GSM BASED PORTABLE ECG MONITORING DEVICE

MAKING HEALTHCARE EASY

[1]Tahir Showkat Bazaz, [2]Yasir Reyaz Mir, [3]Sakiya Jameel, [4]Mir Nashit Rabeet [5]Sahila Fareed
[1]Junior Engineer, [2,3,4] B.Tech ECE, [5]Assistant Professor
[1]BSNL India, Srinagar, J&K
[2,3,4] Islamic University of Science and Technology, Awantipora, J&K
[5] SSM College of Engineering and Technology, Pattan, J&K

Abstract

Mini Cardiac arrest is quoted as the major contributor to a sudden and unexpected death rate in the modern stress filled lifestyle around the globe. A system that warns the person about the onset of the disease earlier automatically will be a boon to the society. This can be achieved by deploying the technology known as GSM based portable ECG monitoring device. ECG (Electrocardiography) is currently the most effective way to detect the heart condition. At present, people have to go to special organization, e.g., hospitals to do the ECG recording. But sometimes when the patient arrives at the hospital, the symptom has disappeared. This may lead to lack of early treatment opportunity. This project aims at designing and implementation of a low cost, efficient and flexible ECG monitoring and alert system using GSM technology. In our work the ECG signals are picked by the ECG plotter and recorded. The acquired signals are processed in a separate module using Arduino microcontroller. This module detects the abnormality if any, present in the recorded signal. The alert message is then sent in real-time to the doctor's mobile using GSM module in case of any abnormal behavior found in ECG.

Index Terms **–** Arduino, AD8232, GSM module, AC to DC Converter.

INTRODUCTION

The Electrocardiogram (ECG) is a measurement of the electrical activity of the heart over time, captured and externally recorded as measured by skin electrodes. The signals indicate the overall rhythm of the heart and weaknesses in different parts of the heart muscle. This technique is the best way to measure and diagnose abnormal rhythms of the heart, and is commonly used in hospitals all over the world. It is also used in sports and military environments for advanced diagnostics of healthy individuals. Our system proposes the design of a real time, ECG monitoring system via GSM platform that includes an alert system with a notification mechanism to alert the concern physician of the patient's condition in case of any abnormalities**. [1] Devara, Kresna & Nur Aisyah, Fitriyanti & Vanda A. W. N., Ketut & Ramadhanty, Savira & Raden Poespawati, Nji & Purnamaningsih, Retno. (2019).** The mobile phone technology which has gained tremendous popularity is used as an inter link between the patient and the physician or the medical practitioner. A major motivator behind this idea is the reduced healthcare costs of remote monitoring, where patients can reside in their homes rather than occupy a hospital bed.

HARDWARE COMPOSITION

The system uses Arduino Nano, AD8232 ECG module, ECG 3 lead Electrodes, GSM Module (SIM900A), Transformer 230V-12V (12-0-12), AC To DC Converter, Voltage Regulators and Capacitors.

SOFTWARE AND PROGRAMMING USED

Arduino IDE
Embedded C/C++

METHODOLOGY

The system uses Arduino nano as the brain that monitors and controls every decision. AD8232 ECG module and an ON button are connected to Arduino. Once the electrodes are put at right places on the body, the ON button is pressed and it activates the AD8232 module and starts recording the ECG data.

