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Real Time Heart Attack and Heart Rate Monitoring Android Application

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***Abstract:** Technological innovations in the field of disease prevention and maintenance of patient health have enabled the evolution of fields such as monitoring systems. This concept deals with the detection of heart attack and heart rate monitoring. It is an android application which continuously monitors the patient's heart beat rate and sends appropriate notifications to the registered users. This will help doctors to monitor the health of remotely located patients, thus enabling a smart health care system. This project can help save the lives of patients in nick time.*
***Keywords:** heart attack, heartbeat, remote monitoring, android application*

I. INTRODUCTION

Heart rate is the number of heartbeats per unit of time, typically expressed as beats per minute (bpm). Heart rate can vary as the body's need to absorb oxygen and excrete carbon dioxide changes during exercise or sleep. The measurement of heart rate is used by medical professionals to assist in the diagnosis and tracking of medical conditions. It is also used by individuals, such as athletes, who are interested in monitoring their heart rate to acquire maximum efficiency. Heartbeat rate is one of the very important parameters of the cardiovascular system. The heart rate of a healthy adult at rest is around 72 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate at which the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher than normal heart rates are known as tachycardia. Most heart rate monitoring devices use a design where the signal is acquired from the subject and a filtering function is applied to remove the high order harmonics and noise from the signal. This is then followed by a hardware or software that uses a zero-crossing algorithm to count the number of beats during a given time interval (e.g. 0 and 0). The zero-crossing algorithm may lead to false readings caused by local noise that may result in multiple local zero crossings. This is a reliable technique that guarantees the automatic filtering of any transient noise in the signal.

A heart rate monitor is a personal monitoring device that allows a person to measure the heart rate in real time or record for later study. Early models consisted of a monitoring box with a set of electrodes leads attached to the chest. The heart rate of a healthy adult at rest is around 72 beats per minute (bpm) and that of a baby will be at around 120 bpm, while older children have heart rates at around 90 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate when the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher is known as tachycardia [3].

Heart rate is simply measured by placing the thumb over the subject's arterial pulsation, and feeling, timing and counting the pulses usually in a 30 second period. This method although simple, is not accurate and can give errors when the rate is high. More sophisticated methods to measure the heart rate utilize electronic techniques. Electro-cardiogram (ECG) is one of the frequently used methods for measuring the heart rate. But it is also an expensive device. Other devices in the form of wrist watches are also available for the instantaneous measurement of the heart rate. Such devices can give accurate measurements but their cost is usually in excess of several thousand rupees, making them uneconomical. So, the proposed heart rate monitor with a heart-beat sensor is definitely a useful instrument for finding the pulse and the temperature of the patient [4] [6].

There are devices which provide an accurate reading of the heart rate using optical technology using standard infrared Light Emitting Diode (LED) and photo-sensor to measure the heart rate using the index finger. A microcontroller programmed to acquire the signal using its embedded analogue to digital converter, ADC, and use the readings to compute the heart rate; eventually, the reading is digitally displayed on an LCD.

A. ANDROID APPLICATION

Android provides a rich application framework that allows you to build innovative apps and games for mobile devices in a Java language environment. The documents listed in the left navigation provide details about how to build apps using Android's various APIs. Android apps are built as a combination of distinct components that can be invoked individually. For instance, an individual activity provides a single screen for a user interface, and a service independently performs work in the background.

From one component you can start another component using intent. You can even start a component in a different app, such as an activity in a maps app to show an address. This model provides multiple entry points for a single app and allows any app to behave as a user's "default" for an action that other apps may invoke. Android provides an adaptive app framework that allows you to provide unique resources for different device configurations. For example, you can create different XML layout files for different screen sizes and the system determines which layout to apply based on the current device's screen size.

B. ANDROID APPLICATION

The android is a operating system and is a stack of software components which is divided into five sections and four main layers that is

- Linux kernel
- Libraries
- Android runtime

C. ANDROID RUNTIME

The android runtime provides a key component called Dalvik Virtual Machine which is a kind of java virtual machine. It is specially designed and optimized for android. The Dalvik VM is the process virtual machine in the android operating system. It is software that runs apps on android devices.

D. APPLICATION FRAME WORK

The application frame work layer provides many higher level services to applications such as windows manager, view system, package manager, resource manager etc. The application developers are allowed to make use of these services in their application.

