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Rectifier Acoustical Cardiac Activity Detection Analysis of ECG Signal

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ABSTRACT- Skilled cardiologists follow a series of steps to recognize the heartbeats of a patient. But it is a very difficult task to tune to particular frequencies for a doctor. So, in this manuscript, it is sorted into two series MIT-BIH data set steps for processing the heartbeat of a person without noise from a respiratory system to save a person from false detection of heart diseases. So, we expect our work is useful for researchers, educators, physicians. If the speed of the heart is faster or slower than it is said to be it is called an abnormality. Sudden cardiac death may also be attained due to false detection of a heartbeat. So, the early detection of this heartbeat is necessary to save the life of the patients. So, the algorithm proposed in this paper is useful in removing unnecessary sounds by surroundings and the overall mortality rate due to heart diseases can be reduced.

Keywords: Heartbeat, Phonocardiogram, Electrocardiogram, Heart rate variability, Noise.

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1. INTRODUCTION

Now a day's cardiac problems are very much common to even-aged, adults and even children due to increased levels of stress. The first stage to escape from this problem is a physical examination by doctors. Most doctors take several years for mastering in perfect detection of disorders of the heart [1-3]. It is even difficult for senior surgeons to estimate the disorder by a simple stethoscope. The period of a normal heartbeat is 30 ms. The characteristics of ECG signal indicating the cardiac disorder is a great deal quieter than others. ECG signal characteristics are shown in *Figure 1* taken from the MIT-BIH database [4-6]. Skilled cardiologists were also confused during this observation because of noise from surroundings. It is important to tune to frequencies of heart sounds to get a perfect diagnosis. Signal processing plays a major role in this medical diagnosis. For newborn babies, it is essential for recognizing holes in ventricles which may cause different heart sounds called murmur. Detection of a murmur by stethoscope is difficult due to human errors [7,8]. In this speech processing plays an important role i.e.., processing of recorded signals can estimate well than humans by computers. This is also called Phonocardiography. Phonocardiography requires more knowledge and time. Here introduced a Graphical User Interface (GUI) called MATLAB to measure the diameter of the hole in the heart. The heart has four chambers upper - atria, lower-ventricles [9-11].

ECG signal detection is related to cardiac activity. It is detected with two approaches first one traditional detection method which detected the ECG by stethoscope approach. The auditory stethoscope approaches are operated by the sound transmission from the heart of the patients [12-16]. It is air-filled tubes in hollow shapes to the ears of the listeners. If the diaphragm is positioned on the patient's body the sound vibrates the diaphragms, created the acoustic pressure wave that is traveling up to the tubing of the listener's ear. It is shown in *Figure 2*.

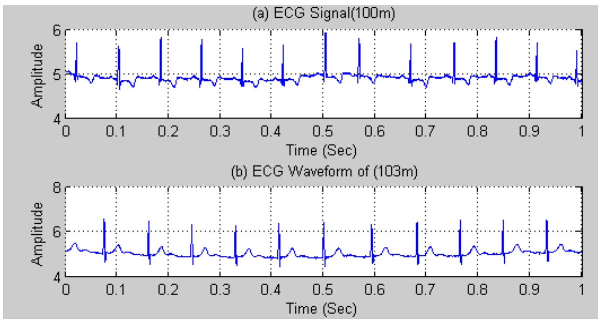

Figure 1: Characteristic of ECG signal (a) ECG signal MIT-BIH (100m database) (b) ECG signal MIT-BIH (103m database)

