

Portable ECG Recorder with GSM

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Abstract

Electrocardiogram is the most effective way to detect heart condition. Previously people have to go to hospital, to take ECG & to know the body temperature they have to use thermometer. But sometimes when the patients arrive at the hospital, the symptoms may get disappeared, by that the exact problem can't easily understand to the doctors. By using this system user can take ECG & body temperature, when user feels something wrong with the heart, he/she can take the ECG waveform immediately. An Android Smartphone is used to display ECG signal, heartbeat count & body temperature value in this system. User can store the wave for the further analysis by this technique. Also the Global System for Mobile communication (GSM) included within the system, sends an SMS which containing heartbeat count and body temperature value of the user, to the prescribed doctor & to and to nearest ambulance service. Thereby necessary medical treatment can be provided as early as possible to the user.

Keywords: ECG sensor, android smart phone, Global System for Mobile communication (GSM), mobile applications

1. Introduction

Cardiovascular diseases are one among top ten causes of people's death in the world. Any age level people have the same possibility of occurrence of heart diseases. But the non-availability of method's to find out cardiovascular diseases at its starting stage is the main reason for the increase in death rate. If the diseases can found out at its starting stage sufficient treatment can be given to the user and by that he/she can be escape from the disease. Several researches were made in medical electronics and embedded systems to find out an easier way for taking ECG at home. In this system an application program is developed on android Smartphone to view the waveform and to store it for further analysis. As nowadays Smartphone (a multipurpose embedded system), has become a personal belonging of everyone. As its users are increasing day by day. For patients with heart disease, it can be used to monitor the heart condition.

An application in android has been designed in our system to display ECG waveform, heartbeat count and body temperature value. To run that application a Smartphone is needed, it should contain following specifications like consisting of android2.2, 800MHZ processor. When the heart count obtained has variation from the given upper/lower threshold

value, it indicate abnormal condition of the heart. Automatically through GSM an SMS containing heartbeat count, body temperature value would send to prescribed doctor & ambulance service. This makes the treatment earlier than the normal time.

A more accurate method other than electrodes has used in this system. An ECG sensor has used to obtain the ECG waveform and heartbeat count. A temperature sensor has used to obtain the body temperature of the user which has taken along with the ECG waveform.

2. Related works

In [1], for recording ECG wave (wireless) continuously for Tele-Home-Care situation. For that electrodes, computer, mobile phone, Bluetooth enabled device, GPRS were used. Electrodes had been used for taking ECG waveform and that had been sending to the mobile phone and computer for viewing the signal. ECG signal gets stored in the computer and this has been provided by the Bluetooth module. Since mobile phone doesn't have enough memory to store the signal computer has been used and by using GPRS the ECG signal have been sends to the diagnostic station at the hospital. The disadvantages of this system are it is compact, high cost, and less accuracy, and it causes allergic problems since a chemical AgCl had been used to get ECG signal through electrodes. And the belt consisting of electrodes and Bluetooth module has to wear all times by the patient (while doing work also). And to use this system a diagnostic system has to install in the hospital.

To decrease the disadvantages another system had been introduced [2]. But it should also have to be wearing all time, allergic and accurate problems were still there by the use of the electrodes and chemical to get the ECG signal. It doesn't need any diagnostic stations at the hospital for sending waveform been stored and viewed by computer (not using mobile phones to view signal) so by cloud computing the signal has been provided at the internet and if the doctor needed can be analysed through GPRS. This system has less cost comparing to previous one.

On further up-gradation a new system has invented [3] where mobile phone has been used for viewing the waveform and an flash disk connected via wire to the mobile phone had been used to store the waveform by that cost has been reduced but storing capacity is less since flash-disk are temporary storage devices so the stored signals get re-writes on further taking of the reading. It also has accuracy and allergic problems since it has been using electrodes and chemical for taking ECG signal and this should also has to be woreed all times and the ECG signal has been send to the hospital via GPRS to the hospital.

3. Motivation

3.1 Real life motivation

Death rate is increasing day by day and heart diseases have the top position for the cause of death. These deaths are caused due to the unrecognized symptoms shown by heart, if these symptoms are recognized at the starting stage; this rate of death can be reduced up to a level. Normal people can depend only the hospitals for obtaining the ECG and further more treatments. This existing condition made us to think about the usage of Smartphone which can be easily available for people.

