Faculty of Electronics and Computers Technology and Engineering

DEVELOPMENT OF IOT-BASED WEATHER MONITORING SYSTEM FOR REAL TIME DATA COLLECTION USING NODEMCU AND SENSORS

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEVELOPMENT OF IOT-BASED WEATHER MONITORING SYSTEM FOR REAL TIME DATA COLLECTION USING NODEMCU AND SENSORS

NURUL NABILAH BINTI MOHD RODZI

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DEDICATION

This study is sincerely dedicated to my loving parents who have been a source of encouragement and inspiration for me during the project progress till it is fully completed. Without their love and assistance, this study would not have been made possible.

I am also dedicating this project to Allah SWT, for giving me strength, my source of inspiration and understanding for this project.

ABSTRACT

The Internet connectivity of Internet of Things (IoT) devices over the network has drastically reduced the facility usage persistence and connection needed to access data over the network. The Internet of Things (IoT) is widely recognized as a reliable technology that may assist in the development of several industrial sectors. The Internet of Things is utilized in the process of developing a weather monitoring system in this project. The weather has a big effect on human activities like farming, transportation, and many others. So, keeping an eye on the weather can help to keep control over the action. Lack of real-time localized weather data and point rainfall measurements impedes accurate weather monitoring is the the one of problem statement. The need of localized weather data is important to get more accurate in weather monitoring. Insufficient data also lead to accurancy and efficiency in a system. The purpose of this system is to develop an IoT based weather monitoring system that can collect and transmit weather related data using IoT technology. In addition, the objective also to display a real result that enables users to access data from any location. Next, to test the capabilities and functionality of the system when generating the data and display the result to user. A weather station is a capability that can be used for measuring atmospheric conditions such as temperature, humidity, rain, ultraviolet and atmospheric pressure in order generate information for weather forecasts as well as to study the weather and climate. The Nodemcu Microcontroller, the raindrop sensor, DHT11 for temperature and humidity sensor, the BMP180 pressure sensor, and UV sensor to measure ultraviolet intensity have all been utilized in the development of this project. The sensor will establish a connection with the NodeMCU, and the result will be presented in the ThingSpeak and mobile application. The integration of NodeMCU, DHT11, BMP180, raindrop sensor, and UV sensor has been successfully developed and tested.

ABSTRAK

Ketersambungan peranti Internet of Things (IoT) melalui rangkaian telah mengurangkan penggunaan kemudahan dan sambungan yang diperlukan untuk mengakses data melalui rangkaian. Internet of Things (IoT) diiktiraf secara meluas sebagai teknologi yang boleh dipercayai yang boleh membantu dalam pembangunan beberapa sektor perindustrian. Internet of Things digunakan dalam proses membangunkan sistem pemantauan cuaca dalam projek ini. Cuaca mempengaruhi kesan terhadap aktiviti manusia seperti pertanian, pengangkutan, dan lain-lain lagi. Jadi, dengan mengawal cuaca boleh membantu mengekalkan kawalan ke atas aktiviti manusia. Kekurangan data cuaca setempat masa nyata dan pengukuran titik hujan menghalang pemantauan cuaca yang tepat ini adalah salah satu penyataan masalah. Keperluan data cuaca setempat adalah penting untuk mendapatkan bacaan lebih tepat dalam pemantauan cuaca. Data yang tidak mencukupi juga membawa kepada ketepatan dan kecekapan dalam sistem. Tujuan sistem ini adalah untuk membangunkan sistem pemantauan cuaca berasaskan IoT yang boleh mengumpul dan menghantar data berkaitan cuaca menggunakan teknologi IoT. Selain itu, objektif projek ini juga untuk memaparkan data cuaca yang membolehkan pengguna mengakses data dimana-mana lokasi. Di samping itu, untuk menguji keupayaan dan kefungsian sistem semasa menjana data dan memaparkan keputusun data kepada pengguna. Stesen cuaca ialah keupayaan yang boleh digunakan untuk menberi bacaan keadaan atmosfera seperti suhu, kelembapan, hujan, sinaran ultraungu dan tekanan udara untuk memberi maklumat dan kemudiannya digunakan untuk ramalan cuaca serta mengkaji cuaca dan iklim. Mikropengawal Nodemcu, penderia titisan hujan, penderia suhu dan kelembapan DHT11, penderia tekanan BMP180 dan ultra unggu semuanya akan digunakan dalam pembangunan projek ini. Sensor akan disambungkan dengan mikropengawal, dan hasilnya akan dipaparkan dalam ThingSpeak dan aplikasi mudah alih. Penyepaduan NodeMCU, DHT11, BMP180, penderia titisan hujan dan penderia UV telah berjaya dibangunkan dan diuji.

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First and foremost, I would like to praise and thanks to Allah SWT, whom with His willing giving me the opportunity to complete this bachelor's degree Project.

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LIST OF SYMBOLS

IoT	-	Internet Of Things
MIT App Invertor	-	Massachusetts Institute of Technology App Invertor
Wi-Fi	-	Wireless Fidelity
IDE	-	Integrated Development Enviroment

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The term Internet of things (IoT), refers to a of network that uses specific protocols to connect various objects to the Internet. By facilitating information access, this level of connectivity can raise dependability, sustainability, and efficiency. IoT is an innovative technology with the ability to drastically change many sectors and completely improve our quality of life. IoT allows for the real-time collection and analysis of enormous amounts of data, which promotes efficiency, production, and creativity. The amount of data being produced increases along with an increase of IoT devices.

Our everyday lives are greatly influenced by the weather, which has an impact on everything from public safety and emergency management to transportation and agriculture. A weather station is a tool that uses several types of sensors to collect data about the environment and the weather. A weather station is a facility that can also be used for studying the weather and climate, providing data for weather forecasts, and measuring atmospheric conditions. The capacity to gather real-time data from a variety of locations is one of the key benefits of IoT-based weather monitoring systems. As a result, meteorologists and other weather specialists can develop a more thorough understanding of weather patterns and trends, which they can then use to make forecasts about the weather's future course with more accuracy. IoT devices are able to transmit the sensor data that they collect by establishing a connection to an Internet of Things gateway that enables data to be sent to the cloud for analysis. The exact IoT applications that are being used determine a lot of the accessibility, networking, and protocols for communication that are used to allow devices. IoT has various uses, one of which is the monitoring and data collection of the weather. Real-time weather data, including humidity, temperature, pressure, raindrop and UV that can be gathered using IoT devices like weather stations, sensors, and other monitoring systems. The Internet of Things may assist with several of factors, one of which is the capability to monitor operations surrounding infrastructure.

1.2 Real - Time Weather Monitoring Project: Understanding its Relevance in the Context of Climate Change

The changing climate is one of the most significant variables that has an effect on both the level of activity of the expanding population and the general quality of life. Climate change generally refers to long-term shifts in temperatures and weather patterns. Extreme weather, whether it be cold, hot, or rainy, occurs frequently today and one of the most major impacts of climate change is the increase in global temperatures. Global warming has resulted in numerous kinds of problems, including the melting of glaciers, increasing sea levels, and an increase in extreme weather conditions, such as floods, storms, droughts, and heatwaves. Each year, these shifts cost billions of dollars in damage and endanger the lives of millions of people.

The development of a real-time weather monitoring system based on the Internet of Things is related to this project given the present climate change issue and its effects on numerous sectors. Temperature, humidity, and rainfall are the climate parameters that can be tracked with the use of weather monitoring. Accurate and fast timely weather information is more crucial to make informed decisions and take preventive measures when extreme weather events occur more frequently and intensely. The initiative to develop an Internet of Things (IoT)-based weather monitoring system for real-time data collecting is related to the current problem of climate change and its effects on numerous sectors. The system can give more accurate weather information by utilizing the power of IoT technologies.

1.3 Problem Statement

The state of the weather has a significant impact on human activity such as agriculture, transportation and others. Hence, keeping track of the state of the weather can assist in maintaining control over the activity. A weather monitoring system would provide more precise and current weather information, allowing individuals and organisations to make wise choices and take the necessary measures in considering current meteorological conditions.

In addition, it is also difficult to make accurate forecasts of the weather when there is insufficient data. Weather patterns are complex and influenced by a variety of factors, making it difficult to make accurate forecasts with a high degree of certainty. Accurate weather forecasting is dependent on collecting and analyzing from different sources. Therefore, there is a need for an IoT-based weather monitoring system that can collect real-time data, including localized weather parameters and point rainfall measurements. By incorporating advanced weather sensors capable of collecting point rainfall and localized weather parameters, the proposed weather monitoring system aims to enhance the accuracy of a parameter weather data collection. Such a system would allow for better understanding and prediction of localized weather patterns, enabling more precise forecasting and decision-making in various sectors. In summary, the problem statements could be summarized as follow:

1. Lack of real-time localized weather data and point rainfall measurements impedes accurate weather monitoring.

2. Existing systems exhibit limited accuracy and precision in collecting weather data, while advanced weather sensors for point rainfall and localized parameters are not widely available.
3. Absence of timely and accurate weather information hinders decision-making processes.
4. Insufficient data poses challenges in accurately forecasting weather with a high degree of certainty.

1.4 Project Objective

The Through the integration of Nodemcu and several sensors, the following goals have been established to guide the project's development and implementation. With the goal of developing an Internet of thing-based weather monitoring system capable of collecting and efficiently transmitting weather-related data utilizing IoT technology the specific objectives are as follows:

1. To develop an IoT based weather monitoring system that can collect and transmit weather related data using IoT technology.
2. To display a real time result of the system that enables users to access data from any location.
3. To test the capabilities and functionality of the system to produce temperature, humidity, pressure, raindrop, ultraviolet data.

1.5 Scope of Project

The project scope is important in determining the boundaries required to meet the project goals and objectives. As a result, the scope of this project includes the following:

1. This system will be developed to collect data in real time on the temperature, humidity, raindrop, pressure and UV value. The data that is being collected in real time will be transmitted to a platform in the cloud so that it will be stored and analyzed.
2. The system will be designed to display real-time results, allowing users to access the data remotely.
3. The project scope includes testing the system's capabilities and operation to ensure consistent data collection for the users.
4. The assembled weather monitoring system will be run outdoors to test its capabilities and functionality for a certain period of time. The system will be tested under different weather conditions.
5. The project will rely on pre-existing weather sensor technology, and any modifications or improvements to the sensors are out of the scope of the project.
6. The project will primarily address the collection and transmission of weather-related data, with a specific emphasis on point rainfall and localized weather parameters. The analysis and interpretation of the data, as well as long-term weather forecasting, are outside the direct scope of this project.
7. It is important to acknowledge that weather sensors may be subject to inherent limitations and external factors that can impact data collection, such as environmental conditions or sensor calibration.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An Internet of Things (IoT) based weather monitoring system is a useful application of IoT technology that can provide real-time data regarding the weather. This idea of an IoT based weather monitoring system involves connecting any device to the internet via an on/off switch. In this literature review, we will observe the different types of microcontrollers that can be used for this project, common cloud applications for storing and analyzing IoT data, and communication protocols used for transmitting data from the sensors to the cloud.

There are four distinct parts to make up a full IoT system. The first component consists of devices or sensors. The sensors will read the value from the surroundings based on their functions. The connectivity of the system is the following step. The data that has been collected is uploaded to a cloud infrastructure, but in order to do so, it requires a transport medium such as wireless networks, cellular networks, satellite networks, or Bluetooth and Wi-Fi. The Internet of Things will next incorporate data processing. In data processing, the acquired data are subjected to various processing operations carried out by the program. The user interface constitutes the final component. There are a few ways to provide information to the end-user such as displaying the result on the web. The weather parameters, such as temperature, humidity, ultraviolet and rain will be displayed in a web that has been created.

2.2 Previous Weather Monitoring Systems

A low-cost weather monitoring station was designed by Pravin Baste et al. (2017) is to provides real-time data acquisition[1]. This system has been developed with the help of a Raspberry Pi, which keeps records of meteorological information such as wind direction, speed, temperature, humidity, atmospheric pressure, rain, and solar radiation. Three-cylinder sites were used to measure the local wind speed and direction using an anemometer. In this project, the air temperature, humidity, and atmospheric pressure were all measured using a BME 280 sensor. The rain gauge, which has a self-emptying tipping bucket mechanism, was used to measure the amount of precipitation. A solar radiation sensor used to measure solar radiation is called a pyranometer. It transforms solar radiation from the global into a measurable electrical signal. Weather information is recorded on memory cards and transferred via a Wi-Fi network to a database server. To display a result, a web application was created that consists of a database server and a website. This weather monitoring station was testing various weather conditions to see how the system would react to unexpected changes in the weather. This research was done in both daytime and nighttime conditions.

According to Rohini and Sushma (2016), have develop a climate monitoring system of a city environment [2]. The authors state that the goal of their initiative is to support a clean, sustainable environment and a population with a reasonable standard of living. The system utilizes the Raspberry Pi, a low cost and low power minicomputer built on the ARM architecture. It can communicate via either the external Wi-Fi module or the local area network (LAN). The Raspberry Pi uses the Python programming language to process user commands. Other terminal devices having internet access, such as a laptop, smartphone, or tablet, can be used to monitor the data. This framework provides access to real-time data regarding the characteristics of the urban environment, such as temperature, humidity, pressure, CO, and risky air pollutants. The system helps the city grow sustainably and enhances the quality of life for its residents. The constant access of dynamic datasheets on the dashboard and the time-to-time graphical representation can help plan ways to stop pollution from getting worse and make people more aware of the problem.

