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Life Tracking Application

Master's Thesis

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Education of Prof.

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Author's Declaration of Originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature, and the work of others have been referred to. This thesis has not been presented for examination anywhere else. Author: Mohsin Khalid 213861IASM.

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Abstract

To help save lives, the healthcare system has undergone extensive development. Health is the most important attribute of every person. In this hectic and fast world, everyone wants to take good care of themselves and wants a good healthcare facility in the hour of need. Many people are employed in rural locations, far from any kind of medical care. When necessary, getting them to the closest medical facility is quite tough. The majority of fatalities are caused by the delays and connectivity problems with healthcare facilities. We are developing a small, portable gadget that can continuously and in real time measure a person's body temperature as our easy solution to this issue. The gadget might take the shape of a wristband that anyone can put on without difficulty. We will have a mobile app for the gadget that can be downloaded from the Google Play Store. The app will track and present a person's overall health data. One can check their health conditions using these statistics. Additionally, it contains a feature that instantly alerts medical systems and a person's close family members if a person's body temperature or heartbeat deviates unexpectedly. The system-connected healthcare facilities will take early action to prevent any complications. We will create a prototype of a device that can connect to the app at the initial stage. This gadget can be developed in the form of a tiny wrist band that is simple to wear and carry. Structure of the thesis is the first chapter provides an overview of the thesis and sets the stage for the rest of the document. It outlines the purpose of the research, including the stated aim, goals that need to be met, and challenges that must be overcome to achieve the stated aim. Additionally, the chapter describes the study's scope and the research's significance to the healthcare industry. The second chapter comprehensively reviews the relevant literature on health monitoring applications, including wearable devices, sensors, and data collection methods. The third chapter describes the methodology used to develop the health monitoring application. This includes the data collection methods, and the process of patient recruitment. The fourth chapter provides a detailed description of the experimental system used in the thesis. This includes a description of the system's key components, interconnections, and purposes. The chapter also provides a complete workflow of the experimental system, including data collection, transmission, and storage. The fifth chapter presents the results of the experiments conducted in the thesis and compares those results to the existing literature. Additionally, the chapter highlights the limitations of the study and suggests avenues for future research.

List of Abbreviations and Terms

Words	**Abbreviation**
EHRs	Electronic Health Records
BANs	Body Area Networks
MEMS	Microelectromechanical Systems
WSNs	Wireless Sensor Networks
IDE	Integrated Development Environment
SPP	Serial Port Profile
HID	Human Interface Device
ECG	Electrocardiogram

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Introduction

In recent years, health monitoring apps have grown in popularity, mostly due to the proliferation of wearable gadgets and sensors that can gather and send health data. These programmes provide the promise of individualized healthcare by allowing users to monitor their health condition in real-time and make educated choices about their welfare. Despite the increasing demand for health monitoring software, there are still obstacles to overcome to assure their efficacy. Access to healthcare services is a basic right that everyone, regardless of geography, should have. Unfortunately, rural communities often encounter considerable obstacles in accessing medical care. In today's fast-paced world, individuals want rapid and easy access to healthcare services, and the distance between rural communities and the closest medical institution may be a significant barrier. In addition, the time and money required to get to a medical facility may be a substantial strain. Delay in seeking medical attention may have severe consequences, such as death, and create further issues for the individual and their family. Consequently, a dependable, portable, and cost-effective healthcare solution that everyone can use, regardless of location, becomes essential. The suggested answer to this issue is the tiny, portable gadget that can measure a person's body temperature in real time.

In the shape of a wristband, our proposed gadget would offer user-friendly healthcare equipment that is simple to use and may be worn by anybody. The device's continuous and real-time monitoring of body temperature may quickly alert users and medical personnel to possible health concerns, preventing serious health issues, reducing treatment delays, and eventually saving lives. Our proposed technology may substantially contribute to the healthcare business by providing an innovative and cost-effective solution that anybody, regardless of location, can use. With the device's ongoing body temperature monitoring, rural inhabitants may get early medical attention and avoid the dangers of delayed treatment. This thesis addresses rural people's difficulties in obtaining healthcare services and presents a solution that would enhance their access to medical treatment and eventually save lives. The findings of this research indicate that the life tracking application created for this thesis is a useful tool for monitoring vital signs and evaluating data over time. It was discovered that the programme accurately tracked heart rate and body temperature and could identify patterns and produce statistics such as averages and standard deviations.

1 Goals of Using Wristband for Health Monitoring

Depending on the particular situation in which they are used, wristbands for health monitoring may serve various purposes. The following are some common objectives for utilizing wristbands for health monitoring:

- Promote Healthy Behavior: People may be inspired to make better decisions and adopt healthier lifestyles by wearing wristbands monitoring their physical activity, sleep, and other health habits.
- Early detection of health problems: Wearable devices that monitor vital indicators like blood pressure, temperature, and heart rate may assist identify health issues early on, before they become severe or need hospitalization.
- Disease Management: Wristbands that monitor vital signs like blood pressure and blood sugar levels may assist people with chronic diseases like diabetes and hypertension better manage their symptoms, lower their risk of complications, and achieve better health outcomes.
- Remote Monitoring: Wristbands may be connected to websites or mobile applications to provide remote health monitoring of a person. This may be extremely helpful for those with chronic diseases who need continual monitoring and treatment.
- Health Research: In this context, "health care" refers to providing health care services to individuals and groups.

Due to its convenience, mobility, and capacity to capture a vast array of health data, wristbands are increasingly employed for health monitoring. The primary purpose of utilizing a wristband for health monitoring is to assist people in understanding their health state and taking the necessary steps to maintain or enhance their wellness. Measuring physical activity is one of the main advantages of utilizing a wristband for health monitoring. The ability of wristbands to track the number of steps taken, the distance travelled, and the calories expended gives users a greater picture of their overall fitness state. This may assist people in establishing and attaining fitness objectives, which can significantly affect their physical and emotional health. Monitoring vital indicators, such as heart rate and blood pressure, is another essential use of a wristband for health monitoring. These measures may give insight into a person's cardiovascular health, alerting them to the possibility of medically necessary health problems. By monitoring these parameters, individuals may take proactive measures to preserve their cardiovascular health and lower their risk of heart disease and other diseases. Additionally, wristbands can be used to monitor sleep patterns, providing data on the quality and duration of sleep. This information may assist people in modifying their sleeping patterns and enhancing their general health. Using a wristband for health monitoring aims to offer people with relevant health data, assist them in gaining insight into their health state, and allow them to take necessary steps to preserve or enhance their health and well-being. With technological advancements and the popularity of wearable health gadgets, wristbands are becoming crucial for health monitoring and management. Utilizing wristbands for health monitoring has the primary goals of promoting health, avoiding illness, and enhancing health outcomes. By collecting crucial health indicators and providing insights into health behavior, wristbands may help individuals take charge of their health and make sensible health decisions.

1.1 Overview

Over the last 50 years, computer hardware expansion has been exponential, and this growth rate is expected to remain for some time. Similar to analogue electronics, digital electronics are becoming smaller while performing better. Consequently, new applications are made possible, enhancing the value of digital electronic equipment. These gadgets are a driving force behind our society's technical and social transformations [1]. Today, numerous gadgets enable individuals to lead regular lives while having health issues, such as pacemakers and hearing aids. The creation of omnipresent technologies has been popular in recent years. Devices that are always with us and serve to support and enhance human abilities. Utilizing ubiquitous computing allows us to free up people from completing laborious, repetitive jobs. A computer may be programmed to keep track of a situation and determine when to warn a person, allowing the latter to shift his attention elsewhere, knowing that everything is under control [2]. Today, computers are used to keep an eye on you while you're in the hospital. Your body's vital indicators are tracked, and medical help is promptly summoned if anything is odd. But what if we could relocate this circumstance from a hospital to the patient's home? What if you could wear a monitoring gadget throughout the day and be certain that you, your loved ones, or medical professionals would be notified immediately if something became abnormal? [3].

The e-health care system has undergone tremendous development as a result of advancements in medical technology. For the people in poor nations, a wireless, creative, and efficient e-health monitor model may be of considerable assistance. Technology helps doctors diagnose and treat patients more effectively even when they are not physically there since it might be important to treat patients who are unfortunate enough to be far from medical care. Modern-day medical technology is significantly improving our daily life. This helps to enhance and save numerous lives across the globe. In the vast realm of medical technology, innovation is essential to preserving health [4].

Wearable health monitoring technology has gained popularity recently, particularly in the healthcare industry. With the aid of these gadgets, people may monitor their health indicators in real-time and take preventative actions to keep themselves in good health. Heart rate and body temperature are two crucial parameters that might provide important clues about a person's general state of health. Individuals may discover possible health concerns early on and take the necessary action to solve them by monitoring these variables [5]. The design and creation of a real-time heart rate and body temperature monitoring wearable application will be examined in this thesis.

Wearable health monitoring is the practice of tracking and observing someone's health and wellbeing using wearable gadgets like smartwatches, fitness trackers, and health monitoring bracelets. These gadgets often use a variety of sensors, such as heart rate monitors, accelerometers, and gyroscopes, to assess a person's heart rate, physical activity level, and sleep quality, among other health-related factors [6].

Wearable health monitoring devices can provide several benefits, including [7], [8]:

- Increased Awareness: Wearable health monitoring devices may raise a person's awareness of their general health and wellbeing by monitoring a variety of health variables. People may be inspired to modify their lifestyle and health practices for the better due to greater awareness.

- Real-Time Monitoring: A person's health parameters may be tracked in real-time by wearable health monitoring devices, enabling them to modify their behavior or treatment strategy as necessary.
- Improved Self-Management: By recording crucial health metrics and sending notifications for critical occurrences, such as low blood sugar levels, wearable health monitoring devices may assist people in managing chronic diseases, such as diabetes or heart disease.
- Personalized Health Insights: Individuals may receive individualized insights into their health and wellbeing by evaluating data from wearable health monitoring devices, which enables them to make better choices regarding their health.

People may monitor and manage their health and wellbeing daily with the use of wearable health monitoring gadgets, which can be both practical and efficient. It's crucial to remember that these tools should not be used in place of routine check-ups with a healthcare practitioner and should be used in addition to them.

As more individuals realize the advantages of regularly tracking their health and fitness, wearable health monitoring has grown in significance in recent years. The following are some of the main arguments in favor of wearable health monitoring [9], [10]:

- Early Detection of Health Issues: By monitoring important health metrics like heart rate, blood pressure, and sleep quality, wearable health monitoring devices may assist people in identifying health concerns early on. Individuals may seek medical care before health problems worsen by recognizing changes in these parameters.
- Chronic Disease Management: By recording vital health metrics and sending notifications for crucial situations, such as low blood sugar levels, wearable health monitoring devices may assist people in managing chronic conditions like diabetes or heart disease.
- Improved Lifestyle Habits: Wearable health monitoring technology may encourage people to adopt healthier lifestyle practices including raising their physical activity levels, getting better sleep, and lowering their stress levels.

- Personalized Health Insights: Individuals may receive individualized insights into their health and wellbeing by evaluating data from wearable health monitoring devices, which enables them to make better choices regarding their health.
- Better Communication with Healthcare Providers: By giving more thorough information about a person's health state, wearable health monitoring devices may help people and their healthcare professionals communicate more effectively.

Wearable health monitoring may be very helpful for those who live in remote regions or places with difficult access to medical care. Some of the most important ways that wearable health monitoring may assist with this problem are as follows [11], [12]:

- Remote Monitoring: Even if they are in a distant place, wearable health monitoring devices may enable medical professionals to check a patient's health state remotely. This may aid in the early detection of health problems and the prompt delivery of medical treatment.
- Real-Time Data: Wearable health monitoring technology may provide healthcare professionals with access to real-time information on a patient's health state, enabling them to choose the best course of treatment.
- Personalized Care: Even if a person is distant from a medical institution, wearable health monitoring technologies may provide individualized treatment depending on their health state and requirements.
- Emergency Alerts: In the case of a catastrophic health problem, such as a heart attack or stroke, wearable health monitoring devices may send out emergency signals. This may aid medical professionals in responding to the situation promptly and dispensing timely medical treatment.

By allowing remote monitoring and individualized treatment, wearable health monitoring may assist in addressing the difficulty of delivering medical care to those in rural locations. It's crucial to remember that these tools should not be used in place of routine check-ups with a healthcare practitioner and should be used in addition to them [13]. Real time monitoring system is depicted in Figure 1.

