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Healthcare Measurement Of ECG Signals Using Android Mobile

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Abstract

A remote monitoring system is presented in this paper for electrocardiographic and temperature signals. It can be accessed through a web application. Here they can present an Android based portable ECG monitor .A small device will be wearing by the patient which senses the ECG data. It will throw the sensed data to the patient's Android mobile from end to end Bluetooth. The Android mobile will be having an application which will be running a heart attack discovery algorithm. If any abnormalities are found with the patient will be intimated through an audible alarm and first aid techniques will be shown to the patient in the phone's display. The chance of survival of the patient increases by the first aid instruction. The patient collect the ECG report from doctor through email so that he can prepare himself for the treatment and also a SMS containing patient's location(GPS data) will be send to the hospital so that help can be given at the earliest even if the patient is travelling. The main goal of this project can provide the heart attack detection so that the patient will be given medical attention within the first few serious hours, thus greatly improving his or her probability of survival.

Keywords: ECG, Android Mobile, GPS, GPRS

Introduction

Electrocardiograms (ECG) have long been used in the hospital environment to diagnose cardiac arrhythmias and screen for heart disease. However, patients had to be tethered to the ECG machine by a few feet of wire [1].The mobile wireless ECG system is an electrocardiogram with wireless ECG system is an electrocardiogram with wireless data transmission capabilities. With this invention patients can now move freely around their environment, allowing their caregivers to easily monitor the patient's status at any location.

ECG is used to measure the rate and regularity of heartbeats, as well as the size and position of the chambers, the presence of any damage to the heart, and the effects of drugs or devices used to regulate the heart, such as a pacemaker.

The monitoring of vital physiological signals has proven to be one of the most efficient ways for continuous and remote tracking of the health status of patients. Electrocardiogram monitors are often used in many medical service centers and hospitals to diagnose and monitor a person's health status by measuring their cardiac activity. An ECG is a non-invasive monitor, which can be utilized to evaluate the heart electrical activity, measure the rate and regularity of heartbeats, the position of the chambers, identify any damage to the heart and investigate the effect of drugs and devices used to regulate the heart. This procedure is very useful for monitoring people with (or susceptible to) impairments in their cardiac activity. In addition, during surgical procedures, the electroencephalogram (EEG) is measured along with his/her ECG to track the consciousness level of a patient during anesthesia [2]. Other physiological parameters such as oxygen saturation in hemoglobin, electromyography and blood pressure similarly provide vital information about the health of a given person when continuously monitored.

One of the invariable risks associated with space missions are the threats posed by the very harsh spatial environments to the physical and mental health of the astronauts. Being exposed to these types of environment for long periods of time has adverse impact on cardiac, muscular, and neurological functions on astronauts [3] (example of reduced gravity, high temperatures, planet dust particles, solar rays, etc). Fortunately, the continuous monitoring of physiological parameters such as electrocardiography, oxygen saturation in hemoglobin and variability of cardiac frequency may provide crucial information for a rapid diagnosis of medical conditions in astronauts; preventing the growth of any health condition to proportions susceptible to cause mission failure or even death of a crew member. The conventional telemetry system they

employ limits the freedom of movement of the subjects whose bio potentials are being measured. First of all, most of these systems receive power from an electrical outlet and are heavy enough to require wheeling to be displaced; making casual movements or urgent transportation of patients from one location to hospital. And, although such stationary conditions might be acceptable in the case of a bed-ridden patient, it cannot be used for astronauts, athletes, and politicians etc. who are required to constantly move by their activities. The alternative commercially available ECG devices which can be used under severe no stationary conditions such as athletic scientific studies are very limited and prove to be costly. These devices are also usually uncomfortable due to their heavy weight, vigorous structure and network of lead cables running from subject to monitor.

The goal of our project is to design and fabricate a Android based portable ECG monitor to help eliminate the restrictions caused by lead wires in conventional systems used in hospitals by permitting the acquisition and wireless transmission of a signal from sensor to recorder. In hospitals, my device allows a patient's vital signs to be kept track of at all times despite his/her proximity to a bedside monitor.

The device will be battery powered, double insulated and isolated. Audio and visual alarms will also be implemented into the device (Android mobile) in order to warn the user when a measured parameter reaches a critical level. Furthermore it will show the first aid details on the screen.

Problem Statement

Using current electrocardiograms in hospitals can be a time-consuming and unsanitary task [5]. Connecting and disconnecting ECG leads from hospital room to hospital room takes up valuable time that nurses could be using to focus on the patient's ailment. Changing wires also introduces bacteria to the patient, further increasing the risk of infection.

