# Faculty of Electrical and Electronic Engineering Technology



**DEVELOPMENT OF SMART HEALTH MONITORING SYSTEM UTILIZING INTERNET OF THINGS (IoT) AND ARDUINO**

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**Bachelor of Electronics Engineering Technology with Honours**

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# DEVELOPMENT OF SMART HEALTH MONITORING SYSTEM UTILIZING INTERNET OF THINGS (IoT) AND ARDUINO

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**A project report submitted**
**in partial fulfillment of the requirements for the degree of**
**Bachelor of Electronics Engineering Technology with Honours**

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**2021**

## DECLARATION

I declare that this project report entitled "Development of Smart Health Monitoring System Utilizing Internet of Things (IoT) and Arduino" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

| | | |
|---|---|---|
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| Date | : | 10/01/2022 |

## APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology with Honours.

Signature :

Supervisor Name : TS. DR. NORHASHIMAH BINTI MOHD SAAD

Date : 11/01/2022

## DEDICATION

*My heartfelt gratitude goes out to my adoring parents, siblings, and friends who have always been by my side and encouraged me to successfully finish my final year project. Meanwhile, I dedicate my thesis to my dear supervisor, TS. DR. NORHASHIMAH BINTI MOHD SAAD, who has imparted invaluable knowledge to me through the process of successfully finishing my final year project. Many thanks. I'm grateful. I am humble and grateful for their willingness to make this endeavour possible via their sacrifice, tolerance, and thoughtfulness. I was at a loss for words to convey my appreciation for their commitment, support, and faith in my abilities to accomplish my goals.*

# ABSTRACT

The use of healthcare monitoring systems in hospitals and other health facilities has grown exponentially, and portable healthcare monitoring systems based on new technologies haveemerged as a severe concern in a number of countries throughout the globe. The emergenceof Internet of Things (IoT) technology has contributed in the progress of healthcare from face-to-face counselling to telemedicine. Nowadays, many Internet of Things (IoT) application are also being developed. So now the doctor or family members can monitor or track the patient’s health through the Android application. When need to monitor, record and monitor changes in patient health parameters over time, Internet of Things (IoT) monitoring comes in handy. The construction of this database of health parameter changes uses Internet of Things (IoT) health tracking. This paper suggests a system of smart health monitoring system in an Internet of Things (IoT) ecosystem capable of monitoring patients'basic health information. The project aims to design a reliable health monitoring system using Internet of things (IoT) that can be used to measure and track various parameters for instance body temperature, heart rate and level of oxygen in the blood in both hospitals and homes. What makes the project unique than the other innovation, the system is capable to verify that the transmission of the sensor’s data to the host computer is done in real time. Overall, this system demonstrated a high level of accuracy, with 99.9 percent accuracy for measuring body temperature, 99.4 percent accuracy for measuring heart rate, and 99.9 percent accuracy for measuring blood oxygen levels. This developed system provides many facilities for medical staff and families to perform the process of health measurement or monitoring, whether at home or in the hospital.

# *ABSTRAK*

Penggunaan sistem pemantauan penjagaan kesihatan di hospital dan kemudahan kesihatan lain telah meningkat dengan ketara, dan sistem pemantauan penjagaan kesihatan mudah alih berdasarkan teknologi baru kini menjadi perhatian utama bagi banyak negara di seluruh dunia. Kemajuan penjagaan kesihatan dari terus bersemuka ke aplikasi secara talian atau maya telah dibantu oleh pengenalan teknologi "Internet of Things (IoT)". Pada masa kini, aplikasi "Internet of Things (IoT)" juga sedang berkembang pesat. Dengan kemajuan teknologi ini, doktor dan ahli keluarga dapat memantau dan mengesan tahap kesihatan dengan mudah melalui aplikasi di telefon pintar. Untuk membuat pemantauan, penyimpanan data, dan pemantauan perubahan dalam parameter kesihatan pesakit dari masa ke masa, "Internet of Things (IoT)" dilihat sangat berguna bagi menjalankannya. Pembinaan pangkalan data perubahan parameter kesihatan ini terbukti berjaya dibina dengan menggunakan teknologi kesihatan "Internet of Things (IoT)". Oleh itu, kertas ini mencadangkan pembinaan pemantauan kesihatan pintar dalam persekitaran "Internet of Things (IoT)" yang dapat memantau dan mengukur gejala kesihatan asas pesakit. Projek ini bertujuan untuk merancang sistem pemantauan kesihatan yang boleh dipercayai menggunakan "Internet of things (Iot)" yang dapat digunakan untuk mengukur dan mengesan pelbagai parameter seperti suhu badan, degupan jantung dan paras oksigen dalam darah tidak kira sama ada digunakan di hospital atau di rumah. Apa yang menjadikan projek ini unik daripada inovasi lain, sistem ini dapat mengesahkan bahawa penghantaran data sensor ke komputer host dilakukan dalam masa nyata. Secara keseluruhannya, sistem ini menunjukkan tahap ketepatan yang tinggi, dengan ketepatan 99.9 peratus untuk mengukur suhu badan, ketepatan 99.4 peratus untuk mengukur kadar denyutan jantung, dan ketepatan 99.9 peratus untuk mengukur tahap oksigen darah. Sistem yang dibangunkan ini menyediakan banyak kemudahan untuk kakitangan perubatan dan keluarga melakukan proses pengukuran atau pemantauan kesihatan sama ada di rumah mahupun di hospital.

## ACKNOWLEDGEMENTS

All praise is due to Allah, the Most Generous and Merciful, who has bestowed upon me the strength and intelligence necessary to achieve this endeavour. Without his blessings, my whole effort to generate ideas for this endeavour would have failed miserably.

To begin, let me begin by thanking my immediate supervisor, Ts. Dr. Norhashimah Binti Mohd Saad, for her essential support in enabling me to accomplish this excellent project. I am grateful for her kindness in providing consistent emotional support and helping me through each stage of the process of completing this project successfully. When I made errors, she was sympathetic with me and just urged me to find a fast solution to every difficulty I had. I appreciate her total support.

Apart from that, please accept my profound thanks for my parents' love and prayers over the duration of this last project's creation. They gave unwavering moral support throughout my education.

Finally, I want to say thank you to everyone in my class, as well as everyone else who helped and worked with me.

Many thanks to everyone. It is greatly appreciated.

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## LIST OF SYMBOLS

| | | |
|---|---|---|
| $nm$ | - | Nanometer |
| V | - | Volt |
| mV | - | MiliVolt |
| A | - | Ampere |
| C | - | Celcius |

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| *JSON File* | - | JavaScrips Object Notation |
| TCP/IP | - | The Internet Protocol Suite |
| HTML | - | Hypertext Markup Language |
| IoT | - | Internet of Things |
| WPAN | - | Wireless Personal Area Network |
| MQTT | - | Massage Queuing Telemetry Transport |
| HTTP | - | Hyper Text Transfer Protocol |
| TLS | - | Transport Layer Security |
| LCD | - | Liquid Crystal Display |
| AC | - | Analog Current |
| DC | - | Direct Current |
| V | - | Voltage |
| A | - | Current |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

This chapter will set the stage for the remainder of the project, which will include the development of a Smart Health Monitoring System utilising the Internet of Things (IoT) andArduino. This project is a wireless healthcare monitoring gadget that can detect andwirelessly transmit the pulse rate, temperature, and oxygen saturation level of the blood to the host computer. This chapter discusses the project's context, problem description, aim, and scope.

## 1.2 Background

Rather than merely the absence of sickness, health is defined as a full condition of physical, emotional, and social well-being. Individuals' aspirations for a better life are inextricably tied to their health. Regrettably, global health crisis has produced a paradox as a result of a variety of causes, including insufficient health care, enormous divides between rural and urban regions, and physician and nurse shortages at important periods. The Internet of Things (IoT) has connected every thing inside during the previous decade, and it has been labelled the next technological revolution. The Internet of Things is most widely used in healthcare management, where it is used to monitor health and environmental factors. The Internet of Things (IoT) is the process of establishing a connection between computers and the internet using sensors and networks. These interlinked components might be utilised in health surveillance systems. Modern technologies now include a customizable interface, personal assistant gadgets, and mental health care to aid individuals in living more intelligent lives.

Approximately 6.4 million Malaysian individuals today have high blood pressure or hypertension, and some are unaware they have the ailment. According to the 2019 National Health and Morbidity Survey (NHMS), there are 6.4 million persons with high blood pressure, with an estimated 3.4 million already aware, and the remainder unaware. According to him, this statistic is quite concerning for the Malaysian Ministry of Health (MOH). When the proportion of hypertension is compared to the previous year, there is a minor decrease of 30% in 2019 compared to 32.7 percent in 2011. Malaysia, on the other hand, has a greater prevalence of hypertension than the world norm and is among the highest in the Asean region. Additionally, the prevalence of hypertension rises with age. As a result, it is necessary to build new high-tech methods to overcome this limit.



Additionally, given the country's present predicament with the Covid-19 virus, monitoring the quantity of oxygen in the blood is critical today. Typical SpO2 readings vary according to an individual's age, ethnic origin, and health, but a value of 95-99 percent is considered normal for a healthy person. There are instances of oxygen intoxication with 100% SpO2, however this occurs primarily in hospitals when the patient is on a continual supply of oxygen due to a specific treatment. When a patient receives an excessive quantity of oxygen, pulmonary toxicity ensues, which may have a detrimental effect on the central nervous system (Graves, 2011). Reduced oxygen levels may potentially be fatal, since organs may become oxygen-depleted when oxygen levels fall below 90%. Hypoxemia occurs often when the human body's tissues and cells are deprived of oxygen.

As a result, the usage of in hospitals and other health institutions, healthcare monitoring systems has significantly enlarged, and new technology-enabled portable healthcare monitoring devices have become a serious issue in a number of nations worldwide. The emergence of Internet of Things (IoT) technology has contributed in the progress of healthcare from face-to-face counselling to telemedicine. Numerous Internet of Things (IoT) applications are also being developed at the moment. Thus, doctors and family members may now monitor or follow a patient's health using the Android application. When monitoring, recording, and tracking changes in patient health metrics over time becomes necessary, Internet of Things (IoT) Monitoring comes in helpful. This database of health parameter changes was created using Internet of Things (IoT) health monitoring. This article presents a smart health monitoring system that can monitor patients' fundamental health symptoms in an Internet of Things (IoT) environment. This device may be used in both hospitals and households to monitor and record numerous factors such as body temperature, heart rate and blood's oxygen level. This is a large sensor-based project using cutting-edge technologies.



## 1.3 Problem Statement

Health monitoring is a significant concern in today's climate. Patients have serious health difficulties as a consequence of an insufficient health monitoring system. The new health monitoring system is unable to deliver real-time patient health warnings and is constrained by the distance between the patient and the hospital. Additionally, the new technique requires time to collect data from patients. Besides, it is inefficient in terms of cost. A low-cost contemporary gadget capable of providing real-time data. As a result, various Internet of Things (IoT) gadgets are now available that may be used to remotely monitor and regulate a patient's health. Health care workers are increasingly using these intelligent gadgets to monitor their patients. The primary reason for developing this system is to address the absence of effective health monitoring in community life, the disparity between rural and urban health care centres, and the inability of the present health monitoring system to give real-time patient health alerts.

## 1.4 Project Objective

i. To design a reliable health monitoring system using Internet of things (IoT).
ii. To analyze the measurement of the health monitoring system based on body temperature, heart rate and level of oxygen in the blood.
iii. To verify that the transmission of the sensor's data to the host computer is done in real time.

## 1.5 Scope of Project

The following are the specifics of this project's scope:

a) The ultimate aim of this project is to create a prototype that can meet the above-mentioned goals.
b) The project's aim is to create a prototype of a healthcare monitoring device that can detect and wirelessly transmit a human body's temperature, pulse rate and the level of oxygen in the blood to a host PC.
c) The health-monitoring equipment created here is an Internet-of-Things (IoT) system. It's based on the Arduino UNO.
d) The Arduino UNO is a common prototyping board that is often used in Internet of Things projects.
e) To develop this medical IoT system, the Arduino is utilised to link the pulse LM-35 temperature sensor, MAX30100 pulse oximeter, character LCD, and ESP8266 Wi-Fi modem.

f) The computed pulse rate, temperature, and oxygen saturation level in the blood are shown on the character LCD attached to an Arduino and sent to the cloud platform through a Wi-Fi access point.

g) On a regular basic, health-related data such as pulse rate, body temperature, and blood oxygen saturation level are updated and recorded to the ThingSpeak platform. The data may be utilised to maintain a patient’s medical history.

## 1.6 Outline of the Project

Chapter 1: Introduction

This chapter summarises the project that will be detailed in the remainder of the report. Thatis the background of the project. This section will describe the project's introduction, whichincludes an overview, a report of issues, the study's objectives, and the scope of work.

Chapter 2: Literature Review

This chapter summarises ideas, experimental studies, and some key findings from prior research that are pertinent to the present endeavour. Additionally, the study will be summarised.

Chapter 3: Methodology

Chapter 3 goes into further depth on the strategy and plan for accomplishing the goals. Thischapter will discuss control theory and demonstrate how to use it. Each step has its own technique, as does the overall project's flow chart.

Chapter 4: Result, Analysis, and Discussion

This chapter discusses the illustrations and graphs accompanying the experiments shown inthe images, as well as the study's findings.

Chapter 5: Conclusion and Recommendation

Chapter 5 summarises the trial's findings as well as the project's critical milestones. Additionally, this chapter makes some suggestions for future growth and improvement. Suggestions for further research are also being prepared for potential innovators.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The objective of this chapter is to conduct a literature evaluation of prior projects and research conducted by other specialists that are relevant to the development of a smart health monitoring system using the Internet of Things (IoT) and Arduino. This project presents a smart health monitoring system that can monitor patients' fundamental health symptoms in an Internet of Things (IoT) environment. This device may be used in both hospitals and households to monitor and record numerous characteristics such as body temperature, heart rate, and blood oxygen saturation level. This is a significant sensor-based project that incorporates cutting-edge technologies. By using this method, it is possible to contribute to the community's disease prevention efforts. Users will be able to check their health in order to avoid contracting or being afflicted by any unanticipated ailments.



