A

Mini-Project Report on

IOT Based weather monitoring system

Submitted in partial fulfillment of the
requirements for the degree of
BACHELOR OF ENGINEERING
IN
Computer Science & Engineering
Artificial Intelligence & Machine Learning

by

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2023-2024

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CERTIFICATE

This is to certify that the project entitled "**IOT BASED WEATHER MONITORING SYSTEM"** is a bonafide work of Maitreyi Phadke (22106007), Rutuja Pawar (22106043), Gauri Ramekar (22106068), Pratiksha Pathak (22106127) submitted to the University of Mumbai in partial fulfillment of the requirement for the award of **Bachelor of Engineering** in **Computer Science & Engineering (Artificial Intelligence & Machine Learning).**

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Project Report Approval

This Mini project report entitled " **IOT BASED WEATHER MONITORING SYSTEM**" by **Maitreyi Phadke, Rutuja Pawar, Gauri Ramekar and Pratiksha Pathak** is approved for the degree of ***Bachelor of Engineering*** in ***Computer Science &Engineering*** , (AIML) ***2022-23***.

External Examiner: ___________________

Internal Examiner: __________________

Place: APSIT, Thane
Date:

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ABSTRACT

The IoT-Based Weather Monitoring System using NodeMCU ESP8266 represents a pioneering approach to weather data acquisition, analysis, and dissemination. Confronting the limitations of conventional weather monitoring systems such as high costs and restricted real-time data accessibility, this project leverages NodeMCU ESP8266 technology to offer an economical and efficient solution. The system integrates a network of sensors to capture crucial weather parameters like temperature, humidity, light intensity. Through the NodeMCU ESP8266 microcontroller and Wi-Fi module, the collected data is processed and transmitted to a central server. A user-friendly interface empowers users to access real-time weather conditions, and forecasts, all presented through intuitive graphical representations. This report comprehensively details the system's architecture, hardware, software components, implementation steps, results, challenges, and future possibilities. By combining IoT and NodeMCU ESP8266, this system unlocks fresh possibilities for data-informed decision-making in various fields.

Keywords: IoT Based, NodeMCU ESP8266 WiFi Module, Sensors, Real time data visualization.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Weather monitoring stands as a critical factor that influences numerous facets of human life, including agriculture, transportation, and disaster management. The ability to gather, analyze, and access accurate weather data in real-time is indispensable for making informed decisions in these domains. However, the traditional systems employed for this purpose have been plagued by significant shortcomings. These include their high costs, which limit their accessibility to only well-funded institutions, and their inability to provide timely, up-to-date information.

In response to these challenges, this project pioneers a transformative solution: the IoT-Based Weather Monitoring System using NodeMCU ESP8266. This system harnesses the power of two key technologies—**Internet of Things (IoT)** and **NodeMCU**—to address the inadequacies of traditional weather monitoring systems.

By seamlessly integrating an array of specialized sensors, an NodeMCU ESP8266 microcontroller, and a Wi-Fi module, this system achieves several crucial objectives. Firstly, it captures real-time data on essential weather parameters, including temperature, humidity, atmospheric pressure. Secondly, it processes and analyzes this data, providing valuable insights and even basic weather predictions. Lastly , it offers a user-friendly interface accessible through web or mobile applications, which allows users to effortlessly accesscurrent weather conditions and forecasts.

The IoT-Based Weather Monitoring System using NodeMCU ESP8266 is designed to be both cost-effective and accessible, democratizing access to critical weather data and thus facilitating more informed decision-making across various industries and applications. In the following sections of this report, we will delve deeper into the intricacies of the system's architecture, hardware and software components, its step-by-step implementation, the results it yields, the challenges it faces, and the promising future enhancements it holds. This comprehensive exploration will shed light on the immense potential of this innovative solution for revolutionizing weather monitoring and prediction.

CHAPTER 2

LITERATURE SURVEY

2. LITERATURE SURVEY

2.1-HISTORY

1: Evolution and Technological Foundations

Weather monitoring has a rich historical background, initially reliant on manual observations and rudimentary instruments. The 19th century brought significant advancements with the introduction of instruments like the mercury barometer, improving the accuracy of weather measurements. In the 20th century, meteorology saw a transformative shift with the development of radar, weather satellites, and automated weather stations. These innovations greatly expanded the capacity to monitor and predict weather patterns on a larger scale. However, traditional weather monitoring systems encountered limitations such as high costs and restricted accessibility to real-time data.

