IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Designing A 3-Lead Ecg Machine For The Diagnosis Of Cardiac Arrhythmia

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Abstract: This paper presents an approach to design a low cost 3-lead ECG and analysis of the recorded ECG signal for Cardiac Arrhythmia diagnosis. The signals will be recorded through three ECG leads placed at different locations of the body, viz. RA (Right Arm), LA (Left Arm) & LL (Left Leg), and the acquired signal will be amplified and filtered using AD8232 bio-potential signal conditioning module. The processed signal will be then interfaced with a GUI created in LABVIEW, which will analyze the heart rate and check if the condition of Arrhythmia (Tachycardia or Bradycardia) is present or not.

Index Terms **- ECG, GUI, LABVIEW, Tachycardia, Arrhythmia, Bradycardia**

I. INTRODUCTION

The human heart consists of four chambers: two atria and two ventricles. The oxygenated blood which comes out of the Lungs flows through the Pulmonary vein and enters the Left Atrium. From here, it gets pumped into the Left ventricle, due to contraction of the heart muscles. The oxygenated blood then leaves the Left ventricle, flows through the main artery (Aorta), and gets distributed to all parts of the body. The deoxygenated blood then flows through the main vein (Vena Cava) and enters the heart through the right atrium. The blood then gets pumped to the right ventricle, and eventually out of the heart, which then flows through the Pulmonary artery, back to the Lungs for getting oxygenated again [1]. Electrocardiography (ECG) is the technique of recording the heart's electrical activity through the placement of bio- potential electrodes known as ECG electrodes at specific locations of the body. For a 3-Lead ECG, electrodes will be placed at RA (Right Arm), LA (Left Arm) & LL (Left Leg), which will produce an ECG waveform. The acquisition of ECG signal through different ECG electrodes is done by Einthoven's triangle [2]. The ECG signal acquired, is very weak, and thus needs to be conditioned for analysis. For, this it is made to go through the signal conditioning module. The acquired signal is amplified by increasing the gain and then filtered for the removal of noise or artifacts. The conditioned signal is then sent to an Analog Digital Converter (ADC) where it gets quantized so that it can be interfaced with a computing system, where it can be further analyzed using processing software. The recorded signal can be stored for further use.

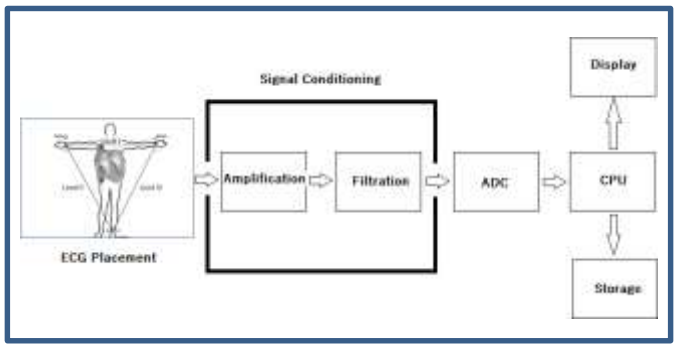


Fig 1. ECG Block Diagram

The ECG signal thus obtained, has three main components: P wave, the QRS complex & the T wave. The P wave represents atrial depolarization, which means contraction of the atria, the QRS complex represents ventricular depolarization which means contraction of the ventricles, and the T wave represents ventricular repolarization. [3]