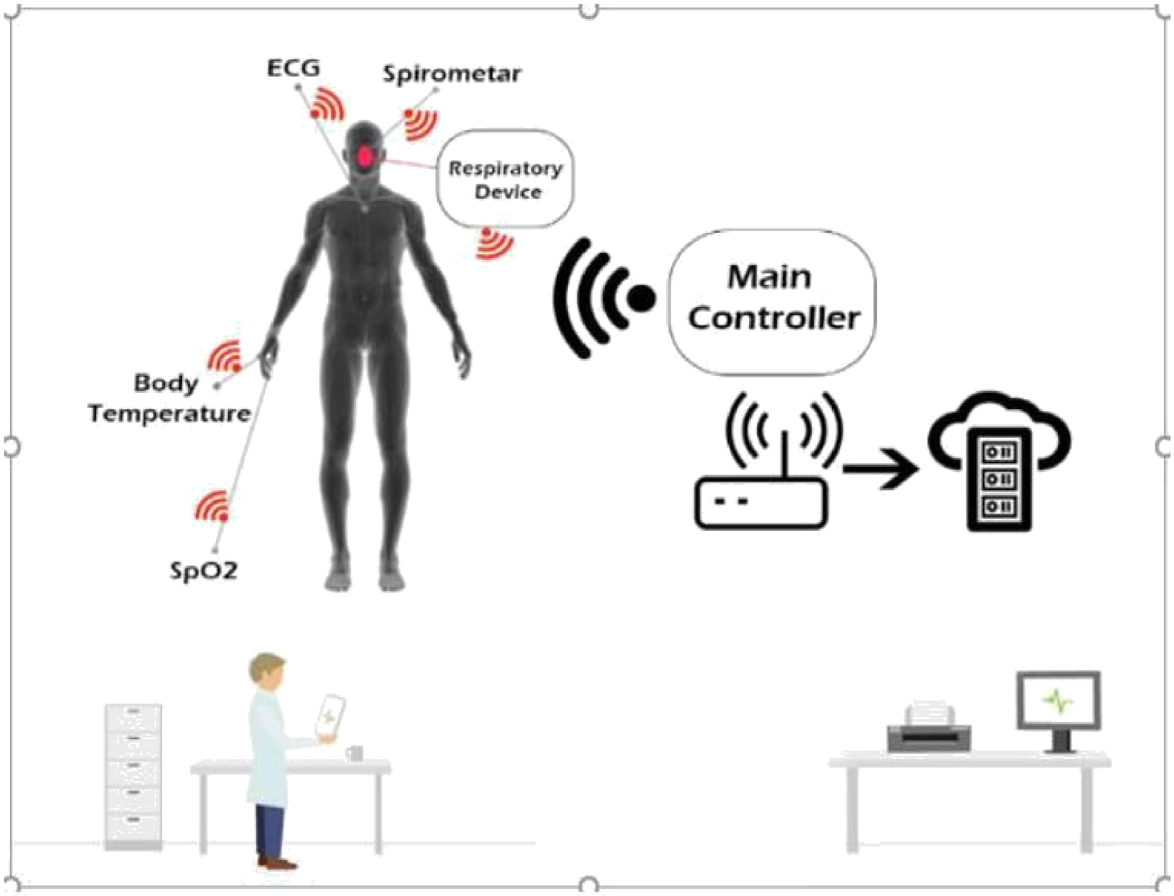

Figure 1. Real Time Monitoring System

1.2 Overview of the Health Monitoring Concept

A person's physical and physiological parameters are continuously observed and measured as part of health monitoring to spot deviations from normal functioning. The idea entails using a range of technology and tools to collect data, evaluate it, and provide consumers or healthcare practitioners' feedback. The main objective of health monitoring is to identify health issues before they worsen or pose a danger to life. People may actively control their health and delay the emergence of chronic illnesses by keeping track of important indicators including heart rate, blood pressure, blood glucose levels, and body temperature [14].

Wearable technology, including smartwatches, fitness trackers, and medical-grade sensors, may be used for health monitoring. Apps, internet platforms, and telehealth services are examples of additional instruments used in health monitoring. With the use of these technologies, people may monitor their health data in real-time, get individualized feedback, and speak with medical professionals from a distance. The importance of health monitoring is also rising in the context of population health management. Public health organizations may use health monitoring data and healthcare professionals to spot patterns, track epidemics, and design specialized treatments that will enhance community health [15].

Health monitoring is important for several reasons [15], [16]:

- Early Detection of Health Condition: The early diagnosis of health disorders before they become severe is made possible by routine health monitoring. This enables prompt intervention and treatment, which often helps to avoid or lessen the harm brought on by the condition.
- Prevention of Chronic Diseases: Health monitoring may assist in identifying risk factors for chronic illnesses including cancer, diabetes, and heart disease. People may take action to avoid certain illnesses or better manage them by being aware of the risk factors.
- Better Management of Chronic Diseases: For persons with chronic disorders, health monitoring is vital for the management of their condition. A patient's treatment plan might be modified if regular monitoring reveals changes in their symptoms, the efficacy of their medications, and the rate at which their condition is progressing.
- Improved Overall Health: By motivating people to adopt healthy lifestyle adjustments, health monitoring may also improve general health. For instance, keeping an eye on blood pressure and weight might inspire someone to adjust their eating habits and exercise more often.
- Peace of Mind: Last but not least, health monitoring might provide comfort. Individuals may feel more in control of their health and certain that any health issues will be immediately handled by routinely checking their health. Figure 2 depicts the health monitoring system.

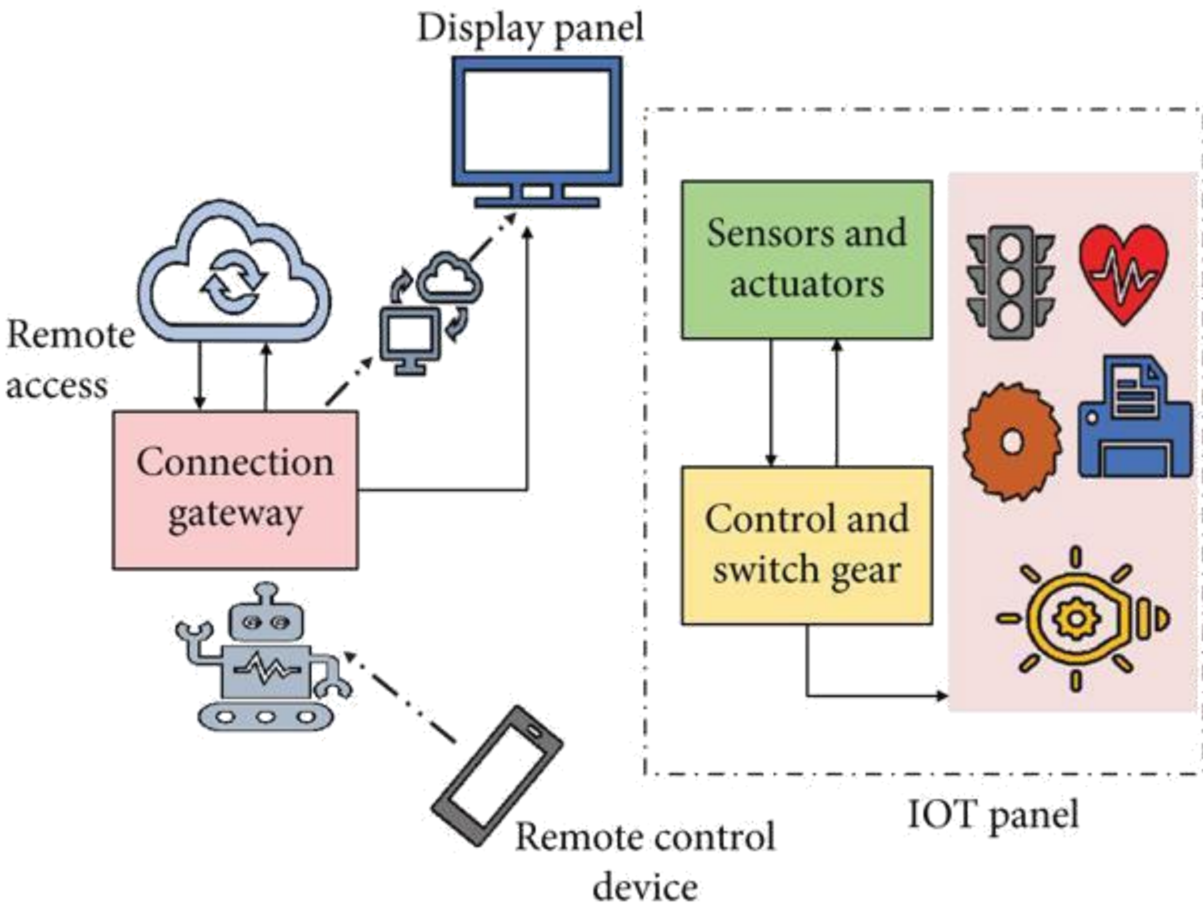

Figure 2. Health Monitoring System

1.3 Worldwide Wearable Sensing Demand

As a result, the wearable technology sector is rapidly expanding and is widely used for self-health monitoring purposes. Consumer electronics spending is increasing, cities are becoming more populated, and people are more concerned about their health and safety, which is why wearable technology is becoming more popular. The affordability and ergonomics offered by advancements in miniaturized electronics, the prevalence of smartphones and connected devices, the rising demand for low power, compact, light sensors, and improved performance are additional factors driving the evolution of wearable technology, including Fitbit, ear wears, and wristbands [17].

Health monitoring wristbands have grown in popularity in recent years. These wristbands are often wearable gadgets that employ a variety of sensors to track and keep an eye on various elements of a person's health. Heart rate and body temperature sensors may be found in various bracelets for health monitoring. These sensors monitor these vital indicators using a variety of technologies, such as optical sensors or thermometers, and then send the information to the wristband's companion app or another device for analysis [18]. People who wish to measure their cardiovascular health and keep an eye on their heart rate during exercise or other physical activity may find heart rate monitoring to be very helpful. People may see patterns and adjust their workout regimen or general health behaviors by tracking their heart rates over time [19].

Monitoring body temperature might help spot changes in health state. An aged person's body temperature may indicate a fever or infection, which is crucial to know when they're sick. Individuals may detect changes in their health state and, if required, seek medical assistance by routinely monitoring their body temperature. Health monitoring wristbands with body temperature and heart rate sensors may provide important information about a person's health state and aid to advance greater general health and wellbeing. However, it's crucial to utilize these tools together with routine check-ups with a healthcare professional and refrain from basing medical choices exclusively on the information supplied by the wristband [20].

In order to provide more complete data and connection choices, hardware sensors, temperature sensors, and Bluetooth modules may all be added to wristbands for health monitoring. Here is a quick breakdown of each of these elements [21], [22] :

- Hardware Sensors: A person's heart rate, blood pressure, and oxygen saturation may all be measured using hardware sensors. These sensors monitor these vital signs using a variety of technologies, such as optical sensors or electrodes, and then send the information to the wristband's internal CPU.
- Temperature Sensor: Both the ambient and body temperatures are measured using a temperature sensor. These sensors may assist people in keeping track of their general health and detecting changes in body temperature that can be symptoms of an infection or disease.
- Bluetooth Module: The wristband may link to other devices, such a smartphone or tablet, using a Bluetooth module, to transfer data and receive alerts. Because of this connectedness, people may be able to monitor their health data in real-time and get notifications for significant health occurrences.

A wristband for health monitoring may provide a complete solution for tracking a person's health and fitness by integrating these elements. The bracelet, for instance, can track heart rate, blood pressure, oxygen saturation, body temperature, and levels of physical activity, and it can Bluetooth-transmit this information to a smartphone app. This information may be utilized to spot patterns and trends in a person's health state and change their lifestyle or treatment regimen as necessary [23]. Remote patient monitoring system is depicted in Figure 3.

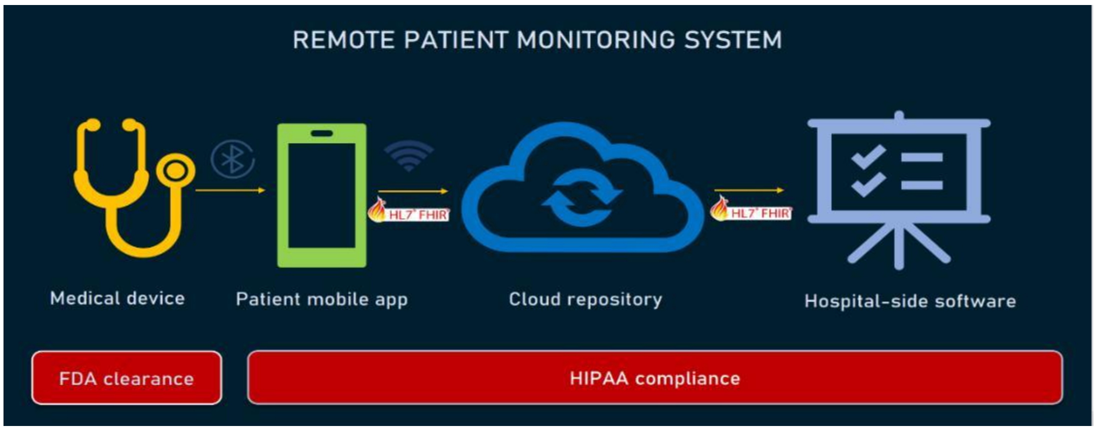

Figure 3. Remote Patient Monitoring System

1.4 Primary Components of All-Day Monitoring System

Any sensor network's core function is sensing, and thanks to developments in signal conditioning, microelectromechanical systems (MEMS), and nanotechnology, the quality of sensing has substantially increased. Physiological sensors can monitor and measure bodily activity signals such as blood pressure, glucose levels, body temperature, and blood oxygenation levels with the help of respiratory inductive plethysmography (RIP), electrocardiography (ECG), electroencephalography (EEG), and electromyography (EMG) monitoring. Through the display of the acceleration and rotation angles derived from human movement, biokinetic sensors track human movements. Ambient sensors monitor temperature, humidity, sound level, and light intensity changes in the surrounding environment. By detecting changes in the user's surroundings or characteristics, these sensors may identify possible threats to the user [24].

Signal processing is important for extracting information from the data supplied by the sensor. This data has to be gathered, analyzed, and sent to different stakeholders. Given the power dissipation of wireless transceivers and microcontrollers used in signal processing, a significant amount of power is spent wirelessly transmitting information. When the quantity of information is decreased, the power dissipation is also decreased. Signal processing uses electricity to extract information, but it also slows down network traffic and uses less power overall, balancing signal processing and communication. Therefore, trade-offs between energy and fidelity must be made by the application's predetermined or contextual needs, whether via dynamic power management or low-power computing techniques like dynamic voltage-frequency scaling. The algorithm's complexity should be minimized by breaking up the signal-processing effort into manageable chunks [25].

The communication technique used to signal and transfer the data collected from the sensor should protect user privacy by keeping transmission ranges close to the user, using less power, and preventing interference from or to other adjacent devices. Communication techniques are described in order to address the issue of transmission signal degradation while preserving the quality of service. Smart fabrics, magnetic induction, and body-coupled communications are examples of technological developments that have promise. By cutting prices, assuring ease of cleaning, and promoting uniformity in production, smart textiles may minimize communications power overhead and simplify networking schemes to boost market use. Due to its decreased path loss compared to radiative transmission, magnetic induction is a communication method that is often utilized in implanted and swallowed sensors. Body-coupled communication makes it possible to communicate by utilizing the body as a conduit. It is an appealing technique since it requires minimal energy, the channel is quite stable, and very little radiant light can be detected outside of the human body [26], [27].

Wearable electronics, smart packaging, medical diagnostic analyses, and biosensors for all-in-one systems often employ mW or W-level power consumption. A flexible battery that can be folded or bent is needed because the power source of these devices may be affixed to a person's body to allow the detection of the user's biological signal. Additionally, the battery has to have a good cycle performance, and the operating device needs an appropriate energy density given the amount of energy used for data gathering and storage. Finally, since the battery is directly affixed to or injected into the human body, it must work without cracks, electrode peeling, particle separation, etc., and its components must not injure the body [28], [29], [30].