2: Emergence of IoT and NodeMCU ESP8266 in Weather Monitoring

The emergence of the Internet of Things (IoT) concept in the early 2000s ushered in a new era for weather monitoring. Researchers and practitioners recognized the potential of integrating IoT devices into weather monitoring systems to enable real-time data collection, processing, and transmission. Simultaneously, the introduction of NodeMCU ESP8266, a versatile, affordable microcontroller platform, played apivotal role in enabling IoT-based weather monitoring projects. NodeMCU ESP8266's ease of use and adaptability appealed to researchers and hobbyists, positioning it as a prominent component in IoT-based weather monitoring systems.

3: Recent Developments, Sensor Advancements

Recent years have witnessed a surge in research and projects related to IoT-based weather monitoring systems. These systems leverage NodeMCU ESP8266 microcontrollers in conjunction with an array of advanced sensors for real-time data collection. Sensor technology has continued to evolve, with enhancements in accuracy, energy efficiency, and connectivity. Modern sensors are indispensable components, offering precise data collection capabilities. Data processing and visualization techniques have also evolved, presenting weather data in user-friendly formats through web and mobile applications, including graphical representations and interactive dashboards. Challenges such as sensor calibration, data security, and power management remain areas of active research. Future directions include the integration of additional sensors, the development of more sophisticated forecasting models, and the expansion of applications in agriculture,transportation, and disaster management.

2.2-LITERATURE REVIEW

Work [1]: IoT-Based Weather Monitoring System with Multi-Sensor Integration

- In the first research work [1], the author introduces an IoT-based weather monitoring system that showcases the integration of various sensors to collect a wide range of environmental parameters. The system's versatility becomes evident as it incorporates sensors for humidity, temperature, pressure, rain, and even light intensity, with a specific mention of the Light Dependent Resistor (LDR) sensor. These sensors collectively form the backbone of the data collectionprocess, allowing for a comprehensive understanding of the surrounding environment.
- One noteworthy feature of this system is its ability to compute the dew point value, a crucial parameter for understanding humidity and moisture levels. The temperature sensor's application extends beyond merely reporting temperature; it provides a means to determine the temperature of a specific region, room, or location. Moreover, the inclusion of the LDR sensor enables the measurement of light intensity, opening up possibilities for applications beyond weather monitoring.
- Perhaps the most significant aspect of this work is the implementation of an SMS alert system. This system can be configured to send alerts when specific thresholds for sensing parameters are exceeded. For instance, it can trigger alerts in response to high temperatures, low humidity levels, changes in pressure, intense light conditions, or

significant rainfall. This added functionality enhances the system's utility, making it invaluable for applications where timely notifications based on weather data are critical.

Work [2]: Low-Cost Real-Time Weather Monitoring with OLED Display

- In the second research work [2], the focus is on creating a cost-effective real-time weather monitoring system with a user-friendly display. Here, the author simplifies the setup by employing just two key devices: the Wemos board and an OLED display. The beauty of this design lies in its simplicity and affordability, making it accessible to a broad user base.
- The data collected by the Wemos board is seamlessly transmitted to the cloud, where it is stored for easy access. Users can conveniently view this data on the Ardinuo IOT Cloud website, providing a user-friendly interface for accessing real-time weather information. The OLED display serves as an additional means of data presentation, allowing users to see weather conditions at a glance.
- The primary objective of this work is to provide users with immediate access to up-to-the-minute weather information through the OLED display. By simplifying the hardware setup and utilizing widely available components, this research work succeeds in delivering a practical and economical solution for real-time weathermonitoring.

Work [3]: Android-Based Weather Reporting with Limited Sensors

- The third research work [3] shares similarities with the second one but introduces an Android application as an interface for accessing weather data stored in the Ardinuo IOT cloud. This innovation brings convenience to users, as they can access weather information on their mobile devices. The Android application communicates with the Ardinuo IOT Cloud server through APIs to retrieve and displaythe data in an easily understandable dashboard format.
- However, it's worth noting that this system employs a more limited set of sensors

compared to the first work. Specifically, it focuses on temperature and rain sensors. While the sensor array may be narrower, the convenience of the Android application interface compensates for this limitation. Users can conveniently check temperature and rainfall data through their mobile devices, making it a practical solution for those seeking essential weather information on the go.

