IoT-Based Smart Weather Repoting System

Project Report

Submitted for the partial fulfillment of the degree of

Bachelor of Technology

In

Internet of Things (IOT)

Submitted By

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UNDER THE SUPERVISION AND GUIDANCE OF

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माधव प्रौद्योगिकी एवं विज्ञान संस्थान, ग्वालियर (म.प्र.), भारत

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Jul-Dec 2024

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We hereby declare that the work entitled "**IoT-Based Smart Weather Repoting System**" is our work, conducted under the supervision of **Dr.Priyanka Garg, Assistant Professor**, during the session Jul-Dec 2024. The report submitted by us is a record of bonafide work carried out by us.

We further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge and belief.

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PLAGIARISM CHECK CERTIFICATE

This is to certify that we, students of B.Tech. in **Internet of Things (IOT)** have checked our complete report entitled "**IoT-Based Smart Weather Repoting System**" for similarity/plagiarism using the "Duplichecker" software available in the institute.

This is to certify that the similarity in our report is found to be 16% which is within the specified limit (20%).

The full plagiarism report along with the summary is enclosed.

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ABSTRACT

IoT-Based Smart Weather Repoting System

The "IoT-Based Smart Weather Reporting System" is a cutting-edge innovation designed to measure and monitor critical weather parameters with high precision and efficiency. This system leverages IoT technology to detect atmospheric pressure, temperature, and rainfall in real-time using advanced sensors. The pressure sensor provides accurate readings of atmospheric pressure, crucial for predicting weather patterns and detecting changes that could indicate storms or other weather phenomena. Simultaneously, the temperature sensor monitors environmental temperature with precision, offering valuable data for climate analysis and forecasting. Additionally, a rain sensor is employed to detect and monitor precipitation, enabling real-time updates on rainfall intensity and duration.

By integrating these sensors with an IoT-enabled microcontroller, the system continuously collects data and transmits it to a centralized platform for visualization and analysis. The recorded data is displayed on a serial monitor and can be further utilized for predictive analytics and historical trend analysis. This smart weather reporting system offers significant applications in agriculture, urban development, disaster management, and environmental monitoring, providing timely and accurate weather insights for improved decision-making. With its automation, scalability, and real-time reporting capabilities, this project aims to contribute to more informed and sustainable weather management practices.

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We would sincerely like to thank our department, **Centre for Internet of Things,** for allowing us to explore this project. We humbly thank **Dr. Praveen Bansal**, Assistant Professor and Coordinator, Centre for Internet of Things, for his continued support during the course of this engagement, which eased the process and formalities involved. We are sincerely thankful to our faculty mentors. We are grateful to the guidance of **Dr.Priyanka Garg**, Assistant Professor, and Centre for Internet of Things, for his continued support and guidance throughout the project. We are also very thankful to the faculty and staff of the department.

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CHAPTER 1: INTRODUCTION

A smart weather monitoring system is an advanced, automated setup designed to track, record, and analyze various environmental parameters such as temperature, humidity, atmospheric pressure, and rainfall in real-time. Utilizing Internet of Things (IoT) technology, these systems integrate multiple sensors with a central microcontroller to continuously gather data, which can be transmitted wirelessly to cloud platforms or local servers. Users can access this data remotely through mobile apps, web interfaces, or dedicated dashboards, offering convenience and up-to-date information.

The significance of smart weather monitoring systems lies in their ability to provide precise, localized, and real-time weather information. Unlike traditional weather monitoring, which relies on broad regional data, smart systems deliver hyper-local insights. This specificity is crucial for various applications, from agriculture and disaster management to urban planning and home automation. For instance, farmers can make data-driven decisions regarding irrigation and crop protection by monitoring temperature, humidity, and rainfall. Similarly, local authorities can use accurate weather data for early warning systems, aiding in the timely evacuation and preparation for extreme weather events.

The integration of IoT technology is a game-changer for weather monitoring. It enables real-time data collection and analysis, ensuring that any sudden changes in weather conditions are immediately detected and communicated. Smart systems can also automate responses to weather conditions; for example, rain sensors can automatically close windows or halt irrigation when precipitation is detected. These automated features save time, reduce manual effort, and optimize the use of resources, enhancing efficiency.