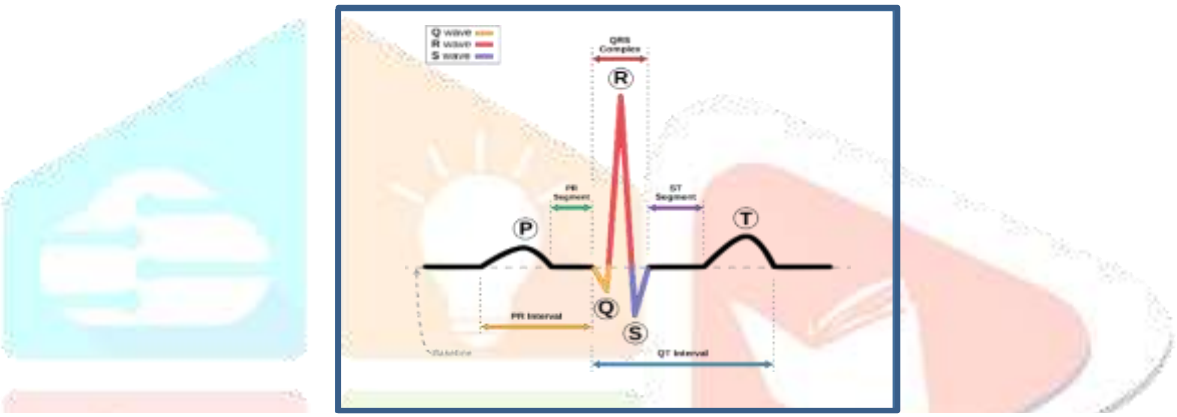
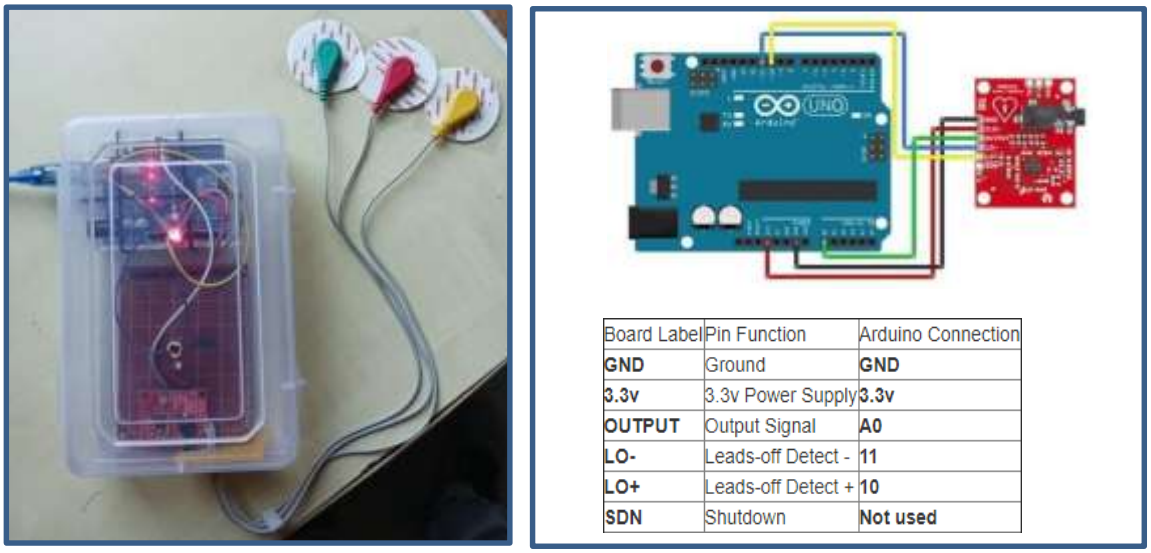


Fig 2. ECG Waveform

The one whole cycle of contraction and relaxation of the heart is called a heartbeat. The number of heartbeats in a minute is called Heart Rate (HR) and is measured in beats per minute (BPM). The heart rate of a normal person is 60- 100 beats per minute (BPM). But, if the heart rate is too fast or too slow, which means if the heart rate is irregular and the condition is known as Cardiac Arrhythmia. There are two major conditions of Arrhythmia, viz. Tachycardia (Tachyarrhythmia) and Bradycardia (Sinus Bradycardia). The condition where the heart rate is less than 60 bpm, is Bradycardia; and the condition where the heart rate is more than 100 bpm, the condition is known as Tachycardia. [4].

II. METHODOLOGY

The main building blocks of this project are as follows: ECG Leads, AD8232 module, Arduino Uno Microcontroller board, and PC with LABVIEW. The ECG Leads are connected to the AD8232 module, which is a signal conditioning circuit, including a combination of amplification and filtration circuits. The AD8232 module is connected to the Arduino UNO microcontroller, per the layout below. After the connection is done, we connect the hardware to the PC's serial port (COM Port), which in this case is COM5.



Board Label	Pin Function	Arduino Connection
GND	Ground	**GND**
3.3v	3.3v Power Supply	**3.3v**
OUTPUT	Output Signal	**A0**
LO-	Leads-off Detect -	**11**
LO+	Leads-off Detect +	**10**
SDN	Shutdown	**Not used**

Fig 3. Arduino Uno connected to AD8232

The programming can be done in Arduino IDE, to verify whether the signal acquisition is taking place or not. The Arduino Source Code Program is given below [5]. The software which has been used here is LABVIEW 2020. It is a graphical programming platform where we can design various models for the analysis of the data provided.

The controls used in this GUI are: Graph, Serial Port Control, Pulse Counter, BPM Counter, Tachycardia, and Bradycardia indicator. When the ECG leads are connected to the patient, the real- time ECG waveform is shown in the graph area, along with their current heart rate.

III. RESULTS AND DISCUSSION

The system was tested by analyzing the ECG signals acquired from five patients, viz. Patients A, B, C & D.

Sample	GUI Output	BPM	Diagnosis
Patient A		63	Normal
Patient B		71	Normal
Patient C		135	Tachycardia
Patient D		45	Bradycardia

Table 1. ECG Analysis of Different Patients

A 3-Lead ECG system has been successfully designed to analyze the ECG signals for conditions like Cardiac Arrhythmia. The system was tested on four different patients and the results were provided.

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