- In summary, these three research works exemplify diverse approaches to IoT-based weather monitoring systems. While the first work showcases a comprehensive sensor array and SMS alerts, the second work emphasizes affordability and simplicity with its OLED display. The third work introduces a mobile application interface for added accessibility, albeit with a more restricted set of sensors. Together, these works illustrate the adaptability of IoT technology in enhancing access to real-time weather data, catering to various user preferences and needs.

CHAPTER 3

Problem Statement

3.PROBLEM STATEMENT

Weather monitoring stands as an indispensable component of modern life, affecting sectors ranging from agriculture and transportation to disaster management and daily decision-making. Timely access to accurate weather data is critical for informed choices and proactive actions. However, conventional weather monitoring systems exhibit notable shortcomings that need to be addressed. Traditional meteorological stations and weather monitoring infrastructure, often centralized and costly, render access to weather information unevenly distributed. Remote and rural areas, in particular, suffer from limited accessibility to real-time weather data, leaving communities and organizations in these regions without vital information for decision-making. Moreover, the financial burden associated with traditional systems proves prohibitive for many entities, encompassing expenses such as the acquisition and installation of specialized equipment, ongoing maintenance, and staffing requirements. This high cost effectively sidelines resource-constrained communities and organizations, preventing them from establishing their weather monitoring capabilities. Additionally, traditional systems often grapple with data timeliness issues, as delays in data collection and dissemination can undermine the relevance of the weather information provided. The repercussions of this delay are acutely felt in sectors where timely decisions are imperative, such as agriculture and disaster preparedness. Lastly, the inflexibility of traditional systems hampers scalability and customization efforts. Adapting these systems to regional or sectoral requirements or integrating additional sensors entails considerable effort and financial investment, making it challenging to cater to evolving needs effectively.

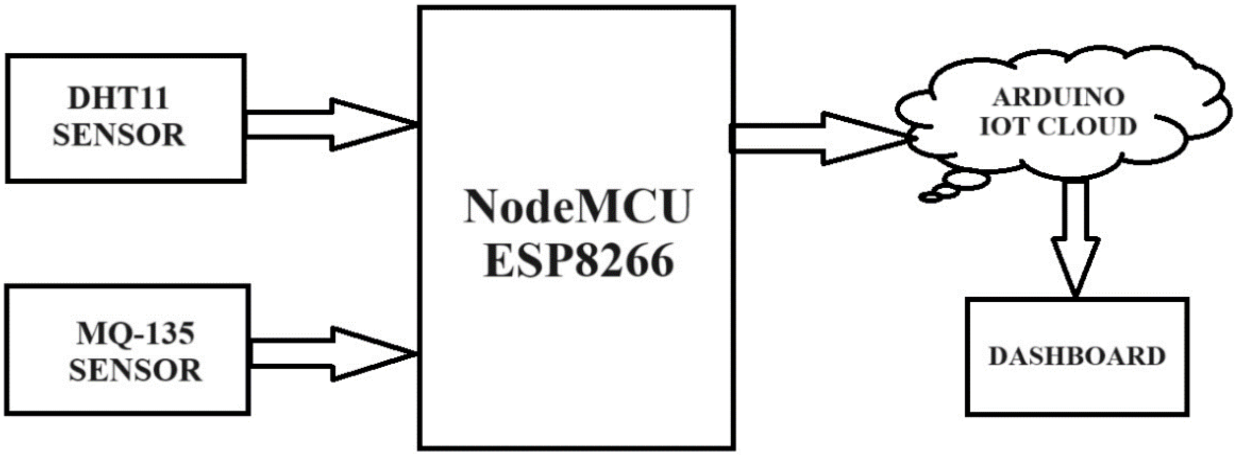
The proposed IoT-Based Weather Monitoring System using NodeMCU ESP8266 WiFi Module endeavors to tackle these pressing challenges by harnessing the capabilities of theInternet of Things (IoT) and NodeMCU ESP8266 technology. This innovative project aspires to offer a solution that is cost- effective, scalable, and accessible. One of its core objectives is to enable real- time data collection of essential weather parameters, including temperature, humidity, atmospheric pressure, wind speed, and rainfall. Through NodeMCU and readily available sensors, this system strives to reduce implementation costs significantly, democratizing weather monitoring and making it feasible for resource-limited communities and organizations. By facilitating continuous and real-time weather monitoring, the project seeks to ensure that data is always accessible to a diverse range of users, from farmers and emergency responders to researchers and decision-makers. In addition to affordability, this system emphasizes customization and scalability. It offers the flexibility to integrate additional sensors or adapt to specific user requirements, allowing for tailored solutions that cater to distinct regional or sectoral needs. Furthermore, the system aims to incorporate timely alert mechanisms that promptly notify users of critical weather conditions as they occur. This feature enhances preparedness and safety, particularly in situations where immediate action can mitigate risks. In sum, the IoT-Based Weather Monitoring System using NodeMCU aspires to bridge the gap in weather data accessibility, mitigate financial barriers, and provide timely, pertinent weather information. By doing so, it empowers individuals and organizations to make informed decisions and enhance their resilience in the face of weather-related challenges.

