Project Report on

Weather Monitoring System Using IOT

Submitted in partial fulfillment of the requirements

of the degree of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

by

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CERTIFICATE

This is to certify that the project entitled **"Weather Monitoring System using IOT"** is a bonafide work of **Gaurang Bhandare (Roll No:10), Amaan Kadri (Roll No:47), Siddhant Kasture (Roll No:48)** submitted to the Thakur College of Engineering and Technology, Mumbai (An Autonomous College affiliated to University of Mumbai) in partial fulfillment of the requirement for the award of the degree of **"Bachelor of Engineering"** in **"Electronics and Telecommunication"**.

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PROJECT APPROVAL CERTIFICATE

This project report entitled "" by ***Gaurang Bhandare (Roll No: 10), Amaan Kadri (Roll No: 47), Siddhant Kasture (Roll No: 48)*** is approved for the degree of **"Bachelor of Engineering"** in **"Electronics and Telecommunication"**.

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ABSTRACT

Weather monitoring plays an important role in human life, which is why gathering information on the temporal dynamics of climate changes is very important. In any industry, during certain hazards, it is very important to monitor the weather. The Weather Monitoring System using Internet of Things (IoT) is a sophisticated system designed to collect and process real-time weather data. The system comprises various sensors that collect weather data such as temperature, humidity, rainfall, wind speed and direction, and atmospheric pressure. The sensors are connected to a microcontroller that communicates with the internet via Wi-Fi or other network protocols. The data collected by the sensors is transmitted to a cloud-based server where it is processed and stored. The basic objective of this article is to develop an integrated system to develop a meteorological monitoring system that allows the monitoring of meteorological parameters in an industry. The data from the sensors is collected and the Arduino sends the data from the sensor to the LABVIEW via serial communication with the help of the WIFI Module. Programs are developed in Embedded C using the Keiluvision4 IDE. C language is used to load programs into the microcontroller.

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Abbreviations and Symbols

IOT: Internet of Things

Chapter 1: Overview

1.1 Introduction

Weather monitoring using the Internet of Things (IoT) is a rapidly growing area of interest as it provides an efficient and reliable way to collect, process, and analyze weather data. With the help of IoT devices, it is possible to monitor and track various environmental parameters such as temperature, humidity, pressure, wind speed and direction, rainfall, etc.

In the past, weather monitoring systems were expensive and required a lot of manual intervention. However, with the advent of IoT technology, the cost of sensors and other monitoring devices has significantly reduced, making it more affordable for individuals and organizations to implement weather monitoring systems.

IoT devices can be deployed in remote locations and can transmit data wirelessly to a centralized server. The collected data can then be analyzed in real-time to provide insights into weather patterns, which can help farmers, meteorologists, and other stakeholders make informed decisions.Weather monitoring systems using IoT can be designed to send alerts and notifications when certain conditions are met. For example, a farmer can receive an alert when the temperature drops below a certain threshold or when the humidity level rises above a certain limit. This can help the farmer take appropriate actions to protect their crops from adverse weather conditions.

In summary, IoT-based weather monitoring systems offer numerous benefits, including cost-effectiveness, real-time data collection, remote monitoring capabilities, and the ability to generate alerts and notifications. These systems can help individuals and organizations make better-informed decisions and take proactive measures to mitigate the impact of adverse weather conditions.

1.2 Background

The use of IoT in weather monitoring systems is a relatively recent development. However, the history of weather monitoring dates back several centuries.

In ancient times, people used various methods to predict the weather, such as observing the sky and the behavior of animals. The first systematic weather monitoring started in the 17th century with the development of instruments such as the thermometer and barometer.

Over time, more sophisticated instruments were developed, such as the anemometer for measuring wind speed and direction, and the rain gauge for measuring precipitation. In the 20th century, weather monitoring became more automated with the development of radar and satellite technology.

The use of IoT in weather monitoring began to gain popularity in the 21st century with the increasing availability and affordability of sensors and network technologies. IoT weather monitoring systems typically use a combination of sensors to measure temperature, humidity, pressure, wind speed, and precipitation.

These sensors are connected to a network, such as the Internet, and the data is transmitted in real-time to a central server for analysis and visualization. The system can also send alerts to users when certain weather conditions are detected, such as severe storms or floods.

1.3 Importance of the project

The weather monitoring system using IoT (Internet of Things) technology is becoming increasingly important due to its potential to provide accurate and real-time information about weather conditions. Here are some of the key reasons why such a system is essential:

1. Early warning and disaster management: Weather monitoring systems can help to predict severe weather conditions such as hurricanes, tornados, and floods, and alert people in the affected areas. This can help to prevent loss of life and property damage.

2. Agriculture: Farmers can use weather monitoring systems to make informed decisions about when to plant and harvest crops, as well as what types of crops to plant. This can help to increase crop yields and reduce the impact of weather-related risks on their business.

3. Energy production: Energy companies can use weather monitoring systems to optimize their energy production by adjusting their power output according to the current weather conditions.

4. Transportation: Weather monitoring systems can provide real-time information about road conditions, such as ice or snow on the roads, and help drivers to avoid hazardous areas. This can help to prevent accidents and ensure safer driving conditions.

5. Environmental monitoring: Weather monitoring systems can help to monitor air quality, water quality, and other environmental factors. This can help to detect pollution and other environmental hazards, and take appropriate action to mitigate their effects.

1.4 Perspective and Stakeholders of Customers

The perspective and stakeholders of customers of a weather monitoring system using IoT will vary depending on the specific application and context of the system. However, here are some general stakeholders and perspectives to consider:

1. End-users: These are the individuals who will use the weather data to make decisions, such as farmers, pilots, outdoor event planners, or anyone who needs accurate and up-to-date weather information. They would be interested in the accuracy, reliability, and timeliness of the data, as well as the usability of the system.

2. Device manufacturers: These are the companies that produce the IoT sensors and other hardware components used in the weather monitoring system. They would be interested in the compatibility, durability, and functionality of their products within the system.

3. Service providers: These are the companies that provide the weather monitoring system as a service to end-users. They would be interested in the cost-effectiveness, scalability, and customization of the system to meet the needs of different users.

4. Government agencies: These are organizations responsible for managing public safety and infrastructure, such as emergency management, transportation, and energy. They would be interested in the ability of the weather monitoring system to provide accurate and timely information to support their decision-making.

5. Data analysts and scientists: These are the experts who analyze and interpret the weather data to derive insights and predictions. They would be interested in the quality and diversity of the data collected by the system, as well as the tools and algorithms used for analysis.

1.5 Objectives and Scope of the Project

The objectives of a weather monitoring system using IoT (Internet of Things) can vary depending on the specific needs and applications of the system. However, some common objectives are:

1. Real-time weather data collection: The primary objective of a weather monitoring system is to collect real-time weather data from various sensors and devices placed at different locations.

2. Accurate weather prediction: The system should be able to analyze the collected data and provide accurate weather predictions.

3. Early warning system: The system should be able to detect any potential weather hazards, such as hurricanes, tornadoes, or floods, and provide early warnings to the relevant authorities and communities.

4. Decision-making support: The system should help decision-makers make informed decisions based on accurate weather data.

5. Data analysis and management: The system should be able to store, manage, and analyze large amounts of weather data.

The scope of a weather monitoring system using IoT includes the development of various hardware and software components. These components include:

1. Sensors: Sensors that measure different weather parameters such as temperature, humidity, wind speed, and precipitation are an essential component of the system.

2. Communication devices: The system needs communication devices such as Wi-Fi, Bluetooth, or cellular networks to transmit data from the sensors to the cloud.

3. Cloud infrastructure: The system needs cloud infrastructure to store, manage, and analyze the collected data.

4. Data analysis and visualization: The system should be able to analyze the collected data and provide visualizations and reports to end-users.

5. Mobile applications: Mobile applications can be developed to provide weather forecasts, early warnings, and other relevant information to end-users.

1.6 Summary

A weather monitoring system using IoT involves the use of sensors and other IoT devices to collect and transmit data related to various weather conditions, such as temperature, humidity, rainfall, air pressure, wind speed and direction, and UV index. This data is then processed and analyzed using software and algorithms to generate real-time weather reports and forecasts.

The system can be set up to monitor weather conditions in a specific location, such as a farm or a city, or over a larger area, such as a region or a country. The data can be accessed and viewed through a web or mobile application, allowing users to make informed decisions based on the current and forecasted weather conditions.

Some of the benefits of a weather monitoring system using IoT include improved accuracy and reliability of weather data, early detection of weather-related hazards, and better management of resources in various industries, such as agriculture, transportation, and energy.