Research by ukhurebor et al. (2017) develop a weather monitoring system that is both functional and affordable [3]. This project was constructed using an Arduino Mega 2560 microcontroller and some contemporary suitable sensors with a real time data logger and LCD. In this system Arduino Mega act as main of the system and integrate with a DHT11 to control the humidity and temperature, TSL 2561 sensor is a light intensity which measures the intensity of the light and BMP180 sensors is used to measure air pressure and temperature. The weather data in this project will be saved on a Memory Card, Data Logger which has a Real Timer (DS 1307) that controls when the data is recorded and an LCD screen to display the result. This study highlights the development of a low-cost weather monitoring system that assures adaptability, portability, and reliability while providing data on a few weather factors. This initiative of monitoring meteorological data is easily accessible for users on a smaller scale such as farmers, travelers, airplane workers, researchers, institutions, and others for the purposes of measuring, monitoring, or evaluating the data. The authors also mentioned there is a good chance that employing standard meteorological instruments to accurately measure, observe, and monitor the atmospheric conditions will assist prevent the occurrence of climate-related environmental disasters in our society.

In a study conducted by Tabassum and Hossain (2018), proposed the system to design for predicting weather variables like humidity, temperature monitored for interior temperature, soil moisture is monitored and managed to control soil moisture level, and rain sensor use to detect rainwater level and delivers a message to the server [4]. This weather monitoring system was developed primarily for agricultural use, and it also serves as a cost-effective weather monitoring system for agricultural farms. This system uses a Raspberry Pi to collect data from multiple sensors, process it, and then make it accessible to users at a distance via a pi monitoring system. The authors of this system also discuss future work that might be done to achieve more beneficial and effective results in real-world applications. It has been suggested that one of the projects to be done in the future would involve expanding the number of sensors to produce more accurate results and creating a mobile application that can predict the weather virtually anywhere in the world.

2.3 Microcontrollers for Weather Monitoring

In this section, is to explore different types of microcontrollers commonly used in weather monitoring projects. A microcontroller is an integrated circuit (IC) device that controls other components of an electronic system, through a memory, peripherals, and a microprocessor unit. A microcontroller can be used in an IoT-based weather monitoring system to gather data from a variety of sensors that detect weather-related variables including temperature, humidity, air pressure, wind speed, and rainfall. This data can then be processed by the microcontroller, examined, and transmitted to a cloud-based platform for analysis. The following subsections discuss the specifications, capabilities and suitability for real-time data acquisition and processing

2.3.1 Raspberry Pi

An Internet of Things-based monitoring system was designed to study the weather that occurred in the region in order to collect data as well as to anticipate problems caused by the strong winds that were occurring in the area. The system described in a study by Muslim et al. (2021) utilized a Raspberry Pi as its main microcontroller [5]. The Raspberry Pi is well-known for being an on-board computer that is both affordable and powerful. It was released in 2012 and functions like a typical PC. It is the ideal device to link with other hardware systems because of its performance and affordability. The Raspberry Pi features 512 MB of RAM and is made up of CPU, GPU, audio, and connectivity components. An ARM-based 32-bit, 700 MHz System on Chip powers the Raspberry Pi. This system's "hard drive" is SD Flash memory. The board needs 5 volts of power to operate, and it provides a variety of connectivity choices, including Ethernet, USB, and Wi-Fi. Wi-Fi is a crucial component in creating wireless internet connectivity for IOT devices.

2.3.2 NodeMCU ESP8266

Internet of Things (IoT) and cloud-based weather reporting system has been built as part of this project. This system is able to detect, record, and display a variety of weather variables including temperature, humidity, and precipitation. The system presented in the recent work by Mazumder and Bharti (2023) incorporates sensors for the detection and monitoring of various weather conditions[6].The system includes a microcontroller, various sensors, and a WiFi connection that communicates with a server that is hosted in the cloud. The NodeMCU ESP8266 microcontroller is an Internet of Things development board that can be used for the creation of applications based on the Internet of Things. The Arduino Software Development Environment (IDE) can be used to easily program this for prototype Internet of Things devices. Microprocessor with 32 bits that can be found on the development board is an ESP8266 chip. This microprocessor operates with a clock frequency ranging from 80MHz to 160MHz. In addition to that, it allows for the concurrent operation of numerous programs. The NodeMCU includes 128 KB of random-access memory (RAM) and 4 MB of flash memory for the purpose of data storage. Because of its powerful processing capabilities and integrated Wi-Fi, it is ideally suited for Internet of Things projects. The micro-USB port or the VIN port can be connected to the power supply in order to activate it.

2.3.3 Arduino MKR Wi-Fi 1010

Based on the research conducted by Oo et al. (2019), the system aims to address the need for an efficient environmental monitoring system by leveraging Internet of Things (IoT) technology [7]. It collects and tracks weather data while providing users with quick and convenient access to the information through a mobile application. In this investigation, a microcontroller based on an Arduino MKR Wi-Fi 1010 Board is used to collect weather parameters from a temperature and humidity sensor designated as DHT11, a digital barometric pressure sensor designated as BMP180, a raindrop module and an ultraviolet sensor. The MKR WIFI 1010 is the next generation of the MKR1000, and it comes outfitted with an ESP32 module that was manufactured by U-BLOX. The Arduino MKR WIFI 1010 may run on battery power or external 5V electricity while charging the Li-Po battery since the design incorporates a Li-Po charging circuit. A source will automatically switch from one to the other. A good 32-bit processing power, the usual wide range of I/O interfaces, low power Wi-Fi with a Cryptochip for secure connection, and the simplicity of the Arduino Software (IDE) for coding and programming. These attributes combine to make this board the top option for developing IoT battery-powered devices with a small form factor. Power (5V) for the board can be provided via the USB connector. The Arduino MKR WIFI 1010 in figure 2.1 is able to run with or without the Li-Po battery connected and has limited power consumption. Figure 2.1 show the Arduino MKR WIFI 1010 are integrating with the sensors and connected to the cloud until it display the result on mobile app.

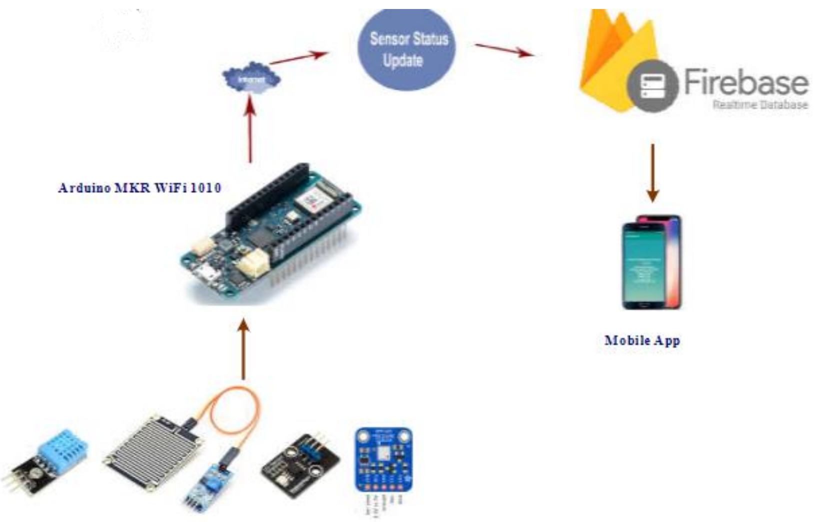

Figure 2.1 System using Arduino MKR Wifi 1010

2.3.4 Arduino Uno

In a study conducted by Thakur and Kumar (2014), the Arduino Uno was utilized as the main microcontroller for the project [8]. The study aimed to develop an affordable hardware component based on the Arduino Uno Board that effectively measures various meteorological parameters. The proposed system aimed to capture crucial weather data, including air temperature, atmospheric pressure, relative humidity, dew point temperature, wind speed, and wind direction. By leveraging the capabilities of the Arduino Uno, the researchers sought to offer a cost-effective solution for accurate monitoring and collection of meteorological data, making a valuable contribution to the field of environmental sensing. The open-source Arduino Uno is hardware and software flexible electronics prototyping platform. The Arduino platform can control lights, motors, and other actuators to have an impact on the environment. The Arduino programming language and the Arduino development environment are used to program the microcontroller on the board. In addition to communicating with computer software, Arduino creations can operate independently. By connecting these meteorological sensors through this microcontroller (ATMega 328) and using the Arduino program, which is running real-time data are obtained for this project. The real-time results of measurements are then displayed on the serial monitor screen of the Arduino software. A USB cable is used in this project to link an Arduino UNO to a computer. There is currently no need for a separate power supply to operate the controller because the USB connection itself supplies the supply voltage and connection.

2.4 Cloud Applications for Data Storage and Analysis

In the following section, the exploration of the various methods of cloud service providers that are typically utilized in weather monitoring projects. A software application that includes both cloud-based and locally hosted components is referred to as a cloud application, or cloud app. This model executes its processing logic on remote servers, which may be accessed via a web browser with a continual internet connection. Utilizing the strength of distant servers and the internet, this program runs totally in the cloud and offers users a variety of services. The cloud in this project will act as storing and transmit the important data. The following parts discuss the types of cloud that are commonly used for this system.

2.4.1 ThingSpeak

Mazumder and Bharti (2023) utilized Thingspeak as a cloud-based data transfer platform in their study [6]. ThingSpeak is an Internet of Things (IoT) analytics platform service that enables users to visualise and analyse live data streams stored in the cloud. MathWorks is in charge of managing the ThingSpeak service. IoT items can be collected, saved, and created in the cloud using the web service offered by ThingSpeak. There is support (pre-existing libraries and existing APIs) for MATLAB, Raspberry Pi, and Arduino.

Any programming language should work with it, even though it makes use of HTTP and the REST API.

2.4.2 MIT Application

In a prior project conducted by Oo et al. (2019), the authors employed MIT App Inventor to display the results on an Android mobile phone [7]. MIT App Inventor is a tool for developing applications for Android phones that can be used with a web browser and either a connected phone or an emulator. The App Inventor servers store design and automatically generate completely functional apps without requiring the user to write any code for their projects. The Mac OS X, GNU/Linux, and Windows operating systems, in addition to a number of well-known Android phone variants, are all supported by the App Inventor development environment. App Inventor allows for the creation of applications that are compatible with installation on any Android device. MIT App Inventor was used to create a weather app that tracks changes in the weather as part of this research project. An Android app receives a reading from a weather station, which includes weather data such as temperature, humidity, moisture, and rain level as well as the UV index. This data is then sent to a Firebase database, which is connected to the app. This allows the app to provide farmers with the most accurate and relevant weather information possible, allowing them to improve their farming decisions and assist one another by sharing important information.

2.4.3 Blynk

In the previous article by Zohari and Johari (2019) are use a blynk application as medium transmission to receive the data from cloud [9]. The main component of this project is an Arduino UNO were connected to WiFi-WeMos ESP8266. This Wi-Fi module is a wireless weather monitoring system that uses three sensors to monitor the weather such as a carbon monoxide sensor, a rain sensor, and a temperature sensor. After that, it will present all of the collected sensor data within the Blynk application. The authors mention that creating an account requires signing up. The Auth Token will then be sent by Blynk to the registered email address. The user can utilize the application and create their own data, such as a graph, display value, button, table, and others when the Auth Token has been sent.

2.5 Communication Protocols

In this part, we will learn about communication protocols and the different types that are often used in weather monitoring projects. Protocols for communication are crucial for programmes involving weather monitoring. It will enable data collection and transmission from the sensors to a central point for storage and analysis. Understanding these protocols' features will help to choose the most suitable one for the project of weather monitoring, providing effective and dependable data transmission. A communications protocol is a set of formal rules that describes how data should be transmitted or exchanged, particularly via a network. These protocols can be divided into the wired and wireless categories in general. In local area networks (LANs) and wide area networks (WANs), where physical connections like Ethernet cables or fiber optics are used, wired protocols are frequently used. On the other hand, wireless protocols are created for wireless communication technologies, where data is delivered using radio waves, such as Wi-Fi, Bluetooth, or cellular networks. In telecommunications networks and other systems, communication protocols are crucial because they establish uniformity and consistency for message transmission. The following subsections discuss the features, functionality and the types of communication protocols that are used for this system

2.5.1 XBEE

Thakur and Kumar (2014) conducted research where they utilized XBEE as a wireless communication protocol for their project [8]. XBee and ZigBee are both brand names that belong to Digi International and describe a series of radio modules. Digi XBee 802.15.4 modules are the RF devices that are the least complicated to use, most dependable, and most cost effective. These modules are able to connect with one another either point to point, from one point to a personal computer, or in a mesh network. Figure 2.2 show the XBEE communication protocol which is one of a low cost component and easier to use.

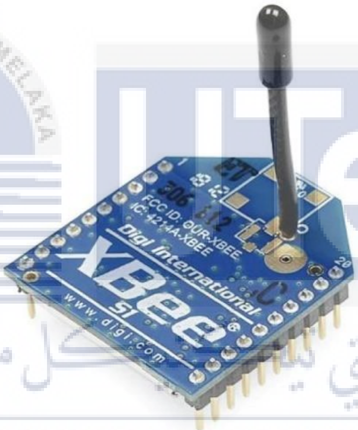

Figure 2.2 XBEE Component

2.5.2 ESP8266 Wi-Fi

Based on article by zafar et al. (2018) were using Wi-Fi ESP8266 module in order to upload sensor readings data from DHT11 to the open-source cloud ThingSpeak [10]. It is an affordable Wi-Fi microchip that has a complete TCP/IP stack. It operates on the 3.3V on the Arduino UNO supplies system. The module has client and server functionality. Once connected to Wi-Fi, the module receives an IP and uses that address to communicate online using the internet. After the ESP8266 module had been tested, an Arduino UNO connection was made, and Arduino UNO was then programmed to setup the ESP8266 Wi-Fi module as a TCP client and send data to the ThingSpeak server, an open IoT platform for visualising and analysing real-time sensor data.

2.5.3 RF433 HC12

In this research paper by Abdulrazzak et al. (2018) were using RF433 HC12 as a medium transmission for transmitter and receiver [11]. This project employed a DHT22 sensor, which can give an accurate reading of humidity and temperature parameters. A multichannel wireless data transmitter with 100 channels is called the HC-12. This series port communication module's operating range is 433.4 to 473 MHz, and its stepping frequency is 400 kHz.This sensor's benefits include low power consumption, quick data transmission, high receiving sensitivity, low cost, and accuracy, with a communication range of 1 kilometre in open space. built-in MCU, and it can send and receive a limitless number of bytes simultaneously with external devices. Spring antennas can extend the range of communication.

