Distinguishing Normal and Abnormal ECG Signal

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Abstract

The problem of the heart are normally monitored by ECG. ECG waveform comes in the slope of P-Q-R-Spattern. Q-R-S is the most critical part of the waveform. In this study of ECG signals and examination of different conditions, two must required parameters are Q-R-S duration and heart rate. Abnormal condition results in artificial arrhythmia in which there will be a remarkable change in these parameters. The aim of this work is to determine whether arrhythmia exist are not. Extraction of Q-R-S complex is done by Pan–Tompkins algorithm. ECG signal is made to pass through a LPF and HPF filters. There the signal is made to pass through derivation squaring, integration to compare it with a set of slopes case of abnormality are studied. Thus, the method serves as easy technique for studying cardiac abnormality.

Keywords: Abnormal, ECG Signals, High Pass Filter, Low Pass Filter, R-R Intervals, Q-R-S Pattern

1. Introduction

The ECG tool plays a vital role in diagnosing and treatment of several diseases related to cardiac. Doctors can provide the important information about status of disease and condition of patient by studying the ECG signals generated by heart. ECG[1] signal consists of   components like segments, intervals, and waves are studied and evaluated based on the size, and duration time. Cardiac rhythm type is determined by studying these different components. Abnormal rhythm of the heart called arrhythmia (or dysrhythmia) is indicated when above mentioned components vary with expected norm. The extraction of QRS[2] complex from the ECG signal is done with the help of well known Pan – Tompkins algorithm. The procedure followed is ECG signal is made to pass through a low-pass filter and then through high-pass filter for removing noise from ECG signal. Then the noise removed signal is made to pass through the derivative, squaring, integration and decision makingcircuitsresulting in QRS complex of ECG signal[3].

2. Significance of QRS Complex

The letters P, Q, R, S, T are used to represent the peaks and valleys of the ECG wave form and in few instants another peak labelled U is also used. The heart upper chambers activation is represented by the P-wave, while the heart lower chamber activation is represented by the T-wave[4] and QRS complex. The QRS complex does a vital role in identifying the problems that occur with the functioning of heart. An extensive study of ECG signal which includes heart rate QRS duration and ST segment etc., is done after the identification of QRS complex.

The high frequency components in ECG signal constitutes QRS complex. If the ventricles work properly, then the duration of QRS complex will. If there are any

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problems associated with the heart, then the QRS complex lengthens or widened or becomes shorter. If there is more muscle mass in the ventricles of atria, then QRS[5] complex will be larger when compared with the P wave. Figure 1 Shows the QRS complex.
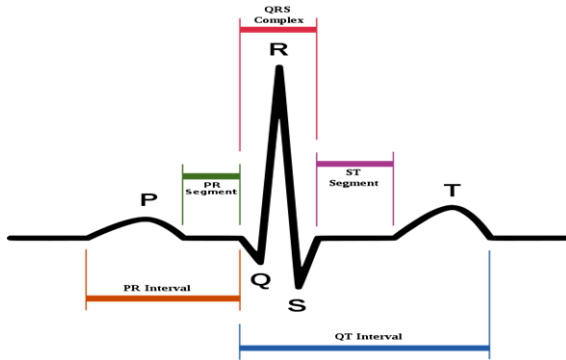

Figure 1. QRS complex of ECG signal.

3. Parameters

The parameters used for the analysis of the QRS complex are QRS duration[6], R-R interval and heart rate of the signals. These parameters are described below.

QRS duration: The duration of QRS complex of ECG is found by dividing the number of samples between the QRS complex and the sampling frequency of the signal[7]. By knowing this duration, we can know whether the signal is abnormal or normal[8]. As per the standards, the standard QRS duration of a normal ECG signal will rangefrom 0.06 to 0.10 seconds.

R-R interval: R-peak is the longest amplitude peak in ECG signal. The R-R interval is calculated by dividing number of samples between two R peaks and sampling frequency of the signal. It plays a vital role in finding abnormalities of a signal[9,10].

