

REPUBLIC OF TÜRKİYE

ALTINBAŞ UNIVERSITY

Institute of Graduate Studies

Department of Computer Engineering

**EARLY PREDICTIVE ANALYSIS FOR HEART ATTACK IDENTIFICATION**

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Master’s Thesis

Supervisor

Dr. Timur INAN

Istanbul, 2023

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2023

The thesis titled EARLY PREDICTIVE ANALYSIS FOR HEART ATTACK IDENTIFICATION prepared by MUHAMMAD ZARYAB KHAN and submitted on 03/02/2023 has been **accepted unanimously** for the degree of Master of Science in Information Technologies.

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I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Muhammad Zaryab KHAN

Signature

DEDICATION

This work is dedicated to my supervisor, who provided guidance and support throughout the journey, and to my family, including my mother, father, brothers, wife, and friends, who helped me through challenging times. Their support and assistance acted as a catalyst that kept me motivated and moving forward.

PREFACE

I am overjoyed and extremely grateful to have reached this stage in my master's studies. I owe this success to my supervisor, Dr. Timur INAN, whose unwavering guidance and support have been invaluable to me. His assistance in our weekly discussions and his ability to help me overcome obstacles and make constant progress on the research topic have been critical to my success. His insightful observations have allowed me to view the research subject from a more objective and comprehensive perspective. Without his time and effort, I would not have been able to reach this point. I am extremely thankful to have had the opportunity to work with him on this fascinating topic.

# ABSTRACT

EARLY PERDICTIVE ANALYSIS FOR HEART ATTACK IDENTIFICATION

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Date: May / 2023

Pages: 46

This thesis investigates the evolution of an early predictive analysis system for the identification of heart attacks, with the help of Arduino. The purpose of this research is to design and develop a reliable and cost-effective mechanism that can accurately identify the risk of a heart attack before it occurs.

The proposed system utilizes an Arduino microcontroller board to accumulate and process real-time data from a range of sensors, including heart rate, blood pressure, and other vital signs. The collected data is then transmitted to a machine learning algorithm, which analyzes the data and speculate the likelihood of a heart attack occurring.

The system is designed to trigger an alarm if the predicted risk of a heart attack exceeds a predefined threshold. This alarm can be sent to healthcare providers or family members, allowing for timely intervention and prevention of heart attacks.

The system's reliability and accuracy were evaluated through extensive testing on a dataset of patient records, which demonstrated a high level of accuracy in identifying individuals at risk of experiencing a heart attack. The system's low cost and portability make it accessible to a broader range of users, particularly those in developing countries or with limited healthcare access.

The findings of this research have significant implications for the prevention and treatment of heart disease, particularly in underserved communities. The system developed in this research demonstrates the potential of using low-cost and accessible technology such as Arduino to develop early predictive analysis systems for heart attack identification.

**Keywords:** Early Prediction, Predictive Analysis, Heart Attack, Cardiovascular Disease, Risk Assessment, ECG Signals, Patient Monitoring

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ABBREVIATIONS

|  |  |  |  |
| --- | --- | --- | --- |
| ADC | : | Analog-to-Digital Converter |  |
| AS | : | Android Studio |  |
| BP | : | Blood Pressure |  |
| CVD | : | Cardiovascular Disease |  |
| DB | : | Database |  |
| DC | : | Direct Current |  |
| ECG | : | Electrocardiogram |  |
| GND | : | Ground |  |
| GPS | : | Global Positioning System |  |
| GUI | : | Graphical User Interface |  |
| HR | : | Heart Rate |  |
| IBI | : | Inter-Beats Interval |  |

# INTRODUCTION

Nowadays, there is an increasing amount of people who are experiencing fatalities caused by heart attacks. A heart attack can happen when the blood supply to the heart is obstructed. Unfortunately, due to delayed detection of heart attacks, we are not able to rescue the lives of a significant number of individuals [1]. Healthcare systems are generally divided into two categories, hospital-based and home-based, and are usually found in urban region of a country. However, traditional healthcare systems are currently encountering multiple difficulties, including limited accessibility, outdated technologies, issues with tracking, monitoring, and reporting patient and disease statuses, as well as high expenses. Despite these challenges, technological advancements in fields such as cloud computing, mobile, IoT and web development, and computer technology have provided new possibilities for developing an effective healthcare system that can benefit everyone. These innovative technologies can automate patient monitoring, transmit medical information in real-time, store data in cloud servers, modify data for future use, present real-time situations to relevant parties, and offer many other benefits [2]. The World Health Organization (WHO) reports that about 17.9 million individuals die annually from cardiovascular illnesses, with more than four out of five deaths being caused by heart attacks and strokes. It is concerning that individuals below the age of 70 account for one-third of these deaths [3].

In the new era of technology and communication, including smartphones and tablets, has become an integral aspect of modern life in this era of technology and communication. The next phase of this interconnected world is known as the Internet of Things (IoT), which involves the connection of devices, sensors, appliances, vehicles, and various other objects. These objects may include tags, mobile phones, sensors, and actuators, among others. Through the IoT, it is possible to obtain statistic about any object. The aim of the IoT is to enhance the advantage of the internet by incorporating devices, sharing information, maintaining constant connectivity, and utilizing embedded sensors that collect data continuously. All devices are linked to local and global networks [4]. Therefore, detecting cardiac abnormalities early and having tools to divine heart disease can potentially save numerous lives and allow physicians to develop effective treatment plans that can reduce the mortality rate associated with cardiovascular disease. The advancement of healthcare systems has led to an abundance of patient data, such as Big Data in electronic health records, which can be used to develop forecast models for cardiovascular disease. Data mining, also known as machine learning, is a method of discovery that can be used to analyze vast amounts of data from various perspectives and convert it into beneficial information. " Data mining refers to the non-trivial extraction of implied, previously anonymous, and potentially valuable facts from data". Currently, the healthcare industry generates a significant amount of data on disease diagnoses, patient profiles, and so on. Data mining offers several techniques for discovering hidden patterns or similarities in the data. A heart disease prediction system can be implemented using machine learning algorithms, validated with two freely available heart disease prediction datasets, and medical histories such as age, gender, blood pressure, and diabetics levels to indicate the possibility of heart diseases. A web-based questionnaire application can be used as an approach to diagnosing patients with cardiac disease, which can serve as a training tool for nurses and medical students. While cardiac patients are continuously monitored through ECG and heartbeat monitoring in hospitals, there is a possibility of disease recurrence once they leave the hospital. To overcome this, patient data such as temperature, heart rate, ECG, and position can be measured regularly and transmitted to a server. The frequency of data transmission (e.g., every 1 minute) can be adjusted, and the person monitoring the data can learn patient-specific thresholds. For instance, if a patient's average body temperature is 37°C, exceeding 37.0°C may indicate a fever. By utilizing averages over a relatively long time, the observer can learn these thresholds for patients [5] [6].

## 1.1 MOTIVATION

The primary drive behind the project's work and objective was to provide assistance to individuals with cardiac problems who are experiencing paralysis or hypertension, or those who have undergone bypass surgery or have had a stent inserted for specific reasons. This is particularly crucial for individuals who are paralyzed and unable to communicate their emotions effectively.

## 1.2 PROBLEM STATEMENT

With the world population now exceeding 7 billion, there has been a rise in the number of deaths resulting from cardiovascular diseases. A report by the World Health Organization (WHO) states that 17.9 million individuals die each year due to such diseases, which constitutes 31% of all global deaths. Of these fatalities, 85% are a result of heart attacks and strokes. Cardiovascular diseases, encompassing heart attacks, strokes, and other circulatory conditions, are the primary reason for premature death worldwide. In low and middle-income nations, over 75% of deaths resulting from cardiovascular diseases occur.