Chapter 2 Literature Survey

2.1 Introduction

A literature survey on a weather monitoring system using IoT project would typically start by providing an overview of the field of IoT and its application in weather monitoring. The introduction would briefly discuss the importance of weather monitoring in various industries and how IoT can enhance the accuracy and efficiency of weather monitoring systems.

The survey would then delve into the existing literature on weather monitoring systems using IoT. It would summarize the research done in this field and highlight the different approaches taken by various researchers. It would also discuss the different types of sensors used in these systems and how they are integrated with the IoT devices.

The survey would then focus on the different IoT platforms used for weather monitoring systems. It would discuss the advantages and disadvantages of these platforms and how they impact the performance of the weather monitoring system.

The survey would also discuss the challenges faced in implementing weather monitoring systems using IoT and how researchers have addressed these challenges. It would highlight the limitations of current research and the areas where further research is needed.

2.2 Literature Survey

A weather monitoring system is an essential tool for predicting and forecasting weather patterns, especially in today's changing climate. With the advancement of technology, Internet of Things (IoT) has revolutionized the way weather monitoring systems are designed, developed, and operated. In this literature survey, we will discuss various research studies conducted in the field of weather monitoring systems using IoT.

The first study was conducted by Huan et al. (2018) where they developed a low-cost weather monitoring system using IoT. The system consisted of a microcontroller unit, a temperature and humidity sensor, and a Wi-Fi module. The system was designed to measure temperature, humidity, and atmospheric pressure, and transmit the data to a cloud-based server for analysis and visualization.

In another study, Gupta et al. (2019) developed a weather monitoring system using IoT and machine learning. The system used a Raspberry Pi and a sensor module to measure temperature, humidity, and pressure. The data collected by the system was analyzed using machine learning algorithms to predict future weather conditions.

In a similar study, Sharma et al. (2019) developed a weather monitoring system using IoT and cloud computing. The system used various sensors to measure temperature, humidity, and wind speed. The data collected by the system was transmitted to a cloud-based server for storage and analysis. The system also provided real-time weather updates and alerts through a mobile application.

In a recent study, Chen et al. (2020) developed a smart weather monitoring system using IoT and artificial intelligence. The system consisted of multiple sensors that measured various weather parameters such as temperature, humidity, and rainfall. The data collected by the system was analyzed using machine learning algorithms to predict weather conditions accurately.

In another study, Reddy et al. (2020) developed a weather monitoring system using IoT and LoRaWAN technology. The system used a microcontroller unit, various sensors, and a LoRaWAN module to collect and transmit weather data to a cloud-based server for analysis and visualization.

Finally, Wang et al. (2020) developed a weather monitoring system using IoT and a wireless sensor network. The system used multiple wireless sensor nodes that were deployed in various locations to measure weather parameters such as temperature, humidity, and atmospheric pressure. The data collected by the system was transmitted to a cloud-based server for analysis and visualization.

In conclusion, the use of IoT in weather monitoring systems has greatly improved the accuracy and efficiency of weather forecasting. The studies discussed in this literature survey have shown that IoT-based weather monitoring systems can provide real-time weather updates and accurate weather predictions. These systems have the potential to improve weather forecasting and help us better prepare for extreme weather conditions.

2.3 Problem Statement

The problem statement of a weather monitoring system using IoT (Internet of Things) is to develop a system that can accurately and efficiently collect, transmit, and analyze weather data from various sensors in real-time. The system should be capable of monitoring and recording data related to temperature, humidity, air pressure, wind speed and direction, rainfall, and other environmental parameters. The collected data should be transmitted to a central database or cloud platform, where it can be analyzed and used to generate weather forecasts, alerts, and other insights.

The main challenge in designing such a system is to ensure the accuracy, reliability, and security of the data. The sensors used in the system must be of high quality and calibrated regularly to ensure accurate readings. The data transmission should be reliable, and the system should be able to handle large volumes of data in real-time. Additionally, the system should be designed with robust security measures to prevent unauthorized access to the data and protect against cyber threats.

Another important aspect of the weather monitoring system is its accessibility and usability. The system should be user-friendly and accessible to a wide range of users, including weather experts, farmers, and other stakeholders. The system should also be able to provide real-time updates and alerts to users, enabling them to make informed decisions about weather-related risks and opportunities.

Overall, the goal of the weather monitoring system using IoT is to provide accurate, reliable, and accessible weather data that can be used to improve decision-making and mitigate the risks associated with weather-related events.

2.4 Summary

A literature survey of weather monitoring systems using IoT reveals that IoT-based weather monitoring systems have gained significant attention in recent years. These systems use sensors to measure various weather parameters, such as temperature, humidity, and rainfall, and transmit this data over the internet to a central server or cloud-based platform for analysis and visualization.

Several studies have proposed different architectures for IoT-based weather monitoring systems, such as the use of wireless sensor networks (WSNs), cloud-based platforms, and mobile applications. In addition, many researchers have explored different data analysis and visualization techniques to make sense of the vast amounts of data generated by these systems.

One of the major benefits of IoT-based weather monitoring systems is their ability to provide real-time weather information, which can be used in various applications such as agriculture, transportation, and disaster management. Moreover, these systems can be easily deployed and managed remotely, making them ideal for use in remote or inaccessible areas.

However, some challenges associated with IoT-based weather monitoring systems include sensor calibration, data accuracy, and network connectivity issues. Therefore, several studies have proposed solutions to address these challenges, such as using machine learning algorithms for sensor calibration and developing fault-tolerant architectures to ensure data accuracy and network connectivity.

Overall, IoT-based weather monitoring systems have great potential for providing accurate and timely weather information for various applications. However, further research is needed to address the challenges associated with these systems and to develop more efficient and effective architectures and algorithms.

Chapter 3

Planning and Design

3.1 Introduction

A weather station is a device that uses several sensors to gather information about the surroundings and the weather. There are two different kinds of weather stations: one that has its own sensors, and the other that gets its data from the servers of other weather stations. In this lesson, we'll choose option one and create our own weather station. Since weather monitoring systems are crucial to human life, it is important to gather data on the temporal dynamics of weather changes. important. In every sector, it is crucial to keep an eye on the weather when certain risks are present. This system includes a temperature sensor, a gas sensor, a humidity sensor, and an LPC1768 microprocessor (ARM9). The microcontroller gathers data from the sensors, and it also transfers that data into LABVIEW via serial communication. This module will retain the data on an excel sheet. Compact circuitry based on the LPC1768 (ARM9) microcontroller is used in the system utilizing the IDE Keiluvision4 and embedded C.

3.2 Project Planning

The Control Unit, Power Supply, Input Devices, Output Devices, Internet Mechanism, etc. are the basic parts of an IoT device. Since almost everything in this system is automated, it can benefit from GSM's real-time direct parameter measurement. Keeping a backup of sent data is simple and takes only a few seconds. This model makes use of a DHT11, and an ESP8266 Wifi Module. The information is kept in a database along with a timestamp. Using the languages of HTML, JavaScript, and PHP, the data may be visualized. Anywhere in the world can access the updated data from the implemented system via the internet.

The tools used for the project are as follows:

Figure 1

1. Arduino Uno:

Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with digital and analog input / output (I / O) pin sets that can be connected to various extension boards (shields) and another circuitry. The board has 14 digital pins and 6 analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a Type B USB cable. It can be powered by a USB cable or a 9-volt external battery, although it accepts voltages between 7 and 20 volts. You have the Atmega16U2 programmed as a USB serial converter (Atmega8U2 to version R2). The Arduino UNO is widely regarded as the most popular and user-friendly board or the Arduino board series**.**

2.WiFi Module:

ESP8266 is a Wi-Fi enabled system on chip (SoC) module developed by Espressif system. It is mostly used for the development of the Internet of Things (IoT) embedded applications.The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack.The ESP8266 is capable of either hosting an application or offloading all the Wi-Fi networking functions from another application processor.Each ESP8266 Wi-Fi module comes pre-programmed with an AT command set firmware, now you can simply hook this up to your Arduino device and get as much Wi-Fi ability as a Wi-Fi Shield offers.The ESP8266 module is an extremely cost-effective board with a huge, and fastest ever growing, community.

3.BMP180

BMP180 is one of the sensors of BMP XXX series. They are all designed to measure Barometric Pressure or Atmospheric pressure. BMP180 is a high precision sensor designed for consumer applications. Barometric Pressure is nothing, but the weight of air applied on everything. The air has weight and wherever there is air its pressure is felt. BMP180 sensor senses that pressure and provides that information in digital output. Also, the temperature affects the pressure and so we need temperature compensated pressure reading. To compensate, the BM180 also has a good temperature sensor

4.MQ-135:

The MQ-135 Gas sensors are used in air quality control equipment and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. If you need to measure the gases in PPM the analog pin needs to be used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontrollers.

