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Smartphone based ECG Acquisition and Analysis

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Abstract: ***Health monitoring and technologies related to health monitoring is an appealing area of research. The electrocardiogram (ECG) has constantly being mainstream estimation plan to evaluate and analyse cardiovascular diseases. Heart health is important for everyone. Heart needs to be monitored regularly and early warning can prevent the permanent heart damage. Also heart diseases are the leading cause of death worldwide. Hence the work presents a design of a mini wearable ECG system and it's interfacing with the Android application. This framework is created to show and analyze the ECG signal got from the ECG wearable system. The ECG signals will be shipped off an android application via Bluetooth device. This system will automatically alert the user through SMS.***
Keywords: ECG, Bluetooth communication, Android Application.

I. INTRODUCTION

Heart health is one of the significant boundaries of human body. ECG framework is an ideal instrument for patient checking and management. The daily ECG monitoring empowers not just the recognition of cardiovascular diseases. Advancement of portable correspondence innovation makes it possible to make a minimal and effectively accessible Smartphone based ECG gadgets. ECG signal could utilize to analyse the medical issue of heart.

The electrodes recognize the smaller electrical changes are after effect of heart muscle depolarization followed by repolarization during every beat of heart. In abnormal ECG pattern, there are various cardiovascular abnormalities, heart rhythm disturbances. In this project, we proposed an ECG signal monitoring and analysis system using computation power of Smartphone devices. The proposed system has great extensibility and can simply consolidate other physiological signals to suit different types of telehealth situations. This device will send the ECG signals to both user and doctor. JavaTM based software running on Smartphone perform task like raw ECG data compression, decompression, encryption.

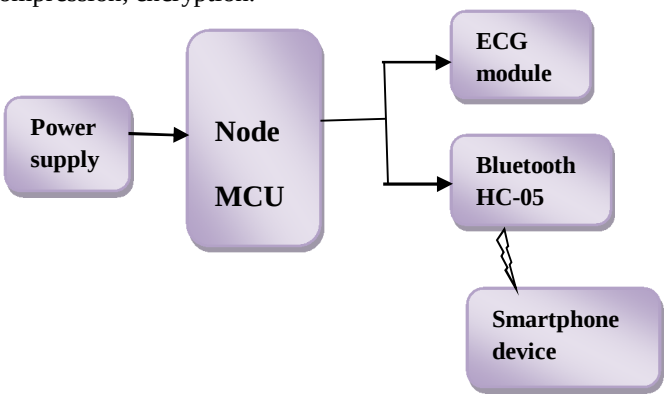

Fig.1. Block diagram of proposed system

This system can automatically alert clinical benefit supplier through Short Message Services (SMS), when clinical help is considered essential for the user based on analytical results.

II. THEORY

A. Electrocardiogram

The electrocardiogram is an advance chronicle of heart rhythm activity. The electrocardiogram is used to calculate the heart rhythms, heart rate. Application of ECG is to diagnose heart attacks, heart arrhythmia, heart failure, peacemaker function. The ECG can be examined by contemplating the segments of waveform. The waveform given below shows the normal electrical activity of heart.

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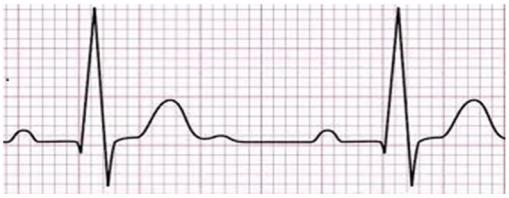

Fig. 2.Normal ECG waveform

B. Android Platform

We chose Android as a Smartphone stage since it is open source and broadly utilized, so that users can create and develop application according to their own desires. Android platform has total tools and libraries for creating the app simpler.

In this system, there are three primary parts: AD8232 ECG sensor used to sense the heart activity, access the Bluetooth communication to receive the information of ECG, Android application for ECG result.

III. SYSTEM DESCRIPTION

This system is comprises of three modules: user's ECG acquisition device, Bluetooth module, Android application in Smartphone. ECG device is real time consistently went to wandering cardiovascular checking framework. Remote cardiovascular observing alludes to ECG checking administration given while user is at home or performing day by day exercises. The user will be wearing a wearable electrode consistently and user's ECG will record consistently on real time basis. This information is send to Smartphone of user where it is processed, filtered and plotted as genuine ECG signal. Then this signal is send to physician by server. It has 24 hours access to doctor to take a clinical decision regarding to user.