Additionally, smart weather monitoring systems are often designed with low power consumption and sustainability in mind. Many setups are powered by renewable energy sources like solar panels, making them environmentally friendly and suitable for remote or off-grid locations. This sustainability is essential as climate change drives the need for more adaptive and resilient weather monitoring solutions.

In summary, smart weather monitoring systems play a crucial role in modern society by providing precise and reliable weather data. They support a wide range of applications, from agriculture and environmental conservation to disaster preparedness and home automation, highlighting the importance of real-time, accessible, and accurate weather information in today's world.the transformative potential of IoT in weather forecasting.

CHAPTER 2: LITERATURE SURVEY

This chapter provides an overview of existing work and studies related to IoT- based weather monitoring systems. It highlights key technologies, methodologies, and research contributions that influenced the development of this project.

Introduction

The development of IoT-based weather systems has gained significant traction due to the increasing need for real-time environmental monitoring. Several research efforts and technological advancements have contributed to designing systems that measure weather parameters such as temperature, pressure, humidity, rainfall, and air quality. This literature survey reviews prior work in this field to understand the current state of technology and identify gaps.

Review of Existing Systems and Research

IoT and Weather Monitoring

Kumar et al. (2019) demonstrated the potential of IoT for remote weather monitoring by integrating sensors with cloud platforms to collect and analyze environmental data. Their system provided real-time weather updates and data storage for trend analysis.

[1]Sharma and Dubey (2017) implemented an Arduino-based weather reporting system that measured temperature, humidity, and pressure. The study highlighted the ease of using DHT11 and BMP180 sensors for low-cost implementations.

Sensor Technologies

The DHT11 and DHT22 sensors are widely used for measuring temperature and humidity due to their affordability and reliability, as documented in studies by Moghavvemi and Lu (2004).

BMP180 and its successor BMP280 have proven effective in measuring barometric pressure and altitude, often used in IoT weather stations.

Rain detection modules using capacitive or resistive sensors are popular in studies like Patel et al. (2020) for rainfall monitoring.

Comparative Analysis of Existing Systems

System	Parameters Measured	Technology Used	Strengths	Limitations
IoT Weather Station by Sharma[1]	Temperature, Humidity, Pressure	Arduino, DHT11, BMP180	Cost-effective, easy to implement	Limited parameters
Smart Weather Monitoring (2021)	Temp., Humidity, Rainfall	Raspberry Pi, Cloud Integration	Real-time monitoring, scalable	High initial cost
Advanced IoT Weather System	Temp., Pressure, Air Quality	NodeMCU,IoT Platforms	Accurate, cloudbased storage	Complex setup

CHAPTER 3: COMPONENTS USED AND THEIR SPECIFICATIONS

1. DHT11 Sensor: The **DHT11 sensor** is a low-cost, reliable sensor used for measuring **temperature** and **humidity** in smart weather monitoring systems. It provides a digital output, making it easy to interface with microcontrollers like the ESP8266. With its single-wire communication protocol, the DHT11 efficiently collects environmental data, enabling real-time weather updates. Its compact design and low power consumption make it ideal for continuous, battery-powered monitoring in IoT-based weather systems

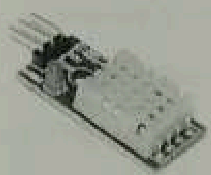

Fig.1 DHT11 sensor

2. Rain Sensor: The rain sensor detects precipitation and measures rainfall intensity, making it a key component in smart weather monitoring systems. It offers both analog and digital outputs, distinguishing between light rain and heavy downpours. By interfacing with microcontrollers like the ESP8266, the rain sensor provides real-time rain data, enabling automated responses like adjusting irrigation or triggering alerts. Its ease of integration and low maintenance make it ideal for continuous, efficient weather tracking in IoT projects.

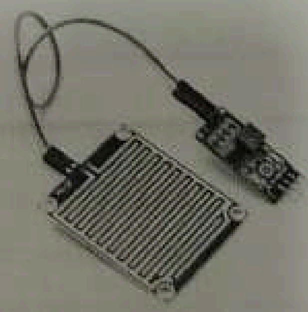

Fig:2 Rain Sensor

3. BMP180 Pressure sensor: The BMP180 sensor is a compact, high-precision sensor used in smart weather monitoring systems to measure atmospheric pressure and temperature. It provides accurate barometric data, which can predict weather changes and determine altitude.