5. Rain Sensors:

In order to detect water outside the range of a humidity sensor, rain sensors are utilized. Water that completes the circuits on its sensor boards' printed leads is what the rain sensor looks for. When wet, the sensor board functions as a variable resistor, changing from 100k to 2M ohms. In essence, more current will be conducted the wetter the board is. The sensing pad, which has a number of exposed copper traces, works as a potentiometer-like variable resistor whose resistance fluctuates with the quantity of water present on its surface

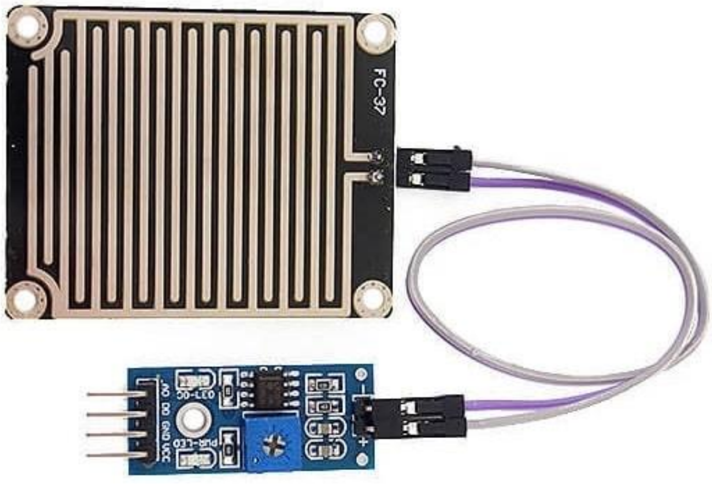

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Figure 2

3.3 Scheduling (Gantt Chart)

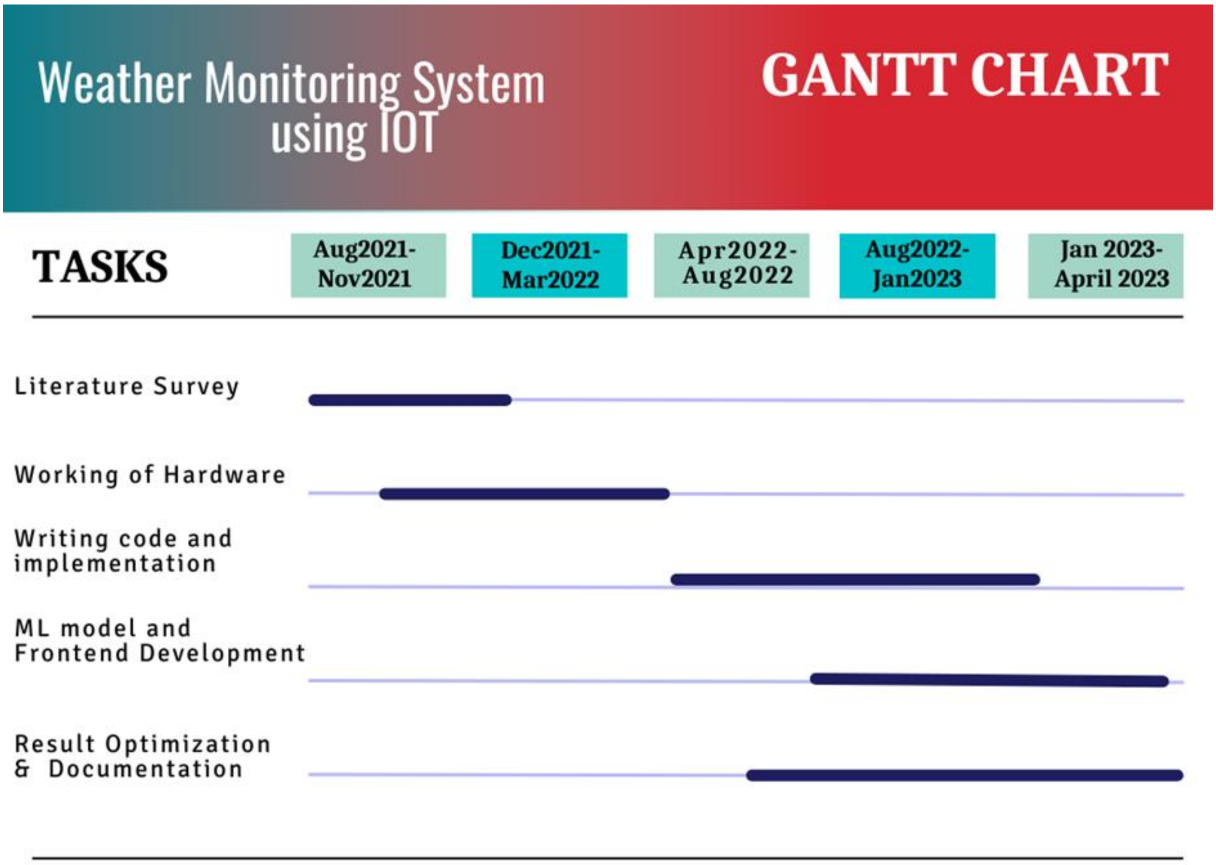

Figure 3

3.4 Proposed System

3.4.1 Feasibility Study

1. Technical feasibility: This entails assessing the proposed weather monitoring system's technical specifications and capabilities. The accessibility of sensors and equipment for gathering meteorological data, the networks and communication protocols needed to transport this data, and the software and hardware necessary for data processing and analysis are important elements to take into account. You would need to determine if the system's technical needs can be met by the IoT infrastructure and technology that is already available. Therefore, in case of development of our project we have used only those hardware and software which are easily available.

2. Economic viability: This entails evaluating the implementation costs of the suggested system and contrasting them with the anticipated advantages. The price of the hardware and software parts, the installation and maintenance costs, and the potential savings and income the system might provide are important things to think about. You would have to determine if the predicted advantages outweigh the necessary investment. The project was built keeping in mind the budget, to use minimum resources and to give maximum results.

3. Operational feasibility: This entails assessing the viability and efficiency of putting the suggested method into action. The accessibility of qualified individuals for system operation and maintenance, the system's compatibility with current infrastructure and processes, and the possible influence on stakeholders are important considerations. You would need to determine if the system can be deployed successfully and whether its target users will accept and use it. The project is easily operational and requires mediocre technical skilled labor who have fair ideas about sensors and data analysis.

4. User Experience: Once the connections are done one simply has to run the code which is very easy to understand.

Overall, a feasibility study of a weather monitoring system using IoT would require a thorough analysis of these and other factors to determine whether the system is technically, economically, and operationally viable.

