Detection of Ventricular Arrhythmias on a Smartphone

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Abstract

In most cases of sudden cardiac death the reason is in emergence of ventricular tachycardia which leads to ventricular fibrillation. Early detection of ventricular arrhythmias make it possible to provide necessary help in time.

In PetrSU FRUCT laboratory the smartphone application is developed for detection of several kinds of arrhythmias [1]. Nevertheless, currently implemented arrhythmia detection algorithms substantially base on the structure of ECG waves. These algorithms don't suit for detection of ventricular arrhythmias having quite different quasisinusoidal waveform. From the other side detection of these kinds of arrhythmias is of the high importance for any real-time ECG processing system.

In order to bring the functionality of ventricular arrhythmia detection to developed application, the review of recently published algorithms was carried out and two algorithms were selected for implementation using the following criteria:

1) the algorithm should demonstrate acceptable values of quality parameters;

2) the algorithm should avoid heavy calculation in order not to drain the battery fast.

First algorithm is described in [2], [3]. For the original signal *x(t)* the Hilbert transform *xH(t)* is computed. Then the two-dimensional phase-space plot is constructed with *x(t)* on the x-axis and y(t) on the y-axis. The 40x40 grid is applied to the plot and the number of visited cells is counted. The ratio of the number of visited cells to total number of cells represents the measure, which is used to differentiate normal sinus rhythm and ventricular tachycardia or fibrillation.

Second algorithm is based on multiscale analysis and is described in detail in [4]. Wavelet decomposition of the original signal is performed at different scales. Then the Hurst index is computed. Smaller Hurst index corresponds to larger fractal dimension and more irregular signal.

Both algorithms were implemented and tested on MIT-BIH arrhythmia database [5]. These implementations are planned to be integrated to the next release of mobile arrhythmia detection application.

Index Terms: Ventricular arrhythmia, Mobile, mHealth..

REFERENCES

[1] Y. Zavyalova, A. Borodin, "Mobile Arrhythmia Detector", *The 11th Conference of Open Innovations Association FRUCT*, Saint-Petersburg, Russia, 23-27 April 2012.

[2] A. Amann et. al., "A New Ventricular Fibrillation Detection Algorithm for Automated External Defibrillators", *Computers in Cardiology*, Vol. 32, 2005, pp. 559–562.

[3] A. Amann et. al., "Detecting Ventricular Fibrillation by Time-Delay Methods", *IEEE Transactions on Biomedical Engineering*, Vol. 54, Issue 1, 2007, pp. 174–177.

[4] Y. Sun et. al., "Life-threatening ventricular arrhythmia recognition by nonlinear descriptor", *BioMedical Engineering OnLine*, 4:6, 2005.

[5] Massachusetts Institute of Technology, MIT-BIH arrhythmia database. http://www.physionet.org/ physiobank/ database/mitdb