification Based on Parallel QRS Detections

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The aim of this study was to develop a method for heartbeat classification into QRS morphology types based on parallel operation of multiple QRS detectors on ECG signal.

The proposed heartbeat classification method uses the differences in R-peak time locations detected by multiple QRS detection algorithms operating in parallel (Fig.1 and Fig.2). The outputs of the detectors are the inputs to the k-Nearest Neighbor classifier. The classification is done into three QRS morphology types: Normal and Atrial premature, Ventricular, and Other. The types Normal and Atrial premature were grouped together as their QRS shapes reflect electrophysiological ventricular phenomena that are essentially the same. The classification method was developed based on analysis of the QRS morphology types: N, L, R, V, A, P (Paced) that constitute 97% of MIT-BIH Arrhythmia Database (MIT-BIH AD) annotations. The classifier was trained based on training set - 70% of annotations of the upper channel data of MIT-BIH AD, and tested with test set - 30% of annotations. The proposed method was implemented in Python 3.10.4, with Numpy, Pandas and Sklearn libraries. Four low power QRS detectors were selected for development and testing of the QRS classifier.

The classification results for test dataset are the following. For the class Normal and Atrial premature - sensitivity 95.70%, specificity 92.65%, class Ventricular - sensitivity 73.98%, specificity 81.20%, class Other - sensitivity 62.95%, specificity 72.71%.

The proposed classification method returns reliable QRS morphology classification with battery-operated ECG devices that can be used for real-time mobile ischemia detection and HRV analysis.

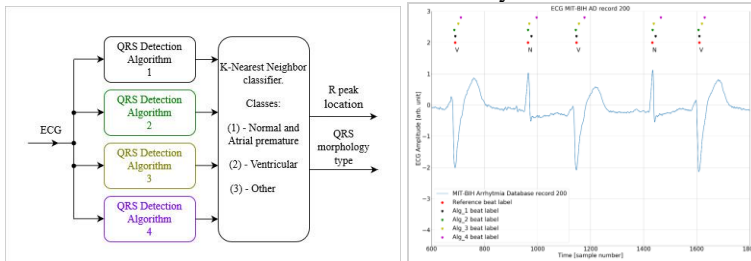


Fig. 1. Parallel QRS detectors QRS classifier Fig. 2. Differences in QRS detections