3.2 Technical motivation

Many works were conducted related to this topic. One of them [1] has the disadvantage that, it should have to be worn all the time for the purpose of taking ECG. More expense and less efficiency made the system less useful. In second one [2], similar to our work storing of data was possible. But the storing will be in a flash memory which is temporary. i.e. When ECG is measured it will be in USB storage for a short time only. When another reading is taken, new data will overwrites the previous data. Also the data can be transmitted only through computer networks; only through computer networks; through phone it is not possible. In [3] system also electrodes have used to obtain ECG waveform, where computer with a GPRS connection has used. Its accuracy of data obtaining is very less and it's of big cost. All these complexities were overcome in our work.

4. Problem domain

In this system an application of Android Smartphone and Bluetooth module is used. ECG waveform taken using sensor has displayed in the Smartphone. An SMS was send to the nearest ambulance service and prescribed doctor through GSM. Body temperature has measured by using LM35 (temperature sensor).

Here our aim is to implement a method for taking ECG signal, from which the condition of heart can be identified. It is made

possible by an ECG sensor. Corresponding signal is available in the android Smartphone via Bluetooth module. If heartbeat count has been less than 30 or greater than 100, an SMS will send to the prescribed doctor and ambulance service via GSM technique. This makes the treatment as early as possible. Thus here medical electronics is combined with the embedded system for developing the system.

5. Problem definition and statement

To implement a system which sense the ECG signal by an ECG sensor and make it available in an Android based Smartphone. Output of ECG sensor will be digitalized by the use of ADC within the microcontroller. Embedded C program has been used to convert the digital data to ASCII characters for sending it to the phone via Bluetooth module. At the Smartphone, the variation of heart count with threshold count value will be identified and will be informed to the nearest hospital or ambulance service by sending an SMS by making use of the GSM. Also the ECG signal will be stored within the phone for further investigation. Temperature sensor senses the body temperature and it will be also available within the phone.

6. Problem issues

Compared to other related systems, there is no need to wear our system all the time, for the purpose of taking ECG. It has to wear only at the time of taking ECG. Here the corresponding ECG can be stored for further application, thereby avoid the overwriting of data. In addition to that, the GSM within the system will automatically send an SMS to the nearest hospital about the current condition of the heart and the treatment can be started earlier. A temperature sensor included in this system will measure the body temperature and make available with the phone

7. Problem capture

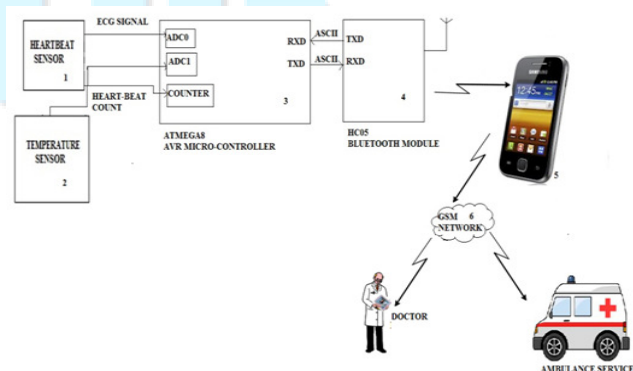


Fig.1. Block diagram of Portable ECG Recorder with GSM

Fig. 1 shows the block diagram of Portable ECG recorder with GSM. The block diagram consists of two sections as:

- 1) Transmitter section
- 2) Receiver section

7.1. Heartbeat sensor

Traditionally, the standard electrode pads are used to measure the electrocardiogram (ECG). When using traditional electrode pads, the surface is covered with AgCl to help electric conduction, which may cause users allergic reaction or discomfort. Therefore, it is difficult for users to wear over a long period. Proposed system uses a heartbeat sensor with touching pads to measure the ECG signal. The measured result is similar to the traditional method.

7.2. LM35 Temperature sensor

LM35 has been here used as the temperature sensor which used to find out the temperature of the patient and the resulting waveform has been given to the ADC pin of the AVR microcontroller.

7.3. Atmega8

The output of both the sensors has given to the ADC pin of (Atmega8) AVR microcontroller. Heartbeat count is also an output of the sensor and it has been given to the T0(counter/timer) pin of the microcontroller, the corresponding digital values had been converted to its ASCII value, then packets of data has been send to the Bluetooth module.

7.4. HC-05 Bluetooth module

HC-05 has been used as the Bluetooth module packets of data has been given as the input of the module and needed modulation has been done to the data and RF wave has been transmitted to mobile phone.

7.5. Smartphone (Android system)

The received data has been demodulated, de-multiplexed and detects the temperature and heartbeat sensors output (digital). After converting ECG waveform to analog waveform using DAC, output will be plot in the mobile phone. For that an android based Smartphone has been used and to synchronize these functions an app has been designed.