* + 1. Make people who are paralysis and cannot express their heart pain.
    2. Helping old people they cannot monitor their health.

## 1.3 CONTRIBUTION

Heart disease is a major public health concern, and heart attacks are a leading cause of death worldwide. Early detection of heart attack symptoms is critical to improving patient outcomes and reducing mortality rates. Predictive analysis models offer the potential to identify individuals at high risk of heart attacks before symptoms appear, allowing for timely medical intervention and preventative measures. The implementation of such models in clinical settings could optimize patient care and reduce the burden on emergency departments. The use of machine learning algorithms and artificial intelligence could enable more accurate and reliable predictions of heart attack risk. Furthermore, the integration of data from multiple sources, such as electronic health records, wearable devices, and genetic data, could enhance the predictive power of these models. The development of early predictive analysis for heart attack identification has significant potential for improving patient outcomes and healthcare efficiency, making it an important area of research for the future.

## 1.4 AIM AND OBJECTIVE

The objective of this thesis is to create an affordable and efficient device that can measure an individual's heart rate and detect heart attacks. This is achieved by placing sensors on a finger or any area on the body where the heart rate can be estimated and exhibiting the results on the serial screen of an Arduino software engineer. The system is based on an Arduino Nano microcontroller and is designed to be compact, providing an advantage over traditional tape-based recording systems for heart rate monitoring:

* + 1. People who are paralyzed partially or completely.
    2. People who have mental illness or mental disability.
    3. Old people and people who have lack of medical knowledge.

## 1.5 DESIGN AIMS

This project focus to build a gadget that will help to detect heart attacks that can get input from a finger sensor and send it to our mobile or web, it will also identify heart-related diseases, and will provide suggestions for medicine.

* + 1. Collecting pulse from finger using the sensor.
    2. Transmitting the data of pulse to android device for processing.
    3. Once data sent to android device, the device would open up the patients. health condition. According to the condition of the patient it would notify the kind to disease or problem the patient is suffering from and provide with appropriate medication or prescription.

Our device will be having the dataset of all heart related diseases and their medication, so when the information is taken from the patient it will be matched with the dataset in the system, then upon accurate match or nearest match the disease would be detected and along with it the medication and treatment will be provide.

## 1.6 SCOPE OF THE RESEARCH

The project encompasses two key aspects, namely hardware, and software. Concerning hardware, the project involves the creation of ECG circuits that can interpret data from an ECG simulator, which mimics the data that would be received from a patient's ECG. Furthermore, a temperature sensor was developed to estimate the body temperature of a human. Both systems are operated by an Arduino uno board and require programming. The Arduino Nano board is linked to a Bluetooth module. As for software, the project utilizes the Arduino IDE software as programming language.

The thesis consists of five primary chapters which are:

1. Chapter One: This chapter presents a comprehensive summary of the project, covering various aspects such as its context, goals, driving factors, range, and organization the thesis.
2. Chapter Two: This chapter provides a concise introduction to the heart and its functioning, followed by a review of literature on remote health monitoring system.
3. Chapter Three: This chapter outlines the approach taken in designing the system, it's functioning, techniques used in its implementation, and a detailed description of the individual components utilized.
4. Chapter Four: In this chapter, the outcomes of the system's implementation are presented along with a concise analysis of these results.
5. Chapter Five: This section provides a conclusive summary of the project's outcomes and discusses potential opportunities for future improvements to enhance the project's performance.

# LITERATURE REVIEW

## 2.1 OVERVIEW

The assessment of vital signs is crucial as they reflect the overall health of an individual. Variations in these signs can indicate an underlying health issue. Many medical diseases can be detected by observing changes in one or more vital signs. Unfortunately, the current devices available for measuring vital signs are often bulky and not easily portable. Thus, this proposal recommends using a wearable armband that functions as a disposable heart rate monitor and a mobile phone as a diagnostic tool to address this issue [7].

In most therapeutic settings, four essential signs are commonly used.

1. The Pulse rate of the patient.
2. The Respiratory rate of the person.
3. The Blood Pressure rate of the person.
4. The Body temperature of the patient.

## 2.2 HEART

The heart, located in the middle of the chest, is responsible for circulating blood throughout the body. It is an internal organ surrounded by the lungs and positioned slightly towards the left side of the chest.

In Figure 2.1, it is demonstrated that the heart is composed of two individual pumps - the left auricle and right heart ventricles. The right heart is responsible for blood circulation to the lungs, whereas the left auricle of heart pumps blood to the peripheral organs. Each of these pumps consists of two chambers - an atrium and a ventricle, which work together as two-chamber pumps. Together, they circulate blood into the ventricle. The main circulation of blood force that propels blood through the pulmonary and peripheral circulations is provided by the left auricle and right ventricles, respectively.

The heart's right ventricle propels blood, which has a low oxygen content, to the lungs. The lungs perform a process called oxygenation, which adds oxygen to the blood. The newly oxygenated blood then flows back to the heart via the left ventricle. From there, it is pumped to the body's various tissues and organs to provide them with the oxygen they require to function properly. The lungs play a critical role in maintaining the body's cellular functions by exchanging oxygen and carbon dioxide. Oxygenated blood is essential for the healthy functioning of organs and systems, such as the brain, heart, and muscles. To sum up, the blood travels from the heart's right ventricle to the lungs to get oxygen, and then it returns to the left ventricle to be distributed to the rest of the body.

The heart's right ventricle moves the blood flow, which is carried to the lungs where it obtains oxygen. After this, the blood flow goes back to the heart chambers through the left atrium and enters the left ventricle. The left ventricle then pumps the oxygenated blood throughout the body, providing oxygen to the organs and tissues. In summary, the blood travels from the right ventricle to the lungs for oxygenation and then to the left ventricle for distribution throughout the body.

The heart is composed of three main muscle groups: ventricular muscle, atrial muscle, and specialized conductive and excitatory muscle fibers. How left atrial and right ventricular muscles contract differs from how the particular excitatory muscles contract. These specialized muscles are responsible for controlling the heart's rhythmic beat, and they operate through either automatic rhythmic electrical discharge or conduction of movement possibilities throughout the heart. This excitatory system manages the cardiac cycle, which is the sequence of events that takes place from the start of one heartbeat to the beginning of the next [8] [9] [10].

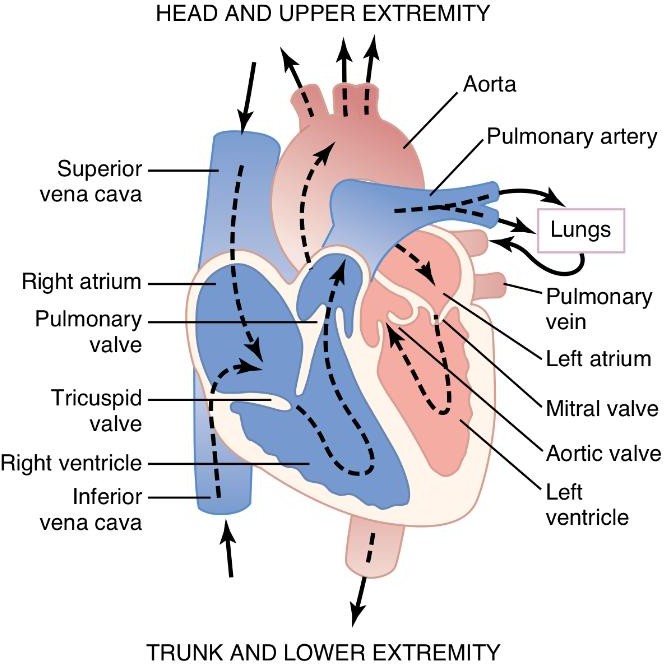


Figure 2.1: Heart Structure.