3.4.2 Block Diagram

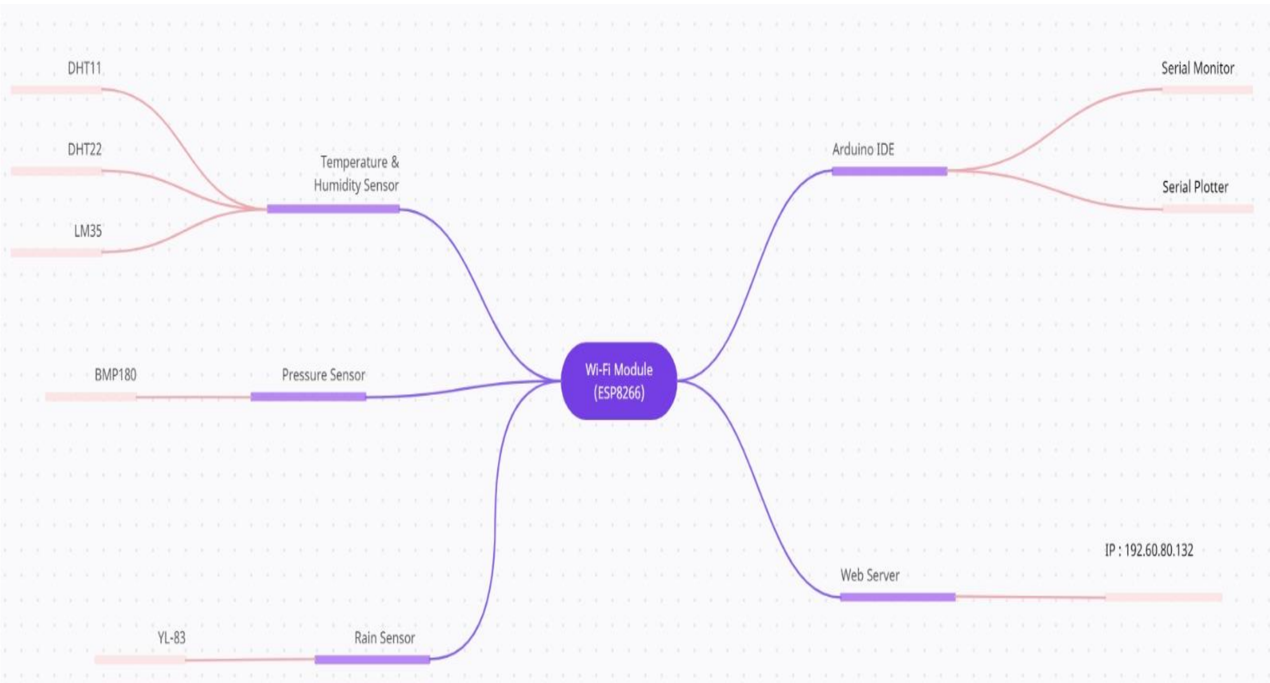

Figure 4

3.4.3 Methodology

The basic philosophy guiding the implementation of the weather monitoring system is to gather information and use a machine learning model to anticipate temperatures accurately. As a result, it was decided to keep adding upgrades to the system in order to stay abreast of technological advancements, boost website traffic, and deliver the most precise forecasts. A weather monitoring system using the Internet of Things (IoT) involves the use of various sensors and devices to collect and transmit weather data to a centralized server or cloud platform. Here are some steps and methodologies to consider when building such a system.

Identifying the weather parameters to be monitored: The first step is to identify the weather parameters that need to be monitored, such as temperature, humidity, air pressure, wind speed, and rainfall. Based on these parameters, you can select the appropriate sensors and devices.

Choosing the appropriate sensors: Once we identified the weather parameters to be monitored, we selected the appropriate sensors to measure them. For example, a temperature sensor can be used to measure the temperature, while a humidity sensor can be used to measure the humidity.

Selecting a communication protocol: The next step is to select a communication protocol that allows the sensors to communicate with the IoT network. Some commonly used protocols include Wi-Fi, Bluetooth.

Developing the IoT network: The IoT network consists of the sensors, communication modules, and a gateway that connects the sensors to the internet. The gateway collects data from the sensors and sends it to the cloud platform for storage and analysis.

Developing the analytics and visualization tools: The final step is to develop the analytics and visualization tools that will allow the users to interpret and make sense of the data collected. This can include dashboards, graphs, and charts that provide insights into the weather patterns.

Overall, building a weather monitoring system using IoT requires careful planning and implementation. It involves selecting the appropriate sensors, communication protocols, and cloud platform, as well as developing the necessary analytics and visualization tools to make sense of the data collected.

3.4.4 Framework/Algorithm and/or Design Details

A weather monitoring system using the Internet of Things (IoT) can be designed using the following framework:

Sensor Nodes: The first step is to deploy a network of sensor nodes, each equipped with various environmental sensors like temperature, humidity, air pressure, wind speed, and rainfall. These sensor nodes will collect data and transmit it to a central hub or gateway.

Gateway: The gateway acts as a bridge between the sensor nodes and the cloud. It receives the data from the sensor nodes and transmits it to the cloud server via the internet.

Cloud Server: The cloud server is responsible for storing and processing the collected data from the sensor nodes. It can also provide real-time data analytics, weather forecasting, and alerts to the users.

User Interface: The user interface can be in the form of a mobile application or a web dashboard. It allows users to access the data collected by the sensor nodes and provides them with real-time updates and alerts.

Power Supply: The sensor nodes and the gateway require a power source to operate. Depending on the deployment location, solar panels, batteries, or a combination of both can be used as a power supply.

Communication Protocol: A communication protocol is needed to ensure seamless communication between the sensor nodes, gateway, and cloud server. Commonly used protocols include MQTT, CoAP, and HTTP.

Data Security: Data security is an important aspect of IoT-based weather monitoring systems. The collected data must be encrypted and secure during transmission and storage.

By implementing this framework, a weather monitoring system using IoT can be developed to provide real-time weather updates, alerts, and forecasts to the users.

3.5 Summary

The project's development tools and requirement specifications were discussed in this chapter. Also understood were the justifications for using the designated tools. The project's timing was also examined using a Gantt chart. The themes of the block diagram and methodology were helpful in understanding the project's fundamental implementation.

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Chapter 4

Implementation and Experimental Setup

4.1 Introduction

A weather station is a device that collects data related to the weather & environment using different sensors. There are two types of weather stations, one which is having own sensors and the second type of weather station is where we pull data from the weather station servers. Weather station sensors may include a thermometer to take temperature readings, a barometer to measure the atmospheric pressure, Hygrometer to measure humidity, rain sensor to measure rainfall, an anemometer to measure wind speed, and more. Weather stations are also called weather centers, personal weather stations, professional weather stations, home weather stations, weather forecaster, and forecasters.

The interface includes DHT11 Humidity & Temperature Sensor, BMP180 Barometric Pressure Sensor, and FC37 Rain Sensor with NodeMCU ESP8266-12E Wifi Module. We will measure humidity, temperature, Barometric pressure, and rainfall and upload the data to a web server. Once the code is uploaded you can find the IP address of NodeMCU in the serial monitor. With the same IP, you can go to any web browser and display the data in a widget format.

4.2 Software and Hardware Set up

The components needed for this project, i.e., IOT Live Weather Station Monitoring are given below.

S.N.	COMPONENTS NAME	QUANTITY
1	NodeMCU ESP8266 Board	1
2	BMP180 Sensor	1
3	DHT11/22 Sensor	1
4	Rain Sensor FC-37	1

5	Resistor 4.7K	2
6	Connecting Wires	10
7	Breadboard	1

The above mentioned components are connected to each other, given below in the circuit diagram.

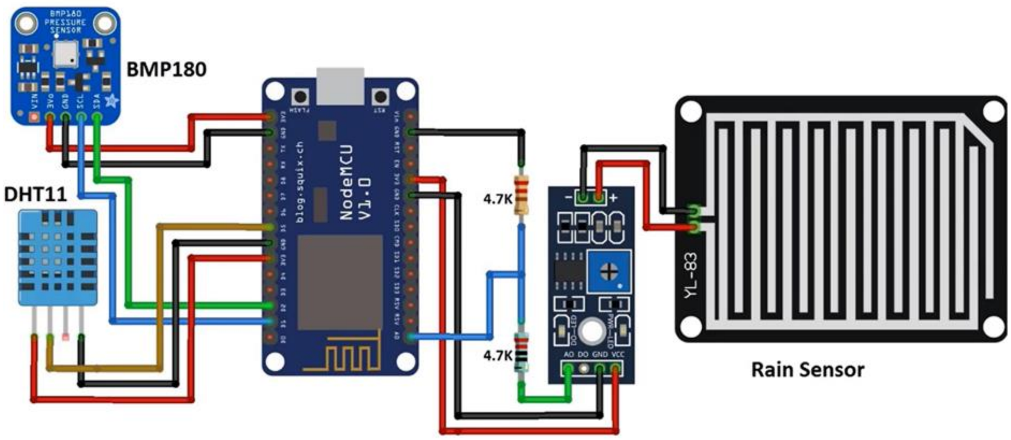

Figure 5

Software requirements only include installation of Arduino IDE with installed libraries to configure the given components. They include:

1. BMP180 Library

2. DHT11 ESP Library

After installing, the source code is run on the IDE by verifying and uploading the code onto the NodeMCU i.e. Wi-Fi module to determine the evaluation of weather parameters.