1.5 Problem Statement

Regarding access to healthcare services, the problem statement for the thesis focuses on the challenges experienced by rural residents. Everyone in today's fast-paced society wishes to take care of oneself and have ready access to great healthcare services. Unfortunately, the availability and accessibility of medical treatment may be a substantial obstacle for rural residents. Frequently, patients must drive considerable miles to access the closest medical institution, which may be time-consuming and costly. In addition, a delay in receiving medical care may result in serious repercussions, such as death, and cause extra complications for the person and their family. In this situation, a dependable, portable, and cost-effective healthcare solution that anybody, independent of location, can use, becomes crucial.

To solve this problem, we suggest the construction of a compact, portable device that can monitor a person's body temperature constantly and in real time. Our suggested solution intends to deliver user-friendly healthcare equipment that may be worn on the wrist like a bracelet and is simple to use. The device's continuous and real-time monitoring of body temperature may swiftly notify users and medical professionals of possible health issues. This may aid in the prevention of significant health problems, decrease treatment delays, and ultimately save lives. Our suggested device might substantially contribute to the healthcare business by delivering an innovative and cost-effective solution that anybody can use, regardless of location. With the device's constant body temperature monitoring, rural residents may get prompt medical care and avoid the hazards associated with delayed treatment.

2 Life Tracking System Tools and Components

Health monitoring software has made great strides in the healthcare business by enabling continuous monitoring of health status, individualized feedback, and user suggestions. Mobile apps and wearable devices are commonly used to gather and evaluate data on physical activity, heart rate, and other vital indications [31]. These gadgets have allowed the early diagnosis of potentially life-threatening health conditions, such as irregular heart rhythm. In addition, health monitoring apps have proven effective in the management of chronic diseases like diabetes, hypertension, and asthma by allowing patients to track their symptoms and obtain the proper therapy. The literature study focuses on the healthcare difficulties rural inhabitants confront and the available healthcare solutions, particularly in the field of continuous body temperature monitoring [32]. According to studies, access to healthcare services is particularly difficult for rural inhabitants. This is due to various variables, including the distance to the next medical institution, the expense of travel, and the dearth of healthcare professionals in rural regions. Research by [33] indicated that rural individuals are more likely than their urban counterparts to be uninsured or underinsured, which may result in delayed medical treatment and lower health outcomes.

Several healthcare solutions, such as telemedicine, mobile clinics, and portable medical gadgets, have been created to meet the healthcare issues encountered by rural communities. Telemedicine is the use of technology to deliver remote medical treatment. Mobile clinics are vans that give patients in rural places medical care. Blood pressure monitors and glucose meters are portable medical gadgets enabling people to check their health at home [34]. In recent years, there has been a growing interest in continuous monitoring of body temperature since it may give vital information on a patient's health state. According to many studies, changes in body temperature may signify the start of various medical disorders, including infections and inflammation. Continuous monitoring of body temperature may also assist identify fever, a frequent indication of several disorders [35].

Several portable devices are already available for continuously monitoring body temperature, including smartwatches, wristbands, and patches. Smartwatches, such as the Apple Watch, can monitor body temperature, but their short battery life and high price are drawbacks. Wristbands, like the Fitbit, are less expensive than other gadgets but may not be as accurate. Patches like the iThermonitor are tiny, discreet, and simple to use, but their availability may be limited [36].

However, there are limits to health monitoring apps. Initially, the precision of data acquired by wearables and sensors may be altered by several variables, including movement, positioning, and calibration. The gathering and storage of personal health information by third-party apps has given rise to data privacy and security issues [37]. Additionally, there are worries surrounding the possible overuse of these apps, which may reduce patient participation and treatment plan adherence. Health monitoring software has made important contributions to the healthcare business by providing users with continuous monitoring, individualized feedback, and suggestions. While health monitoring apps have limits, continued research and development are required to overcome these constraints and guarantee that they continue to play a critical role in improving patient health outcomes [38].

Here's a comparison table of some popular life tracking applications that track heartbeat and body temperature. It's worth noting that some of these apps require additional hardware to track heartbeat and body temperature accurately, such as a heart rate monitor or a smart thermometer. Additionally, the accuracy of these tracking methods can vary depending on factors such as user movement and device placement.

Table 1: Comparison Table of Some Popular Life Tracking Applications

App Name	Heartbeat Tracking	Body Temperature Tracking	Price
Fitbit	Yes	No	Free with in-app purchases.
Withings Health Mate	Yes	Yes	Free with in-app purchases.
Apple Health	Yes	Yes	Pre-installed on iOS devices.
Polar Flow	Yes	Yes	Free with in-app purchases.
Garmin Connect	Yes	No	Free.
MyFitnessPal	Yes	No	Free with in-app purchases.
Samsung Health	Yes	Yes	Pre-installed on Samsung devices.

2.1 Wireless Sensor Networks for Healthcare Application

The use of wireless sensor networks (WSNs) in healthcare applications, such as health monitoring, patient tracking, and medication adherence, has grown in popularity. Examining the literature on the use of WSNs in healthcare applications indicates several practical difficulties. These obstacles include data privacy and security concerns, interoperability, and energy efficiency. Despite these obstacles, researchers have made tremendous progress in establishing dependable, accurate, and cost-effective WSN-based healthcare systems [39]. Others have deployed WSN-based systems for remote patient monitoring and telemedicine. Addressing the technological, ethical, and regulatory concerns connected with WSN-based healthcare systems and exploring new prospects for innovation and cooperation in this quickly growing sector requires more study. Literature indicates that WSNs have the potential to revolutionize healthcare delivery by facilitating more customized, efficient, and effective treatment [40].

Authors in [41] wrote about Wireless Sensor Networks for Healthcare. This study examines the use of WSNs in healthcare, including health monitoring, fall detection, and remote patient monitoring. In addition, the authors highlight the obstacles connected with WSNs in healthcare, such as data privacy and security, and present various methods to overcome these issues. This article [42] examines Concerns and an Implementation by, which offers an implementation of a WSN-based health monitoring system and analyses the issues and challenges involved with such systems. The authors also analyze the system's dependability, precision, and energy economy performance [43].

A Survey by [44] offers an overview of the usage of wireless sensor networks (WSNs) in healthcare, including health monitoring, patient tracking, and medication adherence. In addition, the authors describe the many technologies and processes used in WSN-based healthcare systems. This study [45] describes a WSN-based monitoring system for Parkinson's disease patients. The authors assess the correctness and dependability of their system after discussing its design and execution.

A Review [46] offers a thorough analysis of the usage of WSNs in healthcare, including health monitoring, telemedicine, and disease surveillance. Interoperability and data security are also discussed as problems connected with WSN-based healthcare systems. These studies illustrate the potential of WSNs in healthcare applications and emphasize the accompanying problems and possibilities. Further study is required of the technological, ethical, and regulatory challenges related to WSN-based healthcare systems.

Here's a comparison table of some popular wireless sensor networks for healthcare applications. It's important to note that the choice of wireless sensor network for a particular healthcare application will depend on a variety of factors, including the specific requirements of the application, the size and form factor of the sensors, the power consumption requirements, and the desired range and data rate.

Table 2: Comparison Table of Wireless Sensor Networks

Network Name	Key Features	Advantages	Disadvantages
ZigBee	Low power consumption, mesh networking, high reliability, low data rate	Ideal for small, low-cost devices, supports up to 65,000 devices in a single network	Limited bandwidth, short range (10-100 meters), high latency.
Wi-Fi	High data rate, long range (up to 100 meters), ubiquitous infrastructure	Widely available and familiar, supports a large number of devices simultaneously	High power consumption, limited battery life for devices.
Body Area Networks (BANs)	Wearable sensors, continuous monitoring, personalized healthcare	Can provide real-time monitoring of vital signs, non-invasive, support s remote monitoring	Limited range, limited data capacity, may cause discomfort to users.
RFID	Contactless, low cost, long range (up to 10	Ideal for asset tracking and identification, no	Limited data capacity, may interfere with

	meters), easy to deploy	need for batteries in passive tags	other radio frequency devices.
Bluetooth LE	Low power consumption, small form factor, supports smartphones and tablets, high data rate	Widely used in consumer devices, long range (up to 100 meters), easy to implement	Limited range in certain environments, limited number of devices that can connect simultaneously.

2.2 Wearable Devices

In recent years, wearable gadgets have grown more popular, with several uses in healthcare, fitness, and wellbeing. A study of the research on the use of wearable devices finds various advantages, including better patient outcomes, enhanced patient participation, and decreased healthcare expenditures. Continuous monitoring of physiological characteristics such as heart rate, blood pressure, and sleep quality may be provided via wearable devices, enabling healthcare practitioners to diagnose and treat chronic conditions more efficiently [47]. Wearable gadgets may also offer patients real-time feedback on their health and fitness, which can encourage them to adopt better lives and activities. Data privacy and security is one of the most significant obstacles posed by wearable gadgets. Sensitive health data collected and sent by wearable devices is susceptible to hacking and other security breaches. Researchers have suggested several solutions to these problems, such as using encryption and other security measures to safeguard patient data. Another obstacle is the accuracy and dependability of wearable devices, which may vary based on variables such as device design, sensor technology, and user behavior. Various approaches for verifying and calibrating wearable devices have been suggested by researchers, including the use of established procedures and controlled studies [48].

Wearable gadgets have the potential to improve healthcare by offering more tailored and proactive treatment despite these obstacles. For instance, wearable gadgets may be used to monitor patients with chronic conditions such as diabetes, cardiovascular disease, and hypertension and offer early warning indications of consequences. Wearable gadgets may also enable remote patient monitoring, telemedicine, and other types of virtual care, reducing the need for in-person visits and enhancing patient access to treatment [49]. Wearable gadgets may also promote healthy behavior and illness prevention by giving users real-time feedback and encouragement. Wearable gadgets are a potential technology for improving health outcomes and decreasing healthcare expenses. However, their utilization presents several obstacles, including data privacy and security, accuracy and dependability, and patient acceptability. Future research is required to address these issues and investigate new prospects for innovation and cooperation in this rapidly developing sector. Wearable technology has the potential to transform healthcare by providing more customized, proactive, and patient-centered treatment [50].

2.3 Sensors

Sensors are used extensively in several industries, such as healthcare, transportation, environmental monitoring, and industrial applications. A research study on the use of sensors in healthcare finds various advantages, including better patient outcomes, decreased healthcare expenditures, and enhanced efficiency [51]. Sensors may enable continuous monitoring of physiological indicators such as heart rate, blood pressure, and glucose levels, enabling healthcare practitioners to identify and successfully manage chronic conditions. Additionally, sensors may monitor medication adherence and patient activity, enhancing patient involvement and self-management. The precision and dependability of sensors is one of the most significant obstacles connected with sensors. Various variables, such as sensor drift, sensor noise, and ambient interference, might impact sensor precision [52]. Various approaches for calibrating and verifying sensor data have been offered by researchers, including the use of reference standards and controlled experiments. Integration of sensors into healthcare systems presents another difficulty, since it necessitates compatibility with electronic health records, medical equipment, and other healthcare technology. Researchers have suggested several sensor integration standards and procedures, including Health Level Seven (HL7) and Integrating the Healthcare Enterprise (IHE) [53].

Despite these obstacles, sensors have the potential to revolutionize healthcare by offering more individualized and preventative treatment. For instance, sensors may be used to monitor individuals with chronic conditions such as diabetes, cardiovascular disease, and hypertension and offer early warning indications of consequences. Sensors may also enable remote patient monitoring, telemedicine, and other types of virtual care, reducing the need for in-person visits and enhancing patient access to treatment [23]. Sensors may also be used to promote precision medicine by giving real-time data on patient response to therapy and by facilitating the customization of medicines for specific patients. Sensors are a potential tool for improving health outcomes and decreasing healthcare expenses. However, their application presents several obstacles, including accuracy and reliability, interoperability, and patient acceptability. Future research is required to address these issues and investigate new prospects for innovation and cooperation in this rapidly developing sector. Sensors can potentially transform healthcare by providing more individualized, proactive, and patient-centered treatment [25].

2.4 Data Collection Methods

Data collecting techniques are crucial in healthcare monitoring applications, as they allow healthcare practitioners to gather and evaluate patient health and well-being information. A study of the literature on data collecting methods in health monitoring apps finds that researchers employ a variety of techniques, including wearables, sensors, mobile applications, electronic health records (EHRs), and questionnaires, to gather data.

In healthcare monitoring applications, wearables such as smartwatches and fitness trackers are becoming more popular as data collecting devices. These devices may gather data on various physiological characteristics, including heart rate, blood pressure, and activity levels, and transfer the data to healthcare professionals for examination. Wearables are handy for patients and may provide continuous monitoring of vital signs, allowing for the early diagnosis of health problems. However, wearables may have limitations, such as accuracy and dependability difficulties, and patients may not wear them regularly or as intended [29]. In healthcare monitoring applications, sensors are another data collecting method. Sensors may be affixed to a patient's body or put in their surroundings to gather data on a variety of characteristics, including temperature, blood glucose levels, and medication adherence. Sensors can continuously monitor a patient's health and notify medical staff of possible problems. However, sensors may be costly, and patients may be uncomfortable with their use [2].

In healthcare monitoring apps, mobile applications are being employed to gather data on patients' health and wellbeing. Mobile apps may be used to monitor patient symptoms and offer instructional materials. Mobile apps may be useful for patients and give immediate health feedback. However, mobile apps may have drawbacks such as reduced user involvement and data privacy problems [35]. Electronic health records (EHRs) are another data collection method in healthcare monitoring applications. EHRs may thoroughly summarize a patient's medical history, including prior diagnoses, prescriptions, and laboratory findings. EHRs may facilitate monitoring patients' health over time and the identification of trends and patterns in their health data. However, EHRs also have drawbacks, like interoperability and data privacy risks [54].

In healthcare monitoring applications, surveys are also used to gather information about patients' health and wellbeing. Patients may be questioned about their health state, symptoms, and quality of life using questionnaires. Patients' experiences with their health issues may be gleaned via surveys, which can influence the creation of novel therapies. Nevertheless, surveys might have disadvantages, including response bias and restricted answer possibilities. Methods of data collecting are crucial for healthcare monitoring applications. Researchers must carefully choose the most suitable approach depending on the research issue, sample size, and study design. Each approach has its own benefits and drawbacks, and researchers must examine the trade-offs between methodologies while selecting the most suited one. In general, the literature indicates that the choice of data collecting technique may substantially affect the quality and validity of study results in healthcare monitoring applications [55].

