FACULTY OF ELECTRICAL AND ELECTRONIC

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DEVELOPMENT OF SMART WEATHER MONITORING SYSTEM USING IOT

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DEVELOPMENT OF SMART WEATHER MONITORING SYSTEM USING IOT

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A project report submitted
in partial fulfilment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled "Development of Smart Home: Fire Safety System Using IoT" 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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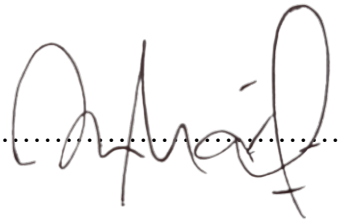
Date : 23 / 1 / 2023 ……...

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 Computer Engineering Technology (Computer System) with Honours.

Signature : 

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Date : .....

ABSTRACT

In this moment, weather is something that we cannot predict. Meteorologists' weather forecasts are dependent on data, which might be inaccurate at times. There are also hard to find a cheap, portable and easy to use weather monitoring system that allowed the user to monitor the weather at their home, office and remote area. The weather detection project was created to address this issue by allowing users to see the current weather conditions in their home. Because it will be immediately connected to the database that will hold the data for the user, this project will notify the user via their smartphones. The objectives of this project are to design a weather monitoring system using analog sensor, microcontroller, to develop a database system to store and monitor the collected data and to validate the developed project prototype for weather monitoring. This system is using ESP8266 as the main component, Light Dependent Resistor (LDR), DHT 22, Rain sensor and Ultraviolet level sensor as their sensors. This system is link to the website that display the real-time data and a database to store all the data. The benefits of this system are users can be more aware about the present weather with this system, and in some situations, users can analyse weather patterns based on data collected through the system. Overall, this project is designed to assist the general public, particularly meteorologists, in being more aware of current weather conditions and for research purposes.

ABSTRAK

Pada masa ini, cuaca adalah sesuatu yang tidak dapat kita jangkakan. Ramalan cuaca pakar meteorologi bergantung pada data, yang mungkin tidak tepat pada masa-masa tertentu. Terdapat juga sukar untuk mencari sistem pemantauan cuaca yang murah, mudah alih dan mudah digunakan yang membolehkan pengguna memantau cuaca di rumah, pejabat dan kawasan terpencil mereka. Projek pengesanan cuaca telah dibuat untuk menangani isu ini dengan membenarkan pengguna melihat keadaan cuaca semasa di rumah mereka. Kerana ia akan segera disambungkan ke pangkalan data yang akan menyimpan data untuk pengguna, projek ini akan memberitahu pengguna melalui telefon pintar mereka. Objektif projek ini adalah untuk mereka bentuk sistem pemantauan cuaca menggunakan sensor analog,m mikropengawal, untuk membangunkan sistem pangkalan data untuk menyimpan dan memantau data yang dikumpul dan untuk mengesahkan prototaip projek yang dibangunkan untuk pemantauan cuaca. Sistem ini menggunakan ESP8266 sebagai komponen utama, Perintang Peka Cahaya, DHT 22, Sensor Hujan dan Sensor Tahap Keamatan Ultraviolet sebagai sensornya. Sistem ini adalah pautan ke laman web yang memaparkan data masa nyata dan pangkalan data untuk menyimpan semua data. Faedah sistem ini ialah pengguna boleh lebih mengetahui tentang cuaca semasa dengan sistem ini, dan dalam beberapa situasi, pengguna boleh menganalisis corak cuaca berdasarkan data yang dikumpul melalui sistem. Secara keseluruhannya, projek ini direka bentuk untuk membantu orang awam, khususnya ahli meteorologi, supaya lebih mengetahui keadaan cuaca semasa dan untuk tujuan penyelidikan.

ACKNOWLEDGMENT

First and foremost, Alhamdulillah. Second, I'd like to thank my parents for always believing in and supporting me in every part of this project. Thank you for your valuable guidance, wise comments, and patience throughout this endeavour, En Noor Mohd Ariff Bin Brahin. My heartfelt gratitude goes to my parents and family members for their love and prayers during my studies. An honourable mention also goes to my friends and housemate with the matrix numbers (B081910066), (B081910068), (B081910239), (B081910238), (B081910181), and (B081910016) for their motivation and understanding during my studying adventure till the establishment of the project development. Finally, I would like to thank everyone of the Faculty of Technologies employees, colleagues and classmates, Faculty members, and those individuals who are not included here for their cooperation and assistance.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Introduction

The background of the project, problem statement, objectives, scope of the project and the project outline will be discussed in this chapter.

1.2 Research Background

Weather is defined as the state of the atmosphere on a given day and refers to quick variations in heat, moisture, and air movement [1]. Weather is the result of processes attempting to balance differences in the distribution of net solar radiant energy. In other words, weather is the weather conditions at any given time [2]. The weather is typically described as fine, fair, foggy, cloudy, wet, sunny, or windy. Because of the state's proximity to the equator, Malaysia has only three types of weather: sunny, cloudy, and rainy [3]. However, the weather in Malaysia can be harsh at times, for example, the weather can be extremely hot, and there will normally be a flood around the east coast of the peninsular Malaysia at the end of the year.

But, weather is something that we cannot predict. Meteorologists' weather forecasts are dependent on data, which might be inaccurate at times. Based on the recent floods that occurred in the Klang Valley, the weather is extremely unpredictable. Thousands of families have lost their valuable possessions as a result of the flood, which pushed them to save themselves before their possessions [4]. Because the incident occurred during business hours, most of them were not at home and did not have time to save anything valuable from their home.

The weather detection project was created to address this issue by allowing users to see the current weather conditions in their home. Because it will be immediately connected to the database that will hold the data for the user, this project will notify the user via their smartphones. If the rain is severe and continues for an extended period of time, there is a high risk of flash flooding and the user can take urgent action by rushing home to save their family and valuables before anything horrible happens. Furthermore, this project also can be used to monitored the weather condition of a state.

1.3 Problems statement

This Weather Detector is a project build to show and alert people for the condition of their climate changes in their area whether their house nor office. Lately, the climate change was very extreme nowadays. It is undeniable that there has been a lot of rain in our country. As the result was there were big flood occurred [4]. As the water level rises, it floods the normally dry areas around it. There is a lot of interest in hydrology when it comes to studying floods. Thunderstorms are the most frequently occurring and widespread natural severe weather event. One inch of water can create several feet of damage; therefore, floods can take on many different forms [5]. In December 2021, an intense tropical recession hit the eastern coast of Peninsular Malaysia, bringing three days of heavy rain to the region. At least 54 people have been killed and two are still missing as a result of the devastating floods that have hit eight states across the country. There were thousands of people affected by the shocking climate change. Most of their shelter was destroy and broken by the floods [6].

Serious action needs to be taken to make sure all people to be alert of the climate change on their surrounding so that they can prepare themselves from the worst case. So, this project is suitable to all the people in Malaysia because of its features that easy to use and affordable in terms of price. Furthermore, more people will now be alert when the rains come to avoid any damage as early as possible. Following that, this study will look into the shortage of a low-cost, portable monitoring device. A portable, low-cost weather monitoring system that can be swiftly set up at a remote place is tough to come by. We require a portable, low-cost, and simple-to-use monitoring device in some circumstances where we need to collect weather data from a remote location.

1.4 Project Objectives

To complete this project, numerous objectives must be met in terms of determining the project's success. The main objective of this project is designing a weather detector device that directly connect to the database and the user smartphone:

a) To design a weather monitoring system using analog sensors and microcontroller.

b) To develop a database system that stores and monitoring the collected data.

c) To validate the developed project prototype for weather monitoring.

1.5 Scope of Research

This project focuses on new product technology in accordance with current requirements. Additionally, this project is followed by designing a weather detector that link with the database and user smartphones. Therefore, this project follows the scope of the study below:

I. Design a weather detector system that contain a number of sensors.

II. Type of sensor that have been used in this system is Light Dependent Resistor (LDR) that will detect the light to determine whether the weather is sunny or cloudy.

III. Secondly, rain sensor is used to determine the absent of rain.

IV. Thirdly, humidity sensor is used to calculate the humidity level and temperature.

V. All the input from the sensors will be shown in Liquid Crystal Display (LCD).

VI. All the input from the sensors will be stored in database and send to the user's smartphone notification at the same time.

1.6 Project Outline

The project's introduction is the most significant component of Chapter 1, which we must go through in detail. This chapter also includes details on the project's beginnings, goals, problem statement, scope of work, and explanation.

Following that, Chapter 2 describes and compares an existent product to the one presented in Chapter 1. The benefits of this project, as well as the flaws of the current product, will be discussed in Chapter 2. After that, some different simulation approaches employed by various analysers will be reviewed in this section.

In Chapter 3, the project technique will be discussed. The intricacies of component selection and project functionality, as well as how the interface will be conducted, will be exposed in this chapter. This chapter will also cover the installation of the project's flow chart and block diagram.

Chapter 4 will go through the product prototype, as well as the expected outcome and analysis. The method for guaranteeing that this project is completely operational will be examined, though.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter discusses the significant points and information that have been discovered by various studies and research from prior studies. Therefore, the discussion begins with the study of smart weather monitoring with connection to database concepts. It is critical to conduct research on these themes because they are the project's key objectives. Furthermore, because this project uses the Internet of Things (IoT), it is critical to understand the technology's fundamentals in order to have a comprehensive understanding of the scope. In conclusion, this chapter concludes with a comparison of prior relevant projects and the type of implementation that will be appropriate for this project.

2.2 Concept of Smart Weather Monitoring

In general, smart refers to technology that is sensor-based, data-driven and more programmable [7]. Weather monitoring is a method where meteorologist have been used for the since the 19th centuries [8]. Smart weather monitoring benefits in multiple ways by using the same method that has been improved with novel technology, such as providing live weather updates, an easy to access database, and various types of weather information [9]. Furthermore, it will also a useful device to install at home or office to monitoring the weather that sometimes cannot be predicted. It is important to know the live weather so that we can know and prepare for every possibility. It is much simpler if we create a simple system that easy to install and easy to use. Based on that, this technology has done many changes in weather monitoring sector such as:

1. Real-time monitoring system
2. Data from sensor will store in database
3. Data from sensor will be transfer to user smartphones

Smart weather monitoring concept consists of various type of sensors that are able to monitor the detail of the weather in real-time. With that, the sensors will perform their part to detect the input and to take part in the control system that will be aid to monitor the weather.

2.3 Concept of Internet of Things (IoT)

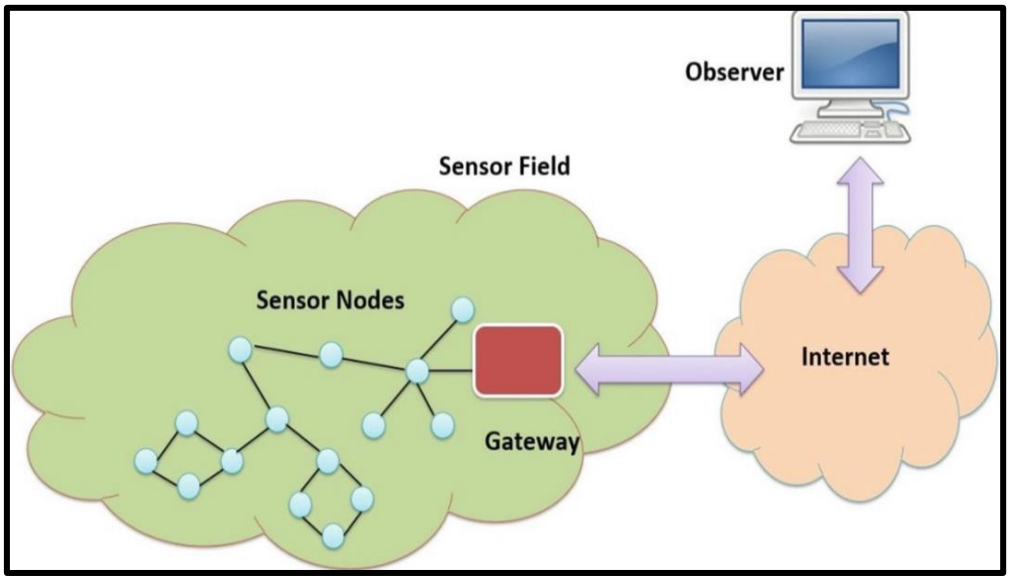


Figure 2. 1: Concept Internet of Things (IoT)

The Internet of Things (IoT) is a trying to cut process and cost-effective solution for linking the rest of the world of objects in a network and interacting with them via the internet [10]. It is a system that collects weather and environmental data using advanced electronic sensors and transmits it via the world wide web to a website for real-time weather monitoring and data handling for future research and analysis. The use of an IoT-based weather monitoring system is beneficial because it allows for real-time monitoring of weather conditions from any location. It is also excellent for data storage [11].

