Automatic detection of QRS complex, P and T wave in the electrocardiograph

Martin Bachler[1], Christopher Mayer[2], Bernhard Hametner[1], Siegfried Wassertheurer[2]

[1]Vienna University of Technology, Institute for Analysis and Scientific Computing, Wiedner Hauptstr. 8, 1040 Vienna
[2]AIT Austrian Institute of Technology, Health & Environment Department, Muthgasse 11, 1190 Vienna

Every third death in developed countries is caused by cardiac diseases, making them the number one cause of death. Duration and dynamic changes of PR and QT intervals of the ECG are well established indicators in the diagnosis of cardiac diseases. Furthermore, several agencies require the assessment of the effect on the QT interval caused by newly developed drugs.

Automated measurement and annotation of the ECG shows numerous advantages over manual methods, therefore the aim is to develop an all-in-one device for data acquisition and ECG analysis. The development process is conducted in different stages, whereas the first step consists of creating algorithms in Matlab and validating them against ECG signals manually annotated by medical experts. This early stage will be followed by hardware-in-the-loop simulations coupling the measurement hardware with the Matlab model and finally by porting all algorithms to the aimed platform.

The presented algorithm detects R-peaks based on the signals amplitude and first derivative as well as RR intervals. False positive detections due to artifacts are prevented by analyzing the signals local statistic characteristics. These intermediate results are automatically classified to distinguish normal heartbeats from potential premature ventricular contractions. QRS complexes, P and T waves are detected by their first derivative for each class and separately refined for each detected heartbeat.

The algorithm was validated against four PhysioNet databases and achieved a sensitivity of 98.5% and a positive predictive value of 98.3%, respectively.

These results are promising, but further work is still required to implement the algorithm on an embedded system to build an easy to use all-in-one device.