ABSTRACT

The dissertation is devoted to the development of algorithms for automatic detection of cardiac arrhythmias, particularly atrial fibrillation, in non-invasive cardiological diagnostic systems. Atrial fibrillation is one of the most common cardiac rhythm disorders and is associated with an increased risk of stroke, thromboembolic complications, and heart failure. This condition often occurs asymptomatically or in a paroxysmal form, which significantly complicates its timely diagnosis. Therefore, the development of automated methods for analyzing electrocardiographic signals under long-term monitoring conditions represents an important scientific and applied problem in modern biomedical engineering.

The aim of the study is to develop an algorithm for automatic detection of atrial fibrillation based on the processing and analysis of electrocardiographic signals and to substantiate its applicability in non-invasive cardiac diagnostic systems. To achieve this goal, an analysis of modern ECG signal processing methods was performed, a system of diagnostic features based on RR and ΔRR intervalograms was formed, and several machine learning models were developed and comparatively evaluated.

The research methodology includes digital processing of electrocardiographic signals, heart rate variability analysis, statistical data analysis, and machine learning techniques such as logistic regression, k-nearest neighbors, support vector machines, Random Forest, and XGBoost. The performance of the proposed approach was evaluated using standard binary classification metrics, including accuracy, sensitivity, specificity, confusion matrix, and ROC analysis.

The scientific novelty of the work lies in the development of a computationally efficient and structurally compact algorithm for atrial fibrillation detection based on the analysis of ECG rhythm dynamics. The use of diagnostic features derived from RR and ΔRR intervalograms in combination with machine learning methods improves the effectiveness of arrhythmia detection. The proposed algorithm is adapted to operate on short time windows and can be implemented in near real-time conditions.

The theoretical significance of the study is associated with the advancement of automated ECG signal analysis methods through the integration of heart rate variability features and machine learning techniques. The practical significance lies in the possibility of implementing the proposed algorithm in non-invasive cardiac diagnostic systems, including portable and wearable monitoring devices. The developed approach contributes to improving early detection of cardiac rhythm disorders and enhancing automated analysis of long-term monitoring data.

The main results of the dissertation have been published in scientific papers and presented at international and national conferences.