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Analysis and Classification of Electrocardiogram Signal for Accurate Diagnosis – A Review

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ABSTRACT: Though electrocardiogram signals obtained from the heart has been used as a diagnosis tool for over several decades still there is room for improved methods of reducing noise in the electrocardiogram and analysing P, Q, R, S and T curve of a waveform for detecting of cardiac arrhythmia and monitoring the heart condition. Since last few decades, a number of researchers have come out with improvements and suggestions in studying electrocardiogram signals. This paper reviews the latest developments in this field so that doctors and researchers can a brief and panorama view of this state of the heart of this field as on now.

KEYWORDS: Electrocardiogram signal, Arrhythmia, Heart Rate Monitoring, Support vector machines, Heart Murmur.

I. INTRODUCTION

In earlier days the only tool available for the doctors to examine the condition of the heart to listen to the murmur and heartbeat using a stethoscope, which was objective and dependent very much on the experience of the doctor. An electrocardiogram detects the abnormalities in the heart with the help of some electrical parameters, these parameters are generated in the form of electrical waves, which are detected by ECG machine, which is used for medical test [1, 2, 4]. These waveforms of the systole and diastole of the heart as recorded by the machine contain some extreme noise, which has to be eliminated for proper diagnosis by the doctor.

Electrocardiogram is a universally used diagnostic test for rate ailment because it is a simple test conducted by an electrocardiogram machine [15, 17], which is compact and even portable most of the medical partisan can equip themselves to make this facilities and conduct as a primary test before enforcing to expect doctors [18, 21]. Even in the specialized cardiac hospital this is used and the doctors can obtain the information about heart rate, heart rhythm, the thickened of heart muscles, whether these as been a prayer heartache, any coronary heart diseases and any abnormalities in a condition of electrical impulse across the heart [8, 11]. All above information's are significant, important and it can be further identified by the more sophisticated test.

An irregular function of heart rhythms is known as arrhythmia, due to problems in the electrical conduction systems of the heart. Every year a large number of people die because of cardiac arrhythmias [4, 5, 7]. In various characteristics including the shape of electrocardiogram signal (ECG) waveform amplitude, width or even occurrence, at the time of P, Q, R, S, and T points have significant roles in detection of cardiac diseases including arrhythmias other features like RR intervals, ST segments, QT intervals and P wave variability are significant in diagnosis [9,12,15].

Any variation in any of these features in an electrocardiogram signal (ECG) indicates the presence of the particular type of arrhythmias, also obtaining P, Q, R, S and T [14] waveforms helps in studying cardiac arrhythmia and heart rate monitoring [22, 23]. These paper reviewed shows the progress and improvement in the above noise reducing, electrocardiogram signal (ECG) analysis and heart rate monitoring [17, 20].

The process of categorization of ECG Signal which gives the identify, separate & inferred analysis, but in categorization of ECG signal as no proper set of rules & act because many issues involved in categorization process. This paper shows the review of feature extraction and classification ECG signals.

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II. LITERATURE SURVEY

Mansi Varshney et. al in [1] proposed artificial neuron network classifier with Support vector machines (SVM) modeling technique to extract ECG features and classification from the noised electrocardiogram signal to give the best treatment.

Wei Liang et. al in [2] used Integral co-efficient band rejection filter (ICBS) preprocessing technique) used to reduced noise in an ECG and to extract the features of ECG signal with help of modeling technique two layered Hidden Markov Models (HMMs).

E. Roland Adams et. al in [3] made a technique Artificial Neuron Network (ANN) and generalized discrete Fourier Transform is used to extract Cardiac arrhythmias feature from noised ECG signal by applying preprocessing technique.

Shivnarayan Patidar, et. al in [4] proposed a preprocessing technique Statistical Properties on raw noised electrocardiogram signal to obtain the segmentation of cardiac signals by applying tunable Q – wavelet transform (TQWT) to obtain extracted features.

C. V. Banupriya, et. al in [5] proposed a modeling technique probabilistic neuron network (PNN) to classify Electrocardiogram signal to find the distortions present in between Q-R-S Segments and estimating accuracy in noised Electrocardiogram signal like average classification, specification, sensitivity.

Leigang Zhang, et. al has [6] proposed technique to classify Electrocardiogram signal by applying wavelet transform and decision tree classification to extract R-R characteristics by applying ID3 algorithm technique.

Mehmet Korürek, et. al in [7] explained the extraction of characteristics like peaks P-Q-R-S-T from noisy Electrocardiogram signal and rhythms classification by applying technique swarm optimization and radial basis function neural network modeling technique.