There are four separate components make up a comprehensive IoT system. The sensors or devices are the initial component. Sensors aid in the collection of extremely small data from the environment. The connectivity component comes next. The data is transported to a cloud or database, but it must be delivered across a network such as mobile, satellite, Wi-Fi, or Bluetooth. The IoT's next component is data processing [12]. The software performs data processing on the data that has been acquired. The user interface is the final component. The data is revealed available to the end user in some way. This can be done by setting alarm systems on their smartphone or sending notifications or emails to them.

2.4 Concept of Weather Monitoring

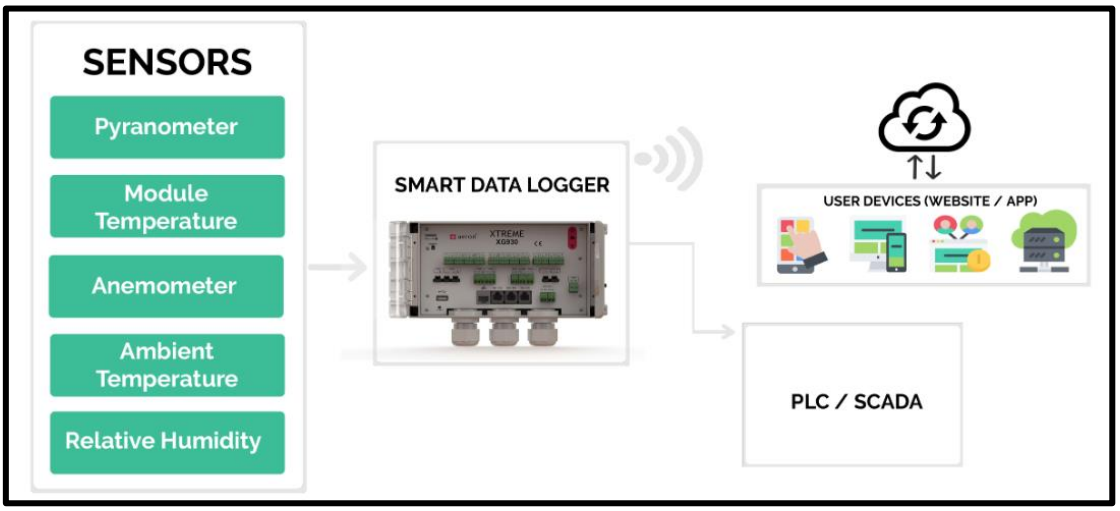


Figure 2. 2: Concept of Weather Monitoring

The periodic or continuous analysis or assessment of the conditions of the environment and climate, including factors such as temperature, moisture, wind velocity, and barometric pressure [13], is known as weather monitoring. Weather monitoring is important not only for documenting present situation, but also for perceiving climate change and giving information for models that can forecast future changes in our environment. It's also crucial for us to be aware of the current or forecasted weather so that we can prepare for any eventuality [14]. Like the most recent calamity in the Klang Valley, the majority of the victims are not at home and are not prepared to salvage anything. That is why, at times, we must be aware of the weather conditions.

Weather monitoring is also necessary for study and forecasting future weather based on patterns and behaviour. They can forecast the weather for future days and act to warn people about coming disasters based on the information received [15]. As a result, many people can plan for a disaster and protect their valued item from harm.

2.5 Previous Related Projects

The study of previous related projects that are largely focused on weather monitoring system via wirelessly is vital to have a good consideration of the project so that fundamental bits of knowledge is gathered to meet the objectives of this project. This IoT project comprises of smart weather monitoring system. As a result, this section will cover past projects that use a similar strategy and have a similar goal to fulfil the main goal of this project.

2.5.1 IoT based Data Logger System for Weather Monitoring Using Wireless Sensor Networks

Kondamudi Siva Sai Ram and A.N.P.S Gupta's [16] development is about weather monitoring using wireless technologies. To connect the sensor network to the internet, they used a Wi-Fi module as an information transmission interface controlled by the microcontroller. They used an ESP8266 Wi-Fi module with an integrated TCP/IP protocol stack. As a result, any microcontroller can use it to connect to a Wi-Fi network. The research and development of a system based on an IoT scenario is now complete. The system was tested indoors, and the weather patterns were successfully updated using sensor data. It is also a less expensive option due to the use of minimal wireless sensors and an integrated Wi-Fi module in the SoC.

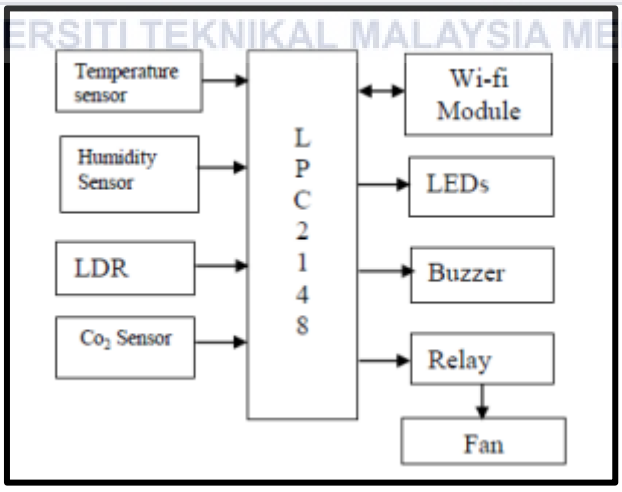


Figure 2. 3: Block Diagram of the Project [16]

2.5.2 Weather Monitoring Using Wireless Sensors Network Based on IoT

The authors of this project [17] are L.Chandana and A.Sekhar, and they indicated that the advantages of observing the weather conditions at a specific location and making the data visible anywhere in the world. The technology underlying this is known as the Internet of Things (IoT). The framework monitors and adjusts natural factors such as temperature, relative humidity, light intensity, and CO2 level using sensors, and then sends the data to a website page. The microcontroller is an LPC2148, and the Wi-Fi module is an ESP8266. The evaluation and development of systems for evaluating natural parameters necessitates expertise. In this project, a web page is also used to plot sensor data and convert it to graphical understanding.

2.5.3 IoT based Monitoring System

This project's authors are R Suresh Babu, T Palaniappan, K Anushya, M Kowsalya, and M Krishnadevi [18]. The project's goal is to control and monitor various activities remotely, then collect information to forecast the weather behaviour of a specific location. They want to formulate and construct an efficient monitoring system that can be controlled remotely via the internet, and the data collected from the sensors will be stored in the cloud for the research study to estimate trend on the web browser. For the hardware components they using ESP 8266 as the heart of the device and also to provides the platform for IoT. All the sensors are connected to this microcontroller where they send the data to it and this microcontroller will upload it to the cloud where the values are analysed.

The sensors that have been used in this project are DHT11 sensor, soil moisture sensor and rain gauge sensor. They also used ThingSpeak to analyse the data in the clouds. The simulation result for this project show that all the data from the sensors have been automatically send to the web server and they use a graphical method to show the result on the web page. The weather monitoring system employing IoT developed as a result of this research provides a low-power and cost-effective alternative for weather monitoring.

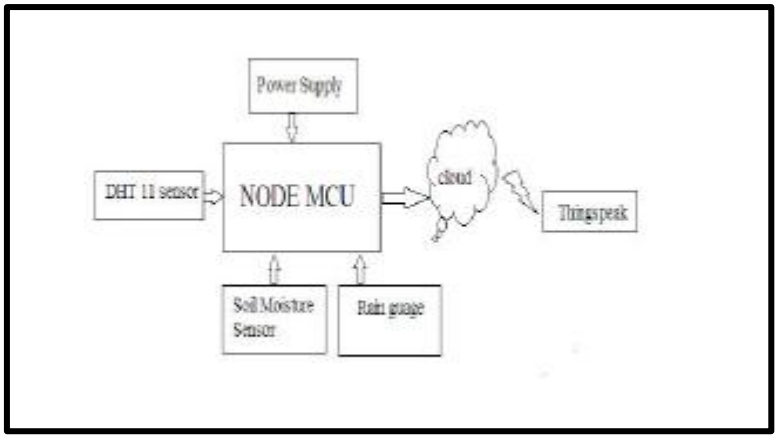


Figure 2. 4: System Architecture of the Project [18]

2.5.4 Smart Weather Monitoring and Real Time Alert System Using IoT

Yashaswi Rahut, Rimsha Afreen, and Divya Kamini [19] created a system to become the advanced solution for weather monitoring using IoT to make its real information easily accessible over a wide range. Temperature, moisture, wind velocity, humidity, light intensity, UV radiation, and even carbon monoxide status in the air can all be detected by the system. This system is small and compact, making it simple to install. This system hardware component consists of Arduino Uno, Node MCU, LDR (Light Dependent Resistor), CO2 sensor, DHT11, ML8511, Anemometer and Dark Sky.net. Dark Sky is an open source Internet of Things (IoT) application and API that interfaces with a Raspberry Pi and uses the HTTP protocol to retrieve the information from things over the Internet or a local area network. They are using an Android app which provide notifications on weather live updates and to act as a warning system for the software portion of this project.

The simulated outcome for this project is that all of the sensors are operational, and all of the sensed data is automatically transferred to the web server via a secure connection. They can also supervise and control the system by entering the IP address of the server being monitored on the web server page. The web page displays the weather conditions in the geographical area where the implanted monitoring system is installed. Finally, the project's result is that all of the data collected is displayed in a graphical representation to allow the viewer to easily identify weather patterns and behaviour. The conclusion for this project is that all the system is working well and the project is successful.

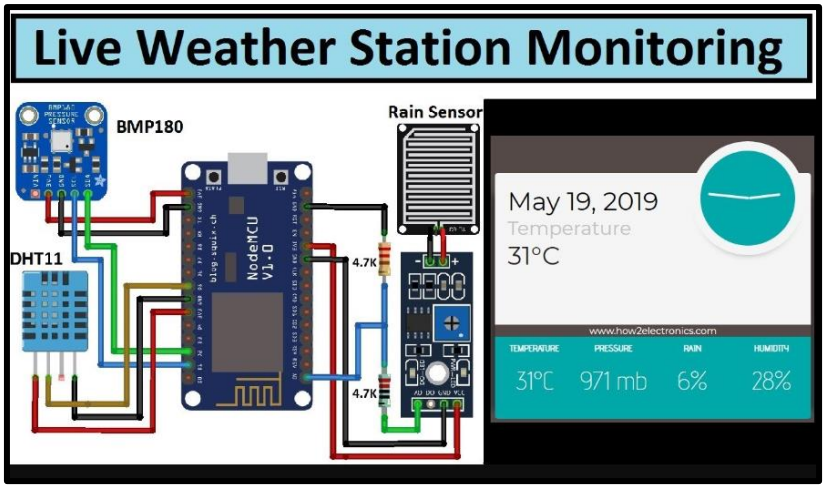


Figure 2. 5: Circuit Diagram of Weather Monitoring System [19]

2.5.5 Real Time Weather Monitoring System Using IoT

The main goal of Puja Sharma and Shiva Prakash's [20] project is to produce a weather monitoring system that will perceive the weather situation and continuously monitor live climatic factors via Wi-Fi. This system has three sensors, a DHT11 temperature and pressure sensor, a BMP 180 barometric pressure sensor, and a Rain Sensor that detects rain. The type of sensor used in this project is determined by the weather pattern at the location to be monitored. Sensors are connected with node mcu8266. They are using node MCU as a model gateway in this project. Records is sent to the local network via the system connection, and this data is displayed on the web page. When the device connection is established, the HTTP request begins processing and presents an IP address on the serial monitor. Then user can use their favourite web browser to paste the IP address and the output will show all the data form the system. They also wanted to create a cost-effective and affordable system. The concept of recording all sensor data and sending it to a webpage via HTTP request protocol on a webserver so that anyone can use it.