## 2.2 Previous Research Paper

From the previous study, [1] proposed paper IoT based Patient Health Monitoring using ESP8266. The study objective was to construct a health monitoring system, which detects body temperature and heart rate, to construct a system for storing patient data in the cloud over time, and to conduct analysis on the sensor data acquired. The suggested solution incorporates health care security and the cloud of things. The system is divided into two key stages which are storage and data retrieval. Data is kept and modified at the storage stage for future usage. Retrieve data from the cloud during the data retrieval step. The Arduino Uno AtMega328P is used to receive data from the sensor and deliver it to the cloud through ESP8266. The ESP8266 connects to the internet through Wi-Fi and transmits data from the Arduino to the cloud. Following that, when a figure is placed on it, this system uses a pulse sensor to provide a digital output to the Arduino and an LM35 temperature sensor to provide an analogue output to the Arduino.


Figure 2.1 : Interfacing of LCD and sensors with Arduino


Figure 2.2 : Graphs of sensor output on IoT platform (ThingSpeak)



Another study, [2] proposed paper Health Monitoring system using IoT is established to construct a health monitoring system capable of measuring body temperature and heart rate, to construct a system capable of storing patient data over time through database administration, and to conduct sensor data analysis. For data gathering, health monitoring sensors are utilised to gather health-related data. Communication may be accomplished using a controller capable of wirelessly transmitting data over the internet. The server was used to process the data. At the server level, all data is captured and aggregated. This project included a number of components. The primary component is an Arduino Uno based on the ATMega328, a temperature sensor LM35, a pulse sensor, a WiFi module ESP8266, and an Internet of Things (IoT) platform called "ThinkSpeak."

The temperature and heart rate of the subject will be determined using an LM35 and a pulse sensor, respectively. An Arduino Uno board is used to interface with these sensors, which acts as the controller. Arduino transmits data wirelessly through a wifi module. The ESP8266 is used to transmit data wirelessly on an Internet of Things (IoT) platform.

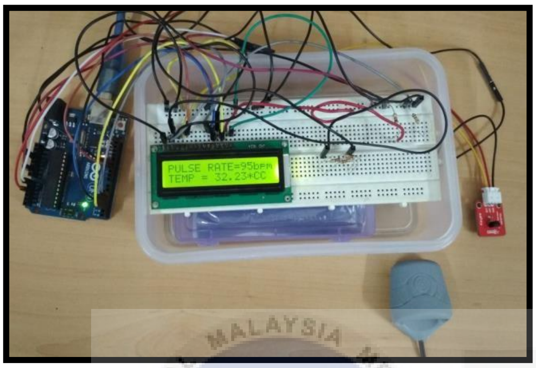


Figure 2.3 : The system setup


Figure 2.4 : Graphs of sensor output in IoT platform (ThingSpeak)



Elsewhere, from the previous study, [3] proposed paper Heartbeat And Temperature Sensor Monitor Via Mobile Phone. The project's objective is to develop a new system that monitors both heartbeat rate and body temperature simultaneously via mobile phone, to ascertain the body's core temperature and pulse rate of the human body, which are highlyrelated to heat stroke and heart attack. Having access to this information and avoiding unnecessary trips to the doctor and hospital saves time and effort. The purpose of this projectis to produce an accessible gadget for individuals of all ages. This is to show the feasibility of our project and to ascertain that it can be accomplished within the specified time and budget limits. The most crucial feature of this gadget is that it must be easy to use. This project included a number of components. The Arduino nano, LM35 temperature sensor, heart rate sensor, and WiFi-Modulator are the primary components. The method used by thissubproject is centred on the utilisation of mobile phones and applications. The application ispowered by Internet of Things (IoT) technology. This software will act as a bridge betweenthe wearable device and the mobile application. When the switch is activated, the sensor starts measuring the human body's temperature.

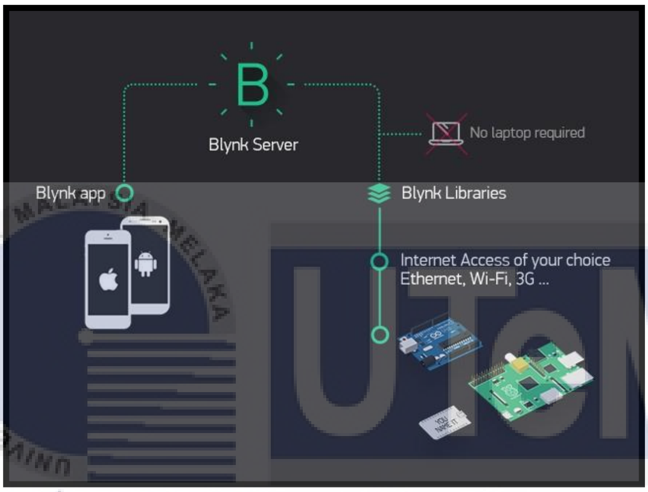


Figure 2.5 : Android App (Blynk) Based on IoT



From a preceding research, [4] proposed paper Developing IoT Based Smart Health Monitoring Systems. The purpose of this research is to uncover a similar approach to conceptualising and implementing solutions trends for intelligent IoT-based patient-centered smart health monitoring devices. Additionally, the system attempts to identify health risks in patients early, allowingcritical emergency actions to be done more quickly, perhaps saving a huge proportion of these patients' lives. Additionally, patients can be monitored in real time and alerted to any abnormalities that are detected by this system tracking health via the Internet of Things. This system is comprised of a Raspberry Pi as the central processing unit, a Lo-Ra module for data transmission, and

RFID tags for security and detection of hearing difficulties, headaches, and high pulse rate. It is capable of detecting aberrant cardiac rhythms as well as changes inbody temperature. The system discussed before included a pulse oximeter, blood glucose metre, and accelerometer, as well as a Wi-Fi module for data transfer, to determine chronicillness development. It was secured by RFID and recognised a range of chronic diseases. Electrode pads were used to detect the system's cardiovascular sickness. A gadget based on an Arduino Uno was used to detect hypothermia. The approach employed a smartphone appand a glucometer to detect diabetes mellitus. The costly device was capable of detecting cardiac issues. A smartphone, a laptop, and a VGA display were used as feedback devices. The technique identifies irregular heartbeats. The rate of breathing was monitored using a respirator and an accelerometer. The system, which made use of a number of gas sensors, gave the health monitoring capability.

Figure 2.6 : The implementaion of IoT and Health care Monitoring

In another previous research, [5] proposed paper Development of Monitoring and Health Service Information System to Support Smart Health on Android Platform. This research presents a concept for a health monitoring system named Mooble (Monitoring for a Better Life Experience), which would monitor patient health and aid in illness prevention.This research is organised into three sections: application design, application development, and application testing. The method was developed using the Rational Unified Process (RUP) framework. At the conclusion of this trial, patients will have access to a mobile application. The primary objective of this project proposal is to develop Mooble (Monitoringfor Better Life Experience), a health monitoring system that will track patient health and aidin illness prevention. To offer health personnel with patient health information through the Android platform. To assist patients in scheduling appointments with physicians. A mobileapplication based on Android has been created to monitor patient health status in order to provide health care to patients as quickly as possible and to enhance health services. Patient registration, login, insert health condition, view health condition chart, request appointment with doctor, view appointment schedule, view medical treatments, view health article, view message from doctor, make emergency calls, and logout feature are included in the developed android application.

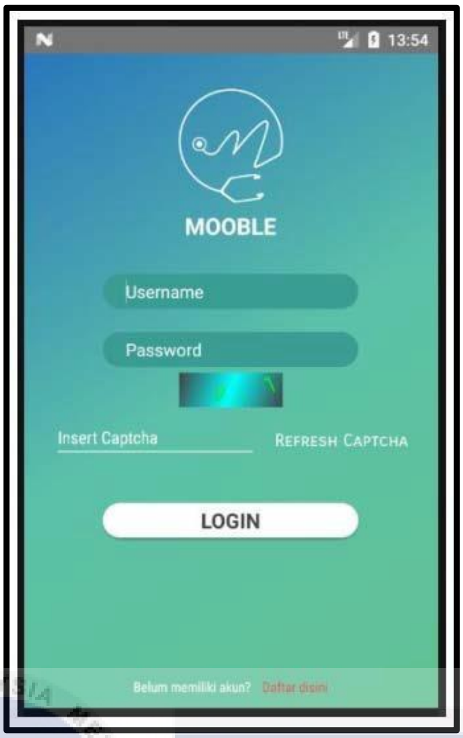


Figure 2.7 : The system's login interface

From a prior research, [6] proposed article Smart Patient Health Monitoring System Using Iot. The major purpose was to design a trustworthy patient management system basedon IoT that would allow healthcare professionals to monitor patients who were either hospitalised or at home using an integrated healthcare system based on IoT to ensure their safety. Sensors, a data collection unit, an Arduino-based microcontroller, and JAVA-based software were used to construct a wireless healthcare monitoring system that is mobile device-based and capable of providing real-time online information on a patient's physiological condition. The device continually monitors, displays, and records the patient's temperature, heart rate, and EEG data, which is then sent through the application to the doctor's mobile phone. As a result, a patient management system powered by the Internet of Things can accurately monitor a patient's health status and respond in time to save lives. The recommended patient monitoring system utilises an Arduino Uno to monitor the patient's vital signs. Once linked to the internet, the Arduino Uno is linked to a cloud storage system that serves as a server. The server then sends data to the target device automatically. As a result, the doctor may monitor the patient's health data in real time. The temperature, EEG, and heart rate of patients are monitored using appropriate sensors, and the data is presented on a computer screen using an Arduino Uno connected to a cloud computing system, as well as viewed remotely through an internet connection from anywhere in the globe.

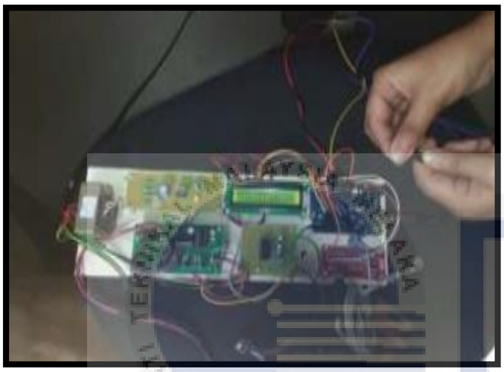

Figure 2.8 : The configuration of the system

Figure 2.9 : The output is shown on the mobile application device.



In another research, [7] proposed paper Development of Application based Health Monitoring System using GSM module. The primary objective of this project is to concentrate on health monitoring through the implementation of a wireless body area network. The suggested system is designed to monitor numerous patients concurrently, to provide health management flexibility, and to offer an intuitive user interface. Multiple sensors, such as a temperature sensor and a pulse sensor, will be used to detect the patient's temperature and heart rate. To construct a wireless body area network, sensors (Pulse sensor SEN11574, Temperature sensor DS18B20), a microcontroller (Arduino Uno), and a GSM modem are utilised. The gadget may be affixed to the patient's body, and the collected data will be regularly sent to the website. The suggested system is a low-cost wearable device equipped with an Android web application. The doctor monitors the patient from a distant location. The gadget will be used to collect data/vital signs from the patient, which will subsequently be sent to the database for storage. The doctor may then access the data throughan Android application.

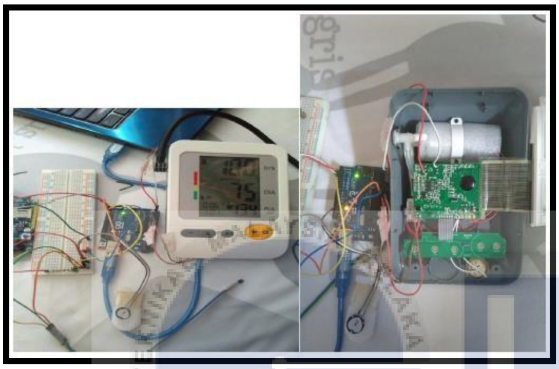

Figure 2.10 : The circuit connection with Arduino

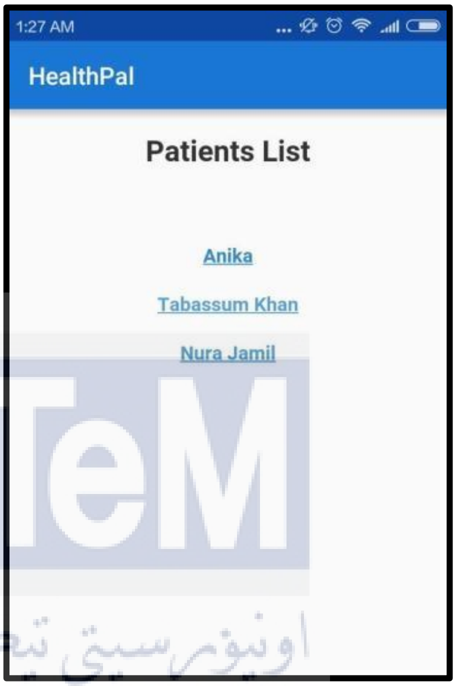


Figure 2.11 : Interface of patient list



Another research, [8] proposed paper Healthcare Monitoring System Using Wireless Body Area Network (WBAN) is being developed to construct a prototype of a healthcare monitoring system capable of detecting and wirelessly transmitting a human body's pulse rate and temperature to a host PC. The healthcare monitoring gadget will gather data and wirelessly transmit it in real time to a host computer, regardless of the distance between them. An Arduino Uno, a temperature sensor, a pulse oximeter, an Xbee Zigbee Module, and an Xbee Explorer form this system. A prototype was constructed using the Arduino UnoR3 platform and the ZigBee wireless framework. The accuracy of the prototype's sensors isdetermined by calculating the standard deviation of the collected data set. Following that, the reading's correctness is determined by computing the percentage inaccuracy of the meanvalue from the collection of data using established sensor readings as the genuine value. Thepulse sensor generates a standard deviation of 1.35 and a percentage error of 1.61 percent, while the temperature sensor generates a standard deviation of 0.74 and a percentage error of 0.75. The interface is designed to show the data sent wirelessly and to alert the user to anyaberrant readings of the patient's temperature or pulse rate. The pulse rate range is set at 60 beats per minute for the low range and 100 beats per minute for the high range. A human's typical pulse rate is between 60 to 100 beats per minute, and any figure outside of this rangeis deemed abnormal. Meanwhile, the average human body temperature is 37°C, with a rangeof 33°C to 39°C. For a person, 40°C is already regarded as high and signals that the patient's body is developing a fever. As a result, any deviation from this range is regarded as abnormal.