E. GLOBAL SYSTEMS FOR MOBILE

GSM stands for Global System for Mobiles. This is a world-wide standard for digital cellular telephony, or as most people know them Digital Mobile Telephones. GSM was created by the Europeans, and originally meant "Groupe Special Mobile", but this didn't translate well, so the now common more globally appealing name was adopted. GSM is a published standard by ETSI, and has now enjoys widespread implementation in Europe, Asia, and increasingly America. There are many arguments about the relative merits of analogue versus digital, but for my mind it comes down to this: Analogue sounds better and goes further, Digital doesn't sound as good, but does a whole lot more. Examples of what digital can do that analogue doesn't (or doesn't do very well) are Fax send & receive Data calls, and Messaging.

Throughout the evolution of cellular telecommunications, various systems have been developed without the benefit of standardized specifications. This presented many problems directly related to compatibility, especially with the development of digital radio technology. The GSM standard is intended to address these problems.

F. THE GSM NETWORK

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS).

G. GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a satellite-based navigation system that consists of 24 orbiting satellites, each of which makes two circuits around the Earth every 24 hours. These satellites transmit three bits of information – the satellite's number, its position in space, and the time the information is sent. These signals are picked up by the GPS receiver, which uses this information to calculate the distance between it and the GPS satellites.

With signals from three or more satellites, a GPS receiver can triangulate its location on the ground (i.e., longitude and latitude) from the known position of the satellites. With four or more satellites, a GPS receiver can determine a 3D position (i.e., latitude, longitude, and elevation). In addition, a GPS receiver can provide data on your speed and direction of travel. Anyone with a GPS receiver can access the system. Because GPS provides real-time, three-dimensional positioning, navigation, and timing 24 hours a day, 7 days a week, all over the world, it is used in numerous applications, including GIS data collection, surveying, and mapping.

II. EXISTING METHODS

1) OPTICAL METHOD

Android based heart rate monitor which uses the camera and it's flash to determine the user's heart rate in beats per minute. It uses data smoothing in an Integer array to figure out the average red pixel value in the image. Once it figures out the average it determines a heartbeat when the average red pixel value in the latest image is greater than the smoothed average.

Wearables with optical heart-rate monitors have small LEDs on their undersides that shines green light onto the skin on your wrist. The different wavelengths of light from these optical emitters interact with the blood flowing through your wrist. When that light refracts (or reflects) off your flowing blood, another sensor in the wearable captures the information. That data can then be processed, along with motion information detected by the device's accelerometer, with algorithms to produce understandable pulse readings.

If the tip of the index finger is pressed too hard over camera, the circulation will be cut off which will result in an inaccurate reading. Devices with optical sensors that read the wrist (instead of the fingertip) had the most trouble tracking heart rate. In this method the light has to penetrate through several layers and so darker the person, the more difficult it is for light to bounce back. The skin color issue is something that this technology compensates for.

2) ELECTRICAL METHODS

Electrical Method The chest strap of a heart rate monitor uses electrodes to monitor the electric volts that occur when your heart beats. The receiver detects this information from the electrodes via radio signal from the chest strap. The receiver, then, uses this information to determine your heart rate. Some monitors also include a "coded signal" which uses a special code in the radio signal, so that the receiver does not receive radio signals from other nearby transmitters. This is not always a huge problem, but can be a problem. [7]

The disadvantage with the electronic method is that it can produce annoying or corrupt your data. This method has disadvantages like inaccurate results, hectic wired connections over the body.

Device	Error % at 80 90 BPM	Error rate at 160 170 BPM
Garmin vivofit	10.7	0.0
Withings pulse 02	5.3	57.5
Basis carbon steel	10.2	57.1
Samsung gear fit	4.2	unable to read
Samsung galaxy S5	3.1	0.2

TABLE A : COMPARISON OF ERROR RATES OF VARIOUS HEARTBEAT RATE MONITORING SYSTEMS

Heart attack (coronary artery disease) is one of the most common and very serious effects of aging. We are developing a system which will help to decrease the death rate due to the heart attack by early heart attack detection. In our system, we will be using smart Heart Beat sensor.

III. HEART BEAT SENSOR (PULSE SENSOR) AND IT'S WORKING

Heart attack detection using Heart Beat Sensor (Pulse Sensor) works on Photoplethysmography (PPG) technique. It uses an infrared light source to illuminate the finger on one side, and on the other side of the finger a photodetector is placed, this will measure the small variations in the transmitted light intensity. The light-absorbing property of haemoglobin is used in the measurement of Heart Beat rate. The light from an infrared light source on the underside of the monitor is shone on blood vessels just under the skin. The light that is not absorbed, but reflected back is captured by a photodetector. The variations in the photodetector signal are related to changes in blood volume inside the tissue. The photodetector produces an electrical signal when the reflected back light strikes it. The signal which we obtained from the sensor is an analogue signal and it is converted into a digital signal. Furthermore, the signal can be filtered and then amplified to obtain a perfect PPG (PhotoPlethysmoGraph) waveform, which is synchronous with the heartbeat.

