HEART ATTACK DETECTION AND HEART RATE MONITORING USING IOT

PROJECT REPORT

Submitted By

VENKATESH KUMAR R (720821106061)

in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

In

INFORMATION TECHNOLOGY

HINDUSTHAN INSTITUTE OF TECHNOLOGY, COIMBATORE

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2025

BONAFIDE CERTIFICATE

Certified that this mini project report **"HEART ATTACK DETECTION AND HEART RATE MONITORING USING IOT"** is the bonafide work of **"VENKATESH KUMAR R(720821106061),"** who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
Mr.D.Vimal kumar , M.tech.,(Ph.D).,	Dr. M.Duraipandian, M.E., Ph.D.,
SUPERVISOR	**HEAD OF THE DEPARTMENT**
Information Technology	Information Technology
Hindusthan Institute of Technology	Hindusthan Institute of Technology
Coimbatore - 641032	Coimbatore - 641032

Submitted for the University Main Project Viva Voice Examination Conducted on …………………

INTERNAL EXAMINER	**EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We express our sincere thanks to Hindusthan Educational and Charitable Trust for providing us the necessary facilities to bring out the project successfully. We felt gratefulness to record our thanks to the **Shri.T.S.R.Khannaiyann, Chairman, Smt.Sarasuwathi Khannaiyann Managing Trustee, Shri K.Sakthivel, Trustee** and **Smt.Priya Satish Prabu, Executive Trustee**, for all their support and the ray of strengthening hope extended to our project. It is a moment of immense pride for us to reveal profound thanks to our respected Principal, **Dr.C.Natarajan, M.E.,Ph.D.**, who happens to be the striving force in all our endeavors.

We make immense pleasure in conveying our hearty thanks to **Dr.M.Duraipandian,M.E.,Ph.D.**, Professor and Head of Information Technology Department for providing an opportunity to work on this project. His valuable suggestions helped us a lot to do this project successfully.

A word of thanks would not be sufficient for the work of our project guide **D.VimalKumar,M.Tech.,(Ph.D).**, Associate Professor, Department of Information Technology whose leads us through every trying circumstance. We deeply express our gratitude to all the Faculty Members and Support staff of the Department of Information Technology, for their encouragement, which we have received throughout our project.

VENKATESH KUMAR R

TABLE OF CONTENTS

ABSTRACT

The increasing prevalence of cardiovascular diseases has highlighted the need for innovative solutions to monitor heart health in real-time. This paper presents an Internet of Things (IoT)-based system for heart attack detection and heart rate monitoring, designed to provide continuous, non-invasive health monitoring for individuals at risk of heart-related events. The system integrates various sensors, including heart rate sensors (PPG or ECG), blood oxygen sensors (SpO2), accelerometers, and temperature sensors, into a wearable device that collects physiological data. This data is then transmitted wirelessly via Bluetooth or Wi-Fi to a mobile application or cloud platform for real-time analysis.Through advanced data analytics, the system detects irregular heart patterns, The incorporation of real-time location tracking, emergency alerts, and user-friendly interfaces ensures rapid intervention in the event of a heart attack, enhancing patient outcomes. Moreover, the system supports remote monitoring, allowing healthcare providers to track patient vitals continuously and intervene when necessary.While this IoT-based solution offers significant improvements in preventative healthcare and timely response, challenges related to data security, device accuracy, and user adoption remain key concerns. Nonetheless, this approach promises to empower individuals with better control over their heart health, reduce the burden on healthcare systems, and potentially save lives by detecting heart attacks early and facilitating rapid medical response.

Keywords: Traffic congestion, emergency vehicle prioritization, real-time traffic monitoring, smart city, alternative route guidance.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Acronyms	**Abbreviations**
IoT	Internet of things
ECG	Electrocardiogram
Spo2	Peripheral Capillary oxygen saturation
GSM	Global system for mobile communication
MCU	Microcontroller unit
PPG	Photoplethysmogram
Wi-Fi	Wireless fidelity
BLE	Bluetooth low energy
GPS	Global positoning system
LED	Light emitting Diode
EHR	Electronic health record
HTTP	Hypertext transfer protocol
OLED	Organic light emitting diode
IDE	Integrated development environment
SMS	Short message service
IR	Infrared
API	Application programming interface

CHAPTER 1
INTRODUCTION

1.1.Overview

Cardiovascular diseases, including heart attacks, remain one of the leading causes of mortality worldwide. Timely detection and intervention can significantly reduce the severity and improve survival rates in individuals experiencing heart attacks. However, traditional methods of monitoring heart health often rely on periodic check-ups and in-person medical consultations, which may not provide continuous, real-time insights into a person's cardiovascular status. The advent of the Internet of Things (IoT) has revolutionized healthcare by enabling continuous, remote health monitoring, allowing for proactive management of conditions such as heart disease.

This paper introduces an IoT-based heart attack detection and heart rate monitoring system designed to provide continuous, real-time monitoring of a user's heart health. By leveraging wearable sensors, including heart rate sensors, ECG sensors, and SpO2 sensors, this system tracks key physiological indicators such as heart rate, blood oxygen saturation, and electrical activity of the heart. The collected data is wirelessly transmitted to a mobile application or cloud platform for analysis, enabling immediate detection of irregularities such as arrhythmias or abnormal heart rate fluctuations that may indicate a potential heart attack.One of the key features of this system is its ability to provide real-time alerts to both the user and healthcare providers in the event of abnormal readings. Additionally, the system supports emergency alerts, GPS tracking, and remote monitoring by healthcare professionals, ensuring quick intervention during critical moments. This IoT-enabled solution not only improves the chances of timely medical intervention but also empowers individuals to take a proactive approach to their cardiovascular health, potentially saving lives and reducing healthcare costs associated with heart disease.

1.2. Problem Identified

Heart attacks are one of the leading causes of death globally, often occurring without timely detection or immediate medical response.Traditional heart monitoring systems are either too bulky, not real-time, or inaccessible to patients outside clinical settings. This leads to delayed diagnosis and treatment, especially for high-risk individuals who may not be under continuous medical supervision.

Despite advancements in medical technology, there is a **lack of portable, real-time, and intelligent systems** for continuous **heart rate monitoring and early heart attack detection**—especially in remote or underserved areas.

.

