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Comparative Study of Tachyarrhythmia ECG and Normal ECG

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***Abstract*—ECG is the electrical activity of heart functioning which is used to diagnosis the heart related diseases. ECG helps to decide whether human is healthy or not. Today most of death happened in the world due to the heart diseases. It is very important to know the accurate information about the heart activity to diagnosis the actual diseases. The data base is taken from the MIT-BIH physionet bank. In this paper the features of tachyarrhythmia ECG and normal ECG are extracted using wavelet transform. After that t-test is used for statically analysis. This study shows that the most of morphological features of tachyarrhythmia ECG has strongly significant changes.**

***Index Terms*—ECG, Tachyarrhythmia, Wavelet transform, Hypothesis test, MITBIH.**

I. Introduction

The electrocardiogram is graph which shows the electrical activity produced by the heart. Electrical activity is due to electrical potential of heart muscles. When the heart rate of human heart is exceeds above the 100 beats per minute that is tachycardia. Tachycardia is also called tachyarrhythmia. In Tachyarrhythmia 'tachy' for increased rate and 'arrhythmia' for changes or irregularities in heart rhythm. This type of heart condition is occurred due to abnormal electrical impulses of heart. Tachyarrhythmia can be diagnosed by an electrocardiogram (ECG). The disturbance of rhythm and patterns of heart rhythm can be observed on monitor [1].

The structural graph of electrocardiogram ECG is widely used to diagnosis the heart disease because of it is low cost and effective procedure [2]. The polarization and depolarization of atria and ventricles generates electrical activity which is reflects in ECG graph. Normal ECG has five prominent points [3]. The Fig 1 shows the ideal waveform and the prominent point of ECG.P wave is small spike occurs due to atrial depolarization. Inter ventricular depolarization relates to Q wave. Ventricular depolarization reflects in R wave which is biggest wave in term of amplitude in ECG signal. Final depolarization of ventricular reflects by the S wave. T wave reflects the re-polarization.

The major symptoms of tachyarrhythmia are increased heart rate and irregular heart rhythms. This type of condition can be occurred due many causes. Super ventricular tachycardia caused narrowing of the QRS complex. Ventricular tachycardia caused wider QRS complex and rapid heart rate. In this paper the morphological features are extracted from tachyarrhythmia ECG and statistically analyze with normal ECG. After analysis result shows the changes in tachyarrhythmia ECG as compared to normal ECG.

II. Database

Database is the most important task for this work. Normal ECG data base is taken from MIT-BIH arrhythmia Database

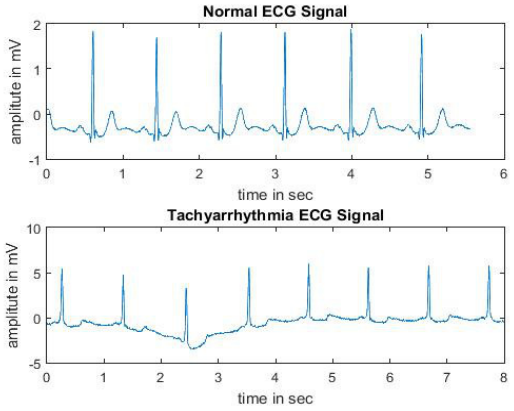

Figure 2: Tachyarrhythmia and Normal ECG signal

directory of ECG signals from physionet [5]. The sampling frequency of this signal is 360Hz and the resolution of signal is 11bit. The tachyarrhythmia ECG is taken from MIT-BIH tachyarrhythmia Database directory of ECG signals from physionet [6]. The sampling frequency of these signals is 250Hz and resolution is 12bit. 10 signals of both databases are used for this purpose. The Fig. 2 shows the normal ECG and tachyarrhythmia ECG signals.

III. METHOD

Fig. 3 shows the process of this work. MIT-BIH phsyionet bank provides raw ECG data. When ECG data is fetched from human body there are low and high frequency noises introduced in ECG. To remove these types of noises high and low pass filters are used. After noise removal features of ECG signals are extracted using wavelet transform. The morphological features are used in this work [7]. For statistical analysis the t-test is used. Result of features is represented as mean and standard deviation (SD). 5% significance level is chosen for two tailed t-test.

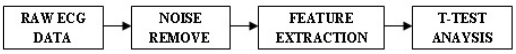

Figure 3: Block Diagram of Process.

A. Preprocessing of Signal

At the time of data acquisition through electrode various type of noises introduce with ECG signal. Power line interference, shot noise, electrode motion artifacts, base line wander, electrocardiography noise(EMG),etc. are various type of noises. Due to these types of noises it is very difficult to extract features of ECG signals. Appropriate filters (LPF, HPF and BPF) are used to remove these noises [8].

B. Wavelet Transform

ECG signals are the mixtures of multiple components of time varying properties. These types of components may have varying duration and overlap one another. Wavelet transform is

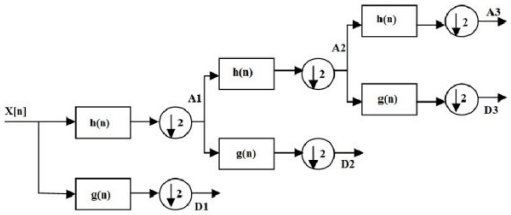

Figure 4: Decomposition of signal using wavelet transform.

used for different purpose in ECG signal processing like noise removing [9], heart rate detection [10] and feature extraction [11]. In this paper wavelet transform is used for morphological feature extraction of ECG signals. Daubechies wavelet of order 8 was used for their simplicity.