Heart rate: Heart rate can be measured by using the formulae shown in Equation (1).
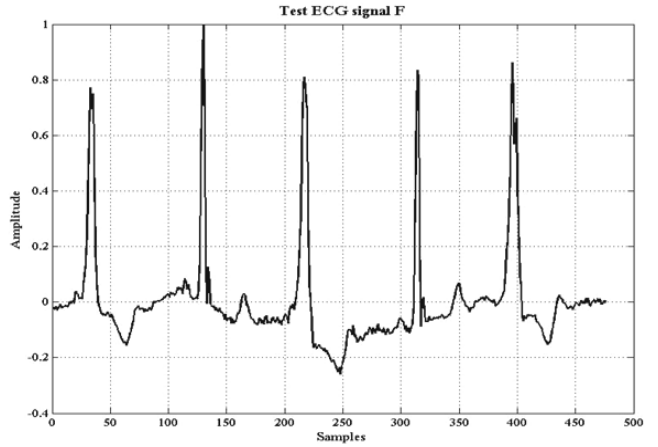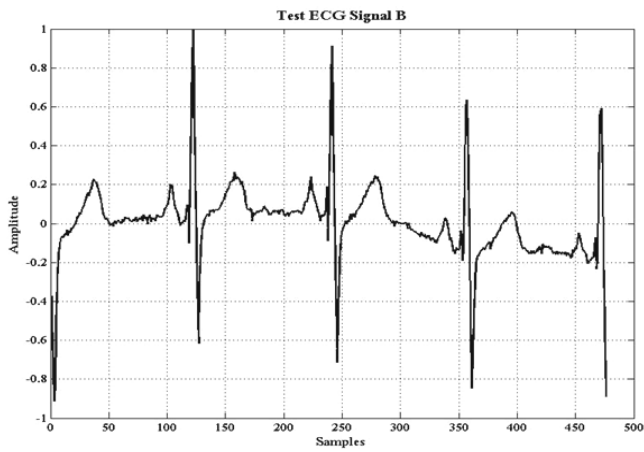