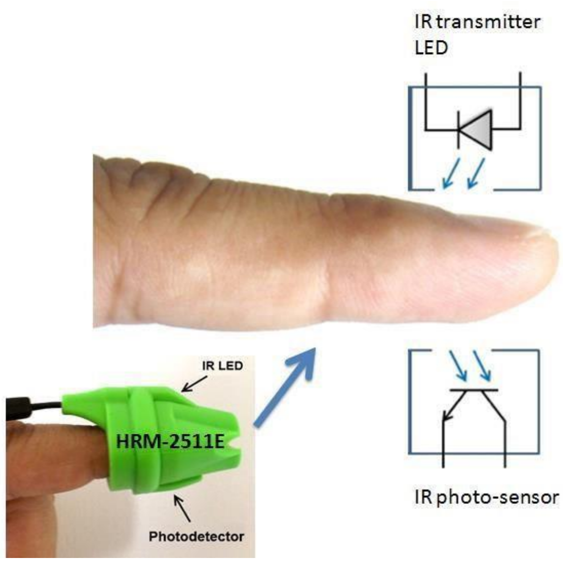

Figure 2. HeartBeat sensor working principle

Determination of heartbeat bps depends on computing the Fourier Transform of the heartbeat signal assuming a relatively high heart rate of 120 bpm.

The heartbeats per second = 120/60 =2 bps

The PPG sensor used gives accurate reading of the heart beat rate. The heart beat rate can be computed by knowing the time period of the PPG waveform. Two heart rates are computed from the three consecutive PPG peaks and their average value is displayed as an instantaneous heart rate.
Our device will compute the bps and compare the measurement against the maximum safe limit for the subject in question. The maximum safe bpm value will be computed depending on the gender of the subject and his/her age. A number of methods for calculation of the maximum safe bpm are used in the medical profession like Martha, Londeree-Moeschberger, Miller and other techniques. [5]

Age	Error % at 80-90 BPM	Error rate at 160 170 BPM
New born	100-160	30-50
0-5 months	90-150	25-40
6-12 months	80-140	20-30
3-5 years	80-120	20-30
6-14 years	70-110	15-30
14+ years	60-100	12-20

Table B : Heart rate and respiratory rates for different ages

Percentage/Age	18-35	36-64	Above 64
Normal heart rate	72–75 (BPM)	76-79 bpm	70-73bpm
Bradycardia	HR ≤ 55	HR<=60	HR<=65
Tachycardia	HR ≥ 110	HR>=120	HR>=100
Hypertension	BP ≥ 150/100	Bp>=145/95	Bp>=140/90
Hypotension	Systolic BP < 85 mmHg	Systolic BP < 96 mmHg	Systolic BP < 117 mmHg

Table c : Age-wise threshold values for adaptive alarming mechanism

IV. Fourier transform algorithm for heartbeat rate calculation

```
Initialise input and output Ports
Enter user data
Forever Do
        Acquire samples from ADC (5 Seconds)
        Compute Fourier components
        Find Heartbeat rate
        Display rate on LCD
        If HR is outside the safe range   Send SMS msg to assigned person (if not already sent)
                Switch Buzzer ON
        Else
                Switch Buzzer OFF (if already ON)
Endif
End forever
```

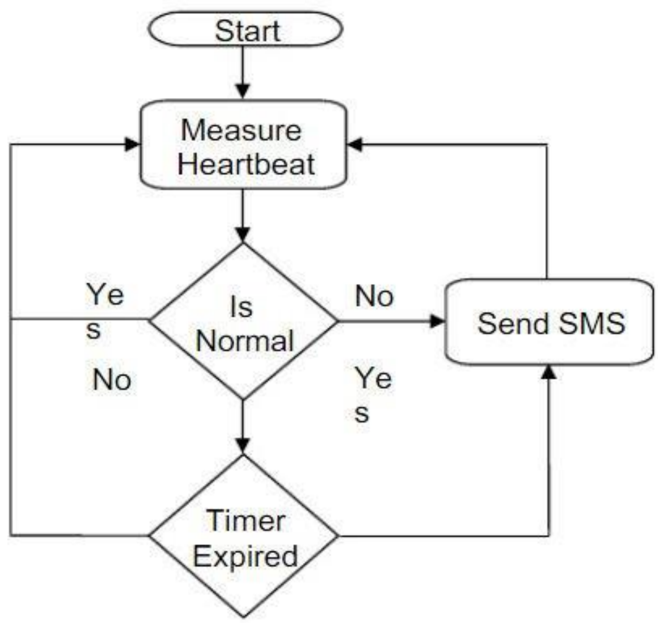

Figure 3: Flow chart for transmitter.