A. Selected Technology

The proposed system has used Bluetooth module as transmission convention for connection between acquisition module and Smartphone. This paper presents a portable system where heart's electrical activity is transmitted via Bluetooth to mobile device. This type of system is desirable because it can operate without relying upon the view of obstacles in between.

The HC-05 is exceptionally cool module. It can add full-duplex remote functionality to project. It can be used to impart through two microcontrollers or connect with each gadget having Bluetooth functionality. The Bluetooth module communicates by using USART at 9600 baud rate thus it isn't hard to connect with microcontroller which upholds USART. Power it with +5V and connect the RX pin of Bluetooth with TX pin of Node MCU and vice versa.

B. Android Application

We used MIT App Inventor to create an Android Application for ECG monitoring. It is a web application coordinated development environment given by Google. It permits novices to create application software for two operating systems (OS): Android and iOS. The Android application can be categorized as high level programming for Smartphone. The application consists of Bluetooth module and data processing.

The block editor in the initial form ran in different Java process for making visual block programming language. The client may use an "on computer" emulator accessible of Windows, MacOS, and Linux.

1) Connecting mobile device's Bluetooth adapter to acquisition device's Bluetooth module.
2) Then acquisition device send the data to Smartphone via Bluetooth.
3) Then received data is processed, filtered and plotted as ECG waveform.

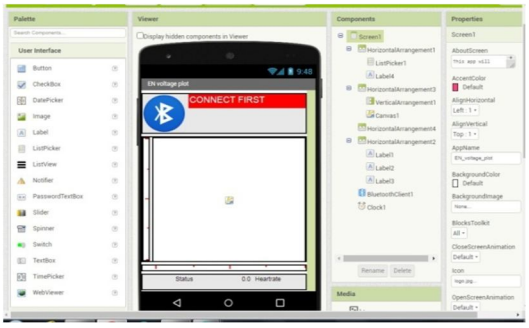

Fig.3.View of application in PC

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IV. HARDWARE DISCRIPTION

The proposed system comprises three lead terminals for real-time continuously attended ambulatory cardiovascular observing. A circuit board was created for ECG signal processing and wireless data transmission via Bluetooth module. The circuit has class I Bluetooth module with high power transmitter (100m). The actual range might be restricted to 100 feet or due to internal receiving antenna or type of user device used to associate with it. Once the device is connected with Bluetooth, it is ready to receive data. Some exceptional character commands are defined to operate the unit. Results are quick; anyway any commands given don't survive a power cycle and should be re-issued if the unit is shut down or rebooted distantly.

This system uses three electrodes. Lead I placed on LA (Left Arm) which is positive electrode and negative electrode is placed on RA (Right Arm) which is Lead II and lead III is placed on RL (Right Leg).

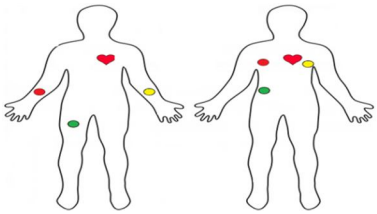

Fig.4.Proper placement of electrodes

We have used AD8232 ECG sensor to extract, amplify and filter the biopotential signals having noisy condition. The ECG sensor AD8232 consists of nine pins so that we can solder pins, wire or other components with its pins. This board provides the RA (Right Arm), LA (Left Arm), RL (Right Leg) pins. Also, there is LED indictor that will throb to rhythm of heartbeat. It is prescribed to remove the sensor cushion on the lead earlier placed on body. Closer the pads to heart, better the estimation.

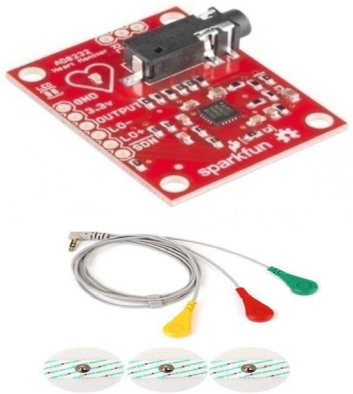

Fig.5. AD8232 ECG sensor with electrodes

There are so many types of microcontrollers used in ECG monitoring system. Here, in this system we used NodeMCU chip. By examining handiness with the ESP8266 chip, NodeMCU goes with ESP8266 Development pack. It has Analog (A0) and digital (D0-D8) pins.

