Real Time Arrhythmic Detector & Analysis Using Lab VIEW

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Abstract: *Arrhythmia is non regular rhythm of the heartbeat. During Arrhythmia, the heart can either beat; too fast (Tachycardia), too slow (Bradycardia), or with an irregular rhythm. It is a case in which heart loses its natural rhythm of synchronous beating, which is both, painful and fatal at times. A simple device used as a training system for medical staff to treat patients in a better way is made. The purpose of this study is to construct a basic arrhythmia detector, considering ECG waveform coming from database that can detect and identify different types of basic arrhythmias. Comparison and analysis of the standard normal ECG pattern with abnormal ECG pattern (input from patient) is done, to detect different types of Arrhythmias. In this work, Lab VIEW is used as a tool for modelling and analysis. The system also has features of monitoring transmitting as well as limits setting for certain parameters.*

Keywords: Arrhythmia, Atrial Flutter, Atrial Fibrillation, Bradycardia,, Tachycardia, Ventricular Fibrillation.

1. Introduction

The heart is one of the vital organs of the human body. It is very important and necessary to diagnose and treat any diseases or malfunctioning related to the heart. Some disorders may lead to a normal lifestyle, while some may be fatal. Thus, it is necessary to study the anatomical functionality and all other available parameters related to the heart. In this project we will consider "Arrhythmia", a term used for malfunctioning and irregular rhythm of the heart. Arrhythmia is related to the "electrical conduction of heart" and which can be classified based on their origin. Heart beats are started by a small electric current that is in the mill volt range. This tiny electric pulse spreads rapidly throughout the heart and makes the heart beat. The electric wave in a heartbeat is initiated at the top of the heart, Sino-Atria node (SA Node). Because of the heart muscle cell's ability to spread its electric charge to adjacent heart muscle cells, this initial wave will be enough to start a chain reaction. The electrical impulse moves in a wave from SA node to AV node, then bundle of hiss and ends in purkinje fibres. If there was just one impulse there would be no pumping action [1].
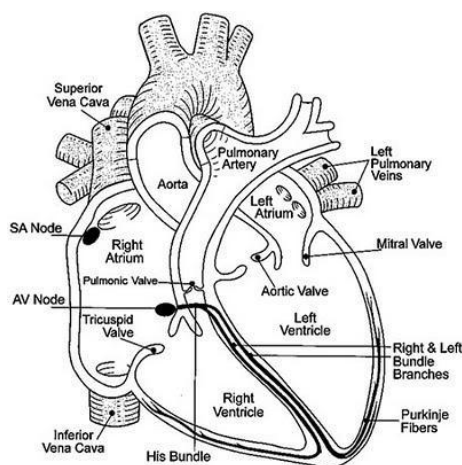
1.1 Electrocardiogram

The electrocardiogram (ECG) is a diagnostic tool that is routinely used to assess the electrical and muscular functions of the heart. The heart is a two stage electrical pump and the heart's electrical activity can be measured by electrodes placed on the skin. The electrocardiogram can measure the rate and rhythm of the heartbeat, as well as provide indirect evidence of blood flow to the heart muscle. A standardized system has been developed for the electrode placement for a routine ECG [2].

1) **P wave** - coincides with the spread of electrical activity over the atria and the beginning of its contraction at the top of the heart pushing blood in the ventricles.

2) **QRS complex** - coincides with the spread of electrical activity over the ventricles and the beginning of its contraction- the spread of the electrical signal through the lower ventricles causing the pumping action

3) **T wave** - coincides with the recovery phase of the ventricles-while the heart muscles are relaxing and preparing for their next contraction [2].
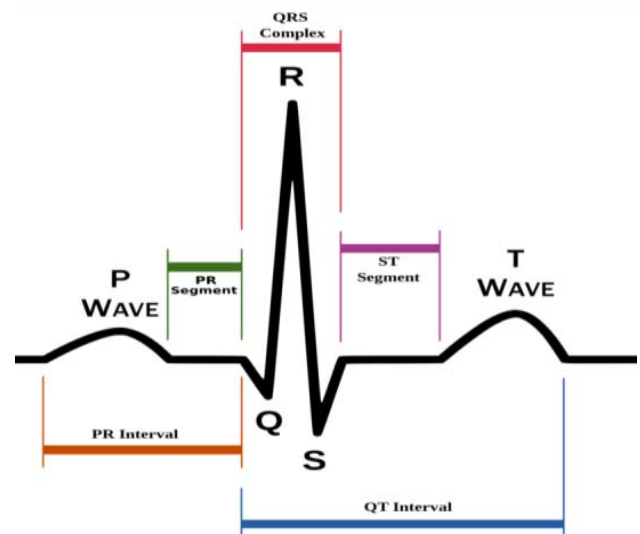

Figure 1: Cardiovascular System

Figure 2: Electrocardiograph

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Table 1: Normal Range of ECG

Parameters	Normal Range (ms)
PR Interval	120-200
QS Complex	<120
QT Interval	<400
RR Interval	600-1500

1.2 Arrhythmia

The term "arrhythmia" can describe a wide variety of conditions in which there is abnormal electrical activity in the heart. Many people who are affected do not know that they have an arrhythmic condition and are able to go into old age because it is passive. However, some arrhythmic conditions are life-threatening. Arrhythmias can be classified as to where they begin (the atria, AV node, or the ventricles). Those that do not originate from the ventricles are called supra ventricular arrhythmias while those that come from the ventricles are called ventricle arrhythmias [3].

