Heart Arrhythmia Detection

Author: Mansi Vyas
(Bio-Medical Engineer, M-Tech Ganpat University)
Co-Author: Heena Patel, Palak Parikh
(Professor in Bio-Medical Department)

ABSTRACT

Development of medical domain application has been one of the most active research areas as people have showing most of their interests for their health issues. Cardiac arrhythmia is becoming one of the leading causes of cardiovascular disease for men and women. Cardiac Arrhythmia is the most common cause of death. These abnormalities of heart may cause sudden cardiac arrest or cause damage of heart. The early detection of arrhythmia is very important for the cardiac patients. Electrocardiogram (ECG) feature extraction system has been developed and evaluated based on the Lab-VIEW. ECG feature extraction plays a significant role in diagnosing most of the cardiac disease. One cardiac cycle in an ECG signal consist of the P-QRS-T waves. This feature extraction scheme determines the amplitudes and interval in the ECG signal for subsequent analysis. The amplitude and interval of P-QRS-T segment determine the function of heart. The ECG signal will be de-noised by removing the corresponding wavelet coefficients at higher scales. Then, QRS complexes are detected and each complex is use to locate the peaks of the individual waves, R-R interval which are present in one cardiac cycle and evaluated the algorithm on MIT-BIH Database, the manually annotated database. Modern ECG monitors offer multiple filters for signal processing. The most common settings are monitor mode and diagnostic mode. In monitor mode, the low frequency filter (also called the high-pass filter because signals above the
threshold are allowed to pass) is set at either 0.5 Hz or 1 Hz and the high frequency filter (also called the low-pass filter because signals below the threshold are allowed to pass) is set at 40 Hz. This limits artifact for routine cardiac rhythm monitoring. The high-pass filter helps reduce wandering baseline and the low-pass filter helps reduce 50 or 60 Hz power line noises (the power line network frequency differs between 50 and 60 Hz in different countries). In diagnostic mode, the high-pass filter is set at 0.05 Hz, which allows accurate ST segments to be recorded. The low-pass filter is set to 40, 100, or 150 Hz. Consequently, the monitor mode ECG display is more filtered than diagnostic mode, because its pass band is narrower. Detected arrhythmia is sinus bradycardia, sinus tachycardia, second degree AV block-type 1, atrial flutter, sinus arrhythmia, and first degree AV block.

INTRODUCTION

With the growing of global population there has also been a corresponding increase in chronic age related diseases such as heart failure, dementia, sleep apnea, cancer, diabetes, and chronic obstructive pulmonary disease. From last few years world is experiencing high rate of heart diseases that have become the leading cause of death. World Health Organization (WHO) states that cardiovascular diseases are the world's largest killers, claiming 17.1 million lives a year .In India more than 1.17 billion people are living(july,2009 estimation) that is more Than one-sixth if world's population, experiencing heart related diseases and that is becoming the one third of all deaths caused by heart diseases. Heart is one of the most critical organs in the human body so it is becoming critical to develop techniques that can examine its functionality. Electrocardiography is basically a diagnostic tool that is used to measure and record the electrical signals by comparing activity of heart. And this can be done by placing the electrodes on the body of the patient. Then current is passing through the body which stimulates the cardiac muscles that causes contraction and relaxation of the heart .At the end these electrical signals are characterized by peaks and valleys that are labeled by the letters P, Q, R, S and T. The detection of QRS Complex of ECG signal has been researched from past three decades. According to the medical terms, the most important findings of ECG signal depends on P wave, QRS complex and T wave parameters. To detect the QRS complex more accurately it is necessary to identify the exact R-peak location from the recorded data but the exact detection of QRS complex is difficult, as the ECG signal is added with different types of noise like electrode motion, power-line interferences, baseline wander, muscles noise etc.

