**The Development of Heart Rate Detection Using Arduino Microcontroller and Android**

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**Abstract.** Nowadays heart attack is becoming a very deadly disease of human. This attack cannot be predicted, but it can be known from the human heartbeat which is a very vital health parameter of the human cardiovascular system. Heart rate reflects the health conditions of the human cardiovascular system that determined by such as stress at work, before or after sports and the psychology factor. Unfortunately, some people do not know their heart rate before or after doing an activity. This paper proposes of measuring technique of heart rate by using pulse sensor, Arduino microcontroller, and Android Smartphone. It is based on the principle of measuring the variation of blood volume in our body using a light source and detector. We also measure the heart rate by using the ECG or EKG (electrocardiogram) waveform as the comparison result of the pulse sensor with ECG waveform. The sensor consists of an infrared light-emitting-diode (LED) and a photodiode. The LED transmits an infrared light into the fingertip which is reflected back from the blood inside of finger arteries. The results show that this tool can detect the value of the heart rate and is displayed on the screen of an Android. The sensor takes under 10 seconds to detect the value of the heart rate. Notification via SMS will be sent the heart rate such as under normal conditions (BPM, Beat Per Minute <50, normal (BPM = 60 to 100) or above normal (BPM > 100).

1. Introduction

The heart attack or myocardial infarction occur when there is a reduced or blockage of blood flow. This results in a heart attack which can lead to death [1]. This technology is based on various types of devices, such as embedded environment, personal devices such as cellphones, tablets, etc. Many patients use this device [2].

Data from the World Health Organization (WHO), the main cause of death in the world is Cardiovascular Disease (CVD), almost representing all global deaths. Around the world very many people die of heart attacks or strokes every year. [3], developed a heartbeat detector to avoid the heart attacks. Sudden death from someone who has a heart attack often occurs because they do not know that the pain is due to a heart attack. Most people consider heart attack pain as a pain from several other physical problems such as the stomach. If you know what the pain really is, then we can minimize the victim. The condition of our heart can be measured by heart rate. [4], described monitoring of SPO2 and heart rate in order to know the condition of heart attack from several problem.

In recent years, medical technology has developed rapidly by using computer science components. Scientists have developed various devices to detect patients’ heart attacks early. There are several
basic functions called Vital Signs that can be measured from someone, which shows their physical condition whether the condition is normal or not. Through vital signs, most medical conditions can be diagnosed and confirmed by several special test kits of these signs. Every vital sign is measured using special equipment. There are four vital signs, which become the standard measurements of cardiac indications, including Pulse rate, respiratory rate, blood pressure and body temperature.

In medical science, "Pulse" is defined as rhythmic expansion and arterial contraction that describes each heartbeat. [5], have developed the microcontroller to control heartbeat rate for health care Systems. The pulse is identical to the human heartbeat. Pulse can be measured both in the neck wrist given by beats/minutes. The important for measuring beats are the fingers, wrist, neck, inside the elbow, behind the knee and ankle joint. If the pulse is higher or lower, it indicates an abnormality in the body [6].

The other works in the literature relating to heart disease is a technique for developing multi-parametric features with linear and nonlinear characteristics of HRV (Heart Rate Variability). This technique uses HRV characteristics with several experiments carried out to assess several classifiers, such as SVM (Support Vector Machine) [7]. Another work is the Mobile Stethoscope application available on smartphone devices. Apple Computer, Inc. develop a moving stethoscope. It records the sounds of the heart, lungs and intestines. However, it cannot detect the heart condition of the human body. Other scientific literature [8] works also try to use at a real time Recognition of Heart Attack in a Smart Phone.

In addition, Health-Smart has developed a breathing exercise application that can help patients practice breathing properly. Common pulse oximeters are based on different light-absorbing characteristics of oxyhemoglobin and de-oxyhemoglobin at two different wavelengths (i.e., 660 nm red and 940 nm infrared) and pulsating properties of arterial blood flow. [9], describes the heartbeat monitoring & alert system using GSM technology.

By using pulse oximeters, finger probes are used in red light-emitting diodes (LEDs) and infrared LEDs are located on one side of the probe, and photodetectors are located on the other side. [10], describe the android based heart monitoring and reporting system, in order to detect and monitor the heart rate. The transmitted light is received by the photo detector and is divided into two components. Component A is transmitted light from variable intensity that occurs during systole and is a function of oxygenated arterial blood pulses. Component B is transmitted light that has a constant intensity and is a function of various networks. The other literature [11] proposed the estimation of heart rate from Signal Using SVR (Support Vector Regression) method, in order to calculate the oxyhemoglobin saturation.

2. Methodology

2.1. System Architecture

Figure 1 shows the System Architecture. Our development system is divided into two: Hardware and Software parts. The hardware module is embedded on Microcontroller. Microcontroller serves as the main control of all the operations of the hardware components. GSM module acts as an intermediate between the sensor and the smartphone, providing a two-way communication, and connects the hardware and software modules of the system to the Android.
2.2. Hardware Design
We have assembled the hardware and electronics needed for this project. Some of the components needed for installation are Arduino Uno, Bluetooth module, Pulse Sensor, LED screen and USB cable. The microcontroller and component circuit is shown in figure 2.