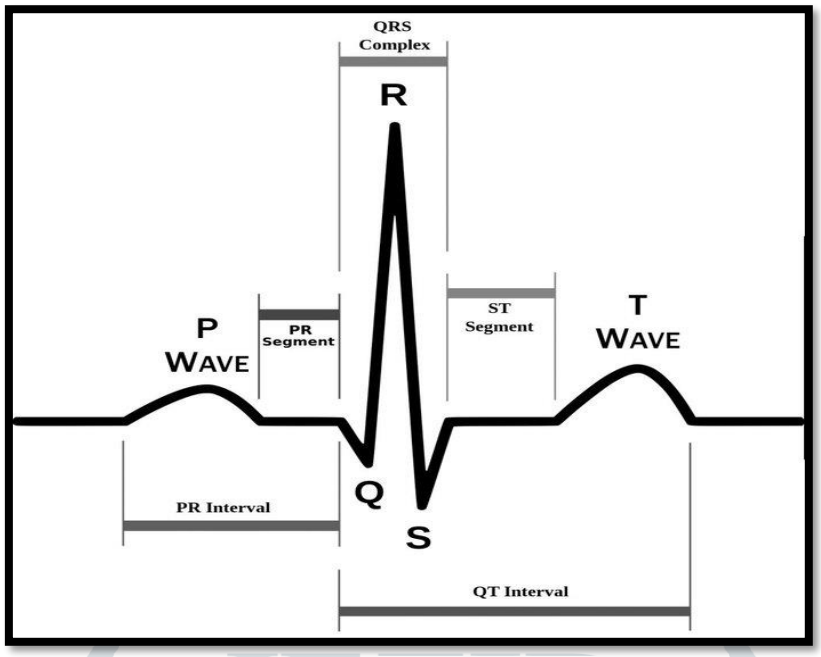

FIGURE I: Standard ECG Cycle

The figure above displays one standard cycle of ECG signal from a heart beat. From the figure one cycle consist of P wave, QRS wave until T wave. P wave offers benefit information about the propagation time of the impulse to both atria. Then, follow with a flat trend called with the PR segment which is in consequence of propagation of the electric impulse from atria to ventricles. And follow with QRS complex wave which you can look in above figure. Q,R and S complex contains of three small wave i.e small Q wave, the high R wave and the small S wave. The QRS complex give information about the ventricular systole in consequence of the impulse propagation to the ventricles (Q wave), whereas the transmission to the whole tissue is caused by the R and S wave. The QRS complex provides information about fibrillation and arrhythmias, it can be helpful to analyze heart attacks. And then ST interval, it is following by the S wave and including with the T wave, it can point out the ischemia occurrences. It represents the period during which ventricles are contracting, which is the last stage of the heart cycle. The T wave permits one to have information about the cardiac hypertrophy, heart attacks, and ischemia. Finally, the ECG signal ends with a small peak, U wave.

Table Normal ECG Parameters :

Phase	Duration	Amplitude
P Wave	0.06-0.11	<0.25
PR Interval	0.12-0.20	
PR Segment		0.08
QRS Complex	< 0.12	0.8-1.2
ST Segment	0.12	
QT Interval	0.36-0.44	
T Wave	0.16	< 0.5

Changes in parameters of ECG with Heart Diseases:

Abnormal Parameter	Effect on Heart
Short QT Interval	Hypercalcemia, Hyperkalemia
Long QT Interval	Hypocalcemia

Flat or inverted T waves	Coronary ischemia, hypokalemia, left ventricular hypertrophy
Peaked T wave, Long PR, QRS wide, QT short	Hyperkalemia
Prominent U waves	Hypokalemia
Increased HR	Tachycardia
Decreased HR	Bradycardia
Increased QRS	Bundle branch block
Increased PR	AV block

[2]. Parikh, Harikrishna & Savaliya, Jatin & Vyas, Gumjan & N Sidpara, Ankit & Pandya, H. (2019)
From these ECG parameters, analysis of Heart Rate Variability (HRV) of the ECG signal can be implemented. Comparing these parameter changes to the normal parameters above, the system may predict which disease the patient is suffering from. In case any abnormality is found in the ECG plot, an SMS is generated and sent to the doctor of the patient for urgent treatment.

1. **Transformer**

Since all the components operate on low voltage in the range of 3V to 12V so we need a step down transformer.
It steps down the normal home voltage (230V) AC to 12V AC.

2. **AC-DC Converter**

AC-DC converter takes the supply of 12V AC directly from transformer and converts it into 12V DC. We need this because the equipments used in our project operate on DC supply. It has a full wave bridge rectifier which converts AC to DC, to smoothen the voltages we use two capacitors of 1000 micro farad and 100 micro farad. We have used two voltage regulators of output 12V and one voltage regulator of output 5V in order to get accurate voltages.
12V DC is given to Arduino Nano and GSM SIM900A and 5V DC is again converter into 3.3V which is fed to AD8232 ECG Module.

3. **ECG 3 Lead Electrodes**

Wehave used three electrodes, positive, negative and neutral which are placed at different locations on body. They catch the analog ECG signals from our body and transmits them to AD8232 chip.