Arrhythmia is a condition of abnormal electrical activity of heart. Some arrhythmias are lethal while the other basic arrhythmias are just painful. The basic arrhythmias which are detected by this model are:
Bradycardia-Condition when Heart Rate falls below 60.
Tachycardia- Condition when Heart Rate increases above 100 [4].

2. Implementation Scheme

2.1 Detection Parameter

Peak detection finding the location and duration of the peak signal [5],
- Detection of R wave was the first step. The R wave peak was detect by finding the point greater than the point previous and next with the threshold greater than 0.4 milli volts for ensure that it is not P wave or T wave. [6, 7].
- The midpoint between two R waves was used to be the reference.
- The Q wave defines as a lowest point between the R wave and the reference point before that R wave.
- The S wave was defining as a lowest point between the R wave and the reference point after that R wave.
- P wave was detected like detection of R wave. Finding the point greater than the point previous and next but that point have to between the reference point and Q wave.
- T wave is the highest point between the S wave and the next midpoint.

When all necessary parameter were detect the program compute the interval and collect all parameter for the classifying of arrhythmia.
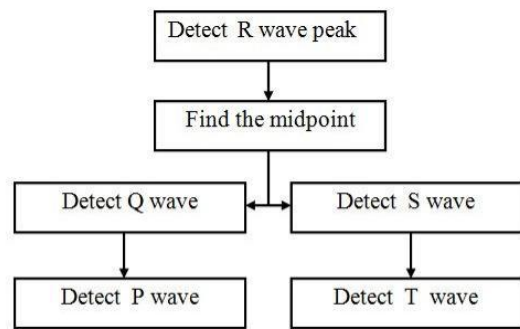

Figure 3: Flow Chart of Peak Detections

2.2 Basis for classification of Arrhythmia

The five basic steps for classifying arrhythmias were applied with Lab VIEW [8, 9].
1) Rhythm: Regular rhythm or irregular rhythm was determined by the difference between maximum RR interval and minimum RR interval.
2) Heart Rate: The normal range of heart rate is about 60 - 100 beats per minute. If the heart rate is less than 60 minute, it is called bradycardia. If the heart rate is more than 100 beats per minute, it is tachycardia.
3) P wave: Considered of the amount of P wave per a QRS complex.
4) PR Interval: Considered whether PR Interval is in normal range.
5) QRS complex: The characteristic and duration of QRS complex is considered. It is in normal range or too broad.

Table 2: Type of Arrhythmias with five basic steps for classification of Arrhythmias

Arrhythmia	Rhythm	HR (bpm)	P	PR (ms)	QRS (ms)
Normal Sinus Rhythm	Regular	60-100	1	120-200	<120
Bradycardia	Regular	<60	1	120-200	<120
Tachycardia	Regular	>100	1	120-200	<120
Atrial Fibrillation	Irregular	Any	>1	No	<120
Ventricular tachycardia	Regular	>100	No	No	>120
Ventricular Fibrillation	Irregular	>250	No	No	>120

2.3 Testing of Program (Simulations and Observations)

Lab VIEW software was used to execute this program for analysing and detection of ECG and arrhythmias. All the conditions used in this program were implied in the block diagram panel of Lab VIEW. The different conditions applied for different types of arrhythmias to be detected were differentiated by using individual indicators [10].

Each indicator corresponded to a particular arrhythmia having the corresponding conditions (rhythm, heart rate, P wave, PR interval and QRS complex).

The raw data with the known type of arrhythmia was used for testing the efficiency of the program. The data was obtained from patients and stored in the computer in the excel spreadsheet format (.xls). Testing was done using the

program like a real user and checked the result for both detection and classification [11].

3. Results and Discussions

The program (Waveform) shows detection of all peaks in the ECG graph. It show the necessary parameters on the top of the ECG waveform displayed. The RR interval shows both the maximum and minimum values for determination of the rhythm. The result of the data analysis shows the type of arrhythmia or normal sinus rhythm.

Figure 4: Diagnoses of normal ECG Waveform

Figure 4 shows us the ECG waveform detected. All the necessary parameters are displayed on top of the waveform which the indicators below display the type of arrhythmia. In Fig 4, since no indicator is ON, therefore it states that the ECG waveform falls in the normal range; also the heart rate is 73.04 which is perfectly normal.

Figure 5: Diagnose as Atrial Fibrillation

Figure 6: Diagnose as Ventricular Fibrillation

Figure 4 and 5 indicate "Atrial Fibrillation" and "Ventricular Fibrillation" respectively. As stated earlier in Table 2 both the waveforms satisfy the necessary conditions and thus the respective indicators are ON, indicating Atrial Fibrillation and Ventricular Fibrillation.

Atrial Fibrillation can have any heart rate and irregular rhythm. Thus figure 4 indicates irregular heart rate and bradycardia i.e. less than 60bpm. The heart rate displayed here is 27.13bpm.

Ventricular Fibrillation always has Heart rate greater than 250bpm and tachycardia has a condition of heart rate greater than 100. Thus the tachycardia indicator is ON and Heart rate is displayed as 365.33bpm.

4. Conclusion

All the signal processing, parameter detection and analyses are done using Lab VIEW. This program gives us sufficient information about ECG parameters and cardiac arrhythmias. It provides of great help to inexperience staff and can be used as an alternative tool to assist and train the medical staff in cardiac analyses. The major advantage of using this method for arrhythmia detection is that the parameters of the algorithm can be easily altered to an individual's unique heart waveform. The algorithm gives accurate results for the stored waveforms of the patients. This scheme is also capable of doing real time monitoring and analysis of the signal.

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