CHAPTER 4

Experimental Setup

4.1 HARDWARE SETUP

For weather monitoring system hardware setup is required.



The implemented system consists of a microcontroller (ESP8266) as a main processing unit for the entire system and all the sensor and devices can be connected with the microcontroller. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates it to the internet through Wi-Fi module connected with it.

List of components:

1.BreadBoard:

A breadboard is a fundamental tool in electronics used for prototyping and testing circuits. It provides a platform for quickly and easily building electronic circuits without the need for soldering.

2.DHT11(Temperature and Humidity Sensor):

(image insertion of dht11)

The DHT11 is an essential, ultra minimal effort computerized temperature and humidity sensor.

It utilizes a capacitive humidity sensor and a thermistor to gauge the surrounding air, and releases a digital data on the data pin (no analog information pins required). The main genuine drawback of this sensor is you can just get new information from it once every 2 seconds, so when utilizing our library, sensor readings can be up to 2 seconds old. It works on 3 to 5V power supply. Good for 20- 80% humidity readings with 5% accuracy and for 0-50°C temperature readings ±2°C accuracy

3.MQ135(Gas Sensor):

(insert image)

The MQ135 is an inexpensive gas sensor designed to detect various gases such as Ammonia, Sulfide, Benzene Vapors, Smoke, and other harmful gases in the atmosphere. It offers a broad sensitivity range, providing an analog output voltage that fluctuates with the concentration of the detected gases. Known for its high sensitivity and rapid response time, the MQ135 is commonly used in air quality control systems for both residential and industrial settings. However, users should be aware that the sensor might require periodic calibration to ensure accurate and reliable gas concentration measurements. Its versatile applications include indoor air quality monitoring, gas leakage detection, pollution detection, and environmental monitoring projects, making it a popular choice for those seeking an affordable solution for gas detection needs.

4.NodeMCU ESP8266 (Microcontroller):

Here we used ESP8266 Wi-Fi module which is having TCP/IP protocol stack integrated on chip. So that it can provide any microcontroller to get connected with Wi-Fi network. ESP8266 is a preprogrammed SOC and any microcontroller has to communicate with it through UART interface.. It works with a supply voltage of 3.3v. The module is configured with AT commands and the microcontroller should be programmed to send the AT commands in a required sequence to configure the module in client mode. The module can be used in both client and server modes.

4.2 Software Setup

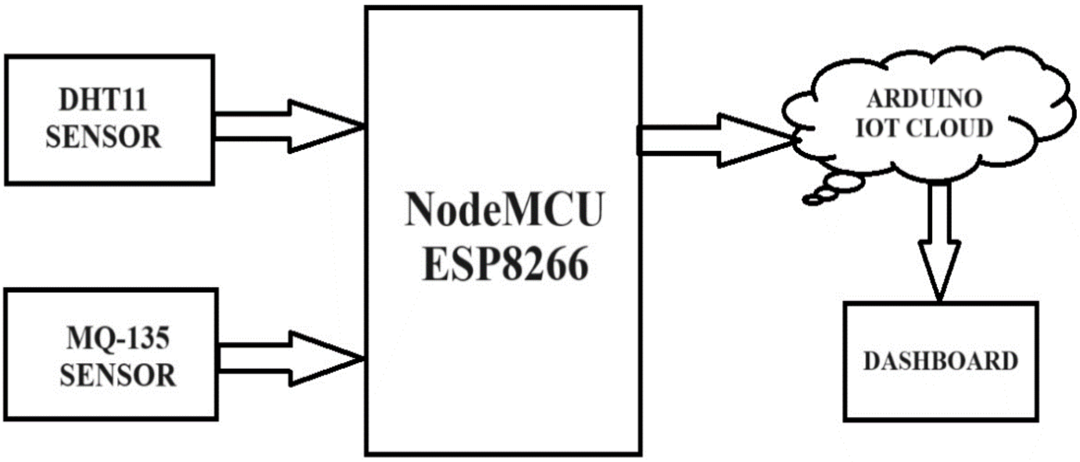
Ardinuo IOT Cloud:

The Arduino IoT Cloud is a comprehensive platform designed to facilitate the development of Internet of Things (IoT) projects using Arduino boards and related components. It simplifies the process of creating and managing IoT applications by providing tools for device registration, monitoring, and management. Users can easily visualize and analyze data from their connected devices, gaining valuable insights into their IoT systems' performance. The platform seamlessly integrates with various Arduino boards and compatible hardware, supporting a wide array of sensors and communication modules commonly used in IoT projects. With a strong focus on security, the Arduino IoT Cloud ensures secure communication between devices and the cloud through robust authentication and encryption protocols. It also enables remote control and monitoring of IoT devices, allowing users to manage their projects conveniently from anywhere using a web browser or a mobile application.

CHAPTER 5

Proposed System & Implementation

5.1 Block diagram of proposed system

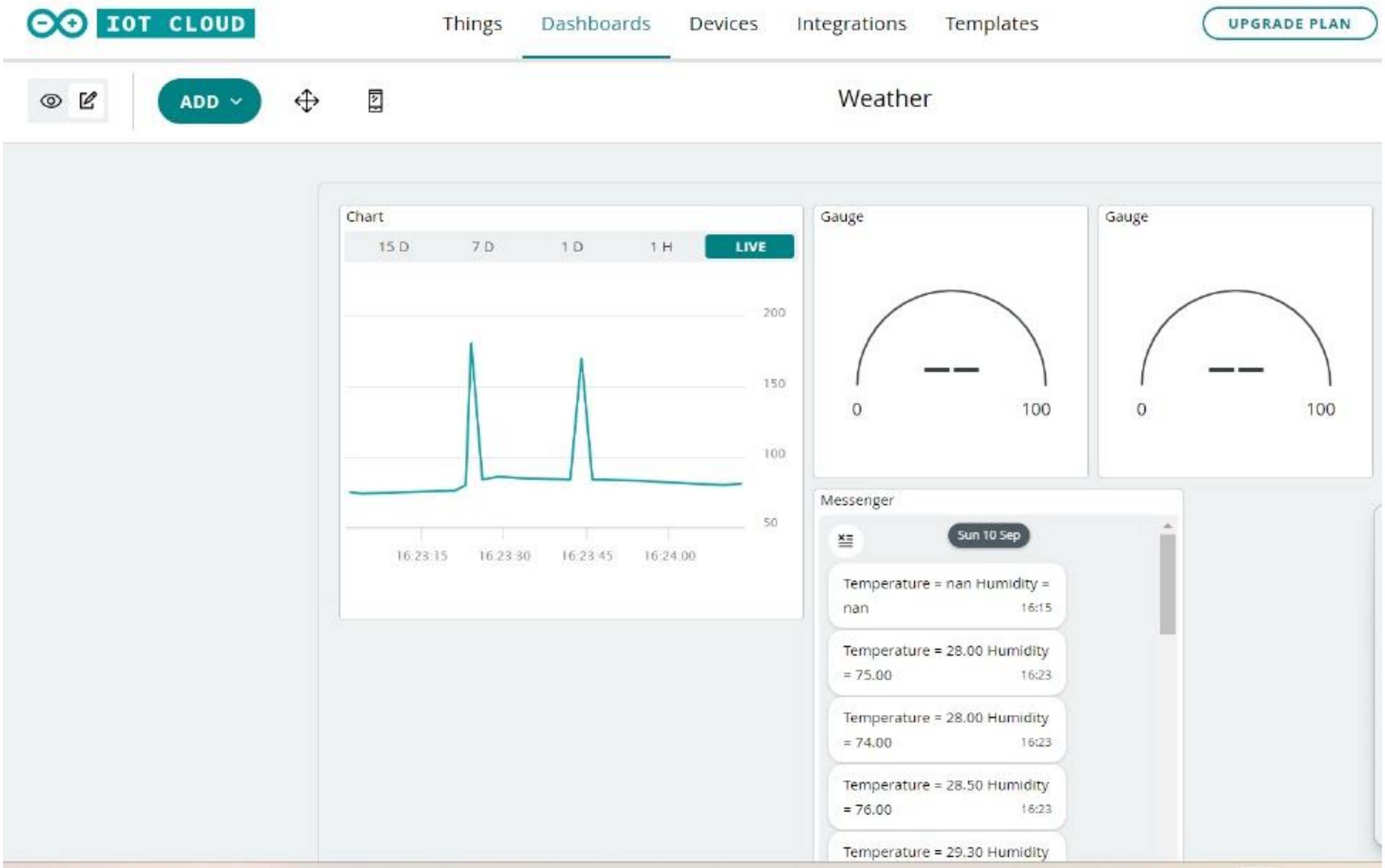


5.2 Description of block diagram

The brain of the project is an NodeMCU ESP8266 WiFi Module and the surrounding components are digital and analog sensors for acquiring local weather and environment data. The NodeMCU ESP8266 WiFi Module has **Arduino like** Analog (i.e. A0) and Digital (D0-D8) pins on its board. . It supports serial communication protocols i.e. UART, SPI, I2C, etc and sends the sensor data to a cloud server where the data gets updated in real time and also gets stored for future analysis.

5.3 Implementation

DHT11 is a digital sensor responsible for collecting temperature and humidity data from your surroundings. It has three terminals namely: Vcc GND Data. Vcc connects to Vcc, GND connects to GND and data pin connects to D4 of NodeMCU. MQ-135 is an analog air quality sensor which takes air samples from your surroundings and gives out an analog voltage at its output terminal. MQ-135 can detect the following gases: NH3 NOx Alcohol Benzene Smoke, CO2 etc. The sensor has built-in heater for heating the sensor for its normal operation and if the sensor is exposed to strong wind we may get incorrect readings. The sensor takes typically around 3 to 5 minutes to reach optimum temperature depending on surrounding air flow. The Analog Output is connected to A0, Vcc and GND to GND. Now, attach the USB cable from the NodeMCU ESP8266 WiFi MODULE to the laptop or PC. Create