Figure 2. 6: Result on the Web Page [20]

2.6 Comparison of previous related projects

Based on the past research projects that have been addressed, certain discrepancies in terms of the methods utilised can be discussed and compared. As a result, the table below compares and contrasts the research publications in terms of methodologies, benefits, and drawbacks.

Table 2. 1: Comparison of Previous Related Project

No.	Reference	Method	Advantages	Disadvantages
1.	[16]	This project using ESP8266 Wi-Fi module which is a microcontroller that can connect to the Wi-Fi. It also functions as the main component for this project that will collect the data to send it to the assigned webpage.	- Less cost - Simple circuit and have a low power consumption	- Esp8266 did not have many input pins so limited sensor can be used in this project.

No.	Reference	Method	Advantages	Disadvantages
2.	[17]	LPC2148 microcontroller is the main component for this project, this project also uses ESP 8266 as the Wi-Fi module and all the data will be send to the website page. The purpose of this project is to monitoring the natural parameters for the weather.	- Simple circuit that easy to use. - Easy to link to the internet	-LPC2148 microcontroller is costly. -The circuit is complex to handle
3.	[18]	This project is using ESP8266 as the main component and also the link to the IoT platform. By using a various of sensor, the send the data to the cloud and ThingSpeak software to analyse the data. They generate a graphical method to show the result of the data.	- The circuit is small and compatible - Less cost - Low-power circuit - Data is presented in a graphical format to make it easier to comprehend.	- Esp8266 did not have many input pins so limited sensor can be used in this project. - DHT11 is less accurate

No.	Reference	Method	Advantages	Disadvantages
4.	[19]	This project is using Arduino uno as their main component and nodeMCU and Dark Sky as the Wi-Fi module. This project includes many sensors as the input and the data is transfer to the web server. They also use web server and android app to monitor and the data is displayed in a graphical representation to the user.	- Many sensors can be used. - Data is presented in a graphical format to make it easier to comprehend.	- The circuit is complex - The total cost is expensive
5.	[20]	This project is using a nodeMCU as the main component and as the Wi-Fi module. Three sensors acted as the input for this project and the data will be display in the page. For the output part, HTTP request will start processing once the hardware connection is establish and user need to enter the IP address in the web browser to see the data.	-Simple and effective circuit -Less cost	- NodeMCU did not have many input pins so limited sensor can be used in this project. - Unpractical to the user to see and monitor the data

2.7 Summary

Overall, it is clear from a comprehensive reading and observation of prior related projects that the classic microcontroller has significant shortcomings when compared to the ESP8266, which are advancements over the old technology. Because of the project's practical requirements, it is reasonable to conclude that ESP8266 technology is the best and most understandable concept that can be implemented and is also appropriate for this project. The research on a weather monitoring-based project is extremely beneficial in understanding the project's principal goal and structure. As a result, the usage of wireless networks in these previous connected projects emphasises the benefits and drawbacks of each communication mode.

CHAPTER 3

3.0 METHODOLOGY

3.1 Introduction

This chapter will describe the methods used to build the project and fulfil the goals. The study design and elaboration of the process flow, as well as the hardware specification, are the three primary aspects of this chapter. To ensure that the project's flow remains steady, detailed research on the used hardware was conducted in order to gain a clearer picture and a better understanding of how to handle it and the best model to employ for this project. This chapter is also important for gaining a broad understanding of the project flowchart. The process flow is described in great detail, and the hardware specs will be detailed after that. Last but not least, a schematic showing the project's connectivity is shown and briefly explored in this chapter.

3.2 Study Design

The goal of this project is to create a smart weather monitoring system for general usage that uses the Internet of Things (IoT) to help Malaysians stay vigilant in any weather situation. In general, this project employs a variety of sensors, including the Rain Sensor, which detects the presence of rain. The brightness level is then detected using a Light Dependent Resistor (LDR). The humidity and temperature are measured by the DHT22. Furthermore, ESP8266 serves as the main component and the receiver, allowing the mobile application to connect and transmit data. The Arduino IDE software is used in this project to compile and upload the coding to the hardware, and Proteus software is used to build the operating project virtually.

To begin, a flowchart of the tasks for this final year project is displayed to ensure that each activity is carefully considered and implemented. A flowchart is also prepared to show the process of the procedures that are carried out in this project.

3.3 Project of process flowchart

3.3.1 Project Implementation Flowchart

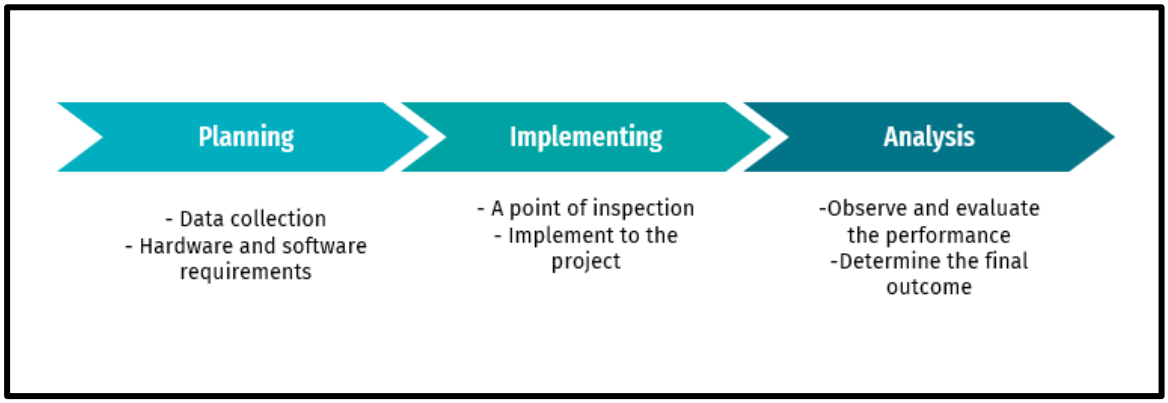


Figure 3. 1: Project Implementation Flowchart

The flowchart of this project's implementation may be seen in figure above. This section will describe the theory portion of the project, which is crucial to ensuring that the project is completed using information. The project implementation process has been separated into three stages: planning, implementation, and analysis. First, based on the sources from the literature review, an observation is made. The study literature review's aims aid in the development of the problem statement, objectives, and methodology for this project. Then, by looking at previous projects, you can figure out what gear and software you'll need for this project.

The data collection from the literature reviews is the second step in the project implementation process. The circuit and computer code are designed in this step to ensure that the intended results are achieved. The circuit design was done with Proteus software, and the coding for this project was done with the Arduino IDE. The designed circuit and coding will be put into the project once it has produced successful results.

The data analysis is the flowchart's final step. The data analysis technique is separated into two parts: one is observing and analyzing the project's performance, and the other is determining the ultimate output. The constructed circuit and coding are observed and evaluated in order to determine the project's performance. Various outcomes and analyses are collected to evaluate the project's performance based on the observation of the outcome. Finally, the ultimate outcome is determined, and the desired outcomes are recorded to demonstrate that the project's objectives were met.

3.3.2 Project Development Flowchart

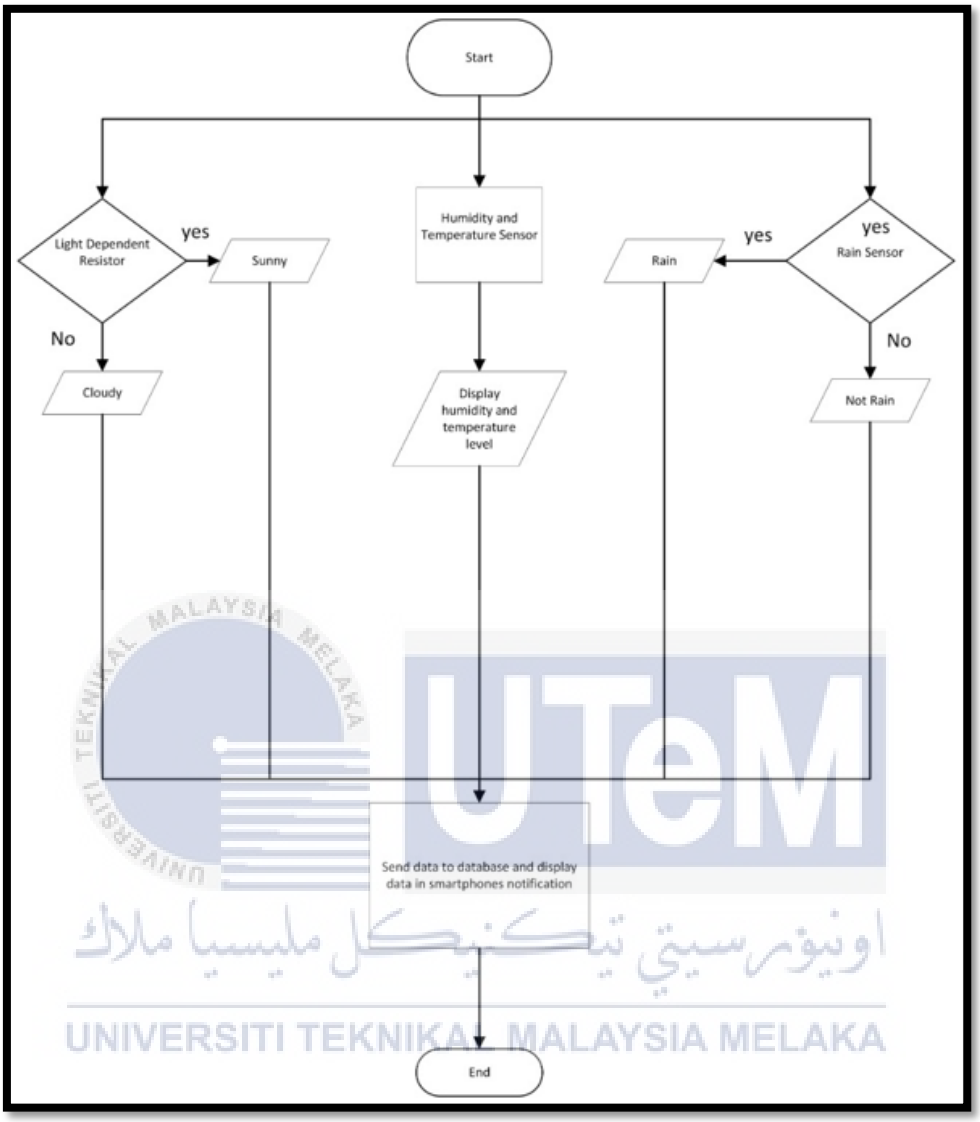


Figure 3. 2: Project Development Flowchart

A flowchart is a visual or graphical representation of an algorithm that employs standard symbols [21]. It clearly depicts the flow of information and processing that occurs in this project. The project begins with sensors that detect and identify the current weather, such as the Light Dependent Resistor (LDR), which detects the brightness level of the current level, the rain sensor, which detects the presence of rain, the DHT 22 humidity and temperature sensors, which measures the humidity and temperature level of the current weather. All of the sensors will play their part to measure the detail of the weather.

Furthermore, the main component ESP8266 will process all of the data acquired from the sensors and send it to the database and the users' smartphones and also link the system to the internet so that the features in this project can be completed. In this project, the database's goal is to store data for the user to monitor and analyse. It will be simple for the user to analyse the weather pattern and make appropriate preparations based on the data. The function of transmitting current weather data to the user's smartphone ensures that the user receives the most up-to-date information on the current weather.