4. **AD8232 ECG Module**

The aim of the ECG AD8232 is to produce a typical ECG waveforms from data received from different electrodes and as many arrhythmias as possible. **[3] Ankhili, Amale & Zaman, Shahood & Tao, Xuyuan & Cochrane, Cédric & Koncar, Vladan & Coulon, David. (2019).** It works as an interface between electrodes and Arduino Nano. It receives the ECG signals from electrodes, amplifies it and produces the typical waveform and transmit this waveform to Arduino Nano through OUT pin which is analog. The two pins L0+ and L0- are used to set upper and lower threshold values of ECG graph in digital form. These pins are connected to Arduino Nano at pins D2 and D3.

5. **Arduino Nano**

The two L0+ and L0- pins of AD8232 are connected to Arduino Nano at D2 and D3 pins. GSM module is connected to Nano at pins Tx/D0 and Rx/D1. The ECG graph can be seen on laptop or PC in Arduino IDE's Serial plotter.

6. **GSM SIM900A**

It is connected to NANO through Tx and Rx pins. It's function is to receive the message and phone numbers from Arduino Nano and transmit this message to given phone numbers.

RESULTS

ECG is seen using Arduino IDE Serial Plotter.
We have tested this device on different people and the results are shown below.

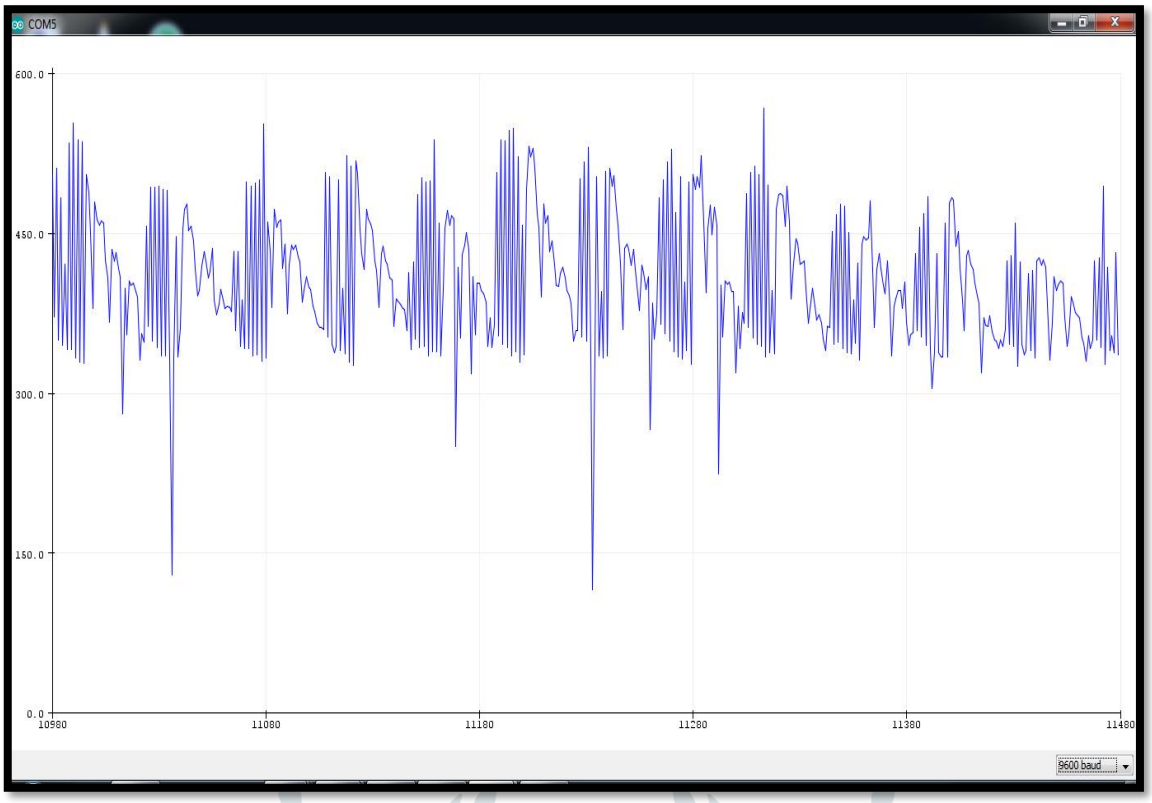

FIGURE II: ECG of a Healthy person.