1.3. Objectives

The primary objectives of this project are as follows:

- **Continuous Heart Rate Monitoring:**To design and implement an IoT-based system capable of continuously monitoring a user's heart rate in real time using wearable sensors.
- **Early Detection of Abnormalities:**To detect irregularities in heart function (e.g., tachycardia, bradycardia, arrhythmias) that could be early signs of a potential heart attack
- **Heart Attack Risk Prediction:**To develop or integrate intelligent algorithms (possibly using machine learning) to analyze heart rate data and identify patterns associated with high risk of heart attacks.
- **Real-Time Alert System:**To notify the user, family members, or emergency responders immediately through SMS, app notifications, or email in case of critical health conditions.

- **Remote Health Monitoring:**To allow doctors and caregivers to monitor patient health remotely through a web or mobile dashboard connected to the IoT device.
- **Data Logging and Visualization:**To maintain historical data logs for heart rate and detected anomalies, and visualize trends over time to assist in diagnosis and treatment planning
- **Low-Cost and Portable Design:**To create a cost-effective, energy-efficient, and compact wearable system suitable for daily use and accessible in remote or rural areas.
- **Integration with Cloud or Mobile App:**To sync data securely with a cloud platform or mobile application for easy access, backup, and analysis.
- **User-Friendly Interface:**To ensure the system is easy to use and interpret for both medical professionals and non-technical users.
- **Enhancing Preventive Healthcare:**To promote preventive healthcare by enabling users to monitor their cardiovascular health and take action before a serious condition arises.

1.4.Purpose

The purposeThe primary purpose of this project is to enhance cardiovascular health monitoring and enable early detection of heart-related issues—especially heart attacks—through the integration of Internet of Things (IoT) technology.

Heart diseases often progress silently and are not detected until a critical emergency occurs. Traditional monitoring methods are limited to clinical settings and are not accessible or practical for continuous use. This project aims to bridge the gap between patients and real-time medical monitoring by developing a smart, wearable, and connected system.

By leveraging IoT, the system can continuously track heart rate and detect abnormal patterns, instantly notifying users or healthcare professionals in case of emergencies. The ultimate goal is to reduce mortality rates, enable timely medical intervention, and empower individuals to manage their heart health proactively.

1.5. Importance of the project

- **Early Detection Saves Lives:** Heart attacks can be fatal if not treated immediately. By detecting abnormal heart patterns in real time, the system can trigger early warnings and potentially prevent death or severe complications.
- **Real-Time Monitoring:** Unlike traditional checkups, IoT devices offer 24/7 monitoring. This ensures that heart conditions are tracked continuously, even outside hospitals, helping in timely diagnosis and treatment.
- **Reduces Hospital Dependence:** Patients, especially those with chronic heart conditions, don't need to stay in hospitals for long-term observation. IoT allows remote monitoring, which reduces hospital crowding and costs.
- **Empowers Patients:** Individuals gain more control over their own health by being able to monitor their vitals through a mobile app or device, encouraging healthier lifestyles and better awareness.
- **Critical for Elderly and At-Risk Patients:** Elderly people or those with known heart disease are often at high risk. This system offers peace

of mind by providing immediate alerts in case of a critical situation, even when they're alone.

- **Rural and Remote Area Healthcare:**In regions with limited access to healthcare facilities, this technology can provide life-saving monitoring and communication with doctors without requiring constant travel.
- **Data-Driven Healthcare:**The project generates a valuable stream of real-time health data, which can help doctors make more informed decisions and allow researchers to study heart health trends more accurately.
- **Supports Preventive Medicine:**Continuous tracking and alerts for irregular heart activity can help prevent major cardiac events by prompting early medical intervention before an actual heart attack occurs.
- **Cost-Effective Healthcare Solution:**IoT-based systems are affordable and scalable, making them ideal for deployment in both personal use and public health programs.
- **Data-Driven Healthcare:**The project generates a valuable stream of real-time health data, which can help doctors make more informed decisions and allow researchers to study heart health trends more accurately.
- **Rural and Remote Area Healthcare:**In regions with limited access to healthcare facilities, this technology can provide life-saving monitoring and communication with doctors without requiring constant travel.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews relevant research on Heart attack detection and heart rate monitoring. Each section presents a study, summarizing its key contributions and relevance to the project.

2.1. IoT and Machine Learning Based Health Monitoring and Heart Attack Prediction System

- Authors: Sudarsan Sahoo, Priyanuj Borthakur, Niharika Baruah, Bhaskar Pratim Chutia
- Year: 2021
- Published In: Alexandria Engineering Journal

1. Developed a real-time health monitoring system integrating IoT and machine learning.
2. Utilized sensors to collect vital signs, transmitting data to the ThingSpeak server via an access point.
3. Implemented a heart attack prediction system using machine learning techniques.
4. Notified users through GSM modules upon detecting anomalies.
5. Emphasized cost-effectiveness and efficiency in data transmission

2.2. Heart attack detection and heart rate monitoring using aurdino

Authors: I.S. Priya, L. Keerthi, C. Jeevana, J. Sirisha, K. Brahmateja, B.Dilli, C. Dinesh Kumar

- Year: 2024
- Published In: IEEE Access

1. Focused on developing a system using Arduino and IoT technologies.
2. Integrated pulse and ECG sensors for continuous heart rate monitoring.
3. Transmitted data to a cloud-based platform for real-time analysis.
4. Enabled alerts to users, caregivers, or medical professionals upon detecting irregularities.
5. Aimed to enhance patient safety through timely responses in emergencies

2.3. Heart Attack Detection and Heart beat Monitoring using IoT

- Authors: Prajakta Gujale, Shrutika Kamble, Arti Mane, Ankita Waman, Prof. Rajendra Mohite
- Year: 2020
- Published In: IEEE Transactions on Intelligent Transportation Systems

1. Designed a system employing IoT for heart rate monitoring and heart attack detection.
2. Utilized wearable devices to measure heart rate and detect anomalies.
3. Implemented notification mechanisms to alert users and medical personnel.
4. Emphasized the portability and user-friendliness of the monitoring device.