3.3.3 Project Block Diagram

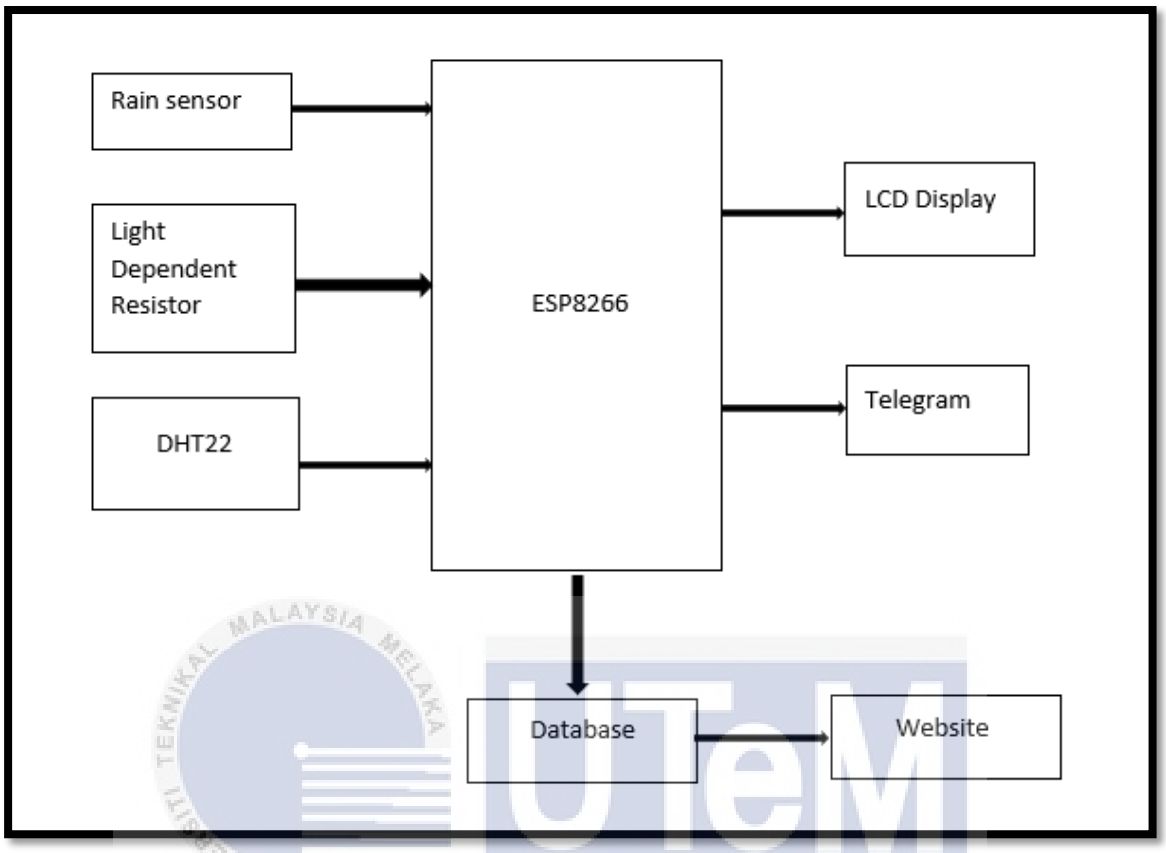


Figure 3. 3: Project Block Diagram

A block diagram is a schematic representation of the general structure of the parts of a system [22]. Firstly, the sensors are the first components that will pass the data to the main component which is the ESP8266. This section selects appropriate hardware components for the project. In terms of software, the Arduino IDE is utilised to code. The Arduino IDE is more user-friendly than other programming applications. Because it can read the input signal and convert it to an output signal, it can detect an item in front of the sensor.

For ESP8266, it will control all the data from the sensors to pass it to the output form. In this case, the output components are LCD Display, Website and User's smartphone. For LCD Display, it will act as a short-range output device that will shows the user the real-time weather. Website for this project is to shows the user the detail and overall data about the weather and the output that go to the user's smartphones will show the user the real-time weather.

3.4 Hardware Specifications

3.4.1 ESP8266

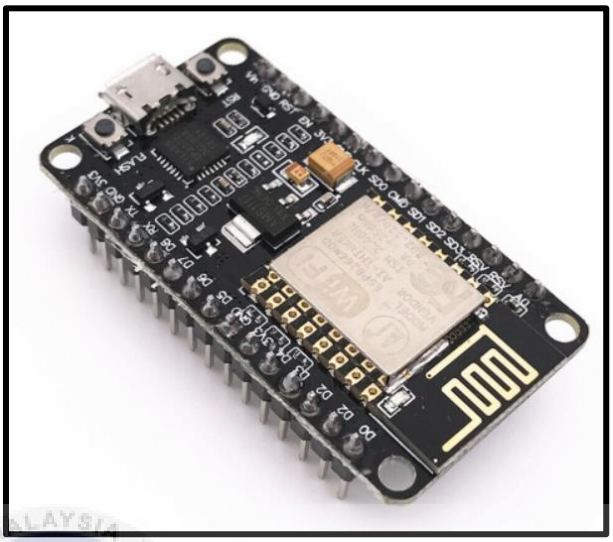


Figure 3. 4 ESP8266

The ESP8266 Wi-Fi Set of self SOC with an integrated TCP/IP routing protocol that allows any microcontroller to connect to your Wi-Fi network. The ESP8266 can host an application or delegate all Wi-Fi network functional ability to a various application processor [28]. This component is suitable for usage and will function as the project's principal component, regulating all sensor operations and providing the system with an internet connection to complete the system's objective.

Table 3. 1: ESP 8266 Specifications [28]

Microcontroller	Tensilica 32-bit RISC CPU Xtensa LX106
Operating Voltage	3.3 V
Input Voltage	7V until 12V
Digital I/O Pins	16
Analog Input Pins	1
Flash Memory	4 MB
SRAM	64 KB
Clock Speed	80 MHz

3.4.2 Light Dependent Resistor

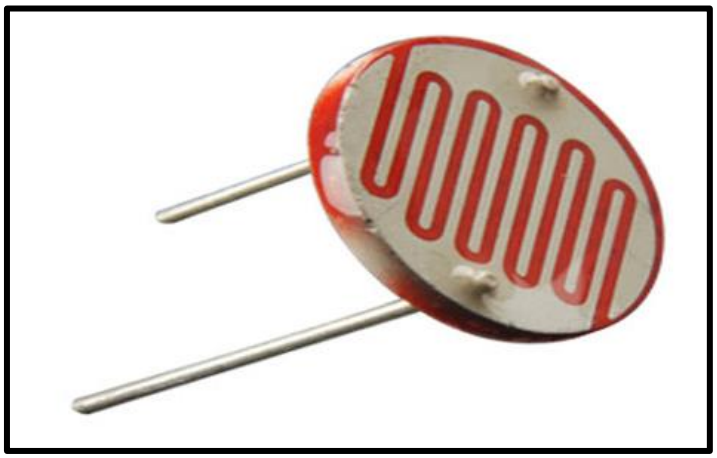


Figure 3. 5: Light Dependent Resistor

A light dependent resistor (LDR), also known as a photoresistor, is an electrical component that responds to light. When exposed to light, the resistance changes. The LDR's resistance can vary by many orders of magnitude, with resistance reducing as the amount of light rises. This component can be used to detect light or, in the case of this project, the current brightness of the weather [24]. When the sensor detects light, we can infer the present weather is sunny; when the sensor detects a tiny quantity of light or does not detect light, we can conclude the current weather is overcast or cloudy. And if the current weather is overcast, the user can make a preparation for the possibility of rain.

Table 3. 2: Light Dependent Resistor (LDR) Specifications [24]

Max Power Dissipation	200mW
Max Voltage at 0 lux	200V
Minimum Resistance at 10 lux	1.8kΩ
Maximum Resistance at 10 lux	4.5kΩ
Type Resistance at 100 lux	0.7kΩ
Dark Resistance after 1 sec	0.03MΩ
Dark Resistance after 5 sec	0.25MΩ

3.4.3 Rain Sensor

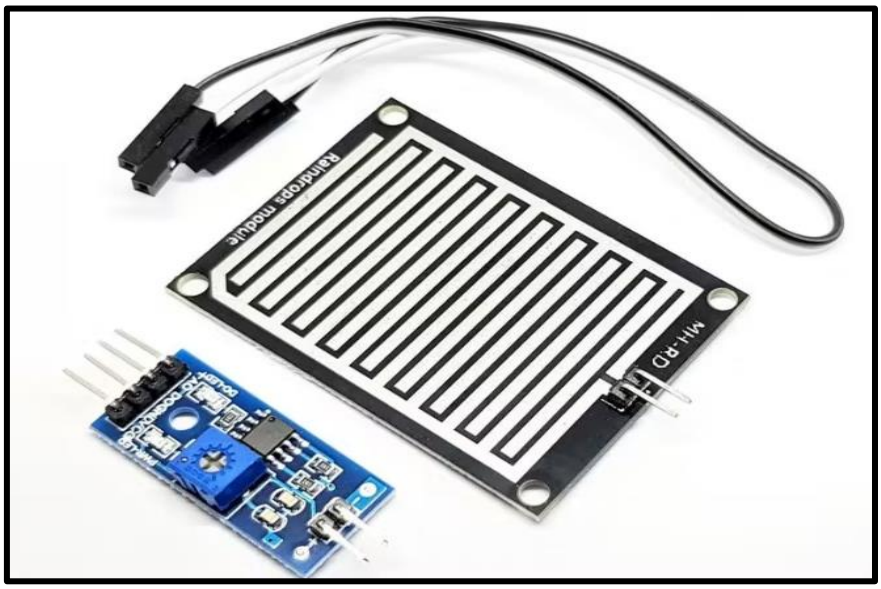


Figure 3. 6: Rain Sensor

A rain sensor, also known as a rain switch, is an electronic component sensor that is activated by rainfall. The rain sensor sense water that short circuits the printed circuits' tape. The sensor functions as a variable resistance that changes state; resistance will increase when the sensor is wet and decreases when the sensor is dry [25]. This device is critical to the weather monitoring system as the tropical climate in Malaysia. The devices are used to detected the presence of rain and send the data to the Arduino to process it.

Table 3. 3: Rain Sensor Specifications [25]

Operating Voltage Range	3.3V until 5V
Operating Current	15mA
Sensing Pad Size	5cm × 4cm
Comparator Chip	LM393
Output Types	Analog O/P voltage and Digital switching voltage

3.4.4 DHT22 Sensor

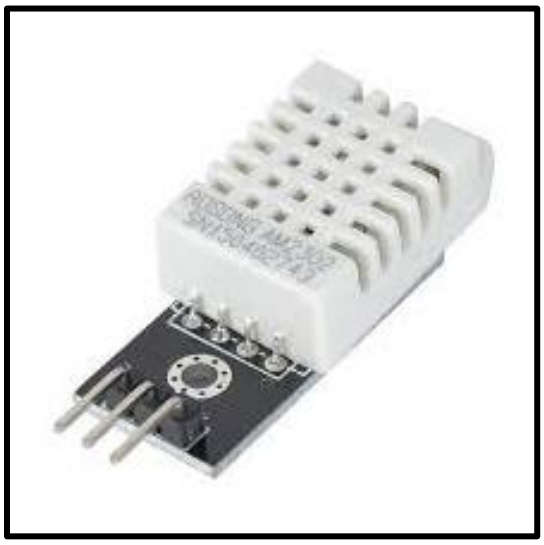


Figure 3. 7: DHT 22 Sensor

The DHT22 is a low-cost basic digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to test the ambient air and no analog pins needed to send a digital signal on the data pin as the output but data collection necessitates careful planning [26]. In this project, the sensor plays a significant role in measuring the humidity level and temperature of the weather, which is an important aspect of the weather monitoring system. The user can know the humidity level of the current weather to be prepare for any probability.

Table 3. 4: DHT 22 Specifications [26]

Operating Voltage	3.5V until 5.5V
Operating Current	0.3mA (measuring), 60uA (standby)
Output	Serial Data
Temperature Range	-40ºC until 80ºC
Humidity Range	0% until 100%
Accuracy	±0.5 ºC and ±1 %

3.4.5 Liquid Crystal Display (LCD)

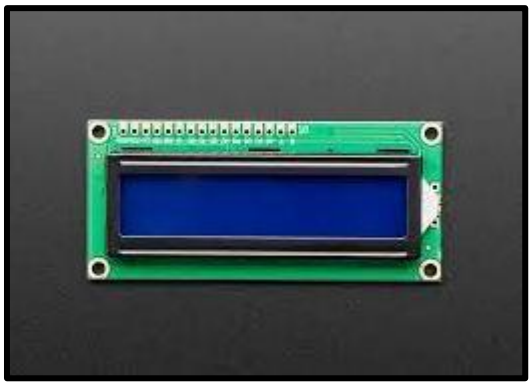


Figure 3. 8: Liquid Crystal Display

The liquid crystal display, abbreviated LCD, is a flat, thin visual representation of data. LCD technology improves picture quality and allows for higher resolutions. In general, LCD describes the type of monitor that uses LCD technology, but it also refers to flat-screen displays found in laptops and calculators. In this project, LCD will work as an output display for short range distance that will shows the real-time weather condition.