During a heart attack, heart muscle is depraved of oxygen and will literally die if the artery remains blocked. The first few hours are critical in saving much of the dying heart muscle and preventing permanent heart damage. Unfortunately, the symptoms vary and the most common reason for critical delays in medical treatment is lack of early warning and patient unawareness. It is possible to detect the onset of a heart attack and eliminate patient error using this project.

The current systems are very heavy and very costly. Thus a patient can't carry it with him all the time while he is doing his work. The current systems which have automatic diagnosis will cost more than 75K.

Motivation

The number of deaths caused by heart attacks is about 25% of the total deaths in India. This occurs due to the delay in detecting the symptoms or lack of early diagnosis. This can avoided by integrating the mobile computing technologies with healthcare systems. Which will lead to the detection of abnormal heart rhythms and predict heart attack before it occurs.

Project Objective

Project objective is to develop a Portable ECG monitor that will continuously monitor the ECG. It will notify the user and the doctor through email if any irregularities occur. If the signal is above the critical threshold then it will generate alarm and it will also send the GPS location to the hospital so that help can be provided at the earliest. This project will allow a patient to move freely and at the same time can be monitored continuously.

Literature Survey

Currently there are a few mobile electrocardiograms being implemented. But they do not have any automatic detection method to diagnose illness. Whenever heart discomfort occurs patient have to press a button which will lead to the generation of ECG and will be send to the physician who have to manually interpret the ECG[6].

Other device in market is Zenicor-ECG [7], here the patient have to take reading at regular intervals and the doctor have to manually detect the variation in heart rhythm. The readings are user initiated and the data will be send to a database. The doctor has to manually check the database and then only the problem can be diagnosed. If the more number of patients are using Zenicor-ECG it will take a lot of time for the doctor to check the report and the checking interval will increase as the number of patient's increases.

The OMRON HCG-801[8] can record and store electrocardiogram (ECG) measurements of your heart rhythm. Each ECG reading records an approximately 30-second measurement and these ECG readings can help your doctor monitor your

condition. The monitor is supplied with an SD memory card that can store up to 300 measurements, including the ECG data along with the date and time of measurement. The main disadvantage of this is it doesn't have leads that attach to the body the device has to be kept in a particular angle in order to get correct measurement otherwise the data acquired will be not accurate and will lead to wrong diagnosis. And also it doesn't have wireless capabilities so the patient has to physically carry the device to the doctor in order to diagnose the problem.

The Ambulatory Data Acquisition System (ADAS) is composed of the recorder base (Fig.1) and the signal input module. The recorder base acquires signals from twelve sensors through the signal input module. This can measure ECG, body position, limb position, heart rate, blood pressure, skin temperature, respiration and skin conductance level. After the sensors pick physiological signals, they are processed, displayed, saved and transmitted to a HRF portable computer (PC), which allow the users to setup the recorder base and view the signals [9].

The reception and visualization interface was developed in java, under platform Net beans. Such interface make possible to visualize both of the signals simultaneously. Also it allows sending them via IP to a web server and storing them in a configured database with patient's registry. This application is developed to fill medical personnel information requirements (Fig. 2).

For mobile communication, a library called Amarino was used. This is constituted by three main parts: the first one, for Operating systems using Android, the second one, which uses the Meet Android library installed inside the folders of Arduino and a third one called Plugin Bundle [10]. Fig. 3, shows the steps for Bluetooth device registry.

The mobile device is previously programmed to complete the connection to Bluetooth module by using the information about MAC address. Once the application "Receptor SenalesBiomdicas" connects the transmitter, data reading process starts. In the application the user can select the type of signal to visualize (Fig 2.).

The Life Sync Wireless ECG System is an innovative method for monitoring a patients ECG without the attachment of any data cable between the electrodes and the monitor. This device (Fig.1) is composed of a patient transceiver, which acquires the bio potential via leads attached to 3 or 12 electrodes placed on the subject's skin. This unit is usually worn on the arm. Once, the signals are acquired, they are amplified and wirelessly transmitted using a Bluetooth module embedded in this first unit to a secondary unit, the monitor transceiver. The monitor transceiver is connected via input cables to a conventional monitor which then processes the signal as usual: numerical display of heart rate, graphical display of waveform, etc. [10].