2.4. IoT Based Heart Attack Detection and Heart Rate Monitor

- Authors: Abhishesk Patil, Snehal Sutar, Ishwari Malwade
- Year: 2023
- Published In: IEEE

1. Developed a system integrating heartbeat sensors with GSM technology.
2. Enabled real-time monitoring and control of patient heart rates.
3. Facilitated data access through various electronic devices, enhancing accessibility for patients and doctors.
4. Addressed the need for immediate action in the event of heart rate anomalies

2.5. Heart Health Monitoring Using IoT and Machine Learning Methods

- Authors: Sergio Márquez-Sánchez, Israel Campero-Jurado, Daniel Robles-Camarillo, Juan Manuel Corchado Rodríguez
- Year: 2023
- Published In: IEEE Transactions on Intelligent Transportation Systems

1. Explored the use of wearable technologies for monitoring heart rate and physical activity.
2. Implemented real-time monitoring systems to detect anomalies and reduce occupational health risks.
3. Transmitted collected data to servers for processing and analysis.
4. Highlighted the role of IoT in enhancing workplace safety through health monitoring.

CHAPTER 3

REQUIREMENTS AND ANALYSIS

3.1. Requirements

3.1.1. Functional Requirements

Functional requirements define the core operations and behaviors of the system.

- **Heart Rate Monitoring**:The system must continuously measure the heart rate of the user using appropriate sensors (e.g., pulse sensor, ECG sensor).It should detect abnormal heart rates such as tachycardia (high) or bradycardia (low).
- **Heart Attack Detection:**The system must analyze heart rate data in real-time to identify patterns indicative of a possible heart attack or serious cardiac event.It should trigger an emergency alert when such patterns are detected.
- **Data Processing and Analysis**:The device must be able to process the raw sensor data locally or send it to a cloud platform for real-time analysis.Algorithms should analyze this data to detect anomalies and patterns.
- **Real-Time Alerts:**The system must send alerts via **SMS, app notification, or email** to predefined contacts (e.g., family, doctor, emergency services) when a critical condition is detected.
- **Remote Monitoring Interface:**A **web or mobile app dashboard** should display real-time heart rate and alert status.Authorized users (like doctors) should be able to access this data remotely.
- **Data Logging and Storage:**The system must store historical heart rate data for later review.The data should include **timestamp, heart rate values**, and **any abnormal event logs**.
- **User Authentication and Access Control:**Only authorized users should be able to access or modify system settings and data.The

system should support **user login** for doctors, patients, and caregivers.

- **Connectivity:**The system must support **wireless communication** (e.g., Wi-Fi, Bluetooth, GSM, or LoRa) to transmit data to the cloud or mobile application.
- **Battery and Power Management:**The wearable device should manage power efficiently and notify the user if **battery is low**.
- **Device Calibration and Testing:**The system must allow for sensor calibration and test mode to ensure **accurate readings**.

3.1.2. Non-Functional Requirements

Non-functional requirements focus on the system's performance, reliability, and usability.

- **Reliability:**The system must be highly reliable, especially in detecting and reporting critical heart conditions.It should function consistently without frequent breakdowns or crashes.
- **Accuracy:**The heart rate and health data captured must be accurate and precise, minimizing false positives or missed alerts.Sensor calibration and signal filtering must ensure clean and valid data.
- **Availability:**The system should be available and operational 24/7 for continuous monitoring.Downtime should be minimal, especially for cloud services or alert mechanisms.

3.1.3. Hardware Requirements

The system relies on essential hardware components to function effectively.

Table 3.1.3: Hardware Requirements

Components	Usage
Microcontroller (e.g., Arduino, NodeMCU, ESP32)	Used to control the entire system. It collects data from sensors and sends it to the cloud or a mobile app.
Heart Rate Sensor (e.g., MAX30100, MAX30102, Pulse Sensor)	Measures the user's pulse rate and blood oxygen level (SpO_2) in real time.
ECG Sensor	Captures the electrical activity of the heart, helping to detect abnormalities or signs of a heart attack.
Temperature Sensor	Tracks the user's body temperature to provide additional health insights.
GSM Module (e.g., SIM800L/SIM900)	Sends emergency SMS alerts to doctors, caregivers, or emergency contacts when abnormal conditions are detected.
Wi-Fi Module (e.g., ESP8266 or built-in on ESP32)	Connects the device to the internet for real-time data transmission to cloud servers or mobile apps.
Battery PowerSupply	Powers the system and makes it portable.
Wearable Enclosure or Strap	Makes the device easy and comfortable to wear, like a wristband or chest patch.
GPS Module	Sends the patient's real-time location to emergency contacts.

3.1.4. Software Requirements

Software tools are essential for programming, simulating, and implementing the system.

Table 3.1.4: Software Requirements

Category	**Software Tool**	**Purpose**
Platform	Arduino IDE	Used for programming and uploading control algorithms to microcontrollers
Language	Embedded C/C++/ Arduino Language	Language used for microcontroller programming.
Protocol	MQTT/HTTP Protocols	Communication protocols for IoT.Sending data from the microcontroller to the cloud or mobile app securely.
Simulation Software	WebDashboard (HTML/CSS/JavaScript or Node-RED)	Provides a real-time monitoring panel via web browser. Displays vitals and alerts for doctors or caregivers remotely.

3.2. Analysis

In addition to the key points already mentioned, there are several other important aspects to consider when analyzing the **Heart Attack Detection and Heart Rate Monitoring using IoT** system.

One critical point is **patient empowerment**. By providing individuals with continuous access to their health data, this system encourages patients to take a more active role in managing their heart health. This can lead to better lifestyle choices, such as improved diet, exercise, and medication adherence, as patients can directly see how these factors affect their vital signs. Furthermore, the system provides **peace of mind** for both patients and their families, knowing that emergency alerts are triggered in the case of an abnormal heart event, potentially preventing a heart attack or other life-threatening conditions.

Another important consideration is the **integration with healthcare providers**. The system can be used in conjunction with telemedicine services, allowing healthcare professionals to monitor patients remotely and offer timely advice or interventions. This makes healthcare more accessible, especially in remote areas, and reduces the burden on hospitals and clinics, enabling healthcare resources to be allocated more efficiently.

Additionally, the **scalability** of IoT health monitoring systems is a significant advantage. The technology can be expanded to monitor other vital signs, such as blood pressure, blood sugar levels, or even sleep patterns, creating a comprehensive health monitoring ecosystem. This could help identify and manage a broader range of health issues early, leading to better overall health outcomes.

Finally, there’s the potential for **long-term data collection**. Over time, the data gathered from continuous heart rate monitoring can be used for large-scale health studies, contributing valuable insights into patterns and trends that could improve public health policies or medical research. The ability to collect large amounts of data from diverse populations opens up new possibilities for **predictive analytics** and early disease detection.