Table 3. 5: Liquid Crystal Display (LCD) Specifications

Operating Voltage	4.7V to 5.3V
Operating Current	1mA without a backlight
Number of columns	16
Number of rows	2
Number of LCD pins	16
Characters	32

3.5 Software Specifications

The goal of using Arduino IDE as the key software in this study is for it to work as planned. Furthermore, this programmed was used as a framework for developing the project in this study. The Arduino Integrated Development Environment (IDE) software is used to set up the Arduino Mega, which serves as the project's microcontroller.

3.5.1 Arduino IDE

It's open source software that's mostly used to write and compile code for Arduino modules. The official Arduino software is Arduino IDE. Compiling the code is far too simple. Even a novice with no technical understanding might get complacent while learning. It is built on the Java platform, which includes built-in orders and functions for troubleshooting, filtering, and produced code in the environment. It may be used on many operating systems such as MAC, Windows, Linux, and others [29]. Each has a microcontroller on the board that is destined and expects to receive data in the form of code. The core code, also known as a sketch, that is listed on the IDE platform will eventually generate a hex file that will be transmitted and uploaded to the board controller. The IDE environment consists mostly of two components: an editor and a compiler. The former is used to develop the appropriate code, after which it is compiled and loaded into an Arduino module. This environment supports the C and C++ programming languages.

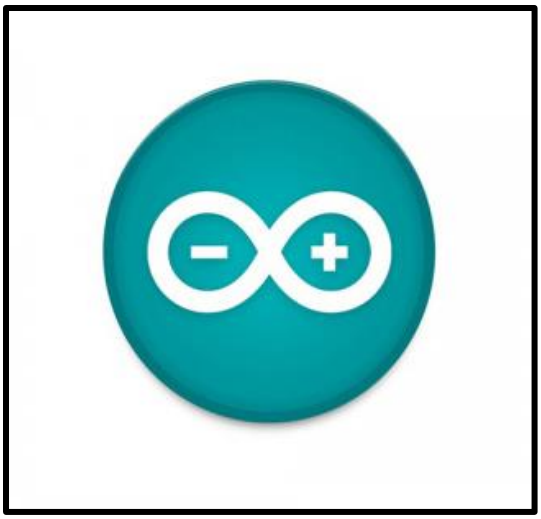


Figure 3. 9: Arduino IDE Logo

Table 3. 6: Arduino IDE Specifications [29]

Developer	Arduino Software
Written in	Java, C++
Operating System	Windows, macOS, Linux
Platform	IA-32, x86-64
Type	Integrated Development Environment
License	LGPL or GPL

3.5.2 Firebase

For the database features in this project, there are two choices of backend tools to use which is ThingSpeak and Firebase. For Firebase, cloud Functions in Firebase are completely insulated. Private and secure functions are available [30]. Run your mobile backend code without having to manage servers and with minimal upkeep. For use in mobile or web applications. It is user friendly and easy to use and set up their own personal database for their project. It also very easy to use and set up because there are many guidelines for beginner.

Figure 3. 10: Firebase Logo

3.5.3 HTML, CSS and JavaScript

HTML, CSS, and JavaScript are the three main languages we use to develop website. These three languages are used to structure, design, and programmed web pages. When some web pages connect with embedded links, along with all of their assets on the server computer, such as images, videos, and so on, it is rendered into a website. This rendering typically occurs on the front end, where users can see and interact with what is displayed. These three languages are used to develop a website to display the data for this project.

Figure 3. 11: HTML, CSS And JavaScript Logo

3.6 Summary

This chapter describes and explains the methodology of 'Smart Weather Monitoring System Using IoT'. One of the most important chapters in project management is project methodology, which ensures that the project may be finished in a methodical manner by following the correct sequence of project techniques. There are four stages of the approach, the project developer generates a project development strategy, project operation development, project determination, and final project integration. These four steps serve as a roadmap to complete this project.

Control parameter was determined in the certain of the project in the formulation of the project structure plan based on previous study and literature review. Later on, the project's development was improved. The study and identification of all project components and control elements is an important feature of this stage. A phase in the design and manufacturing of mechanical, electronic, and software design is defining the project. The entire project integration will then be repeated and troubleshooted in order to achieve the project's major objectives.

CHAPTER 4

4.0 RESULT AND ANALYSIS

4.1 Introduction

This chapter will elaborate on the outcome and discuss the overall project. All project test results from simulation prior to data finalization, operating conditions, and data analysis are included. The final results of these reviews and evaluations serve as a guideline for determining whether the project is meeting its primary goal.

4.2 Project Simulation

To begin, this project's simulation is built before the hardware to test the connection. Proteus 8 Simulator is used to run the simulation. The main component, ESP8266, Light Dependent Resistor (LDR), DHT11, Rain sensor and Liquid Crystal Display (LCD) are assembled in this section. The Arduino IDE is used for the coding part in the ESP8266 microcontroller. When an advanced sensor, such as a Rain Sensor, is included, the component's library must also be included to make sure the microcontroller can read the data form the sensor.

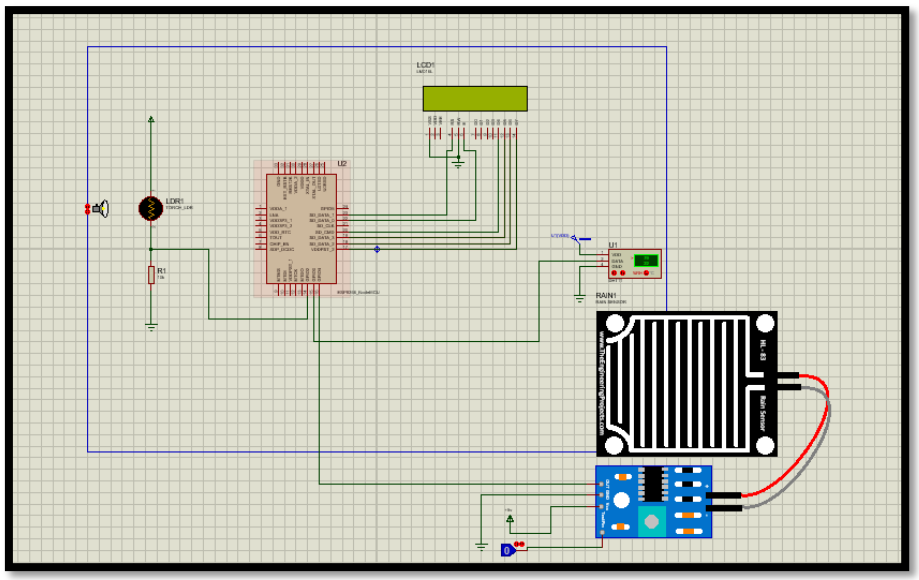


Figure 4. 1: Simulation of the Project

4.3 Software Development

To begin the software element of this project, a database must be created in order to ease data storage, retrieval, modification, and deletion in conjunction with other data-processing operations. Firebase's real-time database is created to handle such operations. When an event occurs, Firebase will wait for changes to a specific database location and triggers and complete its job. To allow the internet connection for the system, the detail of the network information must be defined in ESP8266 coding, and with the internet connection by ESP8266, all data from the sensors will be sent and saved directly at Firebase's database.

The website is then built to show the user all of the data from the sensors in this project. This user-friendly website was created using HTML and CSS on a practical and straightforward theme. The website is linked to Firebase via a JavaScript program, allowing the user to view all data from the Firebase database in real-time. This website contains all of the data from sensors that will show the state of the sky, the current weather, the temperature and humidity of the surrounding environment in a table for the user to monitor, as well as some graphical illustrations to help the user understand the current weather at the location where the device has been placed. Figure 4.2 until Figure 4.5 shows the interface of the website.

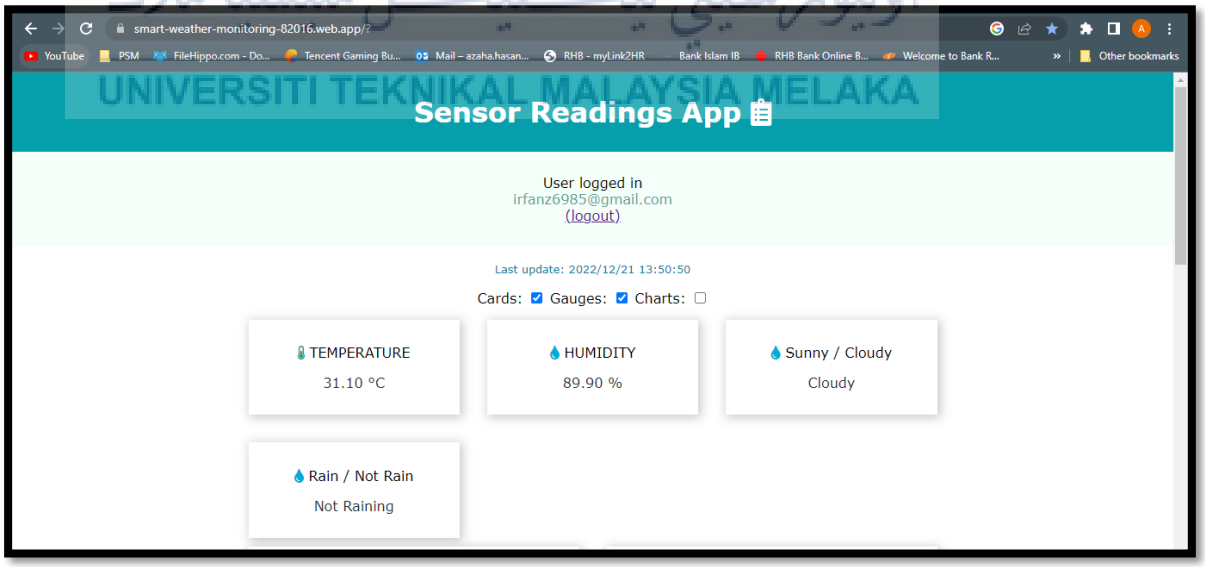


Figure 4. 2 : Website Page (1)

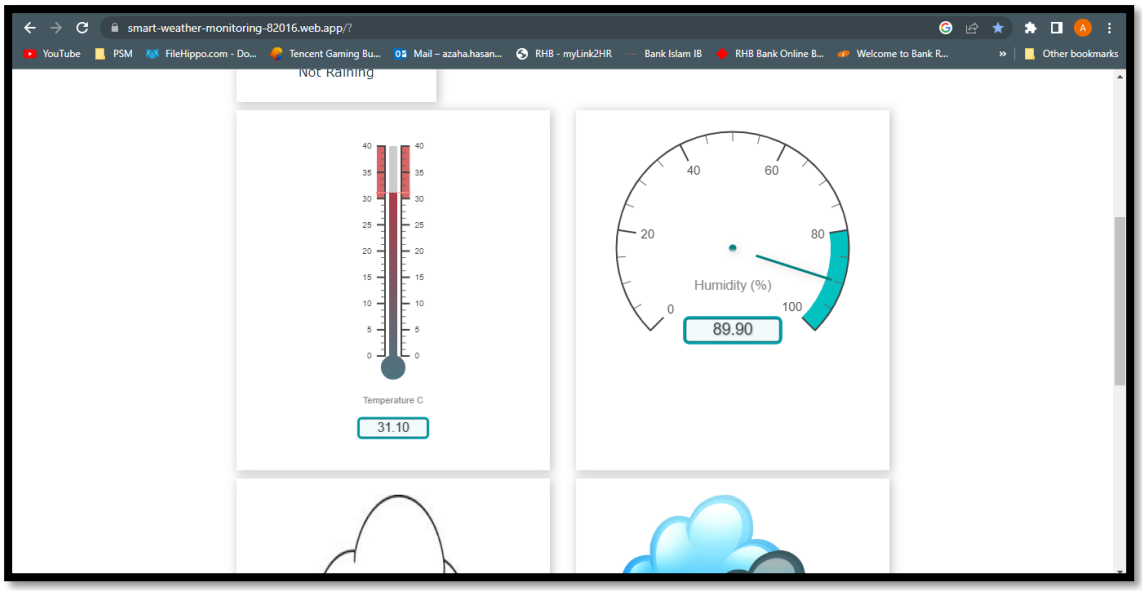


Figure 4. 3: Website page (2)

