Analysis of Prolonged Interval of PR Segment for First AV Blockage

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Abstract: Electrocardiogram (ECG) is a graphic recording of the electrical activity produced by the heart. ECG signals have a wide array of applications whether the heart is functioning properly or suffering from any abnormalities. ECG analysis is the gold standard for the evaluation of cardiac arrhythmias. Data obtained from ECG signals provides invaluable tools for diagnosing cardiac disorders. However, ECG signals recorded from electrocardiograph are usually corrupted by noise attributed to several factors. The objective is to analyze accurately an ECG signal is especially important for feature extraction of the ECG signals and to locate the interested characteristic points that can be used to detect possible cardiovascular abnormalities. To solve these problems, we develop a simple but inexpensive and easy to implement MATLAB model that generates ECG signals and gives us mathematical control over the ECG signal.

Index terms: ECG, MATLAB

I. INTRODUCTION

Electotrocardiogram (ECG) is a diagnosis tool that reported the electrical activity of heart recorded by skin electrode. The morphology and heart rate reflects the cardiac heath of human heart beat. It is a non-invasive technique that means this signal is measured on the surface of human body, which is used in identification of the heart diseases. Any disorder of heart rate or rhythm, or change in the morphological pattern, is an indication of cardiac arrhythmia, which could be detected by analysis of the recorded ECG waveform. The amplitude and duration of the P-QRS-T wave contains useful information about the nature of disease afflicting the heart. The electrical wave is due to depolarization and re polarization of Na+ and k-ions in the blood. The ECG signal provides the following information of a human heart.

A typical ECG signal shows the oscillations between cardiac contractions (systole) and relaxations (diastole) states as reflected in a heart rate (HR)[1]. Thus the ECG signal determines the number of heart beats per minute. A number of important events characterize cardiac functions. Atrial and ventricular depolarization/re-polarization takes place for each heartbeat. The cardiac cycle is associated with portions of the heart becoming positively charged, while the remaining parts become negatively charged interchangeably. This potential difference generated initiates the flow of current.

II. ECG DESCRIPTION

A typical ECG signal depicts a series of waveforms which occur in a repetitive order. The waveforms are initiated from the isometric line, from which a deflection indicates electrical activity. One normal heart beat is represented by a set of three recognizable waveforms that start with the P-wave, followed by the QRS complex and ends with the T-wave. The relatively small P-wave is initiated by the **depolarization** of the atrial muscles and is related to their contraction. The large QRS-wave complex, made up of three waves, is caused by the **depolarization** of the ventricles and is connected to their contraction. Atrial re-polarization happens during the depolarization of the ventricles but its weak signal is undetected on an ECG. The T-wave is caused by currents flowing during the **repolarization** of the ventricles. A normal cardiac cycle of an individual at rest consisting of all waveforms (from P −T waves) spans 0.8 seconds.

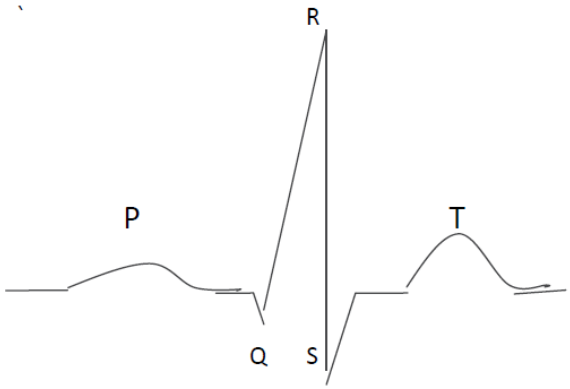


Fig: ECG waveform

III. ECG INTERPRETATION

ECG waveform used for diagnosing various diseases by analyzing variation in different individual waves and segments of ECG waveform. ECG waveform consists of small individual waves deviation in them from standardized values indicated the improper functioning of heart [6]. It is decomposed into P, QRS complex, T waves. It is interpreted as the following:

1. Heart Rate
2. Rthym

Heart Rate:

- calculated from R-R interval ,also known as HRV analysis[1,8,9]
- 300/(# no of large boxes)
- 1500/ (# no of small boxes)
- Bradycardia (less than 60 bpm)
- Tachycardia (more than 100bpm)

Rhythm:

