Cardiac Arrhythmia Diagnosis System from Electrocardiogram Signal using Machine Learning Approach

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***Abstract*- People nowadays come cross lot of life threatening diseases. One of the crucial diseases is cardiac disease. Cardiac arrhythmia is a disorder which needs timely diagnosis for avoiding sudden cardiac arrest. In Arrhythmia, the heartbeat is too irregular, too slow, or too fast. The Cardiac diseases are monitored using electrocardiogram (ECG). The major objective of this paper is to discriminate between the normal and diseased persons using machine learning approach. The Cardiac Arrhythmia Diagnosis system involves the following processes such as feature extraction, feature selection and classification. Feed forward Neural Network is proposed in this work and results are compared with support vector machine.**

Keywords—Electrocardiogram, Pan Tompkins QRS detection, Feature Selection, Neural Network

I. INTRODUCTION

The timely diagnosis of heart diseases is a primary need for the prevention of deaths because of cardiac diseases. Cardiac diseases diagnosed using Electrocardiogram (ECG) analysis. The ECG contains five major peaks and valleys such as P, Q, R, S and T. These peaks and valleys contain lot of important information for diagnosing cardiac diseases.

The ECG signal contains noise to be removed. The noises in ECG signal occurs due to body movement, power fluctuations etc., The noise in ECG signal are removed by using noise removal techniques. After removing the noise, the important characteristics or features are extracted from the ECG signal. The ECG signal of a normal person is shown in figure1.

Arrhythmia is an irregular electrical activity. The heart beats too slowly or too quickly. There are diverse types of arrhythmias. They are Normal sinus Rhythm, Atrial Fibrillation, Ventricular Fibrillation and Supraventricular tachycardia. The ECG signals are gathered from the Physionet database.

The features are extracted using the discrete wavelet transform; the features are selected using feature selection technique and classified using neural network and support vector machine.

The main objective of this paper is diagnosis of heart diseases using machine learning techniques. This reduces the death rate due to the heart diseases. The reminder of this paper is organized as follows. Related works, database, System architecture, Results & discussion and conclusion and future work

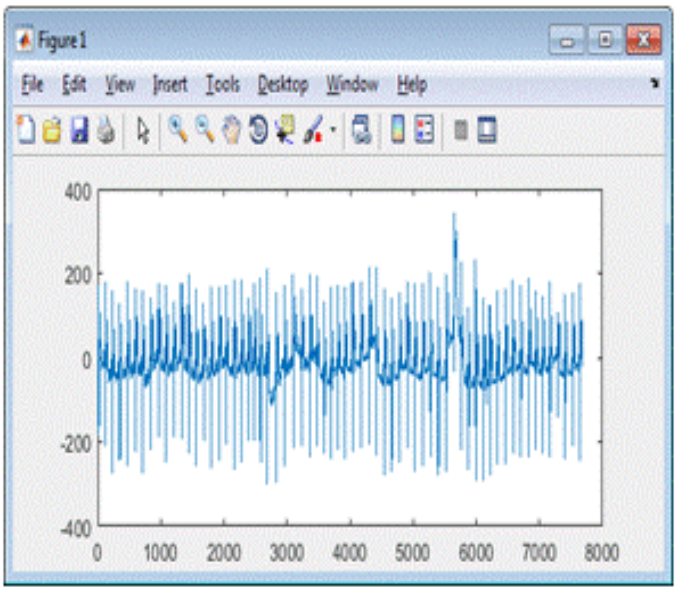

Fig. 1 .ECG Signal

II. RELATED WORK

Abdullah Caliskan et al. [1] proposed deep neural network for the classification of coronary artery disease dataset. The deep neural network was applied and tested in Cleveland, Hungarian, Long Beach and Switzerland data from the UCI repository.

The IoT devices, sensors and mobile apps are widely used in telemedicine and telehealth for remote healthcare via the medical Internet of Things (mIoT) [5].

