Weather Monitoring System Using IoT

B. Tech Project Report

Submitted to

GOVERNMENT COLLEGE OF ENGINEERING, JALGAON
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In partial fulfilment of the Requirement for the Degree BACHELOR of TECHNOLOGY in Electronics and Telecommunication Engineering.

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CERTIFICATE

This is to certify that the project work, "**Weather monitoring system using IoT**" which is being submitted here with for the partial fulfilment of the requirement for the **Degree of Bachelor of Technology in Electronics and Telecommunication Engineering**, is the result of the work completed by **GURU VIJAY HARSH, MADANKAR MAYUR DEBOJI , NIMSARKAR PUSHPAK SANTOSH , DAWARE DHRUV SHIVAJI,** under my supervision and guidance, with the declaration of students the work embodied in this project report has contributed to the best of my knowledge and belief.

Dr. S.C. Kulkarni
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DECLARATION

We hereby declare that the Project entitled, **"Weather monitoring system using IoT."** was carried out and written by us under the guidance of **Dr. S. C. Kulkarni** assistant Professor, Department of Electronics and Telecommunication Engineering, Govt. College of Engineering, Jalgaon. This work has not previously formed the basis for the award of any degree or diploma or certificate nor has been submitted elsewhere for the award of any degree.

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We extremely grateful to **Dr. S. P. Mohani**, Head of Department, Department of Electronics and Telecommunications, and thanks to **Prof. Suhas S. Gajre**, Principal, Government College of Engineering Jalgaon, for providing all the required resources for the successful completion of our project.

We express our thanks to all staff members and friends for all the help and co-ordination extended in bringing out this project successfully in time.

ABSTRACT

The "Weather Monitoring System Using IoT" project aims to develop a comprehensive weather monitoring system integrating Internet of Things (IoT) technology. The system is designed to measure key meteorological parameters, including temperature, humidity, wind speed, wind direction, light intensity in the surroundings, and rainfall.

Utilizing a GSM module, the collected data is seamlessly uploaded to a network, where it can be monitored in real time through the ThingSpeak platform. This enables users to access accurate and up-to-date weather information remotely.

The system focuses on collecting and displaying accurate weather data, providing users with valuable insights into current weather conditions. The integration of IoT enhances the system's ability to provide real-time and localized weather information, catering to a variety of applications, from agriculture to urban planning.

In summary, the "Weather Monitoring System Using IoT" project offers an innovative and scalable solution for real-time weather monitoring, leveraging the power of IoT technology to enhance data accuracy and accessibility.

(Keywords: Internet of Things (IoT), forecasting, weather monitoring, IoT)

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Chapter 1

INTRODUCTION

1.1 INTRODUCTION

In an era characterized by unprecedented technological advancements, the integration of Internet of Things (IoT) technology has revolutionized various aspects of daily life. One such application is weather monitoring, where IoT-based solutions offer real-time access to weather data, enhancing decision-making processes and improving overall preparedness. This project, titled "Weather Monitoring System Using IoT," seeks to leverage the power of IoT to provide accurate and timely weather information. By combining IoT sensors with advanced data collection techniques, our project aims to create a reliable system capable of delivering precise weather data.

The necessity for our project arises from the critical need for dependable weather information, especially in regions vulnerable to unpredictable weather phenomena. Conventional weather monitoring approaches, centered around centralized systems, often struggle to deliver timely and accurate updates, particularly in remote or geographically challenging areas. By harnessing the capabilities of IoT technology, our project aims to revolutionize weather monitoring by decentralizing these processes. Through the deployment of IoT sensors, we endeavor to provide communities with localized, real-time data, empowering them to make informed decisions and effectively manage weather-related risks and challenges [1].

This shift towards decentralized weather monitoring has the potential to significantly enhance resilience and preparedness in the face of dynamic weather patterns and climatic uncertainties. Through the incorporation of sophisticated data analysis techniques on the vast datasets gathered from IoT sensors, our system endeavors to produce accurate and actionable weather information. This approach enables us to provide users with valuable insights into weather conditions, facilitating informed decision-making and proactive measures to mitigate potential risks associated with fluctuating weather conditions [6].

1.2 OBJECTIVES

The objectives of this project are as follows:

- Real-time monitoring: IoT sensors gather meteorological data continuously, including temperature, humidity, and pressure, providing a comprehensive understanding of local weather conditions. This enables timely responses and informed decision-making.

- Integration of Sensor Data for Real-time Monitoring: Integrate data from IoT sensors measuring temperature, humidity, pressure, and other meteorological parameters to provide continuous and real-time monitoring of local weather conditions. This integration enables stakeholders to access up-to-date information for timely responses and decision-making.

- Development of User-Centric Interface: Used a user-friendly web application interface that allows stakeholders to visualize current weather data and forecasted trends in an intuitive and comprehensible manner. This interface should provide interactive features for exploring different parameters, enabling users to make informed decisions based on clear and actionable insights derived from the data.

- Scalability and Adaptability: Ensure that the system is scalable and adaptable to different environments and regions, allowing for easy expansion and customization based on specific local requirements.

1.3 ORGANISATION OF REPORT

Rest of the report is organized as:

1. Chapter 2 Literature Survey: This chapter reviews existing research on machine learning-based weather prediction and IoT monitoring systems, comparing methodologies, and discussing current technological advancements.

2. Chapter 3 System Overview: Provides a detailed overview of the IoT weather monitoring system, including block diagrams, circuit diagrams, algorithms, and flow charts, elucidating the system's design and architecture.

3. Chapter 4 Hardware and Software Description: Describes the hardware and software components used in the IoT weather monitoring system, outlining specifications and implementations for data collection, processing, and analysis.

4. Chapter 5 Result and discussion: Chapter 5 presents the results and discussion of the machine learning-based weather prediction and monitoring system using IoT. The chapter begins by showcasing the output of the system, including visualizations of temperature, humidity, wind speed, light intensity, air quality, and rainfall data collected over time.

5. Chapter 6 Conclusion and Future Scope: Summarizes project findings, discusses significance, and outlines potential areas for future research and development, providing insights into the system's contributions and prospects.

SUMMARY

This chapter 1 introduces the weather monitoring system using IoT, outlining its purpose and significance. It presents the main objectives of the project, including real-time weather data collection, integration with smart systems, and development of a user-friendly interface. Additionally, this chapter details the organization of the report, providing a roadmap of the subsequent chapters that cover the design, implementation, and analysis of the system.

Chapter 2

LITERATURE SURVEY

Weather Prediction and Climate Analysis using Machine Learning: In the collaborative work authored by Christina Mary Jolly, Safna K.M, and Dr. S. Brilly Sangeetha, titled "Weather Prediction and Climate Analysis using Machine Learning," a comprehensive review of machine learning techniques for weather prediction is presented. The paper explores various methodologies, including linear regression, support vector machine, artificial neural network, random forest, k-nearest neighbour, among others.

The authors delve into the challenges and limitations associated with these techniques, addressing concerns such as data quality, scalability, and interpretability. The paper concludes by asserting that machine learning has the potential to enhance the accuracy and efficiency of weather forecasting, offering valuable insights for further advancements in the field [4].