BLOCK DIAGRAM

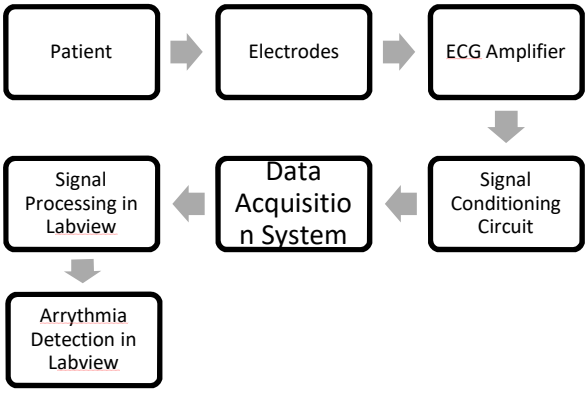

Figure 1 Block Diagram

ECG signal is the main input of the system which is extracted from human body via electrodes placed over different parts of the body. We have used disposable as well as clamp electrode and Button lead wires for this process. We have placed electrodes on left arm, right arm and right leg.

ELECTRODE:

Electrode is not the same concept as lead. An electrode is a physical patch which connects to the patient; meanwhile, a lead is a specific vector in which voltage is measured. ECG electrodes are used for sensing bioelectric potential (electrical activity) as caused by cardiac muscle. It converts physical signals into electrical voltage. The voltage is in the range of 1 mV ~ 5 mV. A Bioelectric potential electrode is transducer that senses the ion distribution on the surface tissue and ion current into electric current. This transducing function is carried out by electrodes that consist of electrical conductors in contact with the ionic solutions of the body.
The interaction between electrons in the electrodes and ions in the body can greatly affect the performance of these sensors and requires that specific considerations be made in their application.

Figure 2 Disposable Electrodes

INSTRUMENTATION AMPLIFIER:

The main purpose of the amplifier is to increase the signal level from the electrodes or sensors to a value in excess of the noise level in making it easier to measure the signal. The instrumentation amplifier is very use in this system because it is the received small voltage from the probes and need to be amplifying significantly processing stages.

Summarized reason to uses:

- High CMRR
- High input impedance.
- Stability in low gain
- Get differential voltage

It differentiates the signal from RA & LA and removes the common signal. Deference of them gives the electric activity of the heart called ECG. It is used mainly to remove the common mode signal and amplify the signal.

Over all differential amplifiers is given by:

$GD = G\alpha\, G\beta = (1+2\frac{R2}{R1})*\frac{R3}{R4}$

From our design we choose Rgain = 1k since the gain we get 30. Actually the gain not very large for reason that although the instrumentation amplifier has high common mode rejection ratio (CMRR) but the noise still effect to the output of the circuit and noise is also amplify.

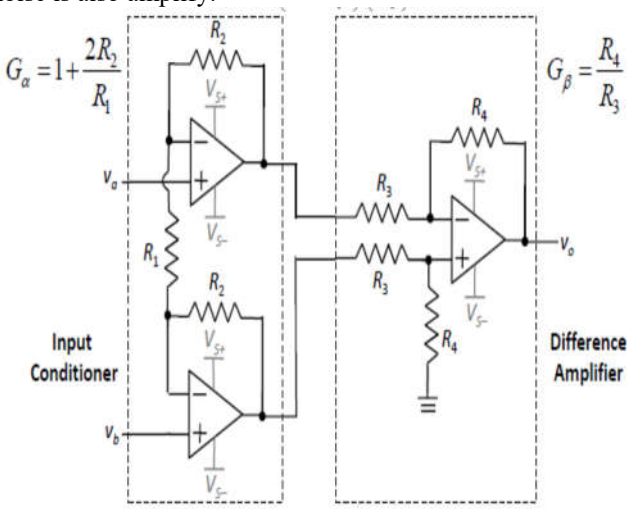

Figure 3 Instrumentation Amplifier

SIGNAL CONDITIONING CIRCUIT:

Signal from the instrumentation amplifier is various type of noise so this signal to applied the filter and remove the noise. There are use filter as follows:

1) High Pass Filter:

The High pass filter is used to remove a very low DC frequently noise of base line wandering by patientmovement.Here used of fourth order High pass Butterworth filter.

2) Low Pass Filter:

The Low pass filter is used to remove a very high frequency EMG & other unwanted noise. An Electromyogram (EMG) measures the electrical activity of muscles at rest and during contraction. Muscular activity (especially shivering) can lead to large interference ECG signal.

DATA ACQUISITION SYSTEM:

FTDI Module:

The FTDI USB to TTL serial converter module is a UART (Universal Asynchronous Receiver-Transmitter) board used for TTL serial communication. It is a breakout board for the FTDI FT232R chip with a USB interface, can use 3.3 or 5 V DC and has Tx/Rx and other breakout points.