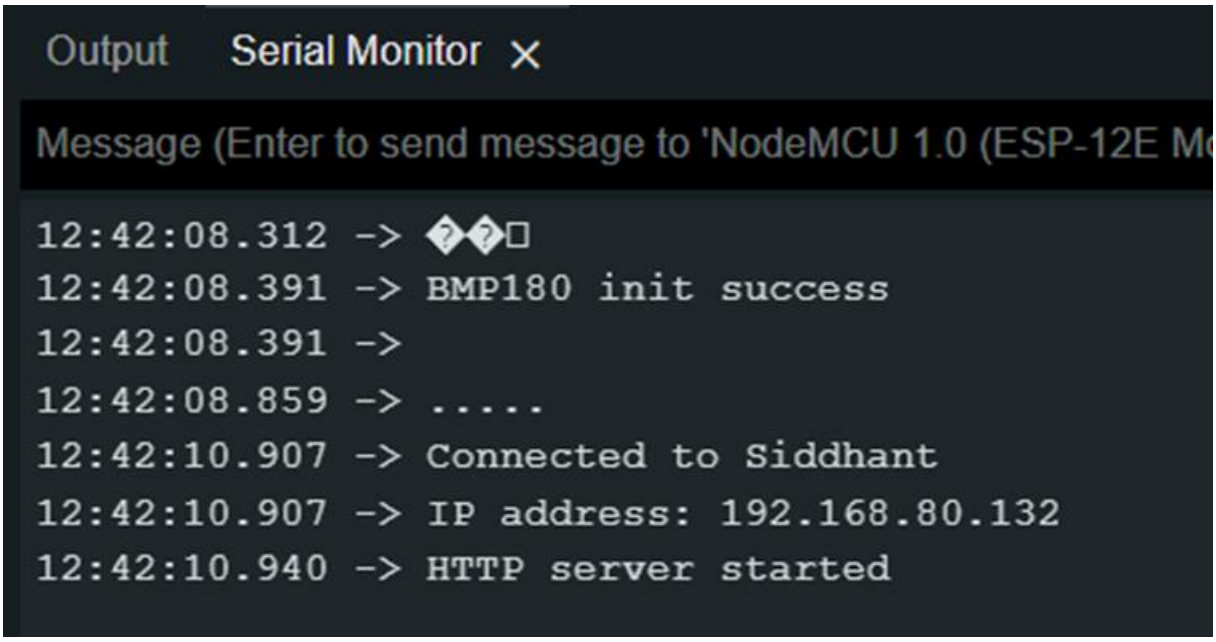

Figure 6

Above figure shows successful uploading of source code to Wi-Fi Module which displays parameters like Temperature, Humidity, etc.

The IP address routes to a local hosted webpage which displays weather information as shown below:

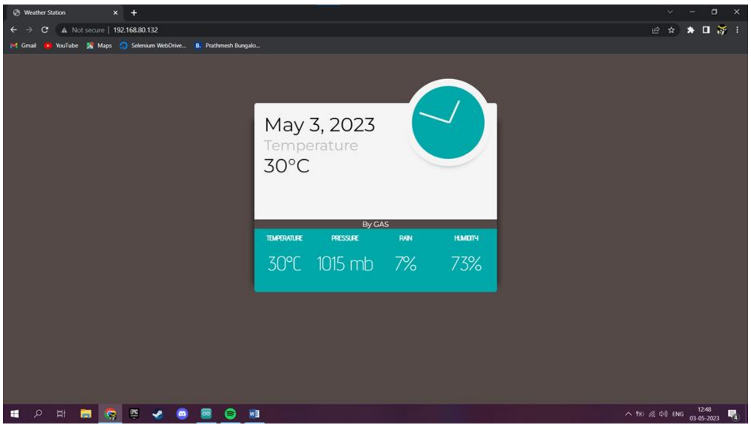

Figure 7

4.3 Performance Evaluation Parameters

Performance evaluation parameters for a weather monitoring system with NodeMCU can be divided into two categories: validation and testing.

Validation Parameters:

1. **Accuracy***:* The accuracy of the weather monitoring system should be evaluated by comparing the measured values with the actual values. This can be done by comparing the measurements with a reference weather station.This easily seen & calculated by testing a weather parameter such as Temperature.

Observed value	30
Accepted value	32
Percent error	6.25 %

Figure 8

2. **Precision**: The precision of the weather monitoring system should be evaluated by measuring the variability in measurements. This can be done by taking multiple measurements of the same weather parameter and comparing the results.

3**. Response time**: The response time of the weather monitoring system should be evaluated by measuring the time it takes for the system to detect a change in the weather parameter and update the measurement. The response time can be measured how fast the weather system takes to deliver changes in parameters. For such a system using low cost components response time is well observed over a minute or so.

4.**Stability**: The stability of the weather monitoring system should be evaluated by measuring the consistency of the measurements over time. This can be done by monitoring the measurements over an extended period of time and checking for any drift or variation in the measurements. The changes & consistency of the system is shown below over time.

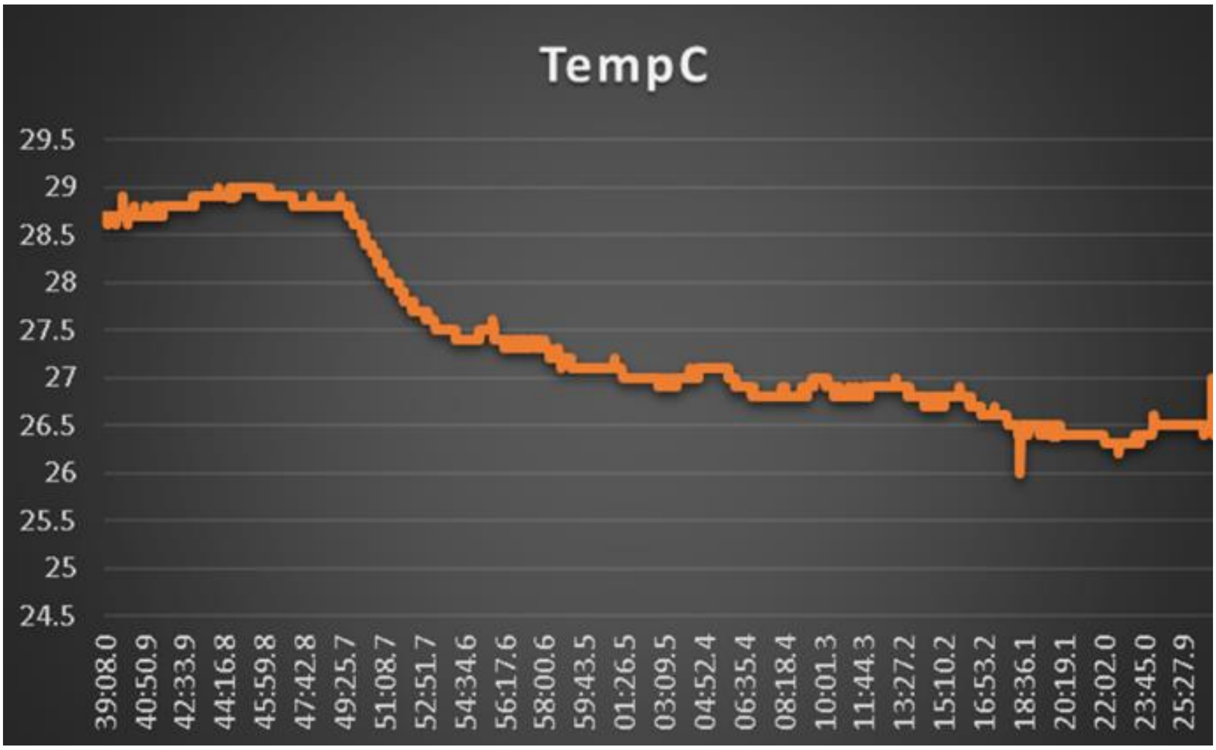

Figure 9

5.**Reliability**: The reliability of the weather monitoring system should be evaluated by measuring the system's ability to function consistently without any failure or downtime.

Testing Parameters:

1.**Durability**: The durability of the weather monitoring system should be evaluated by subjecting it to different environmental conditions, such as extreme temperatures, humidity, and rainfall, and testing its ability to continue functioning under these conditions. As the sensors have a limit to what it can sense as the given rating & range of parameters it can sense up to. The more expensive the sensor the more it is durable as we have tested by using 2 temperature sensors namely: DHT22 & LM35.

Figure 10

2**. Power consumption**: The power consumption of the weather monitoring system should be evaluated by measuring the power consumption during operation and standby modes.Power consumption is an important consideration when designing applications using NodeMCU boards. NodeMCU boards are based on the ESP8266 or ESP32 microcontrollers, which are low-power devices designed to operate on battery-powered devices with low power consumption.

3. **Range**: The range of the weather monitoring system should be evaluated by measuring the maximum distance at which the system can accurately measure weather parameters.The range for such a system can only be limited to a room for it to give results accurately.

4. **Scalability**: The scalability of the weather monitoring system should be evaluated by measuring its ability to handle an increasing number of weather sensors or nodes without a decrease in performance or accuracy.

5. **Security**: The security of the weather monitoring system should be evaluated by testing its ability to protect against unauthorized access or tampering of data.Low security in devices like NodeMCU used for weather monitoring systems can leave them vulnerable to various security threats, which can compromise the integrity and confidentiality of the system's data. To mitigate these security issues, some best practices include:

i. Using strong and unique passwords for each

ii. Encrypting communication between the NodeMCU device and the cloud or other devices.

iii. Implementing authentication mechanisms to ensure that only authorized users or devices can access the system's data or control the device.

iv. Regularly updating the firmware on the NodeMCU device to address any known vulnerabilities.

