A Novel Approach of ECG Classification for Diagnosis of Heart Diseases: Review

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***Abstract*-Modern day lifestyle and our ignorance towards health have put the most vital organ of our body Heart at great risk. India today is witnessing a lot many young people suffering from heart diseases which even lead to untimely demise. Most common heart abnormality includes arrhythmia which is nothing but irregular beating of heart. Going by the trend/statistics, middle aged people (30-45yrs) are at great risk because of high stress in both personal and professional lives. This necessitates the need for a system which can not only detect any anomaly in functioning of our heart but warns us against any threat. Our project is based on developing such a system that can give us prior information about the upcoming threat or the heart disease which we are prone to. This system involves 3 basic steps that is, preprocessing, feature extraction and finally classification.**

***Keywords*- Arrhythmia, preprocessing, feature extraction, classification.**

I.INTRODUCTION

According to a recent survey, it is being discovered that, by 2030, almost 23.6 million people will die from Cardiovascular Diseases (CVD), primarily from heart disease and stroke. They are found to remain the main cause of death. One of the CVD risk factors is Cardiac Arrhythmia[5].

Cardiac arrhythmia is a major kind of abnormal heart activity. An arrhythmia is a problem with the heartbeat rate or rhythm of the heartbeat. For the period of an arrhythmia, the heart may beat too fast or too slow, or with an irregular rhythm. Fast heartbeat is said to be tachycardia whereas slow is called Bradycardia. Most arrhythmias are not dangerous, but some can be and some can be even fatal[1],[3].

Classification of cardiac arrhythmia is a difficult task. One of the ways to detect cardiac arrhythmia is to use electrocardiogram (ECG) signals. The ECG is the most important biomedical-signal used by cardiologists for diagnostic purposes. The ECG signal provides all the required information about the electrical activity of the heart[1]. The early detection of the cardiac arrhythmias can save lives and enhance the quality of living through appreciates treatment.

ECG is the graphical depiction of the cyclic rhythm of contraction and relaxation activity generated by the heart. [3], An ECG comprises of the P wave, QRS complex, T and U waves. They are denoted by the capital letters P, Q, R ,S, T and U. The P wave is the contraction of the atria, while the QRS complex is related with the contraction of the ventricles. The T wave is generated by relaxation of the ventricles. The P, Q, R, S, T and U waves of the ECG signal contain all the important features that describe the activity in the heart. A

ISSN: 2278 – 1323

typical ECG signal waveform of a normal heart beat is shown in Figure 1.

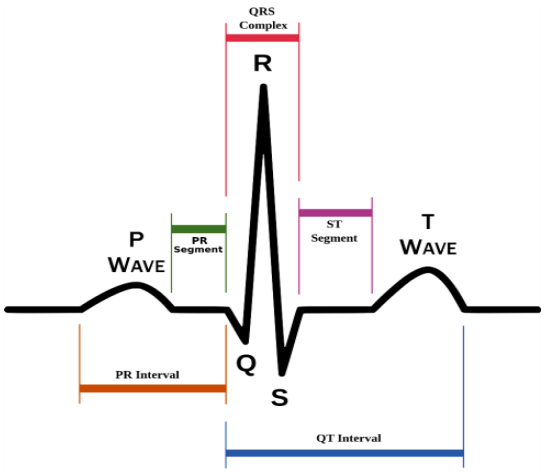

Fig 1:- ECG signal showing P, Q, R, S, T and U wave.

The ECG signal is measured through several electrodes that are normally placed in different positions of a patient's body. ECG recordings typically contain high and low frequency noise. Amplitudes within beats vary from person to person. That is why the effective detection of ECG arrhythmia is very important, but it is tedious and time consuming. Since the monitoring of ECG signal have to be carried out over several hours because the volume of the ECG data is vast. This difficulty turns out to be a high possibility of the analyst missing (or misreading) vital information.

Therefore,[2]computer-based investigation and detection of diseases can be very helpful in cardiologist's diagnoses process especially in the intensive care units the electro-cardiogram (ECG) care unit's recordings, especially in real-time long-term (24h) monitoring. This paper proposes an algorithm to detect and classify the ECG arrhythmia.

A successful ECG arrhythmia classification typically involves three important procedures: signal preprocessing, feature extraction, and classification of ECG signal. Feature extraction is the important procedure that usually affects the classification performance of any ECG arrhythmia classification system. That is why, the extraction of relevant features to achieve best possible classification results has become major task for the ECG arrhythmia classification problems[1].

II.PREVIOUS WORK

Over the last decade, several researchers have been working on detecting and predicting the Heart Diseases. In present research, the focus is on the early stage of Heart diseases.

A. INPUT ECG SIGNAL

From the earlier studies, most of researchers used the standard database as the data for all the data analysis and classification. The PhysioNet website is a site containing medical data of various diseases. PhysioNet provides the database that contains a group of records for one or more digitized ECG signal, as well as their corresponding beat annotations [2].Most research commonly used MIT-BIH arrhythmias database [1] [2] [3] [4]. MIT-BIH database consist of numerous ECG signal that indicate different type of diseases and abnormalities of the heart rhythms. As the heart of this project is on Arrhythmia, the selection of the data is more toward the early symptoms of it.

B. PRE-PROCESSING

It removes artifact signals from the ECG signal. These artifact signals include baseline wander, power line interference, and high-frequency noise. The major sources of noise are: Power line interference, Muscle contractions, Electrode contact noise, Motion Artifacts, Baseline wandering. The preprocessing stage is of great importance since it contributes significantly to the overall classification result.

Aim of preprocessing is to remove all the above and make the ECG signal suitable for the further feature extraction and Classification processes. The various Preprocessing

ISSN: 2278 – 1323

Techniques are: FFT (Fast Fourier Transform), FIR Filter, IIR Filter, DCT (Discrete Cosine Transform), DWT (Discrete Wavelet Transform).

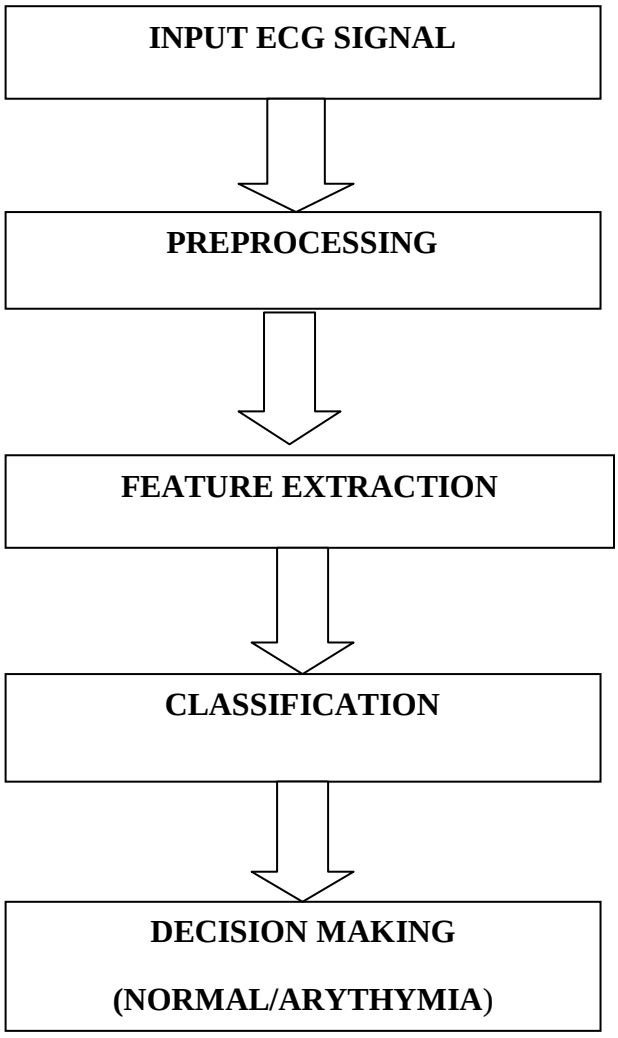

Fig 2:- Proposed Scheme of Work.

C. FEATURE EXTRACTION

The 2nd stage consists of feature extraction modules. The heartbeat detection module attempts to position all heartbeats .The feature extraction part forms a feature vector from each heartbeat. The feature extraction modules are required, because superior classification performance is often achieved if a smaller number of discriminating features are first extracted from the ECG[15]. The Feature Extraction Parameters: QRS complexes, RR interval evaluation, ST segment, which gives a sign of possible cardiac problems.

ECG Feature Extraction plays a significant role in diagnosing most of the cardiac diseases. One cardiac cycle in an ECG signal comprises of the P-QRS-T waves. This feature extraction method determines the amplitudes and intervals in the ECG signal for subsequent analysis. The amplitudes and intervals value of P-QRS-T segment determines the operation of heart of every human. Recently, numerous research and techniques have been developed for analyzing the ECG signal. The proposed schemes were mostly based on following Feature Extraction Techniques: Autoregressive (AR), Wavelet Transform (WT), Eigenvector, Fast Fourier Transform (FFT), Linear Prediction (LP), Independent Component Analysis (ICA), Daubechies Wavelets transform.

D. CLASSIFICATION

It contains one or more classifier units which select one of the required classes in response to the input feature vector. After going through the last step that is Classification the persons ECG is classified into Normal or with Arrhythmia. If arrhythmia detected early can be treated with proper medication and care. Arrhythmia can be broadly classified into many categories including: Left bundle branch block (LBBB), Normal sinus rhythm (NSR), Pre-ventricular contraction (PVC), Atrial premature contraction (APC), Supraventricular tachycardia (SVT), Ventricular tachycardia (VT).

The various classification techniques are**:** Perceptron model, Feed-forward Neural Network, Multi-layer Perceptron, SVM (support vector machine), Competitive learning network, PCA (principal component analysis), Radial Basis Funtion, Random forest algorithm.

III.PROBLEM IDENTIFICATION

A. *Noise Removal*

In some ECG signals the noise level is very high and it is not likely to recognize it by single recording, it is vital to gain a

ISSN: 2278 – 1323

good understanding of the noise processes involved before one attempt to filter or preprocess any signal. The ECG signal is very sensitive in nature, and even if small noise is added to original signal the characteristics of the signal changes.

The most difficult problem faced by an automatic ECG analysis is the large deviation in the morphologies of ECG waveforms, it happens not only for different patients or patient groups but also within the same patient. So the Neural network is the most suitable technique because it is more tolerance to morphological variations of the ECG waveforms.

B. *Proper Selection of Algorithm for Feature Extraction.*

Feature Extraction technique provides three main benefits when constructing prognostic models:

- improved model interpretability,
- shorter training times,
- better generalization by reducing over fitting.

Feature Extraction is also useful as part of the data examination process, as it shows which features are important for calculation, and how these features are related.

C. *Selection of A Good Algorithm For ECG Classification.*

The ECG classification problems have been solved by means of a definite method, which has the capability to enhance the ECG classification performance. The computational requirements of exhaustive search method (those which test all possible subsets) increase greatly with the number of features in the original set. The main requirement for such a system is to achieve high accuracy. Furthermore, a classification learning algorithm is expected to have a short training and prediction times. Such a system should be robust to noisy training instances. Also, in some real-world areas, both training and test instances may contain some missing values.

D. *Problem Statement*

We are proposing a project on the topic , "A Novel Approach of ECG Analysis for Diagnosis of Heart Diseases" as a solution for the above problems being identified

IV.CONCLUSION

We have only implemented a small portion of the different techniques available for preprocessing, namely FIR filter, FFT (fast Fourier transform) and notch filter . However, our prospect primarily focus on feature extraction and classification of an ECG signal. In addition we look forward on utilizing different transformation technique that provides higher accuracy in feature extraction and classification processes. The parameters that must be considered while developing an algorithm for feature extraction and Classification of an ECG signal are simplicity of the algorithm and the accuracy of the algorithm in providing the best results. The future scope of this project is to develop an algorithm which will be compatible with the real time applications by means of Hardware Interfacing.

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ISSN: 2278 – 1323