With low power consumption and I2C/SPI interfaces, the BMP180 easily integrates with microcontrollers like the ESP8266, enabling continuous data collection.

Its reliability and efficiency make it ideal for IoT-based weather stations requiring precise environmental monitoring.

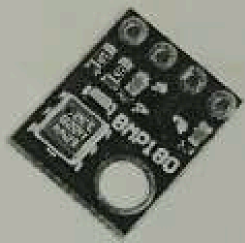

Fig.3 **Pressure Sensor**

4. Node MCU: The NodeMCU is a versatile, Wi-Fi-enabled microcontroller based on the ESP8266, ideal for smart weather monitoring systems. It acts as the central unit, collecting data from sensors like the DHT11, BMP180, and rain sensors. It has built-in Wi-Fi, NodeMCU easily connects to cloud platforms for real-time data logging and remote monitoring. Its low cost, ease of programming, and compact design make it a popular choice for efficient IoT based weather stations.

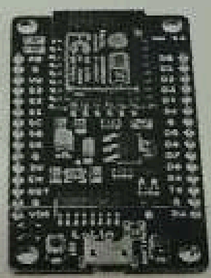

Fig.4 Node MCU

5.Breadboard: A breadboard is a reusable platform for prototyping electronic circuits without soldering, making it ideal for smart weather monitoring systems. It allows easy connections of sensors like DHT11, BMP180, and rain sensors to microcontrollers such as NodeMCU. The breadboard enables quick modifications and troubleshooting during development. Its versatility supports experimenting with different sensor configurations, making it essential for testing and refining IoT-based weather stations before final deployment.

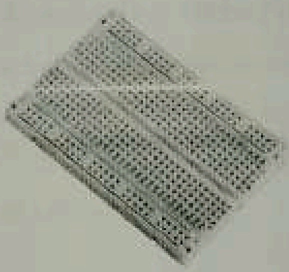

Fig5: Breadboard

6. Jumper Wires: Jumper wires are straightforward electrical cables with connector pins on both ends that are used to connect parts of a microcontroller or a breadboard temporarily. Depending on the needs of the connection, they can be classified as male-to-male, female-to-female, or male-to-female. The sensors (such as the MQ-3 or IR sensor) in an IoT helmet are connected to the NodeMCU via jumper wires, which facilitates seamless data transfer between the parts.

Fig 6: Jumper Wire

7. Thingspeak: ThingSpeak is an open-source Internet of Things (IoT) platform designed for data collection, storage, analysis, and visualization in real-time. It provides a cloud-based environment where sensor data from IoT devices can be sent, processed, and displayed in an organized and user-friendly manner. ThingSpeak is widely used for monitoring, analyzing, and controlling IoT systems remotely and efficiently.

CHAPTER 4: METHODOLOGY AND ALGORITHM

METHODOLOGY

The IoT-Based Smart Weather Reporting System follows a structured methodology to accurately detect atmospheric pressure, monitor temperature, and track rainfall. The system begins by integrating specialized sensors, including a barometric pressure sensor to measure atmospheric pressure, a temperature sensor to monitor environmental temperature, and a rain detection module to identify and measure precipitation. These sensors are interfaced with a microcontroller, such as an Arduino or ESP32, which serves as the central processing unit. The microcontroller collects and processes data from the sensors, converting it into meaningful information.

To enable real-time monitoring and reporting, the system utilizes IoT communication protocols, such as MQTT or HTTP, to transmit the processed data wirelessly to a cloud-based platform via a Wi-Fi module. This platform stores the data and provides visualization through user-friendly dashboards on platforms like ThingSpeak or custom web applications. During development and testing, the sensor readings are also displayed on a serial monitor for immediate observation.

This system is a practical and efficient solution for real-time weather monitoring, with applications in agriculture, urban planning, disaster management, and environmental studies. By leveraging IoT technology, it offers scalability, automation, and valuable insights, contributing to informed decision-making and sustainable practices.