## 2.3 HEART RATE

The HR or heart rate is the rate at which the heart beats, and it can be affected by the expansion of arterial walls with each heartbeat. The pulse can be detected in various parts of the body, such as the wrist (Radial artery), neck (Carotid artery), inner elbow (Brachial artery), back of the knee (Popliteal artery), and ankle joint (Posterior artery).

The heart rate (HR) can differ based on age, as well as physical and psychological influences on the body. A higher pulse rate may suggest an anomaly in the body, but it can also result from factors such as anxiety, anger, excitement, emotions, or heart-related problems. While an individual's pulse rate can help identify certain health problems, it should not be the only factor relied on to diagnose abnormalities [8] [11].

On average, inactive men tend to have a heart rate of about 72 beats per minute (bpm), whereas inactive women tend to have a heart rate of around 80 bpm. However, these rates can differ significantly for people who are well-trained athletes.

|  |  |  |
| --- | --- | --- |
| Different Age | Heart Rate (BPM) | Respiratory Rate (Breathes/min) |
| Newborn | 120-160 | 40-60 |
| Infant | 100-150 | 20-40 |
| Toddler | 90-140 | 20-30 |
| Preschooler | 80-120 | 20-30 |
| School-age | 70-110 | 15-25 |
| Adolescent | 60-100 | 12-20 |
| Adult | 60-100 | 12-20 |

Table 2.1: Variations in Respiratory Rate and Heart Rate Across Different Age Groups.

### 2.3.1 Impact of Temperature on The Functioning of The Heart

Body temperature and heart rate are closely linked, with changes in one factor affecting the other. A decrease in body temperature can reason of a slight drop-in heart rate, particularly when the individual is at risk of fainting and their body temperature is between 60° and 70°F. This suggests that heat can impact the cardiac muscle layer's ability to regulate heart rate, leading to an acceleration of the self-excitation process.

### 2.3.2 Techniques for Measuring Heart Rate

There are a few strategies to estimate heart rate, the foremost used techniques are:

#### 2.3.2.1 Carotid

The carotid method is a technique used to measure a person's heart rate by taking their pulse from the carotid artery in the neck. To use this method, a person places their fingertips gently on their neck, just below the jawline, and feels for the pulsing of the carotid artery. They then count the number of pulses they feel within a set period, usually 15 to 30 seconds, and multiply that number by four to get their heart rate in beats per minute. This method is commonly used in medical settings and is considered an accurate way to measure heart rate. However, it should be noted that the carotid method should only be performed by trained professionals, as incorrect or excessive pressure on the carotid artery can be dangerous.

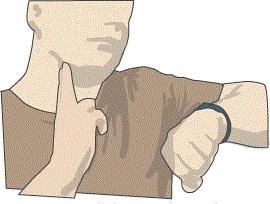


Figure 2.2: Carotid Technique.

#### 2.3.2.2 Radial

The radial method is a technique used to measure a person's heart rate by taking their pulse from the radial artery in the wrist. To use this method, a person places their index and middle fingers on the inside of their wrist, just below the base of the thumb, and feels for the pulsing of the radial artery. They then count the number of pulses they feel within a set period, usually 15 to 30 seconds, and multiply that number by four to get their heart rate in beats per minute. This method is commonly used as a quick and easy way to measure heart rate and is often used in non-medical settings. However, it should be noted that the radial method may not be as accurate as other methods of measuring heart rate and may not be appropriate for certain individuals with medical conditions affecting their radial artery or circulation.

A close-up of a person's hand

Description automatically generated with low confidence

Figure 2.3: Radial Technique.

#### 2.3.2.3 Heart rate monitor

Various devices for monitoring heart rate are available, which claim to provide more accurate readings than manual methods. They are generally preferred in most physical training situations due to their advantages:

1. Distant more precise than finger tests
2. This refers to devices that continuously provide real-time heart rate readings and display them on a digital screen.
3. By using a simple formula when measuring heart rate, it is possible to determine if a person is training at the appropriate level of intensity:
   1. Maximum Heart Rate = 220 - Age
4. These devices are tiny and lightweight, making them easy to carry. Some of them can be customized to emit an alarm or warning if the heart rate exceeds the set range [11] [12].

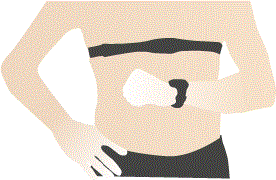


Figure 2.4: Heart Rate Monitor Technique.

## 2.4 ELECTROCARDIOGRAPH

An electrocardiograph (ECG or EKG) is a medical tool utilized for identifying heart conditions, including arrhythmias, heart attacks, and other cardiac abnormalities, by recording the electrical signals produce by the heart. The ECG machine comprises electrodes that are placed on the arms, chest and legs to detect the electrical impulses produced by the heart and transmit them to the ECG machine. These impulses are then recorded and transformed into an electrocardiogram, which is a visual representation of the heart's electrical activity. ECGs are widely used in hospitals, clinics, and doctor's offices as a non-invasive tool to diagnose and monitor heart conditions. Additionally, they are frequently used during exercise stress tests and other diagnostic procedures to monitor the heart's activity.

Below Figure (Figure 2.1) is shown a normal electrocardiogram.

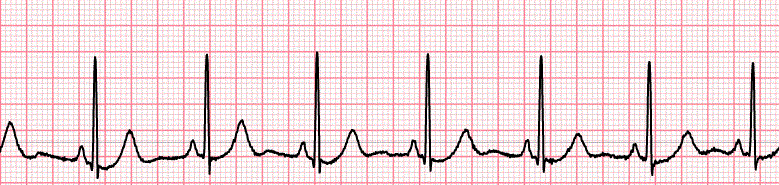


Figure 2.5: Standard ECG

The ECG is a tool that can indicate the condition of a patient's heart by recording its electrical activity, which can be analyzed by trained experts who can extract important information from it. One of the vital signs that can be calculated from an ECG is the heart rate (HR) [13].

## 2.5 PHOTOPLETHYSMOGRAPHY

Photoplethysmography (PPG) is a method that uses light to measure variation in blood volume in the microvascular bed of the skin. This technique is non-invasive and commonly used in medical devices like heart rate monitors and pulse oximeters. PPG works by shining light onto the skin, typically through a finger or earlobe, and measuring the changes in light absorbance that occur with each cardiac cycle as blood volume changes. The resulting signal provides information such as heart rate, blood oxygen saturation, and perfusion index. PPG is a reliable and valid method for monitoring cardiovascular parameters in healthy individuals and patient populations, as extensively documented in medical literature. (Source: "Validity and reliability of photoplethysmography for monitoring cardiovascular parameters in healthy individuals and patient populations.") [13].

Chart, line chart

Description automatically generated

Figure 2.6: PPG Waveforms in Various Health States.

## 2.6 HEART ATTACK

Cardiovascular diseases (CVDs) refer to medical conditions affecting the heart and blood vessels. This category of disorders encompasses a range of conditions:

* + 1. CVDs are medical conditions that affect the blood vessels and heart. These conditions involve the heart and blood vessel.
    2. Some of the conditions that fall under CVDs are coronary artery disease, heart failure, and stroke.
    3. Factors that increase the likelihood of developing CVDs include hypertension, elevated cholesterol levels, tobacco use, diabetes, and being overweight.
    4. CVDs may present with symptoms such as chest discomfort, breathlessness, and tiredness.
    5. Managing CVDs usually involves modifying one's lifestyle, such as adopting a healthy diet and engaging in regular exercise, as well as taking medications to manage blood pressure and cholesterol levels.
    6. CVDs are a major cause of death globally, emphasizing the significance of taking preventive and therapeutic measures to manage these conditions.