These additional factors highlight the broad potential of an IoT-based heart attack detection and heart rate monitoring system to improve individual health management, support healthcare providers, and contribute to public health initiatives on a larger scale.

Finally, there’s the potential for **long-term data collection**. Over time, the data gathered from continuous heart rate monitoring can be used for large-scale health studies, contributing valuable insights into patterns and trends that could improve public health policies or medical research. The ability to collect large amounts of data from diverse populations opens up new possibilities for **predictive analytics** and early disease detection.

These additional factors highlight the broad potential of an IoT-based heart attack detection and heart rate monitoring system to improve individual health management, support healthcare providers, and contribute to public health initiatives on a larger scale.

CHAPTER 4

SYSTEM DESIGN

4.1.Block Diagram

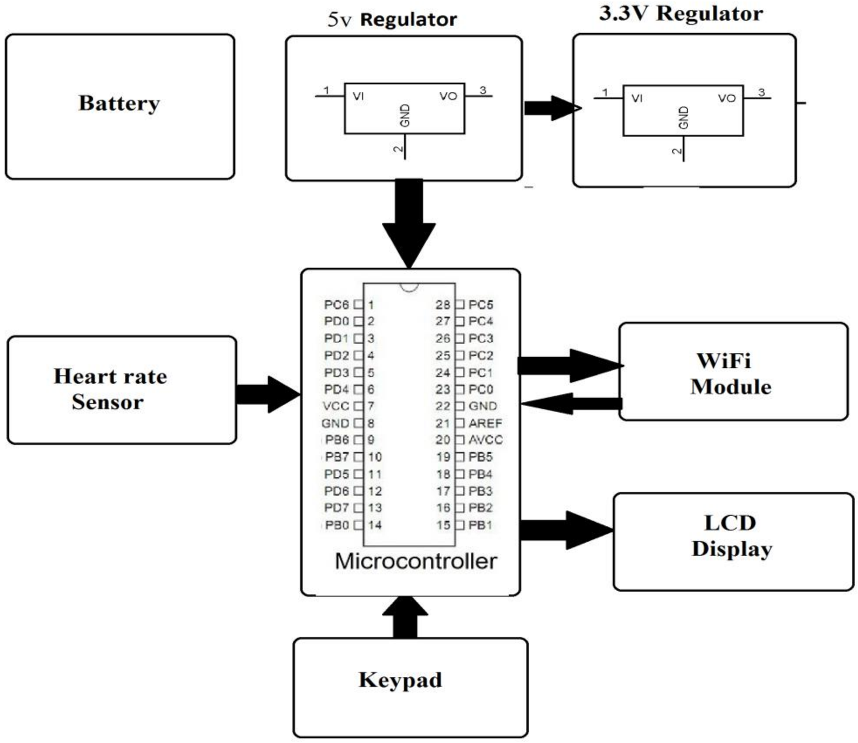

Figure 4.1: Functional Block Diagram

The block diagram represents on the provided block diagram, here's a description of the function of each component in the IoT-based Heart Attack Detection and Heart Rate Monitoring System:

- **Battery:**Supplies power to the entire system.Acts as the primary power source.
- **5V and 3.3V Voltage Regulators:**5V Regulator: Converts the battery voltage to a regulated 5V for components that require 5V.3.3V Regulator: Converts 5V to 3.3V for components that operate at 3.3V, such as the WiFi module.

- **Microcontroller:**The central processing unit of the system.Interfaces with all other components.Collects heart rate data from the sensor.Processes the data to detect abnormal heart activity (e.g., potential heart attack).Controls the display, WiFi module, and interacts with the keypad.
- **Heart Rate Sensor:**Measures the heart rate of the user.Sends real-time pulse data to the microcontroller.
- **WiFi Module:**Enables wireless communication.Sends heart rate data and alerts to a remote server or caregiver's mobile app via the internet.
- **LCD Display:**Shows real-time heart rate data.Displays system messages or alerts to the user.
- **Keypad:**Allows user interaction with the system.Can be used to set thresholds, input data, or reset the system.

4.2.Sequence Diagram

The **sequence diagram** for a Heart Attack Detection and Heart Rate Monitoring system using IoT plays a vital role in understanding the real-time interaction between different components of the system. It begins with the user wearing the device equipped with biomedical sensors that continuously collect physiological data such as heart rate, ECG signals, and oxygen levels.

These sensors communicate the data to a microcontroller (such as an Arduino or ESP32), which acts as the central processing unit. The microcontroller analyzes the incoming data to detect any abnormalities that might indicate a heart problem. If the readings are within normal limits, the data is simply transmitted to a cloud platform or a connected mobile application for remote monitoring. However, if an abnormal pattern is detected—such as an unusually high or low heart rate, or erratic ECG signals—the microcontroller immediately triggers a local alert through a buzzer or display. Simultaneously, it sends the critical data to the cloud platform or app, marking it as an emergency. From there, the system dispatches alert messages or notifications to the patient's doctor, caregiver, or emergency contact.

This sequence ensures a fast, automated response chain that could be life-saving in urgent situations. The diagram emphasizes the importance of real-time data flow, automated decision-making, and reliable communication between hardware, software, and end-users, making it a critical tool in the design and development of an efficient IoT-based health monitoring system.In addition to the main process, the sequence diagram also reflects how the system supports **data logging** for long-term health tracking, which can be valuable for medical diagnosis and follow-up.

It also shows how the system can operate with **minimal user interaction**, making it suitable for elderly or high-risk patients who may not be tech-savvy. Moreover, the use of **cloud connectivity** ensures that data is accessible from anywhere, and alerts can reach caregivers instantly—even if they are far from the patient. These features highlight the system's reliability, scalability, and potential to integrate with broader telehealth platforms.