2.5.4 LoRa

A weather station prototype using LoRa wireless technology is developed in this study by Eko Murdyantoro et al. (2019) [12]. The components of this project are an Arduino UNO, a DHT11 sensor, a raindrop sensor, an anemometer sensor, a BMP180 sensor, a LoRa shield, a LoRa gateway, and the ThingSpeak web application. The Arduino board's LoRa Shield is a remote transceiver that features an open-source library that enables users to deliver data at very long distances with low power consumption. LoRa LG01-S is an open source LoRa gateway and LoRa wireless networks can be connected to WiFi, Ethernet, 3G, or 4G-based IP networks. The long-range wireless communication technology module, also known as LoRa, is designed mainly for Internet of Things (IoT) systems. LoRa network extends the range of wireless cells, allowing them to operate at low power consumption across distances of up to 5 kilometers. With thousands of node devices that may be connected in a network, LoRa technology is a wide area network solution that ensures coverage range with extremely low power consumption and safer security. This makes it very ideal for the Internet of Things.

2.5.5 NRF24L01

In their study Sidqi et al. (2018) proposed a Weather Monitoring Telemetry System Using NRF24L01 [13]. This study's major goal was to create a weather monitoring system that could transmit weather data over radio frequency utilising a NRF24L01+ 2,4GHz radio module. The system will wirelessly transmit data via a radio module, and a receiver system will receive it. A single chip radio transceiver for the licensed-free 2.4 GHz ISM band is called the nRF24L01. The low-cost nRF24L01 is built to combine incredibly low power consumption with very high speed communications up to 2Mbit/s. The transceiver is made up of an enhanced ShockBurst protocol engine, a fully integrated frequency synthesiser, a power amplifier, a crystal oscillator, a demodulator, and a modulator. As a result, it is perfect for creating wireless Personal Area Networks in a variety of applications. This system was using NRF24L01, which means these modules have a transmitter and receiver part. The transmitter part consists of a BMP180, DHT11, LDR, Arduino Uno R3, and NRF24L01. Meanwhile, at the receiver part, the system consists of a NRF24L01, an Arduino Uno R3, and a personal computer. Figure 2.3 show the NRF24L01 component that are used in this article as a communication protocol.

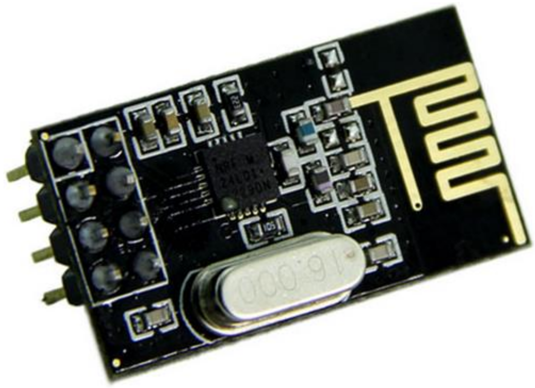

Figure 2.3 NRF24L01

2.6 Sensor and Components in Weather Monitoring System

This section discusses the various types of components and sensors used in weather monitoring. For effective capture and measurement of numerous weather-related information, these systems rely on a variety of sensors and components that cooperate. The various sensor types and project components that are frequently utilised in weather monitoring projects will be discussed in this section. Sensors and other components are essential for collecting and processing data from the physical environment. A sensor is a device that responds and reacts to a certain kind of input from the environment. Meanwhile, component is a functionally independent component of any system. It provides a particular function and might need input or give off output. In modern technology, sensors and components also play an important role which allow for the measurement, detection, and processing of physical quantities across a range of applications. The following subsections discuss the criteria and suitability for the project.

2.6.1 Different between DHT11 and DHT22

In a study conducted by Abdulwahhab et al. (2018) mentioned that the DHT22 sensor provides very accurate parameters when it comes to measuring both temperature and humidity [11]. A system with low cost and good performance is used in this study to measure humidity and temperature accurately before transmitting the information for LCD display. A low-cost digital humidity and temperature sensor is the DHT22. It measures the surrounding air using a temperature sensor component and a capacitor-based humidity sensor. The operating range of the DHT22 is -40C to 80C and 0 RH to 100 RH. This sensor has a 0.5C precision in temperature and a 2% RH accuracy in humidity. A digital signal from the sensor's output needs to be connected to the proper data pin. This sensor is ideal and accurate for operating in a wide range of temperature and humidity.

Another article by Oo et al. (2019) use DHT11 sensor to measure temperature and humidity [7]. The sensor has an accuracy of ±1°C and ±1%. and can measure temperature between 0°C and 50°C as well as humidity between 20% and 90%. This sensor may be the best option for some applications, including determining local weather stations, detecting temperature and humidity, automating climate control, and conducting studies pertaining to environmental monitoring.

In conclusion, the DHT11 and the DHT22 both have their own set of strengths and weaknesses. In comparison to the DHT11, the DHT22 has a faster response time, greater accuracy, and a larger measurement range. The DHT22 is the preferable alternative for the majority of applications; however, the DHT11 is an appropriate option for applications in which cost or speed is prioritized over accuracy.

2.6.2 Tipping Bucket

The major objective of this project by Babalola et al. (2022) is to develop an intelligent system that is both cost-effective and capable of storing data received by measuring a variety of physical characteristics in the environment, such as temperature and humidity levels, as well as the amount of rainfall [14]. The value of the rainfall is determined by this approach utilising a tipping bucket. In this weather monitoring system, to determine the value of rain of how much rain has fallen by using the tipping bucket. 200 millimeters (mm) is the receiver's diameter. Figure 2.4 show the working principles of a tipping bucket. Water falling into a small bucket is measured by tipping bucket gauges. It overturns and empties once the bucket is full. As the amount of "tips" and the rate at which they occur, precipitation quantities and rates are sent.

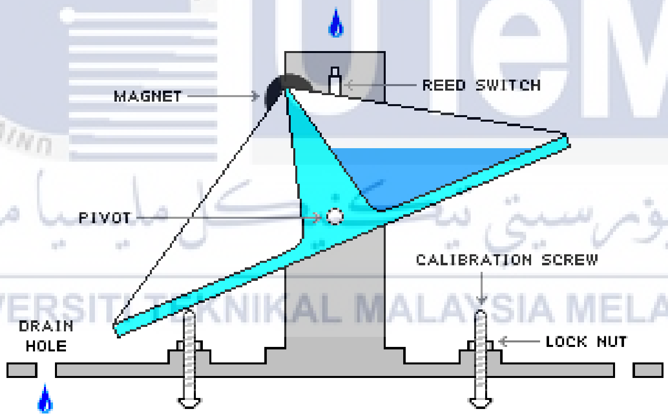

Figure 2.4 Tipping Bucket

2.6.3 RainDrop Sensor

According to the previous article by Shahadat et al. (2020), a study was conducted on the development of a NodeMCU-based, budget-friendly wireless weather station that also included IOT-based graphical application software to make it simple to examine the weather information [15]. It can calculate altitude, pressure, rainfall, humidity and temperature.

Raindrops can be detected with the help of a sensor called a raindrop sensor. The sensor functions by determining how humid the water droplets are on the sensor board. The dripping water modifies the line of parallel resistance on the sensor board. Analogue and digital outputs are available from this module. Digital outputs is low (0) in the case of rain and high (1) in without any of rain. Depending on the amount of rain, the value of the analogue output changes. The output voltage will decrease as the number of water droplets on the circuit board rises, increasing the resistance value. The high output voltage is caused by the few water drops that land on the board. Raindrop sensors offer a number of benefits, including high sensitivity and the ability to monitor conditions in real time, as well as being adaptable and cost-effective. On the other hand, they are sensitive to giving inaccurate readings and might not deliver accurate measures of the volume or intensity of the rainfall. Rain gauges that use tipping buckets are known for their accurate readings and long-term dependability. However, their regular maintenance and expense might be more difficult and expensive. The particular requirements of the project will determine which option is preferable.

2.6.4 BMP180 and BMP280

The purpose of this article by Ambildhuke et al. (2022) is to introduce an easy-to-use rainfall prediction device that consists of of a temperature sensor, BMP180 is an atmospheric pressure sensor, a humidity sensor, and a component that can identify the current condition of the sky to determine the various types of clouds that are there and provide the probability of it raining [16]. The BMP180 is a pressure sensor that has an I2C interface. It is utilized for determining the surrounding pressure as well as the altitude. Additionally, it is utilized in the process of temperature measurement and has the capability of measuring pressures ranging from 300 to 1100 hPa. The BMP180 provides readings of the absolute pressure in pascals (Pa). Changes in the short-term forecast of the weather can be based on observations of pressure changes. A decreasing barometric pressure for instance, is typically an indication that rain or a storm. When the barometric pressure begins to increase it is typically an indication that nice weather.

Another article by Nugroho et al. (2021) is using a BMP280 in order to determine the air pressure in the surrounding area [17]. The purpose of this system is to create an automatic weather station that is powered by solar energy and can be accessible via the website. The HDC1080 sensor is used to measure temperature and humidity, while the BMP280 sensor measures air pressure, the anemometer sensor measures wind speed, the wind vane sensor measures wind direction, the tipping bucket sensor measures rainfall, and the mini solar panel measures irradiance. This BMP280 sensor has the ability to measure relative air pressure ranging from 900 to 1100 hPa. This sensor is ideal for use in equipment that has restricted access to electric sources due to its low current consumption, which is approximately 2.74 uA. Additionally, this project uses the ESP32 and GPRS module, which may give the user information on the weather and other circumstances in and around an agricultural field.

To conclude, this sensor is an upgraded version of the BMP180, which is known as the BMP280. The BMP180 sensor has the ability to measure air pressure, temperature, and altitude, and it is appropriate for monitoring short-term climatic change based on changes in pressure. The BMP280 sensor, on the other hand, provides functionalities that are similar to those of the BMP180 sensor, but it has a greater pressure measuring range and costs more than the BMP180 sensor. Applications requiring minimal power can utilize the BMP280 effectively. From the comparison of the BMP180 sensor and the BMP280 sensor, the BMP180 sensor is the more cost-effective option.

2.7 Application of Real-Time Weather Monitoring

In this part of the discussion, is to discover some of the most significant applications of real-time weather monitoring, including its significance in agricultural monitoring and environmental monitoring. Keeping tabs on the weather in real time is important for a number of industries since it provides crucial data about the weather and helps people make better decisions. By comprehending the requirements and advantages of weather data in various industries, this information can build and put into practise effective weather monitoring solutions suited to the particular needs of a project. The following parts discuss the relevance of applications that are commonly used.

2.7.1 Application for agriculture

In a research paper published by Kalyani G. Gajbhiye et al. (2011) the proposed of the system is used to construct automation in the weather station for providing the best guidelines to the farmers [18]. The system measures the following weather variables: temperature, soil humidity, wind speed, and wind direction. The system makes use of wireless sensor networks which can send signals over far distances by using a mesh topology, this transfers the data and also consumes low power. As a result, this system can be installed in locations that are difficult or challenging to hardwire or have no access to electricity. Using Zigbee/IEEE802.15.4 and GSM SMS technologies, the system focuses on monitoring and checking weather parameters using weather sensors and giving farmers the correct guidance for planning their farms in accordance with the weather conditions.

2.7.2 Application for Environmental Monitoring

This paper was conducted by E. Kanagaraj et al. (2015) to remotely monitor environment with Distributed WSN Weather Stations [19]. There are several weather stations and a Wireless Sensor Network (WSN) system installed across the state of Perlis in order to monitor the weather and the environment. The proposed system will involve the installation of weather stations in six different locations around the state of Perlis. These weather stations will be connected to the local base station in each of these locations via WSN nodes. These local base stations collect and store the data gathered from the weather stations in the area they cover. Users of remote environment monitoring systems will have the chance, as a result of this research, to access real-time environmental data collected from weather stations located across the state.

2.8 Comparison of Existing Real-Time Weather Monitoring Project

In this comparison study, the investigation and assess a number of different real-time weather monitoring projects that are already in existence. Through analyzing the characteristics of these methods, it can determine which methods are the most successful when it comes to monitoring the weather.

Table 2.1 Comparison of Existing Real-Time Weather Monitoring Project

Title	Objective / Purpose	Components	Remark
IoT Based Weather Monitoring System along with Twitter Notification [20].	The purpose of this system is to keep updated with the weather at a specific location and make the data accessible from anywhere in the world.	-Arduino Uno -DHT11 -BMP180 -Raindrop -LDR -LCD 16x2 -ESP8266 Wi-Fi	Users get updated weather parameters on Twitter posts that are easily accessible by anyone.
IoT-Based Real-Time Weather Monitoring and Reporting System [21].	The objective of this project is to design an IoT-based weather monitoring system that's accessible on a global scale	-Arduino UNO -ESP8266 Wi-Fi -DHT114 -BMP1805 -Rain Sensor -LCD Display 16x2	-Smart way to monitor Environment -Providing real-time updates on the latest weather statistics.
Internet of Things (IOT) Based Weather Monitoring system [22].	To develop and utilize use a monitoring system that is effective for remotely using the internet to monitor the necessary parameters.	-Arduino Uno -ESP8266 Wi-Fi -LM35 -Co Sensor -Sound sensor -LDR	-Store the all the value sensor in a google spread sheet. -Providing real time and accessible weather data. -Common weather monitoring system but the sound and gas sensor is added in this project.

Microcontroller Based Remote Weather Monitoring System [23]	The purpose of this system is to use sensors and GSM to develop a low-cost and accurate weather monitoring system that uses both analog and digital components.	-Arduino Uno -GSM module - DHT11 - LDR -Buck converter LM2596 -LM35 -RTC (DS3231N)	-low cost and portability -compact size -not need a computer or the internet to be monitored remotely.
Real Time Weather Monitoring System Using Iot [24].	The major goal of this system is to indicate whether that would benefit farmers before seeding or harvesting.	-Node MCU -DHT11 -BMP 180 -Rain Sensor	-The weather system is tested in different places area locations. -Require less sensors and affordable
Smart weather monitoring and real time alert system using IoT [25].	-To develop weather monitoring-based IoT to make real-time data freely accessible. - To upload the result to a web page and plot it as visual statistics. - To display a result to the application that sends notifications as a reliable alert system.	-Raspberry pi -Arduino Uno -NodeMCU ESP8266 -DHT11 -Anemometer -LDR -GY8511 solar sensor -MQ7 (carbon monoxide levels) -Hygrometer -Ultrasonic (rainwater level)	The result will appear on the notification-sending app as an informative alert system.