CVDs are a group of conditions that affect the blood vessels and heart, which contains coronary artery disease, heart failure, and stroke. A combination of genetic and environmental factors, having highly blood pressure, high cholesterol, smoking, diabetes, and obesity, can cause CVDs. Some of the symptoms of CVDs are chest pain, shortness of breath, and fatigue. The management of CVDs typically involves lifestyle modifications, such as healthy eating and regular exercise, and medications to manage blood pressure and cholesterol levels. Given that CVDs are a significant cause of death globally, it is crucial to take preventive and therapeutic measures such as avoiding smoking, maintaining healthy blood pressure and cholesterol levels, and engaging in regular physical activity.

## 2.7 SYMPTOMS OF HEART ATTACK

Although the symptoms of a heart attack can differ among individuals, typical indications include:

1. A person may experience chest pain or discomfort, which can be described as a sensation of pressure, tightness, heaviness, or pain in the middle of the chest that lasts for several minutes or disappears and then returns.
2. A feeling of breathlessness, characterized by difficulty breathing or the sensation of being unable to catch one's breath, particularly when accompanied by chest pain or discomfort.
3. One may experience pain or discomfort in the neck, jaw, back, stomach, or arms, which can radiate to other areas such as the jaw or arms.
4. Sweating: Breaking out in a cold sweat, even if it's not hot or you're not exerting yourself.
5. Nausea or vomiting: Feeling sick to your stomach, or actually throwing up.
6. light-headedness or dizziness: Feeling lightheaded, dizzy, or faint.
7. Fatigue: Unusual fatigue or weakness, especially if it's accompanied by chest pain or discomfort.

It is worth mentioning that heart attacks are not uniform, and some individuals may experience mild symptoms or none at all, which is referred to as a silent heart attack. If one suspects that they or someone else is experiencing a heart attack, it is critical to seek medical attention without delay. This is because the earlier treatment commences, the more favourable the prognosis.

## 2.8 MICROCONTROLLER

A microcontroller refers to a compact, independent computer system integrated into a one chip. These microcontrollers are commonly employed in specialized gadgets for particular purposes, such as engine management units in automobiles and exposure and focus control units in cameras. They are equipped with dedicated ports on the chip, including input/output ports, serial ports, and analog converters, as well as timers and counters, that enable them to carry out their designated roles. These micro-modules are equipped with powerful digital processors, allowing them to enhance the functions of the gadget through programming and control. Additionally, they are capable of multitasking and processing signals from their environment [14] [15].

## 2.9 BLUETOOTH

Bluetooth is a standard for wireless technology that enables devices like smartphones to connect without using cables or wires, computers, and speakers to connect and communicate with each other over short distances. It uses radio waves in the 2.4 GHz frequency range to transmit data, allowing devices to connect without the need for cables or physical connections. Bluetooth technology is based on a standard set of protocols and can be used for various purposes, such as streaming audio, transferring files, or connecting to wireless peripherals like keyboards and mice. It's also used in many smart home devices, wearables, and IoT applications. It allows devices to connect and communicate with each other in an easy and simple way, without the need of physical connection or other complex setup procedures.

## 2.10 RELATED WORKS

Nowadays, a significant number of individuals are experiencing heart-related health issues, which requires daily or periodic monitoring. Given that it's not feasible to visit the hospital every day, numerous applications have been developed to track patients remotely. However, these applications vary in their accuracy, making it necessary to determine which one is the most precise.

We conducted the survey to determine the particular accuracy of randomly selected heart rate Android applications in comparison to digital heart rate monitors.

This study examines various features of currently available heart rate monitoring applications to provide recommendations for improving their accuracy in the future.

The society at large will reap the benefits of this research since it offers a simple and flexible means of measuring daily heart rate, particularly for patients with cardiovascular diseases and other heart conditions. The study involved college students of varying ages, with a sample size of 20 individuals. Data used for the research was collected by measuring the heart rate of a group of students from the Faculty of Engineering at the University of Khartoum.

Initially, the heart rate was measured manually and with a digital heart rate monitor, under the supervision of a qualified professional. Afterwards, five different heart rate monitoring Android applications were used to compare the resulting heart rate values obtained from each method, all for the same individual.

The used android applications:

1. Instant Heart Rate: a mobile application that measures your heart rate in real-time.
2. Runtastic Heart Rate: a mobile app that tracks your heart rate during exercise and provides insights on your workout intensity.
3. Cardiograph: a heart rate monitoring app that allows you to keep track of your heart health and detect irregularities.
4. Pedometer And Heart Rate Monitor: a device that tracks your steps and measures your heart rate at the same time.

A group of 20 students (10 females and 10 males) from the first to a fifth year were selected randomly for this study. The research was limited to an experiment carried out in the local area and focused on particular Android apps (as mentioned above).

Additionally, the random selection of participants did not take into account the medical history of the students (including their typical heart rate).

The resulting exactness’s are constrained to the estimate of the sample. For way better comes about, the exploration ought to be conducted on a bigger scale.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| patientId | age | sex | cp | Max HR | Weight (kg) | BP | Smoker | Family History | ExerciseAngina | HeartDisease |
| 1 | 52 | 1 | 0 | 172 | 51.25 | 143.1333 | 1 | 1 | N | 0 |
| 2 | 52 | 1 | 0 | 156 | 51.25 | 144.475 | 1 | 1 | N | 1 |
| 3 | 52 | 1 | 0 | 98 | 51.25 | 152.9132 | 0 | 0 | N | 0 |
| 4 | 52 | 1 | 0 | 108 | 51.25 | 148.0682 | 1 | 0 | Y | 1 |
| 5 | 52 | 0 | 0 | 122 | 51.25 | 148.2532 | 1 | 0 | N | 0 |
| 6 | 52 | 0 | 0 | 170 | 51.25 | 145.9729 | 0 | 1 | N | 0 |
| 7 | 52 | 1 | 0 | 170 | 51.25 | 147.3981 | 0 | 0 | N | 0 |
| 8 | 55 | 1 | 0 | 142 | 61.9 | 145.2778 | 0 | 1 | N | 0 |
| 9 | 46 | 1 | 0 | 130 | 50.97 | 139.5171 | 1 | 1 | Y | 1 |
| 10 | 54 | 1 | 0 | 120 | 54.73 | 143.7534 | 0 | 1 | N | 0 |
| 11 | 71 | 0 | 0 | 142 | 57.81 | 152.2691 | 1 | 1 | N | 0 |
| 12 | 43 | 0 | 0 | 99 | 51.77 | 137.0634 | 0 | 1 | Y | 1 |
| 13 | 34 | 0 | 1 | 145 | 56.98 | 133.7276 | 1 | 1 | N | 0 |
| 14 | 51 | 1 | 0 | 140 | 55.55 | 142.6148 | 1 | 0 | Y | 1 |
| 15 | 52 | 1 | 0 | 137 | 52.66 | 142.7836 | 1 | 0 | N | 0 |
| 16 | 34 | 0 | 1 | 150 | 63.50 | 134.4502 | 0 | 0 | N | 0 |
| 17 | 51 | 0 | 2 | 166 | 58.74 | 142.6981 | 0 | 0 | N | 1 |
| 18 | 54 | 1 | 0 | 165 | 64.85 | 145.3952 | 0 | 0 | N | 0 |
| 19 | 50 | 0 | 1 | 125 | 62.55 | 142.0052 | 1 | 0 | N | 1 |
| 20 | 58 | 1 | 2 | 160 | 56.27 | 146.4666 | 1 | 0 | N | 1 |

Table 2.2: The Findings of The Measurement for Each Application Are Showcased.