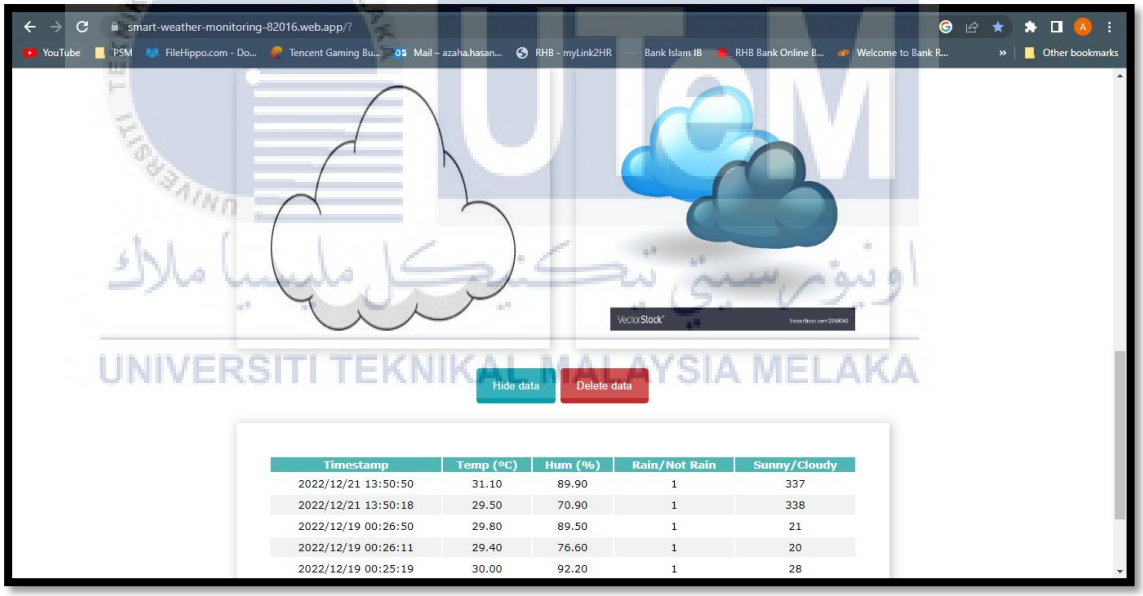


Figure 4. 4: Website page (3)

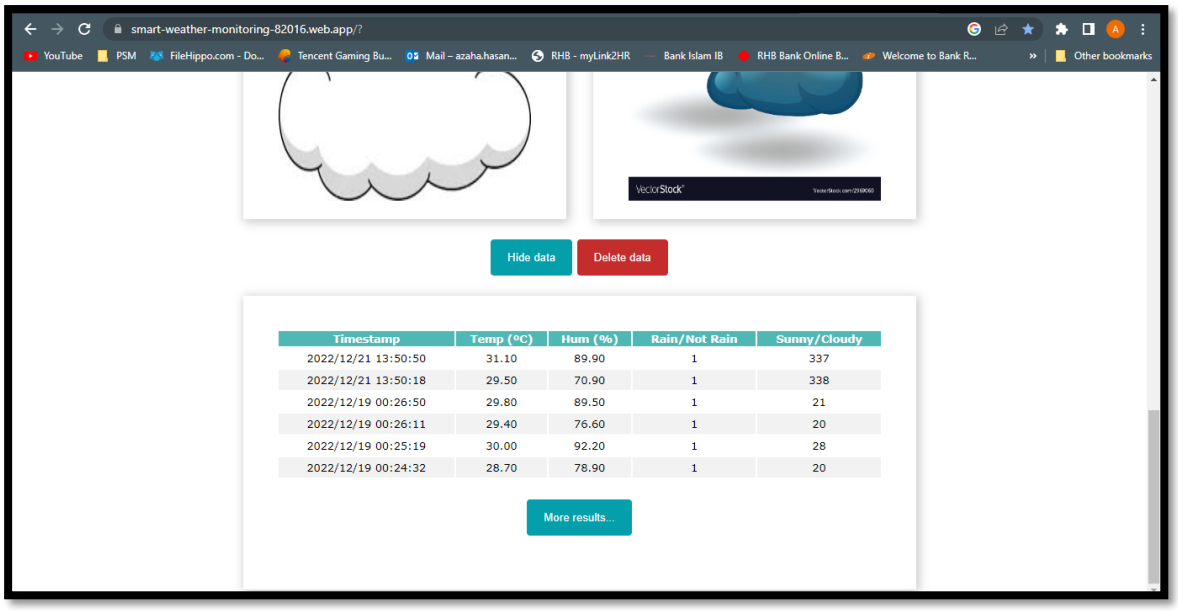


Figure 4. 5: Website page (4)

Telegram bot is the other software component. A Telegram bot is used to send notifications to users' devices. Telegram bot is linked to the ESP8266 by using Telegram Bot library on Arduino IDE platform. Following the selection of the library, the API key is required to get access to the library and decide which bot must be accessed in order to send and access data. In this scenario, it will send a notification to the user if the sky state changes to 'cloudy'. This capability will assist users in being more cautious about the expected rain because the likelihood of rain increases when the sky condition grows cloudy. The telegram bot was chosen for this project since it can be utilized by both Android and iOS users. It may be simpler for the user because Telegram is a popular mobile application and they did not need to download any additional applications to view the data. Figure 4.6 show the list of the chat from the system in Telegram application.

Figure 4. 6: Telegram chat

4.4 Hardware Development

This project's hardware includes an ESP8266, a light dependent resistor, a rain sensor, a DHT22, a potentiometer, and a Liquid Crystal Display (LCD). These components have been soldered to a circuit board to make the circuit appear neater and more orderly. Figure 4.7 depicts the project's hardware.

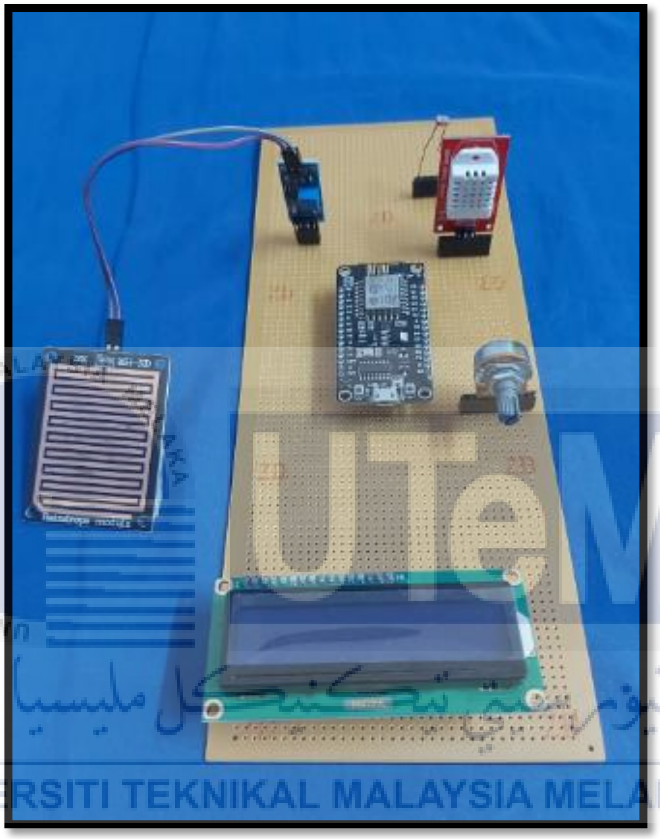


Figure 4. 7: Hardware Component

On this project, there are three input devices (DHT22, Light Dependent Resistor, and Rain sensor), one main component (ESP8266), and two output devices (LCD and potentiometer). The sensors will calculate and measure data depending on their principal roles as the input device, and the potentiometer will control the brightness level on the LCD display. All of the data will be analyzed by the primary component, the ESP8266, and stored in the database in the Firebase console before being displayed in the register website and push the notifications to the user's smartphone based on the certain condition and this project is powered by a 5000mAh power bank with 5V voltage and 2.1A current.

4.5 Prototype Development

4.5.1 Design Prototype

Because this project required the entire circuit to be placed in an open area to ensure that all of the sensors functioned properly, research was conducted to determine the optimal design for the circuit's cover. It is somewhat difficult since the design of the case must be open so that the DHT22 Humidity and Temperature sensor can measure the surroundings while also being waterproof so that the whole circuit is protected from rain, which might cause hardware failure.

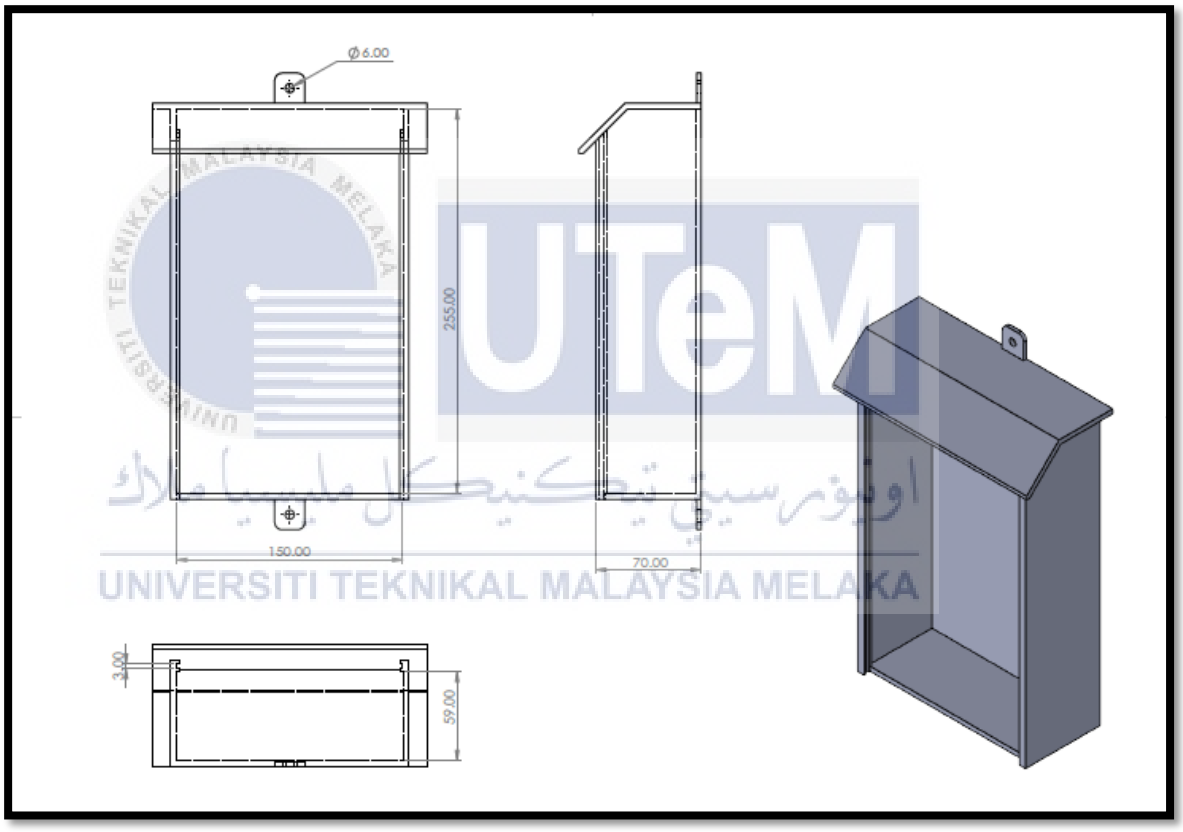


Figure 4. 8: Design of the Circuit Cover

In general, the entire hardware component will be housed inside the cover, with the exception of the rain sensor pad, which will be used to detect the presence of rain, and the Light Dependent Resistor, which will be used to detect the sky condition. The cover will be constructed utilising a 3D printing service.