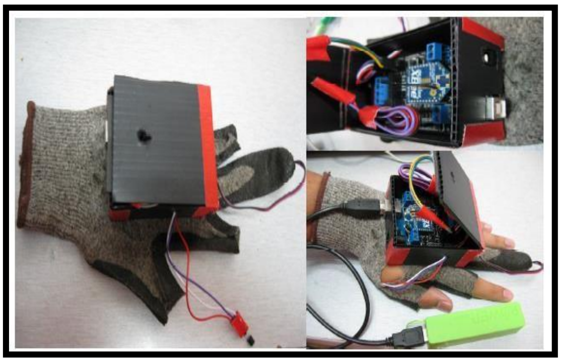

Figure 2.12 : The project prototype

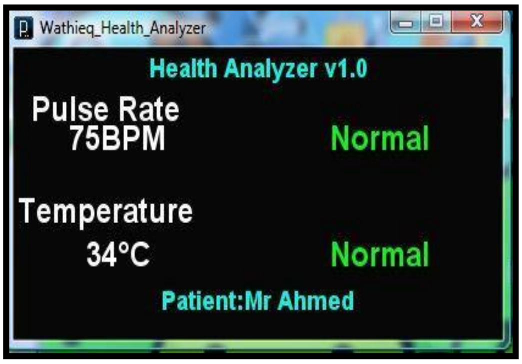


Figure 2.13 : The interface of Healthcare Monitoring System

Another study, [9] proposed a paper Healthcare Monitoring System For Elders. The primary objective was to offer seniors a secure and wearable healthcare monitoring system,to enable users to check the state of things in their homes remotely through a website, and to send an email message to the user's mobile phone when anything unpleasant occurs. Thehardware for this project will include an Arduino Micro board, an Arduino Mega board, an Arduino Ethernet Shield, and various sensors such as a DHT11 sensor (temperature and humidity sensor), an accelerometer, a radio frequency module, and a pulse sensor. The Arduino Micro board will be powered by a battery. The elderly will wear the Arduino Microboard, and the sensor will collect data about them and transmit it to a database via a radio frequency module. To communicate with the hardware, the Arduino IDE is used. The Arduino Mega board will be used in conjunction with the Arduino Ethernet Shield to createa database for storing sensor data. The user may connect to the database's server and check the elderly person's status using remote devices such as a smartphone, laptop, or tablet.



Figure 2.14 : The project prototype for measure body temperature and heart rate for measure body

Figure 2.15 : The output show in the mobile application

From the previous study, [10] suggested a paper Health Monitoring System using PulseOximeter with Remote Alert. The paper's major objective is to demonstrate how a remote Pulse Oximetry System may be used for health-monitoring purposes. The framework is founded on the concept that essential health signals, such as pulse, respiration, and blood pressure, may be gathered from a patient and sent to a processor, where they will be analysed, compared, and monitored in order to alert essential personnel in the case of an emergency. "Photoplethysmography" is a technique used in this research, and it is based on an arterial pulse causing a change in the intensity of light that passes through the tissue. By using lightintensity to compute oxygen saturation, this approach translates light intensity into a voltage signal. Oxygenated blood absorbs different frequencies in the Red and Infrared lightspectrum than deoxygenated blood. This is based on the two absorptions being compared with each other to get the oxygen saturation in the patient's blood. The pulse oximeter continuously and noninvasively monitors the oxygen saturation level in the patient.



Pulse oximetry delivers the data to the physicians' computers. Also, when an abnormal situation is detected, such as "SpO2 level fall, sensor detached, weak signal, and so on," thedevice issues an alert via software. The two primary sections of the system are made up of hardware and software components. These equations show how the AC and DC currents were calculated, respectively, from the infrared and red LEDs. This project has its hardwaredivided into two independent halves. The Oximeter circuit and the Arduino MEGA and GSMshield are on one side of the project, while the other circuitry is on the other. The programming for the software was done using the Arduino Compiler that was created to support and work with the Arduino. Additionally, the compiler supports almost all of the C++ instruction set. This effort led to the pulse oximeter being created, which uses Arduinoand a photoresistor to measure how much haemoglobin is absorbing different wavelengths of light and so is an indicator of SO2 saturation.

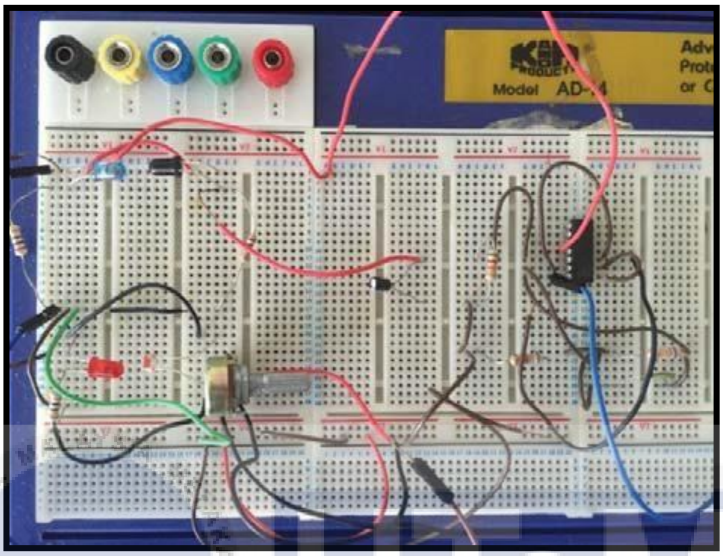

Figure 2.16 : Circuit of Pulse Oximeter

From the previous research, [11] presented a paper based on Design of Smart Pulse Oximeter using ATMEGA 328 Microcontroller. The primary purpose was to develop a noveltechnique of capturing energy to power a medical device and to ensure the gadget'ssustainability. Next, the purpose of this project is to prolong the life of the device, to be environmentally friendly, and to perform remote monitoring and alerts using Internet of Things (IoT) technological interactions. IoT technology enables real-time monitoring of a patient's blood oxygen level through monitoring devices. As a consequence, clinicians maycontinue to discover and monitor a patient's condition. Solar Pulse Oximeters may be used by physicians to continuously detect and monitor a patient's state. Eagle software and the Max30102 model were used to develop a Solar Pulse Oximeter with Remote Monitoring Network. This suggested technology allows patients to monitor their blood oxygen levels athome in order to guarantee that their heart rate remains normal under a variety of conditions.The proposed solar-powered pulse oximeter monitoring system includes a remote alert. Thesolar panel, pulse oximeter sensor, microcontroller (AtMega328), LCD display, and Tera Term display on the PC are all included in the proposed framework. Solar energy is utilisedto power the gadget. Because the energy source is renewable, the supply of energy is limitless. A solar panel is attached to the gadget in order to harvest energy from the sun. A pulse oximeter sensor is used to determine oxygen saturation based on the sent and receivedlight frequencies. The sensor test utilises a Light Emitting Diode and a picture identifier to determine the source of the light. A visible red spectrum (660nm) and an infrared spectrum are included in the pulse oximeter probe (940nm). The microcontroller is attached to the pulse oximeter sensor and processes the sensor's signal before displaying the data on the display and transmitting it to the monitoring device through IOT (HC-05 Bluetooth Module).The Arduino IDE will be used to programme the microcontroller with the code necessary to do data processing, display, and remote control. The suggested system is an eco-friendly technology, and it is more convenient for both the patient and the doctor to periodically check the patient's status. The pulse oximeter's reading is shown on the LCD display. The microcontroller, which has been programmed, will activate the pulse oximeter sensor and communicate with the LCD display. When the fingertip is put on the top of the pulse oximeter, the oxygen level is determined by the wavelengths of light that are sent and received. The measurement result is shown on the LCD as well as on Tera Term through Bluetooth. Users may record the readings provided by Tera Term in a log format and quickly send them to their doctor for monitoring purposes.

Figure 2.17 : Ambient Lighting for Indoors

Figure 2.18 : Outside (Direct Sunlight)


Figure 2.19 : The result is shown on the LCD



Another study, [12] proposed article Internet of Things in Healthcare Monitoring to Enhance Acquisition Performance of Respiratory Disorder Sensors. The system's objective is to optimise application development by obtaining variables in real time and with minimalenergy usage. The suggested model is verified using oxygen saturation, heart rate, and body temperature measurements and monitoring in patients with respiratory diseases. This was accomplished by data collection optimization, which was incorporated into a secure architecture using the Message Queuing Telemetry Transport protocol. A cloud architecturewas created with connectivity to low-cost and open-source devices that link to the network of sensors and actuators. The primary acquisition module is comprised of a high-efficiency wireless personal area network (WPAN) made of low-power sensors and a discontinuous control system for clinical parameters. The Wireless Personal Area Network module is comprised of two sensors that are linked to a custom-developed e-health card. The first is adigital body temperature thermometer.A CMS50DL Pulse Oximeter serves as the second sensor. A synchronisation protocol for e-health communication was created for this device,with a focus on SpO2. E-health cards provide users with access to biometric and medical apps that include body tracking. E-health cards enable the use of nine different sensors, including heart rate, blood oxygen saturation (SpO2), air flow (breathing), body temperature, electrocardiogram (ECG), glucometer, galvanic skin reaction (GSR) sweating, blood pressure (sphygmomanometer), and patient position sensor (accelerometer). This enables effective sensor use, resulting in minimal energy usage during data transmission. Heart rateand oxygen saturation were measured in this study using both body temperature thermometers and pulse oximeters. The transmission module is comprised of programmableArduino Uno and Raspberry Pi Model 3B (Rpi3B) cards. The Internet of Things (IoT) communication and control protocol utilised was Message Queuing Telemetry Transport (MQTT). This system makes advantage of the Internet of Things. Due to the small size, low energy consumption, and compatibility of this kind of monitoring system, it is feasible to manage parameters in the surroundings of patients. Additionally, it enables the examination of past data and behaviour, since it utilises cloud computing and storage capacity. Apart from that, due to the analysis and monitoring, these systems may create alarms, control signals, or new diagnoses for patients in a variety of contexts and locations.

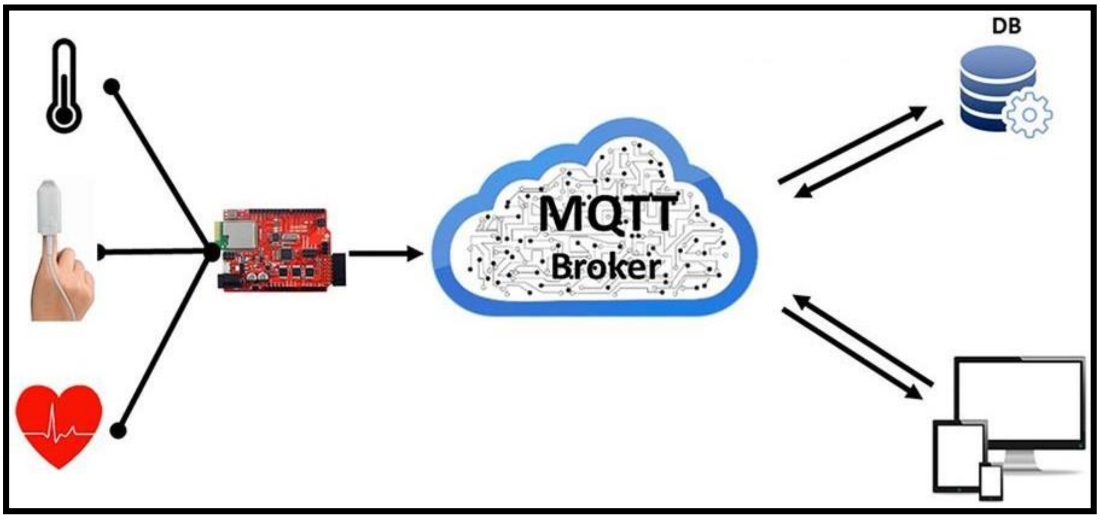


Figure 2.20 : Connectivity of sensors to client-side processes

From the previous study, [13] presented paper Wireless Sensor Platform for Pulse Oximetry. This project's major purpose was to provide a wireless platform for MEMS devices. The pulse oximeter is composed of five components which is an LED driving circuit, a photodiode and current-to-voltage converter, filtering and amplification, a low-passfilter, and a microcontroller with a Bluetooth module. The pulse oximeter was created to demonstrate the feasibility of this wireless platform. Meanwhile, a microcontroller and Bluetooth module were used to transfer data from the sensor to the smartphone, and an Android application was developed to interface with the Bluetooth module in order to receive, design, and store data. Following the development of sensor and Android apps, thedevice's pulse rate and oxygen saturation were compared to those acquired using a commercial pulse oximeter in order to determine the device's accuracy. With an average error percentage of 2.86 percent and 1.08 percent, respectively, the sensor was able to accurately detect heart rate and oxygen saturation.