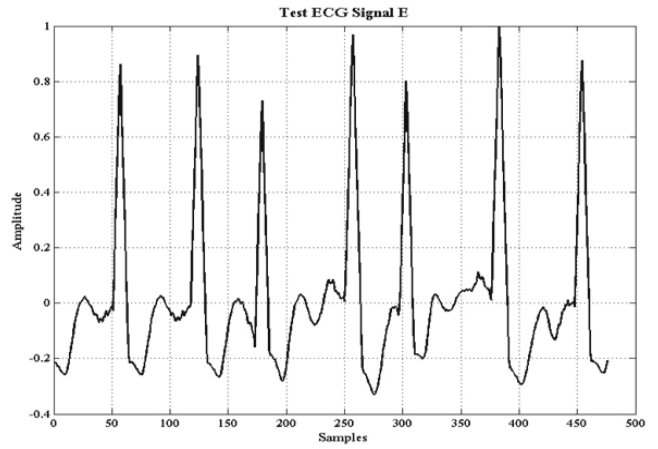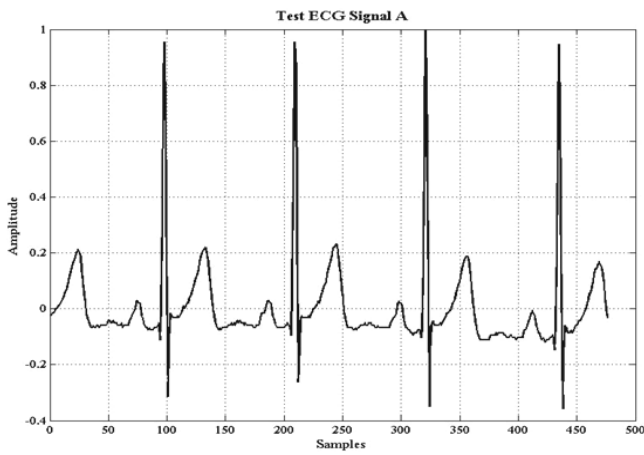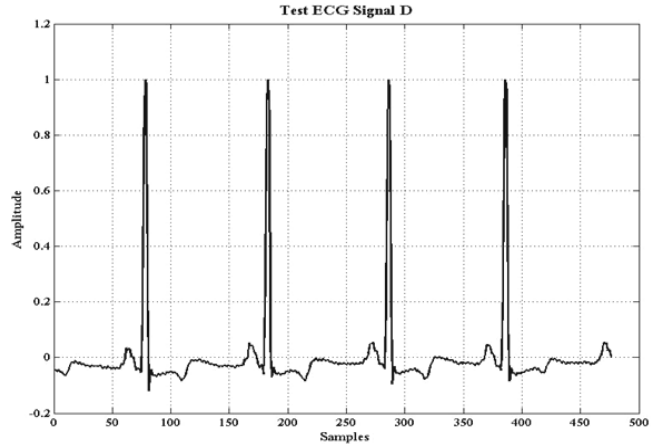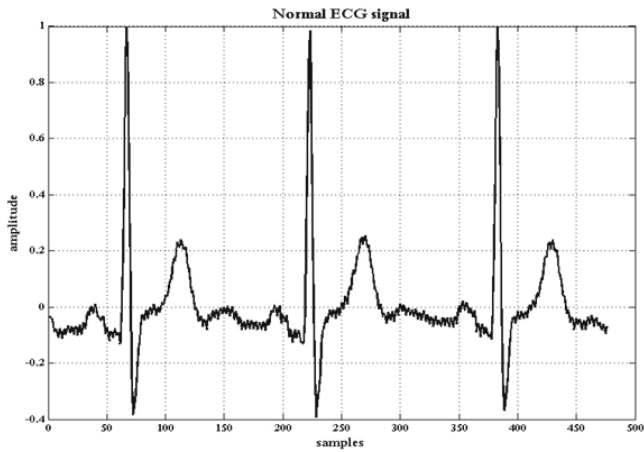
Heart rate=60 /RR interval in seconds (1)