Temperature Forecast Using Ridge Regression as Model Output Statistics: In their paper titled "Temperature Forecast Using Ridge Regression as Model Output Statistics," Niswatul Qona'ah, Sutikno, Kiki Ferawati, and Muhammad Bayu Nirwana address the challenges of high bias in numerical weather forecasting techniques, particularly in Indonesia. They propose Ridge Regression as Model Output Statistics (MOS) to improve temperature forecasts. Utilizing maximum temperature (Tmax) and minimum temperature (Tmin) observations from four stations in Indonesia, with Numerical Weather Prediction (NWP) as predictor variables, the study demonstrates the efficacy of Ridge Regression in reducing bias. Results indicate intermediate to good performance, with Tmax RMSEP ranging from 0.9 to 1.2 and Tmin from 0.5 to 0.8, surpassing NWP accuracy by up to 90.49% for Tmax forecasting [6].

IoT Weather Forecasting Using Ridge Regression Model: "IoT Weather Forecasting Using Ridge Regression Model" by Karthik G. Dath and K. E. Krishnaprasad introduces an innovative initiative leveraging Internet of Things (IoT) technology for weather forecasting. The project aims to deliver real-time weather forecasts accessible via a website. Utilizing multiple sensors, including those for temperature, humidity, rain, and pressure, the Weather Forecasting system collects data to generate accurate forecasts and analyze atmospheric conditions.

Through the integration of IoT, the project facilitates convenient access to weather information for consumers anywhere and anytime. Data storage is managed by a real-time database using Firebase, with visualization provided through a dashboard designed using React JS [3].

Real Time Weather Prediction System Using IOT and Machine Learning: This paper introduces a survey of data mining techniques for weather prediction and concentrates on their advantages. The paper also describes a system that uses IoT devices to collect meteorological data from various sensors and sends it to a cloud server where it is processed by machine learning algorithms. The system then provides real-time weather predictions to the user through a web interfaces [2].

Weather Prediction using Machine Learning and IoT: In their project, "Weather Prediction using Machine Learning and IoT," Gopinath N, Vinodh S, Prashanth P, Jayasuriya A, and Deasione S propose a novel method for forecasting weather conditions and predicting rainfall by leveraging machine learning and IoT technologies. The system comprises two setups: one for measuring weather parameters like temperature and humidity using sensors connected to an Arduino, and another for displaying current values and predicted rainfall based on trained machine learning datasets.

The authors explain that weather forecasting is conducted by comparing historical datasets with current measurements, eliminating the need for users to maintain large data backups. The integration of machine learning algorithms enhances the prediction accuracy, allowing the system to provide reliable real-time weather updates and rainfall predictions [1].

SUMMARY

This literature survey examines advancements in weather prediction using machine learning and IoT technologies. Various studies, such as those by Christina Mary Jolly et al. and Niswatul Qona'ah et al., review machine learning techniques and propose the use of Ridge Regression to enhance temperature forecasting accuracy. Additionally, Karthik G. Dath and K. E. Krishnaprasad introduce an IoT-based system for real-time weather data collection and forecasting. The survey highlights the potential of these technologies to improve the accuracy and accessibility of weather information.

Chapter 3

METHODOLOGY

3.1 BLOCK DIAGRAM

Figure 3.1 shows the block diagram of weather monitoring system using IoT it consists of Arduino Mega board, Anemometer, Rain Gauge meter, GSM/GPRS SIM900A, DTH11, LDR, LM35, MQ -135 gas sensor and dc to dc buck converter. Arduino mega is heart of this system.

The Arduino Mega board captures and processes all this data using input sensor and controller. The data then be sent to a ThingSpeak IoT cloud server via the GSM/GPRS module. Then IoT cloud server used to show weather data via a website or mobile app. The data can also utilize to train a machine learning model for temperature prediction.

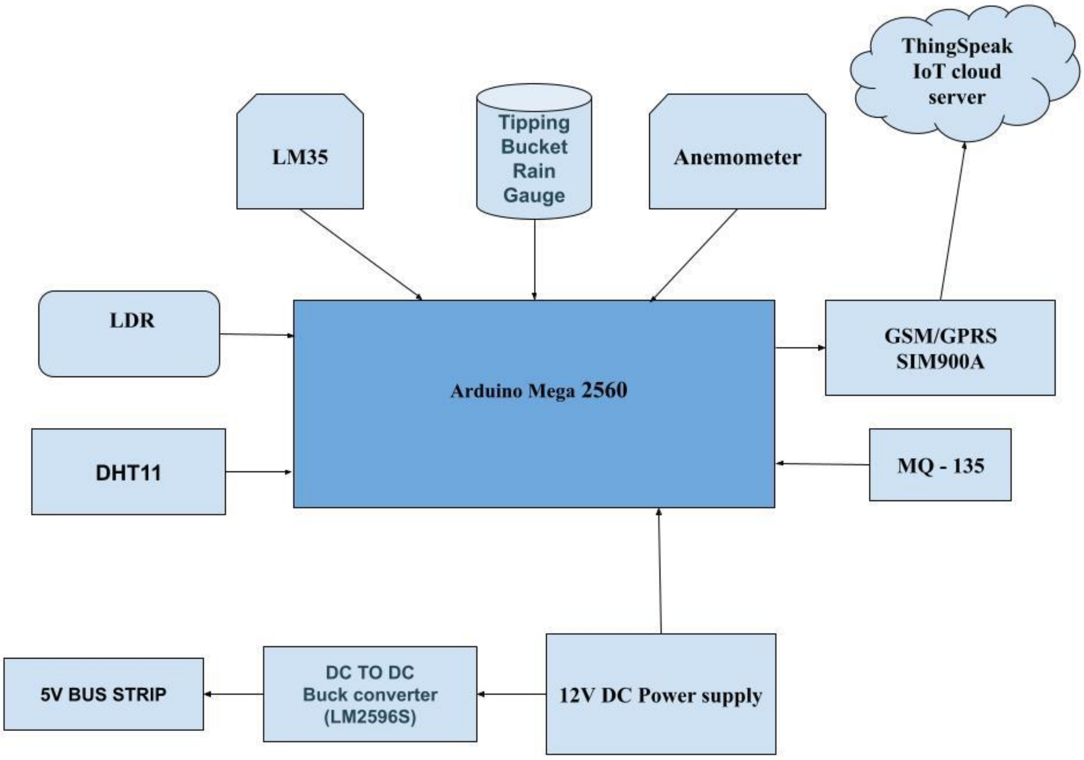

Figure 3.1 Block Diagram

3.2 CIRCUIT DIAGRAM

The working of the project is described in the following sections. Below Figure 3.2 is the detailed circuit diagram to explain the complete process of system.