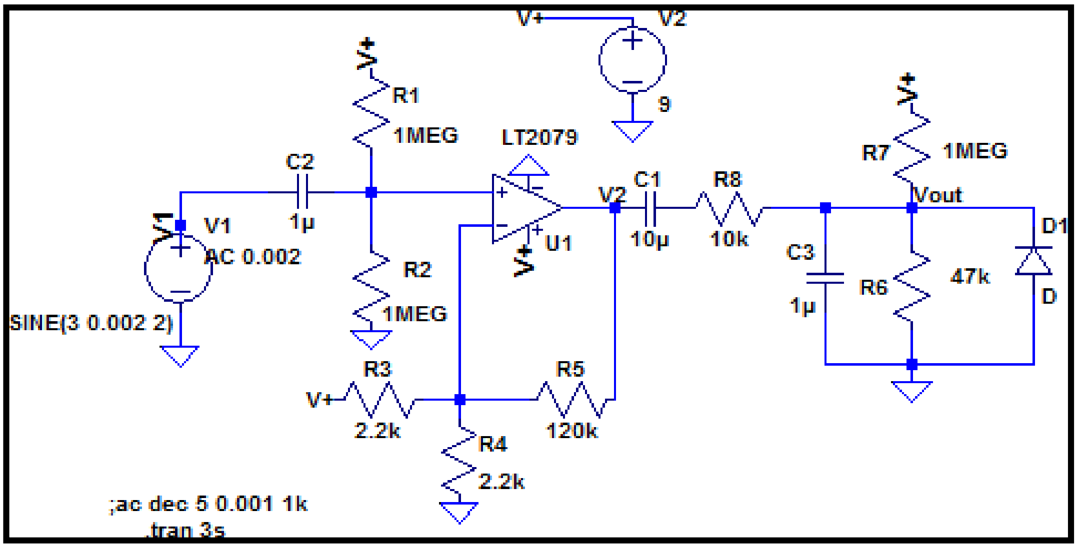


Figure 2.21 : Diagram of a simulated circuit system

From the previous research, [14] proposed paper Design of Mobile Healthcare Monitoring System Using IoT Technology and Cloud Computing. The goal of this project is to create a remote bio signal monitoring device that is low-force, portable, and easy to wear using Internet of Things technology. Four health factors are continuously tracked in real time in this article, which are body temperature, ECG signal, heart rate, and SPO2. These health indicators are tracked in hospitals' CCU (Coronary Care Unit) rooms. The Arduino Uno and the NodeMCU are the microcontrollers utilised in this project for the hardware. TheMAX30102 heart rate sensor was utilised in this project. It is a non-invasive optical instrument that detects heartbeats and peripheral capillary oxygen saturation (Spo2). Additionally, a "AD8232 Single-Lead ECG sensor" was utilised in this project as an ECG sensor, while an LM35 sensor was employed to monitor the body's temperature. For the software portion of this project, the Blynk cloud server was selected as the cloud server. Theheart BPM, Spo2, and body temperature sensor readings are communicated to the NodeMCU through a JSON document in this article. JSON is a structured text-based data transmission format. Its organised architecture assists in ensuring that the received information is accurate. The data is in the right format and does not overlap with other data.The ECG sensor, on the other hand, is directly attached to the NodeMCU. After data is received from this device, a function verifies that all data has been received. Following that,the received data is reviewed to ensure that it is in the correct format. As a result, the data issent to the Blynk cloud server.




Figure 2.22 : Continuous monitoring of a person's health status through the Blynk cloud server.

From the previous research, [15] proposed paper Design and Development of Iot Based Pulse Oximeter. The primary objective of this project is to develop an accessible and mobilehealth monitoring system via the use of Internet connectivity. Even faraway physicians mayaccess the health status of such individuals through web page results. The Internet of Thingshardware circuit has been activated. This pulseoximeter is comprised of a number of components, including power regulators, transformers, a microcontroller, an ESP8266module, and a pulse oximeter sensor. The spo2 sensor detects and transmits oxygen levels to the ESP8266 module, which then transmits the data to the Thingspeak web host server, where it is stored in the clouds. This technology enables doctors, patients, and insurance customers to see the oxygen saturation level of a patient in the client's palm.

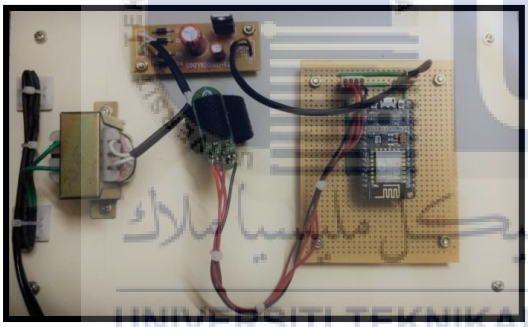

Figure 2.23 : The hardware circuitry of an Internet-of-Things-enabled

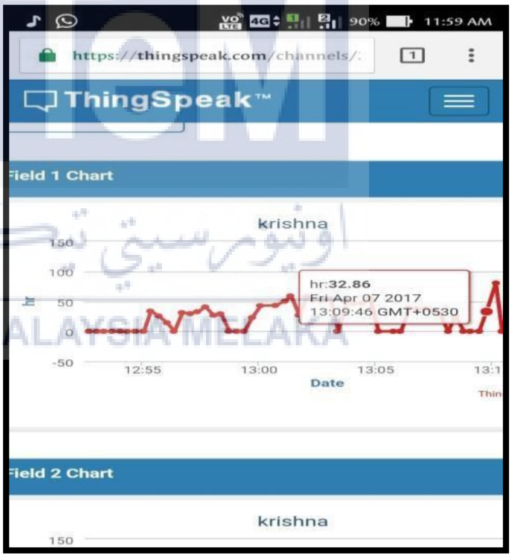


Figure 2.24 : Output on the ThinkSpeak mobile phone application device used by the client

Table 2.1 : Comparison of the previous article

| No | Author | Title | Year | Component | Method | Pros | Cons |
|---|---|---|---|---|---|---|---|
| 1 | Selvanayakam, A.<br>Varishnee, A. C.<br>Kalaivani, M.<br>Ranjithkumar, G. | Internet of Things in Healthcare Monitoring to Enhance Acquisition Performance of Respiratory Disorder Sensors | 2020 | 1. Arduino Uno as a microcontroller of the system.<br>2. Raspberry Pi Model 3B as a host for numerous sensor interfaces connected to the Internet.<br>3. Pulse Oximeter CMS50DL as a sensor for oxygen saturation.<br>4. LM35 Body as an temperature sensor. | - The proposed model is validated by measuring and monitoring oxygen saturation, heart rate, and body temperature in individuals with respiratory disorders. This was done by optimising data gathering and integrating it into a secure architecture using the Message Queuing Telemetry Transport protocol. | - Recent research on accelerating Internet connections using the Message Queuing Telemetry Transport (MQTT) communication protocol are based on low bandwidth use, light data weight, and secure setup. This system makes advantage of the Internet of Things. Due to the small size, low energy consumption, and compatibility of this kind of monitoring system, it is feasible to manage parameters in the surroundings of patients. | - The use of authentication, permissions, and encrypted communication through the MQTT and TLS Handshake protocols resulted in a lengthened connection time.<br>- Additionally, there is a dearth of action with this MQTT. Due to messaging's binary structure, issues may develop without knowledge of its encoding. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | Khan, Tabassum Chakrabarty, Amitabha | Development of Application based Health Monitoring System using GSM module | 2016 | 1. Arduino Uno as a microcontroller of the system.<br>2. DS18B20 as a temperature sensor.<br>3. GSM module (SIM900A) as a communication module between the microcontroller.<br>4. Pulse Sensor (SEN11574) as a sensor for heart rate measurement. | - The project will concentrate on health monitoring through the construction of a wireless body area network, which will be accomplished via the development of a website on an Android application that will use a GSM module as an intermediary between the microcontroller and the GSM module. | - Develop a technology that enables more convenient real-time communication between physicians and patients.<br><br>- The proposed solution is a low-cost wearable device accompanied by an Android web application. The gadgets utilised are not prohibitively expensive. | - The device cannot be used for many purposes. The designed gadget is limited to a single patient at a time.<br><br>- The system device is not suitable for a wide range of applications.A single patient may use the created device at a time. |

## 2.3 Summary

This chapter discussed the conclusions of a survey done on past projects, as well as research completed by other specialists, all of which pertain to the creation of intelligent health monitoring systems that will be implemented utilising the Internet of Things and Arduino technology. According to the findings of the survey, the kind of hardware and techniques employed in past study will serve as a reference and enhancement for the system to be created.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

This chapter will discuss all the details of the whole system from the beginning untilthe end and the flow of steps involved in the development of this Smart Health Monitoring System utilizing the Internet of Things (Iot) and Arduino. Other than that, this chapter also discusses all the details about all the equipment used in this project. In this chapter, we alsoimplemented a project methodology or the way this project will develop.

## 3.2 Methodology

This thesis presents a new and integrated analytical approach to constructing an intelligent health monitoring system. The core of the approach used in this project is centered on the Internet of things (IoT). This approach was chosen to develop an analytical model tomonitor and analyze the rate of health levels in real time using an application that can displayand store health data over time and this application can be viewed directly on the smartphone.

### 3.2.1 Block Diagram of Project System

Figure 3.1 shows the smart health monitoring system's inputs include a temperature sensor and a pulse oximeter sensor, which detects all of the health indicators that must be monitored. The inputs then communicate the measured parameters to the Arduino UNO, which interacts with the data and then exports it to the outputs. LCD and wireless modules serve as outputs. All parameter data is shown in the smartphone application, ThingSpeak Apps, which enables users to monitor their health status based on the gathered data.