Three way alert mechanism via an android application:

If the heartbeat of a person fluctuates outside the predetermined range, three different notifications will be sent using GSM technology. If the notification is sent when the mobile is in silent mode, it automatically switches to general mode:

1. A notification will be sent to the medical consultant who has the mobile application. A document containing instruction for primary treatment is sent to the registered guardian.
2. A notification will be sent to a guardian who has the mobile application.
3. A notification along with the location of the patient will be sent to the nearest ambulance service using GPS technology.

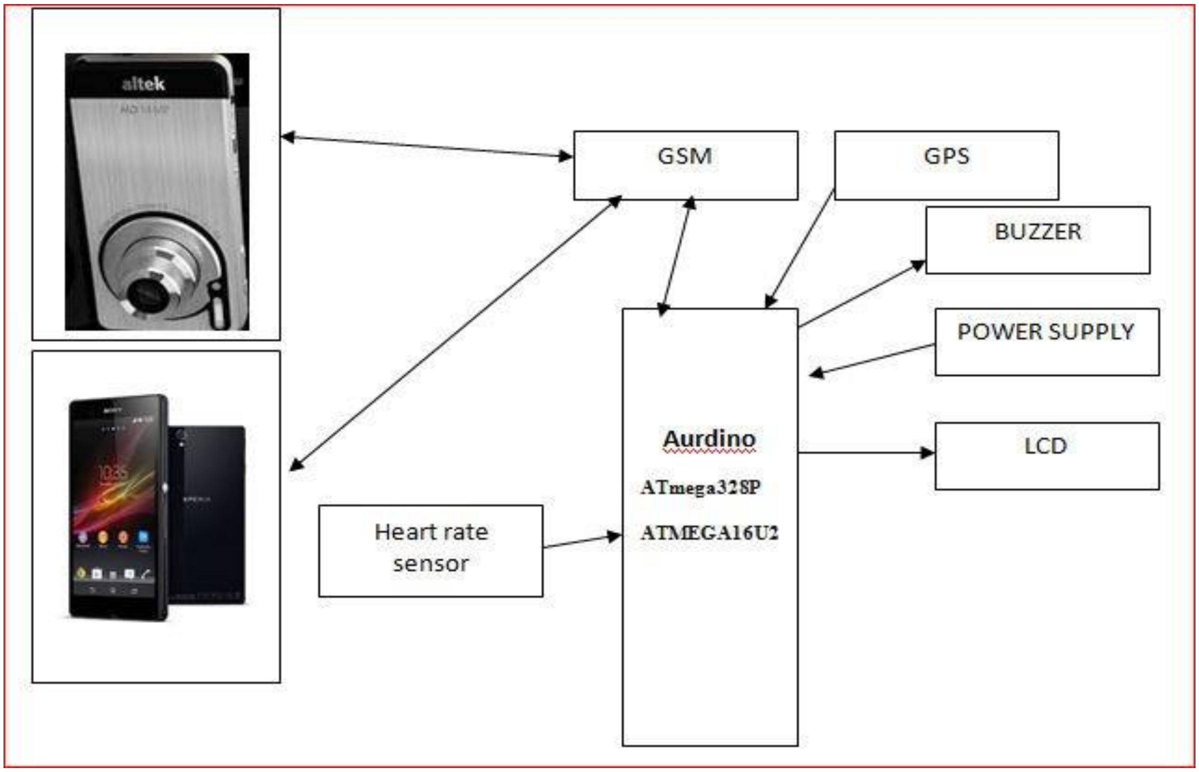

Figure 4 : Schematic representation of the system.