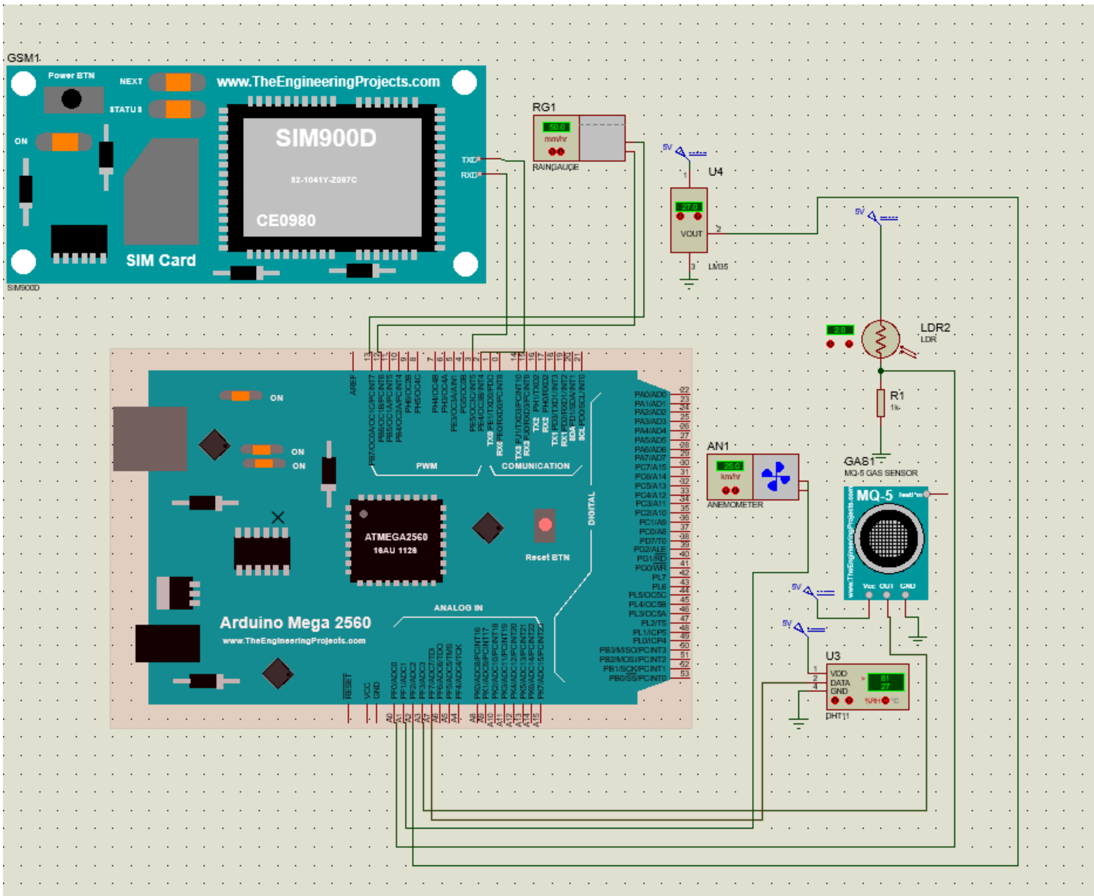

Figure 3.2 Circuit Diagram

3.2.1 Weather Data Input Section

The weather monitoring system integrates various sensors to capture essential meteorological parameters. The DHT11 sensor measures real-time humidity, the anemometer measures wind speed. The Tipping Bucket Rain Gauge quantifies rainfall, and the LDR sensor measures light intensity. LM35 is a Thermistor which provides the temperature, MQ – 135 measure air quality and the SIM 900A GSM module facilitates data transmission to the ThingSpeak IoT platform. Together, these sensors create a comprehensive dataset for accurate weather analysis.

3.2.2 Processing and Uploading on Network

Operated on an Arduino Mega development board, the system processes the collected sensor data. The Arduino Mega orchestrates the integration of sensor inputs, then utilizes the SIM 900A GSM module to upload the compiled data onto the ThingSpeak IoT platform. This platform serves as the central hub for monitoring and analysing the real-time weather parameters, providing a user-friendly interface for remote accessibility and data visualization.

3.3 ALGORITHM

3.3.1 Arduino Mega Program Algorithm

1. Include necessary libraries such as DFRobot_RainfallSensor, Software Serial, MQ135, DHT, RTClib, and Wire.

2. Define global variables and pins:
   i. Define pin numbers for various sensors such as DHT11, LDR, wind speed sensor, LM35 temperature sensor, and MQ135 gas sensor.
   ii. Initialize instances of DHT, MQ135, DFRobot_RainfallSensor_I2C, and RTC_DS3231.

3. Define functions for sensor readings:
   i. humidity_dht1(): Reads humidity from DHT11 sensor.
   ii. getldr_value(): Reads light intensity from LDR sensor.
   iii. getwindspeed(): Reads wind speed from the wind speed sensor.
   iv. temperature_lm35(): Reads temperature from LM35 temperature sensor.
   v. mq135_value(): Reads gas sensor values (e.g., CO2 concentration) from MQ135 sensor.
   vi. tipping_bucket_rainfall(): Reads rainfall from tipping bucket rainfall sensor.

4. Setup function:
   i. Initialize serial communication for both GPRS and debug purposes.
   ii. Initialize DHT sensor.
   iii. Initialize I2C communication.

5. Loop function:
   i. Read sensor values.
   ii. Print sensor values to the serial monitor.
   iii. Check and display GPRS communication status.
   iv. Perform AT commands for establishing GPRS connection and sending data to the remote server (ThingSpeak).
   v. Construct a GET request string with sensor values to send to the ThingSpeak server.

vi. Send the GET request string to the remote server.

vii. Wait for the response from the server and display it.

viii. Close the GPRS connection.

6. ShowSerialData function:

   i. Used to display data received from the GPRS module.