The two units together make up for a small very low weight system (i.e. patient transceiver has dimensions of 8 x 12.5 x 3 cm and weight of 240 g) that allows its users more freedom of movement without jeopardizing continuity of ECG monitoring. It also, eliminates the need for detaching and reattaching lead wires when a patient needs to be transported [11]. The absence of heavy obstructing cables also reduces the amount of noise that interferes with the signal displayed on the monitor as a waveform. The main disadvantage of this is its just act as a wireless sensor and nothing else. It can't display the ECG nor it cananalyse it. It still needs a general and heavy ECG monitor which weighs more than a kilo.

HOSPITAL BEDSIDE MONITORS are generally used in hospitals to monitor the health status of patients. One of the distinct features of these monitors is their usually bulky sizes, making them bedside appliances rather than portable ones as they are sometimes marketed to be. The specifications of these must be thoroughly considered since it constitutes one of the basis for the minimum required specifications for the system proposed here. These systems has a
frequency response range of 0.05 – 100 Hz

Drawbacks of Existing Systems

- Does not have any automatic detection method
- Somebody has to watch over the reports for abnormality
- Some of them take reading only at the time of heart attack by pressing a switch, which won't be of much help.
- Report should be uploaded to a computer for transferring it to the physician
- The ECG monitor which has automatic detection algorithm is bulky and costly

System Design

Proposed solution

The proposed prototype is a portable ECG monitor based on android. A patient will wear the mobile ECG monitor that gathers heart rhythm data and transmits it wirelessly to an android phone for storing and analysis. The android phone will be running detection algorithms to automatically detect abnormal variations in heart rhythm. Since the android is based on Linux it will be easy to port it to other Linux based platforms like PC or PDA etc.

The detection of abnormal heart rhythm will be performed by the android phone which can be achieved by introducing a new detection algorithm using the possibilities of image processing. If any abnormal event occurs it will send an SMS to the ambulance which will be containing the patient's location (GPS data) which will help the ambulance to reach faster. And a copy of the ECG will be send to the physician through GPRS so that he can make necessary arrangements. The overview of the proposed system is shown in Fig.4.

Advantages

- Automatic detection of heart attack
- Alert the user and tells him how to perform first aid
- Alert the ambulance service along with the location
- Alert the physician so he can prepare for the treatment
- No need of frequent visit to hospital
- No need of additional computer for transmitting the report

Disadvantages

- Unavailability of networks leads to failure in alerting ambulance and doctor
- As I am using Bluetooth power consumption will be more

Methodologies

Proposed system overview is shown in Figure 4. A circuit will be worn by the user which will be connected to the android phone using Bluetooth connection. Android phone will process the signals. Detailed description of the sender and receiver is specified below

At the sender (ECG monitor)

Figure 5 shows the function of sender that is the circuit worn by the patient.
Sensor leads will detect the weak electric signal generated by the beating of the heart. The weak electric signal will be amplified by amplifiers. Then the resulting amplified signal will be send to the receiver.

B.At the receiver (Android phone)

Receiver function is shown in figure 6. The receiver receives the data send by the circuit and it will display the ECG in its screen.

At the same time the application will calculate the values and it will compare it with the threshold. If the calculated value crosses the threshold value then three alarms are raised.
First alarm is for the user which will inform the user that he is going into a cardiac arrest and it also includes instructions for first aid.

Second alarm is for the ambulance driver in the form of an SMS. This SMS includes the location of the user so that he can be taken to the hospital with less time.

The third alarm is for the doctor in the Form of an E-MAIL which contains the ECG signal. The doctor can make the necessary arrangements before the patient is brought to the hospital hence saving the time and will increase the chance of patients survival.

Modules

The major components of the system are the software at the receiver part (Android phone) and the hardware circuitry at the sender part. The software part consist of the algorithm to detect heart attack, warning alarm, sending report to email and location to mobile.

FIGURES
The hardware at the sender consist of the sensors, Bluetooth module, noise reduction circuit, battery etc.

Conclusion

An effective heart attack detection system is proposed in this project. It helps to reduce deaths caused by heart attacks since the main cause of heart attack deaths are due to delay in proper treatment. This can be avoided since the system will notify the doctor with ECG report and his present location.
Since the android is based on Linux it will be easy to port it to other Linux based platforms like PC or PDA etc.

Future Work

This idea can be further modified to add biometric authentication using ECG. The problem of remembering password can be avoided.

The circuit can be modified in such a way that it can be implanted on the body.

The algorithm can be expanded to detect additional heart ailments.

Fig.1 The base recorder of ADAS

Fig. 2. Bluetooth linking. (a) Searching. (b) Localizing. (c) Connection.