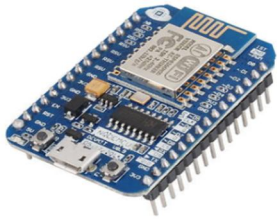

Fig.6.NodeMCU

There is a method of developing NodeMCU with Arduino IDE. This is quite easier for Arduino developers than learning a new language. In Arduino IDE, we compose and accumulate code, the ESP8266 toolchain in background makes a binary firmware document of code we composed. Furthermore, when we transfer it to NodeMCU then it will flash all NodeMCU firmware with recently generated binary firmware code. Indeed, it composes the total firmware.

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V. RESULT

The initial phase for system is associating the Smartphone via Bluetooth module. The Bluetooth associating interface was created. Subsequent to tapping the catch on Smartphone three utilitarian keys appeared on screen. Contacting the "SCAN" key empowers the Smartphone to search for close by Bluetooth gadgets. Select a gadget and Smartphone would interface it with Bluetooth. After connecting the Bluetooth successfully, LED would glow then received ECG waveforms are shown on the Smartphone's screen.
This Android application includes the display of heart rate, ECG waveform and recognized heart beat type. The ECG waveform was displayed on screen and processed in form of 5 sec interval.

Table I. Normal ECG Parameter

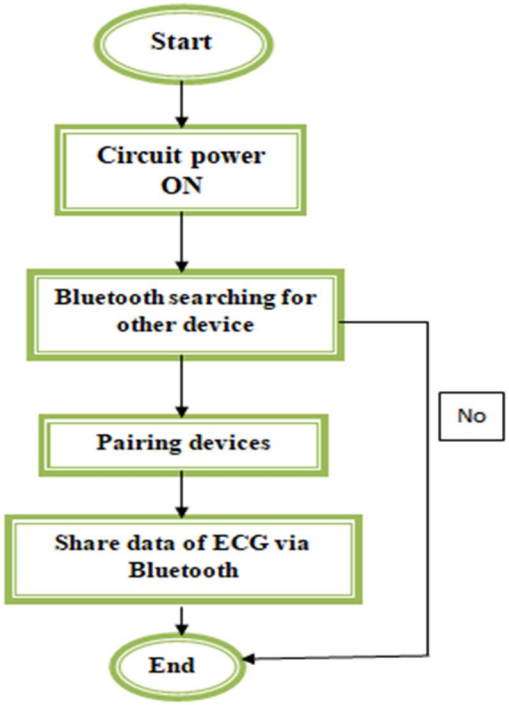
P wave	0.08 sec
PR interval	0.12-0.2
PR segment	0.05-0.12
QRS complex	0.08-0.1
ST segment	0.08-0.12
QT interval	0.36-0.46
T wave	0.16 <0.5

The changes in ECG parameters with heart disease are given below.

Table II Abnormal ECG Parameters

Short QT interval	Hypercalcemia
Long QT interval	Hypocalcemia
Flat T wave	Coronary ischemia
Long PR/ QRS wide	Hyperkalemia
Prominent U wave	Hypokalemia
Increased HR	Tachycardia
Decrease HR	Bradycardia
Increase QRS bundle	Branch block
Increased PR	AV block

Flowchart of proposed system is as follows:



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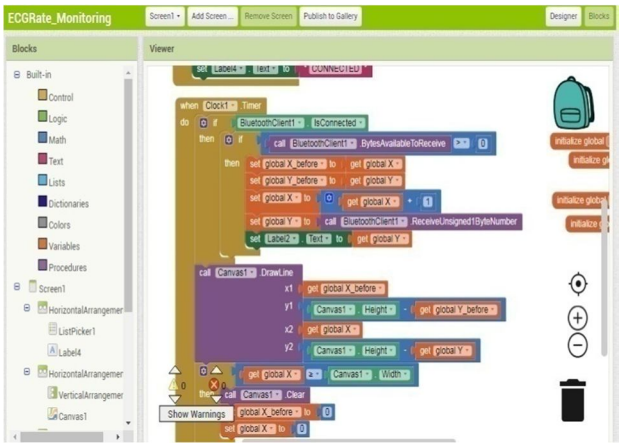

Fig.7.Block diagram of designing ECG heart rate monitoring app with the help of MIT app inventor

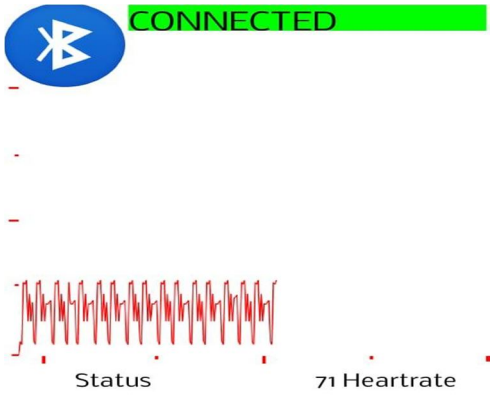

Fig.8. Android Application View

VI. CONCLUSION

Smartphone associated with proper sensing devices could successfully utilize for obtaining, preparing and representation of biosignals, adding adaptability and versatility. Against the significant numbers of communication interfaces implanted in Smartphone and a need was given to correspondence via Bluetooth. Because of low frequency nature of biomedical signals, the input signal is recently regulated utilizing pulse amplitude modulation. The demodulation and QRS recognition are executed in JAVA software on Smartphone.