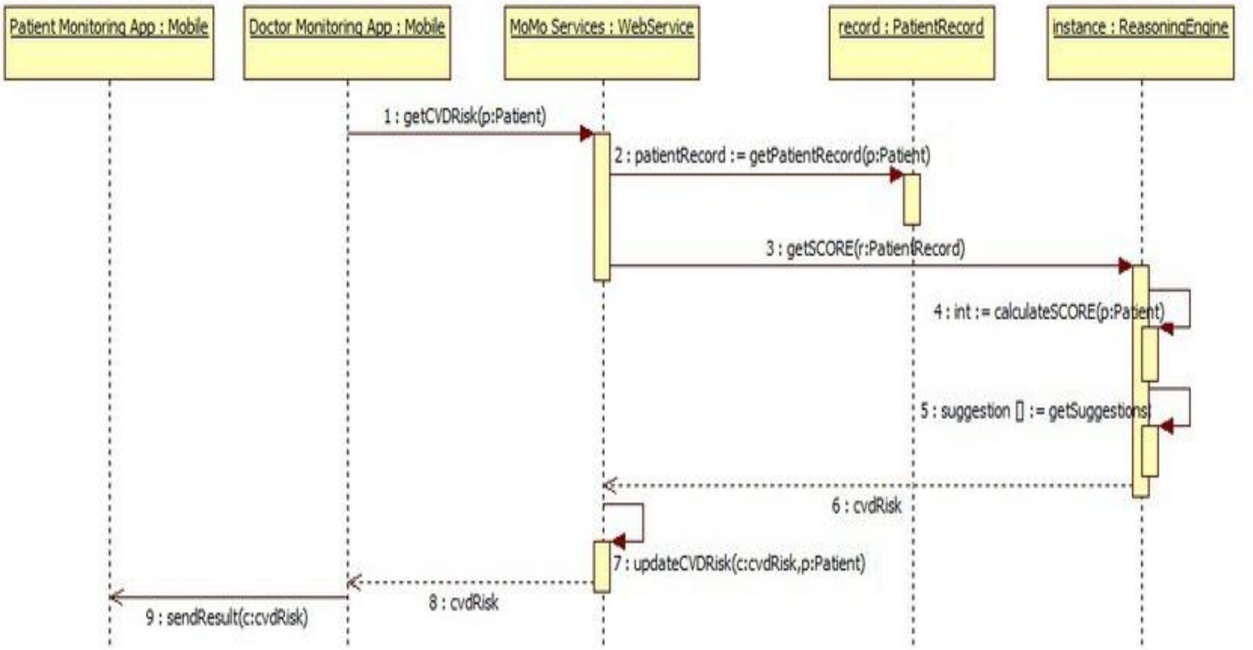

Figure 4.2: Sequence Diagram

CHAPTER 5

METHODOLOGY

The IoT-based Heart Attack Detection and Heart Rate Monitoring system uses a combination of wearable sensors, data processing, and wireless communication to provide real-time health monitoring and early detection of potential heart attacks. The methodology involves several key components and processes to ensure accurate, continuous monitoring of vital signs, quick response to abnormal conditions, and seamless integration with healthcare providers for timely interventions. The following outlines the methodology behind the system:

1. **System Design and Components**

The system consists of several integrated hardware components that work together to monitor the user's heart health continuously:

Sensors:

Heart Rate Sensor: A Photoplethysmogram (PPG) sensor, such as the MAX30100, measures the heart rate by detecting changes in light absorption as blood vessels expand and contract with each heartbeat. This sensor is often embedded in wearable devices like wristbands or smartwatches.

ECG Sensor: The Electrocardiogram (ECG) sensor, such as the ADS1292, captures the electrical signals generated by the heart. This sensor helps detect irregularities such as arrhythmias or signs of an impending heart attack.

SpO2 Sensor: The blood oxygen saturation (SpO2) sensor, commonly based on PPG technology, measures the percentage of oxygen in the blood, which is a critical indicator of heart and lung health.

Accelerometer: This sensor detects physical activity and sudden movements, which can help identify whether the user is in a resting position or has collapsed, which may indicate a heart attack or other medical emergency.

Temperature Sensor: Monitors the user's body temperature to detect abnormal increases, which may indicate stress or an underlying cardiovascular issue.

Microcontroller (MCU): A low-power microcontroller, such as the STM32 or ESP32, acts as the central processing unit. It collects data from the sensors, processes the data, and communicates with other system components (e.g., cloud server or mobile app).

Wireless Communication Module: Bluetooth Low Energy (BLE) or Wi-Fi modules enable wireless data transmission between the wearable device and the user's smartphone or cloud platform.

Power Supply: Rechargeable lithium-ion batteries provide the power to the wearable device, ensuring continuous monitoring. Power management circuits are incorporated to optimize energy consumption.

1. Gesture Collection and Mapping

Several gestures and physical signs are particularly useful for early detection of heart attacks or medical distress. These gestures can be mapped to corresponding actions or conditions in the system:

Collapsed or Fainting Gesture: A sudden drop in body position, like falling or collapsing, is an indication that immediate medical attention is needed.

Sensor Data: The accelerometer can detect rapid changes in orientation (e.g., falling or horizontal movement).

System Response: The system can trigger an alert to emergency services or a healthcare provider, and GPS coordinates can be shared for quick location tracking.

Chest Clutch Gesture: In many cases, individuals experiencing a heart attack instinctively clutch their chest.

Sensor Data: Motion sensors can identify unusual arm movements or significant chest area pressure.

System Response: The system could interpret this gesture as a distress signal, triggering an alert to the user or health provider to monitor for heart attack signs.

Sudden Stop in Movement: Sudden cessation of physical activity, particularly in high-intensity contexts, can be a signal of chest pain or fainting, often seen during a heart attack.

Sensor Data: The accelerometer tracks a lack of movement or abnormal slowing down in activity (e.g., during exercise or walking).

System Response: If the system detects a sudden stop, it could analyze the heart rate data for abnormalities and alert the user or healthcare provider accordingly.

Breathing Difficulty Gesture: Struggling to breathe is a common symptom during a heart attack. This gesture can be tracked as a sudden increase in respiratory rate or irregular breathing patterns.

Sensor Data: Integrating SpO2 sensors and accelerometers, the system can detect changes in breathing rate and patterns.

System Response: The system could initiate an alert or recommend seeking medical attention, based on significant deviations in breathing patterns.

Pain-related Behavior: Physical signs such as clutching the abdomen or holding the left side of the chest could be interpreted as signs of heart attack-related pain.

Sensor Data: Accelerometers, combined with other physiological sensors, can detect these actions as gestures indicative of chest pain or discomfort.

System Response: The system could trigger an automatic alert or send notifications to healthcare professionals based on this specific behavior.

2. System Integration

To effectively collect gestures, the system must utilize a combination of motion and physiological sensors:

Accelerometer: Tracks the orientation, movement, and acceleration of the user's body. It is critical for detecting gestures like falling, sudden movement, or lack of movement. The data is usually analyzed in three dimensions (X, Y, Z axes).