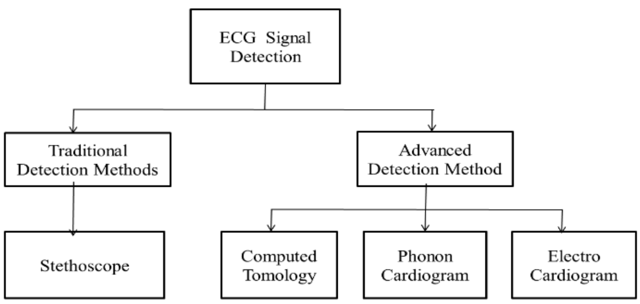

Figure 2: Overview of different Heart Beat measurement techniques

Heart muscles squeeze blood from different organs. The valve of the heart completely opens or completely closes when blood comes and goes out of the heart. But due to Stenosis valve does not close completely or opens completely [6]. Now a day's Magnetic Resonance Imaging (MRI) is mainly used to imaging internal organs. MRI scans can detect only some locations in the heart. This drawback of MRI can be overcome by compressed sensing whose basic principle Signal is processing. One of the mainstream significant processor's gesture dispensations in the authentic moment is the TMS-320C6713 because it is dedicated to the meting out of acoustic signal. In the US nearly 23, a million people have been suffering from cardiac disorders, many of them were dying due to improper identification of disorders [9]. It is nearly 80% of people referred to cardiologists were dying due to cardiac diseases. It is essential to do more researches on cardiac detection to avoid the mortality rate getting higher in the future due to cardiac diseases [10]. This paper provides detection and analysis of ECG signal. This paper comprises of five different subsections apart from introduction. In *Section II*, detailed analysis of related work has been studied. In *Section III*, different ECC signal have been provided and results analysis has been given in *Section IV*. *Section V* concludes the paper.

2. RELATED WORK FOR ACOUSTICAL CARDIAC ACITIVITY

In 1988 Mokrane et al. discussed the detection and measurement of inter cardiac signals in an electrophysiology laboratory on a display screen. This is mainly using the Kalman filter method to detect waveforms of cardiac signals [2]. A new method for early-stage detection is sudden cardiac death. From other methods like k-NN, SVM, MLP, etc. It had been failed due to false reports of SCD. So, in this author invented a new method for SCD i.e., heart rate variability analysis. In 2000 explained how Computed Topology (CT) overcomes the drawback of x-rays during the motion of an object x-ray get clumsy so the chance for perfect diagnosis has been reducing. So adaptive interference cancellation algorithms are used to accurate for organ-motion artifact [2]. In 2001 had explained about avoiding the difficulty of the low declaration of fixed Kernel time and frequency domains analysis had not been detecting murmurs in the heart. This is proposed adaptive cone-Kernel distribution to overcome this problem [3], [9].

In 2004 presented a system on chip for real-time monitoring of abnormal rhythms of the heartbeat of a patient. Bertelli in his paper proposed an idea that each sound of phonon cardiogram has different characteristics by proper frequency analysis of these signals. It can act as biometric identification of an individual's [4]. It is developed an intelligent event-driven electrocardiogram. This event-driven cardiogram is an automatic diagnostic device that is used to automatically recognize the irregular heartbeat of a person and this device has high SNR [5], [10].

3. ECG SINGAL FOR ACOUSTICAL CARDIAC ACTIVITY

Acoustic cardiac activity measurements by ECG signal are divided into different segments. These segments are shown in figure 3. Interval segmentation: Initially the given ECG signal is divided into various stages because pathological alignments may have similar shapes [11]. So, we divide that signal into systolic and diastolic. The given an ECG signal $1 \leq n \leq N$ with an amplitude of threshold 'θ'' is resolute such that

$$\theta = 0.4 \times \max_{n}(|X[n]|) \quad (1)$$

The ECG data is after that rectify and short to combine

$$X[n] = \begin{cases} |X[n]|, X[n] \geq 0 \\ 0, X[n] < 0 \end{cases} \quad (2)$$

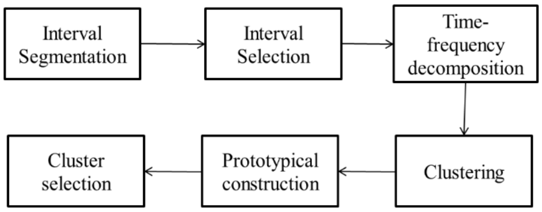

Figure 3: Modular representation of auscultation adopted by the framework

3.1 Interval Section

The given ECG signal is added with noise components along with the original component. So, it is essential to suppress the noise components and select intervals having signal components. This step is mainly used to display the presence of heart disease consisting intervals. I_{qr}a measured as interval selection of peak duration of ECG signal [12].

$$I_{QRS} = 1.00\left(\frac{T_{QRS}}{T_S}\right) \quad (3)$$

3.2 Time-frequency decomposition

Cardiac disorder is connected to vacuolar diseases and stenos are identified by amplitude variations. When the systole of the heart is more the amplitude of the signal is more [13]. As we know that frequency increases with an increase in amplitude. So here use of a small window to cut off signal discontinuities and a long window to acquire comprehensive frequency investigation of gross features.

$$C_i(S, P) = \sum_{n=1}^{N} x_i \psi\left[\frac{n-p}{s}\right] \quad (4)$$

3.3 Clustering

Depending on the nature of the disorder some heartbeats are audible some are not audible. So, eradicate this problem we usually combine a set of group intervals. This projected method for ECG detection used the common entrance collection technique. At this peak, the importance of entrance (t) is calculated as:

$$t = \sigma\sqrt{\frac{2\log(N)}{N}} \quad (5)$$

3.4 Cluster Selection

To reduce the number of clusters, discard the cluster that does not contain a sufficient number of intervals [14]. So here discarded the group of clusters into a single cluster. Here