1. P interval

- First short upward movement of ECG tracing
- Indicates artia is contracting
- Pumping blood into ventricles
- Duration is 0.11s

2. QRS complex

- Normally beginning with a downward deflection Q, a larger upward reflection R and downward S.
- Duration 0.09s
- Indicates ventricular depolarization and contraction

3. PR segment

- Indicates transit time for electrical signal to travel from sinus node to ventricles
- Duration 0.12 to 0.20 s

4. ST segment

- Modest upward waveform
- Representing ventricular repolarization
- Duration 0.05-0.15 s

IV. ECG GENERATION

The ECG signal can be synthetically generated using MATLAB [2,7]. In MATLAB, there is a data acquisition toolbox which provides blocks for acquiring live data and for outputting live signals to the physical hardware.

Generally the recorded ECG signal is often contaminated by noise. Such signals are usually vitiated by several sources of noise which include [3]:

(i) electrical interference from surrounding equipment (e.g. effect of the electrical mains supply)

(ii) measurement (or electrode contact) noise

(iii) electromyographic (muscle contraction)

(iv) movement artifacts

(v) baseline drift and respiratory artifacts

(vi) Instrumentation noise (such as artifacts from the analogue to digital conversion process).

In order to eliminate the problem of noise generated while generating the ECG signal is removed by using three coupled differential equations [1].

Mc Sharry and Clifford captured the spectral characteristics of beat to beat RR intervals including the oscillations in the RR intervals

V. PROPOSED WORK

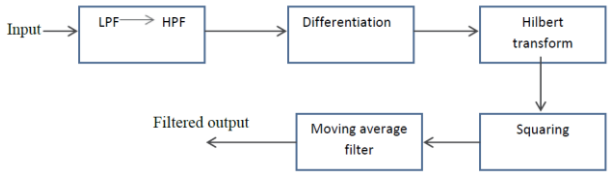
Analyzing PR segment: Since for last 30 years the research has been done on QRS complex of ECG signal whereas PR segment is helpful in diagnosing the first AV blockage at the initial stage. The changes in the duration of PR segment concludes the improper functioning of heart. It might be greater than or less than the standard duration of PR segment. If it is less than the standard duration, then it is not so much dangerous but if it is greater than the predefined PR interval then it indicates the first AV blockage.

Using wavelet transforms: Various algorithms and techniques has been used for pre signal processing and feature extraction of the ECG signal. But due to some limitations, a new approach is used for ECG signal processing that is wavelet transformations [10,11].

VI. ECG SIGNAL PROCESSING

It is divided into two stages: preprocessing and feature extraction [5]. The preprocessing includes removing noise from raw ECG signal and the feature extraction includes extracts diagnostic information from ECG signal.

Preprocessing of ECG signals involves various stages. The "Pan and Tompkins detection " algorithm identifies the QRS complexes based upon digital analysis of slope, amplitude and width of the ECG data[4]



Feature extraction involves extraction of diagnostic information to be extracted from ECG signal for determining the functioning of the heart. The preprocessed signal is inputted to feature extraction part for analyzing the resulted output signal

VII. RESULT

The output ECG signal waveform generated using MATLAB for 10 seconds for a number of heart rats of a resting individual with a peak voltage of 1.2mV. Heart rate in a regular rhythm is usually between 60 and 100 that is when the signal to noise ratio is usually quite good in a person at rest.

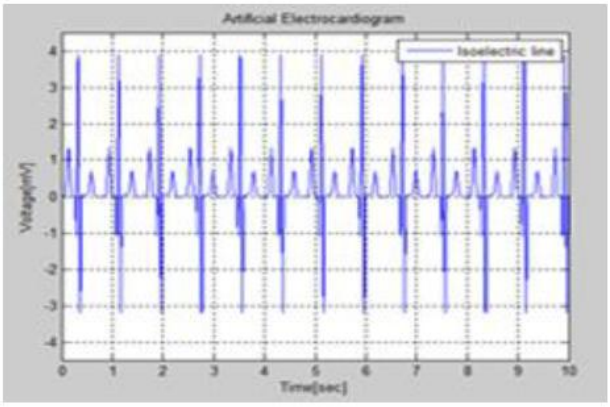


Fig: ECG waveform

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