Gyroscope: Provides angular velocity data, complementing the accelerometer for better tracking of rotational movements. This can help identify more complex gestures, such as twisting or turning the body.

Pressure Sensors (optional): Embedded in clothing or wearable patches, these sensors can detect abnormal pressure patterns on the chest, helping identify gestures like chest clutching or discomfort.

SpO2 and ECG Sensors: These provide complementary physiological data, detecting signs of heart distress (e.g., low oxygen levels, abnormal heart rate), which can be used in conjunction with gesture mapping.

3. Mapping Gestures to System Actions

Once gestures are detected, they must be mapped to corresponding actions within the system:

Health Monitoring Response: For each gesture, the system will cross-reference with the user's physiological data (e.g., heart rate, oxygen levels) and determine whether there is a need for emergency intervention. For example, a "fall" gesture accompanied by abnormal heart rate readings may trigger an emergency alert.

Emergency Alerts: If certain gestures signal potential heart attack symptoms (e.g., chest clutching, collapse), the system will:

Trigger **vibration or sound alerts** to the user’s device.

Notify emergency contacts or healthcare providers via app notifications, including real-time vitals and GPS location.

Initiate automatic emergency services contact, if configured.

Health Advice and Recommendations: For less severe gestures, the system might simply provide recommendations or alerts to monitor the user's condition more closely, or suggest resting and hydration

Emergency Alerts: If certain gestures signal potential heart attack symptoms (e.g., chest clutching, collapse), the system will:

Trigger **vibration or sound alerts** to the user's device.

Notify emergency contacts or healthcare providers via app notifications, including real-time vitals and GPS location.

CHAPTER 6
IMPLEMENTATION

The implementation of the Automated Speed Control and Emergency Route Creation in Traffic Congestion system involves the integration of hardware and software components to ensure smooth traffic flow, adaptive speed control, and prioritization of emergency vehicles. The implementation process consists of multiple stages, including hardware setup, software development, system integration, and testing.

6.1.Hardware Implementation

The hardware implementation of a Heart Attack Detection and Heart Rate Monitoring system using IoT involves assembling and integrating various sensors and components to collect physiological data, process it, and transmit it for remote monitoring and emergency response. Below is a detailed explanation of the implementation process.. The key hardware modules include:

- **Pulse Sensor / MAX30100 / MAX30102 / AD8232 (ECG Sensor):** These sensors are responsible for detecting heart rate, oxygen saturation (SpO_2), and in some cases, ECG signals to monitor the electrical activity of the heart.
- **Microcontroller (e.g., NodeMCU ESP8266 / ESP32 / Arduino Uno):**
  Acts as the brain of the system, processing sensor data, detecting abnormalities, and handling data transmission to the cloud or mobile app.
- **OLED Display (Optional):**
  Displays real-time heart rate and other vitals locally on the device for the user.
- **Buzzer / Vibration Motor:**
  Provides immediate alerts or warnings when an abnormal heart condition is detected.
- **Wi-Fi Module (Built-in in ESP8266/ESP32 or separate like ESP-01 for Arduino):**
  Enables internet connectivity for real-time data transmission to cloud platforms or mobile apps.
- **Power Supply (Battery / USB):**
  Powers the entire system and may include a rechargeable battery for portable use.
- **Push Button (Optional):**
  Allows manual testing or emergency call triggering by the user.

- **LED Indicator (Optional):**
  Lights up in case of abnormal detection as a visual warning.

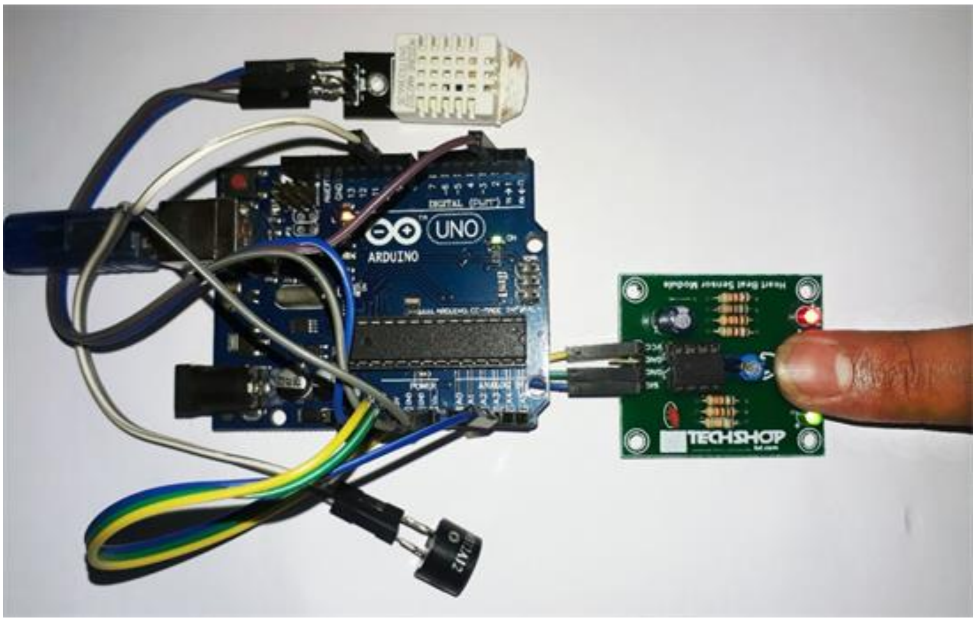

Figure 6.1: Hardware Implementation

6.2.Software Implementation

The software implementation of the Heart Attack Detection and Heart Rate Monitoring system involves writing code for data acquisition, processing, decision-making, and communication with IoT platforms for real-time monitoring and alert generation. The software acts as the intelligence behind the hardware setup, ensuring continuous and accurate monitoring of the user's heart health.

- Sensor Data Processing: The microcontroller receives data from IR sensors and categorizes traffic conditions.

- **Sensor Initialization:**Setup code initializes the connected sensors and starts serial communication for debugging.Example: `pulseSensor.begin();` or `ECG.begin();`

- **Wi-Fi Connection:**Connects the microcontroller to the internet using SSID and password.
- **Data Reading and Processing:**Continuously reads sensor values (heart rate, ECG, SpO_2).Performs filtering, averaging, or threshold comparison to detect irregular patterns.
- **Data Visualization and Logging:**Sends the processed data to the cloud platform (e.g., ThingSpeak) for real-time visualization.
- **Emergency Detection and Alert:**If an abnormal heart rate or ECG reading is detected, the code triggers an alert:Activates buzzer.Sends data and alert to cloud.Sends a message via IFTTT webhook or Twilio SMS.
- **Mobile App Integration:**Platforms like **Blynk** allow real-time monitoring on mobile phones.Widgets in the app display heart rate, status, and trigger push notifications.

