INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE

ISSN: 2057-5688

Robust Machine Learning Model for ECG-Based Heartbeat Classification and Arrhythmia Optimization & Prediction Analysis

K.Kiran Kumar [1], P. Ravi Babu [2], Y. Srinivasa Rao [3]
[1] Associate professor, [2] Assistant Professor, [3] Assistant professor
Department of Computer Science Engineering
Priyadarshini institute of technology & management, guntur

Abstract- We present a fully automatic and fast ECG arrhythmia classifier based on a simple brain-inspired machine learning approach known as Echo State Networks. Our classifier has a low-demanding feature processing that only requires a single ECG lead. Its training and validation follow an inter-patient procedure. Our approach is compatible with an online classification that aligns well with recent advances in health-monitoring wireless devices and wearables. The use of a combination of ensembles allows us to exploit parallelism to train the classifier with remarkable speeds. The heartbeat classifier is evaluated over two ECG databases, the MIT-BIH AR and the AHA. In the MIT-BIH AR database, our classification approach provides a sensitivity of 92.7% and positive predictive value of 86.1% for the ventricular ectopic beats, using the single lead II, and a sensitivity of 95.7% and positive predictive value of 75.1% when using the lead V1'. These results are comparable with the state of the art in fully automatic ECG classifiers and even outperform other ECG classifiers that follow more complex feature-selection approaches.

I. INTRODUCTION

The electrocardiogram (ECG) is tbiosignalportant bio signal used by cardiologists for diagnostic purposes. The ECG signal provides key information about the electrical activity of the heart. The heart signals are taken from ECG, which is known as Electrocardiography. That the heart signals are picked by using electrodes in arms, leg, chest of our body. By using this signal heart disorder can be find out. Depend on the shape of the ECG waveform, find out the cardiac health. ECG signal readings and their analysis are carried out from signal processing. Today signal processing plays a major role in ECG signal analysis and interpretation. The aim of ECG signal processing is diverse and comprises the Improvement of

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measurement accuracy and reproducibility (when compared with manual measurements) and by taking out the information is not readily available from the signal through visual assessment. ECG is composite from 5 waves - P, Q, R, S and T.