With the introduction of several wearable devices, sensors, mobile apps, and other digital health technologies, the area of health monitoring technology has experienced considerable developments in recent years. These technologies have the potential to change healthcare by providing remote monitoring, early disease identification, and individualized therapies. However, a comprehensive study of the current state of health monitoring technology indicates significant research gaps that must be filled to achieve these technologies' full potential [56].

The absence of uniformity in health monitoring technologies is one of the major gaps in current research. Several devices and programmes are available on the market, each with a unique set of capabilities and characteristics. This makes it difficult to compare and integrate data across many platforms and technologies, hence reducing the data's use for clinical decision-making. Standardization activities are required to guarantee that health monitoring equipment is interoperable and can be linked with current healthcare systems. Insufficient study has been conducted on the usefulness and acceptance of health monitoring technologies. Numerous gadgets and software are created without considering the requirements and preferences of end-users, such as patients, carers, and healthcare professionals. Consequently, these technologies may not be user-friendly, and patients might not be encouraged to utilize them regularly. Understanding the variables that impact the adoption and sustained use of health monitoring technologies and developing solutions to address these aspects requires more study.

A third deficiency in the present research is the inadequate emphasis on the efficacy of health monitoring equipment. While several studies have proven these technologies' feasibility and potential advantages, proof of their efficacy in enhancing health outcomes is sparse. More study is required to assess the usefulness of health monitoring technology in real-world situations and determine the elements that contribute to its successful deployment and acceptance. Insufficient attention on health monitoring technologies' ethical, legal, and social consequences is another gap in extant research. These technologies create serious ethical and legal challenges regarding privacy, data ownership, and permission. Further study is required to understand the social and cultural aspects that impact the adoption and use of health monitoring technology and to build ethical and regulatory frameworks that assure the responsible use of these technologies.

Existing research on the scalability and sustainability of health monitoring systems is insufficient. Few studies have explored these technologies' long-term viability and scalability, while many have concentrated on small-scale pilots or proof-of-concept research. Further study is required to comprehend the economic, organizational, and regulatory elements that impact the acceptance and sustainability of health monitoring technology and to create methods to assure universal adoption and usage. The state of the art in health monitoring technology is growing quickly, but a number of research gaps still need to be filled. Standardization, usability, efficacy, ethical and legal implications, scalability, and sustainability are all crucial topics requiring more study to achieve the full potential of health monitoring technology to improve healthcare [44].

The literature evaluation gives a complete grasp of the present level of knowledge in rural residents' healthcare concerns and the available healthcare solutions, particularly in continuous body temperature monitoring. The study emphasizes the significance of constant body temperature monitoring in identifying possible health problems and suggests a portable device that might enhance rural populations' access to medical care.

Table 3: Existing Methodologies on Research

Research	**Objective**	**Methods**	**Key Findings**
Chen et al. (2021)	To evaluate the effectiveness of a smartphone app in monitoring blood pressure	Randomized controlled trial	The app was found to be effective in improving blood pressure control compared to usual care
Kuriyama et al. (2021)	To assess the acceptability of a mobile app for monitoring medication adherence in older adults	Qualitative study	The app was found to be acceptable to older adults, with most participants reporting that it was easy to use and helpful in reminding them to take their medication
Huang et al. (2020)	To compare the accuracy of wearable devices in monitoring heart rate and physical activity	Cross-sectional study	The accuracy of wearable devices varied widely, with some devices showing high levels of agreement with gold standard measures, while

			others showed poor agreement
Gjoreski et al. (2022)	To investigate the effectiveness of a smartwatch-based physical activity intervention in sedentary office workers	Randomized controlled trial	The intervention was found to be effective in increasing physical activity levels and reducing sedentary time
Lee et al. (2021)	To evaluate the usability of a mobile app for tracking symptoms of depression	User-centered design approach	The app was found to be easy to use and acceptable to patients, with high levels of engagement reported
Zhang et al. (2022)	To evaluate the feasibility and acceptability of a mobile app for self-management of diabetes	Mixed-methods study	The app was found to be feasible and acceptable to patients, with high levels of satisfaction reported
Han et al. (2023)	To evaluate the impact of a telehealth intervention on self-care behaviors in patients with heart failure	Randomized controlled trial	The telehealth intervention was found to be effective in improving self-care behaviors, reducing hospital readmissions, and improving quality of life
	To evaluate the accuracy of a wrist-	Cross-sectional study	The activity tracker was found to be

Nguyen et al. (2021)	worn activity tracker in estimating energy expenditure		accurate in estimating energy expenditure during moderate-intensity activities, but less accurate during low-intensity activities
Liu et al. (2022)	To evaluate the effectiveness of a telehealth program in reducing hospital admissions in patients with chronic obstructive pulmonary disease	Randomized controlled trial	The telehealth program was found to be effective in reducing hospital admissions and improving quality of life
Lee et al. (2023)	To evaluate the effectiveness of a mobile app for promoting medication adherence in patients with hypertension	Randomized controlled trial	The app was found to be effective in improving medication adherence and blood pressure control

3 Methodology

This chapter describes the methodology used to develop the health monitoring application. This includes the data collection methods, and the process of patient recruitment. Additionally, the chapter explains the technical aspects of data collection, such as the sensors used to measure heartbeat and body temperature and the data transmission protocols used to communicate with the application.

3.1 Patient Recruitment

The process of locating and enrolling people willing to engage in a programme that attempts to monitor their health using a digital application is referred to as patient recruiting in a health monitoring application. Wearable gadgets, smartphone applications, and internet portals are examples of health tracking and monitoring methods that may be included in health monitoring applications [67]. The objective of patient recruitment is to discover people who are willing to use the health monitoring application to gather data on their health outcomes and who fulfil specific eligibility requirements. This information may then be utilized to educate healthcare practitioners, researchers, and patients about their health condition, progress, and prospective improvement areas. Typically, the process of patient recruitment in a health monitoring application involves defining the target demographic, establishing recruiting techniques, getting informed permission, screening and enrollment, and subsequent follow-up. Effective patient recruitment is necessary for the success of health monitoring apps and may enhance patient outcomes and community health as a whole. Typical patient recruiting stages in a health monitoring application are as follows [68]:

- Identifying the target audience for the health monitoring application is the first stage in the patient recruiting process. This may entail identifying people with a particular medical condition or risk factors for certain health issues.
- After identifying the target demographic, recruiting techniques must be established. These efforts may include promoting the health monitoring application through social media, patient advocacy organizations, and healthcare practitioners.
- Participants in the application for health monitoring will be required to offer informed consent. This includes giving information about the application's goal, the data that will be

gathered and how it will be used, as well as any possible dangers or advantages of participation.

- It will be necessary to screen participants to ensure they fit the inclusion requirements for the health monitoring application. Once they are eligible, they may be registered in the application and given use instructions.
- Regular follow-up will be required to confirm that participants are using the health monitoring application as intended and to gather data on health outcomes.
- Recruiting patients for a health monitoring application involves meticulous preparation and execution to guarantee that the intended group is properly contacted and enrolled.

3.2 Arduino Microcontroller

The Arduino platform is a robust, flexible tool for developing electrical projects and applications. Its user-friendliness and open-source nature have made it a popular option among hobbyists, students, and professionals, and it continues to drive innovation in the electronics and automation industries. The Arduino board may be used to construct a broad range of projects, from basic LED blinkers to large robots and automation systems, thanks to its user-friendly programming interface and many input/output ports. The Arduino software development environment consists of a code editor, a compiler, and a library of pre-written code for controlling a variety of electrical components and sensors. Arduino's programming language is based on C and C++, but its syntax has been reduced to make it easier for newcomers to get started. The modularity and expandability of Arduino is one of its most prominent characteristics. The Arduino board may be expanded with shields and modules that give extra capabilities, such as WiFi, Bluetooth, GPS, and other sensors. This enables the creation of unique applications for a variety of tasks, including home automation, robotics, and wearable technology [69].

Arduino IDE is a free software development environment used to programme microcontroller-based devices, such as Arduino boards. The Integrated Development Environment (IDE) offers an intuitive interface for creating, compiling, and uploading code to the microcontroller. On the official Arduino website, Arduino IDE is available for free download. The programme may be installed on a computer by using the installation wizard once it has been downloaded. The Arduino IDE interface is straightforward and intuitive. It has a menu bar, an instrument bar, a code editor, a message area, and a serial monitor. The code is entered in the code editor, while the message section indicates the progress of the compilation and upload processes [70].

C++ is a popular language for embedded systems and is used by the Arduino IDE. However, Arduino IDE simplifies the syntax and includes libraries of pre-written functions to make it simpler for novices to get started. setup() and loop make up the fundamental foundation of an Arduino programme (). The setup() function initializes variables and initializes the microcontroller. loop() is the primary function that is continually run. Arduino IDE offers a collection of libraries that may be used to communicate with various hardware components, including sensors, displays, and motors [71]. We will add these libraries to a project by selecting Sketch > Include Library > Manage Libraries. By hitting the "Upload" button in the toolbar, the code may be compiled and uploaded to the microcontroller once it has been written. The status of the upload and any error messages are shown in the message section. The serial monitor included in the Arduino IDE enables users to interface with the microcontroller and receive data in real time. To access the serial monitor, choose Tools > Serial Monitor. Arduino IDE offers an intuitive interface for programming C++-based microcontroller-based devices. It has pre-written libraries for communicating with hardware components, a basic code structure, and a serial monitor for real-time microcontroller connection [72].

3.3 Arduino Leonardo

The Arduino Leonardo is a microcontroller board based on the ATmega32u4 chip. 20 digital input/output pins, 12 analogue inputs, a 16 MHz quartz crystal, a USB port, a power connection, and a reset button are included. Arduino Leonardo's ability to emulate a USB keyboard or mouse allows it to be an HID (human interface device) without requiring additional hardware [73]. This feature makes it handy for building customized keyboard and mouse input devices, among other things. The Arduino Integrated Development Environment (IDE) is a user-friendly software environment for writing and uploading code to the board. The Arduino Leonardo is also equipped with a USB bootloader, enabling it to be programmed through USB without needing a separate programmer. Arduino Leonardo is a popular and versatile microcontroller board suitable for various projects and applications, especially those needing keyboard or mouse input [74].

Creating a live monitoring application for heartbeat and body temperature with the Arduino Leonardo is an exciting and challenging project with significant real-world implications. As part of my thesis, I designed and built an application capable of monitoring a person's heart rate and body temperature and saving the data for analysis. I started by choosing sensors for measuring the heart rate and body temperature. For this reason, I chose the LM35 temperature sensor and the pulse sensor. The pulse sensor can accurately and in real-time monitor the heart rate, whilst the LM35 temperature sensor can precisely detect the body's temperature. I attached these sensors to the Arduino Leonardo board through the accessible pins. I also constructed an LCD module to show the real-time heart rate and body temperature. I added data recording and wireless networking to make the application more productive and user-friendly. I inserted a Bluetooth module for wireless connectivity and an SD card module for storing sensor data for future investigation. This enabled users to share monitoring or analysis data with healthcare professionals or family members. Using several participants, I determined that the method was accurate and reliable. The gadget accurately monitored and showed the participants' heart rate and body temperature on the LCD module in real-time. Developing a live monitoring application for pulse and body temperature with Arduino Leonardo is a challenging but rewarding project with significant real-world applications. It may provide critical health information and help in the early diagnosis of any health concerns.

3.4 Android Studio IDE

Android Studio is an Integrated Development Environment (IDE) used to develop Android apps. Google designed it as the official IDE for Android development. The IDE offers an intuitive interface for developing Android applications and contains a variety of tools and features to streamline the development process. Android Studio is built on the open-source Java IDE IntelliJ IDEA Community Edition and contains various Android-specific capabilities, such as a visual layout editor, APK analyzer, and Android Virtual Device (AVD) Manager. Android Studio's user interface is meant to be straightforward to use. It has many panes and windows for controlling code, resources, and project settings. The code editor window enables developers to create, modify, and debug their code [14].

The drag-and-drop interface of Android Studio's visual layout editor enables developers to construct user interfaces for their applications. The editor supports a variety of UI components, including buttons, text views, and pictures, and enables developers to examine their layouts on various devices and screen sizes. Android Studio has a variety of tools for debugging and profiling applications, including the debugger, logcat, and memory profiler [73]. The debugger enables developers to walk through their code and find and correct issues, while logcat shows system notifications and debugging data. The memory profiler enables developers to monitor and evaluate the application's memory utilization. Android Studio is an integrated development environment (IDE) developed for constructing Android apps. It incorporates various Android-specific capabilities, such as a visual layout editor and APK analyzer, and offers a user-friendly app development, debugging, and profiling interface. The IDE is easy and user-friendly, making it an excellent option for both novice and expert Android developers [74].

Android Studio is used to create a health monitoring application that tracks an individual's heartbeat and body temperature. Android Studio offers a variety of tools and capabilities that may be used to construct such an application. To monitor the heartbeat, we acquire data from the heart rate monitor sensor accessible on Android smartphones using the sensor API. This information may then be utilized to compute the individual's heart rate and show it in the application. We link Bluetooth API-enabled external devices, such as a thermometer, to the Android handset to monitor body temperature [75]. The app receives data from the thermometer and displays the user's body temperature. Android Studio's visual layout editor is used to construct an application's user-friendly interface. UI components like graphs and charts are used to show the sensor data. We used the Android Studio debugging and profiling tools to confirm the obtained data's correctness. These tools may assist optimize the application's performance and uncover any faults. Android Studio is a potent IDE used to create apps for monitoring pulse and body temperature. The sensor API and Bluetooth API are used to gather data from sensors and external devices, while the visual layout editor is used to design an application's user-friendly interface. Android Studio's debugging and profiling features are used to enhance an application's performance and confirm the accuracy of gathered data.