![Microcontroller and component circuit](image)

**Figure 2.** Microcontroller and component circuit.

Figure 2 is the module of the Microcontroller circuit which is a media interface for data communication between the Arduino Uno and smartphone in a real time. The brief description as follows:

- Pulse the sensor is a sensor to detect heart rate disturbances that will be forwarded to the Arduino Uno Microcontroller;
• Arduino Uno Microcontroller, functions as a controller processor which is accommodate heart rate detection results by pulse sensors;
• The module of microcontroller circuit is a media interface for the data communication to the smartphone in a real time. This tool uses WiFi connectivity as a tool to connect to the internet, and then connects to the Thingspeak.com as a data container;

2.3. Software Support Design
We have developed the software to support this project are as follows:
• We use Java language for Android and C language for Arduino Uno microcontroller programming.
• Using SIM 808 devices as GPRS / GSM and GPS.
• Using the Pulse Sensor Module as a vibrating detector that is connected to the finger and sending the heart rate of the user to the Android smartphone.

Figure 3 shows a part of the source code of Arduino application.

3. Results and Discussion

3.1 The Arduino Uno Software
The Arduino Uno program module is built using the C programming language and the Arduino’s compiler. The. in extension program file is then inserted into the Arduino Uno microcontroller via a MINI USB cable.

3.2 C-BPM Results
Figure 5 shows an example of the C-BPM (Count-Beat Per Minute) results of pulse sensor detection in real time on a smartphone monitor. The smartphone monitor can display the value of heart rate, pulse wave, time between heart rate and heart rate curve. The smartphone will give the warning if a heart rate is in an emergency situation, so it can to avoid the users from sudden death.
Manual testing via ECG (electrocardiography) is carried out to determine the value of the heart rate with high accuracy. In this test, the tool will be detected in normal and abnormal conditions. The results are shown in figure 5.

The example of ECG results obtained at 63 bpm as shown in figure 6.
Table 1. Result

| Type     | Morning (Normal) | After Sports | Evening (End of Activity) |
|----------|-----------------|--------------|---------------------------|
| EKG      | 63 BPM          | 91 BPM       | 79 BPM                    |
| Pulse Sensor | 56 BPM        | 92 BPM       | 80 BPM                    |
|          | 78              | 121          | 81                        |
|          | 62              | 56           | 90                        |
|          | 42              | 140          | 122                       |
|          | 60              | 120          | 69                        |
|          | 79              | 115          | 72                        |
|          | 120             | 87           | 73                        |
|          | 42              | 112          | 72                        |
|          | 60              | 98           | 83                        |
|          | 60              | 95           | 106                       |
| Average  | 65.9            | 100.6        | 84.8                      |

According to the results, there are found that in the abnormal conditions, the heart rate count is more than when the user is in normal condition. If the heart rate condition is detected abnormally by the pulse sensor, the results will be seen on the smartphone monitor and the smartphone will generate a warning sound automatically.

4. Conclusions

Based on the discussion and the results of the research, it was concluded that heart attack detection system development, has successfully built by using a microcontroller and an Android smartphone. This tool works in accordance with the instructions carried out by the program and displays the results on the LED (Light Emitting Diode) and also the Android device screen. The average error rate for measuring heart rate is 2.9 BPM (beats per minute) when compared with the manual method. The accuracy value of the tool against the ECG calculation is 95.5994%. The detected heart rate varies according to body condition and sample activity. By this tool, the smartphone can continuously monitor in a real time the conditions of the user. We hope can to avoid death caused by sudden heart attacks.

References

[1] Yang and K. Tang 2015 A Pulse Oximetry System with Motion Artifact Reduction Based on Fourier Analysis Int. Symposium on Bioelectronics and Bioinformatics, pp. 1–4. 2015.
[2] P An and M Zeng 2012 Pulse Monitoring System Based on Feedback Algorithm Proc. of World Congress on Intelligent Control and Automation pp.4211-4214. Beijing
[3] Bhagya L, Hariharan R, Udaya S, Nandhini D P and Sowniya N 2015 Heart Beat Detector using Infrared Pulse Sensor Int. J. for Scientific Research & Development 3 9
[4] Sagar C. et al 2014 Ubiquitous Physiological Monitoring of SPO2 and heart rate Int. J. for Research in Technological Studies 1 2
[5] Souvik Das 2013 The Development of a Microcontroller Based Low Cost Heart Rate Counter for Health Care Systems Int. J. of Engineering Trends and Technology 4 2
[6] Komkrit C and Pongpat M 2016 Wireless Heart Rate Monitoring System Using MQTT. Procedia Computer Science 86 p.160-163.
[7] M Magno, C Spagnol, L Benini and E Popovici 2014 A low power wireless node for contact and contactless heart monitoring Microelectronics Journal 45 12 p.1656-1664.
[8] Rad M.Z, Ghuchani S R, Bahaadinebgly K and Khalizadeh M M 2015 Real Time Recognition of Heart Attack in a Smart Phone. Journal Acta Inform Med 23 3 p. 151-4.
[9] Ufoaroh S U, Oranugo C O and Uchechukwu M E 2015 Heartbeat monitoring & alert system using GSM technology Int. J. of Eng. Research and General Science 3 4
[10] M. Navale, et al. 2014 Android Based Heart Monitoring and Reporting System *Int. J. of Advanced Research in Computer and Communication Engineering* 35

[11] Remya R R and Smily J J 2014 Estimation of Heart Rate from Photoplethysmographic Signal Using SVR Method *The Int. J. of Science & Technology* 22

[12] Prisma M F, Fajar A, Irawan E P and Muhammad A S 2019 Based-on microcontroller using combination of perturb observe and constant voltage algorithm *J. Adv. Res. Dyn. Control Syst.* 11 8 p. 3268–3277