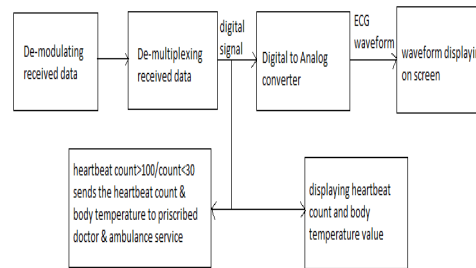


Fig 2. Functional block diagram of android system

8. Algorithm

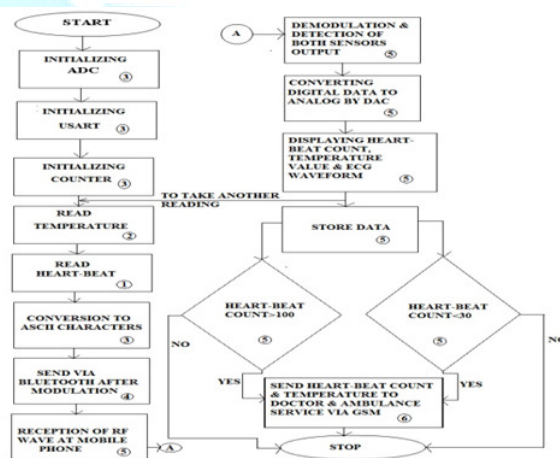


Fig 3. Algorithm of Portable ECG recorder with GSM

9. Circuit diagram

230V AC has been step down to 12V AC & then 12V DC has been obtained by rectifying 12V AC, which then given to 7805 voltage regulator to obtain 5V output. 5V VCC has been given to AVR microcontroller, heart-beat sensor, LM35 temperature sensor & HC-05 Bluetooth module. In between IR LED & receiver user's finger get placed and IR LED will be glowing all time, as by the variation in blood velocity ECG waveform had been obtained. Heart beat sensor also gives count signal. LM35 gives a voltage value corresponding to the user's body temperature. Count signal given to the counter (T1-11th pin) in the Atmega8 controller.

ECG signal given to the ADC1(pin-24) and output of LM35 to ADC0(pin-23) Digital data gets multiplexed and then converted to ASCII characters by adding 48 to each value through Embedded C programming. Then packets of data have sent serially to Bluetooth module. Full duplex communication is taken place in between AVR and HC-05 Bluetooth module. Sufficient modulation process had applied

to the data and the resulting RF wave gets transmitted via Bluetooth to mobile phone. An Android Smartphone receives the data and demodulates, de-multiplexes and find out the digital data. Heart-beat count gets displays along with Body temperature. ECG waveform gets plotted after converting the digital data to analog by using DAC. If heart beat count less than 30 or greater than 100 corresponding heart beat count and body temperature of the user get message to doctor's or ambulance service number: via GSM.

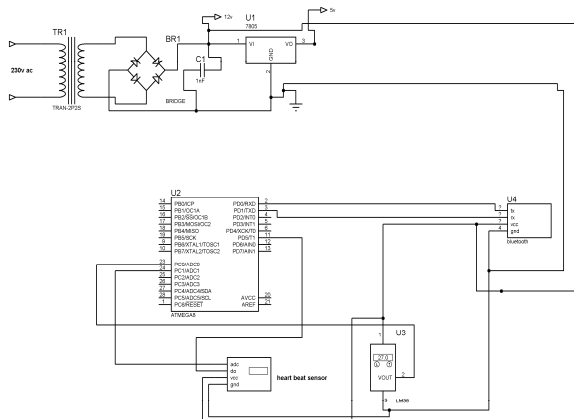


Fig.4. Circuit diagram of Portable ECG recorder with GSM

10. Input-output model

10.1. Heartbeat sensor

Input: Variation in blood velocity at user's finger.
 Process: By the variation in blood velocity at the finger ECG signal and heartbeat count signal is obtained.
 Output: ECG signal & count signal

10.2. LM35 Temperature sensor

Input: Body temperature
 Process: To obtain the body temperature value of the user, this is taken along with the ECG waveform.
 Output: Analog voltage corresponding to body temperature

10.3. Atmega8

(i)ADC

Input: Output of ECG sensor and output of LM35
 Process: To convert both the outputs of ECG and LM35 Sensor to digital data.
 Output: Digital data

(ii)Counter

Input: Count Signal
 Process: To generate heartbeat count from the count signal.
 Output: Heartbeat count

(iii)USART

Input: Output of ADC and Counter
 Process: To convert outputs of ADC and counter to Multiplexed ASCII values.
 Output: Packets of data containing multiplexed ASCII values