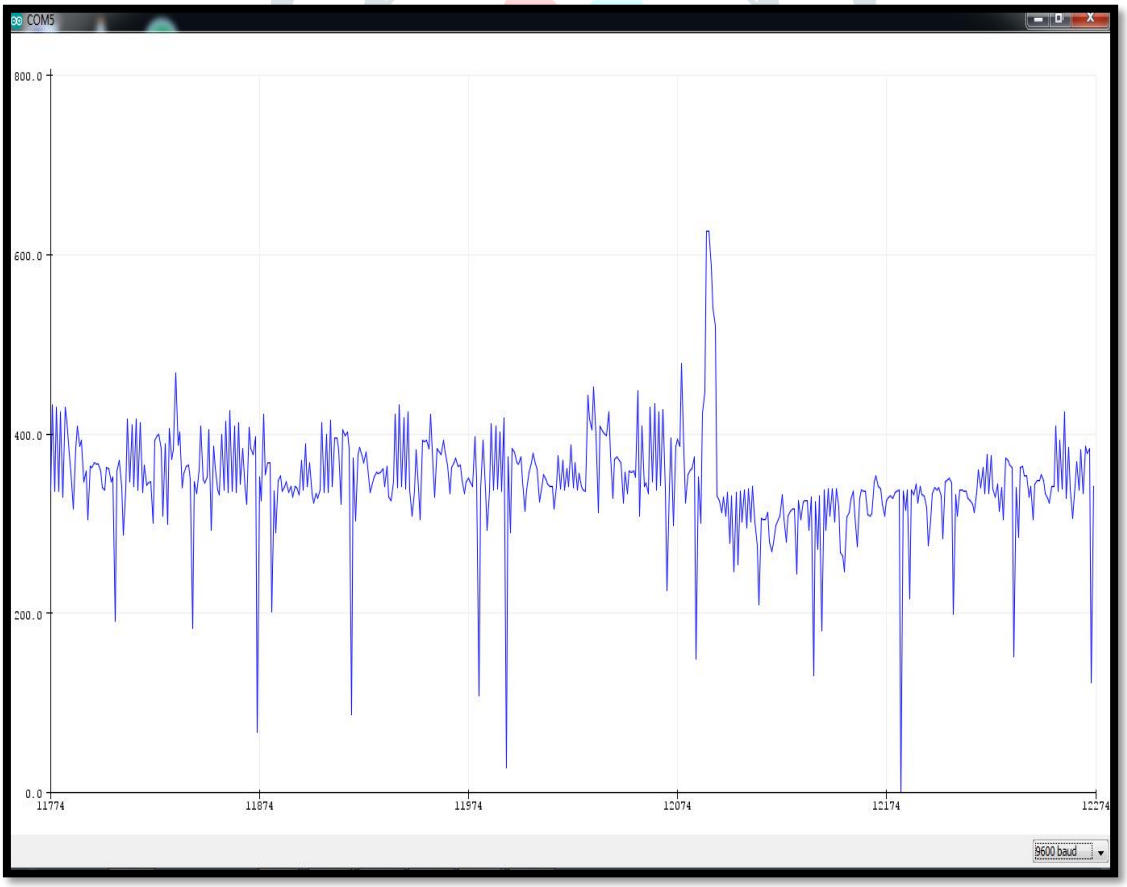

FIGURE III: ECG of a Sick person.