With the help of above Table 2.2 we can create different kind of chats that will provide us the graphical information about the possibility of heart attack parameters such as gender, age, BP, BPM etc.

Chart, bar chart

Description automatically generated

Figure 2.7: Gender and Age Base Heart Attack Prediction.

# METHODOLOGY

## 3.1 INTRODUCTION

The project's design phase is a crucial and time-intensive stage. This part of the report presents comprehensive details about the hardware and software design, which covers the algorithms, components, and circuit diagrams. It also outlines the functions of the project's units and interfaces.

## 3.2 DESIGNING THE PROJECT AT A HIGH LEVEL

The objective of this project is to collect sustained readings of a patient's vital signs for early detection of potential heart attacks. The pulse sensor will convert the blood pulse into electrical signals, which will be analyzed by the Arduino board. An Android app will use Bluetooth to receive data from the Arduino, and GPS will be used to track the patient's location accurately. The Arduino board will continually monitor the patient's heart rate, and an alarm will sound if the heart rate transcends a predetermined highest or falls below a lowest threshold, alerting nearby individuals.

Diagram

Description automatically generated

Figure 3.1: System Architecture.

Diagram

Description automatically generated with medium confidence

Figure 3.2: Diagram of Components.

## 3.3 DETAIL LEVEL PROJECT DESIGN

The objective of this project is to collect continuous readings of a patient's vital signs for early detection of potential heart attacks. The pulse sensor will convert the blood pulse into electrical signals, which will be analyzed by the Arduino board. An Android app will use Bluetooth to receive data from the Arduino, and GPS will be used to track the patient's location accurately. The Arduino board will continually monitor the patient's heart rate, and an alarm will sound if the heart rate exceeds a predetermined maximum or falls below a minimum threshold, alerting nearby individuals.

Diagram

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Figure 3.3: Classification of Units Within the Project’s System.

## 3.4 HARDWARE DESIGN

The equipment used in this project consists of three components that are combined:

* + - 1. Collecting Data.
      2. Communicating through MUC.
      3. Alarm mechanism.

### 3.4.1 Data Acquisition Unit

The primary role of this device is to gather the essential health indicators of the patient with the assistance of sensors. Sensors are instruments that recognize changes in the surroundings, and they can be categorized into two main types: optical sensors and solid-state sensors. Optical sensors function differently from solid-state sensors. In this particular case, the pulse sensor and the temperature sensor are the two sensors that have been used.

#### 3.4.1.1 Pulses sensor

This is an Open-Source heart rate monitor that is used as a non-invasive means of monitoring heart rate and is considered a PPG (photoplethysmography) device. It tracks the patient's heart rate continuously and calculates the BPM (beats per minute) using algorithms that have been programmed into the Arduino system.

The sensor has two sides, and the front side is designed in the shape of a heart to be in contact with the skin. The pulse sensor has three pins, which are displayed in Figure 3.4 below.

Assuming that the front side is directed towards you, the leftmost pin is designated as the ground (GND), and the input voltage is connected to the +5v terminal of the Arduino through the middle pin. The remaining pin is responsible for producing electrical output and needs to be connected to the analog pins of the Arduino.

A picture containing text, control panel

Description automatically generated

Figure 3.4: Arduino Pulses Sensor.

The Pulse Sensor transforms the PPG (photoplethysmography) physical signal into electrical signals. These electrical signals are produced as analog voltage fluctuations that are unprocessed and are then amplified and normalized to V/2. The sensor is placed on a tissue location where the pulse wave moves along all arteries with each heartbeat. As the pulse wave moves beneath the sensor, there is a sudden surge in the signal's intensity, which subsequently reverts to its original level. The signal then stabilizes to the ambient noise level before the next pulse wave passes under the sensor. The peak is selected as a reference point due to the repetitive nature of the pulse wave, making it identifiable. To determine the heart rate, a computational algorithm is utilized to calculate the duration between consecutive peaks. To obtain an accurate measurement, it is crucial to identify the precise moment of the heartbeat.

Heart researchers suggest that the ideal moment to measure heart rate is when the signal reaches 25% or 50% of its maximum amplitude. With the Pulse Sensor, the initial step involves measuring the IBI (inter-beat interval) when the signal reaches 50% of its maximum amplitude. The BPM (beats per minute) is then calculated by averaging the IBI times from ten consecutive measurements [16].

The process is executed by connecting the pulse sensor with the Arduino board, as illustrated in the figure below.

![A picture containing text, circuit, electronics, screenshot

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDaRXhpZgAATU0AKgAAAAgABAE7AAIAAAAFAAAISodpAAQAAAABAAAIUJydAAEAAAAKAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFVzZXIAAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM5NAAAkpIAAgAAAAM5NAAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figure 3.5: Diagram of Pulses Sensor and MCU Interface.

#### 3.4.1.2 LM35 temperature sensor

LM35 is a solid-state integrated-circuit temperature sensor that produces a voltage in proportion to the centigrade temperature, and its utilization results in temperature readings that are more precise than those obtained from a thermistor.

For accurate measurements, it is necessary for the sensor's package to be in touch with the patient's arm tissues. The sensor is offered in a molded or plastic package.

It has many features, some of them are:

1. Ensure precision at a temperature of 25 degrees Celsius.
2. Can operate within a broad temperature range of -55 to +150 degrees Celsius.
3. Appropriate for use in distant locations.
4. Can function with a voltage range of 4 to 30 volts.
5. Low self-heating and result’s impedance.

The LM35-3 component is equipped with three pins, whereby the input voltage is connected to the left pin and the output signal is obtained from the middle pin [17].

Text, whiteboard

Description automatically generated

Figure 3.6: LM35 Temperature Sensor.

We use an Arduino to produce the measured temperature output. The connection between the LM35 and Nano Arduino is illustrated in Figure 3.7 below.