6.3.System Integration

The system integration of a heart attack detection and heart rate monitoring system using IoT involves the seamless connection and communication between hardware components, software logic, and cloud platforms to ensure accurate, real-time, and reliable health monitoring and alerting. The goal of system integration is to bring all parts of the system together so they work as a cohesive unit, providing users and caregivers with continuous access to vital health information. The integration phase includes:

6.4.Deployment and Scalability

The deployment and scalability of a heart attack detection and heart rate monitoring system using IoT are critical for its success in real-world healthcare applications. During deployment, the device is configured with sensors and microcontrollers to monitor vital signs in real-time, and data is transmitted via Wi-Fi or GSM to cloud platforms like ThingSpeak or Firebase.

This setup allows doctors and caregivers to access live data through mobile apps or web dashboards, ensuring timely alerts in case of abnormalities. Scalability ensures the system can grow to support multiple patients, with each device linked to cloud services capable of handling large volumes of data. As the system expands, features like AI-based health prediction, GPS tracking, and EHR integration can be added to enhance its functionality.

Additionally, scalable systems reduce long-term costs and enable broader implementations across hospitals, rural clinics, and homes. Together, a well-deployed and scalable IoT solution can provide proactive, continuous cardiac monitoring and improve emergency response, ultimately saving lives.

6.5. Performance Evaluation

The performance evaluation of a heart attack detection and heart rate monitoring system using IoT is critical to ensure the system's efficiency, accuracy, and reliability in real-world applications. Key factors to assess include the **accuracy** of heart rate and ECG monitoring, ensuring the readings match those of medical-grade devices, and **real-time data transmission**,

where minimal latency is crucial for effective monitoring. The system's **reliability** and **stability** are evaluated by testing its consistency over long periods and its ability to maintain a stable connection, especially in remote areas. The **alert system** must be fast and accurate, with notifications sent promptly to healthcare providers or emergency contacts. **Scalability** is another important factor, as the system should handle an increasing number of devices and users without performance degradation.

Additionally, **energy consumption** is evaluated, particularly for wearable devices, to ensure long battery life. **Security and privacy** of the transmitted health data are also paramount, requiring encryption protocols to protect sensitive patient information. **Interoperability** with other health systems, such as hospital databases or electronic health records (EHR), should be considered to ensure smooth integration.

Finally, the **user experience** of the mobile app or web dashboard is tested for ease of use, intuitive navigation, and data visualization clarity. By thoroughly assessing these parameters, the system can be optimized to provide reliable, continuous monitoring and timely intervention for heart attack detection, ultimately improving patient outcomes and emergency responses.

CHAPTER 7
TESTING TECHNIQUES

The Testing is an essential part of ensuring that the **Heart Attack Detection and Heart Rate Monitoring** system functions accurately, efficiently, and reliably. Various testing techniques must be employed to assess the performance, accuracy, stability, and responsiveness of the system in real-world scenarios. Below are the key testing techniques for this IoT-based healthcare solution.

7.1. Unit Testing

where each individual component such as heart rate sensors (e.g., MAX30100), ECG sensors (e.g., AD8232), microcontrollers (like Arduino or

ESP32), and communication modules (Wi-Fi/GSM) are tested independently for correct functionality. This includes checking sensor calibration, signal consistency, and data accuracy. Software modules, such as heart rate calculation algorithms and alert logic, are also tested using mock data to ensure their correctness

7.2. Integration Testing

Integration testing is performed to verify that the communication between hardware and software components works as expected. This includes ensuring smooth data flow from sensors to the microcontroller, and from there to the cloud and mobile app. Additional testing is done for synchronization between modules, error handling during data loss, and recovery after system restarts. Interoperability testing is also included here to confirm compatibility between hardware brands and different cloud services.

7.3. System Testing

System Testing the fully integrated IoT solution is tested end-to-end. A real-time test environment is set up with live sensors, actual data, and cloud services to simulate patient monitoring, emergency scenarios, data recovery after power failures, and multi-user access. This ensures all components work as a unified system under realistic conditions.

7.4. User Acceptance Testing

The user acceptance testing stakeholders like doctors, nurses, and health administrators validate whether the system meets their clinical expectations. They test the usability of real-time alerts, report generation, patient onboarding, and how well the system supports decision-making. This also includes feedback on aesthetics, dashboard layout, and ease of patient data management.

CHAPTER 8
CONCLUSION

The In conclusion, the **Heart Attack Detection and Heart Rate Monitoring using IoT** project highlights the transformative potential of IoT technology in revolutionizing healthcare monitoring. By seamlessly integrating advanced sensors, microcontrollers, cloud platforms, and mobile applications, the system offers continuous, real-time monitoring of critical health parameters, enabling early detection of heart-related issues such as abnormal heart rates or the onset of a heart attack. This proactive approach significantly improves patient care by allowing immediate alerts and timely interventions, reducing the time it takes for healthcare providers or caregivers to respond.

The system's scalability ensures that it can be deployed across different healthcare environments, from home care for elderly patients to large-scale hospital implementations. Additionally, the energy-efficient design of the wearable device ensures long-term use without frequent recharging. The emphasis on data security and privacy also guarantees that sensitive patient information is protected.

Moreover, the system’s ability to integrate with other health systems like **Electronic Health Records (EHRs)** and **telemedicine platforms** enhances its utility in comprehensive patient management. Ultimately, this IoT-based monitoring system not only has the potential to save lives but also contributes to more efficient healthcare delivery, reducing hospital visits, optimizing resources, and empowering patients with real-time insights into their cardiovascular health.