		-Raindrop sensor	
Localised Weather Monitoring System [26].	To enhance the forecasting of weather's accuracy	-Arduino Uno -DHT11 -BMP180 -Sound sensor -LDR -Rain Drop sensor	-This study is conducting tests in two different locations (in each building) in order to observe the varying climatic conditions.
Integration of GPS and GSM for the Weather Monitoring System [27].	The purpose of this project is to design a system for monitoring the weather in remote locations using a combination of GPS and GSM.	-Arduino Duemilanove -LM-35 (Temperature sensor) -HIH4000 (Humidity Sensor) -MQ-7 (CO gas sensor) -LDR (light sensor) -GPS -GSM Modem	-For rural places, it is simple to accessible and is remotely monitored. - This system utilizes GPS, which enables location details such as latitude and longitude, together with the time and date, to be tracked.
Weather Station using IoT [28].	- To develop a weather station with real-time data that will allow users to access information instantly wherever they are - To provide data for the user and evaluate the	-NodeMCU -Ultrasonic sensor -Solar panel -Temperature and Humidity sensor -Pressure sensor	-This weather monitoring system provides weather detail in database every 5 minutes. -The result such as temperature, humidity and pressure reading

	weather station's capabilities and functionality.		display on telegram application.
Internet of Things Based Wireless Weather Monitoring System using Blynk Server [29].	- To design a portable weather monitoring system that users may access using smart phones by connecting to the internet.	-Arduino Uno -ESP8266 -DHT11 -Vibration sensor -Soil Moisture sensor	-This weather station is used for application industrial sector and agriculture. -The vibration sensor is utilized to measure the pressure, acceleration, and vibration changes of a system or a device such as movement in machinery.

In conclusion, the comparative analysis of several real-time weather monitoring projects is provided on the various methodologies and technologies that are used in this field. We have obtained significant insight into the capabilities and constraints of these initiatives through the investigation of a variety of approaches and methodologies.

2.9 Summary of Chapter 2

Initiative to develop an Internet of Things-based weather monitoring system requires careful consideration to ensure the functionality of the system. There are a several number of local weather stations located all around the world, and the data from these stations can be collected and displayed to the user in a several ways. Cloud services can be used to store sensor data, and the information can then be shown on a website. Microcontrollers as a main device in the system such as Arduino, NodeMcu and Raspberry Pi can be used to build weather stations. The integration of IoT devices and sensors into weather monitoring systems has allowed for the collection of real-time weather data that can be analyzed to provide accurate weather predictions. In general, a weather monitoring system that is based on the internet of things and is well-designed can give data that is useful for a range of various applications.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The development of a weather monitoring system plays a crucial role in a wide variety of fields. This chapter focuses on the methodology used in this project's development. Choosing an ideal or optimal methodology technique is important as it can enhance the efficiency of the development and management process. The discussion in this chapter focuses on a variety of material and hardware that are related with this project. The NodeMCU serves as the primary microcontroller, and it is responsible for collecting data from a variety of sensors in order to complete this project. This method also looks through how to integrate the suitable connection protocols and techniques for efficient data transfer. Using wireless connections like Wi-Fi, the weather monitoring system makes sure that data will be transmitted to a central server or cloud-based platform in real time.

3.2 Promoting Sustainable Development: Component and Hardware Selection for a Low-Cost Weather Station

The United Nations General Assembly established the seventeen Sustainable Development Goals (SDGs) to encourage a sustainable future for all people. In the United Nations' report on sustainable development for the year 2020, "climate action (SDG13)" is listed as one of the 17 Sustainable Development Goals (SDGs). The negative impacts of climate change are becoming more obvious on a global scale. This can be seen in an increase in the number of wildfires, a shift in biodiversity, the melting of glaciers, and an increase in the level of seas. These effects have been noticed all over the world. SDG 13 aims to prevent climate change and its consequences. The SDG objective seeks to improve resilience and adaptation ability in the context of climate-related risks and natural disasters.

3.2.1 Component Selection

When developing a low-cost weather station, the selection of components is the most important issue in ensuring that sustainable environmental standards are maintained. It is essential to take consideration of the weather station's long-term durability, the energy efficiency of the components, and the environmental impact. In addition, it is possible to reduce the amount of waste produced and the regularity of replacements by designing a weather station out of a material that is long-lasting. By applying this consideration to the project, it will be possible to design a weather station that not only produces valuable information but also reduces the impact on the environment. The project incorporates the use of specific sensors, including the DHT11 for temperature and humidity monitoring, the BMP180 for barometric pressure measurements, a raindrop sensor for precipitation detection, and a UV sensor ML8511 for assessing ultraviolet radiation levels.

3.2.2 Harware Consideration

When it comes to optimizing hardware, making the right component choices and ensuring it are properly integrated are both crucial steps. For instance, NodeMCU ESP8266 is frequently regarded as an appropriate option for developing a remote weather station with a set distance in the context of low-power network connection technologies. To minimize impact on the natural world, another practice can take is to prioritize the use of sustainable energy sources and design systems with longevity. By incorporating these best practises into the hardware design of low-cost weather station project, it will be able to make a contribution towards a more sustainable future and encourage environmental responsibility. For useful and cost-effective reasons, the weather station's case is made of plastic. It is important to note that the hardware parts are also made of durable plastic. This choice was made on purpose to make sure that the product would last and be affordable. It also fits with our larger goal of making the future more sustainable by lowering the environmental impact.

3.2.3 Energy Management

Techniques of energy management were implemented into practice as a way to further improve the sustainability of the project. Renewable energies such as solar panels or wind turbines are generated to help satisfy energy demand, facilitate communities development and promote environmentally sustainable development on the worldwide level. Renewable sources of energy provide the possibility of expanding access to modern energy facilities and providing a solution to the energy issue that has been affecting the world for the better part of the past several decades, all without having a negative effect on the environment or natural systems. Renewable energy is gathered using a solar panel, and the power generated is effectively managed and regulated using a boost module (MT3608). In order to further improve sustainability, the system has a charger module (TP4056) that makes it easier to recharge a 3.7V lithium battery.

3.3 Hardware Requirements

The specifications for the necessary hardware are a critical consideration in determining the functionality of the project. The hardware requirements play a vital role in ensuring the success and functionality of the project. The selection of hardware components should be based on the specific objectives of the weather monitoring project. In this chapter, the essential hardware requirements for a weather monitoring project are discussed. The exploration of the various components necessary such as microcontrollers, several types of sensors and communication. In the next parts of this chapter, will discuss the specific hardware components needed, including functionality and installation.

3.3.1 NodeMCU ESP8266

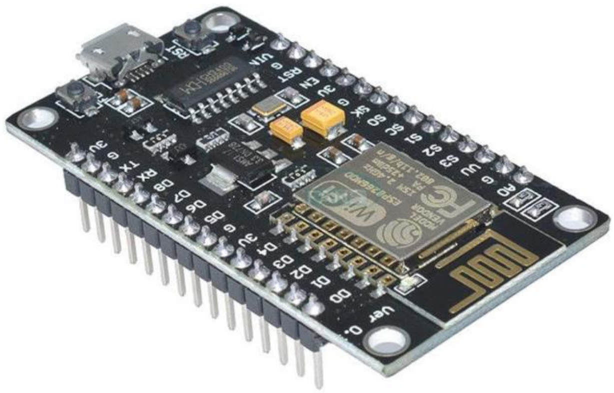

Figure 3.1 NodeMCU ESP8266

When it comes to Internet of Things (IoT) developers, the Nodemcu ESP8266 is among the most popular microcontroller development boards. This particular microcontroller is fairly comparable to Arduino UNO, with the additional advantage of having a Wi-Fi Module built right in. This particular microcontroller is powered by a low-power System on Chip (SoC) microprocessor that incorporates both dual mode Bluetooth and Wi-Fi built into its design. In addition to having a full TCP/IP stack, this WiFi microchip is also very inexpensive, and it operates on the 3.3V that is supplied by the NodeMCU. This device is equipped with a 32-bit TenSilica L 106 microcontroller, which is characterised by a very low power consumption. Through the use of its GPIO pins, which provide a means of connecting the ESP8266 board, it is simple to incorporate application-specific devices or sensors into the ESP8266 board.

3.3.2 Temperature and Humidity Sensor (DHT11)

Figure 3.2 DHT11

The DHT11 sensor module is a combination module for sensing humidity and temperature that produces a calibrated digital output signal. It has a humidity and temperature complex with a calibrated digital signal output. With great reliability and long-term stability, DHT11 provides us with extremely precise humidity and temperature readings. Figure 3.2 show the DHT11 sensor and it is a low-cost sensor that measures temperature and humidity using a thermistor and a capacitive humidity sensor. The sensor delivers humidity readings with a 5% accuracy and temperature readings with a 2°C accuracy. The DHT11 sensor is simple to use and works well with applications that call for real-time monitoring of temperature and humidity because it connects to the microcontroller utilizing a single-wire serial interface.

3.3.3 RainDrop Sensor

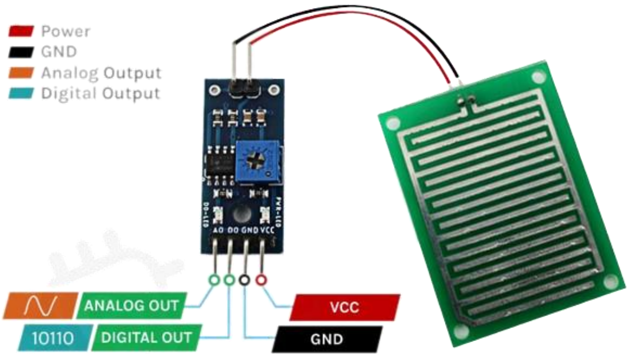

Figure 3.3 RainDrop Sensor

Detecting rain or other precipitation is possible with the use of a raindrop sensor. It is frequently employed in automated irrigation systems, weather monitoring systems, and other situations where the requirement to detect rain is present. A control board and a sensor board make up the sensor typical two components. Two conducting probes are located close together on the sensor board. A circuit is formed between the two probes when a raindrop contacts the sensor board, sending a signal to the control board. The control board analyzes the signal and can be set to turn on additional devices, such an alarm or an irrigation system. Raindrop sensors are frequently combined with microcontrollers like Arduino or Raspberry Pi, which may be programmed to understand the sensor signal and take different actions based on the information received. Figure 3.3 show the RainDrop sensor. The weather station can easily detect rain with the help of the rain sensor module. When a raindrop passes through the raining board, it can act as a switch, and it can also be used to gauge the intensity of the rain.

3.3.4 BMP180

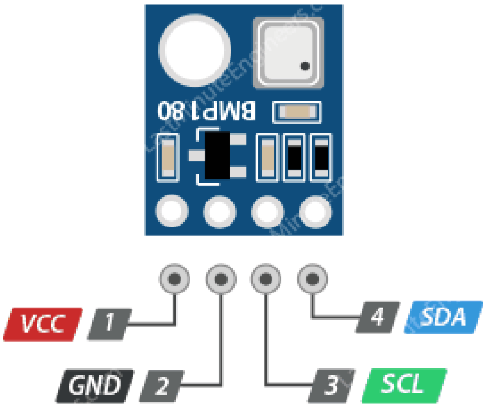

Figure 3.4 BMP180 Sensor

A sensor from the BMP XXX series is the BMP180. Figure 3.4 show the BMP180 sensor will integrating in this system. This sensor's purpose is to measure the surrounding air's compressive value. With an I2C interface that makes system integration with a microcontroller simple, the BMP 180 provides high performance. The BMP180 is a highly accurate sensor that also measures temperature. With an accuracy of 0.02 hPa, it can measure pressure in the range of 300 hPa to 1100 hPa (-500 m to +9000 m above sea level). This sensor is suitable for battery-powered applications because of its low power consumption design.

3.3.5 Ultraviolet Sensor

An informal UV light sensor is represented by the ML8511 module. In order to function, the ML8511 sensor generates an analog signal that is proportional to the amount of ultraviolet light that it detects. The voltage converter that is built within the device is compatible with operating voltages of 3.3V and 5V. The component is designed to measure UV rays in addition to visible light, and it also provides an output value for the intensity of light. This breakthrough has the potential to be highly useful in the creation of devices that can detect the UV index or notify the user of the possibility of sunburn as it communicates with the meteorological conditions.

3.3.6 Mini Solar panel

The solar cell is a photovoltaic device with a voltage of 5V 250mA and a current of 1.25W is designed to convert sunlight into electrical energy. It is capable of producing an output voltage of 5 volts, which is indicative of the electrical potential that is generated when it is present in sunlight. The current output is recorded at 250 milliamperes (mA), which is the amount of electric current that the solar cell is capable of producing when exposed to the most optimal circumstances for sunlight. This solar cell has a power output of 1.25 watts (W), making it suited for a variety of applications. Some of these uses include providing power to low-energy sensors, charging small electronic devices, and contributing to off-grid renewable energy systems.

3.3.7 MT3608 DC-DC Boost Module

A voltage booster module known as the Boost MT3608 is widely used in the field of electronics to increase low voltage to a higher level that is more useful. This outstanding capability is accomplished by storing energy in an inductor and then releasing it to the load at a voltage that is higher than the initial voltage. When it comes to powering applications that demand a consistent and manageable output voltage, this compact and efficient module is very useful. An adjustable potentiometer that enables the required output voltage to be set is one of the features that distinguishes the MT3608 module from other modules. This device is excellent for a broad variety of applications due to its wide input voltage range, which allows it to boost input voltages from as low as 2 volts all the way up to higher levels. The module is tiny, which makes it simple to incorporate into a variety of projects. It is frequently used in situations where a voltage boost that is both dependable and efficient is required for the purpose of providing power to electronic components.

