# Neural Networks for Detection of Low-amplitude ECG Components

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***Abstract*** **– The application of neural networks to the problem of low-amplitude ECG components detection is considered. The ECG signals with late potentials and without this pathology are analyzed.**

***Keywords – neural networks; late potentials; ECG***

## I. INTRODUCTION

The methods of heart functional state diagnostics based on high-resolution electrocardiography (ECG HR) make it possible to explore the subtle mechanisms of cardiac electrical activity. It is believed that the late potentials (LP), which are low-amplitude high-frequency components of ECG signal, reflect the presence of slow and fragmented depolarization, associated with the "re-entry" circles and development of heart tachyarrhythmia [1].

A number of methods is used for LP detection. The classical approach is time domain analysis with measurement of amplitudes and durations of ECG components. In this case the frequency content of ECG signal couldn't be estimated. Fourier transform implies analysis in frequency domain, but doesn't enable to determine the exact position of frequency components in a signal. Wavelet transform is considered as an alternative to the Fourier transform and allows data in both domains (time and frequency) to be analyzed at the same time. ECG analysis in the coordinate basis of eigenvectors for LP revealing is proposed in [2].

## II. NEURAL NETWORKS FOR LATE POTENCIALS DETECTION

Considering the complexity of identification the patients with LP it is suggested to solve the problem of ECG classification into normal and pathological with using the neural networks (NN) approach. NN designing consists of the architecture choice, the algorithm programming, the training data set formation, and an output target function creating.

The multilayer NN with the back propagation algorithm and the sigmoid activation function is proposed for ECG signals classification (Fig. 1).

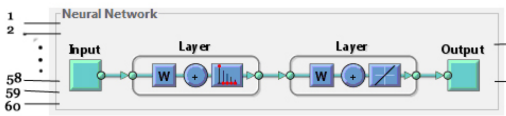


Figure 1. The architecture of the neural network

The right training data set must be selected for NN training. It affects the classification quality and diagnostic value of the algorithm. Training set can be formed from ECG signal parameters: time-domain parameters (amplitude-time parameters of *P*-wave and *QRS*-complex), frequency-domain parameters (spectral parameters of the Fourier transform), and wavelet analysis parameters (decomposition coefficients).

In this work the training set was created using the coefficients of *P*-waves wavelet decomposition as input variables. The detail coefficients of the first level for ECG discrete wavelet decomposition reflect the features of high-frequency low-amplitude potentials of ECG and contain the signs of LP (Fig. 2).

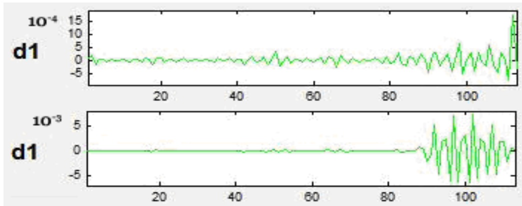


Figure 2. The first level details for ECG discrete wavelet decomposition: the absence and the presence of LP

The neural network was trained to distinguish between 2 classes of ECG signals: "norm − no LP" and "pathology − LP are present". The application of the neural network to the testing data set showed the correct classification results.

## III. CONCLUSION

The performance of the neural network approach in the diagnostic classification of electrocardiograms with LP and without LP was investigated. The network was based on the multilayer perceptron with 60 inputs, 2 outputs and the back propagation algorithm. [3] The training data set included feature vectors for 50 electrocardiosignals. The neural network showed a high accuracy of ECG signals classification.

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