3.4 FLOW CHART

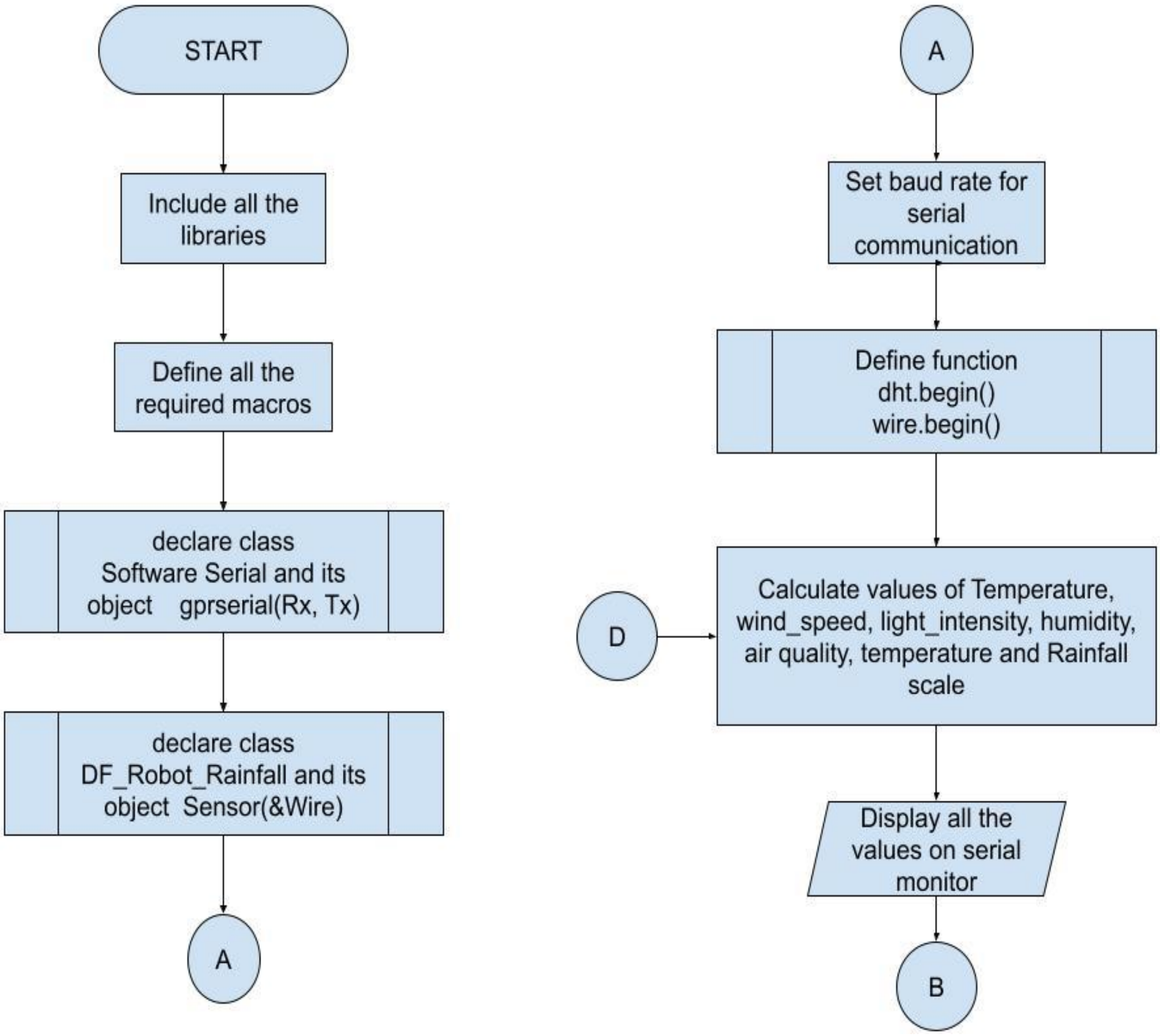

Figure 3.3 Flowchart (a)

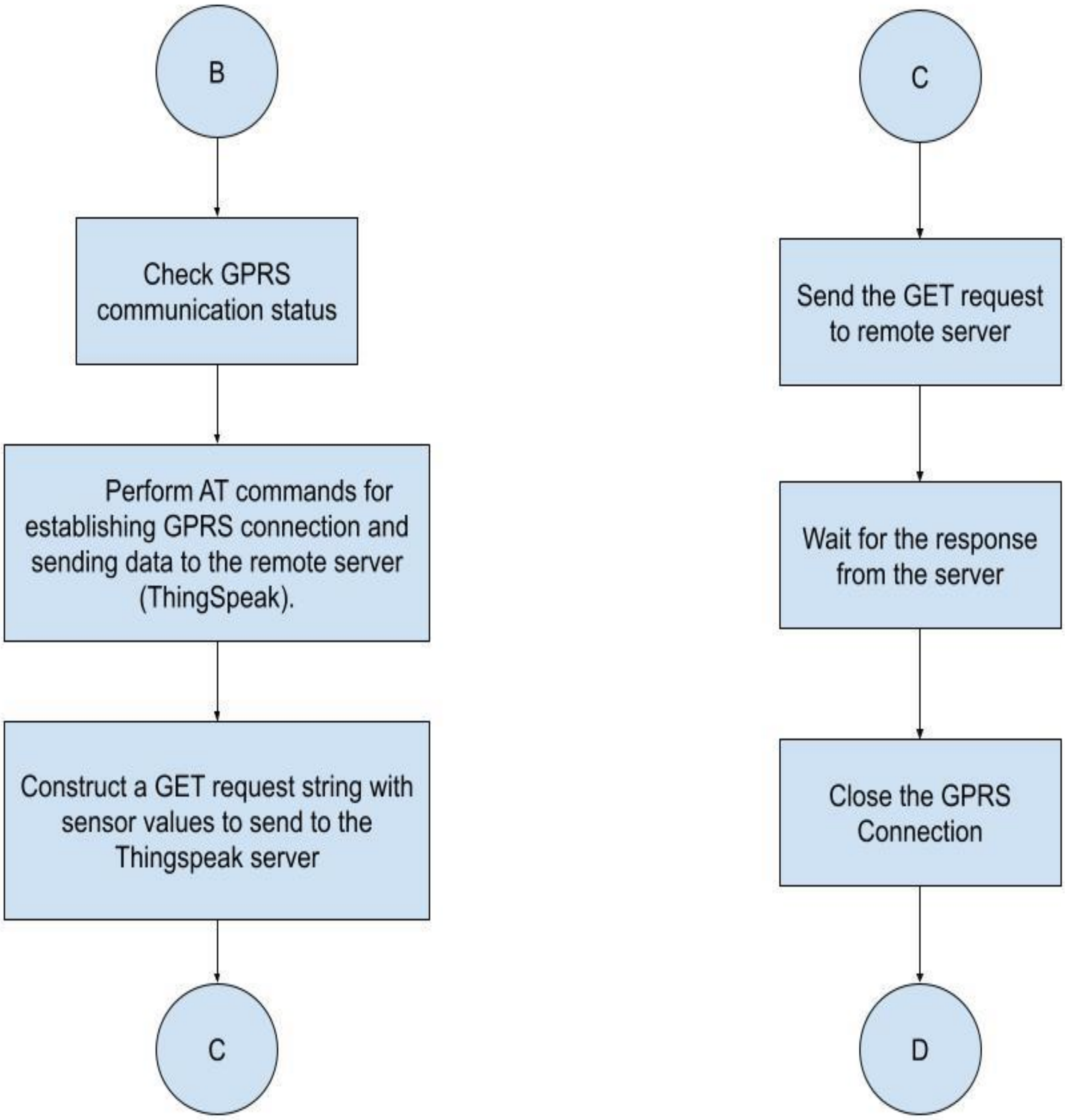

Figure 3.4 Flowchart (b)

SUMMARY

Chapter 3 provides a comprehensive overview of the system's design and functionality. It begins with a detailed block diagram that outlines the major components and their interactions within the weather monitoring system. The circuit diagram is then presented, illustrating the electrical connections and integration of various IoT sensors used to collect meteorological data. The working of the system is explained, highlighting how data from sensors is gathered, processed, and transmitted for real-time monitoring. This chapter also describes the algorithm that governs the system's operations, ensuring accurate data collection and analysis. Finally, a flow chart is included to visually represent the step-by-step process of the system, from data acquisition to user interface interaction, facilitating a clear understanding of the system’s workflow.

Chapter 4

HARDWARE DESCRIPTION & SOFTWARE

4.1 COMPONENTS DESCRIPTION

The project of Weather monitoring system using IoT is consist of following components such as Arduino Mega, GSM/GPRS Module, DHT11, LM35, MQ-135 Gas Sensor module, wind direction sensor (Anemometer), Rain Gauge Senor, Light emitting diode (LDR). The detailed description for all component used are as follows.

4.1.1 Arduino Mega

Figure 4.1[5] shows Arduino Mega, Arduino Mega is a powerful and versatile microcontroller board designed for complex projects that require more processing power, memory, and input/output capabilities than standard Arduino models. It is equipped with an ATmega2560 microcontroller, offering ample storage and runtime with 256 KB of flash memory, 8 KB of SRAM, and 4 KB of EEPROM. It also boasts 54 digital input/output pins, 16 analog inputs, and 15 PWM outputs for extensive connectivity options. Communication interfaces like UART, SPI, and I2C cater to diverse project needs, while the USB interface allows for programming and communication with a computer.