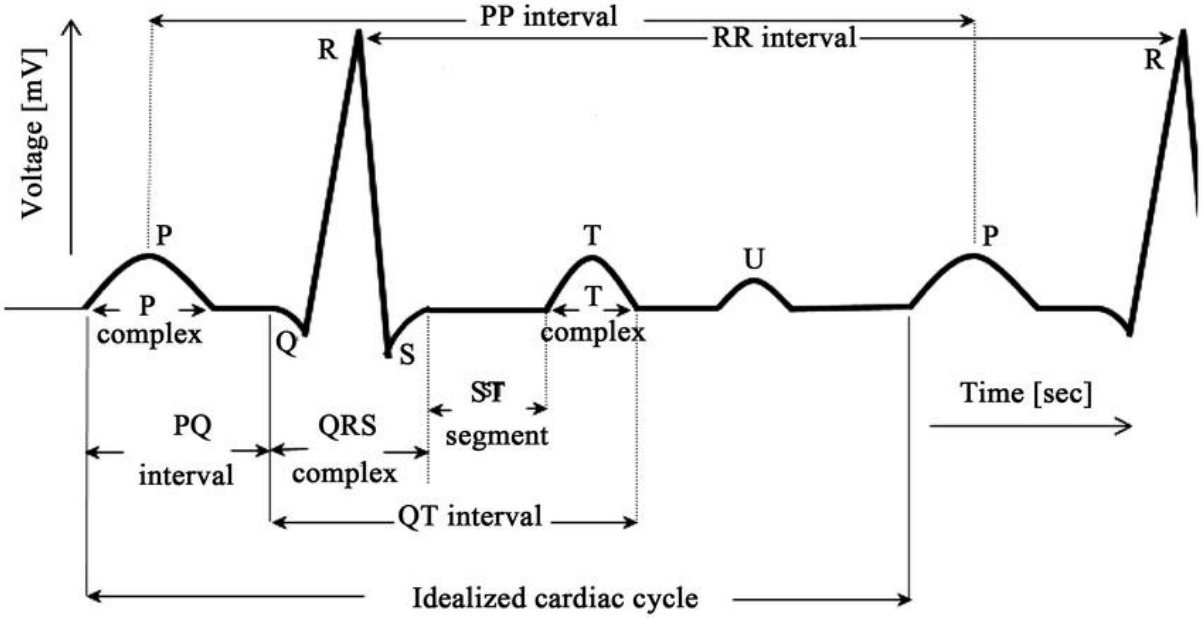

Fig 1 : ECG Signal with Idealized Cardiac Cycle Process

This signal could be measured by electrodes from human body in typical engagement [2]. In today's world, an optimal and intelligent problem solving approaches are required in every field, regardless of simple or complex problems. Researches and developers are trying to make machines and software's more efficient, intelligent and accurate. This is where the Artificial Intelligence plays its role in developing efficient and optimal solutions. Data mining techniques are used to explore, analyze and extract data using complex algorithms in order to discover unknown patterns in the process of knowledge discovery. Prediction is done with the help of available knowledge or previous values so accuracy in prediction is the main challenge. The artificial neural network (ANN) can use for pattern recognition, classification as well as a prediction because it is based on biological neurons, an artificial neural network (ANN) is a self-adaptive trainable process that is able to learn to resolve complex problems based on available knowledge Genetic algorithm is one of most pervasive and

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advanced developed heuristic search technique in Artificial Intelligence.

II. LITERATURE REVIEW

Qian Zheng, Chao Chen, Zhinan Li (2020). A Novel Multi-Resolution SVM (MR-SVM) Algorithm to detect ECG signals anomaly in WE-CARE project – Center for wireless communication and signal processing.

Cardiovascular disease (CVD) has become the leading cause of human deaths today. In order to combat this disease, many professionals are using mobile electrocardiogram (ECG) remote monitoring system. While using mobile ECG systems, most of the cardiac anomalies can be observed, especially when serious myocardial ischemia, heart failure, and malignant arrhythmia occur. Thus, ECG anomaly detection and analysis have attracted more and more attention in the clinical and research communities. Currently, the existing solutions of ECG automatic detection and analysis technologies are challenged by an accuracy requirement. Based on this motivation, we propose a novel MultiResolution Support Vector Machine (MRSVM) algorithm to detect ECG waveform anomaly. This proposal is tested in our WECARE (a Wearable Efficient project.

Sarikal, P. and Wahidabanu, R. (2020). Robust R peak & QRS detection in electrocardiogram using wavelet transform (IJACSA) International Journal of Advanced Computer Science Applications, 1(6), 48-53.

In this paper a robust R Peak and Q,RS detection using Wavelet Transform has been developed. Wavelet Transform provides efficient localization in both time and frequency. Discrete Wavelet Transform (DWT) has been used to extract relevant information from the ECG signal in order to perform classification. Electrocardiogram (ECG) signal feature parameters are the basis for signal Analysis, Diagnosis, Authentication and Identification performance. These parameters can be extracted from the intervals and amplitudes of the signal. The first step in extracting ECG features starts from the exact detection of R Peak in the QRS Complex. The accuracy of the determined temporal locations of R Peak and QRS complex is essential for the performance of other ECG processing stages. Individuals can be identified once ECG signature is formulated. This is an

ISSN: 2057-5688

initial work towards establishing that the ECG signal is a signature like fingerprint, retinal signature for any individual Identification. Analysis is carried out using MATLAB Software.

Qibin Zhao and LiqingZhan. (2021). ECG Feature Extraction and Classification Using NN Transform and Support Vector Machines, International Conference on Neural Networks and Brain, ICNN&B, vol. 2,pp. 1089-1092.

This paper presents a new approach to the feature extraction for reliable heart rhythm recognition. This system of classffication is comprised of three components including data preprocessing, feature extraction and classification of ECG signals. Two different feature extraction methods are applied together to obtain the feature vector of ECG data. The wavelet transform is used to extract the coefficients of the transform as the features of each ECG segment. Simultaneously, autoregressive modelling(AR) is also applied to obtain the temporal structures of ECG waveforms. Then the support vector machine(SVM) with Gaussian kernel is used to classify different ECG heart rhythm. Computer simulations are provided to verify the performance of the proposed method. From computer simulations, the overall accuracy of class The electrocardiogram (ECG) is routinely used in clinical practice, which describes the electrical activity of the heart. In physical checkups at hospitals, physicians record the ECG after the patient has exercised to check his/her cardiac condition. The Holter ECG device is used most frequently for recording the ECG. Physicians apply the device to a patient when they need to monitor his/her ECG to find the few abnormal cycles in the ECG throughout the day. Physicians then interpret the shapes of those waves and complexes. They calculate parameters to determine whether the ECG shows signs of cardiac disease or not. The parameters are the height and the interval of each wave, such as RR interval, PP interval, QT interval, and ST segment. Recognition of the fiducial points and calculations of the parameters is a tedious routine for the physician. Therefore, there is an urgent need for an automatic ECG recognition system to reduce the burden of interpreting the ECG. Various studies have been done for classification of various cardiac arrhythmias [1][2][3][4]. In this paper, we propose the combination of wavelet transform and AR model as the feature