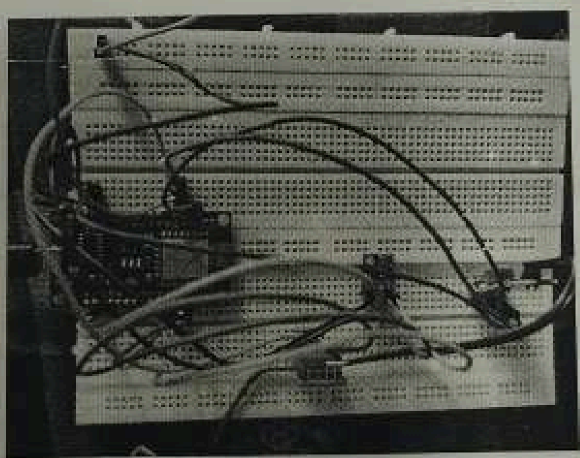

Fig.7 circuit diagram

Detailed Algorithm

Step 1: Start the system and initialize all components.

Step 2: Configure Wi-Fi or communication protocol.

Step 3: Begin sensor data collection:

a. Read temperature and humidity from DHT11/DHT22.

b. Read pressure from BMP180/BMP280.

c. Check rainfall status using the rain sensor.

Step 4: Process and validate sensor data.

Step 5: Display data on the serial monitor or send to cloud:

a. Format the data for transmission.

b. Push data to the IoT platform (e.g., ThingSpeak).

Step 6: Check for alerts or threshold values (optional).

Step 7: Repeat Steps 3 to 6 at predefined intervals.

Step 8: Stop the system when required.

Tools and Technologies

Hardware:

Sensors: DHT11/DHT22, BMP180/BMP280, Rain Sensor Module.

Microcontroller: Arduino Uno or NodeMCU.

Software:

Arduino IDE for coding and uploading sketches.

ThingSpeak or Blynk for cloud-based data visualization.

Python (optional) for data analysis and visualization.

Communication Protocols:

Wi-Fi (ESP8266) for wireless data transmission.

HTTP or MQTT for communication with IoT platforms.

CHAPTER 5: MODELLING AND QUICK DESIGN

The **modeling phase** of the **IoT-Based Smart Weather Reporting System** focuses on creating a conceptual and practical representation of the system to ensure seamless integration and functionality. The sensing layer includes the integration of a pressure sensor (e.g., BMP280), a temperature sensor (e.g., DHT11 or LM35), and a rain sensor (e.g., YL-83) for collecting real-time weather data. The processing layer is centered around a microcontroller, such as Arduino or ESP32, which processes the data collected from the sensors. The communication layer utilizes a Wi-Fi module (e.g., ESP8266 or ESP32) to transmit the processed data to a cloud platform for visualization and storage.

Design Process:

The design process of the IoT-Based Smart Weather Reporting System involves a systematic approach to integrating hardware and software components for effective functionality. The process begins with a detailed requirement analysis to identify the parameters to be measured—pressure, temperature, and rainfall . A microcontroller such as Arduino Uno or ESP32 is used to process sensor data, while a Wi-Fi module enables real-time data transmission to cloud platforms. The hardware design involves creating a circuit diagram and ensuring optimal placement of sensors, with the rain sensor positioned externally and other components shielded from environmental disturbances.

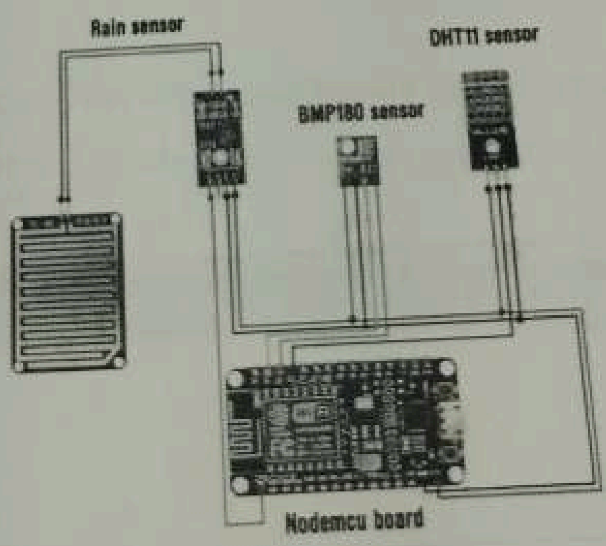

Fig.8 circuit diagram

CHAPTER 6: RESULTS ANALYSIS

1. Accuracy of Sensor Data

Assess the reliability and precision of sensors in measuring parameters like temperature, humidity, air quality, etc.Example Analysis:Temperature: ±2°C deviation from standard thermometer.Humidity: ±5% RH deviation from a hygrometer.