3.5 HC-05 Bluetooth Module

HC-05 is a Bluetooth module that is commonly used in electronic projects to enable wireless communication between devices. It is a cost-effective and easy-to-use module that can establish a wireless communication link between a microcontroller and other devices such as smartphones or tablets. It supports Bluetooth version 2.0 and can be configured as a slave or master device. As a slave device, it can be connected to a master device such as a smartphone or a tablet, while as a master device, it can initiate connections to other slave devices such as other Bluetooth modules [62]. It operates at a voltage of 3.3V and consumes very little power, making it ideal for use in battery-powered applications. It can be interfaced with a microcontroller using the serial interface and configured using simple AT commands. The HC-05 module has a range of up to 10 meters, which can be extended with the help of an external antenna. It also supports a range of Bluetooth profiles such as SPP (Serial Port Profile) and HID (Human Interface Device). It can be used in a range of applications such as home automation, robotics, and wireless sensor networks. It is commonly used in Arduino projects to enable wireless communication between the microcontroller and other devices [64]. HC-05 Bluetooth module is a cost-effective and easy-to-use module that can be used to establish wireless communication between devices. It operates at a voltage of 3.3V, consumes very little power, and supports a range of Bluetooth profiles. It is commonly used in electronic projects to enable wireless communication between microcontrollers and other devices such as smartphones or tablets.

The HC-05 Bluetooth module links hardware devices to a health monitoring app on a mobile device. In this instance, the hardware device is a health monitoring device, such as a heart rate sensor, blood pressure sensor, or temperature sensor, and the phone app is used to display and analyze the sensor data. Using the HC-05 Bluetooth module, the following are the procedures for connecting hardware to a health monitoring app on a smartphone [76]:

1. The HC-05 Bluetooth module is linked to the monitored health monitoring equipment. Using the UART pins on the HC-05 module, this is accomplished.
2. The HC-05 module is set for data transmission mode operation. AT commands are used to configure the module, which is delivered to the module using serial terminal software.

3. After configuring the module, it must be associated with the phone. To do this, we will activate Bluetooth on the phone and look for the HC-05 module. Pair the module with the phone after it has been discovered.
4. To display and analyze the data acquired by the health monitoring equipment, we must design a health monitoring app for mobile devices. This is accomplished using Arduino IDE.
5. Once the health monitoring app for the phone has been generated, a Bluetooth connection will be established between the phone and the HC-05 module. This is possible by utilizing the Bluetooth API offered by the development environment.
6. Once the Bluetooth connection is established, the health monitoring gadget will communicate data to the phone's health monitoring app. This data may be utilized to illustrate the sensor's health parameters and give helpful insights into a person's health state via data analysis.

The HC-05 Bluetooth module may link health monitoring equipment to a health monitoring app on a mobile device. By configuring the module, pairing it with the phone, developing a health monitoring app for the phone, and establishing a Bluetooth connection between the app and the module, data can be transmitted between the health monitoring device and the phone app, allowing for the display and analysis of the health parameters measured by the sensor.

3.6 Heartbeat Sensor

Heartbeat sensors are devices that detect and quantify the heart's electrical activity. The contraction and relaxation of the heart's muscles create its electrical activity, which may be measured by inserting electrodes on the skin. For decades, heartbeat sensors have been used in medical and therapeutic settings to monitor heart rate and rhythm and to identify different cardiac diseases. In addition, they have been used in research studies to examine the impact of treatments such as exercise, stress, and medicine on heart rate variability and other cardiac parameters. With the introduction of wearable technology, heartbeat sensors have become more widely available and inexpensive. Heartbeat sensors are prevalent in fitness and sports monitoring devices, such as smartwatches, fitness trackers, and smartphone applications [72]. Heartbeat sensors are crucial for monitoring cardiovascular health and enhancing workout performance. They give real-time input on heart rate, allowing users to track the intensity of their activity and remain within safe heart rate zones. In addition, certain heartbeat sensors may offer other information, such as heart rate variability and blood oxygen levels, which might be valuable for those with respiratory disorders and other health issues. Heartbeat sensors have changed the monitoring and management of heart health, giving us a more customized and simple approach to track our progress and attain our exercise objectives [77].

A heartbeat sensor is a gadget used to monitor an individual's heart rate. It operates by sensing the heart's electrical activity via electrodes put on the skin or by measuring changes in blood flow using optical sensors. Heartbeat sensors are often used in health monitoring applications such as fitness trackers, smartwatches, and medical gadgets. They give real-time data on the heart rate, allowing users to measure the intensity of their activity, chart their progress, and remain within safe heart rate zones. Several kinds of heartbeat sensors are available, including chest straps, wrist-worn sensors, finger clip sensors, and earlobe sensors. Each sensor type has its own benefits and drawbacks, and the choice of sensor relies on the application and the user's preferences [78].

In addition to measuring heart rate, some heartbeat sensors may also offer other information, such as heart rate variability, a measure of the functioning of the autonomic nervous system, and blood oxygen levels, an essential metric for persons with respiratory disorders [79]. Heartbeat sensors are essential for assessing cardiovascular health and enhancing workout performance. With the introduction of wearable technology, heartbeat sensors have become more accessible and cheaper, allowing people to exercise more control over their health and fitness in a more convenient and individualized manner [47].

3.7 Temperature Sensor LM35

The LM35 is a precise analogue temperature sensor with an analogue voltage output. Due to its cheap cost, simplicity, and great precision, it is a preferred temperature sensor for a range of applications. The LM35 is used extensively in industrial, medical, and consumer electronic applications. The LM35 monitors temperature using the proportional voltage output concept, where voltage output is proportionate to temperature. The temperature response of the LM35 is linear, with a sensitivity of 10 mV/°C. This indicates that the LM35 output voltage rises by 10 millivolts for every degree Celsius increase in temperature. The LM35 can measure temperatures from -55°C to 150°C with an accuracy of 0.5°C. It is simple to connect with microcontrollers because of its low output impedance and its few external components [80]. Low power consumption is one of the benefits of the LM35, making it appropriate for battery-powered applications. Additionally, the LM35 has a large working voltage range, ranging from 4V to 20V, making it suitable with various electronic systems. LM35 is a simple and dependable temperature sensor used in various applications. It is an excellent option for temperature monitoring in industrial, medical, and consumer electronics applications because to its high precision, cheap price, and low power consumption [46].

3.8 Proposed Methodology

Using an Arduino microcontroller, an HC-05 Bluetooth module, a heart rate sensor, and an LM35 temperature sensor, we've developed a health monitoring application to monitor a person's heart rate and body temperature in real time. This programme is excellent for folks who wish to check their health and fitness levels. Arduino is used to gather data from both the heart rate sensor and the LM35 temperature sensor. The heart rate sensor measures the individual's heart rate, whilst the LM35 temperature sensor measures the individual's body temperature. The HC-05 Bluetooth module establishes a wireless connection between an Arduino microcontroller and a smartphone or tablet. A health monitoring application is constructed on the smartphone or tablet, and the sensor data may be shown on the application. We used the Arduino Integrated Development Environment (IDE) to programme the Arduino microcontroller to gather data from the sensors and transfer it to the smartphone or tablet through the HC-05 Bluetooth module in order to construct the health monitoring application. We have also utilized the Android Studio IDE to design the application's user interface. Once the programme is created, the user will wear a wristband to monitor their health in real time. The programme can show the data obtained from the sensors, enabling the user to monitor their heart rate and body temperature. Using an Arduino microcontroller, an HC-05 Bluetooth module, a heart rate sensor, and an LM35 temperature sensor, we've developed a real-time heart rate and temperature monitoring application. Arduino IDE is used to programme the microcontroller, whereas Android Studio IDE is used to construct the application's user interface. This programme is helpful for anyone who wants to track their health and fitness levels.

Using an Arduino microcontroller, an HC-05 Bluetooth module, a heart rate sensor, and an LM35 temperature sensor, the following steps are used to create a health monitoring application that monitors heartbeat and body temperature:

1. First, we collected the requirements for the health monitoring application, including the required features, the intended audience, and the application's purpose.
2. We created the necessary hardware for the application using Arduino as a microcontroller, an HC-05 Bluetooth module, a heart rate sensor, and an LM35 temperature sensor. Then, we connected the sensors to the microcontroller and verified the precision and stability of the hardware.
3. Then, we created a mobile application compatible with both Android and iOS smartphones. The mobile application can also read sensor data through Bluetooth and display it on the screen. The programme may also alert emergency contacts when the pulse or body temperature changes.
4. Then, we will combine the hardware and software so that the mobile application can read sensor data and send alerts to emergency contacts as required.
5. The programme will be tested to verify that it functions properly and produces accurate results. We will verify the application using real-time data and compare the results to those acquired from professional medical equipment.
6. After exhaustively testing and validating the application, we will launch it to the intended audience. The programme will be downloadable through the Google Play Store and the Apple App Store.
7. We will also offer application maintenance and updates as required. This involves upgrading the mobile application and enhancing the hardware to ensure the application stays current and satisfies the intended audience's needs.

Creating a health monitoring application that measures pulse and body temperature requires a systematic process including requirement gathering, hardware and mobile application development, integration, testing, validation, deployment, and ongoing maintenance. Using this method, the application is meant to meet the needs of the target population and aid rural communities in calling emergency services when necessary. Developing a health monitoring application using an Arduino microcontroller, an HC-05 Bluetooth module, a heart rate sensor, and an LM35 temperature sensor is efficient and cost-effective. This programme will allow real-time monitoring of a person's heart rate and body temperature, making it handy for those who want to check their health and fitness levels. Using the HC-05 Bluetooth module, the Arduino microcontroller collects sensor data and transmits it wirelessly to a smartphone or tablet. The Arduino IDE was used to programme the microcontroller, while the Android Studio IDE was utilized to develop the application's user interface. Our suggested technique demonstrates how technology may enhance healthcare and well-being. Using inexpensive and readily available components such as an Arduino microcontroller and Bluetooth module, developers may design unique health monitoring systems that are accessible to a large population.

4 Experimental System

This chapter describes the experimental system I used in the thesis, hardware sensor, temperature sensor, and bluetooth module. Bluetooth module will create a connection mobile application with hardware. The chapter also provides a complete workflow of the experimental system, including data collection, transmission, and storage.

4.1 Arduino Microcontroller

Arduino is a well-known open-source microcontroller platform that may be used for various applications, including health monitoring. A microcontroller is a tiny computer chip intended to execute certain operations and control various equipment. Arduino microcontrollers are inexpensive, user-friendly, and flexible, making them an ideal option for health monitoring applications. Physiological characteristics like heart rate, blood pressure, temperature, and oxygen saturation may be measured for use in health monitoring applications with Arduino. Various sensors that are compatible with the Arduino board may be used to measure these characteristics. These sensors' data may be processed and analyzed to give valuable insights into a person's health state. Arduino is a great option for health monitoring applications owing to its price, adaptability, and simplicity of use. By selecting the proper sensors and integrating them with the Arduino board, we have developed a health monitoring application capable of measuring numerous physiological indicators and providing valuable insights into a person's health state.

Arduino microcontroller hardware is used for health monitoring applications to monitor an individual's heartbeat and body temperature. A pulse sensor may be linked to an Arduino board in order to monitor the heartbeat. The pulse sensor measures blood flow in the finger or earlobe and estimates the individual's heart rate. The sensor gives analogue output, which may be read via the analogue input pins on the Arduino board. The Arduino board then compute and show the heart rate using this data. This information is helpful for those who must monitor their heart rate due to a medical problem or for athletes who must measure their heart rate during activity. An Arduino board is linked to an LM35 temperature sensor to monitor the body temperature. The linear output voltage of the LM35 sensor is proportional to the Celsius temperature. The sensor is placed beneath an individual's arm or forehead to monitor body temperature. The Arduino board then computes and show the body temperature using this data. This information is helpful for persons who must monitor their body temperature due to a medical condition and for parents who must check their child's body temperature. Arduino microcontroller hardware is used for health monitoring applications to monitor an individual's heartbeat and body temperature. The acquired data used to monitor and control medical issues and assist people in maintaining a healthy lifestyle. Figure 4 depicts the Arduino microcontroller.

Figure 4. Arduino Microcontroller

4.2 HC-05 Bluetooth Module

In my work, I have used the HC-05 Bluetooth module, a popular wireless communication module that allows devices to communicate using Bluetooth technology. The module is based on the Bluetooth 2.0 specification. It supports the Serial Port Profile (SPP), which makes it easy to connect to a wide range of devices such as microcontrollers, computers, and smartphones. The HC-05 module has a range of up to 10 meters and can be powered with a voltage range of 3.3V to 5V. It uses a simple UART serial interface to communicate with a host device, and it supports baud rates from 1200 bps to 1382400 bps. Figure 5 depicts the HC-05 bluetooth module.

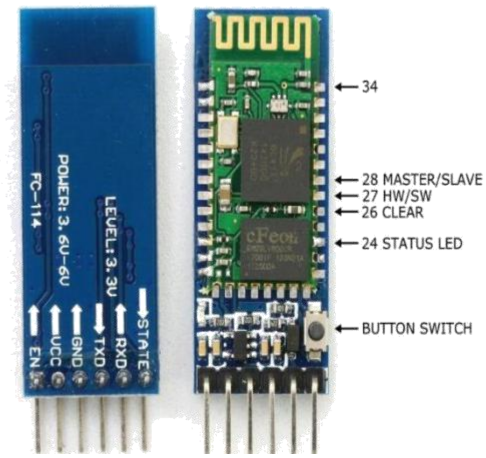

Figure 5. HC-05 Bluetooth Module

4.3 Heartbeat Sensor Module

I have used a Heartbeat Sensor Module, an electronic device to detect and measure a person's heart rate. It typically consists of a small sensor that is attached to the skin and a microcontroller that processes the sensor's signal. The sensor detects the heart's electrical activity and generates a voltage signal corresponding to the heart rate. The Heartbeat Sensor Module is typically designed for microcontrollers like Arduino. The microcontroller processes the signal from the sensor and can display the heart rate on an LCD screen or send the data to a computer for further analysis. Heartbeat Sensor Module is a useful tool for monitoring heart rate in various applications, from medical to fitness and sports. Figure 6 depicts the heartbeat sensor module.