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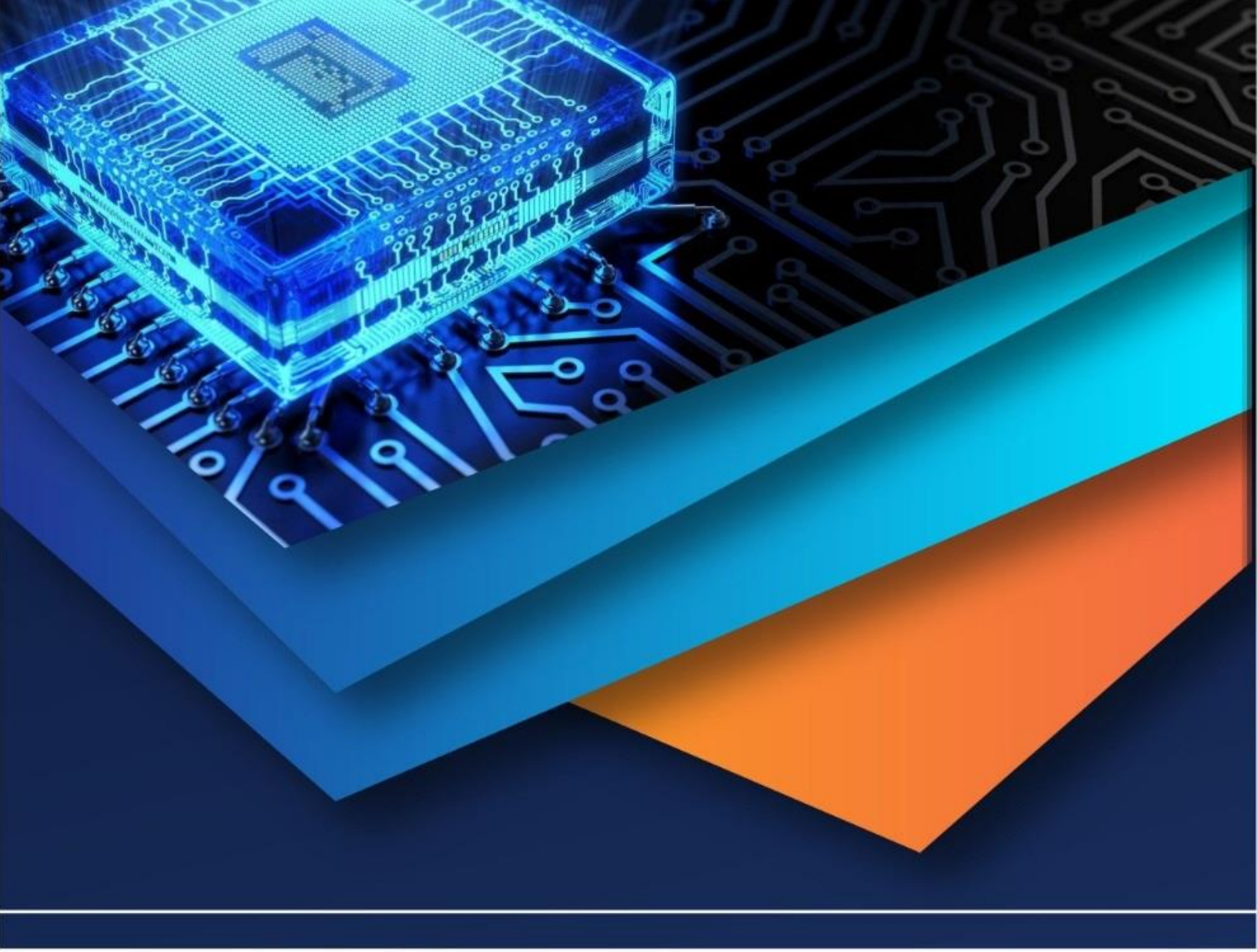

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