ISSN: 2057-5688

extraction method, then use the SVM to classify the ECG heartbeat. The proposed approach is validated in the MIT-BIH Arrhythmia Database[5] and get high accuracy of classification. All ECG data were obtained from MIT-BIH arrhythmia database that contains records of many patients with heart troubles or abnormalities. The frequency of the ECG data was 360HZ. Each record has its respective annotation file that indicate the class of the heartbeat. A single channel ECG is collected and used to algorithm evaluation. Since there are few categories of abnormal QRS complexes in one record, we select different abnormal QRS complexes from several records. Six types of QRS complexes appeared frequently in the database. Therefore, we mainly deal with six types heartbeats which include normal beat(NORMAL), left bundle branch block beat(LBBB), right bundle branch block beat(RBBB), paced beat(PACE), premature ventricular contraction(PVC) and atrial premature contraction(APC). In the data preprocessing process, continuous ECG signals must be separated into many segments which contain one heartbeat. The extracted data of ECG complexes is centered around R peak. Considered that some PVC duration is great and sometimes R peak detection may be not the center of the complex, we have selected segment of 250ms before the fiducial point and 400ms after that with the R peak point is the 90th point. The R peak is detected using the Pan and Tompkins algorithm[6].

III. PROPOSED MODEL

From the above literature survey we have concluded that heart activity is very important in health care monitoring system. And it is done through the ECG signals. Different machine learning algorithms were used for predicting the heart diseases as well as heart attack. The all research is done using MATLAB tool.

Proposed System Architecture:

¬ Raw Data ECG normal and abnormal signal dataset for male and female taken from MIT-BIH arrhythmia dataset that is raw ECG data take it for further process.

¬ Data Selection This includes operations involved the selecting of either normal or abnormal ECG signal data for further process.

¬ Data Preprocessing This includes operations applied to the data to prepare it for further analysis. Typical pre-processing

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operations include data cleaning to filter out noisy data elements, data interpolation to cope with missing values, data normalization to cope with heterogeneous sources, temporal alignment, and data formatting.

¬ Feature Extraction This includes operations for representing the data appropriately and selecting specific features from this representation.

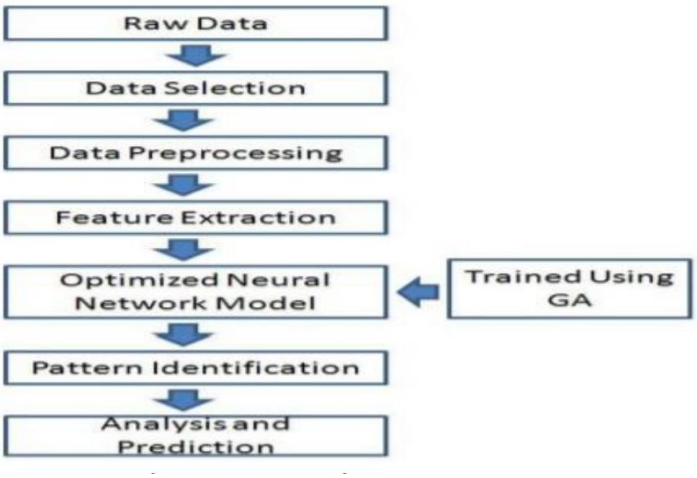

Fig 2: Proposed System Architecture

¬ Optimized Neural Network Model This stage, also called mining applies knowledge discovery algorithms to identify patterns in the data. Modeling problems can be classified into six broad categories: anomaly detection to identify statistically deviant data, association rules to find dependencies and correlations in the data, clustering models to group data elements according to various notions of similarity, classification models to group data elements into predefined classes, regression models to fit mathematical functions to data and summarization models to summarize or compress data into interesting pieces of information. Here, we are applying Optimized neural network using GA for classification and prediction of heart Attack.