Ebenezer Obaloluwa Olaniyi et al. [6] used feed-forward multilayer perceptron and support vector machine (SVM) for the diagnosis of heart disease.

Oleg Yu. Atkov et al. [7] proposed an artificial neural networks-based (ANNs) diagnosis model for coronary heart disease (CHD) using a compound of conventional and genetic factors of the disease.

Jae Kwon Kim et al. [10] proposed a system for diagnosis of coronary heart disease with neural network using Feature correlation analysis (NN-FCA).

Mrs. M.Nirmala Devi et al. [12] proposed a computer aided system to diagnose heart diseases.

Pranav Rajpurkar et al. [14] proposed a model that detects the wide range of Arrhythmias using convolutional neural network .

III. DATABASE

The ECG signal for training the classifier was collected from PhysioBank ATM. ECG signal was collected from MIT-BIH Normal Sinus Rhythm Database (nsrdb) for normal ECG signals and MIT-BIH Supraventricular Arrhythmia Database (svdb) for Arrhythmia affected ECG signals.

IV. CARDIAC MONITORING SYSTEM

A. System Architecture

Fig.2 shows the system architecture. The ECG data was collected from PhysioBank ATM. The ECG signal is processed and extract the features from ECG signal using discrete wavelet transform. The R-peaks are marked to find the RR interval. Heart Rate Variability features are calculated from the RR interval. The Heart Rate Variability features are given to the classifier for classifying normal or arrhythmia diseased person.

The performance measures of the classifiers are compared. The diagnosis result was sent to the Doctor as well as the patient's caretaker.

B. Feature Selection

Feature selection is the process of selecting most relevant feature for the classification based on score metrics of the feature. Here the Feature selection is based on the neighborhood component analysis. In this technique, the weight of each feature is calculated. The weight of the irrelevant features will be close to zero.

C. Classification

a. Neural Network System

The HRV features are given as an input. The data are trained by feed-forward neural network in MATLB. The trainlm and learngdm are used as the training function and adoption learning function respectively. The neural network classifier is built as two models. One model is with entire feature set and the other with selected features.

