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CLASSIFICATION OF ECG ARRHYTHMIA WITH MACHINE LEARNING TECHNIQUES

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Abstract— **The ECG uses some methods to diagnose these cardiac arrhythmias and tries to correct the diagnosis. ECG signals are characterized by a collection of waves such as P, Q, R, S, T. These five waves are preformed, wave transformed, and classified. In the current literature, the P, Q, R, S, T waves in ECG signals are classified using some machine learning techniques. In the work to be done, MLP (Multi Layer Perceptron) and SVM (Support Vector Machine) classification techniques which are not compared with each other using these signals will be compared. Is study, BP (Back Propagation) algorithm with MLP classifier and K-A (Kernel-Adatron) algorithm with SVM classifier were used. In addition, the use of these methods is new in the field of ECG classification. It will try to find a more effective method with new uses in the study and the literature will contribute to this area. In addition, wave transformation techniques such as DWT, DCT, and CWT will be used to increase the success of the classification used in the study. This will lead to the most effective classification method in the existing data set. In the work to be done, it is aimed to bring improvements to the classification methods used in existing studies. It is aimed to develop a method to improve the calculation time and standard classification performance of MLP and SVM, and it is aimed to contribute to the informed consciousness of this work.**

Keywords—Machine learning, ECG, SVM, MLP, DWT, DCT, CWT.

I. INTRODUCTION

Most of the deaths occurring today are related to heart diseases. According to the World Health Organization WHO, about 17.3 million people died of heart diseases in 2008 in the world. According to a survey conducted by the IHME in 2015, Turkey is the first with %14.9 of deaths. The ECG is a device that graphically displays the electrical activity of the heart (heart rhythm, frequency, rhythm of heartbeats, spreading of the heartbeats, and disappearance of the reaction) graphically through electrodes adhered to the skin. Pre- processing and pre-monitoring of heart arrhythmia using ECG can prevent these deaths.

ECG analysis is critical for the diagnosis and treatment of heart disease. Computer-aided diagnosis of arrhythmias depends on the analysis of cardiac disorders. Determining arrhythmia is a challenge for a system that diagnoses heart disease. Therefore, various techniques are used to classify the arrhythmia. Studies that extract information using different techniques from ECG signals have been examined. It is seen that the specific techniques used in the literature and the techniques to be used according to the success of these techniques and the steps to be followed are decided.

In the study, the MIT-BIH Arrhythmia database will be used for training and test data. Data were collected from 48 patients from a single electrode and two electrodes. Of the 452 samples, 280 attributes (classes) were extracted, including age, gender, height, weight values and intervals of P, QRS, T waves. Sixteen disease classes have been established in line with these specifications. This data set will be used in the classification of ECG arrhythmia and in the analysis of diseases in MATLAB application.

In this study, ECG signals Support Vector Machine (SVM) and Multilayer Sensor (MLP) classifiers will be used. Because the MLP and SVM classifiers gave the most successful results when working in this area. The calculation time is important for classification and feature extraction operations. The performance of the classifiers to be used and will be compared according to the time and other performance criteria. The contribution of the study is to apply some wave transformation techniques such as DWT, CWT, DCT to ECG signals and it is aimed to improve the classification performance by these wave transformations.

II. AIMS

Having a single abnormal ECG signal in the nature of a disease based on the information obtained may not be enough alone to determine. Multiple qualifications for it to determine a disease with a combination may give a better result. It is considered better to evaluate multiple ECG indications to diagnose. It is aimed to make

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data belonging to arrhythmia to be suitable for evaluation with regulated data set. It is aimed to detect abnormalities correctly with fewer parameters, help doctors to diagnose quickly and early, reduce doctors workload and gain time.

In the current literature, the P, Q, R, S, T waves in ECG signals have been classified using some machine learning techniques. In the study to be done, these signals will be used to compare MLP and SVM classification techniques that have not been compared before. Thus, the most effective method of classification will disclose the present data set. It is aimed to bring improvements to the classification methods used in existing studies. For this purpose, BP algorithm with MLP classifier and K-A algorithm with SVM classifier were used. In addition, the use of these methods is new in the field of ECG classification. By comparing the methods used together, it has been tried to show which method is more appropriate to use in which case. With these interoperability and some wavelet transform methods, it is aimed to develop a method for improving the calculation time and standard classification performance of MLP and SVM.

Wave transformation techniques such as DWT, DCT, CWT will be used to increase the success of the classification used in the study. These wave transformation techniques have previously been used in fields such as data summarization, medical image processing. The wave transformers used have also been applied on ECG signals in the literature. However, a single classifier or a single wave transformation technique was used and an adequate evaluation was not achieved. In this study, it is aimed to improve the performance by performing wave transformation before classifying with different classifiers.

III. LITERATURE REVIEW

There are some selected studies in this area and introduced as follows; Khorrami and Moavenian (2010) conducted a study that compared the training and comparison of SVM and MLP classifiers. In this study, the first dataset was measured by taking an ECG signal from an electrode and the second dataset was generated by taking two electrons. In this study some wave transformers such as DWT, DCT, CWT are used together with SVM classifier. It has been observed that when the classification is done with the wave converters, the performance improves.

In Sayeed (2013) study, ECG signals were collected in long time periods and high resolution. Various wave transformation methods such as DST, DCT2, DWT, DCT, FFT are used to summarize ECG signals in the study. Analysis and summarization work in the study was done in the MATLAB program. The methods show that the performance of DWT is better when compared to DCT. However, Hybrid methods performed better than DWT and DCT.