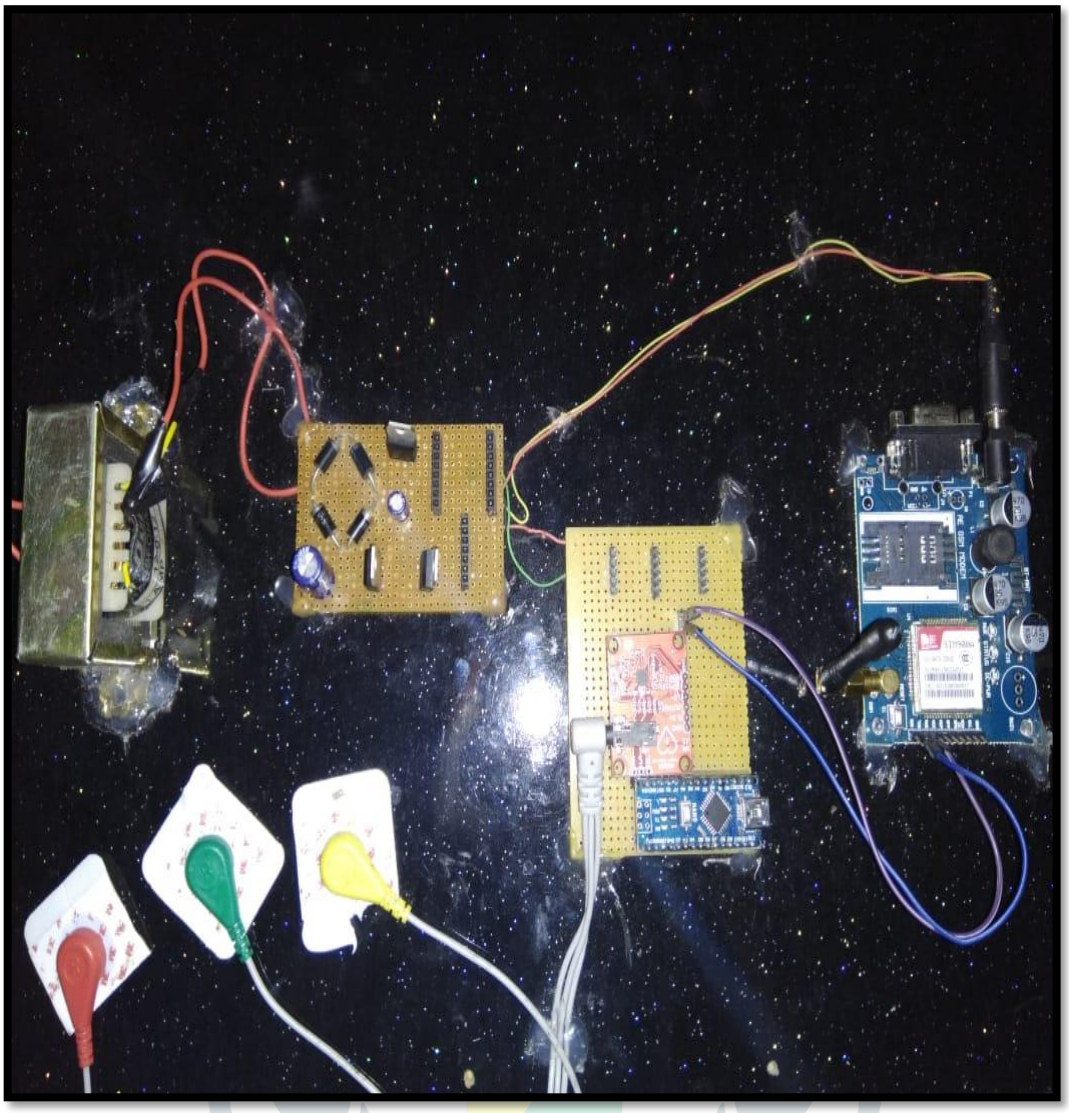

FIGURE IV: Prototype of our Project.

CONCLUSION

With technological advances in communication it is important to use this system for benefit of the heart patients. Remote access of the patient is possible. In addition other parameter of body like temperature, pulse oximetry, respiratory data can also be monitored. The most important advantage of this system is flexible excellent functionality. The main part of this system is monitoring using 'GSM network'. So such system allows remote access of patient and also patient does not have to stick to one place (Hospital).

REFERENCES

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3. Ankhili, Amale & Zaman, Shahood & Tao, Xuyuan & Cochrane, Cédric & Koncar, Vladan & Coulon, David. (2019). Washable embroidered textile electrodes for long-term electrocardiography monitoring. Textile & Leather Review. 10.31881/TLR.2019.27.