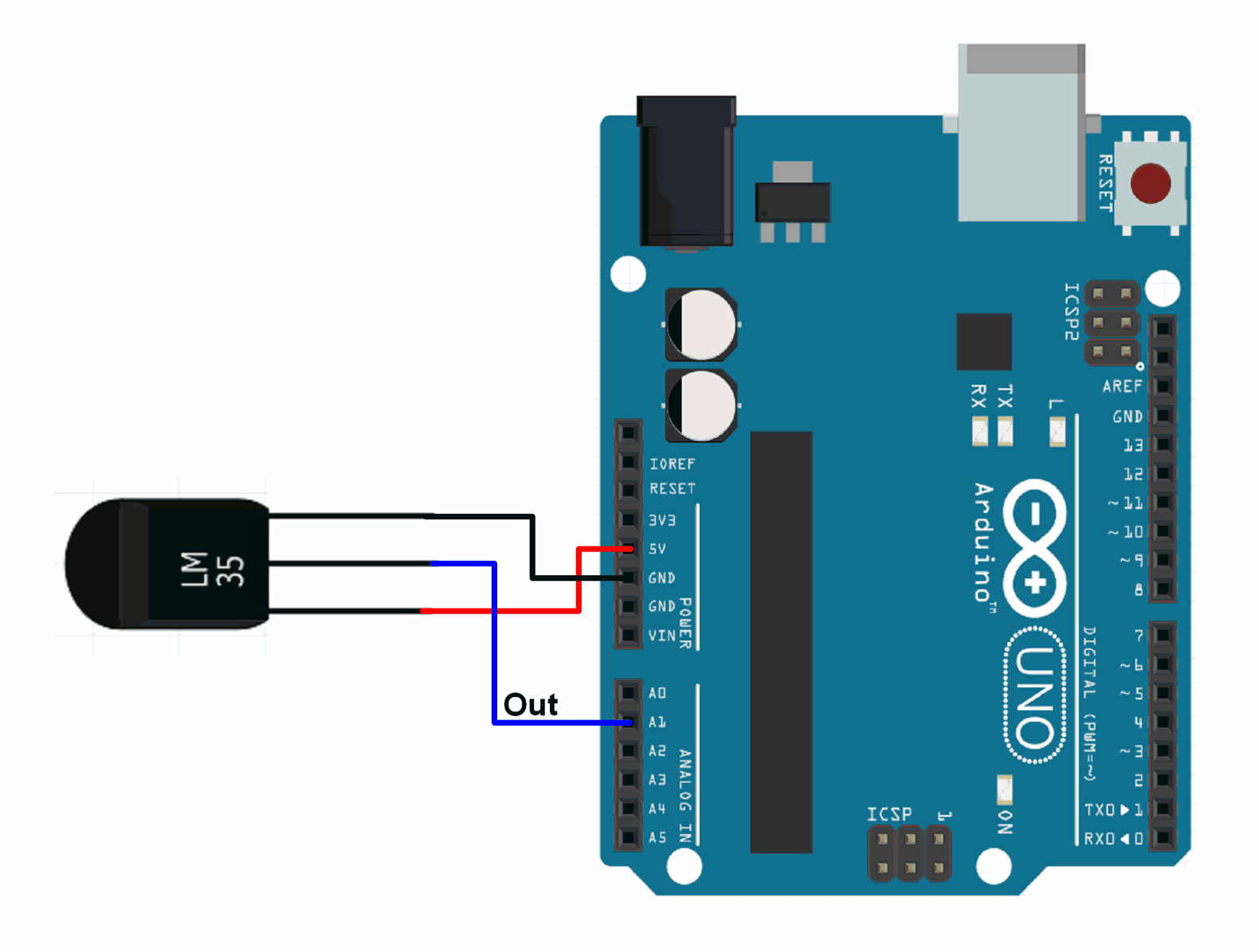


Figure 3.7: Diagram of LM35 and MCU Interface.

## 3.5 CONVERTING BPM VALUE TO BLOOD PRESSURE VALUES

There is a correlation between BPM and blood pressure, but it is not a direct relationship. Blood pressure is measured in mmHg, while BPM is measured in beats per minute. To convert BPM to blood pressure, you need to use a mathematical formula or look-up table that takes into account factors such as age, weight, and gender.

float weight = 70.5; // replace with actual weight in kg

int age = 30; // replace with actual age

int sex = 1; // 0 for female, 1 for male

### 3.5.1 Calculating Blood Pressure

float sbp = 109 + (0.5 \* age) + (0.1 \* weight) + (0.6 \* sex) + (1.4 \* bpm/100.0); // calculate the estimated SBP

## 3.6 MICROCONTROLLER (MUC)

MUC, short for Microcontroller Unit, is a small computer on a single integrated circuit that is responsible for controlling various devices or processes. MUCs are widely used in many applications, from simple household appliances to complex industrial automation systems. They typically consist of a central processing unit (CPU), memory, input/output ports, and various peripheral interfaces. MUCs offer several advantages over traditional microprocessors, such as low power consumption, small size, and high processing speed. They are also relatively inexpensive and easy to program, making them an ideal choice for many embedded system designs.

Arduino Uno is a popular microcontroller board based on the Atmel ATmega328P microcontroller. It is designed to provide an easy and affordable way for hobbyists, students, and professionals to create and prototype their own interactive electronic projects. The Arduino Uno features 14 digital input/output pins, six analog inputs, a 16 MHz quartz crystal, a USB connection, and a power jack. It can be programmed using the Arduino Integrated Development Environment (IDE), which is a simple and user-friendly software tool that supports a wide range of programming languages, including C++ and Python. With its ease of use, versatility, and low cost, the Arduino Uno has become a popular platform for makers and developers all over the world to create innovative and exciting projects.

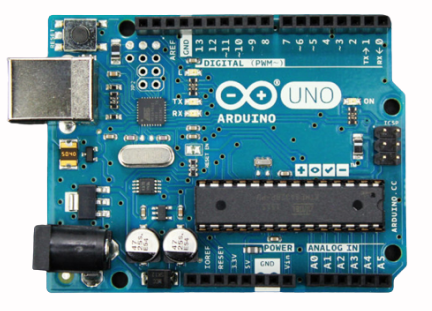


Figure 3.8: Arduino Uno.

### 3.6.1 Communication from Android Application to MCU

The Bluetooth serial port module is responsible for enabling communication. Its main purpose is to send information from the MCU (microcontroller unit) to the interfaces of the Android application for display.

### 3.6.2 Serial Port Module That Utilizes Hc-05 Bluetooth Technology

The HC-05 Bluetooth to Serial Port Module is a small electronic device that allows two-way wireless communication between a microcontroller or other serial-enabled device and a Bluetooth-enabled device. The module is based on the Bluetooth protocol, which is a standard wireless communication protocol that enables devices to communicate over short distances.

Here are a few key points to understand how the HC-05 module works:

1. The HC-05 module is designed to act as a slave device, which means that it can only be paired with a master device such as a smartphone or a laptop. The master device initiates the connection, and the slave device responds to it.
2. The module uses the Serial Port Profile (SPP) to establish a virtual serial port over Bluetooth. This allows the microcontroller or serial-enabled device to communicate with the master device as if it were connected via a physical serial port.
3. The module can be configured to operate in either a transparent mode or a command mode. In transparent mode, any data received from the Bluetooth master device is simply passed through to the microcontroller or serial-enabled device. In command mode, the module can be configured using AT commands sent over the serial port.
4. The module requires a few basic connections to work: a power source, a ground connection, and two serial data lines (RX and TX) to connect to the microcontroller or serial-enabled device.

Overall, the HC-05 Bluetooth to Serial Port Module provides a convenient and easy-to-use way to add wireless communication to a wide range of electronic projects [18].

A picture containing diagram

Description automatically generated

Figure 3.9: HC-05 Bluetooth Module.

## 3.7 SOFTWARE DESIGN

Throughout the development process of this project, various software tools were utilized to program the Arduino board, which is regarded as the heart of the project. Additionally, an Android application was developed to detect and issue an alert when a heart attack is suspected.

## 3.8 ARDUINO IDE

Arduino IDE (Integrated Development Environment) is a software application used for writing, compiling, and uploading computer code to Arduino microcontrollers. It provides a user-friendly interface that simplifies the process of programming Arduino boards for various projects. The IDE includes a code editor, compiler, and uploader, making it a one-stop solution for creating and deploying programs on the Arduino platform.

The Nano Arduino is programmed using the Arduino Integrated Development Environment (IDE), which involves writing code that serves three primary purposes.

These functions are:

1. Measuring BPM (heart rate).
2. Measuring body temperature.
3. Transmitting the recorded data.

Additionally, the system is programmed to detect abnormalities and provide alerts when necessary [20].

## 3.9 MEASURING BPM

The algorithm for measuring IBI and BPM is:

1. Set up the initial configurations for Arduino with a Baud Rate of 9600.
2. Send input signals to A0.
3. Collect data by reading A0.
4. Carry out calculations on the collected data.
5. Display the results on the Serial Plotter.
6. Wait for 1000ms before taking the next reading.
7. Start again from step 3 and continue with the same sequence.