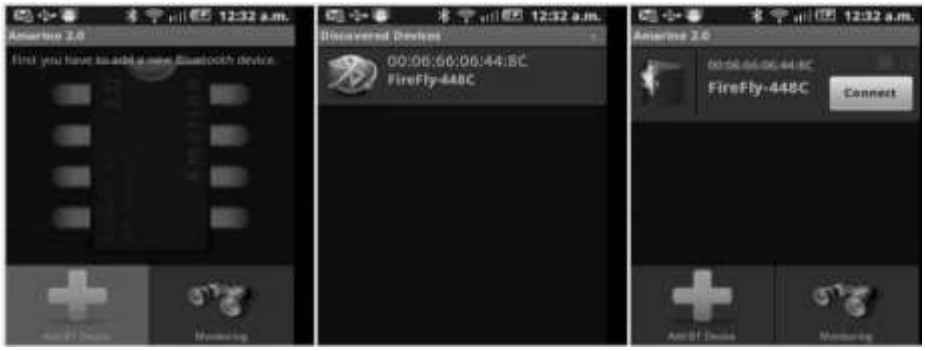
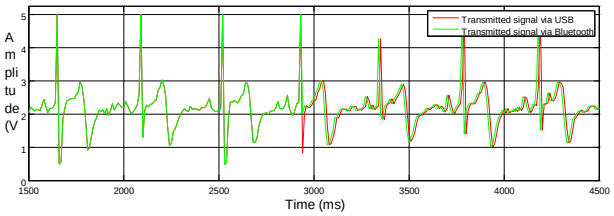
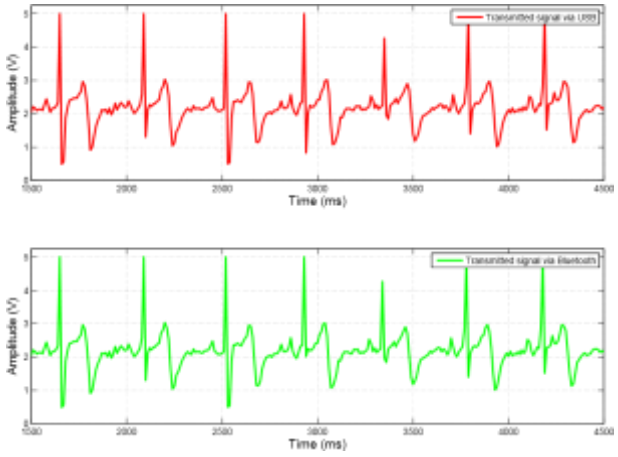


Fig. 3. Visualizing Menu.



Transmission Delay between Bluetooth and USB Wired Signals.

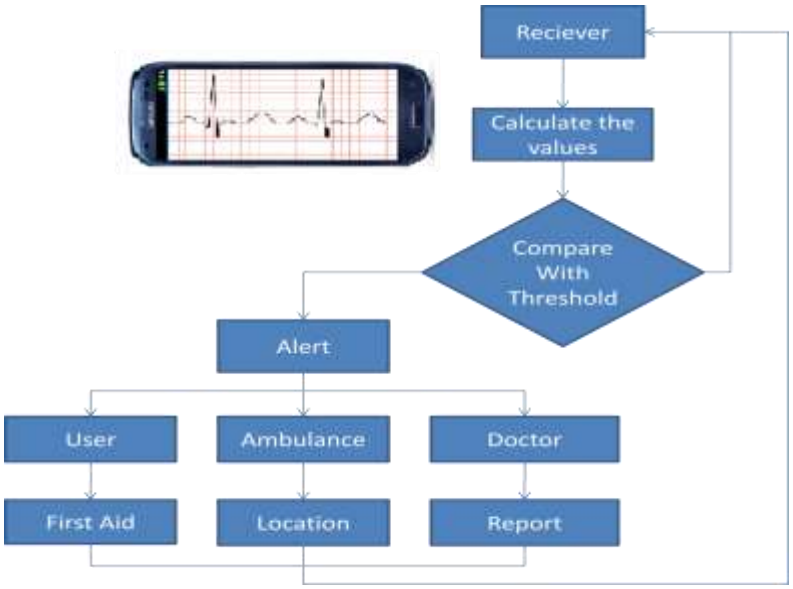


Signals obtained by Bluetooth and Signal Wired Cable.

Fig 4. Proposed system overview

Fig. 5 Sender (ECG monitor) Architecture

Fig. 6 Receiver (Android phone) Architecture



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