3.3.8 TP4056 Charging Module

The TP4056 charging module is a lithium-ion battery charger that is both tiny and extensively used. It was developed with simplicity and efficiency. When it comes to charging single-cell lithium-ion or lithium polymer batteries, this module provides a convenient solution. An integrated linear charging management system, a status indicator for charging progress, and a micro-USB interface are some of its important features. The micro-USB input makes it simple to connect to power sources. The TP4056 is well-known for its protection measures, which prevent batteries from being overcharged or discharged to excessive power.

3.3.9 Lithium Battery

A rechargeable energy storage device that is extensively used in a variety of electronic gadgets is the Li-Ion (Lithium-Ion) battery, which has a capacity of 2000mAh and 3.7V. Its standard working potential is indicated by the nominal voltage, which is 3.7V respectively. Having a capacity of 2000 milliampere-hours, often known as mAh, indicates the amount of charge that the battery is capable of delivering for a period of one hour. In general, a Li-Ion battery with 3.7V and 2000mAh capacity is a powerful and versatile energy storage solution that can be utilized for a variety of portable devices. This particular kind of battery is distinguished by its high energy density, relatively low weight, and the lack of memory effect. It also enables partial charging without having any negative effects on the functioning of the device. However, in order to guarantee its secure operation and the best possible performance, it is essential to treat it with caution and to make use of chargers that are compatible with it.

3.3.10 LCD 16X2 12C

Liquid Crystal Display (LCD) with Inter-Integrated Circuit (I2C) interface is known as LCD I2C. The components of LCD I2C modules include an LCD display, a controller chip, and an I2C interface module. The controller chip interfaces with the I2C interface module to receive instructions and data, and then drives the LCD display to display the information. LCD I2C requires less wires for communication and easy to connect the LCD I2C module to a variety of microcontrollers. As a visual interface, the LCD I2C display serves to show the current temperature, relative humidity, and amount of rain data collected by the DHT11 and rain drop sensor. Additionally, two analog pins A4 and A5 were used to interface a Liquid Crystal Display, which had the advantage of having four or eight I/O pins to correspond to the four and eight LCD modes, respectively. The innovation will enable those I/O pins used for other purposes and its accompanying simplicity. Table 3.1 show the list of components that will using in this project.

3.4 Software Requirements

The collection and evaluation of weather data are very important aspects of the weather monitoring project. The software requirements are an essential in the process of efficiently handling and analysing the gathered meteorological data. The requirements for the programme involve a wide variety of features, such as the logging and retrieval of data, the processing of real-time data, the visualisation and analysis of data. Table 3.2 show the software requirement to make use efficiency of this system. The system should be evaluated based on its dependability, ablilities to collect and store data, and analyse.

3.4.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a complete software platform that is focused on simplifying the process of application development and programming for Arduino microcontroller boards. In order to build a programmed for this project, the Arduino IDE was utilized. The Integrated Development Environment (IDE) provides a space for the creation and organization of Arduino sketches, which are essentially programmed written for these microcontrollers. The IDE also features a user-friendly code editor that supports the C and C++ programming languages. The sketches are converted into machine-readable code using an integrated compiler. The IDE also includes tools such as the Serial Monitor, which aid in real-time data transmission monitoring for debugging purposes. It also features a simple mechanism for managing sketches and integrating pre-written code modules known as libraries. Additionally, the IDE's Upload Tool allows for the upload of compiled code to Arduino boards via USB connection.

3.4.2 ThingSpeak

The Internet of Things (IoT) platform known as ThingSpeak is an open-source application that gives users the ability to collect, analyze, and visualize data from a wide variety of connected devices. ThingSpeak is a cloud-based infrastructure for Internet of Things applications that was developed by MathWorks. It makes it simpler for developers to construct projects that require the collection and monitoring of sensor data. The platform provides a web interface that is easy to use for managing data channels. Users can construct and manage various data sets that are gathered from devices or sensors. A one-of-a-kind application programming interface (API) key is linked to every data channel, which makes the transfer of data more secure.

3.4.3 MIT App Invertor

The purpose of MIT App Inventor is to create apps for Android phones using a web browser and either a connected phone or an emulator. The App Inventor servers save inventor designs and allow you to develop completely functional apps without writing any code. It offers a visual programming environment where users can construct Android applications using a drag-and-drop interface, making it ideal for those without any coding skills. The platform's block-based coding methodology simplifies programming by allowing users to stack and link graphic blocks representing different app functionality. App Inventor is compatible with Mac OS X, GNU/Linux, and Windows operating systems, as well as various common Android phone types. App Inventor applications can be installed on any Android phone.

3.5 System Design

The complete block diagram, flowchart, and schematic diagram of the weather monitoring system will be covered in the coming parts of this chapter. To ensure that the system architecture is achieved, the features, connections, and interactions are included in each system design. Meteorological data may be collected, processed, and analysed more effectively with a system that has been thoughtfully developed. This provides the way for improved weather monitoring and analysis.

3.5.1 Block Diagram

The microcontroller Nodemcu ESP8266 that serves as the primary processing unit for the entire system is a component of the system that has been developed and this microcontroller is also able to connecting to all of the sensors. The DHT11 sensor is used for determining the temperature as well as the relative humidity and the raindrop sensor ability to detect rain values. The BMP180 is use to detect the atmospheric pressure by measuring the changes in air pressure at different altitudes and the ML8511 sensor is to measures UV radiation by detecting the amount of UV light hitting its sensor. The microcontroller has the ability to interact with this sensors in order to retrieve data. The Nodemcu ESP8266 with the built in wifi as a medium of transmission sends the data to the cloud that has been assigned. The result will be displayed on the LCD and display on the web for collecting data. This system also display the resulr on mobile application. The figure 3.6 below presents the block diagram of the weather monitoring system.

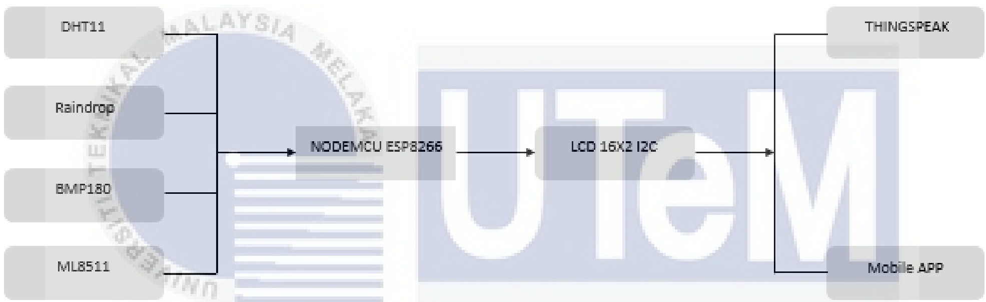

Figure 3.5 Block Diagram

3.5.2 Flowchart

The operation of the system that we have suggested is outlined in the flowchart. This system consists of up of a microcontroller, several types of sensors, Thingspeak and mobile application for displaying the results. This flowchart begin with start and then the system will intialize the micrcocontroller and sensors. The wifi configuration is a important step to transmit the data from the sensors. The value from sensors will send to cloud. The final result data of temperature, humidity and pressure will display on LCD 16X2, Thingspeak and mobile application, The figure 3.7 show the flowchart of this system.

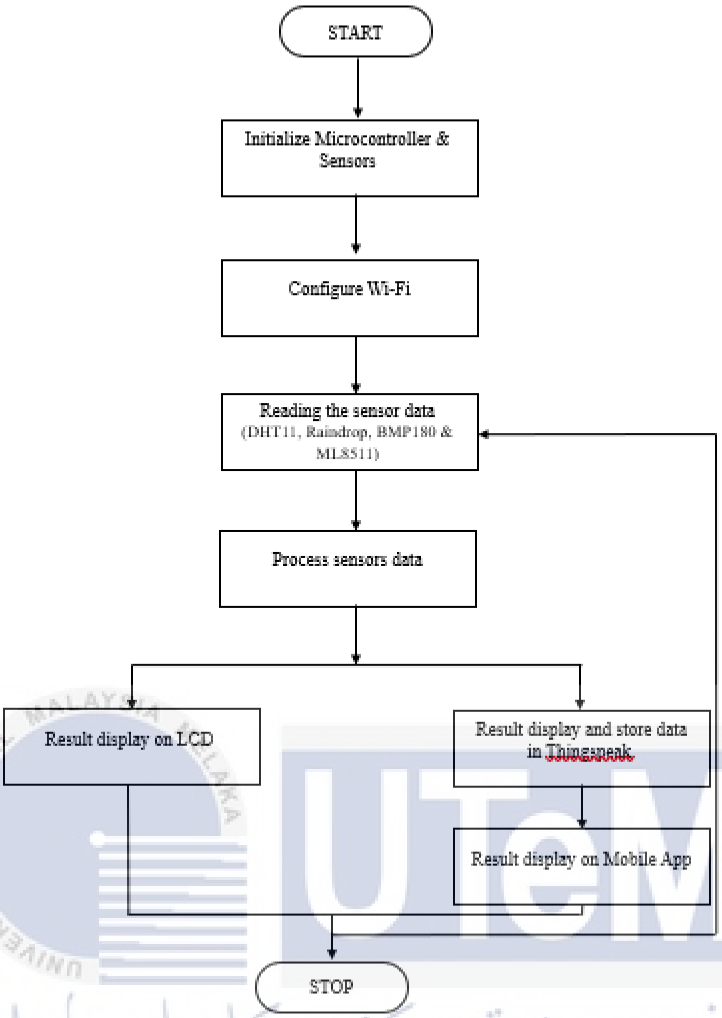

Figure 3.6 Flowchart

3.5.3 Schematic Diagarm

The figure 3.7 show the schemtic design fo weather monitoring system for this project. This schemtic consist of Nodemcu, DHT11, BMP180, Raindrop and ML8511sensor. All the sensors will connected properly to microcontroller. The solar panel is used to convert sunlight into electrical energy. The solar panel will charge the battery via a charger module TP4056. Then the MT3608 DC-DC boost module step up the power to make a microcontroller Nodemcu ESP8266 on.

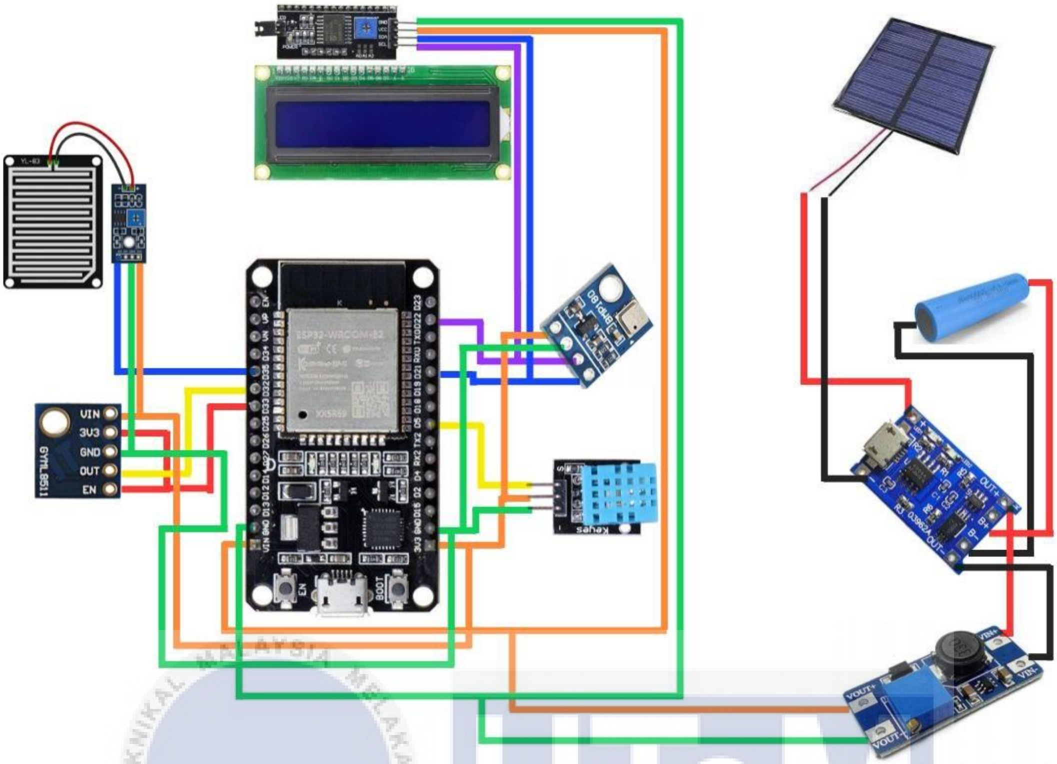

Figure 3.7 Schematic Diagram

3.6 Requirement for Location and Installation

A system for collecting, measuring, and storing weather data is called a weather monitoring system. This information is useful for additional analysis to understand climate change and for tracking weather patterns. The installation of the weather station is a multi-stage process, but the step that requires the most consideration to detail is choosing the location for the station, since this is the factor that most affects the accurateness of the data. When selecting a location for the installation of a weather station, there are various factors that need to be taken into consideration, including the following:

- Weather sensors and equipment must be firmly installed on a stable platform to avoid vibration or movement affecting the sensors.

- In order to obtain accuracy readings, it is necessary to position this system at the suitable heights and in the appropriate orientations.
- The system must be implemented in an area free of obstructions and interference. Additionally, the location of the system must be accessible for maintenance and restorations.

3.7 Limitations of the Project

The aim of this project is to use IoT ideas to make a prototype that shows how a weather monitoring system works. The chosen components may not be able to handle the complexities and demands of a realistic, large-scale deployment, even though they were successful in demonstrating the system's capabilities within the parameters of the project.