## 3.10 MEASURING BODY TEMPERATURE

Considering that the LM35's output voltage (Vout) is linked to ADC channel (A1), the ADC transforms the analog measurements into digital values utilizing the given equation:

ADC value = Sample\* 1024 / Reference Voltage. As per the interface diagram between Arduino and LM35 shown earlier (refer to the figure), the reference voltage is +5V. Therefore, the temperature measurement algorithm is as follows:

1. Set up the configurations for Arduino with a Baud Rate of 9600.
2. Send input signals to A0.
3. Collect data by reading A0.
4. Carry out calculations using the collected data.
5. Display the results on the Serial Monitor.
6. Wait for 1000ms before taking the next reading.
7. Start again from step 3 and continue with the same sequence.

Before transmitting the data over Bluetooth, the algorithm was confirmed by displaying the digital output values on the Arduino IDE's Serial Monitor [15].

## 3.11 ANDROID STUDIO

This is another Integrated Development Environment (IDE), but it is tailored for creating software applications that operate on the Android operating system. It is intended to be used instead of the Eclipse Android Development Tools.

The project utilized the Android Studio platform to develop a personalized application that integrates effectively with the project's various components. The application created has two distinct account types: one for doctors and another for patients. With the doctor's account, they can access their patients' records. On the other hand, the patient's account can receive data from a Bluetooth module, track their location via GPS, and upload their records to the database [21].

The picture below illustrates the user interfaces of the accounts in the application. The initial screen allows patients and doctors to log in to their accounts using a previously established username and password.

## 3.12 NODEJS

Node.js is an ideal choice for developing the backend of an early predictive analysis system for heart attack identification. With its efficient event-driven architecture and non-blocking I/O model, Node.js can handle large amounts of data and requests in real-time. The use of popular Node.js packages such as Express, Mongoose, and Passport can simplify the development process, enabling faster deployment of the application. Additionally, Node.js offers built-in support for machine learning libraries, allowing developers to integrate predictive analysis models directly into the backend. With these features, Node.js provides a robust and scalable foundation for the development of an early predictive analysis system for heart attack identification.for early predictive analysis of heart attack identification. By leveraging the combined power of Node.js and TensorFlow, developers can build a robust and scalable system for identifying heart attack risks in patients and providing early intervention to reduce the likelihood of heart attacks.

## 3.13 TENSORFLOW WITH NODEJS

TensorFlow, combined with Node.js, is an ideal platform for developing an early predictive analysis system for heart attack identification. TensorFlow is a powerful open-source machine-learning library that offers a wide range of tools for building and training predictive models. It can analyze large amounts of data, identify patterns, and provide predictions with high accuracy. By integrating TensorFlow with Node.js, developers can create an efficient and scalable backend system that can handle real-time requests and process large datasets. Node.js offers a non-blocking I/O model, which enables the system to process requests quickly and efficiently, making it ideal for building a system that requires low latency and high performance. By leveraging the combined power of TensorFlow and Node.js, developers can build a reliable and accurate early predictive analysis system for heart attack identification that can help save lives by providing early intervention and treatment..

Graphical user interface, text

Description automatically generated

Figure 3.10: Login Screen.

However, if an account has not yet been created, the registration interface will prompt the user to specify which type of account they wish to create.

Graphical user interface, application, Teams

Description automatically generated

Figure 3.11: Registration Screen.

If a Patient account is selected within the registration interface, the subsequent interface will prompt the user to provide the necessary information needed to create the account.

Graphical user interface, application

Description automatically generatedGraphical user interface, text, application, chat or text message

Description automatically generated

Figure 3.12: Patient Registration Screen.

If the user selects a Patient account during the registration process, they will be prompted to provide the necessary information to create the account in the subsequent interface.

Graphical user interface, application

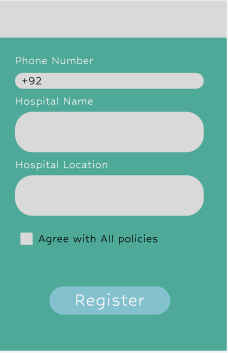
Description automatically generated 

Figure 3.13: Doctor Registration Screen.

Looking at the patient account interface, you will see three buttons to choose from: Medical ID, Health Records, and Measure. This is shown in Figure 3.14.

Graphical user interface

Description automatically generated with medium confidence

Figure 3.14: Patient View Screen.

The doctor's account will include a list view of patients, and there will be buttons for adding and removing patients to enable the doctor to manage their patients.

Graphical user interface, text, application

Description automatically generated

Figure 3.15: Doctor View Screen.

Once the patient account registration is finished, more details need to be provided to establish a medical ID.

Graphical user interface

Description automatically generated with medium confidence

Figure 3.16: Patient’s ID Registration.

When the "Medical ID" button is selected in the "Patient view" interface, the recorded identification information will be displayed in this interface.

A picture containing graphical user interface

Description automatically generated

Figure 3.17: Patient Detail Showing to Doctor.

After the user completes the registration process for a new account, this interface is displayed which provides access to GPS and Bluetooth on a mobile device. This is necessary to utilize all of the application’s features.

Graphical user interface, text, application, chat or text message

Description automatically generated

Figure 3.18: Enable Bluetooth Service Screen.

## 3.14 HARDWARE IMPLEMENTATION

To evaluate the functionality of the complete system, the hardware was set up following the information provided in this chapter, which includes diagrams of all the components, and the software codes used. The circuit for the final system is presented in Figure 3.19.

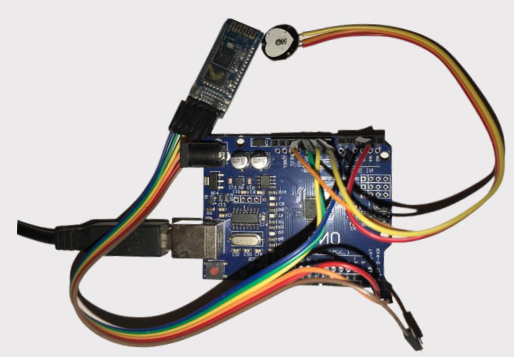


Figure 3.19: System Implementation.

## 3.15 CONCLUSION

In this chapter, a detailed demonstration of the proposed system design for both hardware and software units were provided. The design was proposed in a manner that makes it accessible and convenient for most individuals to use.

Additionally, since there are many arm-bands already available for purchase and usage, this project's functionality can be integrated into one of these bands, and it can offer primary services such as fitness monitoring and calculating daily

# 4. RESULTS AND DISCUSSION

## 4.1 RESULTS

After constructing the circuit according to the instructions provided in Chapter 3 and uploading codes to the Uno Arduino, the project is prepared for testing. The subsequent outcomes were obtained when implementing and testing it.

## 4.2 HEART RATE OUTPUT DISPLAYED ON SERIAL PLOTTER

Two methods were utilized to analyze the accuracy of the circuit in the project, namely the manual method and the pulse sensor method. A 5V power source was used to operate the circuit, and to obtain an accurate reading, the wrist or finger needed to be positioned near the sensor. The results of the output manifested as an ECG in the Serial Plotter, and a qualified physician evaluated its precision.

After analyzing the signal depicted in Figure 4.1, the qualified medical related person noted that the signal is distorted, and detecting the heart rate from it is challenging as it must be measured from at least three consecutive crest that were not present within the signal.

Chart, line chart, histogram

Description automatically generated

Figure 4.1: Displaying HR Wave Results on Serial Plotter.

Afterward, the same experiment was duplicated, but in this instance, the outcomes were demonstrated via the Serial Monitor, as depicted in Figure 4.2.