Afseen Naaz, et. al in [8] has explained the automatic analysis of irregular function of heart beats and extracting the features of electrocardiogram signal by applying pre-processing technique to remove noise, feature extraction by using Pan-Tomkins Algorithm and feature classification by using support vector machine and particle swarm optimization .

S. Celin, et. al has [9] proposed a technique to characterize the electrocardiogram signal has abnormal or normal, by applying different classification and features techniques like linear and non linear methods.

S. T. Sanamdikar, et. al in [10] used a technique to analysis irregular function of heart beats and implementation of noised Electrocardiogram signal to generate de-noised Electrocardiogram signal of P-Q-R-S segments.

Z. Zidelmal, et. al is [11] explained the analysis of irregular function and electrocardiogram beat categories from noisy ECG signal by applying support vector machine to extract feature like R-R section, Q-R-S complex by its co-efficient.

Thomas T. Poels, et. Al in [12] made an analysis of group of patients to detect Q-R-S signal in an Electrocardiogram signal by segregating the patient diseases.

A. D. Jeyarani and T. Jaya Singh is [13] proposed a pre-processing technique to reduce noise in noised Electrocardiogram signal by using Low cut filter, Averaging filter and band elimination filter to generate accurate signal.

Abhinav Vishav, et. al in [14] made a modeling technique automated artificial neural network (ANN) based classification of Electrocardiogram signals to obtain the cardiac arrhythmia.

Nasreen Sultana, et. al in [15] proposed a multiclass support vector machine (MSVM) modeling technique to obtain the ECG features like Normal Sinusitis Rhythm (NSR), Premature Ventricular Contraction (PVC), Right Bundle Branch Block (RBBB), Left Bundle Branch Block (LBBB), Tachycardia (TA) and Bradycardia (BR). This features obtained by applying pre-processing technique LPF and HPF with a QRS detection using Hilbert transform.

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III. METHODOLOGY

The process involved in classification of ECG signal is a major problem, as discussed many researchers the categorization of ECG involves various issues such as standard Electrocardiogram signal features [19, 23] and variability in ECG features, non existence of optimal categorization rules, individuality of ECG patterns [7, 16], variability in ECG waveforms from patient to patient etc..

Various application of Electrocardiogram signal categorization is detecting irregular type of a new patient to give better treatment to a patient then manual [6], also used in diagnosis and treatment of various heart diseases. "Fig. 1" shows the classification of ECG signal with respect time intervals and segments to understand the cardiac problems as shown in "TAB. 1".

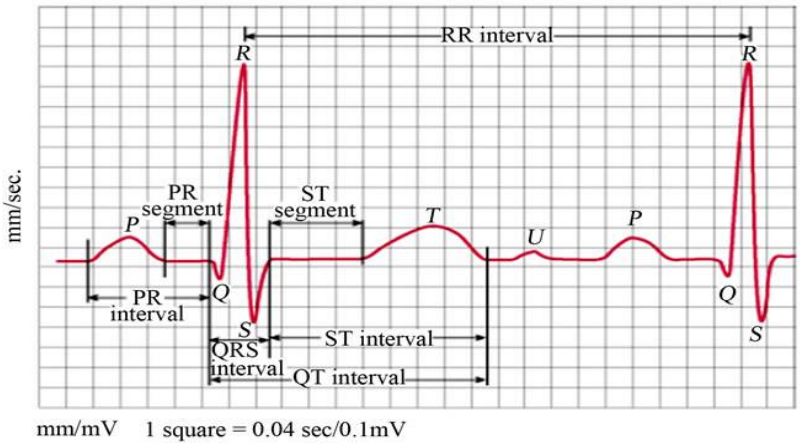

Fig.1 ECG waveform measured from heart beats.

Sl No.	ECG Characteristics		
	Characteristics	*Magnitude (mV)*	*Time Span (mS)*
I.	P signal	0.1 – 0.2 mV	60 – 80
II.	P-R stretch	--	50 – 120
III.	P-R section	--	120 - 200
IV.	Q-R-S complex	1	80 – 120
V.	S-T stretch	--	100 – 120
VI.	T signal	0.1 – 0.3	120 – 160
VII.	S-R section	--	320
VIII.	R-R section	--	(0.4 – 0.2) S

Table 1 Different features of electrocardiogram signal.

The raw ECG signal is available in MIT-BIH or UCI database [15], which is recorded from patients database consisting of cardiac movements called as arrhythmia. The raw Electrocardiogram signal is subjected to preprocessing technique to de-noise the Electrocardiogram signal, which is essential for physicians or doctors to avoid any false diagnosis. The Electrocardiogram information is accumulated in the range of 0.5 Hz to 40 Hz in arrhythmia signal [10].