3.7.1 NodeMCU ESP8266

There is a possibility that the ESP8266 module has a restricted Wi-Fi range, particularly in surroundings that contain obstructions or interference, which may have an impact on the sending and receiving of data. During Wi-Fi transmission, the NodeMCU ESP8266 has the potential to use a significant amount of power, which may restrict applications that are powered by batteries and necessitate a substantial quantity of power supply requirements.

3.7.2 DHT11 (Temperature and Humidity Sensor)

The DHT11 sensor has an accuracy level that is approximately average. It is possible that it will not produce temperature and humidity readings that are extremely exact, and complications with calibration may occur over time, which will have an effect on the accuracy of the readings.

3.7.3 BMP180 (Barometric Pressure Sensor)

The changes in altitude have an impact on the barometric pressure readings obtained from BMP180. It is possible that this will result in inaccurate results, particularly in applications where there are considerable shifts in altitude.

3.7.4 Rain Sensor

The rain sensors can be classified according to sensor sensitivity to the specific forms of precipitation they detect. It is possible for the rain sensor to be triggered by specific environmental circumstances, such as dew or condensation, which can result in inaccurate data.

3.7.5 ML8511 (Ultraviolet Sensor)

It is possible for ultraviolet (UV) sensors to be sensitive to ambient light, which can have an impact on the accuracy of UV index readings, particularly in circumstances when the light conditions are varied.

3.8 Summary of Chapter 3

In conclusion, the methodology that was utilised in the development of this system has provided a comprehensive framework that has enabled the successful implementation of the project. The hardware and software requirements that are described in the methodology helped to determine the necessary components and sensors that are important for the functionality of the system. Block diagrams, flowcharts, and schematic diagrams are all components of the system design, which provides an illustration of the system's comprehensive architecture.

To ensure efficacy when creating this system, selecting the hardware and software components that were appropriate for the specific requirements and functionality of the project was crucial. In summary, the installation requirements that were covered in the methodology served as a guide while set up the system. In order to ensure that the system is installed correctly and that it will perform properly, there are a few crucial procedures on which we need to concentrate our attention.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter covers the outcome results of the development of an Internet of Things (IoT)-based weather monitoring system for real-time data collection using microcontrollers and sensors. This system will develop with the implementation of an Nodemcu ESP8266 and the result will be displayed with the support of the Thingspeak and mobile application. The microcontroller will interact with the sensors, and the data will be transmitted via wifi module that has built in Nodemcu ESP8266, which makes it possible to connect wirelessly. The DHT11 sensor will be used to measure the temperature and humidity of the environment, the raindrop sensor will read the amount of precipitation, the BMP180 sensor will sensed the pressure in the atmosphere and the ML8511 is to to detect the intensity of UV radiation. The process involved in this phase is responsible to establish how the project can achieve the objectives.

4.2 Interface Design

Interface design is crucial to a weather monitoring system's accessibility, functionality, and efficacy. These characteristics help physical components communicate smoothly, enabling reliable data gathering and improving the system's environmental resistance.

4.2.1 Sensor Installation

Figure 4.1 and figure 4.2 shows the installation of 4 sensors, which is DHT11 for reading the temperature and humidity, BMP180 is to read atmospheric pressure by measuring the changes in air pressure, the Raindrop semsor is to detect the rain and the ML8511 is to detect the intensity of UV radiation. All the sensors is mounted outside the box to easily detect the reading sensor data based on their function.

Figure 4.1 Installation DHT11, BMP180 and ML8511 Sensors

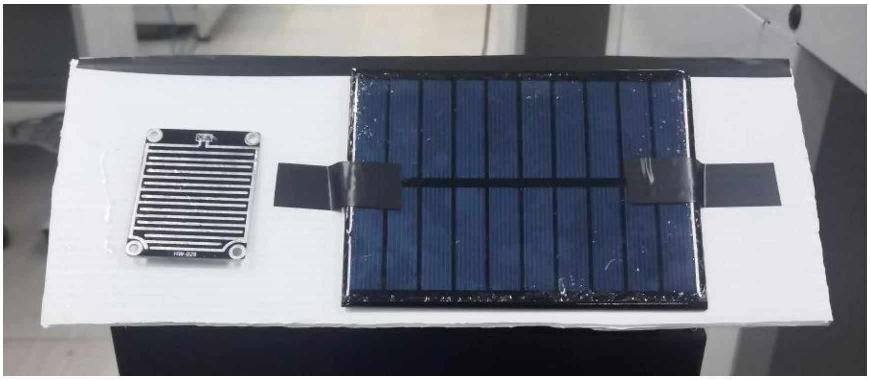

Figure 4.2 Installion Raindrop Sensors

4.2.2 Complete Installation

Figure 4.3 shows the complete installation of the weather station. From the above of the system is the solar panel, this device is designed to convert sunlight into electrical energy and transfer it to power supply. This project used casing to cover the circuit and all the sensors. The pvc pipe and the base of this weather station is attach to casing to make sure the stabilization.

Figure 4.3 Complete Weather Station

4.3 Hardware Configuration

The hardware setup phase is a very significant stage in the development of the weather monitoring system. During this phase, the weather station is tested in various outside situations that are representative of real-world conditions. During this phase, the adaptability, accuracy, and performance of the system are evaluated in the context of the natural environment, which is always shifting and unpredictable. A constant connection is maintained between the Internet of Things platform and the components that are optimized as part of the hardware setup. The figure 4.4 below shows that the weather station was tested outdoors.

Figure 4.4 Weather Station Testing Outdoor

4.4 Result and Analysis of Weather Station

The Result and Analysis of the Weather Station section goes into detail about the results of numerous tests that were carried out in a range of weather situations. This phase tests the weather station's outdoor data collection accuracy and reliability under various weather conditions. The investigation evaluates sensor data transmission from the NodeMCU ESP8266 to the ThinSspeak platform and mobile app synchronization.

4.4.1 Result in ThingSpeak

In terms of the results and analysis of the weather station performance, the integration with the ThingSpeak platform is a crucial aspect. Within the scope of this observation, the efficiency with which the platform receives, stores, and visualizes real-time data that is transmitted by the NodeMCU ESP8266 is the primary focus. The efficacy of the ThingSpeak implementation is crucial in determining the weather station's functioning and reliability under a variety of weather conditions.

4.4.1.1 Temperature and Humidity

In Figure 4.5 shows the result for temperature and humidity data. This data was collected using DHT11 sensor. Based on the temperature result, the data is showing an increase, while the humidity value is showing a decrease. On the basis of the relationship that has been established between temperature and humidity, it is often observed that the relative humidity tends to decrease as temperatures increase. This inverse relation is due to the fact that warmer air has the ability to store more water vapor than cooler air does. There is a correlation between an increase in rising temperatures and a decrease in humidity levels, which in turn influences the overall condition of the atmosphere.

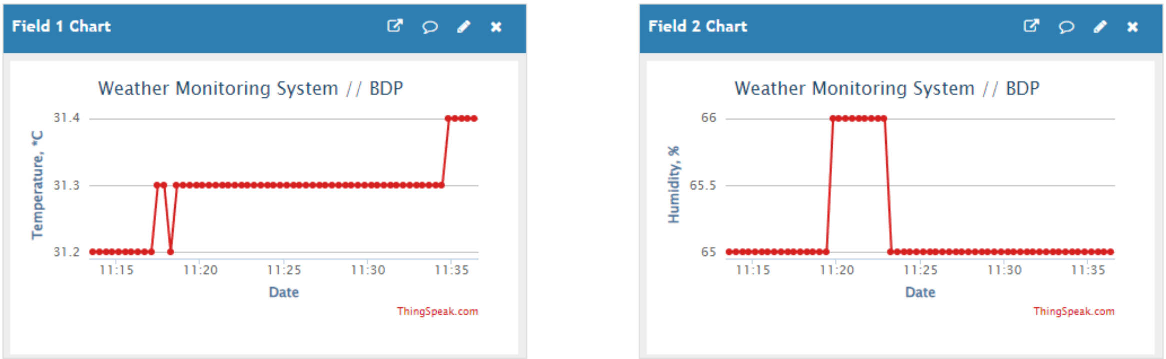

Figure 4.5 Temperature and Humidity Result in ThinngSpeak

4.4.1.2 Atmospheric Pressure

The BMP180 pressure sensor plays an important role in weather monitoring and providing information about atmospheric conditions through pressure measurements. The investigation of high-pressure and low-pressure systems, which have a considerable impact on weather patterns, is made possible by its data, which is frequently expressed in Pascals (Pa). The indicator of weather conditions that are constant high-pressure systems are characterized by a clear sky, light winds, and dry conditions. This is because descending air prevents the production of clouds. In contrast, low-pressure systems, which indicate the possibility of stormy weather, are associated with greater cloudiness, precipitation, and stronger winds as a result of rising air. The BMP180 usual measurement of atmospheric pressure is around 101325 Pa. The figure 4.6 below shows that the pressure data is not consistent because of the weather conditions.

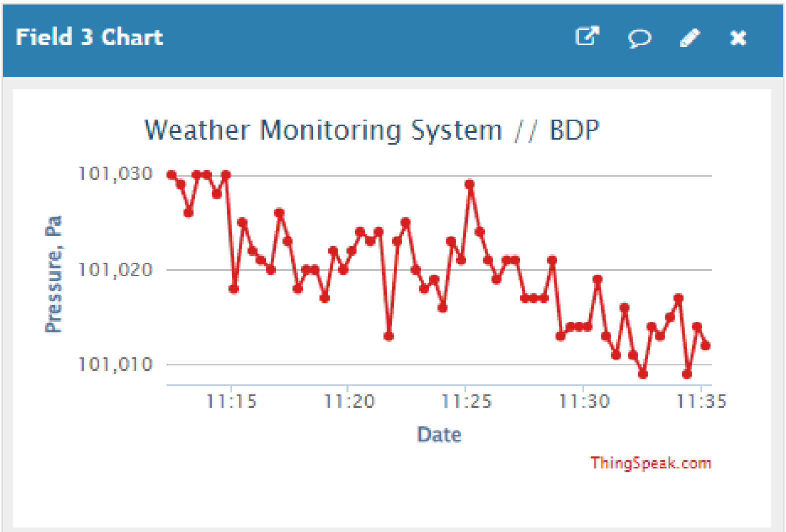

Figure 4.6 Pressure Result in ThingSpeak

4.4.1.3 Ultraviolet

In For the purpose of determining the level of ultraviolet radiation, which is a crucial component of weather monitoring, ultraviolet (UV) sensors are absolutely necessary. The ultraviolet (UV) index is measured by these sensors, which deliver crucial information regarding the potential health dangers and levels of sun exposure. The ultraviolet (UV) index normally falls somewhere between 0 and 11+, with higher values suggesting a higher UV intensity and the possibility of increased injury. A UV index that is low indicates that there is a low risk of harm from exposure to the sun without protection, whereas a UV index that is high indicates that measures are required. Considering the figure 4.7, the recorded value is lies is lower range and it indicates a low UV index.

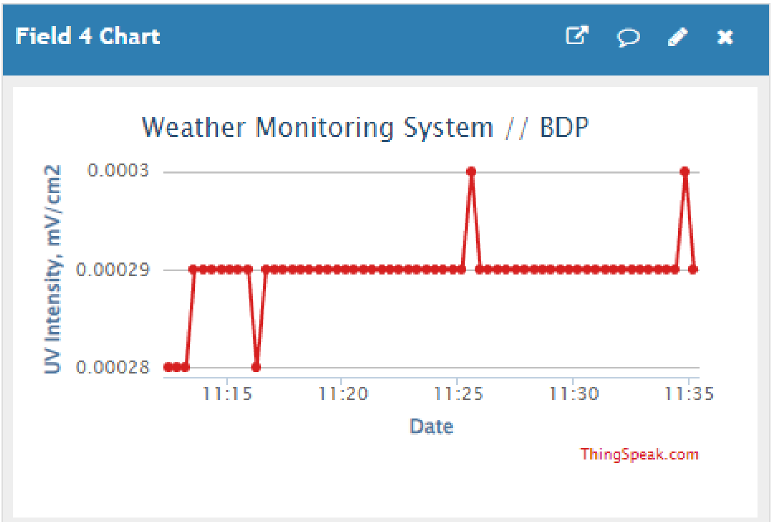

Figure 4.7 Ultraviolet Result in ThingSpeak

4.4.1.4 RainDrop

The purpose of the Raindrop data in ThingSpeak is to determine the weather station's ability in capturing and communicating rain-related information. Figure 4.8 illustrates some variations in precipitation values, the value 1 indicates no rain while 0 indicates raining. A planning raindrop testing was conducted by simulating a raindrop scenario in order to evaluate the ability to respond of the sensor.

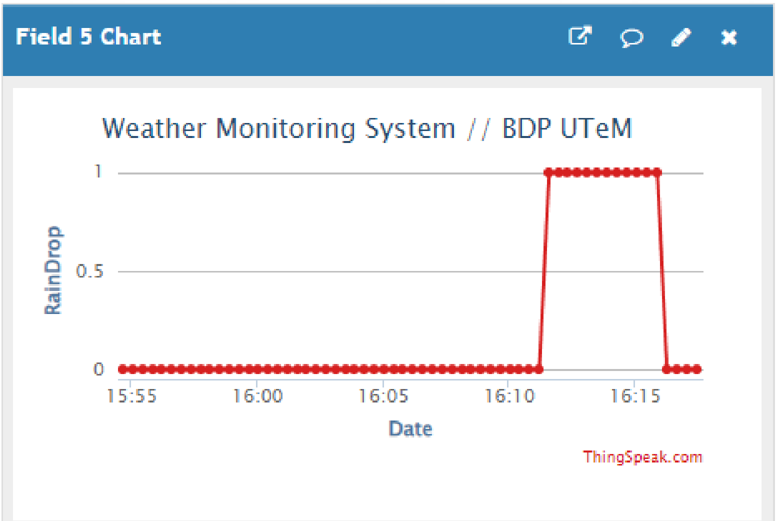

Figure 4.8 RainDrop Data in ThingSpeak

4.4.2 Mobile Application Result

In this project, the weather data is also displayed in the mobile application that has been created by using an MIT app invertor. Figure 4.9 shows the interface of the system in mobile application and the result of this system is shown in figure 4.10. When rain is detected, the red indicator will light up to alert the user as shown in figure 4.11. While green indicator lights up, indicates that is no rain.