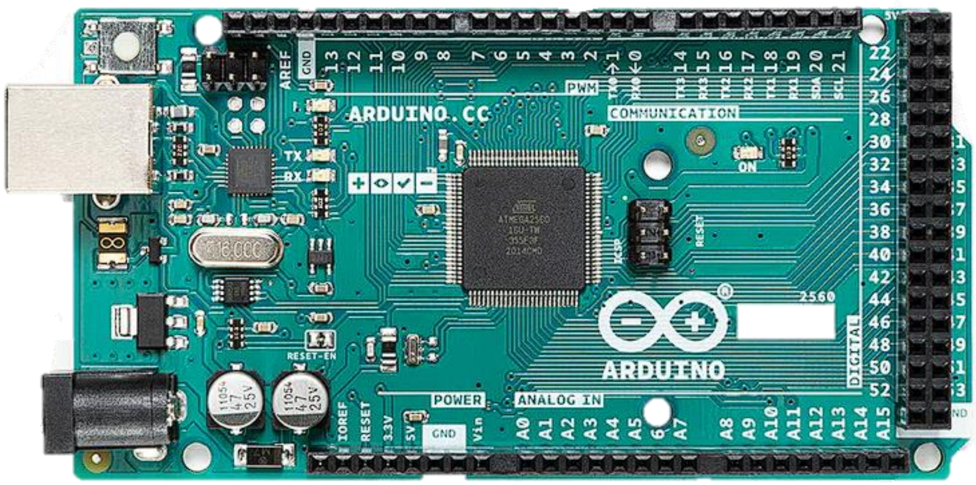

Figure 4.1 Arduino Mega Board

The Arduino Mega's flexibility extends to its power supply, accepting both USB and external power sources. It also features a reset button for manual or programcontrolled restarts. Its compatibility with Arduino Software (IDE) and shields makes it a popular choice for intricate projects like robotics and automation, where multiple sensors, actuators, and peripherals need to be seamlessly integrated [5].

4.1.2 SIM900A GSM GPRS Module

Below fig 4.2 [5] show GSM/GPRRS module is a chip or circuit that will be used to establish communication between a mobile device or a computing machine and a GSM or GPRS system. The modem (modulator-demodulator) is a critical part here. These modules consist of a GSM module or GPRS modem powered by a power supply circuit and communication interfaces (like RS-232, USB 2.0, and others) for computers. A GSM modem can be a dedicated modem device with a serial, USB, or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

Figure 4.2 SIM900A GSM/GPRS Module

SIM900A Modem is built with Dual Band GSM based SIM900A modem from SIMCOM. It works on frequencies 900MHz. SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200- 115200 through AT command. SIM900A is an ultra-compact and wireless module. The Modem is coming interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232) [5].

4.1.3 DHT11 Humidity Sensor

Figure 4.3 show DHT11 Digital Relative Humidity and Temperature Sensor. This Module is pre-calibrated with resistive sense technology coupled with NTC thermistor, for the precise reading of the relative Humidity and surrounding temperature DHT 11 break-out board is a very popular, low-cost sensor, the breakout provides easy installation of the DHT11 sensor module.

Figure 4.3 DHT11Sensor Module

4.1.4 LM35 Temperature Sensor

LM35 shown in Figure 4.4 [7] is an integrated analog temperature sensor whose electrical output is proportional to Degree Centigrade. LM35 Sensor does not require any external calibration or trimming to provide typical accuracies. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy [7].

Figure 4.4 LM35 Temperature sensor

The LM35 sensor operates within a wide voltage range of 4V to 30V, offering flexibility in various applications. With an output voltage of 10mV per degree Celsius and a sensitivity of 10mV per degree Celsius, it provides accurate temperature measurements. Its linearity error is minimal, with a deviation of ±1°Cover the range of 0°C to +100°C, ensuring precise readings. Designed to withstand extreme temperatures from -55°C to +150°C, the LM35 sensor is suitable for harsh environments. With low power consumption of 60µA and available in different package types such as TO-92, TO-220, and SOIC, it offers versatility and reliability for temperature sensing needs [7].

4.1.5 MQ-135 Air Quality/Gas Detector Sensor Module

The MQ135 shown in figure 4.5 [7] is one of the popular gas sensors from the MQ series of sensors that are commonly used in air quality control equipment. It operates from 2.5V to 5.0V and can provide both digital and analog output. The Analog output pin of the sensor can be used to measure the PPM value of the required gas. To do this we need to use an external microcontroller like Arduino. The microcontroller will measure the value of analog voltage and perform some calculations to find the value of Rs/Ro where Rs is the sensor resistance when gas is present and Ro is sensor resistance at clean air.

Figure 4.5 MQ – 135 Gas Sensor

The MQ-135 sensor operates within a voltage range of 2.5V to 5.0V, providing flexibility in various power supply setups. With a power consumption of 150mA, it offers efficient operation for detecting and measuring various gases including NH3, NOx, CO2, alcohol, benzene, and smoke. Typically, it operates at a voltage of 5V, providing consistent performance. The sensor offers both digital and analog outputs, with the digital output ranging from 0V to 5V (TTL Logic) at 5V Vcc, and the analog output spanning from 0V to 5V at 5V Vcc, ensuring compatibility with different interface requirements [7].

4.1.6 Light Dependent Resistor (LDR)

LDR (Light Dependent Resistor) shown in figure 4.6 [5] is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light. It is often used as a light sensor, light meter, Automatic Street light, and in areas where we need to have light sensitivity. LDR is also known as a Light Sensor. LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

Figure 4.6 Light Dependent Sensor

The LDR (Light Dependent Resistor) features a compact diameter of 5mm and is equipped with 2 pins. Designed for PCB Through Hole mounting, it ensures secure and stable installation. With a maximum operating temperature of approximately +800°C. The LDR exhibits variable dark resistance ranging from 1 to 20 Mohm, offering sensitivity to ambient light conditions for diverse applications [7].

4.1.7 Wind Speed Sensor Anemometer Kit

The three Cups type Wind Speed Sensor Current Type (4 to 20mA) Anemometer Kit shown in figure 4.7 [5] is an instrument that can measure the wind speed. It is composed of a shell, the wind cup, and the circuit module. Photovoltaic modules, industrial microcomputer processors, the current generator, electric current, and so on are integrated into the internal drive. The anemometer operates within a 12 to 24 volts DC supply range, consuming a maximum of 0.3W. It outputs signals ranging from 4 to 20 mA, with a resolution of 0.1 m/s and an effective measurement range of 0 to 30 m/s. With a minimal system error of ±3%, it ensures accurate readings.

Figure 4.7 Wind Speed Sensor (Anemometer)

Its robust design allows it to withstand wind speeds of up to 70 m/s and temperatures ranging from -40°C to +80°C. Additionally, it offers a transmission distance of less than 1000 meters, making it suitable for various environmental monitoring applications [5].

4.1.8 Tipping Bucket Rainfall

Based on the principle of tipping bucket rainfall, the rainfall sensor shown in figure 4.8 provides users with rainfall values in millimetres and system operating time. It supports I2C and UART data outputs. The tipping bucket rainfall sensor can provide high-quality rainfall data for weather stations, environmental monitoring stations, or smart farms. The tipping bucket rain gauge is composed of measuring parts and rain receiver parts. When it rains, rainwater enters the water receiver from the uppermost water-receiving port, falls into the water-receiving funnel, and flows into the tipping bucket through the funnel mouth. When the water accumulation reaches a certain height, the tipping bucket loses balance and overturns. And every time the bucket dumps, the switch turns on the circuit and sends a pulse signal to the recorder. The recorder controls the self-recording pen to record the rainfall so that the rainfall process can be measured back and forth.

Figure 4.8 Tipping Bucket Rainfall

The sensor operates within a 3.3 to 5.5 volts DC range, consuming less than 3mA of current. It provides output signals through I2C or UART interfaces with a resolution of 0.28mm. Designed to withstand temperatures from -40 to 85°C, it features a compact PCB size of 32mm x 37mm and a tipping bucket size of 118mm x 59mm x 80mm. Additionally, it includes mounting holes with a size of 3.1mm and weighs 119g for the tipping bucket and 5.3g for the PCB, offering versatility and reliability for various applications [5].