The main steps for Electrocardiogram categorization are pre-positioned feature drawing out, normalization and grouping [13]. There are different pre-processing techniques for electrocardiogram grouping techniques such as averaging filter (LPF), low cut filter (HPF), etc are used for removal of noise [19, 20]. Techniques such as non linear digital filtering technique, linear phase low cut filtrate, mean median filtrate etc are used for adjusting of baseline

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wander. The various methods such as discrete integral wavelet transform (DWT) [11, 21], continues wavelet transform (CWT), Discrete Cosine Transform (DCT), S - Transform (ST), Discrete Fourier Transform (DFT), Principal Component Analysis (PCA), daubechies wavelet (Db4), Independent Component Analysis (ICA) etc. are used for extraction of features [19]. The different methods such as Z-score, unity standard deviation (USD), etc. are adopted for feature normalization. The different grouping technique identified by many researchers by using Eigenvector method for better performance on ECG signal features such as Autoregressive (AR), Wavelet Transform (WT), Eigenvector, Fast Fourier Transform (FFT), Linear Prediction (LP), and Independent Component Analysis (ICA) [24] etc...

To avoid different types of noise, the best technique is to use the Averaging, Low cut filter and band rejection filter to eliminate baseline wander, EMG noise and power line interference [9, 16]. Many researchers have explained different varieties of the algorithm, filters among that one of the methods for extraction of ECG features, can be done by using hybrid technique such as Discrete Wavelet Transform and Autoregressive Model with Rectangular Windowing technique and classification of ECG signal can be done by using hybrid classifier such as Support Vector Machines with Deep Neural Network as shown in "Fig. 2". After apply these technique on raw ECG signal accuracy, sensitivity and specificity can be measured and evaluated for classification of Electrocardiogram signal.

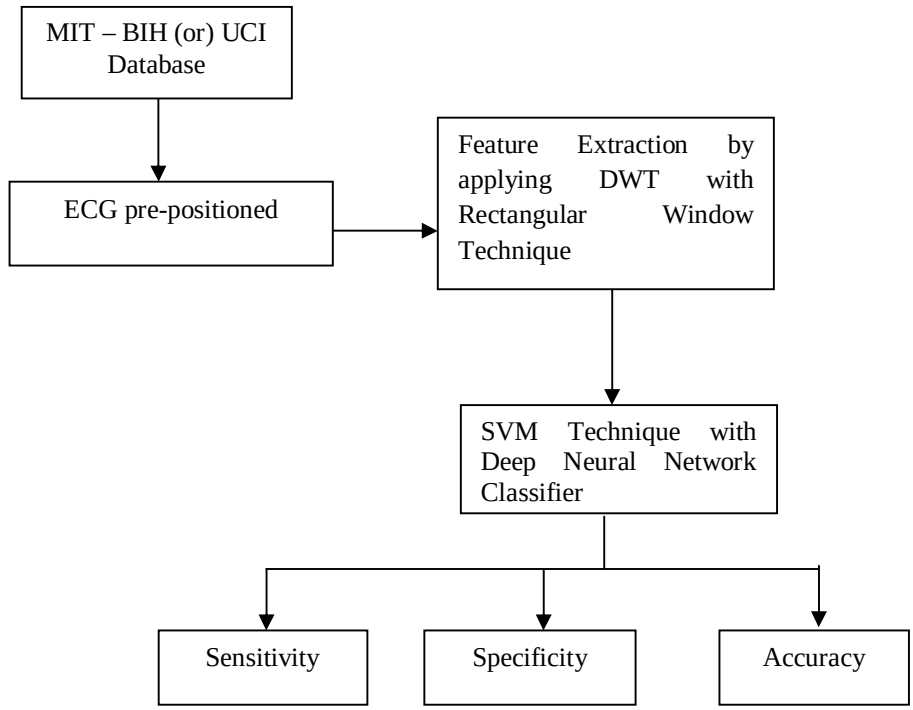

Fig. 2 Steps involved to extract the features and classification of ECG signal.

IV. CONCLUSION

Electrocardiogram signal became an electrical technique to analyse the activity of heart abnormalities, the amplitude of these activity signals varies from person to person. Diagnosis of many cardiac diseases are done by electrocardiogram, This paper presents a survey on different pre-processing technique, classification algorithm and extraction of features from raw ECG signal for accurate diagnosis. From more studies and researches are done to make the utmost possibility of an efficient algorithm to detect diseases at the shortest time. The proposed methods of detection and classification can be improved for easy detection of diseases.

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