2. Responsiveness of the System

Evaluate how quickly the system responds to changes in environmental conditions.Measure the lag time between a change in the environment and the data update.Assess if real-time updates are consistent.

3. Data Transmission and Display

Test the effectiveness of data transfer and display mechanisms.Check the stability of the IoT connection (e.g., Wi-Fi or Bluetooth).

4. Parameter Correlation and Trends

Identify patterns and correlations in recorded data.Are temperature and humidity inversely correlated.Do gas levels spike during specific times or weather conditions.

Example Trend: Air quality worsens during peak traffic hours or specific weather events.

5. Environmental Challenges

Determine how well the system performs under varying conditions.Evaluate the robustness of sensors under extreme temperatures or humidity.Check for interference from nearby electronic devices.

6. Power Efficiency

Assess the power consumption of the IoT system.Record the energy usage during active and idle states.Evaluate if the system is viable for continuous operation.

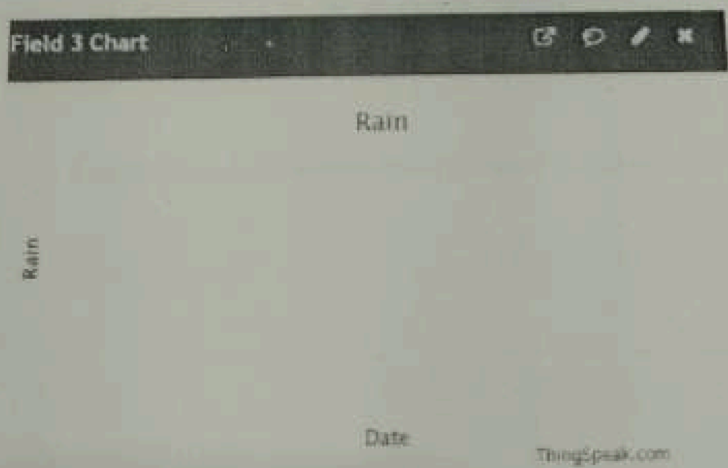

Fig-9 Thingspeak Graph showing Rain data on cloud

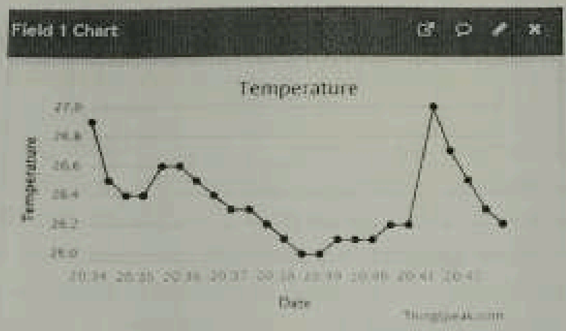

Fig-10 Thingspeak Graph showing Temperature data on cloud

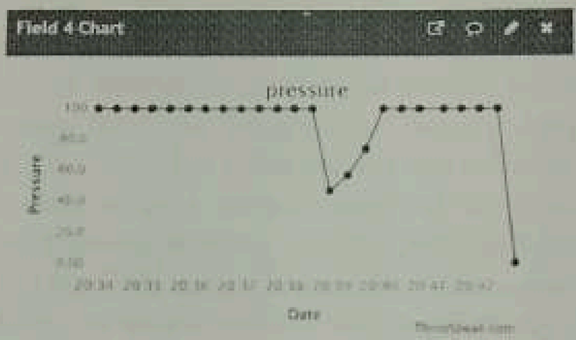

Fig-11 Thingspeak Graph showing Pressure data on cloud

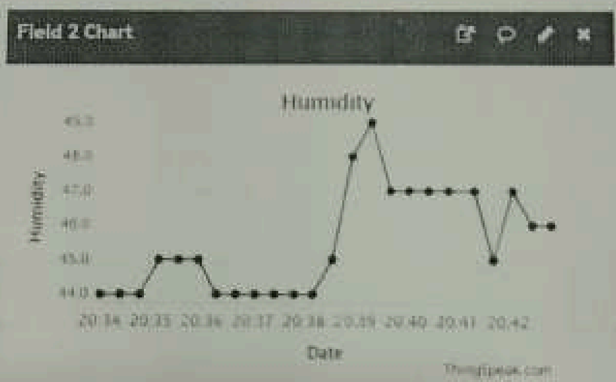

Fig-12 Thingspeak Graph showing Humidity data on cloud

CHAPTER 7: CONCLUSION AND FUTURE SCOPE

The smart weather monitoring system presents an innovative solution for real-time environmental data collection and analysis, integrating multiple sensors such as DHT11, BMP180, and rainfall sensors with IoT technology. This system offers accurate, localized weather information essential for applications ranging from agriculture and disaster management to home automation and urban planning. By providing users with real-time data through cloud platforms, it enables informed decision-making and efficient resource management. The system's ease of use, coupled with its ability to automate responses to weather conditions, makes it a valuable tool for individuals and organizations alike. Its potential to contribute to sustainability efforts, such as energy conservation and efficient irrigation, further enhances its importance in modern society.