4.5.2 Actual Prototype

This section will demonstrate the execution of the prototype design to the actual project prototype for the project prototype. Because not every electronic device can be submerged in water, a research must be conducted to discover which parts of the electronic device can be submerged in water, for example, only the top half of a Light Dependent Resistor (LDR) can be submerged in water. As a result, this prototype must safeguard the other end of the LDR connection. To work properly, the LDR and rain sensor pad must be installed at the top of the cover. The rain sensor pad must be positioned on the slope surface due to its need to detect rain drops but not water. If the pad is placed on a level surface, the rain sensors may be thrown off because it will always read 'raining' as long as water is sensed on the pad. As a result, the safest method is to set the pad on a sloped surface, so that the water falls directly and does not stop at the rain sensor pad. Because it cannot be exposed to water, the final input device, DHT 22, is placed on the inside of the cover. To ensure that it works properly, it should be positioned in an open area where it can precisely measure the humidity and temperature of the surrounding environment. Other devices, such as the ESP8266 and Liquid Crystal Display (LCD), must be placed on the inside of the cover because they cannot be exposed to water.

Figure 4. 9: Project's Prototype

4.6 Project Integration

In general, a few integrations are required to make this project a success. First, using Firebase as a medium, connect the hardware system to the database. The integration of the hardware system and the Telegram bot server comes next. The final integration step is to connect Firebase to the project's website. The connection in those integrations is written in the ESP8266 program, demonstrating how significant the role of the ESP8266 and the advantage of its behavior that supplied a built-in internet connection made the integration part easier.

Figure 4. 10: Firebase console of this project

Figure 4.9 depicts the Firebase console interface, which houses the project's data. The Realtime Database choice is the best fit for the project's requirements, as it must provide the most recent update while also storing past data. The integration between Firebase and the website is critical since it is where the timestamp, type of data, and volume of data are calculated based on the demands of the project using a JavaScript program. Data in the website will be updated in every hour based on the most appropriate timestamp to measure weather.

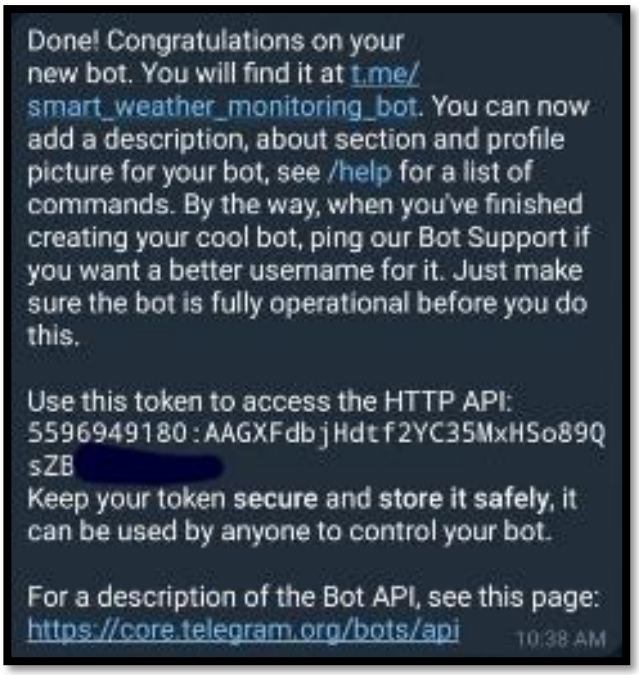


Figure 4. 11: Telegram bot registration

Figure 4.9 shows the interface of the Firebase console that hold the projects data. The option for Realtime Database is the most suitable option that fulfil the criteria of the project that needs to give the latest update and store the previous data at the same time. Figure 4.10 depicts the registration process for this project's Telegram bot server. The registration phase is where the bot's identification is registered to the server, and it will supply the unique API key of the bot registered to the project's needs, and afterwards, the API key inserted to the ESP8266 code to complete the system's linkage to the Telegram Bot Server. This technique includes selecting the suitable Telegram bot library in the Arduino IDE to construct the appropriate bot based on the given parameters. Following the selection of the bot library, such as the Universal Telegram Bot Library, the API key for the previously generated telegram bot is required, allowing the user to interact with and operate the bots via HTTPS requests to the Telegram Bot API. A Telegram bot will be utilised to send a notification message to the user's smartphone informing them of the status in their home. The use of a telegram bot as a notification tool in the specific event or condition will be helpful since it can be accessed from anywhere, not just on Android smartphones, but also on iOS devices and Windows desktops.

4.7 Project's Workflow

The project workflow begins with the user placing the system at the location to be monitored, ensuring that it is open, and registering the system to a nearby network to ensure that all sensors can operate optimally and have an internet connection. This is reliant on the Arduino IDE program, in which the Wi-Fi SSID name and password have been assigned to ESP8266 in order to connect it to the internet network. Next, the user must turn on the system, and as soon as the system is turned on, they will receive a notification on Telegram, as shown in Figure 4.11. The content of that notice is the status of the sky, temperature, humidity level, weather condition (whether it is raining or not), and a link to a website that will offer detailed information and past data on the weather.

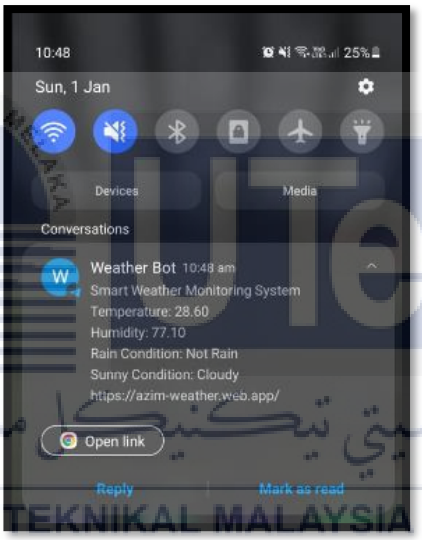
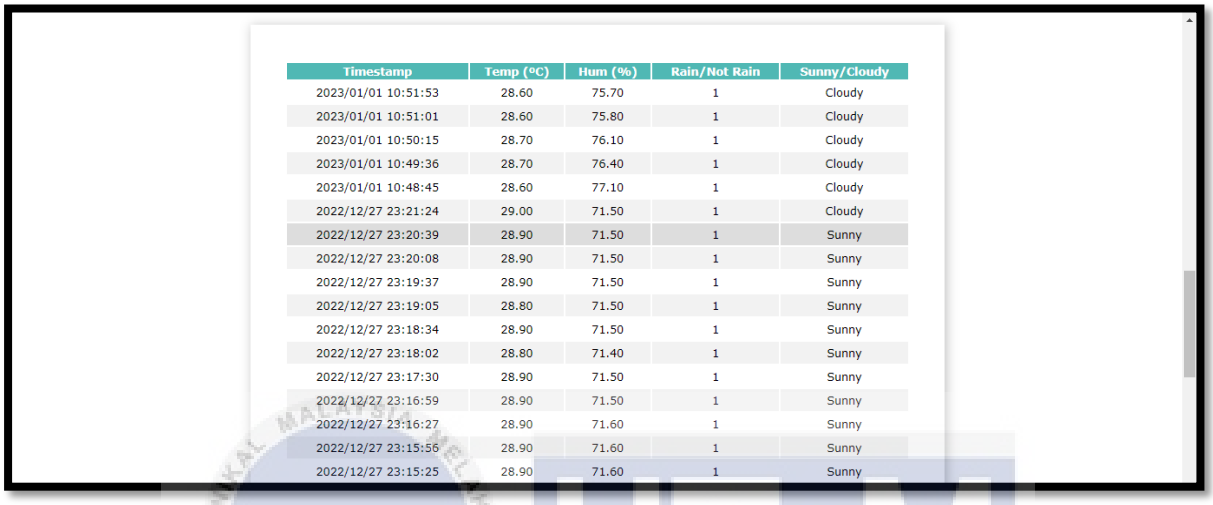


Figure 4. 12: Telegram Notification

The data will be updated within an hour, but the user will only be notified if the sky state changes to 'cloudy'. This condition is meant to provide the user with an early warning that there is a high likelihood of rain, allowing the user to prepare for the approaching rain. Users can also utilize the system to conduct weather research. The property of a database that can assist researchers in determining the weather pattern of any chosen location. The data collected in the database can be used to assess the climate and forecast future environmental changes.

Since the notifications from Telegram Bot did not give the previous and specific information about the weather, the website is built to help address this issue. All previous data from the past will be saved on the website and displayed in the table shown in Figure 4.12. To analyze the atmospheric conditions, all data from a given date and time will be saved in the table for the user's reference and investigation.



Timestamp	Temp (°C)	Hum (%)	Rain/Not Rain	Sunny/Cloudy
2023/01/01 10:51:53	28.60	75.70	1	Cloudy
2023/01/01 10:51:01	28.60	75.80	1	Cloudy
2023/01/01 10:50:15	28.70	76.10	1	Cloudy
2023/01/01 10:49:36	28.70	76.40	1	Cloudy
2023/01/01 10:48:45	28.60	77.10	1	Cloudy
2022/12/27 23:21:24	29.00	71.50	1	Cloudy
2022/12/27 23:20:39	28.90	71.50	1	Sunny
2022/12/27 23:20:08	28.90	71.50	1	Sunny
2022/12/27 23:19:37	28.90	71.50	1	Sunny
2022/12/27 23:19:05	28.80	71.50	1	Sunny
2022/12/27 23:18:34	28.90	71.50	1	Sunny
2022/12/27 23:18:02	28.80	71.40	1	Sunny
2022/12/27 23:17:30	28.90	71.50	1	Sunny
2022/12/27 23:16:59	28.90	71.50	1	Sunny
2022/12/27 23:16:27	28.90	71.60	1	Sunny
2022/12/27 23:15:56	28.90	71.60	1	Sunny
2022/12/27 23:15:25	28.90	71.60	1	Sunny

Figure 4. 13: Data table in website

Finally, another way for users to access weather information is via the Liquid Crystal Display (LCD) on the system's hardware, which will continuously display the readings from all sensors similar to Figure 4.13 below.

Figure 4. 14: LCD Output

4.8 Data Analysis

An analysis is performed to compare the observed weather from the system to actual data recorded from a wunderground.com official website, which is operated by The Weather Company, an IBM subsidiary. The test begins with the system being placed in an open area and attached to a nearby network to ensure the system has an internet connection, as shown in Figure 4.15. The testing began on January 2, 2023, at 1 p.m., and ended at 5 p.m., as indicated in Figure 4.16.

Figure 4. 15: System Testing

Timestamp	Temp (°C)	Hum (%)	Rain/Not Rain	Sunny/Cloudy
2023/01/02 17:09:21	31.20	57.90	1	Sunny
2023/01/02 16:01:07	31.70	55.00	1	Sunny
2023/01/02 15:01:04	31.30	56.60	1	Sunny
2023/01/02 14:01:04	31.00	56.70	1	Sunny
2023/01/02 13:01:04	29.40	70.80	1	Sunny

Figure 4. 16: Data collected from Testing

Based on the results of the testing, it is possible to conclude that all data from the system is reaching the database precisely according to the 1-hour timestamp. However, there is a fault, as evidenced by the fact that the most recent data arrived in the database 8 minutes late. There are a few potential issues, such as the quality of the internet connection dropping or the traffic on the Firebase server being busy at the time.

To determine the accuracy of the measured reading from the system, the result is compared to data from a selected and reputable website that has been used globally by a variety of countries to obtain weather forecasts and reports. The Weather Company employed several weather stations in various locations to assist them monitor and provide a live update of the weather of a given location based on the user's preference.

