HTIC
HealthTech Innovation
CONFERENCE

HealthTech Innovation Conference

Zabrze, 9 – 10th October 2023

Muzaffer Samed VURAL[1], Katarzyna HERYAN[1], Szymon SIECIŃSKI[2,3], Paweł BIŁKO[1], Marcin GRZEGORZEK[2]

[1] AGH University of Science and Technology, Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering, Department of Measurement and Electronics, Kraków, Poland
[2] University of Lübeck, Institute for Medical Informatics, Lübeck, Germany
[3]Silesian University of Technology, Faculty of Biomedical Engineering, Department of Biosensors and Processing of Biomedical Signals, Zabrze, Poland

CLASSIFICATION OF THE HEARTBEATS IN ELECTROCARDIOGRAMS WITH K-NEAREST NEIGHBORS ALGORITHM, RANDOM FORESTS, AND SUPPORT VECTOR MACHINES - A PILOT STUDY

Keywords: Electrocardiograms, Heartbeat classification, Machine learning, K-Nearest Neighbors, Random Forests, Support Vector Machines

Background: Electrocardiography (ECG) is a widely used technique for monitoring and diagnosing cardiovascular diseases. However, automatic interpretation of ECG signals, particularly the classification of heartbeats, is a challenge that should be appropriately addressed due to its significance for diagnosing cardiovascular conditions and evaluating treatment efficacy.
Objective: This study aimed to compare the performance of three classifiers (K-Nearest Neighbors (KNN), Random Forests (RF), and Support Vector Machine (SVM)) in classifying heartbeats using heartbeat and ECG signal features. The performance of classifiers was assessed by evaluating their accuracy, positive predictive value, and sensitivity.
Material and Methods: Three classifiers were trained on 173 selected heartbeats derived from ECG recordings in the MIT-BIH Arrhythmia (MITDB) Database. The ECG signal processing consisted of extracting annotations, manual calculation of features, and normalizing the values using Min-Max normalization.
Due to the class imbalance, the number of heartbeats of each type was equalized with SMOTE (Synthetic Minority Over-sampling Technique). 70% and 30% of data were assigned to the training and testing set, respectively, and the performance was evaluated with 10-fold cross-validation.
Results: The results showed that KNN, RF, and SVM achieved state-of-the-art performance in heartbeats classification. KNN's overall accuracy, precision, and recall were 0.977, 0.978, and 0.978, respectively, RF's overall accuracy and precision was 0.971, 0.972, and 0.971, respectively, and SVM's overall recall were 0.988, 0.989, and 0.988, respectively. SVM had the highest overall performance in heartbeat classification (0.99), followed by KNN (0.98) and RF (0.97).
Conclusion: This pilot study demonstrated the effectiveness of using KNN, RF, and SVM for classifying heartbeats in ECG signals. SVM was found to be the most accurate classifier, with high precision and recall, making it the most suitable choice for automatic heartbeat analysis in ECG signals.