4.1.9 LM2596S DC-DC Buck Converter Power Supply

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Figure 4.9 LM2596S DC – DC buck converter

The power supply offers a rated output current of 2A, with a maximum capacity of 3A when an additional heatsink is utilized. Operating at a switching frequency of 150KHz, it ensures efficient performance. Engineered for industrial-grade operation, it withstands temperatures ranging from -40 to +85°C. With a high conversion efficiency of 92%, it minimizes energy loss. Its load and voltage regulations are both within ±0.5%, ensuring stable output. Additionally, it boasts a dynamic response speed of 5% in 200 microseconds. Compact in size, it measures 45*20*14mm (L*W*H), making it suitable for various power supply applications [7].

4.2 SOFTWARE DESCRIPTIONS

4.2.1 Arduino IDE

Arduino IDE is programming environment that allows the user to draft different kind of programs and load them into the Arduino microcontroller. Arduino uses user-friendly programming language, which is based on programming language called Processing. After the user has written his code, IDE compiles and translates the code to the assembler language. After translating the code, the IDE uploads the program to the Arduino microcontroller. Arduino IDE has a built-in code parser that will check the user written code before sending it to the Arduino. IDE software includes the set of different kind of programs that are ready to be tested on the device. After testing the program, it can be uploaded to the Arduino by USB cable that varies in different models. Figure 4. 10 shows a screen capture of Arduino IDE.

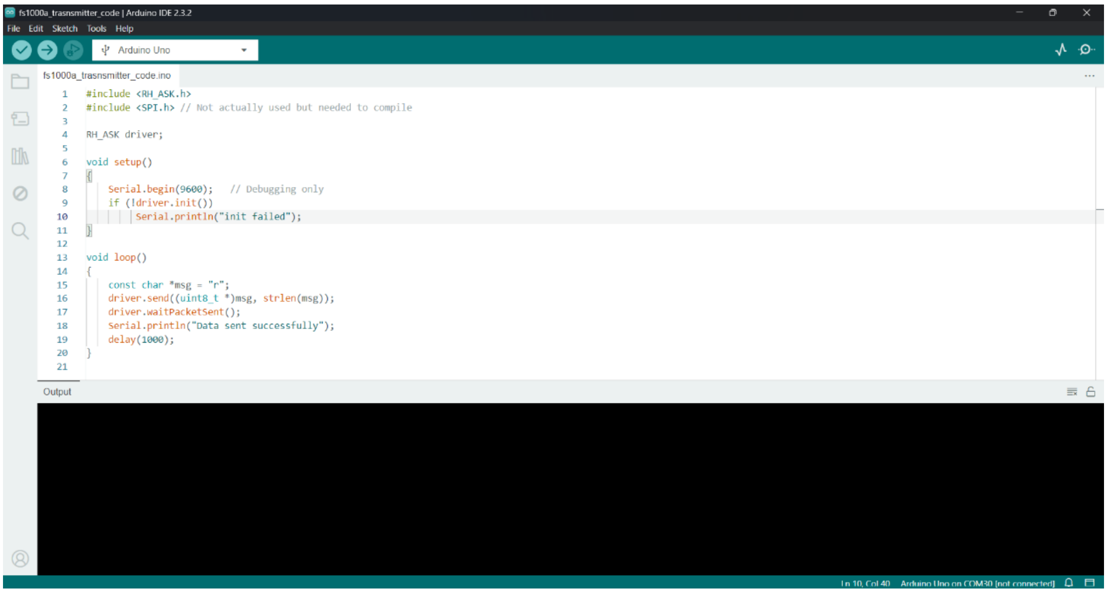

Figure 4.10 Arduin IDE

4.2.2 ThingSpeak

ThingSpeak as shown in figure 4. 11 [8] is a platform providing various services exclusively targeted for building IoT applications. It offers the capabilities of real-time data collection, visualizing the collected data in the form of charts, ability to create plugins and apps for collaborating with web services, social network, and other APIs. We will consider each of these features in detail below. The core element of ThingSpeak is a ‘ThingSpeak Channel’. A channel stores the data that we end to ThingSpeak and comprises of the below elements:

 8 fields for storing data of any type - These can be used to store the data from a sensor or from an embedded device.

 3 location fields - Can be used to store the latitude, longitude, and the elevation. These are very useful for tracking a moving device.

 1 status field - A short message to describe the data stored in the channel [2].

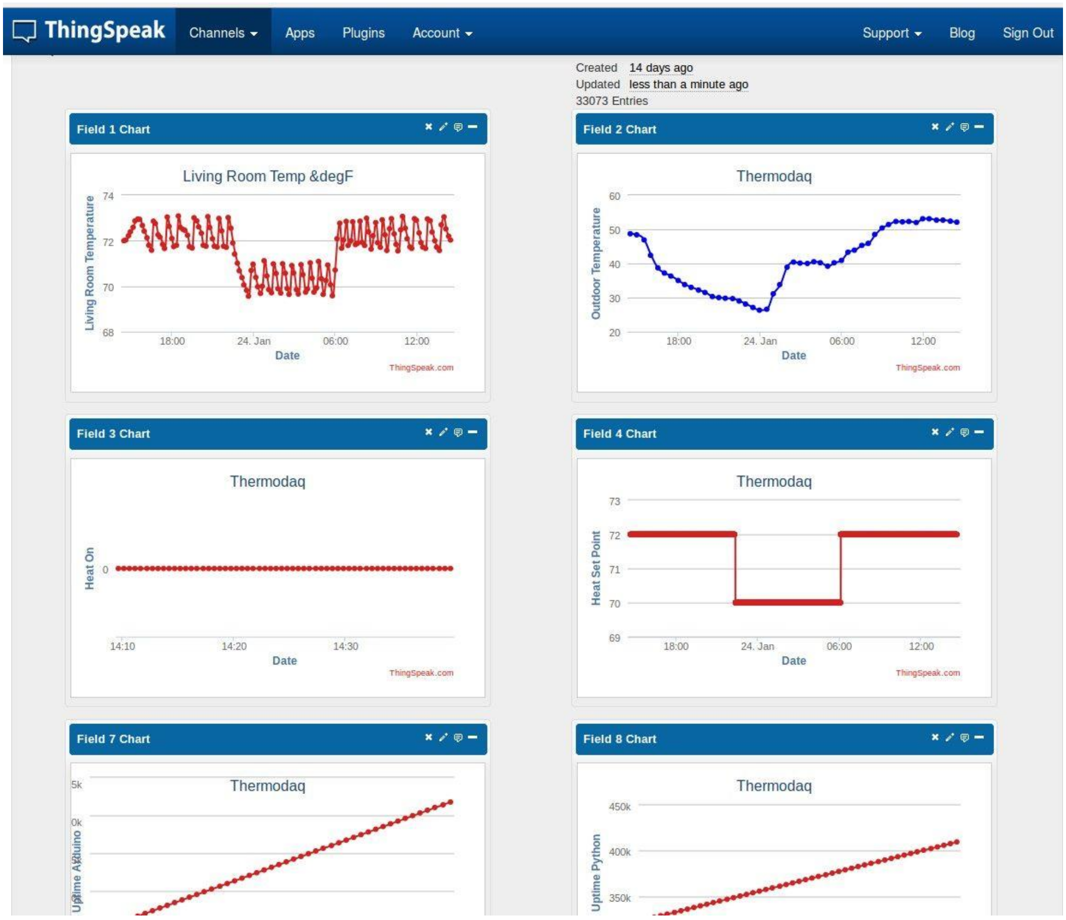

Figure 4.11 ThingSpeak IoT

SUMMARY

Chapter 4 provides detailed descriptions of the sensors and Arduino hardware used in the weather monitoring system. It explains the functionalities and specifications of each sensor, such as those measuring temperature, humidity, and pressure. The chapter also covers the Arduino microcontroller's role in data collection and processing. Additionally, it outlines the software components, including the programming environment and libraries, ensuring effective control and communication within the system.