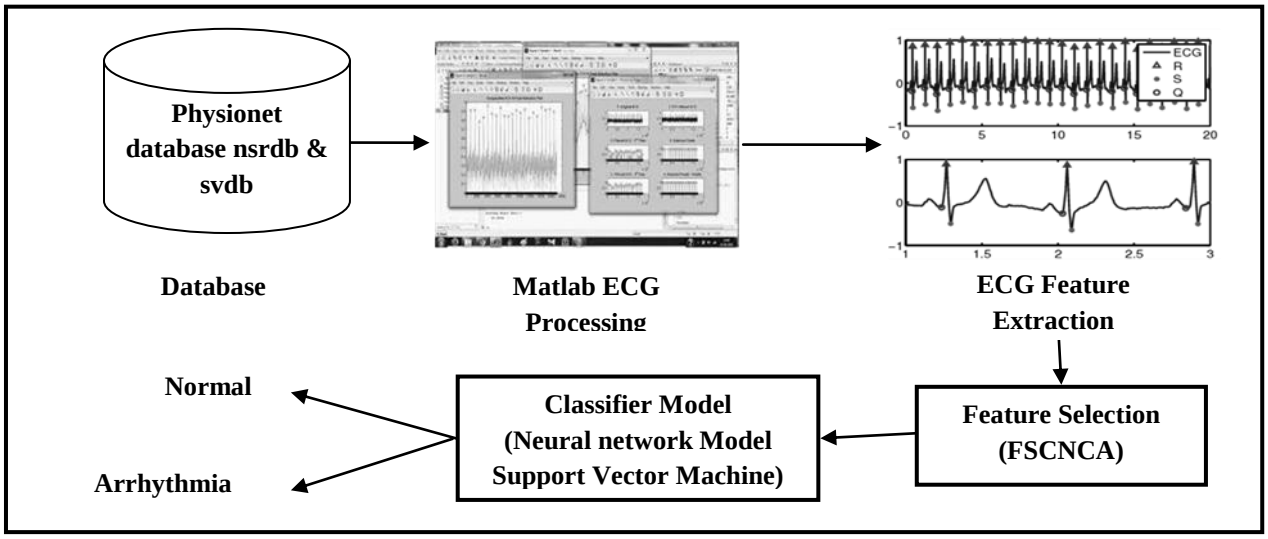

Fig. 2. System Architecture

b. Support Vector Machine

The support vector machine trained the data through classification learner app in MATLAB. The app starts a new session with input and target data and 10 fold cross-validations.

In this paper, we have applied all SVMs such as linear SVM, Quadratic SVM, Cubic SVM, Fine Gaussian, Medium Gaussian and Coarse Gaussian SVM. Among these the medium Gaussian SVM gives better results.

The SVM classifier is also built as two models, one with the complete feature set and the other with selected feature set.

V. RESULTS AND DISCUSSION

The ECG signal dataset collected from Physionet ATM database. Here we have chosen two databases such as MIT-BIH Normal Sinus Rhythm database (nsrdb) and MIT-BIH Supra ventricular tachycardia database (svdb). Totally we have 96 records, having 18 normal persons and 78 persons affected by supra ventricular tachycardia. The Signal was processed by discrete wavelet transform and the R-peaks are marked. From the R-Peaks, RR intervals are calculated. Then the Heart rate variability features are calculated from the RR interval.

Then the most relevant features are selected using feature selection technique. Finally the features are given to classifier models.

VI. PERFORMANCE EVALUATION

The performance of the classifiers is measured using the statistical measures like sensitivity, specificity and accuracy.

TABLE I. THE PERFORMANCE MEASURE OF THE CLASSIFIERS

Sl. No	Performance measures	Gaussian SVM	FSCNCA-Gaussian SVM	Neural Network	FSCNCA-Neural Network
1.	Sensitivity	100%	100%	98.71%	98.71%
2.	Specificity	16.66%	27.77%	44.44%	50%
3.	Accuracy	84.37%	**85.42%**	88.54%	**89.58%**

The TABLE I shows the performance measure of the classifiers used in this work.

The Fig.3 represents the graphical representation of the classifiers. From the analysis of performance measures, it is clear that the neural network classifier outperforms than the support vector machine and the classifier express better accuracy when given the selected features compared to the complete feature set.

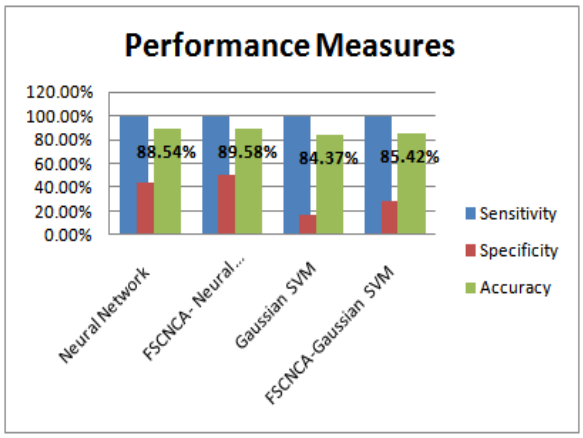

Fig. 3. The Performance evaluation of the classifiers

The accuracy of the FSCNCA Neural Network is higher than the Neural network, SVM classifier and FSCNCA-SVM. Even though the sensitivity of the SVM is high, its specificity is too low.

VII. CONCLUSION

For preventing cardiac diseases, an early diagnosis and exact identification of diseases are important factors. To accomplish this, the system proposed to classify the cardiac arrhythmia disease with reduced number of features. The performance of the classifier shows that the Feed Forward Neural Network classifier gives highest accuracy of 89.58% compared to other classifier models.

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