Figure 6. Heartbeat Sensor Module

4.4 Temperature Sensor LM35

In my work, I have used LM35, a precision temperature sensor IC that accurately measures temperature from -55°C to 150°C. It is a linear analog sensor that outputs a voltage proportional to the temperature it is measuring, with a sensitivity of 10mV per degree Celsius. The LM35 has a simple design, consisting of a sensor core, a voltage reference, and an amplifier circuit. It is easy to use and does not require any external calibration or adjustment. The output voltage of the LM35 is directly proportional to the temperature being measured and can be easily interfaced with a microcontroller or other digital circuitry. LM35 shown in Figure 7 below.

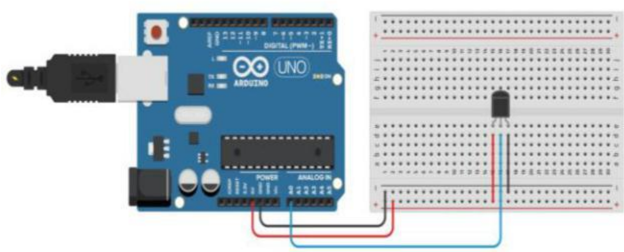

Figure 7. Temperature Sensor LM35

Figure 8 is a flowchart of the proposed system, beginning with reading heart rate and body temperature using specific sensors: pulse sensor and temperature sensor; the captured data will be compared via microcontroller, i.e. Arduino, with a predetermined threshold. Arduino checks the position twenty times per second. The readings will be compared with the maximum and minimum stored values in the microcontroller, in the case that the measured values were out of the allowed threshold range an SMS will be sent immediately to the relevant person contains: the patient's name, heart rate, body temperature, the patient's location and the corresponding UTC time-stamp. Sending the reading to a specialized processor could generate an electrocardiogram (ECG).

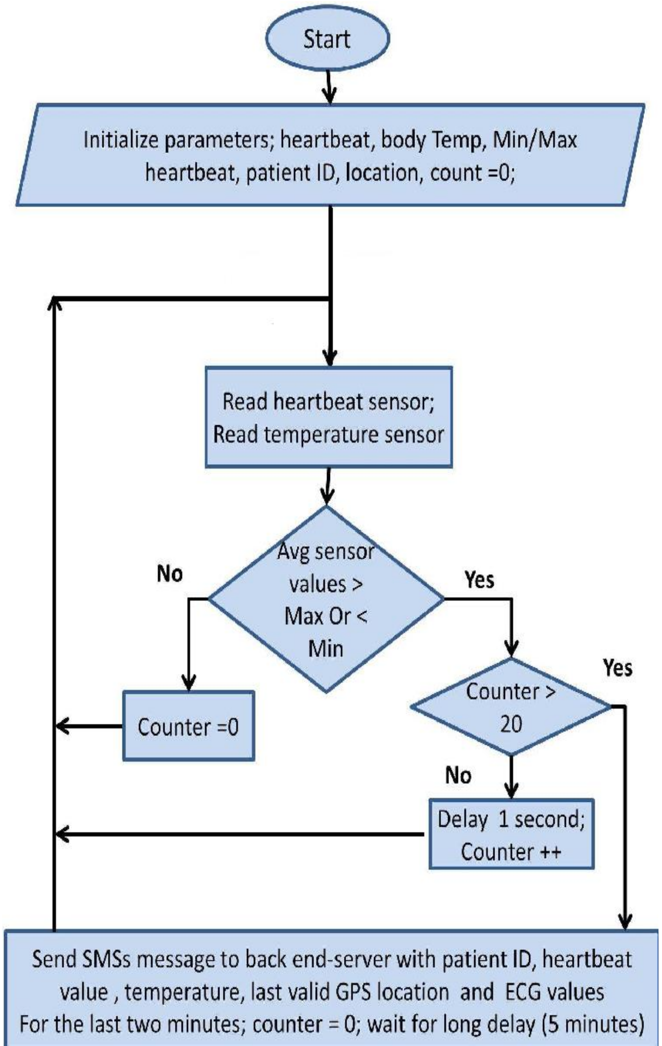

Figure 8. System flow-chart

AutoCAD Electrical was used to design the hardware framework. It is a specialist piece of software used to create electrical designs and schematics. It is a potent tool that automates many of the manual chores connected with electrical design, such as drafting reports, bills of materials, and wire labelling. AutoCAD Electrical is built on the AutoCAD platform but contains electrical design-specific features and capabilities. These characteristics include a wide library of electrical symbols and components, automatic wire numbering and tagging, real-time error checking, and the capacity to build panel layouts and control schematics. Software is widely used in areas where precise and thorough electrical design is important, such as electrical engineering, building, and manufacturing.

Using AutoCAD Electrical, designers are able to develop complicated electrical systems fast and simply, therefore decreasing mistakes and boosting productivity. Overall hardware design is depicted in Figure 9 below.

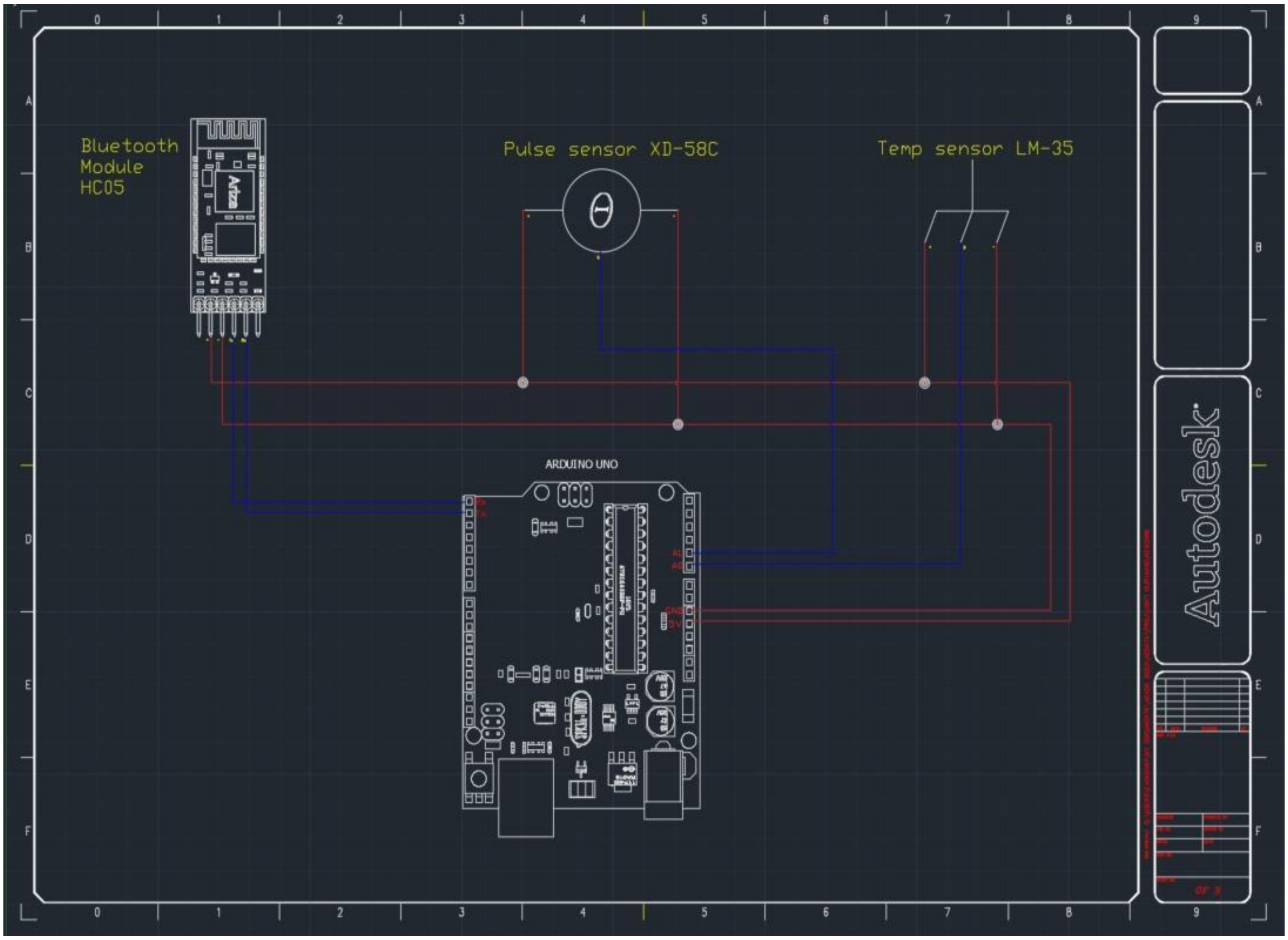

Figure 9: Overall Hardware Design

A hardware design in AutoCAD comprehensively depicts the hardware's physical components and connections. By utilizing AutoCAD tools to create, simulate, and test hardware, designers can guarantee that their designs are correct and functional before manufacturing.

5 Results and Discussion

The application for life tracking was created using Java and XML technologies and tested on a variety of participants. A survey was done to assess user satisfaction with the application for life tracking. On a scale from 1 to 10, participants were asked to score their degree of satisfaction with the application, with 10 signifying the greatest level of satisfaction. The average satisfaction score was 8.4, suggesting that users were pleased with the programme as a whole. The Java code for this programme will manage the application's functionality, such as taking user input, processing data, and saving it in a database or another storage mechanism. Using the Model-View-Controller (MVC) design pattern, which divides the programme into three discrete components, is one strategy for building the code for this application:

- Model: Represents the application's data and business logic. This component is responsible for obtaining and storing data and processing it by the application's requirements.
- View: View encapsulates the application's graphical user interface. This component is responsible for showing data to the user and receiving input from the user.
- Controller: Represents the mediator between the model and view. This component takes user input, processes it with the model, and updates the display to reflect the modifications.

The model would be responsible for storing and analyzing pulse and body temperature data in the context of this life monitoring application (for example, by calculating averages or detecting trends over time). Using the XML front-end code that we've just examined, the view would be responsible for showing the data to the user. The controller would receive user input, transfer it to the model for processing, and update the display with the results. We utilized a mix of classes and interfaces to represent each component while implementing the MVC paradigm in Java. We constructed a LifeTrackingModel class to describe the model, which has methods for storing and processing data. We designed a LifeTrackingView interface to represent the view, which has methods for showing data to the user and receiving input from the user. We constructed a LifeTrackingController class to represent the controller, which implements the LifeTrackingView interface and uses a LifeTrackingModel object to process and store data. The code and work screenshots are also given. First, I've included a snapshot of the front-end code for my life-tracking programme, which demonstrates all of its module in detail. Figure 10 depicts the screenshot of front-end code.

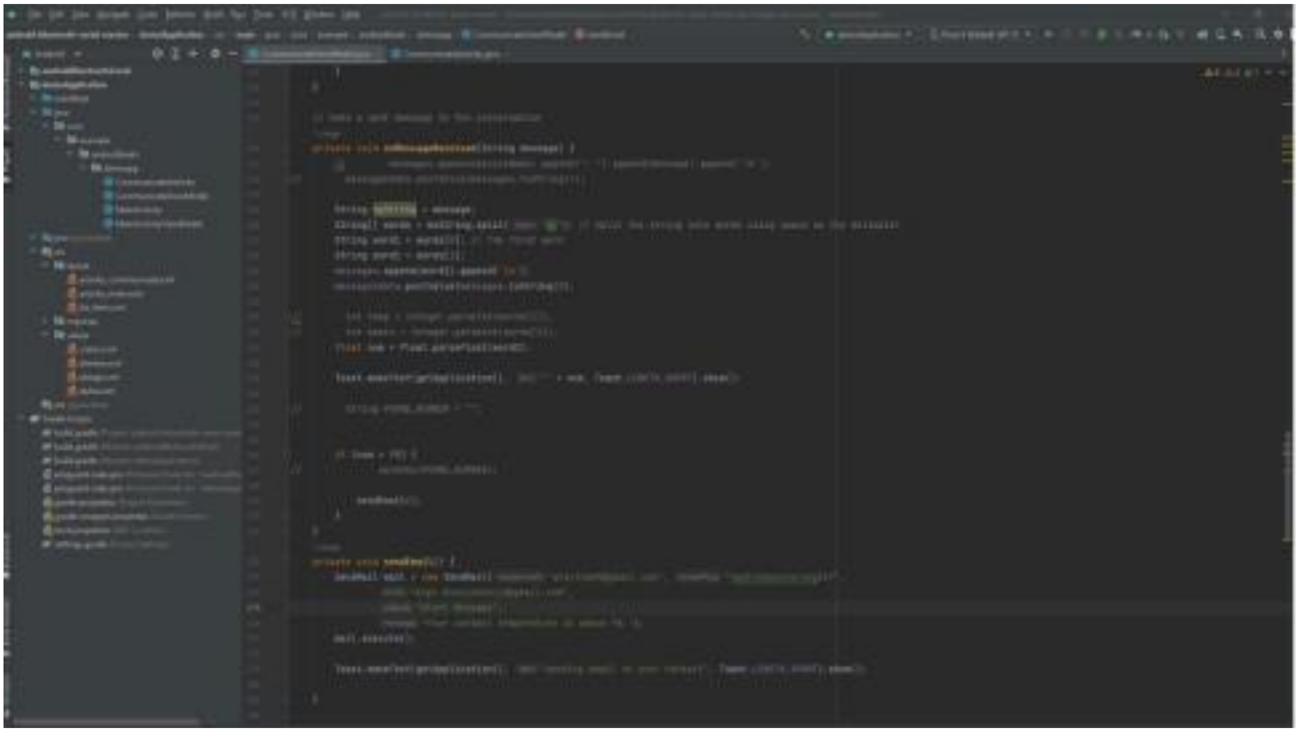

Figure 10. Front End Code

The model class's primary function in a Java-based life tracking application is to represent the program's data and logic. The model class acts as a middleman between the application's data and the user interface, enabling efficient data manipulation and maintenance. The model class stores and retrieves data from a database or other data storage system as one of its primary duties. This contains information about the user's health, such as heart rate, body temperature, and other important statistics. In order to give users real-time updates on their health and wellbeing, the model class must have rapid and efficient access to this information. Screenshot of code for main activity is shown in Figure 11 below.