C:\Users\HP\Desktop\codes of android\pulse results.png

Figure 4.2: HR Values Output in Serial Monitor.

To evaluate the accuracy of the results, the pulse was calculated manually and compared with the value obtained from the Serial Monitor.

Error was calculated to be:

e = (91 – 88) / 91 = 0.032, which means an accuracy of 96.8%.

## 4.3 MONITORING BODY TEMPERATURE THROUGH SERIAL COMMUNICATION

To acquire the body temperature, the LM35 was positioned on the fingertip. The temperature was first measured using a thermometer, and then it was measured again using the LM35 to compare the outcomes.

While being tested, the temperature recorded was approximately 27 degrees Celsius. Figure 4.3 displayed the temperature detected by the sensor, which was continuously exhibited in the serial monitor. To calculate the measurement's margin of error, the most consistent value of 27.83 was chosen, and the thermometer's value was subtracted from it, followed by dividing it by the latter value.

Error was calculated to be:

e = (27.83 – 27) / 27.83 = 0.0298

At approximately 97% precision, the accuracy level is deemed highly acceptable.

Table

Description automatically generated

Figure 4.3: Displaying Temperature Results in Serial Monitor.

## 4.4 BLUETOOTH FEEDBACK IN ANDROID APPLICATION

After powering the circuit, the Bluetooth module was automatically turned on. The Android application included a graphical user interface with a button that permitted the activation of Bluetooth. When the button was pressed, a notification would appear requesting the user's authorization to enable Bluetooth, as shown in Figure 4.4.

Graphical user interface, application

Description automatically generated

Figure 4.4: Bluetooth Enabling Notification.

Once Bluetooth permission was granted, number of available devices appeared, and the HC-05 was found among them. Pairing was completed successfully by clicking on the HC-05 device.

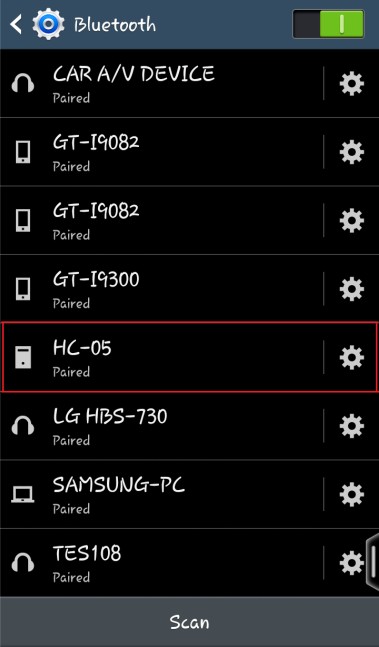


Figure 4.5: Connecting HC-05 via Bluetooth Pairing.

## 4.5 DISCUSSION

According to the specialist physician, the ECG recording of the heart rate was not measurable. This indicates that the signal was contaminated with noise and required initial filtering to extract the actual heart rate value. The background noise could have resulted from improper handling of the pulse sensor or from a fault in the component itself.

In contrast, the temperature readings were significantly more accurate, with a precision of nearly 97%.

The integration of Bluetooth and GPS was performed with precision, and both functions were executed successfully. This included identifying the HC-05 Bluetooth device and establishing a connection with it, as well as acquiring data from the Arduino and ascertaining the patient's location using GPS.

# 5. CONCLUSION AND FUTURE WORK

## 5.1 CONCLUSION

The project utilized a pulse sensor that detects changes in light intensity through infrared technology. The main goal, developed using the Android Open-Source platform, is to quickly notify the medical emergency team and the patient's emergency contacts about the patient's health status.

We are working on creating a sample application that incorporates real-time monitoring of health indicators to identify and anticipate heart attacks and activate an alert if required. The gadget will trigger an alert when the body temperature and heart rate exceed or fall below a specific limit. This goal is accomplished by continually measuring the heart rate and body temperature, which is especially beneficial in critical scenarios requiring constant monitoring. Additionally, the gadget is highly transportable, enabling patients to bring it with them, eliminating the need for hospitalization because the Heart Rate Monitor can be used in almost any setting.

We created an Android Application in conjunction with the Heart Rate Monitor. This application enables both doctors and patients to communicate, records data from the heart monitor through Bluetooth and allows doctors to access these records.

## 5.2 CHALLENGES AND LIMITATIONS

There were multiple obstacles encountered during the entire duration of the project. The initial difficulty was related to the pulse sensor, which failed to produce precise readings when it was either too tightly or loosely attached to the body.

Despite the amplification and filtering of the ECG signal by the pulse sensor, noise can still be present in the signal. Properly grounding all connections can help reduce the noise, but there may still be some noise present in the ECG signal due to the wires attached to the patient's body, which are crucial for obtaining a good signal.

We faced a similar challenge with temperature measurement, as the sensor took some time to respond to the heat produced by the human body, leading to inaccurate readings. However, we were able to reduce hardware costs by using the LM35 component in the project, which was still suitable for our needs.

To obtain reasonably accurate data, it was necessary to take multiple measurements repeatedly. As a result, both of these challenges were successfully addressed.

The subsequent difficulty encountered in the project involved certain components that were bought without a datasheet. This was particularly true for the pulse sensor utilized, which made it arduous to gain a complete understanding of its specifications. Therefore, the team relied mainly on the basic information provided by the vendors on their website.

A further obstacle was encountered with the Android development environment, as it required a significant amount of time for installation and configuration. Additionally, several Gradle errors caused inconvenience and seemed never-ending, although these were eventually resolved. It is worth noting that the software worked correctly after installation, and using AS on Ubuntu was a more positive experience compared to Windows.

## 5.3 ACCOMPLISHMENTS

On the contrary, the project was able to achieve several of its intended objectives. These achievements can be summarized as follows:

* + 1. Obtaining signals that convey vital signs.
    2. Examining these signals concerning vital signs.
    3. Developing a system that measures and monitors heart rate (HR).
    4. Establishing an alert system.
    5. Facilitating communication between patients and physicians.
    6. The utilization of hardware components that are comparatively affordable and consume less power.

## 5.4 FUTURE WORK

It is possible to implement additional enhancements to this project to improve its overall performance:

* + 1. The purpose of the project was to create a system capable of precise measurement of health parameters, even in the presence of external noise. Additionally, the project aimed to devise an innovative approach for the effective transmission of data between the microcontroller unit (MCU) and the Android application.
    2. Additional tests can be carried out on a wider sample of people with varying ages and weights to ensure the precision of the heart rate monitor device.
    3. By utilizing this project, we are able to make recommendations for medication related to individuals who have suffered from a heart attack.
    4. Through the implementation of this project, we can propose the relevant diseases associated with patients who have experienced a heart problem.
    5. To enhance the accuracy and functionality of the temperature measurement, it is recommended to substitute the LM35 with a temperature sensor specifically designed for body measurements.
    6. The project's value to patients could be increased by including additional vital signs parameters such as Blood Pressure and Respiratory Rate.
    7. The measurement of pulse and other vital signs can be added using the camera and other built-in sensors of the mobile phone. This will provide the patient with the ability to measure these parameters on demand in case they experience any symptoms or abnormalities.
    8. Once the buzzer is triggered by the detection of a heart attack, the MCU must send both the measured data and a control signal. This control signal will activate the GPS and suggest the application to send an SMS to the patient's emergency contacts and medical emergency services, including the measured data and the patient's address. The purpose of this is to rapidly inform the patient's loved ones and arrange for an ambulance to be dispatched.
    9. To offer the device for sale to the general public, it is necessary to convert it into a printed circuit board (PCB) and reduce its weight by making it smaller through miniaturization.

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