A healthy person's average rate of heart beat is 72 beats per minute. For a normal person, it will be in between 70–80 beats per minute. In a normal sinus rhythm, bradycardia means a resting heart rate of below 60 bpm and tachycardia will have a heart rate above 90 bpm.

4. Simulation and Results

The simulations are performed and the results are explored in MATLAB®7.8. The test signals are taken from the arrhythmia database of MIT-BIH. The normal ECG signals and input test signals are shown in Figure 2. The plot showing the comparison of the QRS complexes of each test ECG signal with that of normal ECG signal is shown in the Figure 3. The QRS complex duration, RR intervals and heart rates of these signals are measured and are tabulated in the Table 1.

Table 1. Values of QRS complex duration, RR intervals and heart rates of test and normal ECG signals

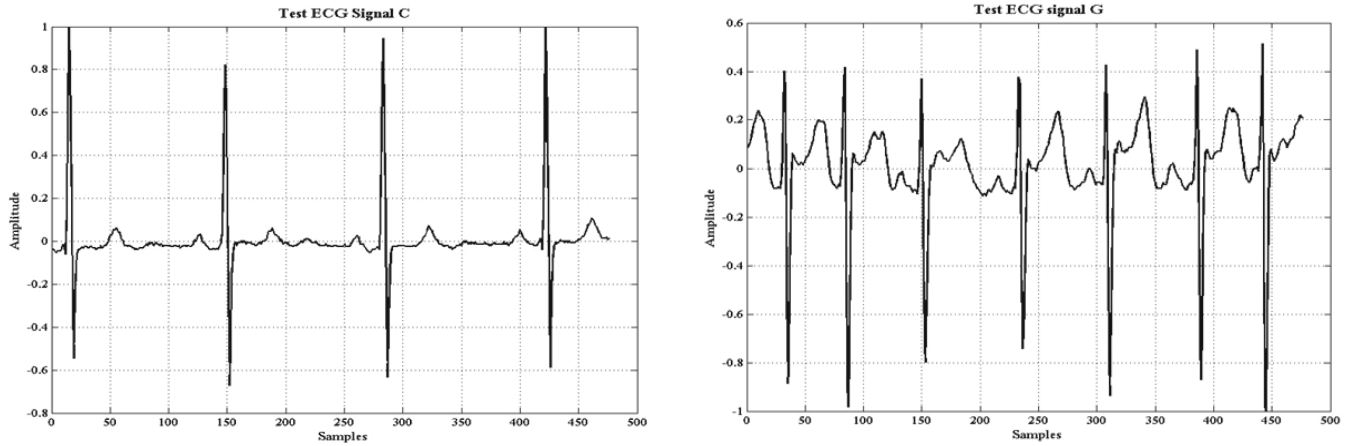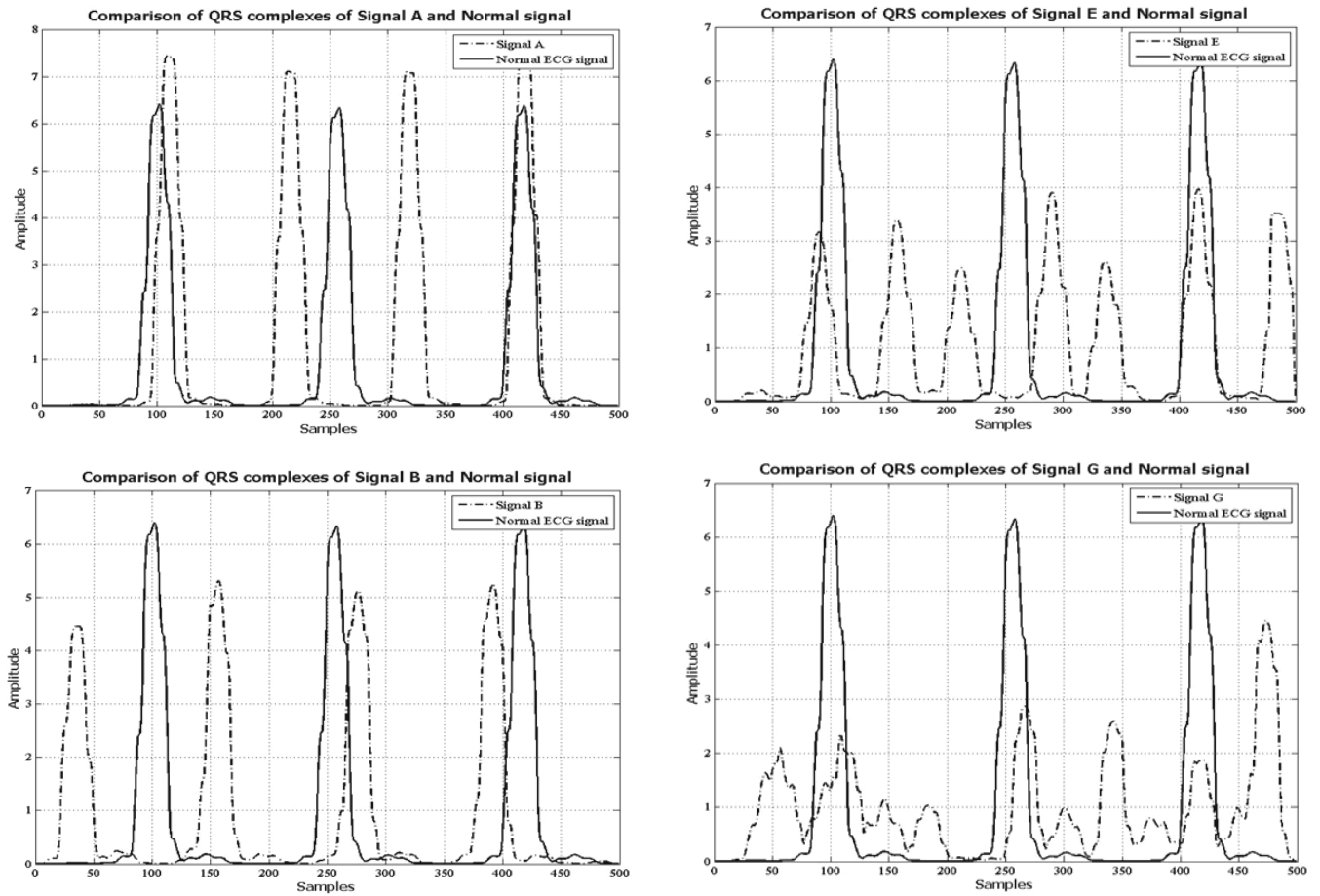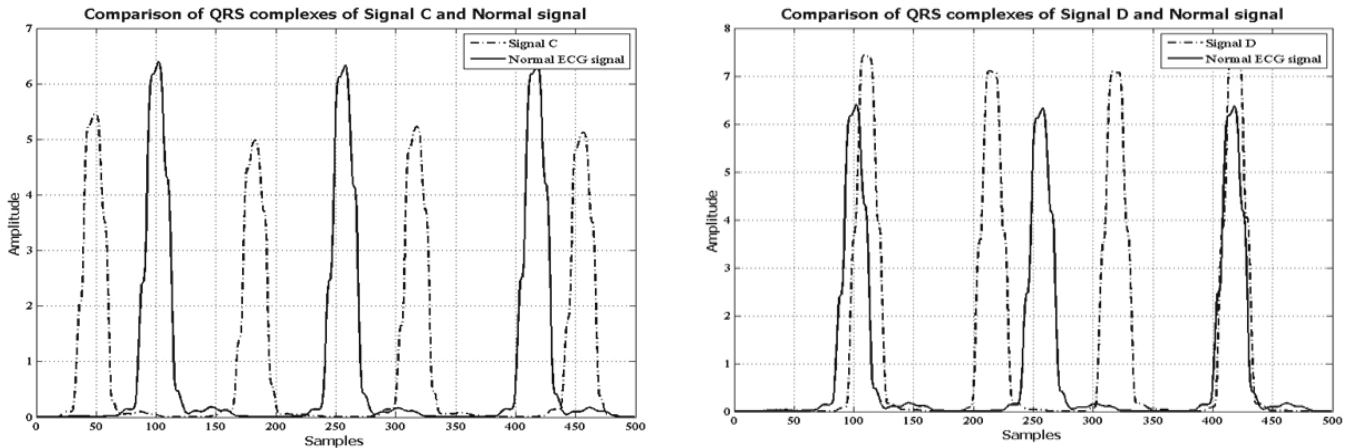| Signal	RR interval (seconds)	Heart rate (beats/min)	QRS duration (seconds)	Condition
Normal signal	0.791	75.84	0.094	STANDARD
Signal A	0.877	68.41	0.093	NORMAL
Signal B	0.911	65.83	0.088	NORMAL
Signal C	1.059	56.65	0.238	ABNORMAL
Signal D	0.80	75.00	0.080	NORMAL
Signal E	0.516	116.07	0.197	ABNORMAL
Signal F	0.78	76.90	0.083	NORMAL
Signal G	0.45	133.33	0.162	ABNORMAL

Figure 2. Input ECG signals.

Figure 3. Plots showing the QRS complexes of test and normal ECG signals.

5. Conclusion

This paper presents the comparison of parameters like QRS complex duration, RR intervals and heart rates of seven different ECG signals with those of normal ECG signal. The signals with heart rates outside the range of 60–100 beats per minute and QRS durations outside the range of 0.08 sec to 0.12 sec are considered as abnormal signals. The ECG signals with heart rates and QRS durations within the range are considered as normal signals. Thus it can be concluded that the analysis of QRS complex of an ECG signal does a vital role in identifying the physical condition of the heart.

6. References

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