Chapter 5

RESULT AND DISCUSSION

5.1 RESULT

➢ Figure 5.1 shows ThingSpeak Iot Platform [8]:

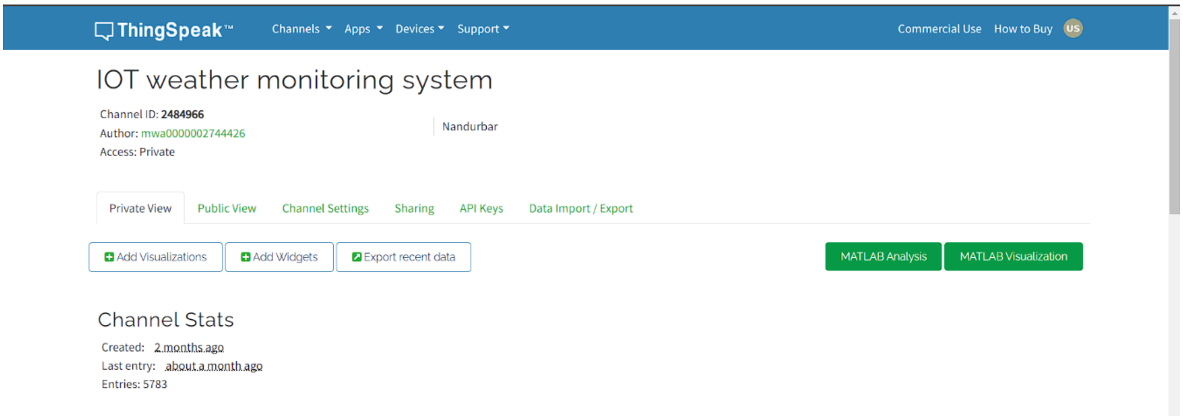

Figure 5.1 ThingSpeak Output Window

➢ Figure 5.2 (a) and Figure 5.2 (b) [8] show the output of the ThingSpeak platform:

1. Field 1: Represents the temperature vs. time graph, where the y-axis shows temperature in degrees Celsius and the x-axis represents time.
2. Field 2: Represents the humidity vs. time graph, where the y-axis shows humidity percentage and the x-axis represents time.
3. Field 3: Represents the light intensity vs. time graph.
4. Field 4: Represents the wind speed vs. time graph, where the y-axis shows wind speed in meters per second (m/s) and the x-axis represents time.
5. Field 5: Represents the air quality index vs. time graph.
6. Field 6: Represents the rainfall vs. time graph, where the y-axis shows rainfall in millimetres (mm) and the x-axis represents time.