The future of smart weather monitoring systems holds vast potential. Integration of machine learning and AI to predict weather patterns and offer predictive insights based on historical data. It could offer accurate weather forecasting and provide personalized alerts for extreme weather events like storms, floods, or droughts. Additionally, integration of more advanced sensors for monitoring air quality, UV radiation, and soil moisture will make these systems more comprehensive, catering to a broader range of environmental concerns. As 5G connectivity becomes widespread, enabling seamless real-time updates and quicker response times. Moreover, use of renewable energy sources like solar power to run these devices will improve their sustainability. As these systems evolve, they will play crucial role in smart cities, enabling efficient urban management, disaster resilience, and environmental sustainability.

REFERENCES

➢ **Online Resources:**

- Instructables - A valuable resource for community-driven guides and projects on building weather stations.
- Stack Overflow - A valuable resource for troubleshooting coding problems related to IoT devices.
- ESP8266 Community Forum - Discussions on ESP8266 projects and troubleshooting tips.

➢ **Books:**

- T. Lay-Ekuakille, G. Vendramin. *Sensors: Focus on Tactile, Force and Stress Sensors*. InTech, 2008.
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- R. Buyya, A. Dastjerdi. *Internet of Things: Principles and Paradigms*. Morgan Kaufmann, 2016.

- **Research papers:**

[1] Sharma and Dubey (2017): A Study on Arduino-Based Weather Reporting System

[2]R. Kumar, M. P. Rajasekaran. "An IoT Based Smart Weather Monitoring System," *International Journal of Computer Applications*, vol. 42, no. 3, 2016.

[3] A. R. Al-Ali, I. Zualkernan, F. Aloul. "A Mobile GPRS-Sensors Array for Air Pollution Monitoring," *IEEE Sensors Journal*, vol. 10, no. 10, pp. 1666-1671, Oct. 2010.

[4]J. Gubbi, R. Buyya, S. Marusic, M. Palaniswami. "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," *Future Generation Computer Systems*, vol. 29, no. 7, pp. 1645-1660, Sep. 2013.

➢ **Websites:**

- Tinckercad- Offers a variety of weather station projects and tutorials for beginners.
- Adafruit Learning System - Provides guides and tutorials on using sensors like BMP180, DHT11, and Rain Sensors with microcontrollers.
- SparkFun - Contains technical details and projects involving IoT weather monitoring systems.

ANNEXURE

SELF-EVALUATION OF THE PROJECT

Month	Start date – End date (DD/MM/YY) - (DD/MM/YY)	Progress of Project
Month- 1	05/08/24 - 31/08/24	Topic Selection and Project planning
Month- 2	01/09/24 - 30/09/24	Hardware selection and Prototype Development
Month- 3	01/10/24 - 31/10/24	Data Analysis and Results
Month- 4	01/11/24 - 18/11/24	Documentation of the Project

Priyanka 19/11/24

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