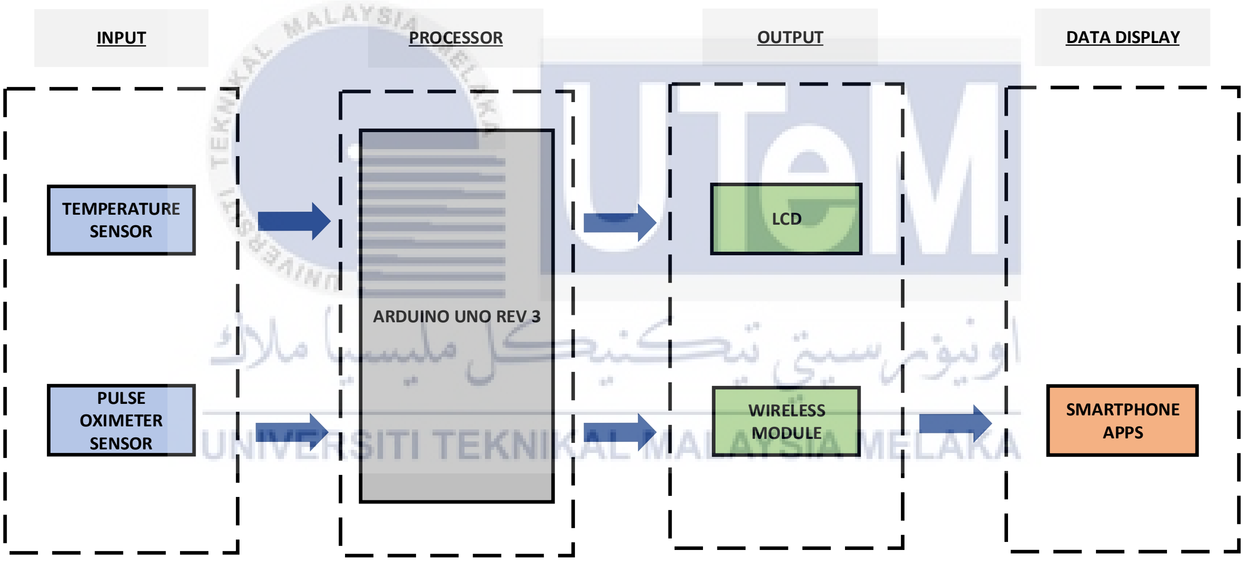



Figure 3.1 : Smart Health Monitoring System Block Diagram

### 3.2.2 Project Flowchart

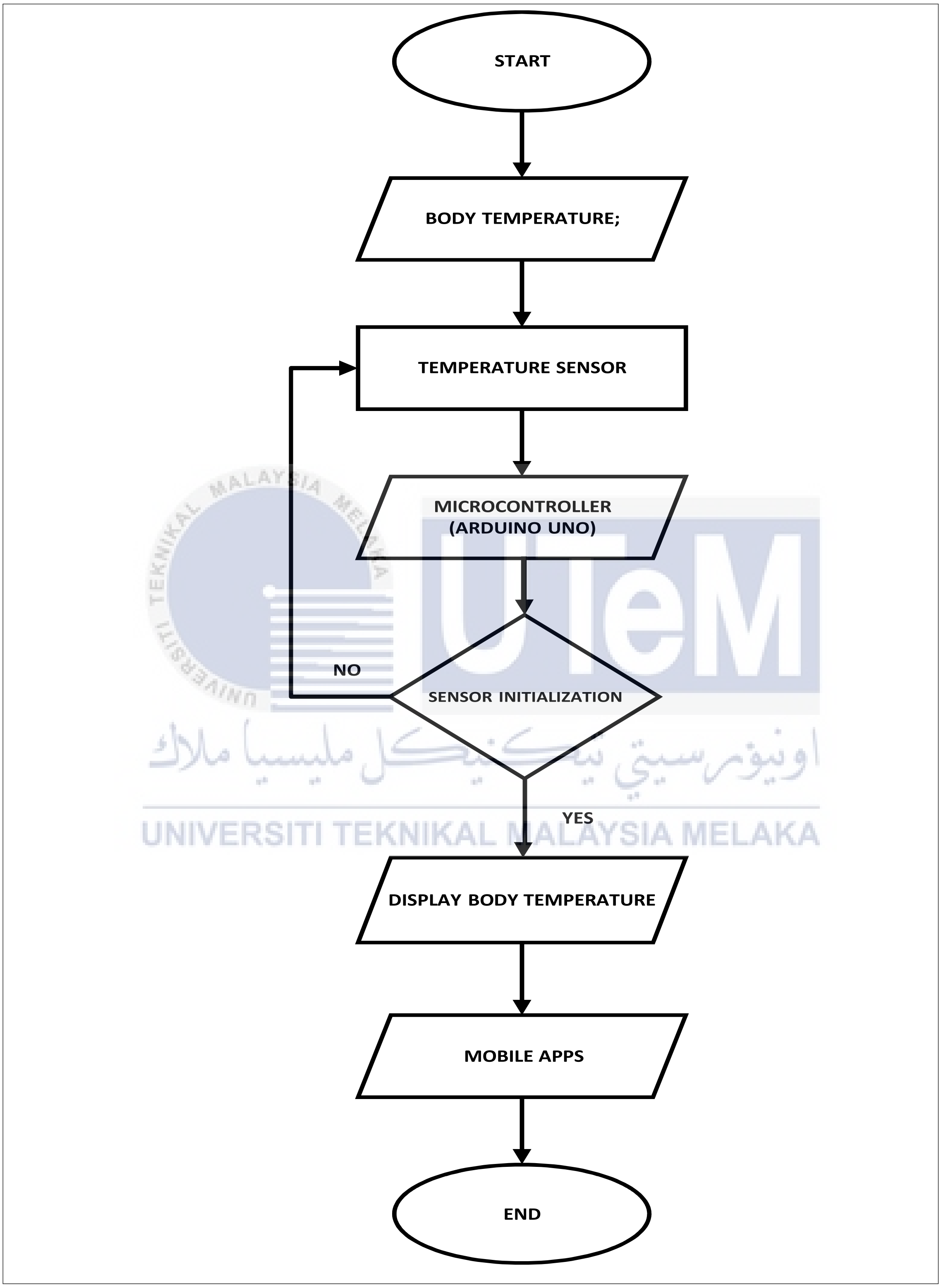


Figure 3.2 : Flowchart of Body Temperature System

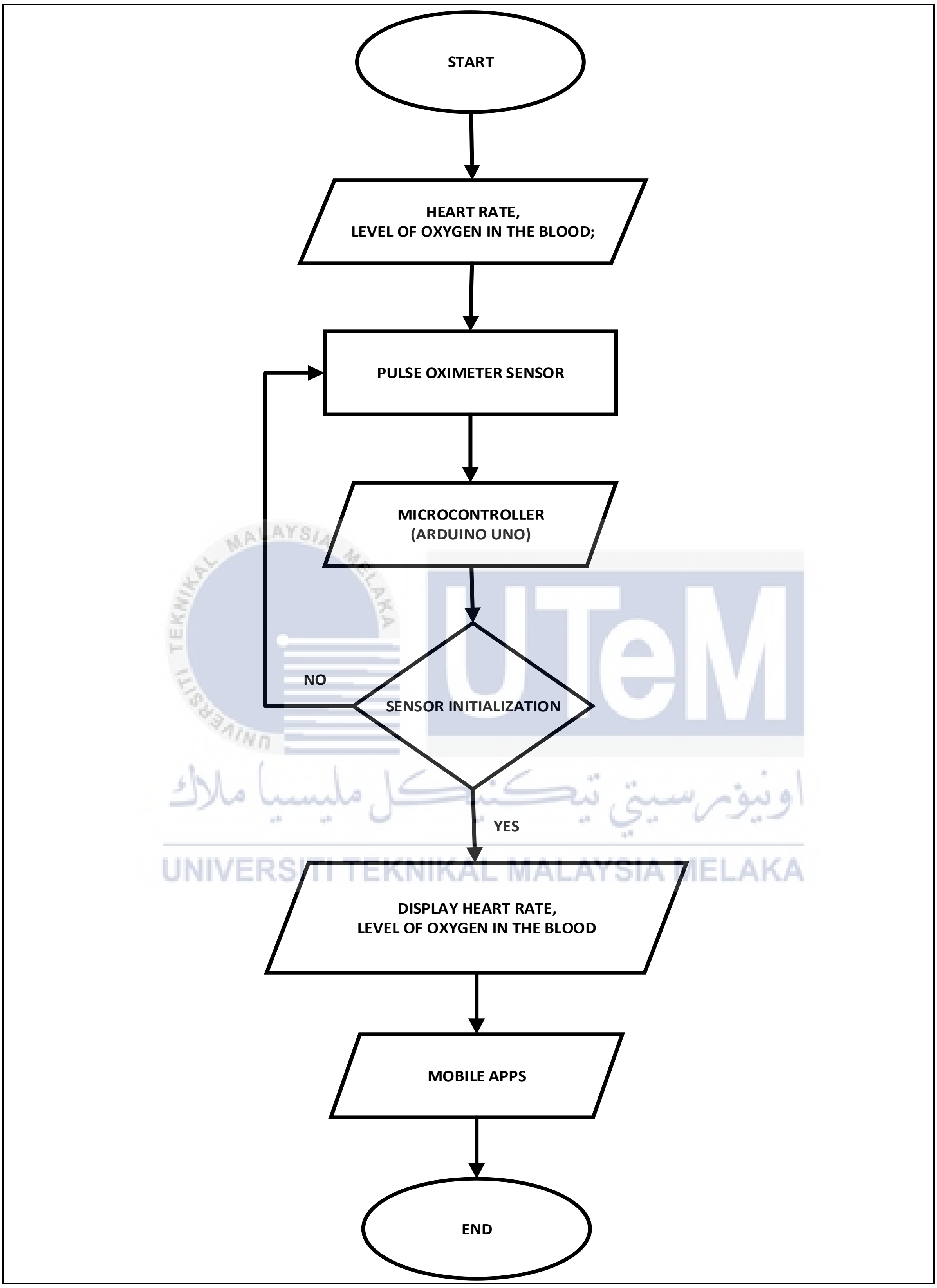




Figure 3.3 : Flowchart of Heart Rate and Oxygen Level System

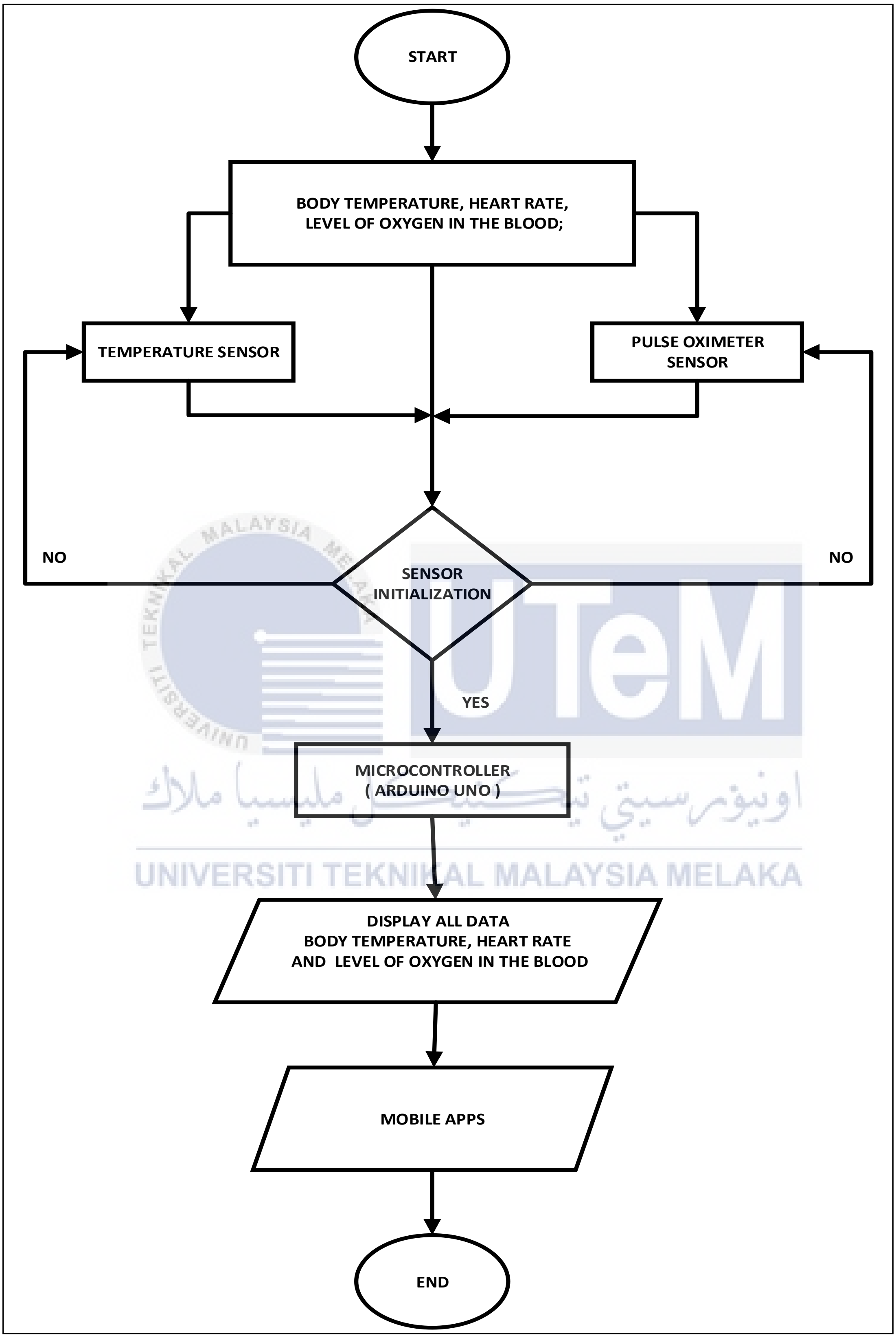



Figure 3.4 : Overall Flowchart of Project System

### 3.2.3 Explanation of The Process Flowchart

For this Smart Health Monitoring System, based on Figure 3.4, the flowchart displays the whole process of constructing a project system, which includes both hardware and software required to operate the system. The system is initiated when two distinct input signals initialise the body temperature through an LM35, the heart rate and the blood oxygen saturation level through a Max30100 pulse oximeter sensor. Following successful initialization of the input sensor, both input sensors are sent to the microcontroller, which is an Arduino Uno Rev 3. After transferring the input data to the microcontroller (Arduino Uno Rev 3), the Arduino Uno rev 3 will transmit the body temperature, heart rate, and oxygen saturation level in the blood to the LCD as output, whichwill be shown on the LCD screen as an output display. The data is sent in real time to the WiFi module and then to the mobile application (www.thingspeak.com) for analysis and display. Simultaneous real-time updates of the processed and visible data represent the state of the human body's temperature, heart rate, and blood oxygen saturation level.

### 3.3 Hardware Requirement

#### 3.3.1 Arduino UNO Rev 3

Figure 3.5 : Arduino UNO Rev 3

The Arduino Uno is a board based on the ATmega328 microprocessor. It has a resonator operating at 16 MHz, a USB connection, a power connector, an ICSP header, and a reset button. It features a 16 MHz resonator, a USB interface, a power connector, an ICSP header, and a reset button, in addition to 20 digital input/output pins (six of which may be used as PWM outputs and six of which may be used as analogue inputs).It includes everything necessary to get started with a microcontroller; just connect it toa computer through USB or power it with an AC-to-DC converter or battery. It includes everything necessary to get started with a microcontroller; just connect it to a computer through USB or power it with an AC-to-DC converter or battery.

The Arduino UNO serves as the system's brain in this project. It connects all of the input and output components together. It is capable of reading inputs such as a pulse sensor, an LM-35 temperature sensor, and a biosensor and converting them to outputs such as an LCD display and the ThingSpeak platform on a mobile phone.

### 3.3.2 LM-35 Temperature Sensor

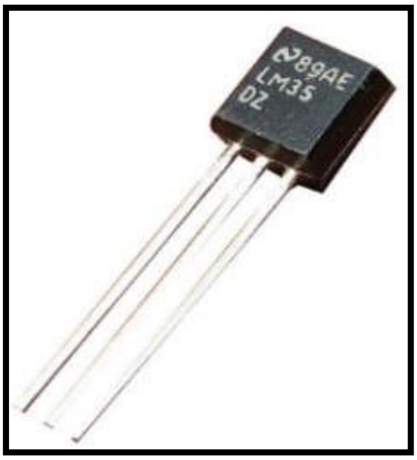


Figure 3.6 : LM35 Temperature sensor

Temperature sensors of the LM35 series are precision integrated circuit devices that produce a voltage proportional to the temperature in degrees Celsius. The output voltage may be easily converted to a temperature value in degrees Celsius. Unlike linear temperature sensors calibrated in Kelvin, the LM35 device does not need a significant constant voltage to be subtracted from the output to achieve practical Centigrade scaling. The LM35 requires no external calibration or trimming to attain average accuracies of 14°C at room temperature and 34°C throughout a temperature range of 55°C to 150°C. Additionally, the cover protects it from self-heating.



The LM35 sensor is used to determine the body temperature in this project. The sensor is positioned against the body and detects the internal temperature of the subject.It is calibrated linearly in degrees Celsius. It has a limited self-heating ability. Additionally, it eliminates the need for external calibration.

### 3.3.3 MAX30100 Pulse Oximeter


Figure 3.7 : MAX30100 Pulse Oximeter

A pulse oximeter is used to determine the oxygen saturation of a patient's blood noninvasively. Light is transmitted through a transparent, pulsating artery bed, which is oftena fingertip or earlobe, using a red and infrared light source, photo detectors, and a probe. During a pulse oximetry reading, a small clamp-like device is placed on a finger, earlobe, ortoe. The quantity of oxygen in the finger is determined by the passage of small beams of light through the blood. This is accomplished by detecting differences in the absorption of light by oxygenated and deoxygenated blood.



Table 3.1: The MAX30100 Oximeter Module's Pin Configuration

| Type of Pin | Feature of the Pin |
|---|---|
| VIN | Input Voltage |
| SCL | Serial Clock – I2C |
| SDA | Serial Data – I2C |
| INT | Low-interrupt active mode |
| IRD | Connection Point for Infrared LED Cathode and LED Driver (Leave as a free-floating component in the circuit.) |
| RD | Connection Point for Red LED Cathode and LED Driver (Leave floating in the circuit) |
| GND | Pin Ground |

### 3.3.4 LCD 20X4 Display

Figure 3.8 : LCD 20X4 Display

A liquid-crystal display (LCD) is a type of flat panel display, electronic visual display, or video display that use liquid crystals to regulate light. 20x4 refers to the fact that each of the LCD's four rows will show 20 characters, for a total of 80 characters shown at any one moment. Our LCD has a total of 16 pins. Each pin is described as follows.

Table 3.2: Description of the Level Pin Number Symbol

| Pin Number | Description |
|---|---|
| Pin 1 (VSS 0V) | Ground |
| Pin 2 (VDD 5V) | Supply voltage for logic |
| Pin 3 VO (Variable) | Operating voltage for LCD |
| Pin 4 (RS) | Data/Instruction code |
| Pin 5 (R/W) | Read/Write select signal |
| Pin 6 (E) | Chip enable signal |
| Pin 7 ~ Pin 14 (DB0 ~ DB7) | Data bus line |
| Pin 15 (A 5V) | Power supply for B/L + |
| Pin 16 ( K 0V) | Power supply for B/L - |

### 3.3.5 NodeMCU V3 ESP8266

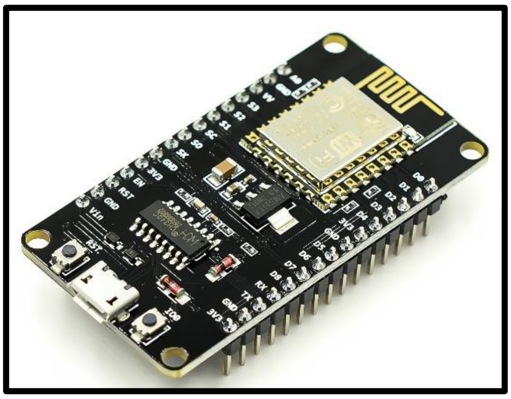

Figure 3.9 : NodeMCU V3 ESP8266 (Wifi Module)

Based on the widely used ESP8266-12E WiFi module, NodeMCU is an open source development board and firmware. It allows you to programme the ESP8266 WiFi module using the Arduino IDE or the simple and powerful LUA programming language. It combines the functions of a WIFI access point and a microcontroller-based station. The ESP8266 is the foundation of NodeMCU, an open source platform that makes it possible to link devices and send data through the Wi-Fi protocol. This is a microcontroller that can fulfil many of the project's requirements by delivering some of the most important microcontroller functions, such as GPIO, PWM, ADC, and more.