¬ Pattern Identification: In this stage system identify the pattern of normal ECG dataset as well as abnormal ECG dataset for the analysis and prediction purpose.

¬ Analysis and Prediction: This stage includes operations for analysis and prediction of the results of the pattern Identification process.

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Simulation Results

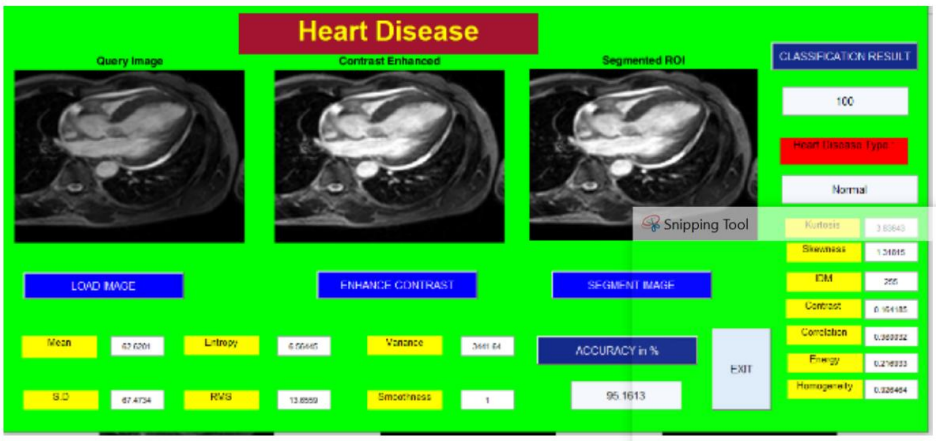

FIG 3: Predicting Heart Disease

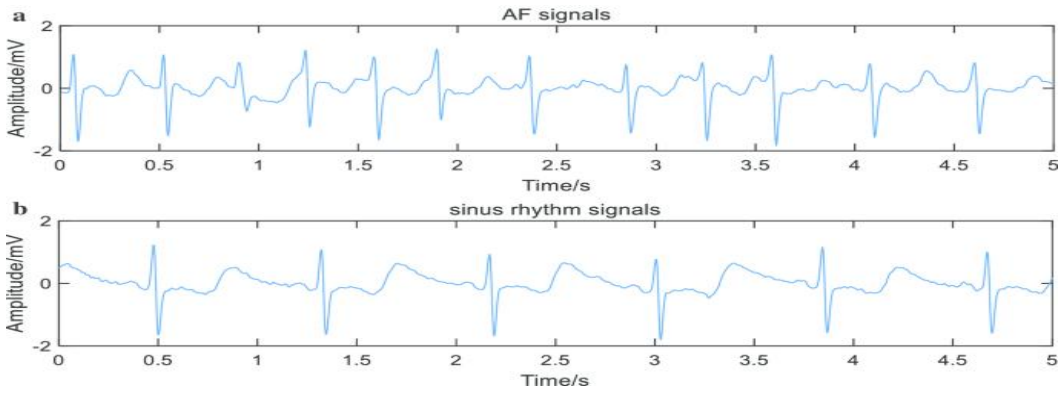

FIG 4 : ECG Signal Analysis with rhythm signal classification process

IV. CONCLUSION AND FUTURE WORK

The ECG is mainly used for diagnosis of heart disease. Genetic Algorithm is used to optimize the initialization of neural network weights. Genetic Neural Network based prediction of heart disease for patient by improving the performance using optimize neural network architecture and predicts whether the patient is suffering from heart disease or not. Also find out possibilities of heart attack based on heart activities. Back propagation is having disadvantage like slow convergence, long training time and local minima. Genetic algorithm is use to solve this problem and gives optimal result as well as get accuracy to predict heart attack. As the healthcare domain is dynamic and this issue is a challenge to the data mining.

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It is also a forcing motivation to the data mining applications in healthcare. This dynamism gives way to new horizons and more data mining applications will be employed to discover new patterns and associations. In the view of the subjects examined in this study, future data mining studies seem to take place, not limited but in considerable weight, in distributed data mining applications and text mining algorithms. With the help of data mining algorithms, classification performance increases. This can be further enhanced and expanded with more prediction algorithm for major life threatening diseases. The further enhancement observes on utilizing different method that provides higher accuracy in feature extraction and classification.

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