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IoT Based Weather Station

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Abstract: The advancement of Internet of Things (IoT) technology has enabled the development of smart environmental monitoring systems with real-time data accessibility. This paper presents the design and implementation of an IoT Based Smart Weather Monitoring System using ESP32 microcontroller and cloud analytics. The proposed system monitors environmental parameters such as temperature, humidity, and rainfall using DHT11 and raindrop sensors. The collected data is displayed locally on an LCD display and simultaneously transmitted to the ThingSpeak cloud platform through Wi-Fi connectivity for remote monitoring and analysis. The system offers low cost, low power consumption, and efficient real-time weather monitoring. The developed prototype can be effectively used in smart agriculture, environmental monitoring, disaster management, and smart city applications. The integration of cloud technology with embedded systems improves accessibility, reliability, and data visualization compared to traditional weather monitoring systems.

Keywords: IoT, ESP32, Weather Monitoring, DHT11 Sensor, ThingSpeak, Cloud Computing, Smart Environment

I. INTRODUCTION

Weather monitoring plays a vital role in agriculture, environmental observation, disaster management, and climate analysis. Traditional weather monitoring systems are generally expensive and require manual observation. With the rapid development of Internet of Things (IoT) technology, smart and automated monitoring systems have become more efficient and accessible.

The proposed IoT based weather monitoring system uses ESP32 microcontroller for collecting and transmitting weather parameters such as temperature, humidity, and rainfall data. Sensors like DHT11 and raindrop sensor are integrated with the ESP32 module to measure environmental conditions accurately. The collected data is displayed on an LCD screen and uploaded to the ThingSpeak cloud server for real-time remote monitoring.

The system provides an economical and portable solution for continuous environmental monitoring. The cloud integration allows users to access weather data from anywhere using internet connectivity. The proposed system is useful for farmers, researchers, industries, and smart city applications

II. LITERATURE SURVEY

Several researchers have developed IoT based weather monitoring systems using various sensors and wireless communication technologies. Existing systems mainly focus on monitoring temperature and humidity using microcontrollers such as Arduino and NodeMCU.

Some systems use GSM technology for data transmission, while others use Wi-Fi enabled microcontrollers for cloud integration. Researchers have also developed smart weather systems for agricultural applications to improve crop productivity and irrigation management.

However, many traditional systems are costly, consume higher power, and provide limited remote accessibility. The proposed system overcomes these limitations by using ESP32 microcontroller with integrated Wi-Fi capability and cloud-based monitoring using ThingSpeak platform.

III. PROPOSED METHODOLOGY

The proposed system consists of ESP32 NodeMCU, DHT11 sensor, raindrop sensor, LCD display, and ThingSpeak cloud platform.

The DHT11 sensor measures temperature and humidity, while the raindrop sensor detects rainfall conditions. The ESP32 microcontroller processes the sensor data and displays it on the LCD display. Simultaneously, the data is transmitted to the ThingSpeak cloud server using Wi-Fi connectivity.

The cloud platform stores and visualizes the data in graphical format, enabling remote monitoring from mobile phones or computers.

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IV. HARDWARE COMPONENTS

A. ESP32 NodeMCU

ESP32 is a low-cost and low-power microcontroller with built-in Wi-Fi and Bluetooth functionality. It acts as the main controller of the system.

B. DHT11 Sensor

The DHT11 sensor is used for measuring temperature and humidity values from the surrounding environment.

C. Rain Drop Sensor

The rain drop sensor detects rainfall conditions and provides corresponding output signals to the ESP32 controller.

D. LCD Display

The LCD display is used for displaying real-time weather parameters locally.

E. ThingSpeak Cloud Platform

ThingSpeak is an IoT cloud platform used for storing, visualizing, and analyzing sensor data remotely

V. WORKING PRINCIPLE

Initially, the ESP32 microcontroller initializes all connected sensors and establishes Wi-Fi connectivity. The DHT11 sensor continuously measures temperature and humidity values, while the rain drop sensor detects rainfall conditions.

The collected data is processed by the ESP32 and displayed on the LCD screen. Simultaneously, the processed data is uploaded to the ThingSpeak cloud server using internet connectivity. Users can monitor the weather parameters remotely through graphical visualization on the cloud platform.

VI. RESULTS AND DISCUSSION

The developed prototype successfully monitors environmental parameters in real time. Temperature, humidity, and rainfall data are accurately sensed and displayed on the LCD display.

The uploaded data on ThingSpeak platform can be visualized using graphs and charts for better analysis. The system demonstrates stable operation with low power consumption and reliable wireless communication.

The proposed system is cost effective, portable, and suitable for both indoor and outdoor environmental monitoring applications.

VII. APPLICATIONS

1. Smart Agriculture
2. Weather Forecasting
3. Environmental Monitoring
4. Disaster Management
5. Smart City Systems
6. Industrial Weather Monitoring

VIII. ADVANTAGES

1. Low Implementation Cost
2. Real-Time Monitoring
3. Wireless Communication
4. Cloud Data Storage
5. Easy Installation
6. Portable and Compact Design

IX. FUTURE SCOPE

The proposed system can be further enhanced by integrating additional sensors such as:

- Air Quality Sensor
- Wind Speed Sensor
- UV Sensor
- Solar Power System
- AI Based Weather Prediction

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- Mobile Application Integration
- SMS Alert System

X. CONCLUSION

This paper presents an IoT Based Smart Weather Monitoring System using ESP32 and cloud analytics. The system effectively monitors environmental parameters such as temperature, humidity, and rainfall in real time. The integration of ESP32 with ThingSpeak cloud platform enables remote monitoring and graphical data analysis. The proposed system is economical, reliable, and suitable for smart agriculture and environmental monitoring applications. The developed prototype demonstrates the practical implementation of IoT technology in weather monitoring systems.

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