10.4. Bluetooth module

Input: Output of USART
 Process: To produce RF wave after modulation.
 Output: RF wave

10.5. Smartphone

Input: RF wave
 Process: The input DC voltage is stored as charge in the battery.
 Output: Plotting ECG signal and displaying heartbeat count along with body temperature value, if heartbeat count >100/<30 sends an SMS to ambulance service and doctor via GSM

11. Result

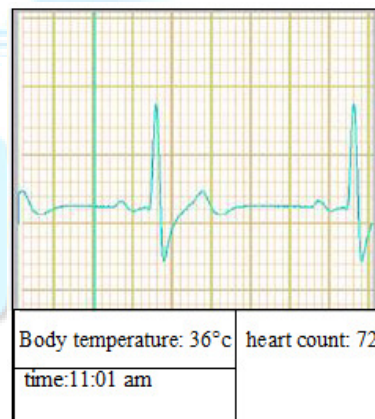


Fig. 5. Result of the system displayed on screen of Smartphone

Fig.5. shows the result that will be displayed on the phone screen. Both body temperature and heart beat count obtained after experiment will be compared with the threshold values. If the heart count is greater than 100 or less than 30 (threshold values) or if the body temperature is greater than 80, then both

values will be sent to the doctor's number, also to the nearest ambulance service. This makes the treatment earlier. Waveform, temperature value, heartbeat count and the time at which the data has taken will be stored in the phone itself for the future purpose.



Fig 6: portable ECG recorder with GSM

12. Comparison of results



Fig. 7. Result obtained at the end on the computer and phone screen [1]



Fig.8. Resulting waveform at the output of system [2]

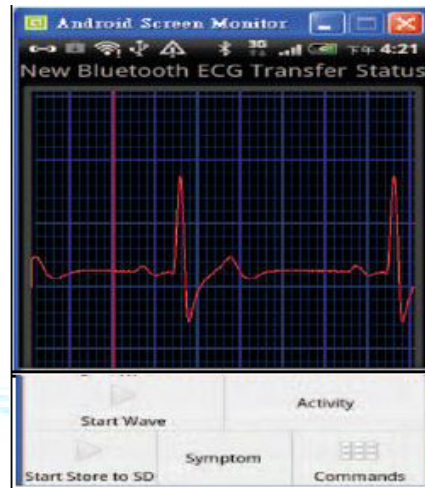


Fig.9. Resulting waveform at the output of system [2]

Fig.7. Shows Result obtained at the end on the computer and phone screen [1] it are clear that it should have to wear all times (during work time and at free time). Also this system uses both computer & mobile phone to view the ECG signal. ECG signal store only at the computer and through GPRS data had send to the diagnostic station at the hospital. In [2] (consider Fig.8.) ECG signal can be stored in USB flash disk and data can send to the diagnostic station at the hospital through GPRS from the Smartphone and it should also have to wear all time. This system can store the ECG for a short period only and data will get overwrite. In [3] (consider Fig.9.) ECG signal can be viewed through mobile phone and can be sending to the computer for storage and this data can be accessed globally through internet. All the three cases need electrodes for measuring ECG, whereas proposed system (consider Fig.6.) uses an ECG sensor to take ECG waveform, which is a simple and costless method. Also it avoids the allergy problems due to the gel used in electrode based method. There is no need to wear this system all the time. Here data overwriting is also avoided. Along with heartbeat count, body temperature can also be taken using this method.

13. Conclusion

The Smartphone will become a common information appliance in the contemporary life. Bluetooth is one of its standard peripheral. By using a Bluetooth enabled ECG acquiring device, the Smartphone can be used to record the ECG waveform. When the user feels something wrong with the heart ECG signal can take along with that the body temperature value can also be taken. Heartbeat count and body temperature value can be send to the nearest ambulance service and to doctor when the heartbeat counts less than 30 or greater than 100. And this data can be viewed using the

Smartphone can be stored in the phone itself. By early discovery of the problem, this may alleviate the life-threatening heart attack problem.

References

[1] "A wearable ECG recording system for continuous Arrhythmia monitoring in a wireless Tele-home care situation"; Rune Fensli, Einar Gunnarson, Torstein Gundersen IEEE International Synopsium June 23-24 2005

[2] "Design of Portable ECG Recorder with USB Storage" HO, C.S. southern Taiwan Univ. Of Technol. Tainan; Chiang T.K; Lin C.H; Lin P.Y; IEEE journal 2008

[3] " A Portable ECG Recorder"; Sung-Yaun Ko, Kang min Wang; Wie-Cheng Lian, Chun Heng Kao IEEE transactions on embedded systems 2012.

