HEART RATE DATA PROCESSING IN IOT ENVIRONMENTS

Biloborodova T., Velykzhanin A., Skarha-Bandurova I.
Volodymyr Dahl East Ukrainian National University, Severodonetsk

Portable medical devices (wearable and embedded ones) are getting widespread due to recent trends in IoT and are used extensively for different health purposes, from sensing and monitoring various health parameters to recognition of activities and managing metabolic changes in the body. Potentially cardiac disorders can be detected through analysis of QRS-complex morphology and heart rate variability of the ECG signal. However, most of the existing methods developed for hospital environment do not suit for IoT in view of their relative computational complexity or high resource requirements. For these reasons, it has been necessary to perform their adaptation and optimization for portable embedded systems or wearable devices.

The study purpose is to explore and find effective methods for feature extraction and anomaly detection in heart rate signal.

In general case, a process of heart rate data processing includes noise reduction, filtering, segmentation, feature extraction and anomaly detection. For our purposes, we choose the ECG signals processing method based on QRS detection algorithm [1] and implement it in Python. The general stages of ECG signal processing include:

- Linear digital filtration;
- Nonlinear transformation;
- R peaks detection;
- Calculation of heart rate based on the time distance between each two consecutive R peaks.

For linear digital filtering, the moving average was chosen. It is a type of finite impulse response filter enabling to analyze data points by creating series of averages of different subsets of the full data set. Then, we used the fast Fourier transform as a method for signal nonlinear transformation. It produces the same result as the other approaches, but more efficient at the expense reducing the computation time.

As a result, the following parameters were obtained: a position of all R-peaks, RR-intervals between adjacent R-peaks, RR-differences between adjacent RR-intervals, the standard deviation of RR-intervals and differences between RR-intervals. To obtain wave feature information in addition to the slope of R wave moving window integration is performed. This algorithm is very simple. It enables to save the computing time and not require high power, but effective for processing the ECG signal. For these reasons, it can be easily implemented in the microprocessor unit. The further stages will be devoted to testing this technique within the Pan-Tompkins QRS detection algorithm, comparison their efficiency for detecting and forecasting.

References:

1. Pan, J., & Tompkins, W. J. (1985). A real-time QRS detection algorithm. IEEE transactions on biomedical engineering, (3), 230-236.