an account on the Arduino IOT cloud website. You'll see IOT cloud on the homepage; install our NodeMCU ESP8266 WiFiMODULE device there. You will receive a secret key when attaching the device; store it for later. At THINGS' Make variables for: temperature, humidity, air quality, and light intensity. To connect to your device, provide your network credentials and the secret key you generated. You will see that your device is linked after entering your code in the setup. Your output will be displayed on the Dashboard as a gauge, chart message, etc.



CHAPTER 6

Conclusion

CONCLUSION

To conclude, the IoT-based weather monitoring system leveraging NodeMCU represents a sophisticated engineering solution for obtaining precise and up-to-date meteorological information. This technology establishes a seamless connection between advanced weather sensors and the digital realm, facilitating the acquisition of critical data for diverse engineering applications. By enabling remote data collection, analysis, and dissemination, this system enhances the decision-making processes in fields such as precision agriculture, environmental engineering, and infrastructure planning. Its capacity to provide real-time, high-resolution weather insights empowers engineers to create more efficient and resilient designs and systems, ultimately contributing to safer, sustainable, and technologically advanced solutions. The project successfully demonstrates the integration of a microcontroller with environmental sensors, enabling the acquisition of critical weather parameters such as temperature, humidity, and possibly more. These data are then transmitted to a cloud-based IoT platform, making them accessible from anywhere with an internet connection. This project not only showcases the practical use of IoT in weather monitoring but also highlights its potential for various applications, including agriculture, home automation, and environmental research. The ability to remotely access and analyze weather data offers significant advantages in terms of data-driven decision-making and resource management. Through this project, students gain valuable experience in hardware integration, programming, and working with IoT platforms. It fosters an understanding of the importance of IoT technology in addressing real-world challenges and opens up possibilities for further innovation and refinement in the field of weather monitoring and beyond.

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