### 3.3.6 Jumper

Figure 3.10 : Jumper Wire

A jumper is used internally or in conjunction with other equipment or components toconnect the components of a breadboard or other prototype or test circuit together. togetherwithout soldering.

### 3.3.7 Breadboard

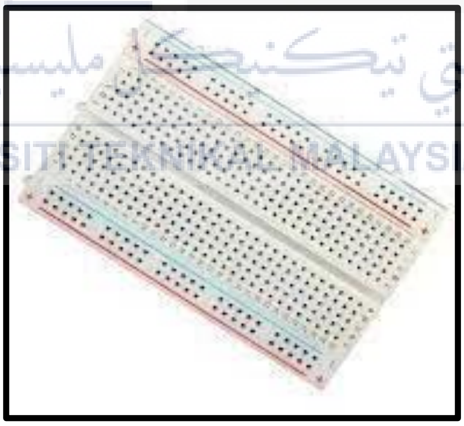

Figure 3.11 : Breadboard

A breadboard is a solderless circuit board that is used to quickly prototype devices and test circuit ideas. The majority of electrical components in electronic circuits may be linked by putting their leads or terminals into the holes and wiring them together.

## 3.4 Software Requirement

### 3.4.1 Integrated Development Environment (Arduino IDE)

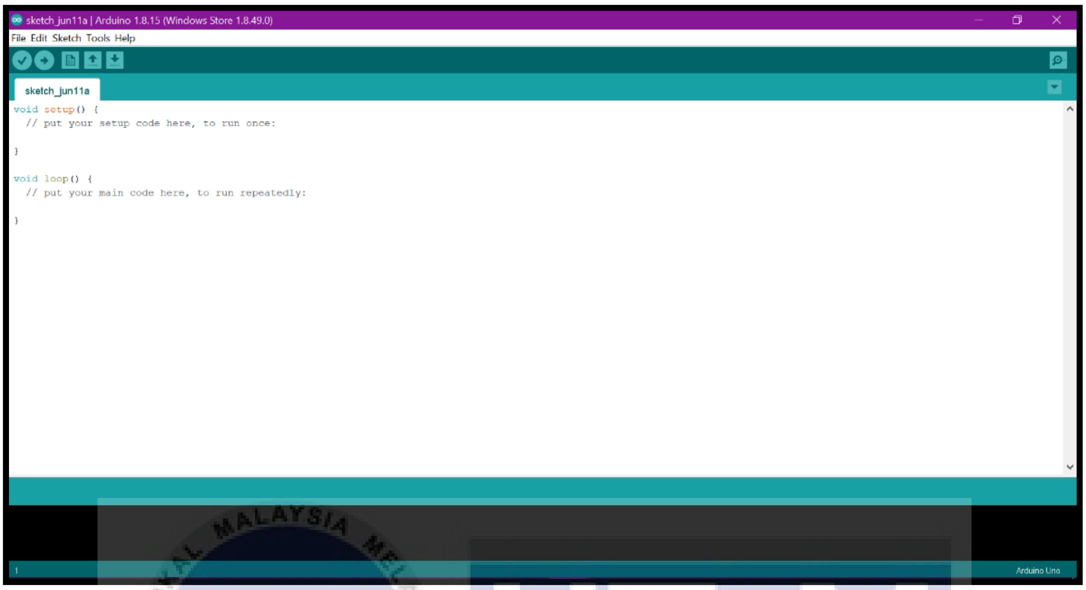


Figure 3.12 : Arduino IDE

This project utilises a separate Arduino IDE (Integrated Development Environment) for software development. The Arduino IDE is a free and open-source software development environment for creating and compiling code for Arduino Modules. It is the official Arduino programme that simplifies the learning process for non-technical individuals.

### 3.4.2 Proteus Design Suite

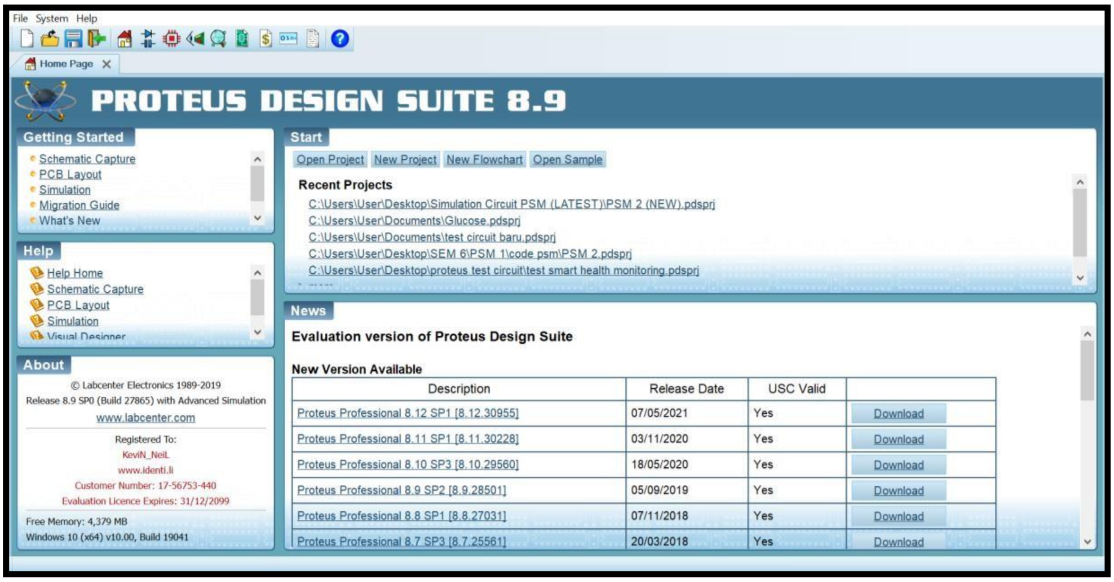


Figure 3.13 : Proteus Design Suite 8.9 Version

Proteus Design Suite 8.9 is used to develop drawings and validate the traceability of project systems. The Proteus Design Suite is a collection of proprietary software tools used mostly for electrical design automation. Electronic design professionals and technicians create electronic schematics and print them for the production of printed circuit boards usingsoftware.

### 3.4.3 Internet of Things Platform (ThinkSpeak)

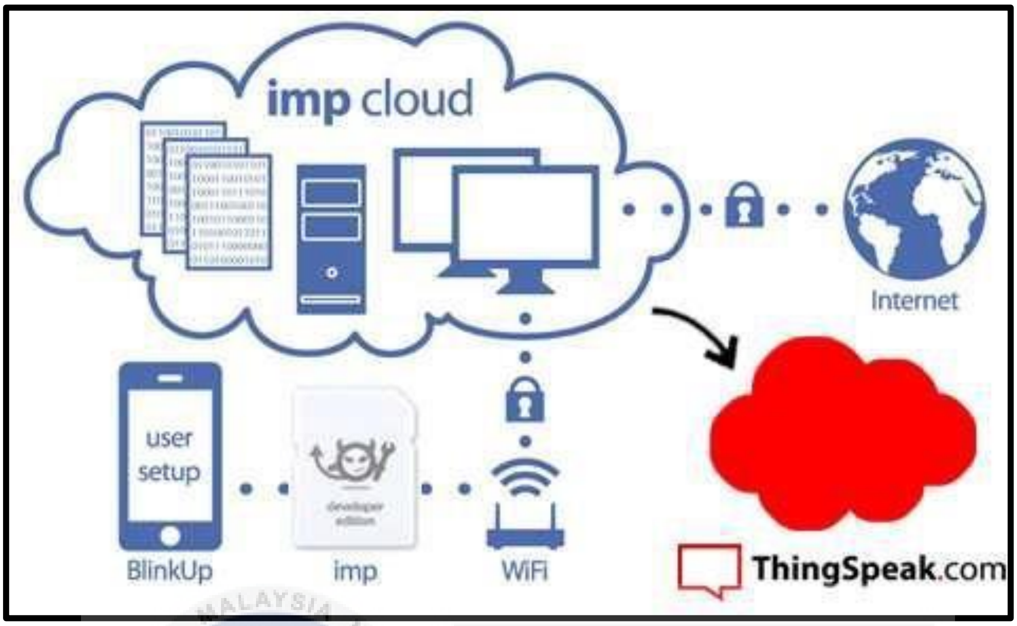


Figure 3.14: Overview of ThingSpeak



ThingSpeak is an open source Internet of Things platform that enables the storage and retrieval of data from HTTP-enabled devices. ThingSpeak enables users to construct sensor recording applications, location tracking applications, and social networks for thingsthat continuously update their state. The ThingSpeak channels are used to store data. Through the ThingSpeak channel, data may be uploaded via the web or transferred from devices. The application is capable of manipulating and visualising data in addition to initiating actions.

## 3.5 Summary

This chapter describes the approach for developing a smart health monitoring system. The technique presented is primarily concerned with the execution and application of this project. This study was done and finished in accordance with the stated goals. To accomplishand finish this project, this device application must be built and implemented. This prototypeproject consists of hardware and software components. Apart from that, the process was planned using a simple flowchart, as seen in the image, with a concise and intelligible structure.

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Introduction

This section contains information on the findings and analysis of the building of a Smart Health Monitoring System using the Internet of Things (Iot) and Arduino. Then, using body temperature and heart rate detection sensors in combination with the Arduino Uno Rev 3, fundamental human health is measured and monitored. Body temperature, heart rate, and oxygen saturation levels in the blood can all be tracked immediately on the LCD while also being watched in real time through the ThingSpeak application on smartphones.

## 4.2 Results and Analysis

### 4.2.1 Results



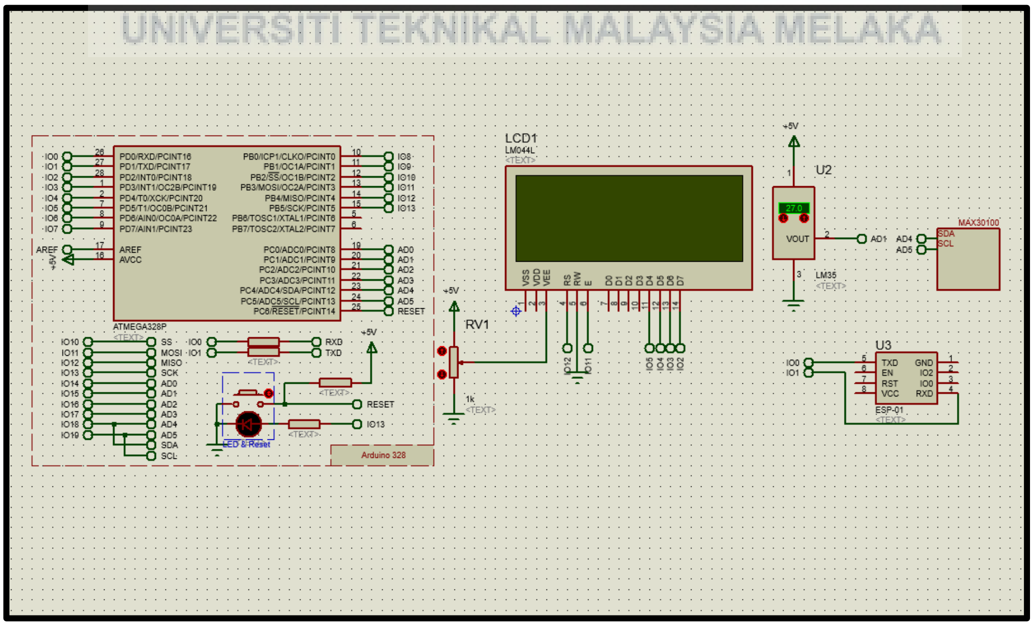


Figure 4.1 : The architecture of a body temperature, heart rate, and blood’s oxygen level system is shown schematically.

**Explanation:**

This is a preliminary result of the project based on the schematic circuit installed using Proteus software as shown in Figure 4.1. The schematic design in Figure 4.1 illustrates the components required to construct a smart health monitoring system. Arduino is the project's brain. The Arduino Uno Rev 3 microprocessor acts as the microprocessor in this system that interface with all component input and output. These components include an LM35 and MAX30100 Pulse Oximeter sensor. The LM35 sensor is used for body temperature detection and a MAX30100 Pulse Oximeter sensor for heart rate and blood's oxygen level detection. It is located on the MAX30100 Pulse Oximeter board in the schematic as the gauge's initialization point. The body temperature, heart rate, and blood oxygen level are sensed when the fingertips are put on the MAX30100 Pulse Oximeter sensor board. The chip receives the collected data. The heart rate, blood oxygen saturation level, and temperature of the human body are all detected and shown on an LCD screen.