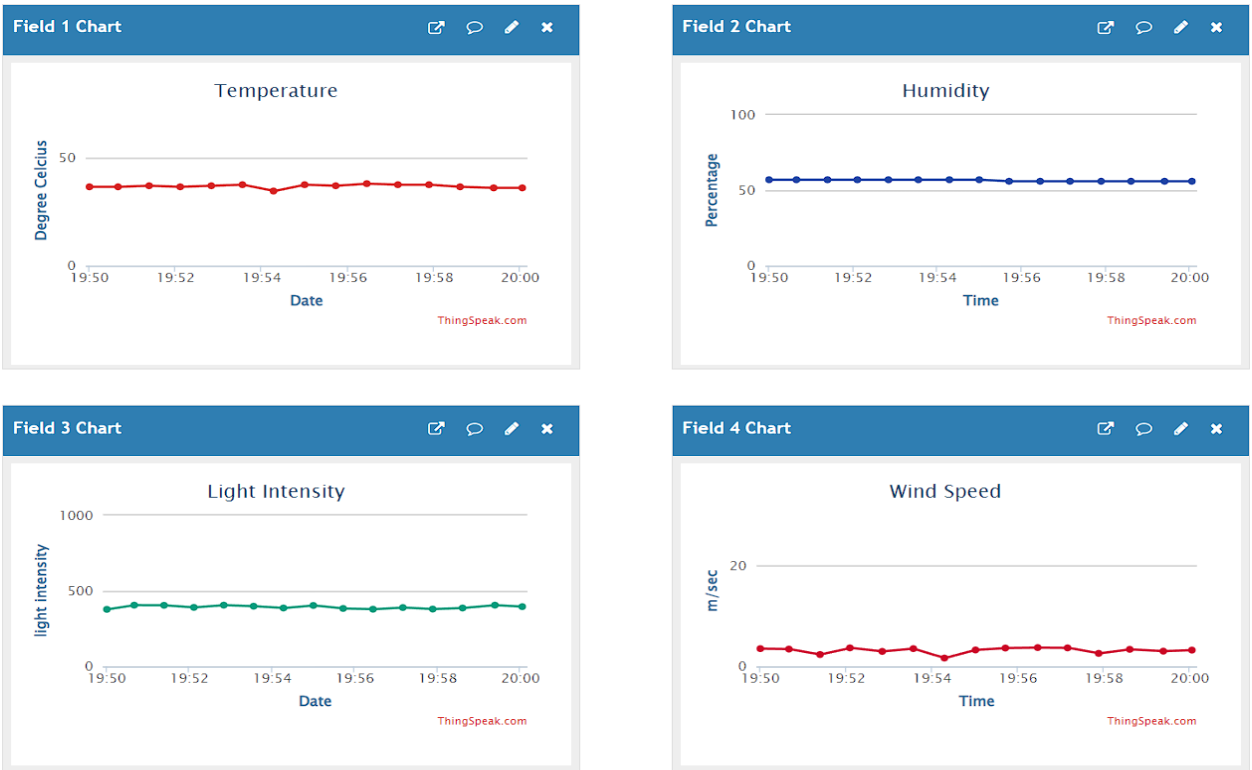

Figure 5.2(a) Output

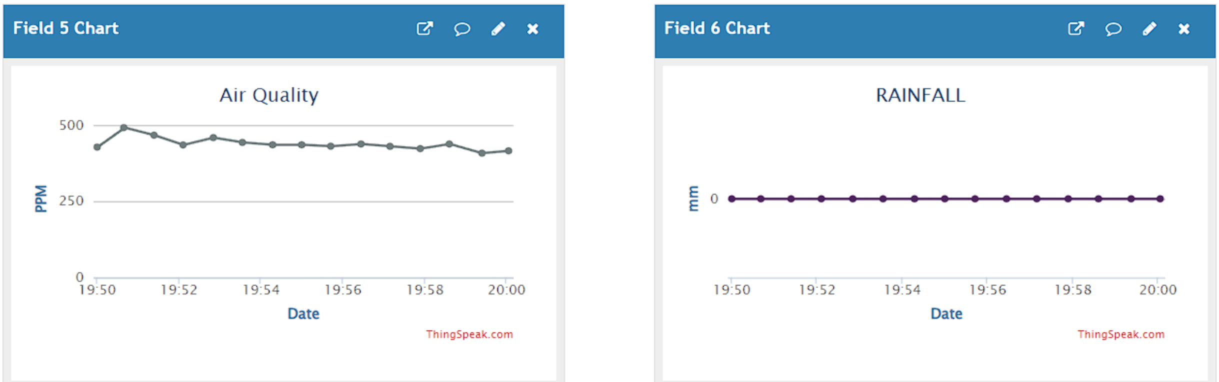

Figure 5.2(b) Output

5.2 DISCUSSION

The data visualized through the ThingSpeak platform provides valuable insights into the environmental conditions over the monitored period. Temperature variations in Field 1 reveal significant patterns influenced by daily cycles and weather events, validated by comparing with seasonal and historical records. Humidity data in Field 2 shows trends and spikes, highlighting its relationship with temperature and its impact on agriculture and health. Light intensity in Field 3 varies due to cloud cover and time of day, affecting solar energy and plant growth. Wind speed in Field 4, crucial for wind energy and forecasting, shows changes and weather system influences. Air quality index in Field 5 identifies pollution trends with health implications. Rainfall data in Field 6 highlights significant events, aiding in water resource management and disaster preparedness. These insights demonstrate the system's comprehensive monitoring capabilities and potential applications in various sectors.

The data visualized through the ThingSpeak platform reveals significant patterns in temperature, humidity, light intensity, wind speed, air quality, and rainfall, demonstrating the system's capability to monitor real-time weather conditions. Evaluating the system's performance highlights its accuracy and potential challenges in data transmission and sensor reliability. These insights have practical applications in agriculture, urban planning, disaster management, and environmental monitoring. Future enhancements, including advanced machine learning algorithms and expanded sensor networks, will further improve the system's accuracy and utility

SUMMARY

This Chapter presents the results and discussion of the weather monitoring system using IoT. The results are showcased through graphs generated on the ThingSpeak platform, displaying measurements of temperature, humidity, wind speed, light intensity, air quality, and rainfall over time. These visualizations demonstrate the system’s capability to collect and monitor real-time weather data effectively. The chapter discusses the implications of the data, highlighting trends and patterns observed, and evaluates the system's performance in providing accurate and timely weather information.

Chapter 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

The implementation of the IoT weather monitoring project has showcased the effectiveness of remote weather data collection and monitoring. By deploying sensors to measure various weather parameters including rainfall, temperature, humidity, air quality, windspeed, and light intensity, we have established a comprehensive system capable of providing real-time insights from remote locations.

Through internet connectivity, the collected data is seamlessly transmitted to a ThingSpeak database, facilitating continuous monitoring and analysis. This capability proves invaluable for diverse applications such as agriculture, environmental monitoring, and urban planning, where access to accurate and timely weather information is essential for decision-making.

Here we conclude that the significant advantages of our IoT weather monitoring project over satellite data is the ability to obtain localized and real-time information. While satellite data provides broad coverage, it may lack the granularity required for localized decision-making. Additionally, our system offers the flexibility to deploy sensors in areas where satellite coverage is limited or unavailable, ensuring continuous monitoring even in remote or challenging environments.

6.2 FUTURE SCOPE

1. Enhanced Predictive Analytics: Implement advanced machine learning algorithms, such as ensemble methods or deep learning models, to improve the accuracy of weather forecasting. Explore techniques like hybrid models combining multiple forecasting methods for better predictions.

2. Integration with Smart Systems: Integrate the weather monitoring system with other smart systems, such as irrigation systems in agriculture or HVAC systems in buildings, to enable automated responses based on real-time weather data. This integration can optimize resource usage and enhance efficiency.

3. Development of Mobile Applications: Develop user-friendly mobile applications that allow stakeholders to access real-time weather data, receive alerts, and visualize trends. These applications can empower users to make informed decisions and take timely actions based on weather forecasts [2].

4. Integration with Disaster Management Systems: Integrate the weather monitoring system with disaster management systems to improve preparedness and response to extreme weather events. Real-time weather data can facilitate early warnings and evacuation planning, potentially saving lives and reducing the impact of natural disasters.

5. Environmental Monitoring: Extend the capabilities of the system to monitor additional environmental parameters beyond weather, such as air pollution levels, soil moisture, or water quality. This expansion would provide a more holistic understanding of environmental conditions and support efforts towards environmental conservation and management.

6. Advanced Machine Learning and Weather Prediction: Enhance the system's predictive capabilities by integrating more sophisticated machine learning models. This includes experimenting with neural networks, reinforcement learning, and other cutting-edge algorithms to improve the precision and reliability of weather predictions Implement Ridge Regression as a model output statistic (MOS) to refine the accuracy of weather predictions, particularly temperature forecasts. This will further enable proactive measures based on anticipated weather changes [6].

SUMMARY

The IoT weather monitoring project effectively collects and monitors real-time weather data, providing valuable insights for applications such as agriculture, environmental monitoring, and urban planning. The system's ability to offer localized and continuous data surpasses satellite limitations. Future enhancements include advanced machine learning algorithms for improved predictive analytics, integration with smart and disaster management systems, development of mobile applications, and expanded environmental monitoring capabilities. These improvements aim to refine accuracy, optimize resource usage, and enhance preparedness for weather-related events.

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SPONSORSHIP LETTER

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Outward No: ES / Doc / 23 / 11 / 05

Date : 01/ 12/ 2023

To,

HOD, E&TC, GCOE Jalgaon,425001

Subject: Sponsorship Proposal for Engineering College Project

Respected sir

I hope this letter finds you well. We, at Electrosoft System, are excited to express our interest in sponsoring a project for the engineering students name as below

Project Topics: Machine learning based weather prediction and monitoring system using IoT

Mr. Guru Harsh Vijay [PRN: 2011019]
Mr. Madankar Mayur Deboji [PRN: 2011030]
Mr. Nimsarkar Pushpak Santosh [PRN: 2011034]
Mr. Daware Dhruv Shivaji [PRN: 2112206]

We believe in nurturing talent and providing students with real-world experiences that enhance their skills and contribute to their academic growth.

Our proposed project sponsorship includes financial support and access to resources needed for the successful completion of the project. In return, we kindly request certain conditions to be met to ensure that our sponsorship aligns with our goals and expectations:

Photography and Videography: We permit to take photographs and record videos during various stages of the project development. These visuals will be used for promotional and documentation purposes by Students. The college agrees to allow our representatives to capture the students' progress, presentations, and any related activities based on that video.

Technical Information Sharing: As part of the sponsorship, we expect the students to share technical details and insights related to the project. This includes providing information on the project's design, methodology, challenges faced, and solutions implemented. The purpose of this is to create a collaborative environment where both the students and company can benefit from the exchange of technical knowledge.

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Date : 01/ 12 / 2023

Acknowledgment: We request acknowledgment of our sponsorship in any official documentation related to the project, including project reports, presentations, and public events. This acknowledgment should include the name of our company and a brief description of our sponsorship contribution.

These conditions are designed to create a mutually beneficial partnership that allows students to gain valuable experience and Electrosoft system to showcase our commitment to education and innovation.

We look forward to the opportunity to collaborate with Government college of engineering Jalgaon on this exciting project. If you have any questions or if there are specific arrangements that need to be discussed, please feel free to contact us at Electrosoftsystemfb@gmail.com.

Thank you for considering our sponsorship proposal, and we eagerly anticipate a positive and fruitful partnership.

Sincerely,

Electrosoft System Jalgaon-425001

Nilesh S. Wagh
MD

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