Wavelet transform provides both time and frequency domain representation [12]. Decomposition of signal over frequency and translated (time) version of a prototype wavelet provides time and frequency domain signal. A low pass filter and high pass filter is used to decomposed the input signal followed by down sampling in each stage (Fig. 4). First stage high pass filter provides detail coefficient D1 and low pass filter provides the approximation coefficient A1. Fig.5 shows the four level decomposition of ECG signal.

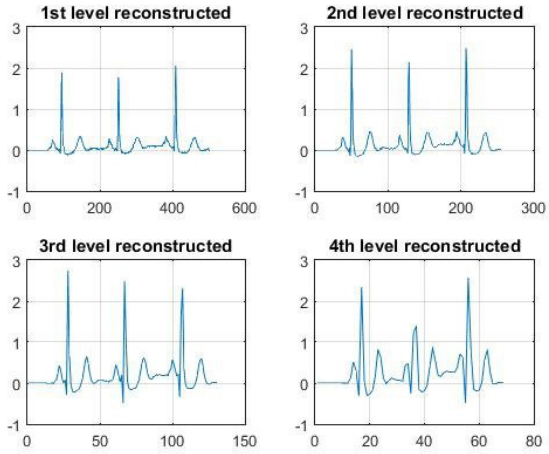

Figure 5: Four level Decomposition of ECG signal using wavelet.

C. Hypothesis test

It is a statistical test which is used to determine in a sample of data to guess for a certain condition is true or not. The Hypothesis test checks two opposing hypothesis about a sample of data, the null hypothesis and the alternative hypothesis. Normal null hypothesis is a `"no effect" statement and alternative Hypothesis is the statement user actually wants to conclude is true. In this work two tail t-tests is used for analysis. t-test formula is

$$t = \frac{\bar{X} - \mu_{H_0}}{\sigma_s/\sqrt{n}} \quad (1)$$

Where

$$\sigma_s = \sqrt{\frac{(X_i - \bar{X})^2}{(n-1)}} \quad (2)$$

Where n is the number of samples, $\bar{X}$ is the mean of samples, μ_{H_0} is the null hypothesis mean and i=1, 2, 3.....n.

IV. RESULT AND DISCUSSION

The statistical test of ECG signal is to test the variation in between tachyarrhythmia and normal signal. Morphological features of ECG are used for this purpose. The statistical

analysis of these features are given in table I. According to result Q wave duration, PR interval, QT Interval, ST Interval, height of RS and QR have strongly significance changes. Slop of RS and QR has moderate significant changes and suggestive significant changes respectively. The result shows that if patient have these types of changes in morphological features it may be possible that he has tachyarrhythmia diseases.

Table I Results of Statistical Analysis

ECG Feature	Normal ECG	Tachyarrhythmia	P value
Q wave (sec)	0.015 ± 0.040	0.066 ± 0.047	$P < 0.01$
S wave (sec)	0.159 ± 0.031	0.119 ± 0.031	$0.01 < P \leq 0.05$
T wave (sec)	0.070 ± 0.045	0.035 ± 0.023	$0.01 < P \leq 0.05$
QR slope (degree)	84.18 ± 4.303	87.428 ± 0.748	$P > 0.1$
RS slope (degree)	-86.49 ± 2.02	-86.37 ± 3.07	$0.01 < P \leq 0.05$
PR Interval (sec)	0.057 ± 0.147	0.120 ± 0.066	$P < 0.01$
QT Interval	0.066 ± 0.053	0.360 ± 0.068	$P < 0.01$
ST Interval (sec)	0.335 ± 0.134	0.063 ± 0.065	$P < 0.01$
Height of QR (mV)	1.330 ± 0.455	4.699 ± 1.200	$P < 0.01$
Height of RS (mV)	1.456 ± 0.441	4.105 ± 1.802	$P < 0.01$

Mean $\pm$ SD (Standard Deviation)
P value: $0.05 < P \leq 0.10$ =suggestive significant
P value: $0.01 < P \leq 0.05$ =moderately significant
P value: $P \leq 0.01$ =strongly significant

Tachyarrhythmia patient have higher number of beats in a minute as compared to normal person. It can be prove in results that the duration of wave decreased in tachyarrhythmia ECG with respect to normal ECG that is repetition of ECG wave is increased. This results RR interval will be decreased. This decreased duration raised the heart rate of human because the heart rate defines 60/RR Interval (in sec).

V. Conclusion

The statistical analysis of morphological features shows that six features have strongly significant changes and rest of four has either moderate or suggestive changes. The PR, QT and ST interval, Height of QR and RS have significant changes. The duration of waves (Q, S and T) have either moderate or significant changes. These results define that the major difference in between tachyarrhythmia and normal ECG is occurred in time domain. Another point in these results that the height of QRS complex is also affected in tachyarrhythmia ECG that is the depolarization of ventricular is not functioning properly. These results can help doctor to classify the tachyarrhythmia from other type of diseases at the time of diagnosis.

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