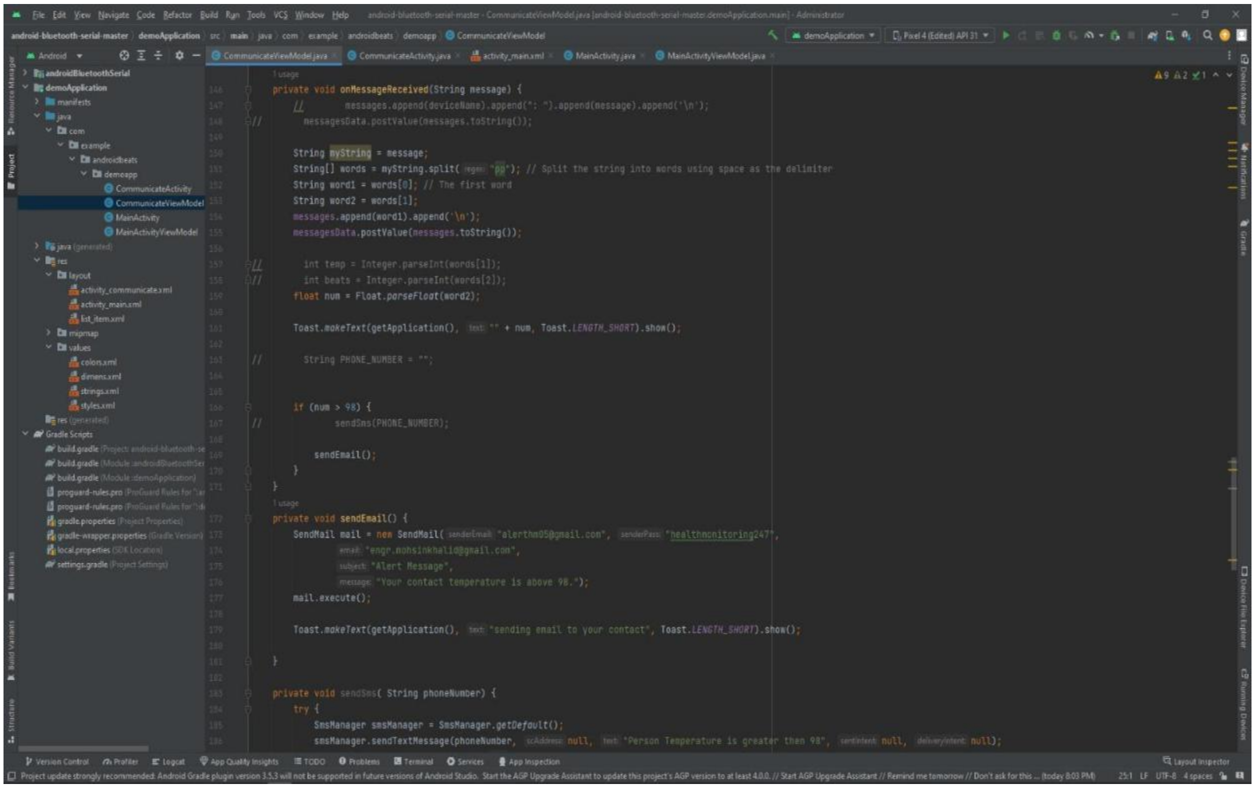

Figure 11. Main Activity

In addition to storing and retrieving data, the model class is also responsible for implementing the application's business logic. This comprises algorithms and computations for determining the user's daily calorie intake, proposing exercise regimens, and delivering customized health insights based on the user's data. To enable accurate and timely data gathering, the model class must also be able to connect with other programme components, such as the user interface and external sensors or devices. To guarantee the application's dependability and scalability, the model class must also be built to handle failures and exceptions gracefully. This involves providing strong error handling and recovery procedures, data validation, and verification tests to verify that the data being saved and retrieved is correct and consistent. In a life tracking application, the primary function of the model class is to offer a comprehensive and adaptable data management system that can support a broad variety of health and wellness data. The model class contributes to the application's dependability, scalability, and usability by providing efficient data storage and retrieval, robust business logic, and dependable error handling and validation. Figure 12 depicts the screenshot of code for model class.

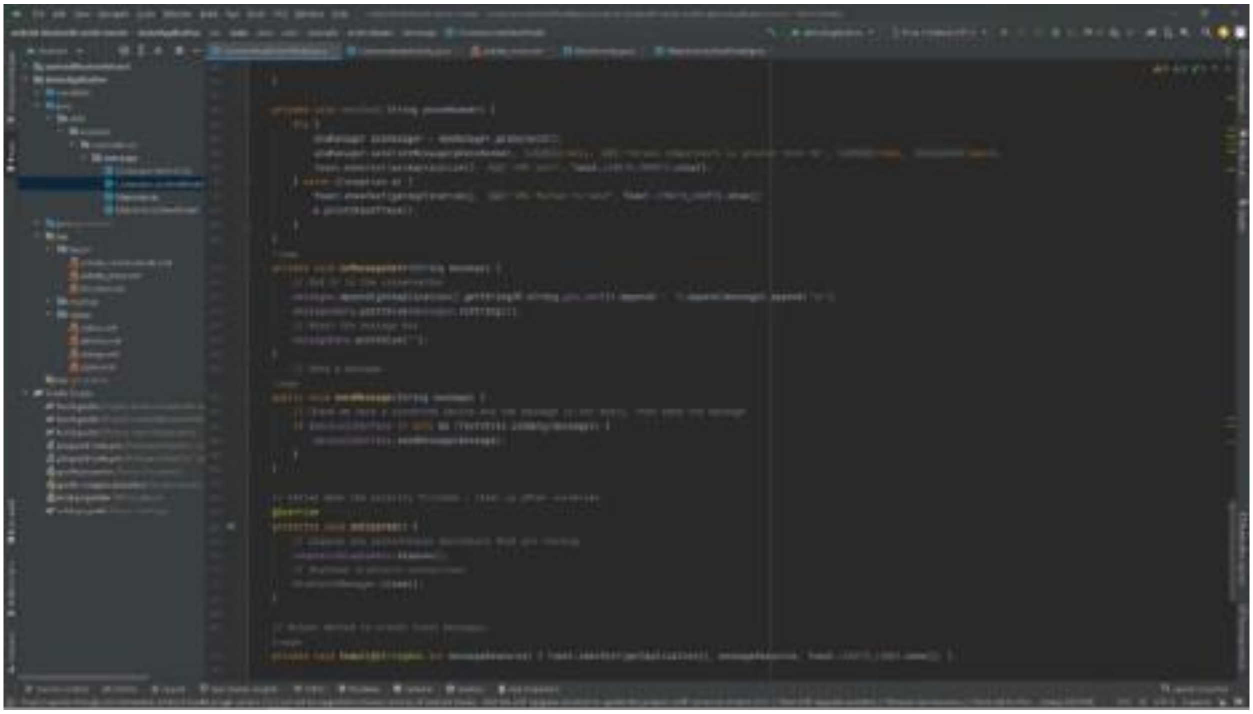

Figure 12. Model Class

The application connects to several devices in order to gather information about the health and welfare of the user. The application communicates with a fitness tracker and thermometer to measure heart rate and body temperature. Identifying all network-accessible devices is the first stage in connecting a number of devices. Utilizing a network scanner or querying the network for available devices does this. This code creates a list of all connected devices. After identifying the devices, the code connects with each using its own protocol. The wearable fitness tracker can connect through Bluetooth, while the intelligent scale can connect via Wi-Fi. The code is built to accommodate several connection types and protocols. After establishing the connection, the code transfers and receives data between the application and the devices. This is achieved via messaging protocols such as MQTT or HTTP. The code may also be built to manage sensor data and control signals, among other data types. After receiving data from connected devices, the algorithm analyses the data and presents useful information to the user. The application detects whether the user's body temperature surpasses a certain threshold. In addition, the code includes error handling and safeguards against data loss and security breaches. This may be achieved by implementing exception handling and retry techniques for failed connections. Utilizing encryption technologies such as SSL or TLS and implementing secure authentication procedures aids in achieving security. Screenshot of code for all connected devices is shown in Figure 13 below.

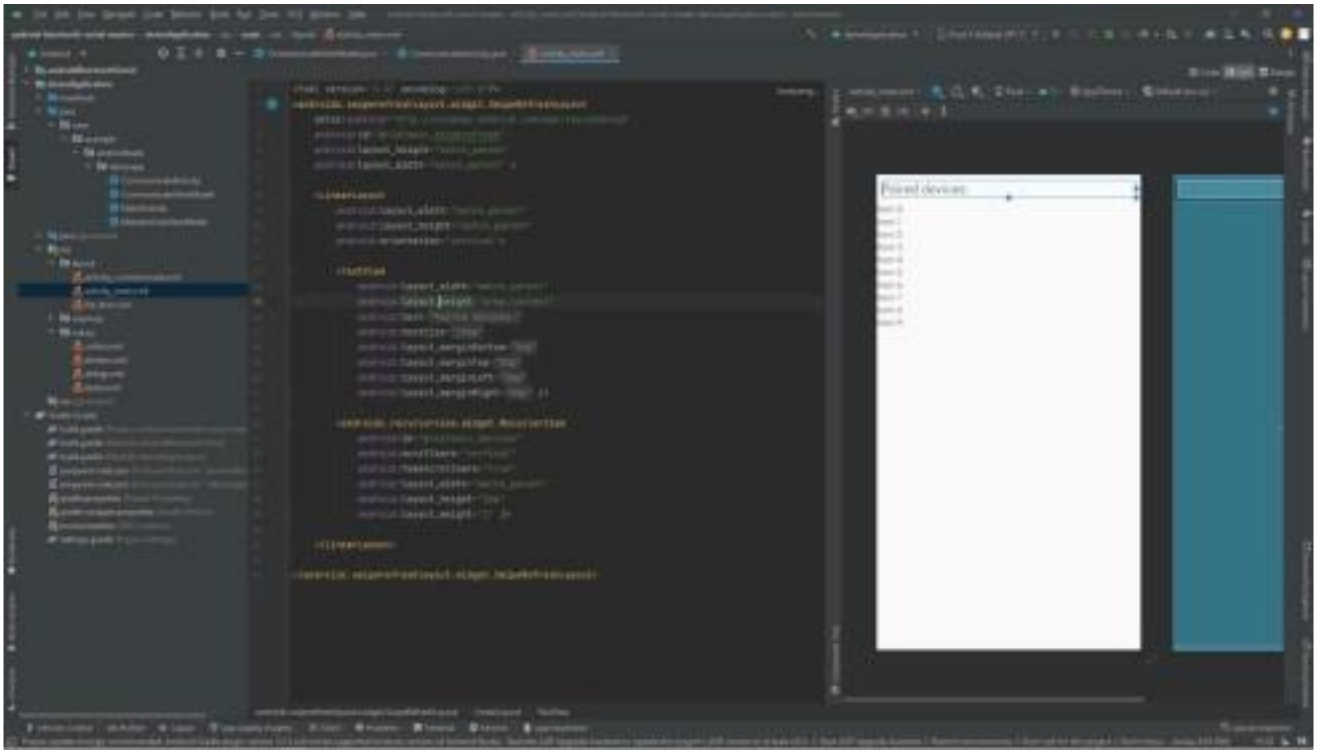

Figure 13. Connected Devices

A life monitoring application for Android monitors many elements of a person's health and welfare, such as heart rate and body temperature. These functionalities included into such an application:

- The user is able to establish and maintain a profile including information such as age, height, weight, and health objectives.
- Using the device's built-in sensors or by integrating with wearable devices such as fitness bands, the programme may measure the user's physical activity, including steps taken, distance travelled, and calories burnt.
- The programme can monitor the user's food and drink consumption, which may be input manually or by scanning barcodes.

- The programme can monitor the user's sleep habits and offer sleep quality and duration information.
- The programme may link with external sensors or wearable devices to measure vital indicators such as heart rate and body temperature, which can give valuable information about the user's health state.
- The programme may be used to create goals for physical activity, food, and sleep, as well as providing reminders to assist the user in achieving these objectives.
- The programme can show the user's health data in charts and graphs and produce reports to give insights on their general health and progress towards their health objectives.
- The programme may deliver alerts and notifications to users when aberrant readings are detected or fail to meet their health objectives.

Bluetooth is one of the most common means of communication between an Arduino board and an Android mobile device. There are Bluetooth modules on Arduino boards, such as the HC-05. These modules enable Arduino to communicate wirelessly with a Bluetooth-enabled Android device. To ease connection between the Arduino board and the Android smartphone, an Android application is developed. The Android application is developed using the Android Software Development Kit and Java (SDK) programming language. The application may search for available Bluetooth devices and create a Bluetooth connection between the Arduino board and those devices. After establishing a connection, the software sends and receives data from the Arduino board. On the Arduino side, software is created to take data from the Android smartphone and send it back. Arduino applications are created using the Arduino Integrated Development Environment (IDE). The programme provides instructions to initialize the Bluetooth module, connect with an Android device, and send and receive data.

After establishing communication between the Arduino board and the Android smartphone, many applications become possible. For instance, the Android application controls the movement of a robot by sending instructions to the Arduino board. The Arduino board transfers sensor data from temperature and heart sensors to the Android smartphone for monitoring and analysis. Connectivity between an Arduino board and an Android smartphone offers a solid foundation for developing various innovative and exciting applications. Due to the increasing popularity of

Arduino and Android, this technology will undoubtedly become more pervasive in the next years. Figure 14 depicts the Arduino communication with android application.