Figure 4.9 Interface in Mobile Application

Figure 4.10 Sensor Data display in Mobile Application

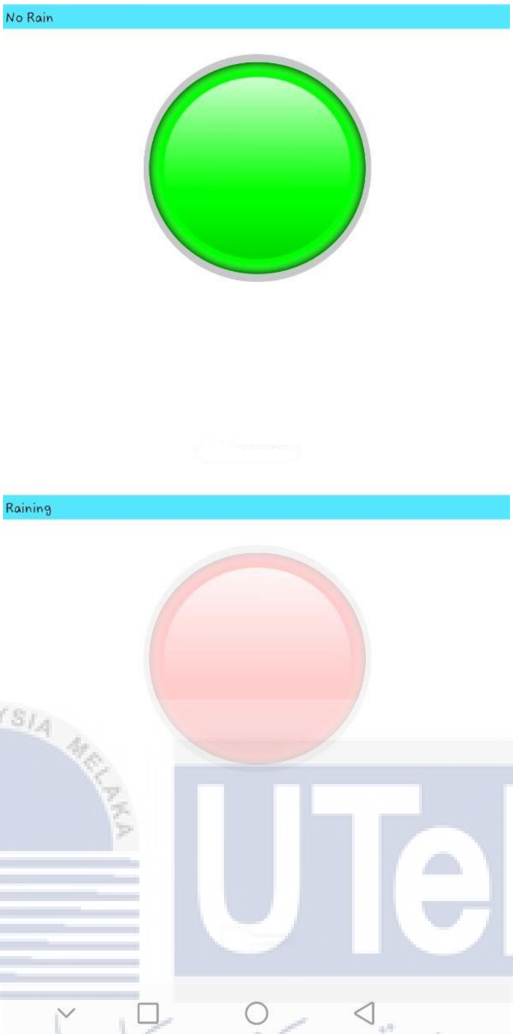

Figure 4.11 Rain Alert in Mobile Application

4.4.3 Analysis on Sensor Data for 5 days

The data acquired by the integrated sensors DHT11, the raindrop, the BMP180, and the UV sensors will be analyzed over the period of five days. In order to evaluate the system's overall reliability in real-time data collecting, this analysis attempts to clarify the performance of each sensor. For a full evaluation of the system's abilities, the longer testing time lets record a range of weather conditions.

4.4.3.1 Temperature and Humidity data

The observation of the data obtained by sensors for temperature and humidity in figure 4.12 and figure 4.13 over a period of five days reveals variable patterns, and it is definitely possible that these variations can be linked to the shifting weather conditions. There is a possibility that the rises in temperature data are a reflection of daily patterns, in which temperatures rise during the day and fall during the night. Cloud cover and other climatic variables are the things that could potentially have an impact on these patterns. This weather monitoring system is not intended to make a simultaneous comparison of sensors but rather to collect comprehensive measurements over a five-day period. This system evaluates the functioning and reliability of each sensor individually, as well as their overall performance over time.

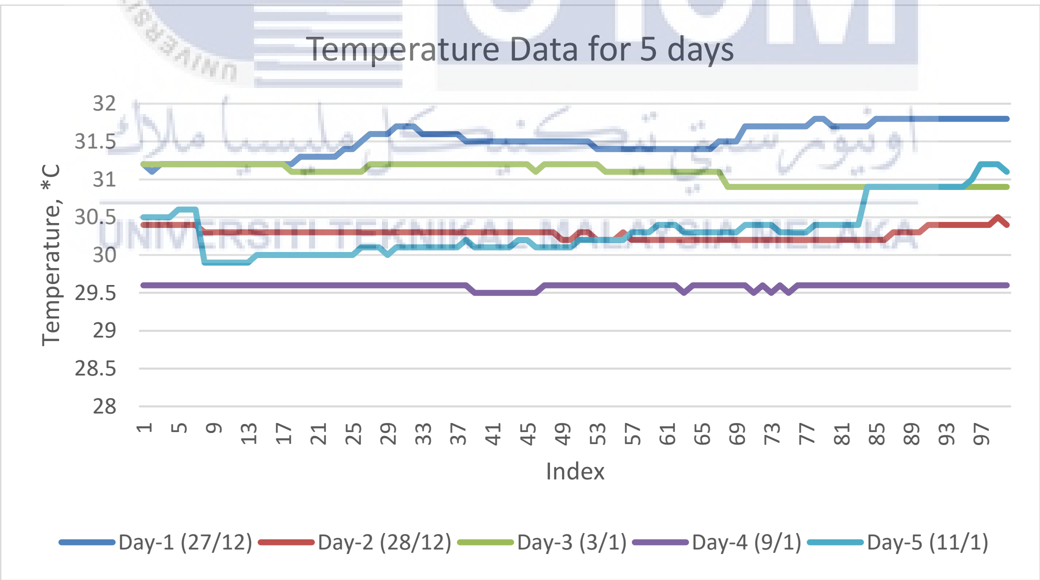

Figure 4.12 Temperature Data for 5 days

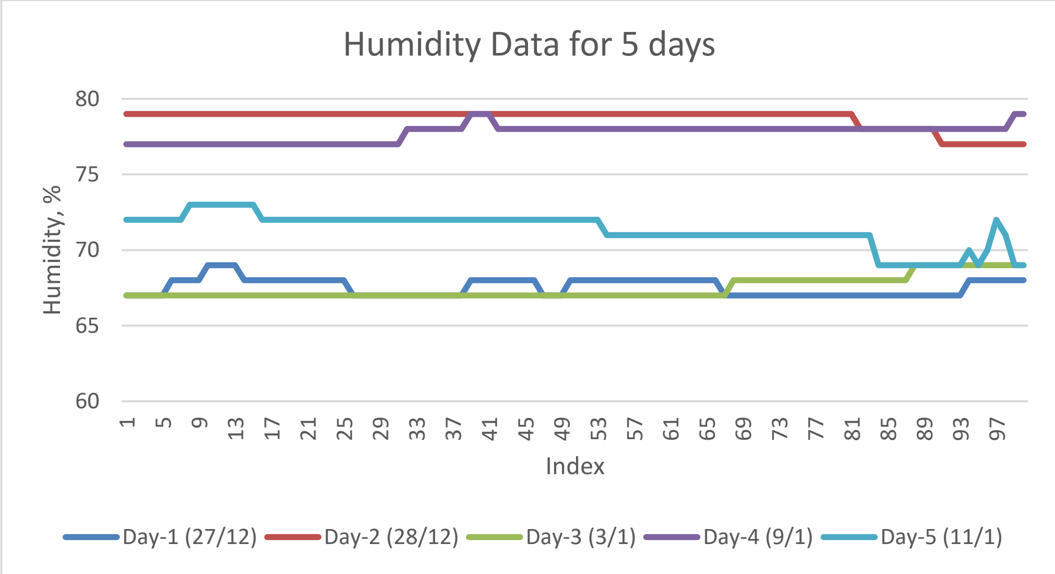

Figure 4.13 Humidity Data for 5 days

4.4.3.2 Atmospheric Pressure data

In a period of five days, the data collected by the atmospheric sensor was analyzed, and the findings revealed that the results are not consistent. The normal range of atmospheric pressure is around 101325 Pa. From figure 4.14 several factors may contribute to the variability in atmospheric pressure readings. Changing weather patterns, such as the presence of high-pressure or low-pressure systems, have the potential to have an impact on the pressure of the atmosphere. This weather monitoring system has no intention of performing a simultaneous comparison at the same time. The intention of this method is to give useful information about how reliable and functional the sensors are over a long period of time. This will allow a better evaluation of their suitability for long-term weather monitoring purposes.

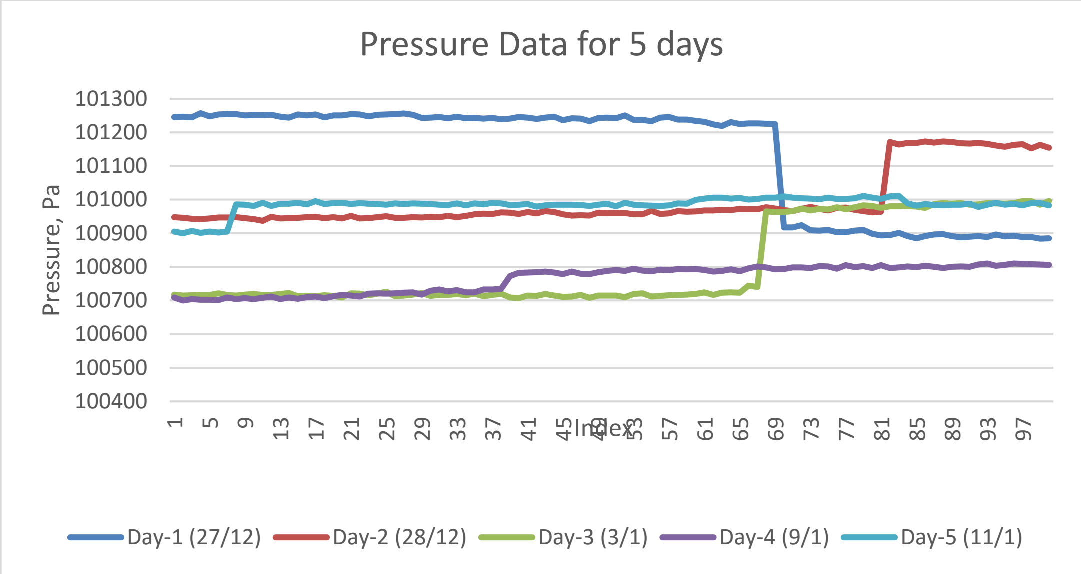

Figure 4.14 Pressure Data for 5 days

4.4.3.3 Ultraviolet data

According to figure 4.15, the results of the analysis of the collected sensor data for ultraviolet (UV) levels reveal values that are consistently low. The ultraviolet (UV) index range is normally between 0 and 11. A UV index of 0 shows minimal exposure to ultraviolet light, which suggests that the levels are extremely low. On the other hand, an index of 11 indicates that the UV intensity is extremely high, which suggests that there is a higher risk of sun related injury. The findings suggest that the data collected over a period of five days indicates a reduced risk of harm caused by exposure to the sun. The low UV index values that were recorded could be influenced by a variety of factors, including cloud cover, the time of day, and the conditions of the atmosphere. Another factor that can contribute to lower UV index values is the presence of cloudy skies or periods of less sunlight. Similar to atmospheric pressure data, this system has no intention to perform a simultaneous comparison but to evaluate sensor functioning and dependability.

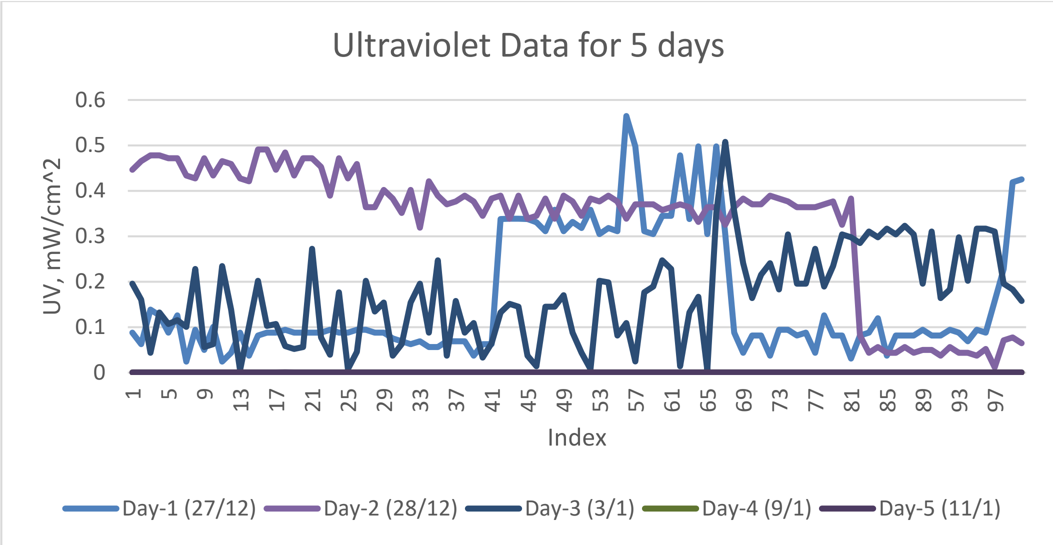

Figure 4.15 Ultraviolet Data for 5 days

4.4.3.4 RainDrop data

A detailed analysis of the Raindrop data over a five-day period provides significant information into the efficacy and dependability of our weather monitoring system. The purposeful testing under different weather situations allows to completely evaluate the raindrop sensor's capabilities. Variations in rainfall values are shown in figure 4.16. To evaluate the sensor's capacity to respond, planning raindrop testing was performed by creating a raindrop scenario. The changes in raindrop value are meant to help test how accurate and reliable the raindrop sensor. This makes sure that the experimental weather station gives useful information even when the weather changes. From figure 4.16 the decreasing in value of rain indicates that there is rain at the moment. Similar to ultraviolet data, the major purpose of this weather monitoring system is not to carry out a simultaneous comparison but rather to obtain a reading from the system. In order to determine the system functionality and reliability, this sensor is being tested.