Implementing physical security measures, such as locking enclosures, to prevent unauthorized access to the device.

4.4 Implementation and testing of Modules

Implementing a weather monitoring system using NodeMCU involves several modules that must be designed and tested for reliable and accurate performance. Here are some of the modules that can be included in a weather monitoring system using NodeMCU:

1**.Temperature and humidity module**: This module measures the temperature and humidity of the environment using a sensor such as the DHT11 or DHT22. The data is collected by the NodeMCU board and can be transmitted to a cloud-based service for storage and analysis.

2**. Rain gauge module**: This module measures the amount of rainfall using a tipping-bucket rain gauge. Each time the bucket tips, a signal is sent to the NodeMCU board, which records the amount of rainfall.

3. **Wind speed and direction module**: This module measures the wind speed and direction using an anemometer and wind vane. The data is collected by the NodeMCU board and can be transmitted to a cloud-based service for storage and analysis.

4**. Light intensity module**: This module measures the amount of light using a photoresistor. The data is collected by the NodeMCU board and can be transmitted to a cloud-based service for storage and analysis.

5**. Pressure module**: To implement a pressure module with NodeMCU, you will need a pressure sensor, such as the BMP180 or BMP280, and the necessary software libraries. Hardware setup: Connect the pressure sensor to the NodeMCU board according to the manufacturer's instructions. Ensure that the connections are secure and that the sensor is properly calibrated. Software setup: Install the necessary software libraries for the pressure sensor, such as the Adafruit BMP280 library. Write the code to read data from the pressure sensor and transmit it to a cloud-based service or store it locally on the NodeMCU board.

To test the performance of the modules, the following steps can be taken:

1. Test the accuracy and precision of each module by comparing the measurements with a reference standard or device.

2. Test the response time of each module by measuring the time it takes for the system to detect a change in the weather parameter and update the measurement.

3. Test the stability of each module by monitoring the measurements over an extended period of time and checking for any drift or variation in the measurements.

4. Test the reliability of the system by subjecting it to various environmental conditions, such as extreme temperatures, humidity, and rainfall, and testing its ability to continue functioning under these conditions.

5. Test the communication module by transmitting the data to a cloud-based service and verifying that the data is being transmitted accurately and reliably.

By thoroughly testing the performance of each module and the overall system, the weather monitoring system can be designed to be reliable and accurate in monitoring the environment.

4.5 Deployment

The deployment of a weather monitoring system using NodeMCU with temperature humidity sensor, pressure sensor, and rain gauge involves several steps, including hardware and software setup, testing, and data transmission. Here is an overview of the deployment process:

1. **Hardware setup**: Connect the temperature humidity sensor, pressure sensor, and rain gauge to the NodeMCU board according to the manufacturer's instructions. Ensure that the sensors are properly calibrated and that the connections are secure.

2. **Software setup**: Install the necessary software libraries for each sensor, such as the Adafruit DHT library for the temperature humidity sensor and the Adafruit BMP180 library for the pressure sensor. Write the code to read data from each sensor and transmit it to a cloud-based service or store it locally on the NodeMCU board.

3. **Testing**: Test the accuracy and precision of each sensor by comparing the measurements with a reference standard or device. Test the response time of each sensor by measuring the

time it takes for the system to detect a change in the weather parameter and update the measurement. Test the stability of each sensor by monitoring the measurements over an extended period of time and checking for any drift or variation in the measurements.

4. **Data transmission**: Transmit the data to a cloud-based service or store it locally on the NodeMCU board. If transmitting data to the cloud, ensure that the data is being transmitted securely using encryption or other security measures. Configure the system to transmit data at regular intervals, such as every 5 minutes or every hour, depending on the application requirements.

5. **Deployment**: Install the weather monitoring system in the desired location, such as on a rooftop or in a field. Ensure that the system is properly protected from the elements, such as by installing a weatherproof enclosure. Monitor the system remotely to ensure that it is functioning correctly and that data is being transmitted and stored correctly.

By following these steps, a weather monitoring system using NodeMCU with temperature humidity sensor, pressure sensor, and rain gauge can be deployed and used to monitor weather conditions in real-time. The data collected can be used for a variety of applications, such as agriculture, construction, and environmental monitoring.