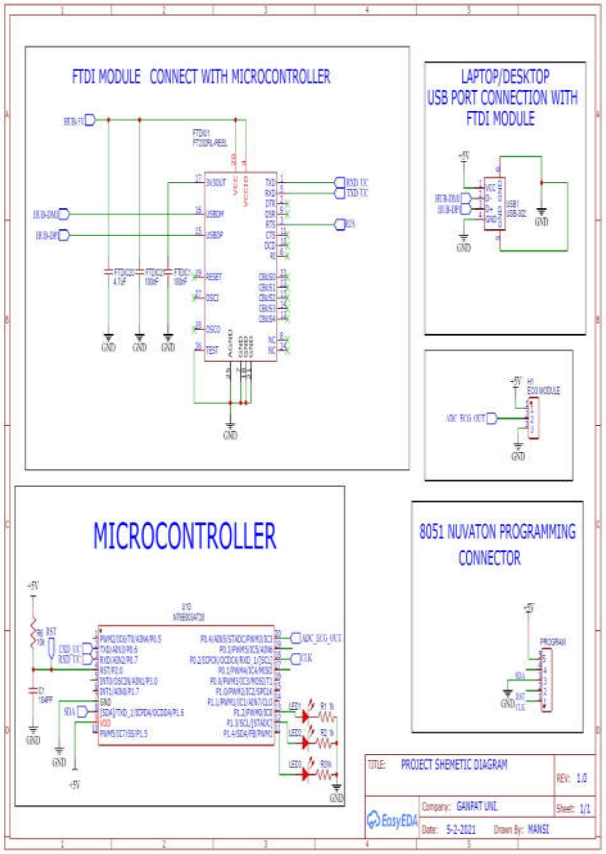

Figure 4 Schematic Diagram of Module

SIGNAL PROSESSING AND DETECTION IN LABVIEW:

LABORATORY VIRTUAL INSTRUMENT ENGINEERING WORKBENCH (Lab VIEW):

It is a graphically programmed computer language for real-time instrumentation. It is a software package developed to build programs with symbols (icons) rather than writing out lines and lines of programming text. It use symbols, terminology, and formats that are familiar to technicians, scientists, and engineers. Lab view is programmed to act as an interface, helping pieces of hardware "communicate" with each other. Moreover, lab view offers built-in libraries that allow the user to work over the Internet and use different programming formats and systems.

FUTURE EXPANTION

- To include detection of more types of Arrhythmias: In future other arrhythmias like PVC, flutters, Atrial fibrillation, ventricular Fibrillation can also be introduced for detection.
- To interface the equipment with artificial intelligence softwares to detect any further occurrence of such arrhythmias. This can be achieved by comparing existing simulated patterns with the patient ECG and by doing Template matching so as to detect any similar patterns before an occurrence of an arrhythmia.

CONCLUSION

This paper presents an efficient and simple detection algorithm based on feature extraction of ECG signal. The efficiency of detection depends on the proper extraction of P-Q-R-S and T points for ECG signal. The overall specificity above 92% and sensitivity above 91% is obtained, which is satisfactorily high considering simplicity. Because of its simplicity it can be a better choice in clinical field of cardiac arrhythmia detection. The efficiency can be further improved by using higher order statistics and support vector machine. Detected arrhythmia is sinus bradycardia, sinus tachycardia, second degree AV block-type attrial flutter, sinus sinus block arrhythmia, first degree Av block.

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- RESEARCH ARTICLE ECG FEATURE EXTRACTION USING NI LABVIEW BIOMEDICAL WORKBENCH Anjali Deshmukh1 and Yogendra Gandole2 1Department of Electronics Shri Shivaji College Akola (India) 2 Department of Electronics Adarsha Science J.B.Arts and Birla Commerce Mahavidyalaya Dhamangaon Rly (India)

- ARRHYTHMIA DETECTION USING ECG FEATURE EXTRACTION AND WAVELET TRANSFORM CHETAN S. PATIL1 & SHAILAJA
- GAIKWAD2 1Department of Electronics and Telecommunication Engineering Terna Engineering College, Nerul, Navi Mumbai, Maharashtra, India 2Department of Electronics Engineering, Terna Engineering College, Nerul, Navi Mumbai, Maharashtra, India