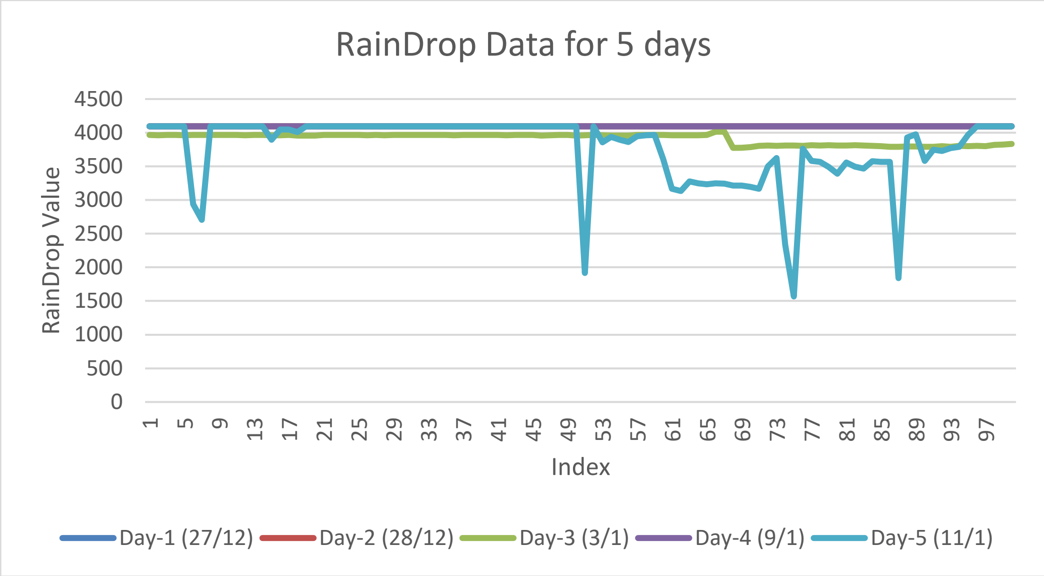

Figure 4.16 Raindrop Data for 5 days

4.4.4 Comparison between the experiment weather station with commercial weather station

Temperature and humidity readings from both the experimental weather station and the commercial weather station were carefully observed as part of the comparison study as shown in the figure 4.17. The experimental weather station's temperature readings are characterised by their precision and accuracy, as evidenced from the figure 4.18 and figure 4.19 the temperature difference between the two systems is slightly different. Furthermore, the humidity levels that were recorded by both stations are very similar to one another. This further demonstrates the dependability of the experimental weather station in terms of collecting data on the atmosphere. The experimental weather station appears to be a reliable instrument for monitoring and measuring the weather conditions, as evidenced by the similar results that have been obtained.

Figure 4.17 Comparison Experimental Weather Station and Commercial Weather Station

Figure 4.18 Result for Commercial Weather Station

Figure 4.19 Result for Experimental Weather Station

4.5 Discussion

The operation of the constructed system includes of two primary operations, which is hardware and software, respectively. In order for the physical devices to function properly, it is dependent on connections to the internet. The software connects the device by utilising the internet as a link. The fact that this system was developed using the Internet of Things (IoT) will prove to be very beneficial throughout the system implementation. Based on the first findings, the integration of a 4 sensors with an Nodemcu ESP8266 was successful develop. Thingspeak is an IoT platform that the project easily connects to and it can provide weather data that has been collected. This two-way communication guarantees that the Thingspeak platform is securely storing real-time weather data for additional analysis, in addition to making it accessible through the specialized mobile app.

4.6 Summary of Chapter 4

At the end of this project, the weather monitoring project have been implemented through the integration of Nodemcu ESP8266 and four sensors. This system is installed outside and allowing for accurate data collecting and monitoring. The system is analyze the current conditions, including the temperature, humidity,pressure, rain value and ultraviolet intensity. When all of the data have been collected by the system, it will then upload them to the Thingspeak for collecting data and also display to the Mobile application. All users are able to view the results and obtain accurate information regarding the current state of the weather within the application.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Finally, the Internet of Things (IoT) weather monitoring system has been developed. NodeMCU ESP8266 as the microcontroller with a various sensor such as raindrop, DHT11, BMP180, and UV sensors have been integrated to enable the real-time collection of data. The objective of providing users with real-time weather information from any place is achieved by the efficient transmission of this data to the ThingSpeak platform for display and collection data. It may also be accessed through the mobile application. Using solar panels to generate renewable energy improves the system sustainability, making it run continuously while being kind to the environment. An important accomplishment, the Internet of Things (IoT) weather monitoring system has been successfully implemented, demonstrating the ability to collect and transmit weather-related data without any issues. Additionally, the results are shown in real-time on the ThingSpeak platform and the mobile application, making them user-friendly and achieving the second purpose of the project. Aligning with the third purpose of the project, the important data collected is based on an analysis of each sensor's capabilities and functionalities. This data empowers users to make informed decisions based on reliable weather information.

The study demonstrates that the Internet of Things (IoT) technology is effective for monitoring the weather and also demonstrates the significance of utilizing renewable energy sources in order to make these systems more environmentally friendly. Following the successful completion of these objectives, the project will be able to make a significant contribution to the field of weather monitoring by offering a solution that is reliable, user-friendly, and environmentally friendly for the collection of real-time weather data.

5.2 Future Works

Future Work in the integration of weather monitoring system involves:

i) Make system function in offline and online when receiving data.

ii) Adding more sensors such as wind speed, wind direction and others related sensor to develop a complete weather station.

iii) Provide a reliable alerting system that can notify users of unexpected weather changes instantly.

5.3 Project Potential

The project has a lot of potential, especially when it comes to serving a wide group of customers. The system is suitable for people or communities that want accurate and up-to-date weather information because it is easy to use and can view data in real time. The good sensors and tools used in the project make sure that accurate data is collected. This system also beneficial for researcher to collect and analyze data for climate change studies.

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APPENDICES

Appendix A Gantt Chart BDP 1 & BDP 2

Task name	Stard date	End date	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
PROJECT TITLE SELECTION	3/20/2023	3/26/2023														
PROJECT RESEARCH -JOURNAL/ARTICLE	3/20/2023	4/2/2023														
STUDY OF COMPONENT & BLOCK DIAGRAM	3/27/2023	4/16/2023														
SELECTION OF COMPONENT	3/27/2023	4/17/2023														
REPORT WRITING : INTRODUCTION	4/3/2023	4/23/2023														
SIMULATION/SCHEMATIC DIAGRAM	4/3/2023	6/18/2023														
SUBMITTING PROGRESS 1	5/1/2023	5/7/2023														
REPORT WRITING LITERATURE REVIEW	3/27/2023	7/2/2023														
PROJECT DESIGN	5/8/2023	6/18/2023														
REPORT WRITING : METHODOLOGY	4/10/2023	6/18/2023														
REPORT WRITING : EXPECTED RESULT & CONCLUSION	4/10/2023	6/18/2023														
SUBMITTING PROGRESS 2	6/12/2023	6/18/2023														
SUBMITTING FINAL REPORT	6/19/2023	6/25/2023														
PSM 1 PRESENTATION	6/26/2023	7/2/2023														

Task name	Stard date	End date	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
BDP 2 BRIEFING	9/10/2023	15/10/2023														
PROJECT DEVELOPMENT	16/10/2023	22/10/2023														
CIRCUIT DESIGN	23/10/2023	29/10/2023														
CONSTRUCTION OF THE PROJECT HARDWARE	30/10/2023	5/11/2023														
THINGSPEAK DEVELOPMENT	6/11/2023	11/12/2023														
DOCUMENTION	13/11/2023	19/11/2023														
SUBMITTING PROGRESS 1	20/11/2023	26/11/2023														
TESTING THE PROJECT	4/12/2023	10/12/2023														
MAKING MOBILE APPLICATION	11/12/2023	17/12/2023														
TESTING AND TROUBLESHOOTING	18/12/2023	24/12/2023														
FINALIZE REPORT	25/12/2023	31/12/2023														
SUBMITTING PROGRESS 2	1/1/2024	7/1/2024														
SUBMITTING FINAL REPORT	8/1/2024	14/1/2024														
PSM 2 PRESENTATION	15/1/2023	17/1/2023														

Appendix B Coding NodeMCU ESP8266

```
#include <Wire.h>
#include <Adafruit_BMP085.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include "ThingSpeak.h"

#define DHTPIN D7
#define DHTTYPE DHT11

const char* ssid = "Huawei";        // your network SSID (name)
const char* password = "123456789";  // your network password
WiFiClient client;

unsigned long myChannelNumber = 2383069;
const char* myWriteAPIKey = "NXJO48EG3YF57BM4";

// Timer variables
unsigned long lastTime = 0;
unsigned long timerDelay = 20000;

int UVOUT = A0; //Output from the sensor
int REF_3V3 = D6;
const int rainSensorPin = D5;

DHT dht(DHTPIN, DHTTYPE);

int lcdColumns = 16;
int lcdRows = 2;
LiquidCrystal_I2C lcd(0x3F, lcdColumns, lcdRows);

Adafruit_BMP085 bmp;

float uvIntensity;

void setup() {
  Serial.begin(115200);
  pinMode(UVOUT, INPUT);
  pinMode(REF_3V3, INPUT);
  dht.begin();
  lcd.init();
  lcd.backlight();
  if (!bmp.begin()) {
    Serial.println("BMP180 Not Found. CHECK CIRCUIT!");
```

```
    while (1) {}
  }

  WiFi.mode(WIFI_STA);

  ThingSpeak.begin(client);
}

void loop() {
  if ((millis() - lastTime) > timerDelay) {

    // Connect or reconnect to WiFi
    if (WiFi.status() != WL_CONNECTED) {
      Serial.print("Attempting to connect");
      while (WiFi.status() != WL_CONNECTED) {
        WiFi.begin(ssid, password);
        delay(5000);
      }
      Serial.println("\nConnected.");
    }

    //DHT11
    float h = dht.readHumidity();
    float t = dht.readTemperature();  // or dht.readTemperature(true) for
Fahrenheit
    if (isnan(h) || isnan(t)) {
      Serial.println("Failed to read from DHT sensor!");
      return;
    }
    Serial.print("Temperature: ");
    Serial.println(t);
    Serial.print("Humidity: ");
    Serial.println(h);

    //BMP180
    Serial.print("Temperature = ");
    Serial.print(bmp.readTemperature());
    Serial.println(" *C");
    Serial.print("Pressure= ");
    Serial.print(bmp.readPressure());
    Serial.println(" Pa");

    //UV
    int uvLevel = averageAnalogRead(UVOUT);
    int refLevel = averageAnalogRead(REF_3V3);

    //Use the 3.3V power pin as a reference to get a very accurate output
value from sensor
```

```
    float outputVoltage = 3.3 / refLevel * uvLevel;
    uvIntensity = mapfloat(outputVoltage, 0, 4095, 0, 2.0);  //Convert the
voltage to a UV intensity level
    // Serial.print("output: ");
    // Serial.print(refLevel);
    // Serial.print("ML8511 output: ");
    // Serial.print(uvLevel);
    // Serial.print(" / ML8511 voltage: ");
    // Serial.print(outputVoltage);
    Serial.print("UV Intensity(mW/cm^2): ");
    Serial.print(uvIntensity);
    Serial.println();

    //Rain Sensor
    int sensorValue = digitalRead(rainSensorPin);  // Read the analog value
from the rain sensor
    Serial.print("Rain sensor value: ");
    Serial.println(sensorValue);  // Print the sensor value to the Serial
Monitor
    if (sensorValue == 1) {
    Serial.println("No Rain");
    lcd.clear();

    lcd.setCursor(0, 0);
    lcd.print("No Rain");

    delay(2000);
    lcd.clear();

  } else {

    Serial.println("It's Raining");

    lcd.setCursor(0, 0);
    lcd.print("It's Raining");

    delay(2000);
    lcd.clear();
    }

    ThingSpeak.setField(1, t);
    ThingSpeak.setField(2, h);
    ThingSpeak.setField(3, bmp.readPressure());
    ThingSpeak.setField(4, uvIntensity);
    ThingSpeak.setField(5, sensorValue);

    int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);
    if (x == 200) {
```

```
      Serial.println("X Channel update successful.");
    } else {
      Serial.println("Problem updating channel. HTTP error code " +
String(x));
    }

    lastTime = millis();
    //LCD
    lcd.setCursor(0, 0);
    lcd.print("Temprt= ");
    lcd.print(t);
    lcd.print(" *C");

    lcd.setCursor(0, 1);
    lcd.print("Humdty= ");
    lcd.print(h);
    lcd.print(" %");

    delay(2000);
    lcd.clear();

    lcd.setCursor(0, 0);
    lcd.print("Pressr= ");
    lcd.print(bmp.readPressure());
    lcd.print("Pa");


//UV
    if (uvIntensity <= 2) {
      Serial.println("UV Intensity = LOW");
      lcd.setCursor(0, 1);
      lcd.print("UV= ");
      lcd.print(uvIntensity);
      lcd.print(", LOW");
    } else if (uvIntensity >= 3 && uvIntensity <= 5) {
      Serial.println("UV Intensity = MODERATE");
      lcd.setCursor(0, 1);
      lcd.print("UV= ");
      lcd.print(uvIntensity);
      lcd.print(", MODERATE");
    } else if (uvIntensity >= 6 && uvIntensity <= 7) {
      Serial.println("UV Intensity = HIGH");
      lcd.setCursor(0, 1);
      lcd.print("UV= ");
      lcd.print(uvIntensity);
      lcd.print(", HIGH");
    } else if (uvIntensity >= 8 && uvIntensity <= 10) {
      Serial.println("UV Intensity = VERY HIGH");
```

```
      lcd.setCursor(0, 1);
      lcd.print("UV= ");
      lcd.print(uvIntensity);
      lcd.print(", VERY HIGH");
    } else {
      Serial.println("UV Intensity = EXTREME");
      lcd.setCursor(0, 1);
      lcd.print("UV= ");
      lcd.print(uvIntensity);
      lcd.print(", EXTREME");
    }
    delay(2000);
    lcd.clear();
  }
}

int averageAnalogRead(int pinToRead) {
  byte numberOfReadings = 8;
  unsigned int runningValue = 0;

  for (int x = 0; x < numberOfReadings; x++)
    runningValue += analogRead(pinToRead);
  runningValue /= numberOfReadings;

  return (runningValue);
}

float mapfloat(float x, float in_min, float in_max, float out_min, float
out_max) {
  return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;
}
```