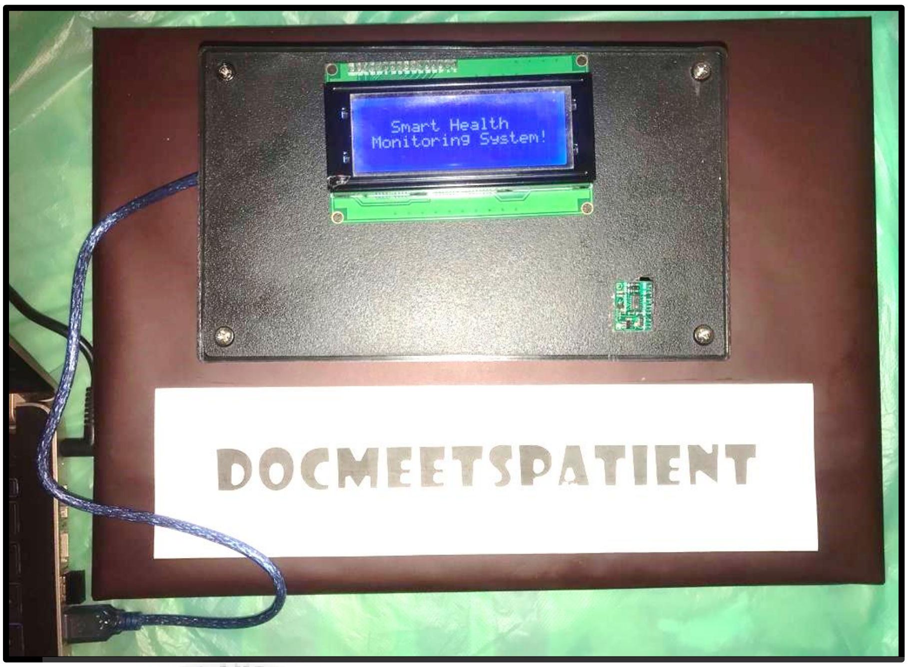


Figure 4.2: Shows the Prototype of Smart Health Monitoring System (DocMeetsPatient)

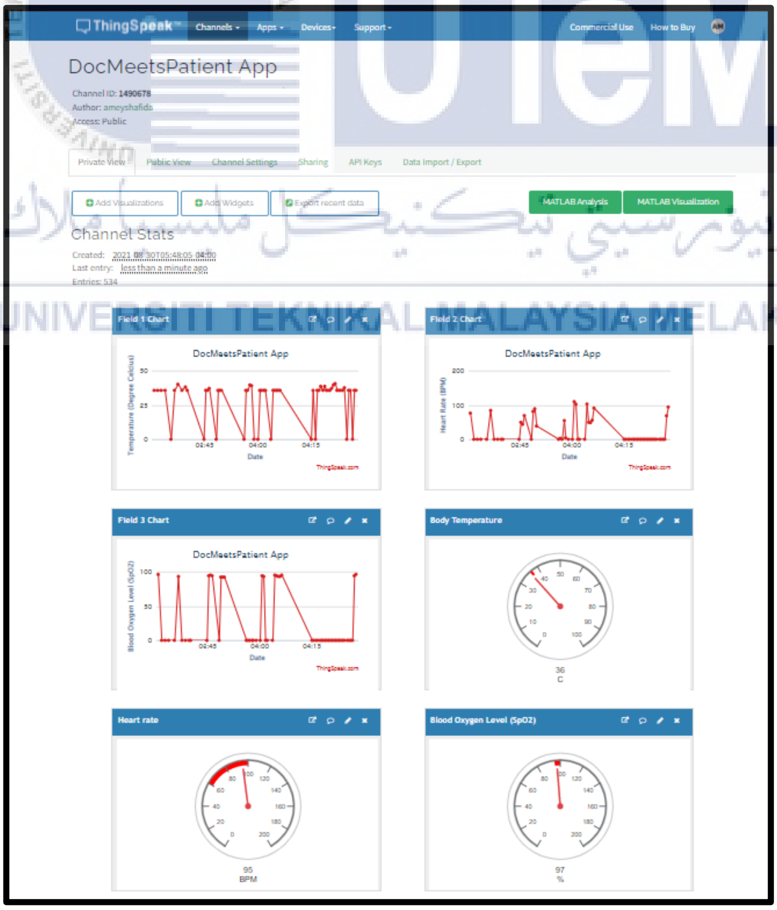


Figure 4.3: Shows the successful development of the Internet of Things (IoT) by using the ThinkSpeak application.

Smart health monitoring with Internet of Things (IoT) and Arduino has been successfully implemented using an Atmega328 microcontroller that uses Arduino Uno Rev 3. This Arduino serves as the primary controller for the project, allowing it to communicate with all of the gear involved. It is capable of measuring and monitoring fundamental human health by using the LM35 sensor, which functions as a body temperature sensor, and the MAX30100 sensor, which functions as an oximeter sensor, which measures heart rate and detects oxygen levels in the blood. This sensor is equipped with two LEDs, one of which emits red light and the other of which emits infrared light. Only infrared light is required to determine the pulse rate. Both red and infrared light are utilised to determine the oxygen saturation level of the blood. Additionally, the Arduino gathers real-time health data via a MAX30100 sensor that measures heart rate, oxygen levels in the blood and a temperature sensor that is linked to the Arduino.

Apart from that, the Arduino is also responsible for collecting, displaying, and transmitting data to the ESP8266, an IoT module, in this project. The common ESP8266 Internet of Things module is linked to the Arduino through a Universal Uniform Transmitter(UART) Receiver, which is responsible for connecting the circuit to the internet and transmitting health data to an IoT (ThingSpeak) server. This ThingSpeak application is in charge of storing and monitoring medical data. Furthermore, this circuit is capable of not only transmitting health data to a server but also displaying real-time data on a 20x4 LCD display. This is advantageous for healthcare workers monitoring patients on-site. Health monitoring is performed non-invasively with this method by simply putting a finger on the sensor and detecting it straight through the skin. Simply by putting a finger on the input sensor, the user will be able to immediately measure and monitor their heart rate, body temperature, and oxygen saturation levels in their blood.

### 4.2.2 Analysis


Figure 4.4: Shows a comparison of body temperature, pulse rate, and blood's oxygen levels that have been measured using a real device with readings measured using a designed Smart Health Monitoring System

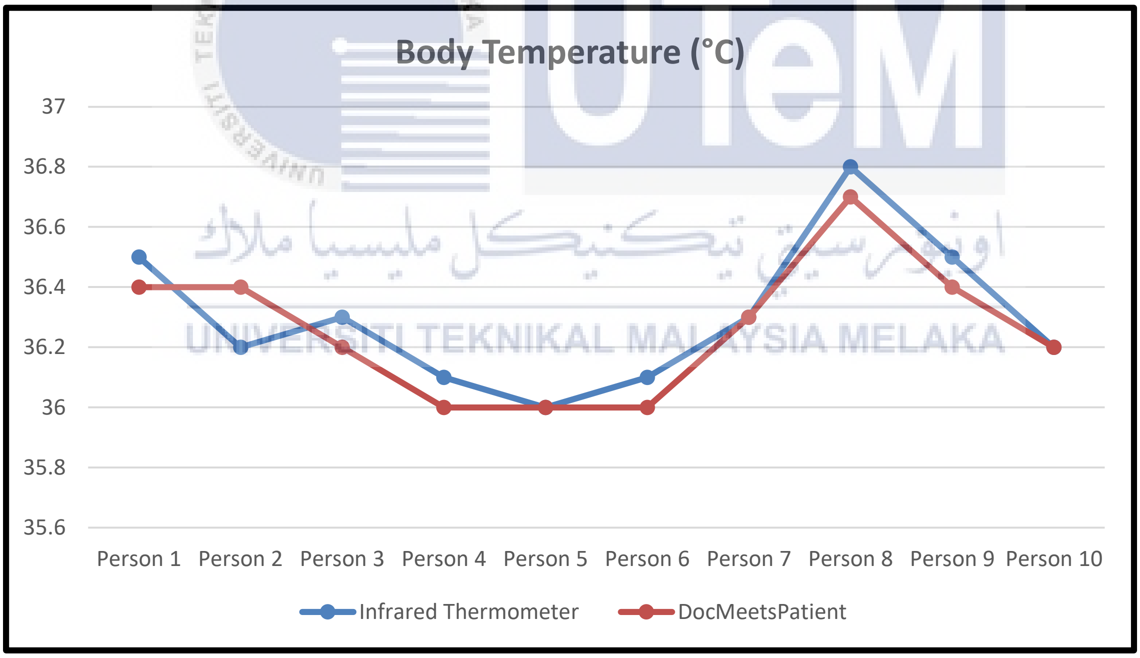




Figure 4.5: Results of 10 trial sample readings for Body Temperature

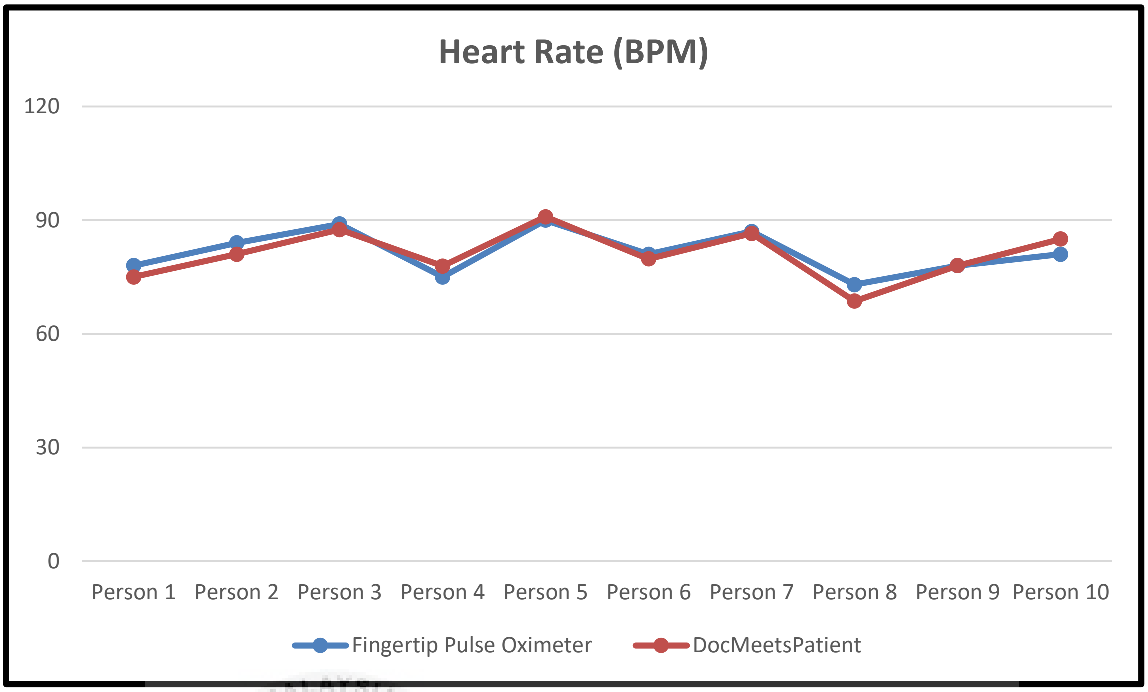


Figure 4.6: Results of 10 trial sample readings for Heart Rate



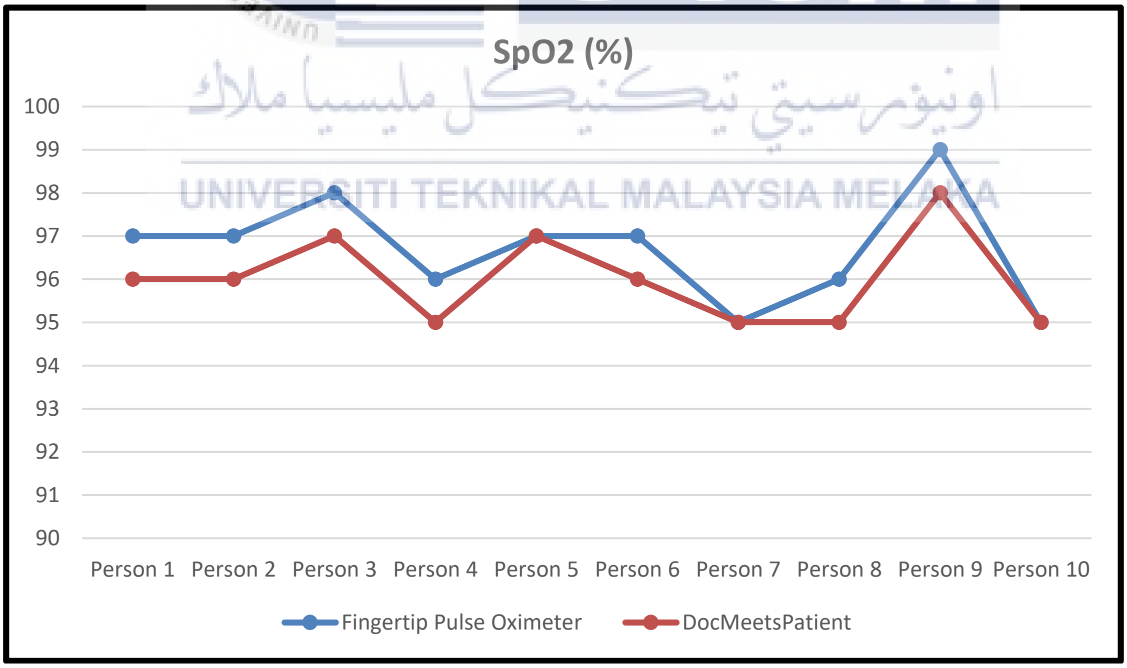


Figure 4.7: Results of 10 trial sample readings for Blood Oxygen Level

The Smart Health Monitoring System uses the LM35 body temperature sensor, and the MAX30100 pulse oximeter sensor to detect the heart rate and oxygen levels in the blood. From these experiments, 10 reading values were taken from 10 different people to test the level of accuracy of the sensor readings used. Once the testing is carried out, the readings from all these sensors show values that are approximately the same as the purchased measuring instrument (the actual device). This indicates that the design of a reliable smart health monitoring system has been successfully developed. However, if the finger is not properly placed on the MAX30100 Pulse Oximeter, an erroneous reading may be generated. For pulse rate, only infrared light is needed. Both red light and infrared light are used to measure oxygen levels in the blood. The amount of ambient light hitting the sensor can have an effect on the final value. While using the MAX30100, keep the finger still to avoid an inaccurate reading. Never press the MAX30100 sensor too hard when using it. This impairs blood flow, resulting in inaccurate readings. To avoid this, insert the finger gently and keep it still, as this will ensure the most accurate reading



## 4.3 Summary

This chapter gives a case study to illustrate many of the components that contributed significantly to the project's completion. The first component is the hardware, which consists of four primary input components, which are temperature sensors to detect body temperature, MAX30100 Pulse Oximteter sensor to measure heart rate, and to monitor blood’s oxygen levels. The Arduino Uno Rev 3 serves as the system's microcontroller and outputs through an LCD display. These components are meticulously prepared and linked to guarantee that the device is constructed according to the schematic designs and that it operates flawlessly when all of the hardware is put in the right box.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

This project is presented to present the construction of a smart health monitoring system by applying the use of Internet of Things (IoT) technology and an Arduino microcontroller. The suggested techniques and approaches operate perfectly and effectively while needing little hardware. The system is suggested to measure a variety of characteristics utilising sensors such as the LM35 temperature sensor, and the MAX30100 Pulse Oximeter sensor. These sensors used to detect data on the body temperature, heart rate, and blood oxygen level. By using the IoT platform, health data collected by the three input sensors can be seen on the LCD display and in real time through the ThinkSpeak platform. ThinkSpeak is one example of an IoT platform that will simplify the process of health monitoring on occasion. This developed system provides many facilities for medical staff and families to perform the process of health measurement or monitoring, whether at home or in the hospital.