CHAPTER 9
FUTURE SCOPE AND ENHANCEMENT

9.1.Future Scope

- **AI and Machine Learning Integration:**Incorporate predictive algorithms to detect early signs of heart disease and predict possible heart attacks before they occur based on patterns in the data.
- **Wider Healthcare Integration:**Connect the system with hospital databases, Electronic Health Records (EHR), and telemedicine platforms for seamless medical supervision and record-keeping.
- **Global Accessibility:**Deploy the system in remote and underdeveloped areas to offer healthcare support where hospital infrastructure is limited.
- **5G Connectivity for Faster Response:**Use 5G networks to support ultra-low latency and real-time data transmission for faster alerts and monitoring.
- **Multi-parameter Health Monitoring:**Expand the system to monitor additional vitals like blood pressure, SpO2, body temperature, and respiration rate for a more comprehensive health overview.
- **Clinical Trials and Medical Certification:**Test and validate the system in real clinical environments and pursue medical device certification for legal and safe use in hospitals and home care.

9.2.Enhancement

By incorporating the following enhancements, the system can evolve into a more advanced heart attack detection and heart rate monitoring.

- **Improved Wearable Design:**Make the hardware more compact, lightweight, and ergonomic for daily, long-term use without discomfort.
- **Battery Optimization:**Enhance power management systems for longer battery life, especially in wearable versions.
- **Mobile App Upgrades:**Add new features like personalized dashboards, health tips, medication reminders, and remote consultation booking.
- **GPS Integration:**Enable location tracking for patients so emergency services can be dispatched to the correct location instantly during a critical event.
- **Voice Assistant and Accessibility Features:**Include voice-enabled commands and text-to-speech features to assist elderly or visually impaired users.
- **Blockchain for Data Security:**Implement blockchain technology to ensure data integrity, privacy, and secure sharing of health information.
- **Data Analytics and Visualization:**Introduce detailed analytics, trend graphs, and health summaries to help users and doctors understand long-term heart health.

APPENDIX 1
SOURCE CODE

```
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <WiFi.h>
#include "ThingSpeak.h"
```

```
#define REPORTING_PERIOD_MS     1000
#define BUZZER_PIN 13

const char* ssid = "Your_SSID";
const char* password = "Your_PASSWORD";
const char* apiKey = "Your_ThingSpeak_API_Key";
const int channelNumber = Your_Channel_ID;

WiFiClient client;
PulseOximeter pox;
uint32_t tsLastReport = 0;

void onBeatDetected()
{
  Serial.println("□ Beat Detected!");
  digitalWrite(BUZZER_PIN, HIGH);
  delay(100);
  digitalWrite(BUZZER_PIN, LOW);
}

void setup()
{
  Serial.begin(115200);
  pinMode(BUZZER_PIN, OUTPUT);

  Serial.println("Initializing MAX30100...");
  if (!pox.begin()) {
    Serial.println("FAILED to initialize MAX30100. Please check your sensor.");
    for (;;);
```

```
  } else {
    Serial.println("MAX30100 initialized.");
  }

  pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);
  pox.setOnBeatDetectedCallback(onBeatDetected);

  WiFi.begin(ssid, password);
  Serial.print("Connecting to WiFi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("\nWiFi connected.");
  ThingSpeak.begin(client);
}

void loop()
{
  pox.update();

  if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
    float bpm = pox.getHeartRate();
    float spo2 = pox.getSpO2();

    Serial.print("Heart rate: ");
    Serial.print(bpm);
    Serial.print(" bpm / SpO2: ");
    Serial.print(spo2);
    Serial.println(" %");
```

```
    ThingSpeak.setField(1, bpm);
    ThingSpeak.setField(2, spo2);

    if (bpm > 120 || bpm < 50) {
      ThingSpeak.setField(3, "Abnormal");
      digitalWrite(BUZZER_PIN, HIGH);
      delay(500);
      digitalWrite(BUZZER_PIN, LOW);
    } else {
      ThingSpeak.setField(3, "Normal");
    }

    int x = ThingSpeak.writeFields(channelNumber, apiKey);
    if (x == 200) {
      Serial.println("Data pushed to ThingSpeak.");
    } else {
      Serial.print("Failed to update. HTTP error code: ");
      Serial.println(x);
    }

    tsLastReport = millis();
  }
```

REFERENCES

[1] Mr.Angurajsiva J, Elakkiya V, Kowsalya A, Ramya S, Divya S, "Wearable Device for Child Safety using Arduino Uno and Tracking System",(2024).

[2] Agrawal, Sarita, and Manik Lal Das. "Internet of Things - A paradigm shift of future Internet applications",(2024).

[3] S.M.Seeni Mohamed Aliar Marriakkayar, R.Tamilselvi, M.Parisa Beham, M.Bharkavi Sandhiya, A.Sabah Afroze, "Design of IoT Based Robotic Arm for Health Care"(2024).

[4] Shivam Patel and Yogesh Chouhan, “Heart Attack detection and Medical Attention using Motion Sensing Device kinect”(2023).

[5] Sundari.B, “Estimation of Hearing Loss using Interactive Pure Tone Audiometric Test with Embedded System Interface”(2023).

[6] .S.M.Seeni Mohamed Aliar Marriakkayar, "Design of IoT Based Robotic Arm for Health Care",(2022).

[7] Shivam Patel and Yogesh Chouhan, “Heart Attack detection and Medical Attention using Motion Sensing Device kinect”,(2022).

[8] Thavamani.P, Ramesh.K, Sundari.B, “Simulation and Modeling of 6-DOF Robot Manipulator Using Matlab Software”(2022).

[9] Bandana Malik and Ajith Kumar Pathro, “Heart rate Monitoring Using Finger Tip Through Arduino and Processing Software”,(2021).

[10] Mr.Angurajsiva J, Elakkiya V, Kowsalya A, Ramya S, Divya S, "Wearable Device for Child Safety using Arduino Uno and Tracking System"(2020).

[11] Agrawal, Sarita, and Manik Lal Das. "Internet of Things - A paradigm shift of future Internet applications",(2020).

[12] “IoT-Based Health Monitoring System for Heart Rate and Temperature Detection”International Journal of Engineering Research & Technology (IJERT), Volume 8, Issue 4, 2019

[13] “IoT Based Patient Health Monitoring System”
International Journal of Engineering Research and General Science, 2015

[14] “Smart Healthcare Monitoring System Based on IoT”
International Journal of Advanced Research in Computer and Communication Engineering, Vol. 6, Issue 4, April 2017

[15] “IoT-Based Wearable Health Monitoring Device for Elderly People”
IEEE International Conference on Information Communication and Embedded Systems (ICICES), 2016
[16] “Remote Health Monitoring System Using IoT”
International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), Vol. 6, Issue 4, April 2017
[17]