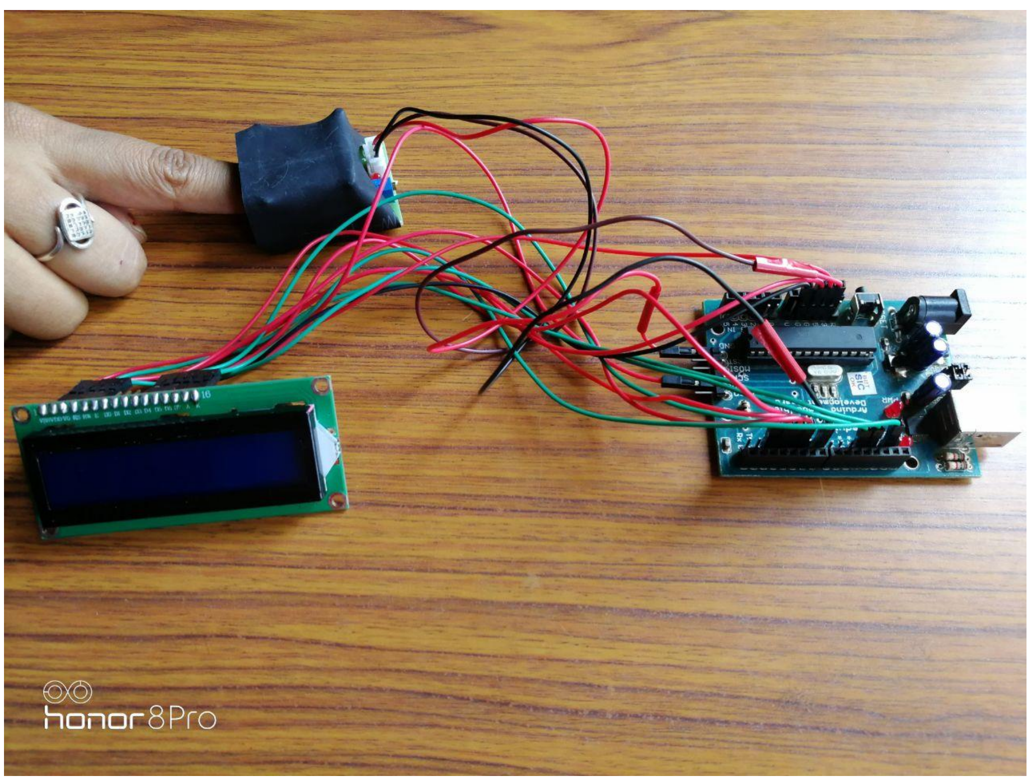

Figure 5 : Hardware implementation

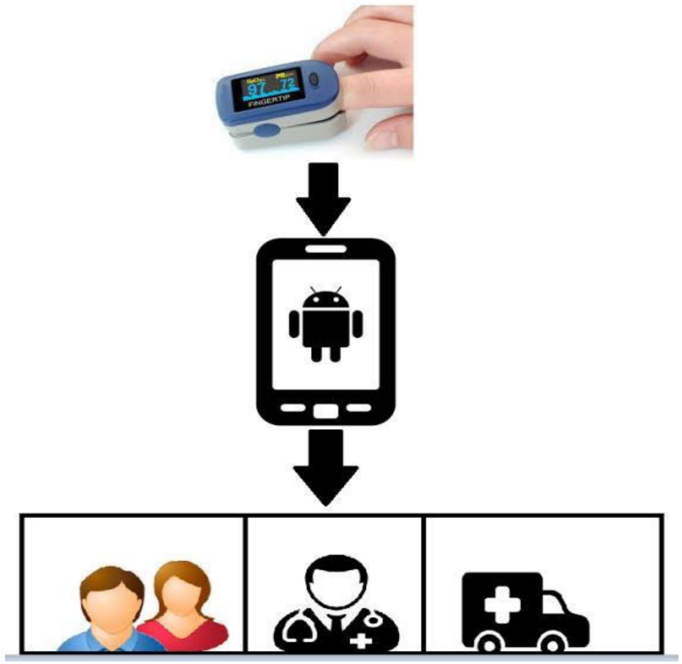

Figure 6 : Android application to send notifications to different users

V. EXPECTED RESULTS

This application will monitor the user activity and will keep a record of it. When the user's heartbeat will be under critical level, it will notify to the emergency contacts. The user has to enter the details of contact, in case of emergency. The application will also notify to the ambulance service. The app will be monitoring the heartbeat of the user and changes the critical level according to it or it can be manually entered by the user. Critical level varies from person to person.

VI. CONCLUSION

Biomedical engineering (BME) combines the design and problem-solving skill of engineering with medical and biological sciences to improve patient's health care and the quality of life of individuals. Cardiovascular disease is one of the major causes of untimely deaths in the world, heart beat readings are by far the only viable diagnostic tool that could promote early detection of cardiac events. By using this we can measure one's heart rate through fingertip. This paper focuses on the heart rate monitoring and alert which is able to monitor the heart beat rate of the patient. The hardware setup enables us to determine the heart beat rate per minute and then send notification to the mobile phone. It is portable and cost effective. It is a very efficient system and very easy to handle and thus, provides great flexibility and serves as a great improvement over other conventional monitoring and alert systems.

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