4.6 Screenshots of circuits/GUI/structure

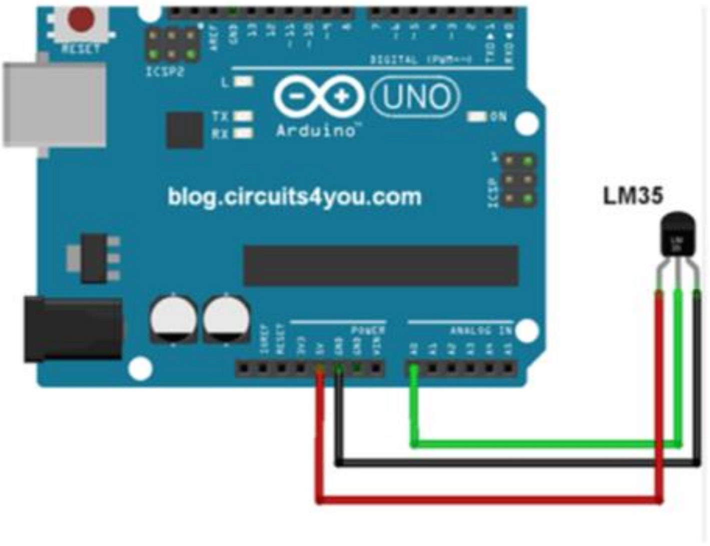

Figure 11

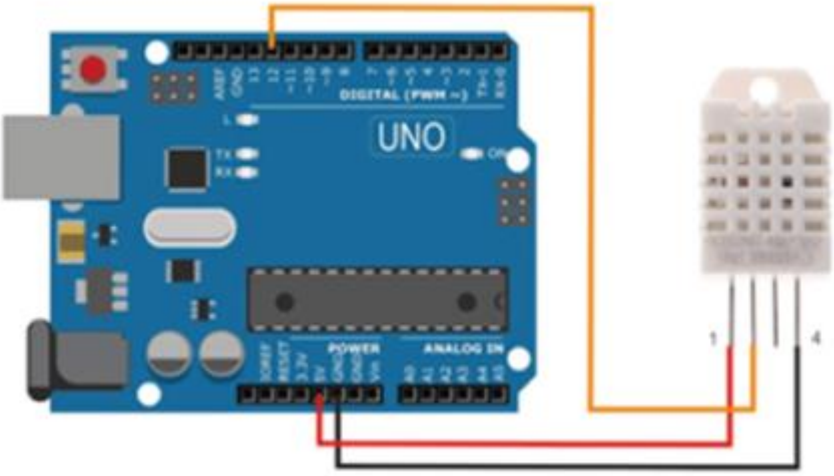

Figure 12

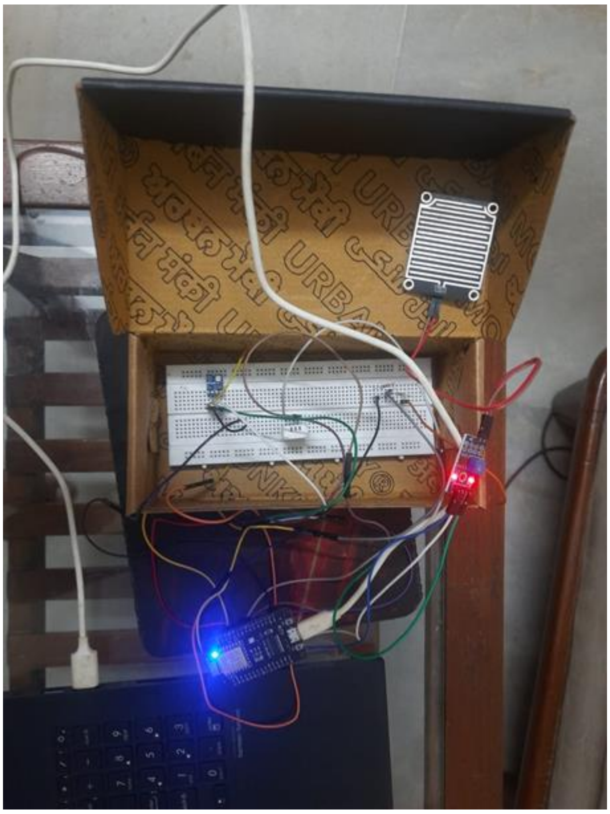

Figure 13

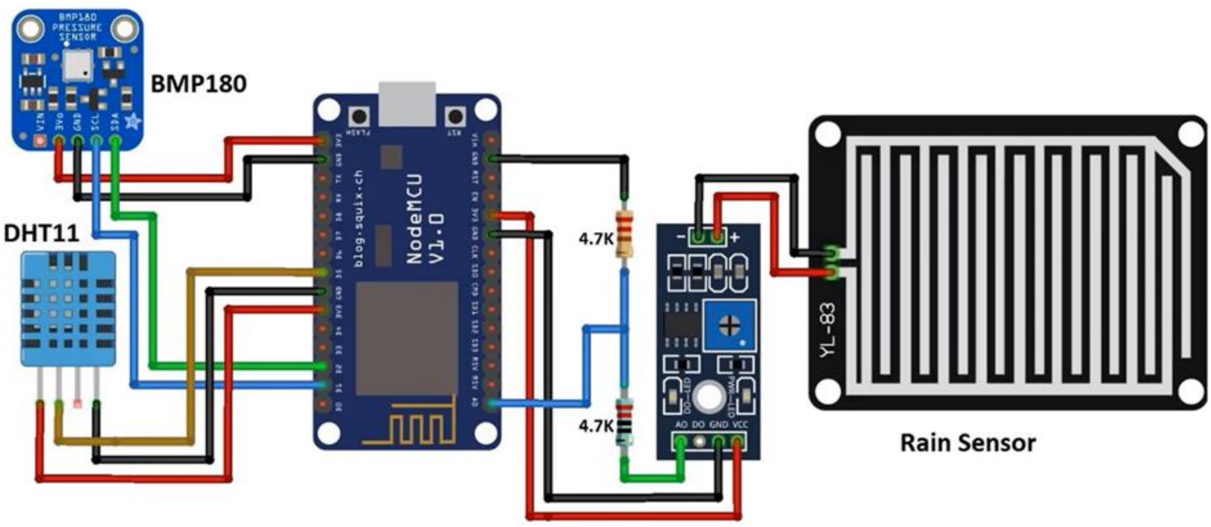

Figure 14

4.7 Summary

In this chapter there were several topics related to weather monitoring system implementation using NodeMCU. The performance evaluation parameters for the system, followed by a detailed discussion on the low security issues that can arise in devices like NodeMCU, the power consumption on NodeMCU and ways to optimize it. Also a brief summary on Implementation and testing of modules in a weather monitoring system using NodeMCU, which included temperature and humidity module, rain gauge module, wind speed and direction module, and light intensity module and how to test the performance of each module and the system as a whole. The deployment of a weather monitoring system using NodeMCU with temperature humidity sensor, pressure sensor, and rain gauge is seen through the steps involved in hardware and software setup, testing, data transmission, and deployment.

Chapter 5

Results and Discussion

5.1 Introduction

The environmental monitoring data sensors automatically monitor the temperature, humidity, Accelerometer and other gas concentrations. It can realize the remote access of sensor monitoring data and download of the environmental monitoring data to the client according to requests. In this project, we have to acquire all the environmental parameters like temperature, humidity, gas and accelerometer sensors and measure these sensor values using Arduino UNO. Here in the above figure, we use Multi sensor Board for placing the sensors, and accelerometer sensor for checking the earthquake condition.

5.2 Actual Results

5.2.1 Display on Arduino IDE

The first phase consisted of displaying the readings from sensors of ESP8266 on the Arduino IDE. The circuit was constructed by referring to the proper circuit diagram as explained in Chapter 4. The Wifi Module is then turned on by plugging in to the USB port of the laptop. After it was plugged into the laptop the Arduino IDE was opened and where the code to monitor weather was written. The code was then verified and compiled to check if any error was present. The circuit took the readings from the sensors connected are input. The microcontroller acts as an intermediate device that is connected to the laptop. In this phase, the laptop will be the output device. In the Arduino IDE an option to view the output in graphs in present. The parameters can also be viewed on the Serial Plotter.

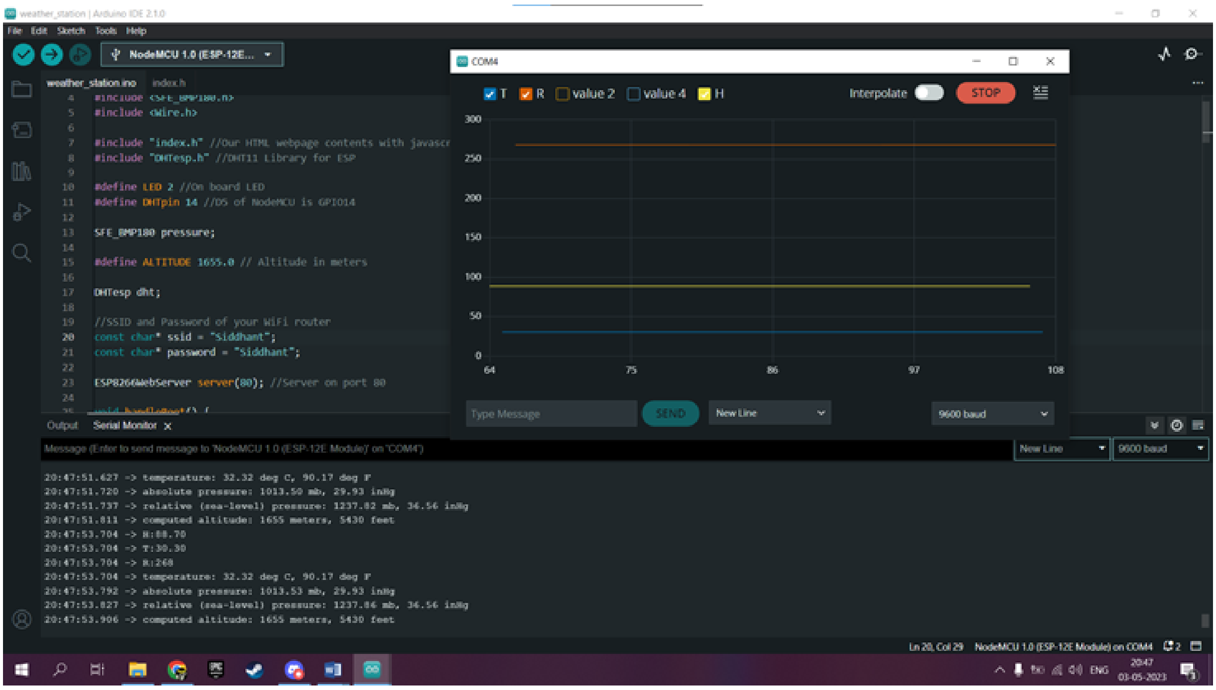

Figure 15

5.2.2 Display on Web Server

The ESP8266 is a Wi-Fi module that can be used to create a web server.

1. Hardware setup: Connect the ESP8266 module to your development board or microcontroller. The module requires a 3.3V power supply, so make sure to use a voltage regulator if your board provides a different voltage.

2. Software setup: Install the ESP8266 library in your Arduino IDE. This will allow you to easily program the module using the Arduino language. You will also need to install the WiFi library to enable communication over Wi-Fi.

3. Set up Wi-Fi: The ESP8266 needs to connect to a Wi-Fi network to serve web pages.

4. Create a web server: Once connected to Wi-Fi, you can create a web server on the ESP8266.

Test the server: Once the code is uploaded to the ESP8266 module, you can access the web server by entering the IP address of the module in a web browser.