In the study has conducted by Kaya (2015), he used wave transformation methods like DCT, DWT, DFT to process images. The logo image on the medical images (MR) was stamped and encrypted by applying different operations to the image. The maximum noise ratio and similarity rate of the signals in the medical images are measured. Compared to other methods, DFT has the worst similarity rate. The DCT, DWT and DFT methods gave almost the same results when the maximum noise ratio was compared.

Another study done by Çekik (2015) proposed a new algorithm to classify ECG signals. In the study, the Rough Set Theory (RST), a rule-based method, was used to reduce the workload of the ECG signals by qualifying the ECG signals. In this study, Çekik developed a new classification method called Weight Weighted Rough Set Classification (WRSC) based on weight matrix and similarity using RST. With this method different data sets are compared in the WEKA program. As a result, the WRSC method, which is specific to the study, achieved more successful results than many methods.

Agawal, Krishnamoorthy, and Pratiher (2016) used Gaussian wavelets to analyze similar behaviors and deviations in ECG signals. In the study, ECG signals were analyzed in more detail using the S-transform to make the results more consistent and reliable.

Bamarouf et al. (2016) developed an embedded system to facilitate real-time arrhythmia findings. The stimuli in the electrocardiogram (ECG) signals are sent via wireless messaging to the doctor. In the study, the Pam-Tompkins algorithm was used and the algorithm produces two templates, the QRS complex and the interval between the two R-hops. The two templates then associate each heart beat with the QRS complex and the RR interval. All algorithms are implemented on the TI CC3200 LaunchPad, a low-cost Wi-Fi card. When three or more consecutive arrhythmias are detected, the short message service (SMS) system is activated. The measurements obtained from the MIT-BIH arrhythmia database were used for design validation. MATLAB was used to simulate signal processing algorithms and Code Composer Studio was used to implement the design in the LaunchPad, where the algorithms were programmed in C.

Gao et al. (2016) have proposed an efficient statistical technique for analyzing ECG signals that generates randomly different peer signals named RSSPD. RSSPD works on a training class model that aggregates signal pairs into a pool and determines all ECG properties. The properties required to determine the class from the RSSPD property pool have been selected. Finally, output signals were generated according to the specifications. As a result of the study, it is seen that the proposed system determines the class relation between the waves with high accuracy and high precision.

Kayıkçıoğlu (2017) aimed to implement an algorithm that can detect whether an ECG signal has an ST segment level drop or rise at any R-R interval. In the thesis study, methods based on time-frequency transforms have been developed in order to early detection of ST segment's depressions or elevations in the ECG R-R interval. Possible results are provided to minimize the possibility of a heart attack to be.

IV. EXPERIMENTAL STUDY

ECG signal analysis is an important field of study in biomedical studies. Many techniques have been applied

to different ECG datasets. The ECG signals received from the MIT-BIH Arrhythmia database will be used in the study. These signals will be used to classify diseases.

Pre-processing is considered in the first stage of the study. This preprocessing will simplify both the quality reduction and the relation between class and quality. After the qualifications are determined, discrete and continuous wave converters will be used, unlike existing studies. Thanks to these converters, it is aimed to improve the performance of the next stage, the classification stage.

Every ECG signal has five distinct points (P, Q, R, S and T) used for the interpretation of the ECG. Every R–R, interval duration was considered as a beat in the study. Because no-fixed ECG base line exists for individual patients, it is located every beat from zero to one vertical scale for better arrhythmias classification.

In the study to be done, It is stated that MLP is capable of recognizing and classifying ECG signals more accurately than other methods of ANN. Thanks to MLP with back propagation (BP) training algorithm, the trained data becomes ready for the test phase. Another mothod used is SVM which work by mapping training data for classification tasks into a high dimensional feature space. SVM is used together with kernel – adatron algoritm (K-A). The algorithm is simple and can find rapid solution for SVM classification with an exponentially fast rate of convergence.

Then, the classification will be done with SVM and MLP on the pre-processed, qualified data. A method for improving the calculation time and standard classification performance of MLP and SVM will be developed. The new method to be developed will be compared to the existing literature and its success will be measured. These operations will be done using MATLAB.

V.CONCLUSION AND RECOMMENDATIONS

This study focused on the analysis of ECG arrhythmias. A literature study on the subject has been done. In addition to many studies in ECG arrhythmia literature, it is aimed to improve classification performance with wave transformation techniques.

In the scope of the study, the techniques mentioned in the MIT-BIH Arrhythmia dataset will be applied. The work will be done using MATLAB. In the future, it may be advisable to study the actual data to be collected in accordance with the study.

In the scope of the study, it is predicted that the classification of the disease will result in a higher success rate than the current studies thanks to both the classification methods with the algorithms used and the wave transformers. it will try to find a more effective method with new uses in the study and the literature will contribute to this area. In the current studies wave transformers have been applied to different areas and have been seen to improve performance. Therefore, while classifying ECG signals, it is predicted that success will affect positively. Methods will be developed for classification of ECG signals in the study and it is predicted that performance will be better than standard studies.

In future studies, applications related to the development of pre-notification systems in case of arrhythmia can be made. In future studies, a system may be developed that continuously processes ECG signals and intervenes when necessary. Today, depending on the rapidly developing mobile technology, a system recommendation that gives ECG stimulation in mobile devices can be presented.

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