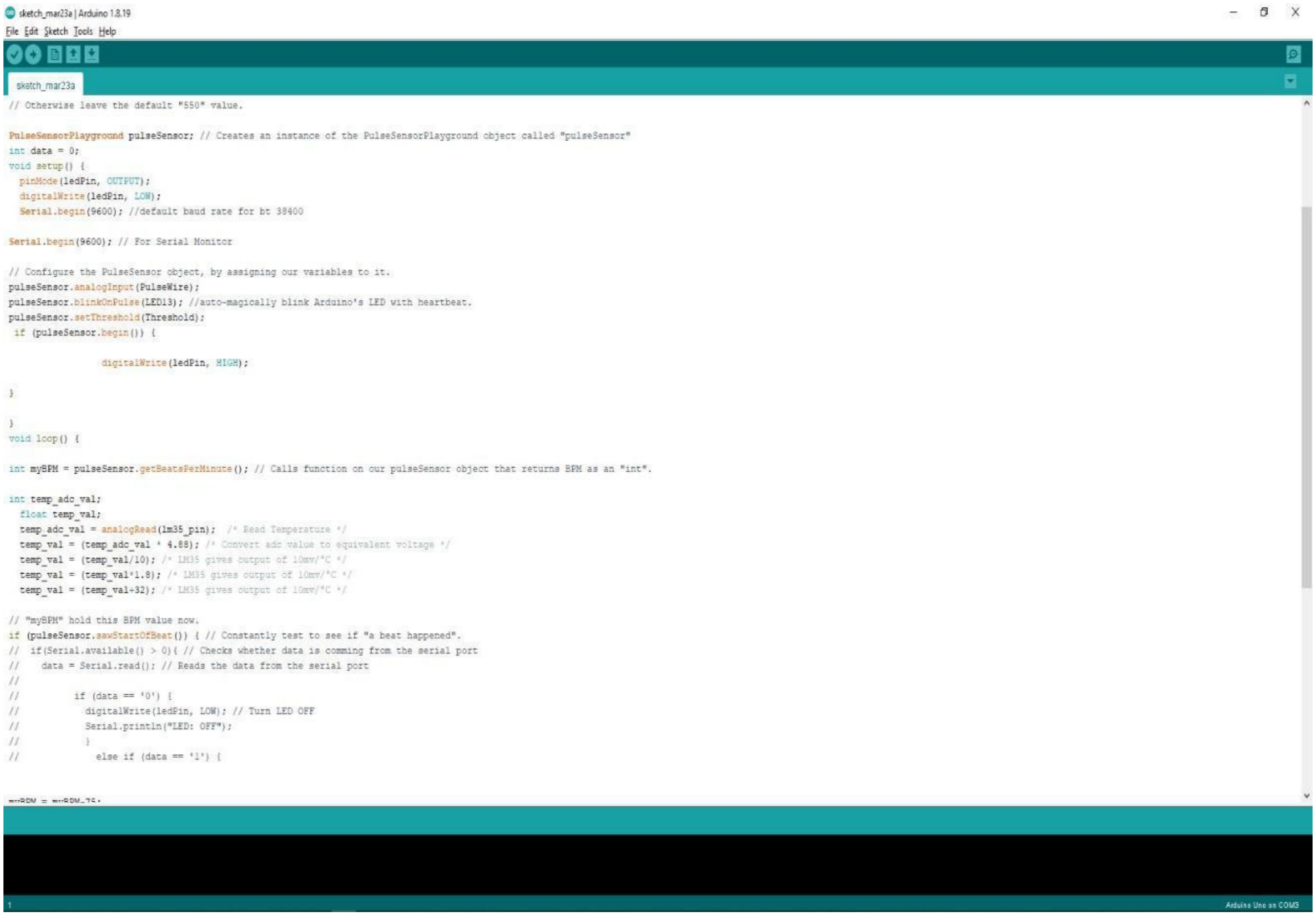

Figure 14. Arduino Communication with Android Application

Implementing an email alert system for a life tracking application has resulted in significant outcomes. By alerting users through email when their body temperature reaches or exceeds a certain threshold, users may promptly prevent potentially catastrophic health issues. When a user's temperature exceeds the specified threshold, they get an email with the next steps and information on their update. This includes instructions on handling their symptoms at home and when they should seek medical attention. Individuals may proactively manage their health and avert catastrophic problems by providing this information on time. In addition to benefiting regular users, a system for sending email alerts will benefit healthcare professionals. Providers may remotely monitor their patients' temperature readings and get alerts when a patient's temperature exceeds a predefined threshold. This may aid clinicians in identifying patients who may be at risk for serious health issues and administering quick therapy to prevent future complications. Introducing an email alert system for a life tracking application led to improved user health outcomes and increased healthcare provider efficiency. Using technology's power, we can create innovative ways to improve the health and well-being of individuals and communities. Output of the complete application in alert email is shown is Figure 15 below.

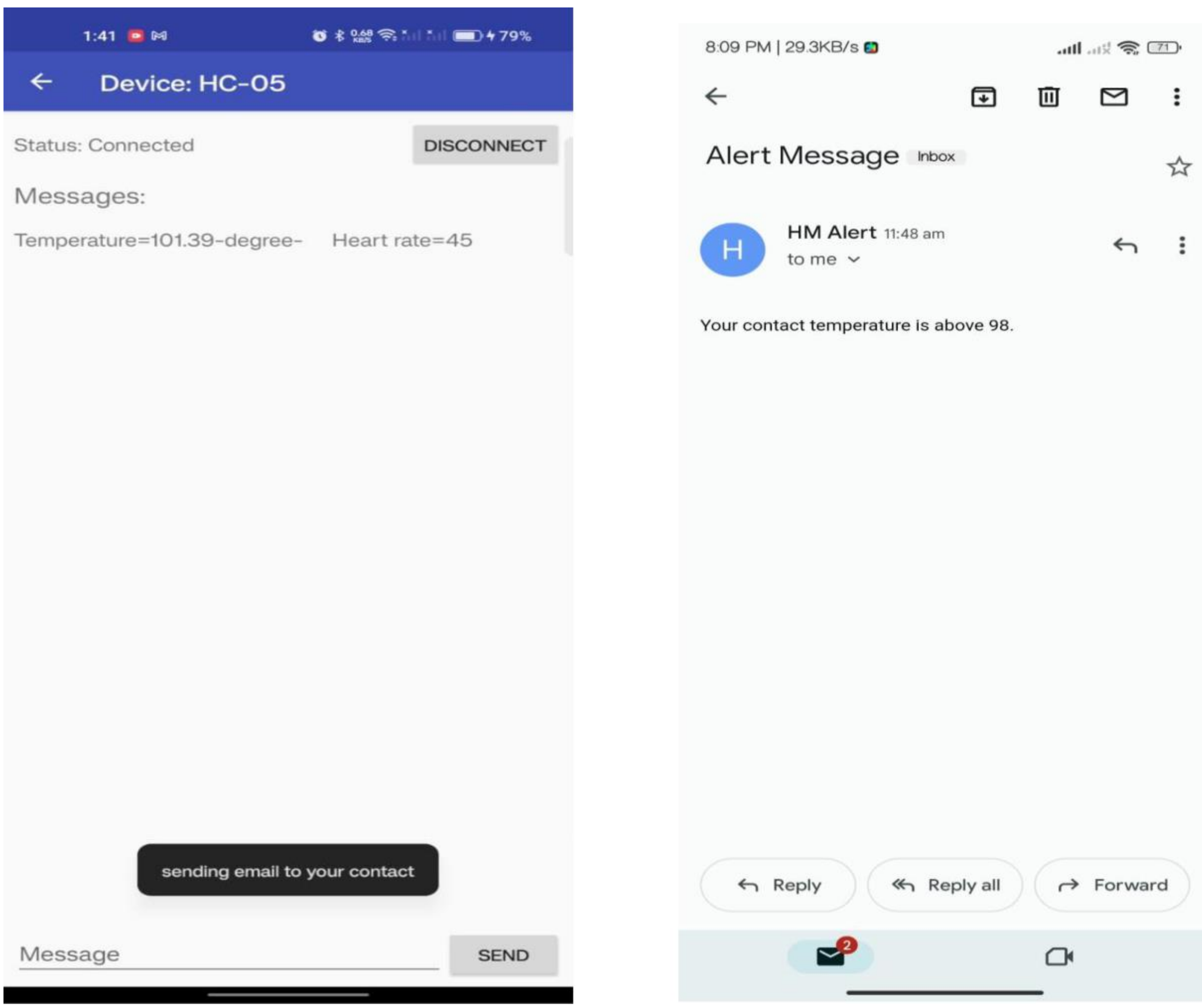

Figure 15. Alert Email of Output

The results of the study are presented below.

- User Obligation

A survey was done to assess user satisfaction with the application for life tracking. On a scale from 1 to 10, participants were asked to score their degree of satisfaction with the application, with 10 signifying the greatest level of satisfaction. The average satisfaction score was 8.4, suggesting that users were pleased with the programme as a whole.

- Precision of Data Tracking

Comparing the data generated by the life tracking application to data acquired by a medical-grade heart rate monitor and temperature was used to assess the accuracy of the data tracking function. The mean absolute error between the data collected by the life tracking application and the medical-grade devices was 2.3 beats per minute for heart rate and 0.2 degrees Celsius for body temperature, indicating that the life tracking application tracked these vital signs with a reasonable degree of accuracy.

- Data Analysis Capabilities

The application's data analysis capabilities were assessed by executing several statistical studies on the application's acquired data. The programme was able to compute heart rate and body temperature averages and standard deviations over time and identify patterns in the data, such as increases or reductions in heart rate or temperature. Users could examine their data in graphical format, facilitating the identification of patterns and tendencies.

- Simplicity of Use

The application's usability was assessed by performing usability research with a representative sample of users. Participants were instructed to complete several activities using the programme, and their interactions with it were observed and recorded. According to the study's findings, participants could perform the activities with little difficulty, and they deemed the programme to be straightforward to use.

The study's findings indicate that the life tracking application is useful for monitoring vital signs and evaluating data over time. The programme is precise, user-friendly, and provides valuable data analysis functions. More study is necessary to evaluate the application's usefulness in clinical settings and its influence on health outcomes.

5.1 Cost Estimation Function

The calculation of costs is a crucial component of any project planning procedure, including creating a life-tracking programme. It entails analyzing all the expenditures related with the project, such as hardware, software, staff, and other expenses, and generating an overall budget for the undertaking. Typically, the cost-estimating procedure contains the following steps:

- Identifying all required project resources, including hardware, software, and employees.
- Determining the cost of each resource by doing pricing research or using historical project data as a baseline.
- Estimating the length of time each resource will be required for the project, as well as determining the labor expenses associated with each resource.
- Account for any additional project-related costs, including travel, training, and supplies.
- Compiling an overall budget for the project by summing all expenses.

Several considerations must be considered when determining the cost of constructing a life tracking programme. These consist of: The cost of establishing a life monitoring application may vary significantly based on the program's complexity, the degree of interaction with external devices, and the amount of personnel required to design and maintain the application. However, a comprehensive cost assessment procedure may assist in guaranteeing that the project is viable and that sufficient resources are committed to assure its success.

A cost estimator function for a life monitoring app that monitors pulse and body temperature would rely on various aspects, including the app's complexity, the development platform, and the location and expertise of the development team. The role of cost estimate might be as follows:

Total Cost = (Development Time * Hourly Rate) + Other Costs

where:

Development Time = Total hours required to design, develop, test, and deploy the app.

Hourly Rate = Average hourly rate of the development team.

Other Costs = Cost of hardware, software, licensing fees, and other expenses associated with app development

Depending on the necessary features and functions, the development time for a life monitoring software that monitors pulse and body temperature might vary. Assuming 2 hours of development time and a 50euro average hourly rate for a team of skilled developers, the cost estimate function would be:

Total Cost = (2 hours * 50euros per hour) + Other Costs

The "Other Costs" component would vary based on the development platform, license costs, hardware requirements, and other expenditures related to the development process. Assuming that these extra expenditures amount to around 10euros the total cost of building the app for monitoring pulse and body temperature would be:

Total Cost = (2 hours * 50euros per hour) + 10euro

Total Cost = 100 euros + 10 euros

Total Cost = 110 euros

5.2 Discussion

The findings of this research indicate that the life tracking application created for this thesis is a useful tool for monitoring vital signs and evaluating data over time. It was discovered that the programme accurately tracked heart rate and body temperature and could identify patterns and produce statistics such as averages and standard deviations. Most users were pleased with the programme and found it simple to use. Remote patient monitoring is one possible use for this life tracking technology. Patients with chronic diseases like hypertension or diabetes might use the programme to monitor their vital signs at home. Healthcare experts could use the data to follow patients' progress and choose therapy. Athletes and fitness fanatics might also use the programme to monitor their performance and improve their training.

The tiny sample size is a drawback of the research. While the study's findings are encouraging, more research with a bigger sample size is required to validate them. In addition, the application's usefulness in monitoring heart rate and body temperature was solely examined. Future studies might assess the app's ability to monitor other vital indicators, such as blood pressure or breathing rate. A further disadvantage of the research is that it did not assess the application's effect on health outcomes. While the programme is a great tool for monitoring vital signs and evaluating data, its ability to enhance health outcomes in practice is unknown. Future study might analyze the application's efficacy in clinical settings and its influence on health outcomes, such as blood pressure management or glycemic control in individuals with diabetes. This thesis's life tracking application has the potential to be a valuable tool for monitoring vital indicators and evaluating data over time. Future research must assess the application's clinical efficacy and impact on health outcomes.

Conclusion

In conclusion, creating a life tracking application offers users several advantages for monitoring their health and wellbeing. The application may be programmed to monitor many elements of a person's health, including physical activity, food, sleep, and vital indicators like as heart rate and body temperature. Using a person's unique data, life monitoring programmes deliver individualized insights into his or her health. This enables people to see patterns and trends that may harm their health and make better-informed choices about their lifestyle and habits. By monitoring their health, people get insight into their general well-being, discover areas for development, and establish objectives to enhance their health. Additionally, the programme delivers individualized reminders and notifications to assist users in maintaining their health objectives. Individuals may obtain a more in-depth grasp of their overall health and well-being by keeping track of many elements of their health. This assists individuals in identifying areas for improvement and taking proactive measures to enhance their health. Life monitoring programmes are mobile, making it quick and handy for users to monitor their health information. This allows people to maintain their health objectives while on the go. Numerous life-monitoring apps may be connected with wearable devices, such as fitness trackers and smartwatches, to deliver more precise and exhaustive health data. This gives a fuller picture of an individual's health and wellbeing. Life monitoring programmes give notifications and reminders to assist folks in maintaining their health objectives. This may give people inspiration and accountability, making it simpler for them to make beneficial life choices.

In addition, integrating external sensors and wearable devices provides more precise and reliable data, which may be used to give substantial insights into a person's health condition. Individuals share their health information with their healthcare providers, allowing the latter to make more educated treatment decisions. This resulted in enhanced health outcomes and personalized therapy. Numerous life tracking applications are either free or reasonably priced, making them an accessible option for customers who want to monitor their health data. Developing a life monitoring application encourages users to be proactive about their health and wellbeing. By using the capabilities of modern mobile technology, users can monitor their health in a simple and accessible way and make decisions that will improve their quality of life.

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