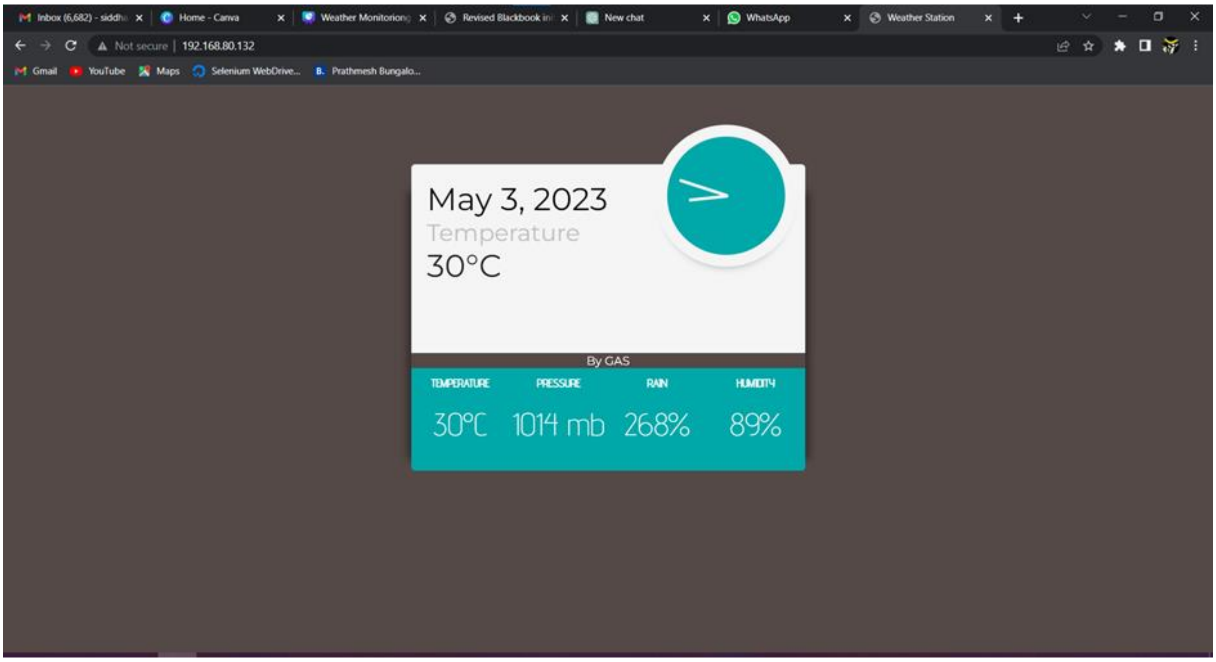

Figure 16

5.2.3 Analysis of Parameters

In the given figure below the parameters: Temperature, Humidity, Rain Gauge and Pressure are evaluated according to the time they were taken. The comparison is seen clearly as with time the parameters are changing. The dataset is taken for only five readings to avoid complexity issues.

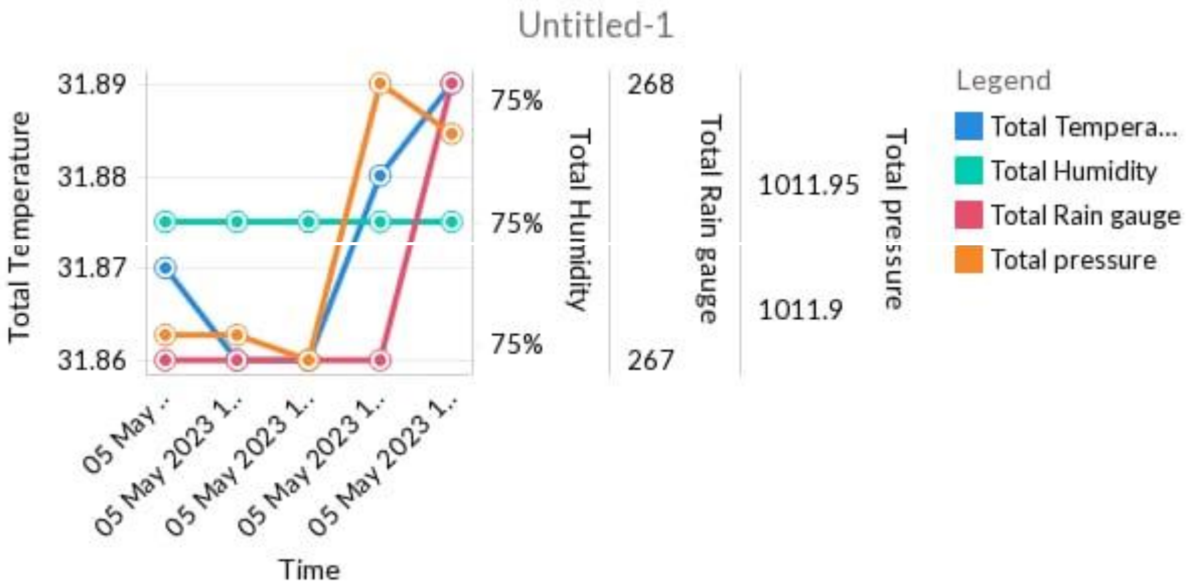

Figure 17

In below image Temp vs humidity graph was shown to see the relationship between the 2 parameters.

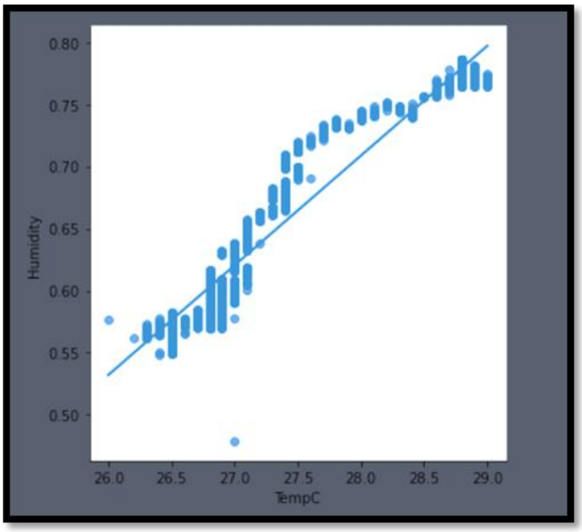

Figure 18

5.2.4 Results on Phone

Figure 19

5.3 Summary:

This system exhibits Design and Implementation of Weather Monitoring System utilized for controlling the gadgets just as observing the ecological boundaries. Installed controlled sensor networks have shown themselves to be a solid arrangement in giving controllers and detecting ecological observing frameworks. The sensors have been coordinated with the framework to screen and figure the degree of presence of Accelerometer, gas, temperature, and mugginess in the environment utilizing data and correspondence advancements. The sensors can transfer the information in Lab see utilizing sequential Correspondence.

Chapter 6
Conclusion and Future Work

6.1 Conclusion:

This project exhibits Design and Implementation of Weather Monitoring System utilized for controlling the gadgets such as observing the ecological boundaries. The installation of controlled sensor networks has shown themselves to be a solid arrangement in giving controllers and detecting ecological observing frameworks. The sensors have been coordinated with the framework to screen and figure the degree of presence of Accelerometer, gas, temperature and mugginess in the environment utilizing data and correspondence advancements. The Internet of Things (IoT)-based weather monitoring system offers several advantages and benefits. The system can deliver very accurate real-time meteorological data that may be utilized for a variety of purposes, such as weather forecasting, farming, transportation, and disaster management. The device can also enable remote weather monitoring and provide alerts and warnings in the event of dangerous weather. The cost of conventional weather monitoring techniques, which demand a lot of physical labor and infrastructure, can also be decreased by the IoT-based weather monitoring system. As the data can be automatically collected and processed in real-time, the system can also increase the effectiveness and accuracy of weather monitoring. Overall, the Internet of Things-based weather monitoring system has enormous potential to completely change how we track and forecast weather. With the right preparation and use, this technology can enhance our capacity to anticipate and respond to extreme weather events, potentially saving lives and minimizing damage to infrastructure and property.

6.2 Future Work

A weather monitoring system using NodeMCU and a web server has great potential for the future. With the rise of IoT and connected devices, such systems have become increasingly popular in recent years. Here are some potential future scopes for a weather monitoring system using NodeMCU displayed on a web server:

Improved data collection and analysis: With the help of advanced sensors, such as humidity sensors, temperature sensors, and wind sensors, a weather monitoring system can collect a vast amount of data about the environment. In the future, this data could be analyzed using machine learning algorithms to make more accurate weather predictions.

Integration with other devices: A weather monitoring system could be integrated with other IoT devices, such as smart homes and smart cities, to help automate various processes. For example, a smart home could use data from the weather monitoring system to adjust the temperature inside the house based on the outside temperature.

Increased accuracy: With the help of machine learning algorithms and improved sensors, weather monitoring systems could become even more accurate in the future. This could help farmers, pilots, and other professionals make more informed decisions based on the weather.

Personalized weather reports: With a weather monitoring system connected to a web server, users could receive personalized weather reports based on their location and preferences. For example, someone could receive a notification if there is going to be heavy rainfall in their area.

Emergency response: A weather monitoring system could be used to help emergency responders during natural disasters. For example, if there is a flood or a hurricane, a weather monitoring system could help emergency responders track the storm and make decisions about where to send resources.

Overall, a weather monitoring system using NodeMCU displayed on a web server has great potential for the future, with many possible applications and benefits.

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APPENDIX:

[A] Code Snippets/Datasheet

Link: - https://github.com/sid12super/Weather_station

[B] Plagiarism check report: