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Arrhythmia Recognition and Classification Using ECG Morphology and Segment Feature Analysis using Support Vector Machine

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ABSTRACT : Accurate detection and classification of ventricular fibrillation (VF) and rapid ventricular tachycardia (VT) is crucial for the success of the defibrillation therapy in automatic external defibrillator and patient monitoring. A huge variety of detection algorithms have been proposed based on temporal, spectral and time frequency parameters extracted from the surface ECG signal by considering each parameter individually. A novel life threatening arrhythmias detection algorithm combining 14 ECG parameters on different domain using machine learning algorithm has been used to improve detection efficiency. To analyze which parameter affects the performance, a novel FS algorithm based on SVM classifiers is used and the proposed methodology was evaluated in two different binary detection scenarios.

KEYWORDS: SVM – Support Vector machine, ECG – ElectroCardio Gram, DWT – Discrete Wavelet Transform, DAQ – Data Acquisition.

I.INTRODUCTION

Arrhythmia is a common medical condition where it possess a broad range of heart-related pathologies. Not all of them require permanent medical attention, they provide hints to the development of serious heart diseases. The ECG is a cornerstone for the detection and diagnosis of such conditions[3]. Though, its interpretation is mostly based on medical experts or specialized hardware which is available in clinical environments[4]. As the availability of clinics and medical experts is low this will become a great problem. To Analyse ECG waveform to detect abnormalities using sample waveform from MIT-BIH database and to Process waveforms to make it easier to classify them[2]. Information gets extracted from ECG waves such as QRS complex using SVM to classify the ECG waves into different classes and translate the ECG from Matlab for the development of a software system and Database[10]. The waves are the most important characteristic features of the ECG. The peaked area in the ECG beat, commonly called QRS complex. With its neighboring P wave and T wave the portion of a signal will contain most of the diagnostically important information. Other information like the elevation of a ST segment and heartbeat rate.

II.OBJECTIVE

The main objective of this project is to purpose a Machine learning algorithm such as SUPPORT VECTOR MACHINE algorithm along with feature selection techniques are used in order to increase the accuracy in detecting and discriminating the image as normal and abnormal.

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III.OVERVIEW

The analysis of the electrocardiogram (ECG) signal is the most readily available method for diagnosing cardiac arrhythmias. Arrhythmia is one kind of diseases that gives rise to the death and abnormal beats may momentarily paralyze blood pressure[2]. Cardiac arrhythmias are dysfunctions or disturbances in the behavior of the heart. These disturbances produce abnormal in rate, rhythm and the site of impulse formation; factors that may in turn alter the normal sequence of atrial and ventricular activation. As the ECG records can be noisy, the main problem is the shape of beats belonging to the same class and beats of similar shape belonging to different classes. Computer-based diagnosis algorithms have generally three steps:" Detection of beat from ECG, extracting features from beats, and classification[8].

IV. EXISTING SYSTEM

In existing system, the eigenvectors are derived from the covariance matrix of the probability distribution over the high-dimensional vector space of face images[1]. The Eigen faces themselves form a basis set of all images used to construct the covariance matrix. Thus dimension reduction can be produced by allowing the smaller set of basis images to represent the original training images. Representing the faces from the basis set, classification can be achieved.

Disadvantages:

- Signal to noise ratio is poor
- Can't be applicable for under determined cases, Require more computations for decomposition.
- Lacking of specific methodology to apply WT to the pervasive noise, performance limited by Heisenberg uncertainly.
- Difficulties exist in establishing the model properties of ECG signal, Not applicable to stationary signals.

V.RELATED WORK

In [1] Chung-chien chiu tong hong, "Using correlation coefficient in ECG waveform for Arrhythmia detection" Biomedical engineering applications basis communications. . To develop an efficient arrhythmia detection algorithm the morphology characteristics of arrhythmias using correlation coefficient in ECG signal gets used. Normal subjects, patients with APC and PVC are the included. So and Chan's algorithm was used to find the locations of QRS complexes. The correlation coefficient and RR-interval were utilized When the QRS complexes were detected, to calculate the similarity of arrhythmias. Using MIT-BIH arrhythmia database the algorithm was tested and in the database every QRS complex was classified.

In [2] Stefan Gradl1, Patrick Kugler1, "Real-time ECG monitoring and arrhythmia detection using Android-based mobile devices" Engineering in Medicine and Biology Society (EMBC). Devices that grow continuously in processing power and become an integral part of daily life, even in developing countries. Communicating devices are also used for biomedical signal processing and ECG analysis. In 2011, Physio Net/Computing in Cardiology arranged a challenge to develop efficient algorithms to improve the quality of ECG recordings using mobile devices and to improve efficiency of ECG diagnosis. Scully et al. describing the features like heart rate, breathing rate and blood-oxygen saturation can be extracted using camera recordings in mobile phones. The authors decided that all processing can be performed on modern mobile devices. However, they did not share their software implementation. An algorithm for real-time detection of QRS complexes and automated can be decided , intervention free normal/abnormal heart beat classification extends well-known analysis methods. Secondly, we present an implementation of the algorithm in an Android-based ECG monitoring application, which can process ECG signals in real-time by accessing a ShimmerTM sensor node via Bluetooth or by using a database of pre-recorded data. Thirdly, detailed evaluation of the application gets conducted and the algorithm is implemented with respect to QRS detection and abnormal beat classification using pre-recorded data of the MIT-BIH Arrhythmia and MIT-BIH Supraventricular Arrhythmia databases.

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In [3] Pedro R. Gomes, Filomena O. Soares, J. H. Correia, C. S. Lima, "Cardiac arrhythmia classification using Wavelets and Hidden Markov Models – A comparative approach". Cardiac arrhythmia detection viewed as a pattern recognition problem, to identify a finite number of patterns (arrhythmias). Hidden Markov Models have been successfully applied to pattern recognition problems in applications spanning automatic speech recognition , image segmentation, ECG modeling and cardiac arrhythmia analysis. The most common approach regarding HMM training is finding the stochastic distribution that best fits the data. As data is derived from the waveform some type of signal processing generally known as feature extraction method. The classical technique for extracting features in the HMM framework is the linear segmentation where the ECG is segmented in straight line segments. More recently advanced signal processing techniques as Fourier Transform, Linear Predictive Analysis, Lyapunov Functions and Multivariate Analysis (MA) have been used in order to overcome some limitations of the linear segmentation.

In [4] Maedeh Kiani Sarkaleh and Asadollah Shahbahrami, "Classification of ECG Arrhythmias using Wavelet Transform and Neural network". The ECG signal can be recorded from the wave passage of the depolarization and repolarization processes in the heart. The potential in the heart tissues is conducted to the body surface and it is measured using electrodes. The shape of ECG conveys important hidden information in its structure. The amplitude and duration of each wave in ECG signals are regularly used for the manual analysis. Thus, the volume of the data being enormous and the manual analysis is difficult and very time-consuming task. Naturally, the possibility of the examiner missing vital information is high. hence, medical diagnostics can be performed using computer-based analysis and classification techniques.

VI. PROPOSED SYSTEM

This project is mainly focused on detection and classification of arrhythmia. Get the input as ECG signal processing. The acquisition of ECG signal is done using DAQ(Data Acquisition)[2]. The filtering of the acquired signal is done using band pass filter set to the frequency range of 4 – 40 Hz. Then differentiate the filtered signal. Then square the differentiated signal and then integrate the squared signal. Then determine the frequency of integrated signal[3]. The calculation of time period is done using determined frequency which gives R_R interval. Time period is the inverse of frequency and calculation of heart rate is given by R_R interval as 60/(R_R interval(msec)). Then find the diseases.

VII.SYSTEM ARCHITECTURE

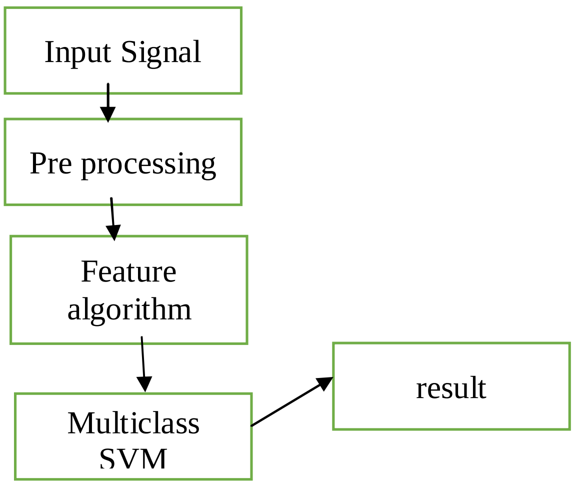

FIGURE 4.1- Overall Architecture Diagram

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The proposed workflow for this project is to get ECG database from the patient, pre-processing of the ECG signal is done to remove the unwanted noise, QRS detection and R peaks detection of the signal is known, feature extraction of complete signal is done and then at last classification is done and disease is known. In this above figure4.1, Shows the workflow process is given for the process. The algorithm used is FS-algorithm(First Search) to know the efficient way for classifying of data. After getting the signal, the noise is removed and acquisition is done by DAQ (Data Acquisition). The filtering for the signal is done by band pass filter to the frequency range of 4 - 40 Hz. Then differentiation of filtered signal is done and square the differentiated signal. Then integrate the squared signal. The calculation for time period is done using determined frequency which gives R_R interval where Time period is the inverse of frequency and calculation of heart rate is given by R_R as 60/(R_R interval(msec))[12]. Then find the respective diseases by classification using SVM(Support Vector Machine). By this classification of data in the form of signal is compared with already affected signals and find the disease.

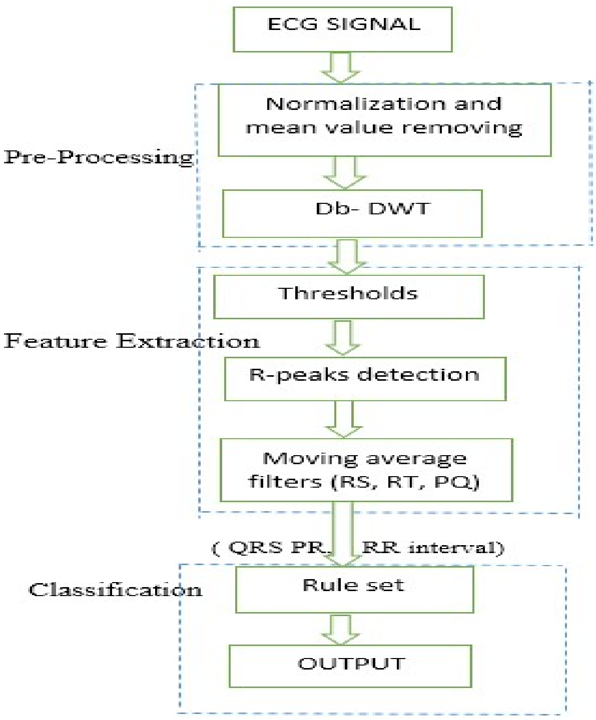

FIGURE 4.2- Detailed Architecture

In the above figure 4.2, represents the detailed view of the project. Using the ECG signal as an input signal,it directs to preprocessing. The preprocessing which helps in normalize and removing the mean value from the given input signal. Then the discrete wavelet transform sampled discretely and used to denoise two dimensional signals. By checking the threshold level that is already given helps in comparing those signals[11]. Then the R-peaks detection, The P, Q, R, S and T waves are the most important characteristic features of the ECG. The peaked area in the ECG beat, commonly called QRS complex, together with its neighboring P wave and T wave, is the portion of the signal through to contain most of the diagnostically important information[12]. Other important information includes the elevation of the ST segment and heartbeat rate, the RR or PP. Finally the classification part is done by the defined rule set, that is support vector machine algorithm which classifies the normal and abnormal points. By applying svm algorithm, the result or an output of this project becomes so efficient.

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VIII.METHODOLOGY

IMAGE PRE-PROCESSING

Pre-processing of an image means "preparation" of the sample/image to introduce it to an algorithm for specified task : tracking targets , recognition, feature extraction, etc .

An example, for pattern recognition : you have set of images for testing/recognition process (like face recognition) and the preprocessing is the size adjusting of the considered image, luminance normalization, statistical normalization (all the samples having mean 0 and variance 1), filtering noise with specified filter (Gaussian kernel, median, Kalman filter, low-pass filter etc.,), conversion to certain class, etc.,[9]

In some cases, some algorithms may be used for "preprocessing" like the PCA (Principal Component analysis) to reduce the samples dimensions.

PAN TOMPKINS ALGORITHM

Pan Tompkins algorithm is a real time algorithm for detection of the QRS complexes of ecg signal. It recognizes QRS complexes based on digital analysis of slope, amplitude and width. A special digital bandpass filter reduces false detections caused by the various types of interference in ECG signals. This filtering permits use of low thresholds, thereby increasing detection sensitivity. The algorithm automatically adjusts thresholds and parameters periodically to adapt to such ECG changes as QRS morphology and heart rate. This algorithm works by derivating of filtered signal. Squaring the derivated signal and then integration of squared signal. It uses patient specific threshold for QRS peak detection.

SVM CLASSIFIER

A Support Vector Machine (SVM) is a selective classifier formally defined by a separating hyperplane. In other words, given labeled training data, the algorithm outputs an optimal hyperplane which categorizes new examples. In two dimensional space this hyperplane is a line dividing a plane in two parts where in each class lay in either side.

IX. CONCLUSIONS

The conclusion of this project of finding the arrhythmia by detecting and classifying through SVM. This will have greater efficiency compared to existing system and the feature extraction module. The comparison with existing data so that it has efficiency, accuracy and simplicity.

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