From the results obtained, the objectives of this project have finally been achieved, where the main objectives are to design a health monitoring system using the Internet of Things (IoT). By referring to the project results, this project system was successfully implemented when the data temperature readings, heart rate, and blood oxygen levels could be detected. The collected data is shown on the LCD screen and the data reading is shown on the Internet of Things (IoT) platform, ThinkSpeak. It displays the same data reading and from this statement, another objective is also achieved, which is to analyse the measurement of the health monitoring system based on body temperature, heart rate, and level of oxygen in the blood. When the fingertips are placed on the MAX30100 Pulse Oximeter sensor board, the body temperature, heart rate, and blood oxygen level are detected. The chip receives the collected data. Therefore, health analysis based on body temperature, heart rate, and oxygen level in the blood can be carried out based on data stored in the Internet of Things system that is implemented in the ThinkSpeak application.

Furthermore, ten reading values were collected from ten separate participants to test the accuracy of the sensor readings employed in these trials. After testing, the readings from all of these sensors reveal values that are nearly identical to the purchased measuring instrument (actual device). This demonstrates that the creation of a dependable smart health monitoring system was successful implemented

Last but not least, the objective of verifying that the transmission of sensor data to the host computer is performed in real time is also successfully achieved when the body temperature, heart rate, and blood oxygen level are felt when the fingertips are placed on the Pulse Oximeter MAX30100 sensor board. The chip receives the collected data. At the same time, heart rate, blood oxygen saturation level, and human body temperature are all detected and displayed on the LCD screen. Simultaneously, the data readings are also shown on the Internet of Things (IoT) platform ThinkSpeak. Overall, this system demonstrated a high level of accuracy, with 99.9 percent accuracy for measuring body temperature, 99.4 percent accuracy for measuring heart rate, and 99.9 percent accuracy for measuring blood oxygen levels. Therefore, it clearly shows that this developed system provides many facilities for medical staff and families to perform the process of health measurement or monitoring, whether at home or in the hospital.

## 5.2 Future Works

Based on the project's results, some enhancements can be made to improve the effectiveness of this project, such as enhancing the project's system with emergency warnings. Examples include determining whether or not a patient's health status is normal or not through the analysis of a scanned medical signal. If the analysis results are abnormal, the embedded device sends a signal directly to the medical facility via the patient's phone. In this instance, the doctor will send the patient medical advice in order to save his or her life.

Besides, further diversify the functions of the project system by adding more health detection sensors such as blood pressure sensors, blood glucose level detectors, and electromyography (EMG) tests which that can identify nerve malfunction, muscle dysfunction, or issues with nerve-to-muscle signal transmission.

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# APPENDICES

## Appendix A Data Sheet for Arduino UNO.

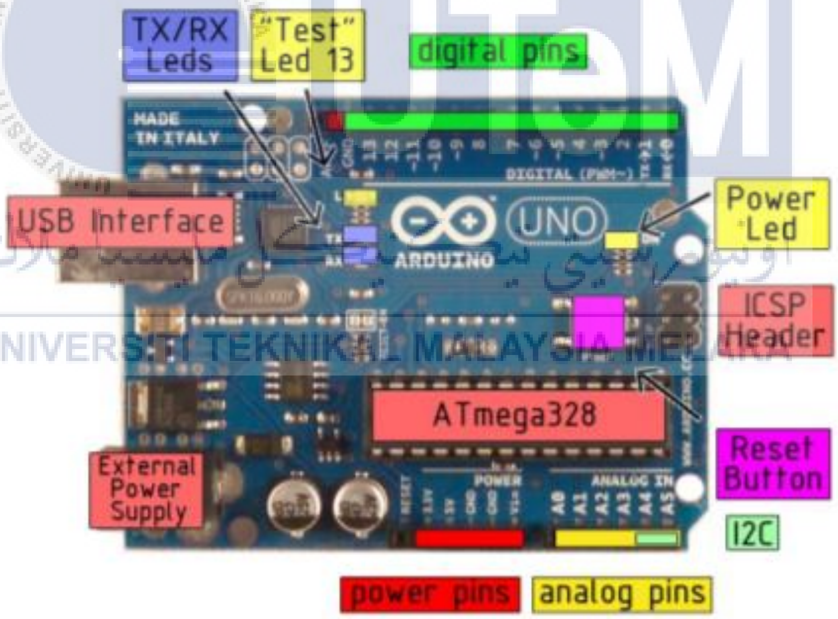
### Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

#### Summary

| | |
|---|---|
| Microcontroller | ATmega328 |
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limits) | 6-20V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| Analog Input Pins | 6 |
| DC Current per I/O Pin | 40 mA |
| DC Current for 3.3V Pin | 50 mA |
| Flash Memory | 32 KB of which 0.5 KB used by bootloader |
| SRAM | 2 KB |
| EEPROM | 1 KB |
| Clock Speed | 16 MHz |

#### the board

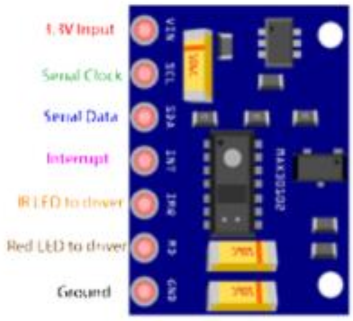


**Appendix B Data Sheet for MAX30100 Pulse Oximeter Sensor.**

## MAX30100 - Heart Rate Oxygen Pulse Sensor

20 May 2021 - 0 Comments


MAX30100 Heart Rate Oxygen Pulse Sensor




MAX30100 Pinout



### Description of MAX30100

MAX30100 is a multipurpose sensor used for multiple applications. It is a **heart rate monitoring** sensor along with a **pulse oximeter**. The sensor comprises two Light Emitting Diodes, a photodetector, and a series of low noise signal processing devices to detect heart rate and to perform pulse oximetry.



### Features of MAX03100

Here are some of the features and specifications of the MAX03100 Heart Rate Oxygen pulse sensor.

1. Operating Voltage - 1.8V to 3.3V
2. Input Current - 20mA
3. Integrated Ambient Light Cancellation
4. High Sample Rate Capability
5. Fast Data Output Capability

**Appendix C Source Code for Arduino Circuit**
**(combination of LM35 body temperature sensor, MAX30100 heart rate and blood oxygen level sensor)**

```
// include the library code:

#include <LiquidCrystal.h>

#include <Wire.h>

#include "MAX30100_PulseOximeter.h"

#include <SoftwareSerial.h>

#define REPORTING_PERIOD_MS     1000


// PulseOximeter is the higher level interface to the sensor

// it offers:

//  * beat detection reporting

//  * heart rate calculation

//  * SpO2 (oxidation level) calculation

PulseOximeter pox;


uint32_t tsLastReport = 0;


// initialize the library by associating any needed LCD interface pin

// with the arduino pin number it is connected to

const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

unsigned long previousMillis = 0;

const long interval = 1000;

unsigned long previousMillis_1 = 0;
```

```
const long interval_1 = 1000;

const int lm35_pin = A1;  /* LM35 O/P pin */

int heart_rate_esp;

int spo2_esp;

float temp_esp;

float calibration_value = +2.00;


// Callback (registered below) fired when a pulse is detected

void onBeatDetected()

{

   Serial.println("Beat!");

}


void setup() {

 Serial.begin(115200);


  // set up the LCD's number of columns and rows:

  lcd.begin(20, 4);

  lcd.setCursor(3,1);

  lcd.print("Running...");

  delay(3000);

  lcd.clear();

  // Print a message to the LCD.

  lcd.setCursor(3,1);

  lcd.print("Smart Health");
```

```
lcd.setCursor(1,2);

lcd.print("Monitoring System!");

delay(3000);

lcd.clear();

lcd.setCursor(2,1);

lcd.print("Initializing");

lcd.setCursor(2,2);

lcd.print("Pulse Oximeter...");

delay(4000);

lcd.clear();

lcd.setCursor(2,1);

lcd.print("Getting Data...");

delay(3000);

lcd.clear();

lcd.setCursor(2,1);

lcd.print("Please wait...");

delay(3000);

lcd.clear();


Serial.print("Smart Health Monitoring System!\n");

Serial.println("Initializing pulse oximeter..\n\n");

  // Initialize the PulseOximeter instance

  // Failures are generally due to an improper I2C wiring, missing power supply

  // or wrong target chip

  if (!pox.begin()) {
```

```
        Serial.println("FAILED");
        for(;;);

    } else {
        Serial.println("SUCCESS\n");
    }

    // The default current for the IR LED is 50mA and it could be changed
    //   by uncommenting the following line. Check MAX30100_Registers.h for
all the
    //   available options.
    // pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

    // Register a callback for the beat detection
    pox.setOnBeatDetectedCallback(onBeatDetected);
}


void loop() {
  // set the cursor to column 0, line 1
  // (note: line 1 is the second row, since counting begins with 0):

  // print the number of seconds since reset:
  //lcd.print(millis() / 1000);
```

```
unsigned long currentMillis = millis();
if (currentMillis - previousMillis >= interval) {
  // save the last time you blinked the LED
  previousMillis = currentMillis;
  int temp_adc_val;
  float temp_val;
  temp_adc_val = analogRead(lm35_pin);  /* Read Temperature */
  temp_val = (temp_adc_val * 5.00); /* Convert adc value to equivalent voltage
*/
  temp_val = (temp_val/10); /* LM35 gives output of 10mv/°C */
  temp_val = temp_val + calibration_value;
  temp_esp = temp_val;
  Serial.print("\nTemp : ");
  Serial.print(temp_val);
  Serial.print(" Degree Celsius\n");
  }
  // Make sure to call update as fast as possible
  pox.update();

  // Asynchronously dump heart rate and oxidation levels to the serial
  // For both, a value of 0 means "invalid"
  if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
    Serial.print("BPM  : ");
    heart_rate_esp =pox.getHeartRate();
    Serial.print(pox.getHeartRate());
```

```
        Serial.print("\nSpO2 : ");

        spo2_esp = pox.getSpO2();

        Serial.print(pox.getSpO2());

        Serial.println("%");

         tsLastReport = millis();

    }


unsigned long currentMillis_1 = millis();

if (currentMillis_1 - previousMillis_1 >= interval_1) {

 Serial.println();

 Serial.println();

 Serial.print("@");

 Serial.print(temp_esp);

 Serial.print("~");

 Serial.print(heart_rate_esp);

 Serial.print("*");

 Serial.print(spo2_esp);

 Serial.println("#");

 Serial.println();


  // temp

  lcd.clear();

  lcd.setCursor(0, 0);

  lcd.print("Temp (C) : ");

  lcd.setCursor(10, 0);
```

```
  lcd.print(temp_esp);
  lcd.setCursor(16,0);
  lcd.print("    ");

  // heart rate/BPM
  lcd.setCursor(0, 1);
  lcd.print("BPM  : ");
  lcd.setCursor(6, 1);
  lcd.print(pox.getHeartRate());

  // spO2
  lcd.setCursor(0, 2);
  lcd.print("SpO2 : ");
  lcd.setCursor(6, 2);
  lcd.print(spo2_esp);
  lcd.print("%");
previousMillis_1 = millis();
//lcd.clear();
}
}
```

**Appendix D Source Code for ThinkSpeak**
**(Implementation of Internet of Things in Project)**

```
#include <ESP8266WiFi.h>

#include <WiFiClient.h>

#include <ESP8266WebServer.h>

#include <ESP8266mDNS.h>

#include <SPI.h>

float Data_1;

float Data_2;

float Data_3;


const char* ssid = "Cari_Apa_Tu?";//

const char* password = "Amey993518";

//WiFiClient client;

char server[] = "api.thingspeak.com";   //eg: 192.168.0.222


WiFiClient client;

void setup()

{

 Serial.begin(115200);

  delay(10);

  // Connect to WiFi network

  Serial.println();

  Serial.println();

  Serial.print("Connecting to ");
```

```
  Serial.println(ssid);


  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {

    delay(500);

    Serial.print(".");

  }

  Serial.println("");

  Serial.println("WiFi connected");


  // Start the server

//  server.begin();

  Serial.println("Server started");

  Serial.print(WiFi.localIP());

  delay(1000);

  Serial.println("connecting...");

 }

void loop()

{

  while(Serial.available())

  {

    char Data = Serial.read();


    if (Data == '@')

    {
```

```
    Data_1 = Serial.parseFloat();
    //delay(5);
    if (Serial.read() == '~')
    {
     Data_2 = Serial.parseFloat();
     //delay(5);
     if (Serial.read() == '*')
     {
      Data_3 = Serial.parseFloat();
      //delay(5);
      if (Serial.read() == '#')
      {
       Serial.print(".");
       //process();
      }
     }
    }
   }
  }
  Sending_To_thingspeak();
  delay(30000); // interval
}
void Sending_To_thingspeak()   //CONNECTING WITH MYSQL
{
 if (client.connect(server, 80)) {
```

```
    Serial.println("connected");
    // Make a HTTP request:
    Serial.print("GET /update?api_key=L9GFSIPKUR2V6LC6&field1=0");
    client.print("GET /update?api_key=L9GFSIPKUR2V6LC6&field1=0");
    Serial.println(Data_1);
    client.print(Data_1);
    client.print("&field2=");
    Serial.println("&field2=");
    client.print(Data_2);
    Serial.println(Data_2);
    client.print("&field3=");
    Serial.println("&field3=");
    client.print(Data_3);
    Serial.println(Data_3);
    client.print(" ");     //SPACE BEFORE HTTP/1.1
    client.print("HTTP/1.1");
    client.println();
    client.println("Host: api.thingspeak.com");
    client.println("Connection: close");
    client.println();
  } else {
    // if you didn't get a connection to the server:
    Serial.println("connection failed");
  }
}
```