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discussed 'α' and 'β' are districted as an invariable parameter, 'Pi' is the sample index of 'i_{th}' recognized R-wave.

$$\left(\frac{P_{i-1} + P_i}{2}\right) \leq x \leq \left(\frac{P_i + P_{i+1}}{2}\right) \tag{6}$$

4. EVALUATION, RESULT AND DISCUSSION

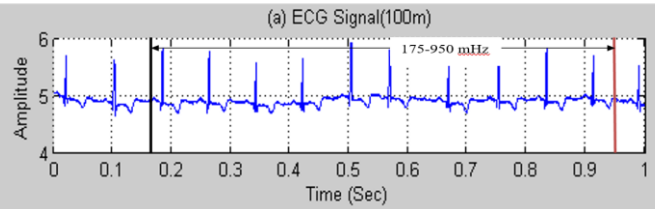
To appraise the staging of this proposed work in ECG cardiac activity. The 'R' peak recognition method is used. Here required the three different parameters. That is namely false positive (FP), false negative (FN), true positive (TP) from the detected 'R' peak. Here defined the TP is the numbers of appropriately detected 'R' peaks. FN is the number of miss 'R' peaks. The FP is the number of noisy spikes as well as wrongly distinguishes as 'R' peaks. Accuracy (ACC), detection error rate (DER), positive predictability (+P), and sensitivity (Se) can be calculated by using FP, FN, TP with the subsequent equations correspondingly.

$$Acc = \frac{TP}{TP + FP + FN} * 100 \tag{7}$$

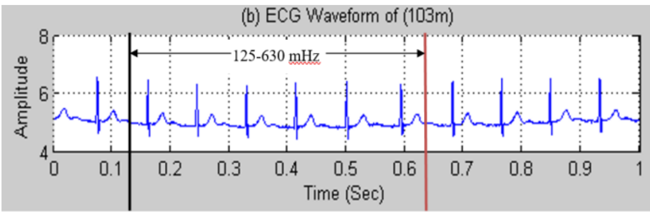
$$DER = \frac{FP + FN}{TP} * 100 \tag{8}$$

$$+P = \frac{TP}{TP + FP} * 100 \tag{9}$$

$$Se = \frac{TP}{TP + FN} * 100 \tag{10}$$



(a)



(b)

Figure 4: Distinguishing of ECG and acoustical cardiac activity is shown (a) Involuntarily interpret ECG characteristics of 100m signal (b) Involuntarily interpret ECG characteristics of 103m signal

In this study, the given systolic signal is passed through interval segmentation and given a threshold value at 70% threshold value the number of false-negative peaks is more i.e., 5. As we reduce the threshold to 26%the number of false negatives decreases. And coming to false positives, at 70% threshold value false positives decreased. At 26% false positives increased.

Table 1: False positive and false negatives for an ECG acoustic cardiac activity human in Figure 4 (a) and (b)

S. No.	Threshold percentage	False negatives	False positives
1	50%	3/11	7/28
2	26%	1/11	13/28
3	70%	5/11	3/28

Table 2: Result of changeable threshold parameter having heart-related disease

Table	Threshold	Cardiologists	Automated classifier
1	50%	3/6	1/6
2	26%	2/6	1/6

The above *table* shows that human errors for detection of heart rate are more when compared to the automated classifier, for every threshold percentage value. Also, for reduction of noise bandpass filter does not reduces the complete combination of lung and heart sounds but computing prototypical systoles can reduce the interference of lung, heart sounds, and surrounding sounds well and gives high SNR.

5. CONCLUSION

The proposed work in this manuscript was experienced using the MIT-BIH arrhythmia database. Here analyzes the classification presentation for accuracy, detection error rate, positive predictability, and sensitivity. Here compares the projected approach with the threshold method to validate the better evolution result as used in this experimental result. The clustering and Interval selection help to moderate the difficulty of difference transversely in beats. Intermission assortment preferential admit sections of the acoustic analysis. Where ECG heart signals were outstanding performance using cardiac activity. An additional solution as the involvement of this footstep was deal utilizing sound such as respiratory artifacts. This may distance the similar frequency engaged by unhealthy sound and cannot forever be detached using the usual bandpass filter. In the future work, would similar to be appropriate investigation technique to detect new peaks point in ECG signal. Detecting dissimilar type of peak in ECG signal determination offer additional helpful information for diagnosing and create a large number of associated applications.

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