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Conditio
12:00 AM	25 °C	23 °C	89 %	NE	6 km/h	0 km/h	1,012.68 hPa	0.0 mm	Fair
1:00 AM	25 °C	23 °C	89 %	VAR	6 km/h	0 km/h	1,012.68 hPa	0.0 mm	Fair
2:00 AM	24 °C	23 °C	94 %	VAR	4 km/h	0 km/h	1,011.68 hPa	0.0 mm	Fair
3:00 AM	25 °C	23 °C	89 %	NNE	6 km/h	0 km/h	1,010.68 hPa	0.0 mm	Fair
4:00 AM	24 °C	23 °C	94 %	NNE	6 km/h	0 km/h	1,010.68 hPa	0.0 mm	Fair
5:00 AM	24 °C	22 °C	89 %	NNE	7 km/h	0 km/h	1,010.68 hPa	0.0 mm	Fair
6:00 AM	24 °C	22 °C	89 %	ENE	6 km/h	0 km/h	1,010.68 hPa	0.0 mm	Fair
7:00 AM	24 °C	22 °C	89 %	NE	7 km/h	0 km/h	1,011.68 hPa	0.0 mm	Fair
8:00 AM	24 °C	22 °C	89 %	NE	9 km/h	0 km/h	1,011.68 hPa	0.0 mm	Fair
9:00 AM	25 °C	23 °C	89 %	NNE	7 km/h	0 km/h	1,012.68 hPa	0.0 mm	Fair
10:00 AM	27 °C	23 °C	79 %	NE	15 km/h	0 km/h	1,013.68 hPa	0.0 mm	Fair
11:00 AM	29 °C	23 °C	70 %	NNE	9 km/h	0 km/h	1,013.68 hPa	0.0 mm	Fair
12:00 PM	30 °C	23 °C	66 %	N	9 km/h	0 km/h	1,012.68 hPa	0.0 mm	Fair
1:00 PM	31 °C	23 °C	62 %	NE	17 km/h	0 km/h	1,011.68 hPa	0.0 mm	Fair
2:00 PM	32 °C	22 °C	55 %	VAR	11 km/h	0 km/h	1,010.68 hPa	0.0 mm	Fair
3:00 PM	31 °C	22 °C	58 %	NE	9 km/h	0 km/h	1,009.68 hPa	0.0 mm	Fair
4:00 PM	30 °C	25 °C	74 %	VAR	6 km/h	0 km/h	1,008.68 hPa	0.0 mm	Fair
5:00 PM	30 °C	25 °C	74 %	W	6 km/h	0 km/h	1,008.68 hPa	0.0 mm	Fair

Figure 4. 17: Data from wunderground.com

A comparison is made to see the accuracy of the system and the data from both sides is place on the Table 4.1 until Table 4.3.

Sources / Time	Project's System (°C)	Wunderground.com weather station (°C)
1.00 pm	29.40	31.00
2.00 pm	31.00	32.00
3.00 pm	31.30	31.00
4.00 pm	31.70	30.00
5.00 pm	31.20	30.00

Table 4. 1: Comparison of temperature data

Sources / Time	Project's System (%)	Wunderground.com weather station (%)
1.00 pm	70.80	62.00
2.00 pm	56.70	55.00
3.00 pm	56.60	58.00
4.00 pm	55.00	74.00
5.00 pm	57.90	74.00

Table 4. 2: Comparison of humidity data

Sources / Time	Project's System	Wunderground.com weather station
1.00 pm	Sunny	Fair
2.00 pm	Sunny	Fair
3.00 pm	Sunny	Fair
4.00 pm	Sunny	Fair
5.00 pm	Sunny	Fair

Table 4. 3: Comparison of sky condition

As can be observed in Tables 4.1 through 4.3, the measured value for temperature data is nearly identical, but for humidity level data, there is a slight variance, for example, between 4 PM and 5 PM data. There are a few possibilities, such as the reading of the humidity level differing in different locations. Figure 4.18 depicts a line graph of temperature against time based on data from Table 4.1, whereas Figure 4.19 depicts a line graph of humidity level against time based on data from Table 4.2. The line graph is used to illustrate the comparison between the system's data and the data from wunderground.com. Finally, the data of sky condition from both mediums has indicated that the sky condition is 'Sunny' for system data and 'Fair' for wunderground.com, which implies the same thing that defines the sky condition is fine and bright with no indication and proof of rain.

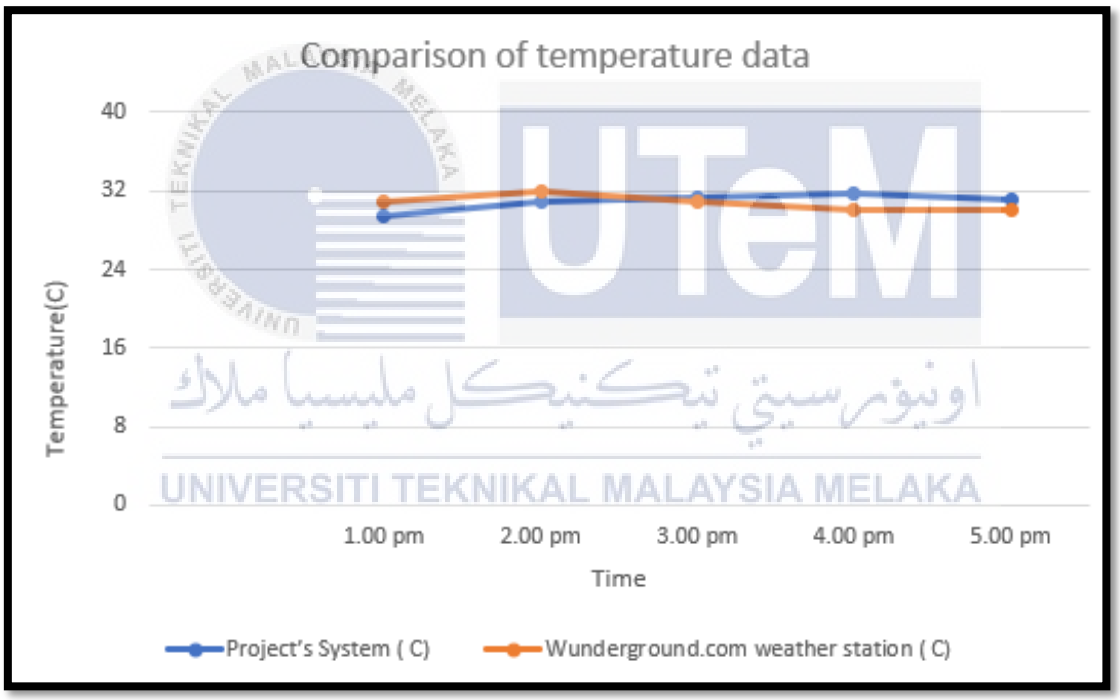


Figure 4. 18: Comparison of temperature data graph

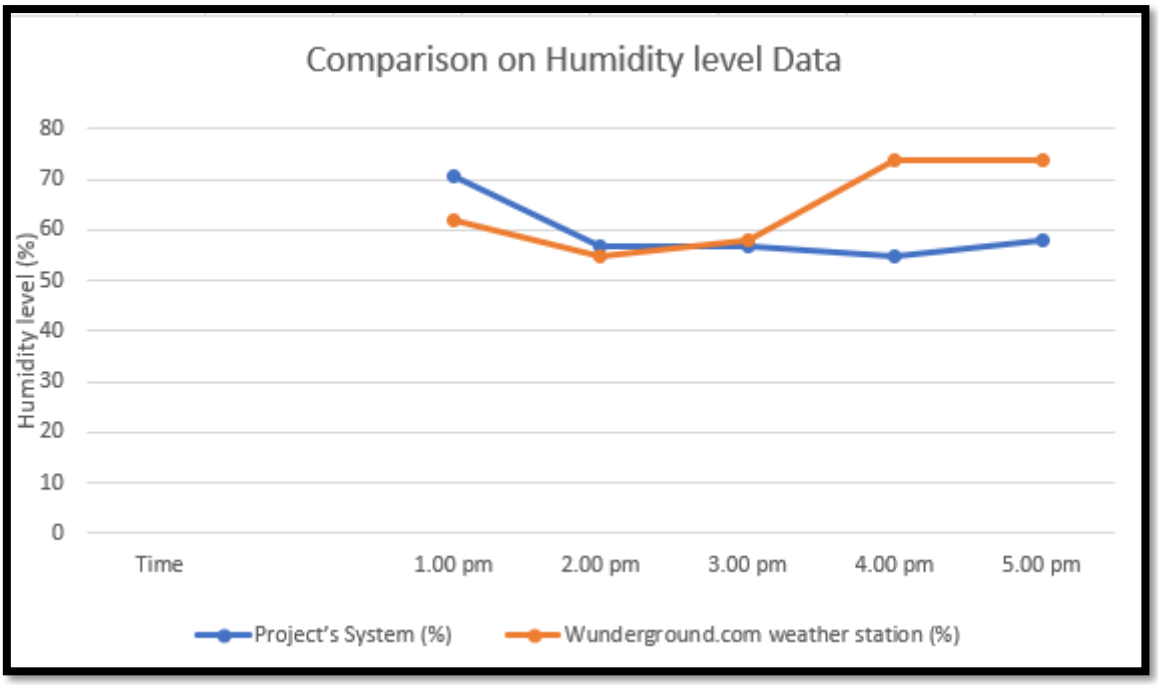


Figure 4. 19: Comparison of Humidity level data graph

The line graphs in Figures 4.18 and 4.19 show that the data from both mediums is similar. The percentage accuracy formula is used to compare the accuracy level of the system's data to the reference data from wunderground.com:

$$A=100-[(Tv-Ov)/Tv*100]$$

Where A is the percentage accuracy (%)

Tv is the true value or theoretical value

Ov is the observed or measured value

The true value is the average of the data recorded by the wunderground.com website, while the observed value is the average of the data obtained during the system testing procedure. The percentage accuracy for temperature data is 99.61%, while the percentage accuracy for humidity level data is 91.95%, indicating that the system's data is correct and successful.

4.9 Summary

This chapter covers in detail the project's development, which began with the project's simulation. The development of hardware and software aspects, as well as the integration methods involved in this project, are then thoroughly detailed. The procedure is described in detail, and the development of the prototype is displayed. The outcome of the construction of the weather monitoring system is included. Furthermore, the output's thorough version and data analysis are discussed.

CHAPTER 5

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter will conclude the overall project implementation and makes future recommendations.

5.2 Conclusion

Weather is something that cannot be predicted, while the weather forecast by meteorologists also can be wrong sometimes. This may be the reason to build a smart weather monitoring system that can tell the user the real-time weather by their smartphones and directly connected to the database. The purpose of a database is to store weather data in order to study the state of the weather in any area and recognize weather patterns. Furthermore, in this moment there are not many choices available for cheap, portable and easy to use weather monitoring system that suitable for normal to use daily. The goal is to build a weather monitoring using analog sensor, Wi-Fi module and microcontroller. The advantage for using component stated is of the cost will be cheaper and it will be easy to use. This system is dependable and practical for ordinary people to install at their homes or offices, as well as for researchers to install in remote areas for research purposes.

5.3 Project Potential

This prototype meets many criteria that will improve overall performance, such as the selection of appropriate sensors and output displays, cheap cost, ease of handling, multifunction, and, most importantly, the ability to conduct more improvements without complexity. As a result, this project is capable of utilizing current technologies and delivering the corresponding signals very well, as well as managing and analyzing the data received from sensors for Research and Development (R&D). The project has various potentials that will assist many parties in monitoring the present weather of any location and saving all data in a database that works nearly automatically. Any company that does weather-related business that helps them obtain weather data for their advantage is a possible beneficiary of this system. Furthermore, the system is excellent for anyone who needs assistance monitoring the real-time weather at any essential location. Finally, weather researchers desperately need a technology that will make their work considerably easier.

5.4 Future Works

For future improvements, efficiency of the Smart Weather Monitoring System could be enhanced as follows:

I. Add another type of sensor so that the system can detect more weather data. With a wider range of sensors, the system can provide the user with more information about the current weather.

II. Upgrade the specifications of the power source or improve the feature of the system such as adding a rechargeable battery so that it can be more practical for the user to use the system.

III. Improving the material used for the hardware model's cover to a completely waterproof material that will provide the user with a 100% assured waterproof system.

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