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Mini Weather Alert System Using IoT for Real-Time

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Abstract - *The Mini Weather Alert System using Internet of Things (IoT) is an intelligent weather monitoring solution designed to collect and transmit real-time environmental data. The system continuously measures important weather parameters such as temperature, humidity, atmospheric pressure, and rainfall using sensors connected to an ESP32 microcontroller. The collected data is transmitted through Wi-Fi to a cloud platform, allowing users to monitor weather conditions remotely using a smartphone or web application. Whenever the measured values exceed predefined threshold limits, the system instantly sends alert notifications to users, enabling timely preventive actions against adverse weather conditions. The proposed system offers an affordable, portable, and energy-efficient alternative to traditional weather monitoring stations, making it suitable for agriculture, educational institutions, smart cities, industries, and residential areas. The integration of IoT technology enables continuous monitoring, secure cloud storage, and real-time visualization of environmental parameters. Experimental testing demonstrated reliable sensor performance, accurate data transmission, and low power consumption. The developed system improves weather awareness and supports early decision-making by providing instant alerts during abnormal weather conditions. This low-cost solution can be further enhanced by incorporating artificial intelligence for weather prediction and additional environmental sensors to improve forecasting accuracy and expand application areas.*

Key Words: Internet of Things (IoT), ESP32, Weather Monitoring, Temperature Sensor, Humidity Sensor, Cloud Computing, Real-Time Alert, Environmental Monitoring

1. INTRODUCTION

Weather monitoring plays an important role in agriculture, disaster management, transportation, industrial safety, and environmental protection. Accurate and timely weather information helps individuals and organizations make informed decisions and minimize the impact of adverse weather conditions. Traditional weather monitoring systems are often expensive, require manual observation, and are not suitable for continuous monitoring in small-scale applications.

The rapid development of the Internet of Things (IoT) has enabled the design of intelligent monitoring systems that can collect, process, and transmit environmental data over the Internet. IoT-based weather monitoring systems provide real-time access to weather information from any location using cloud computing technologies. These systems reduce human intervention while improving monitoring efficiency and accuracy.

The proposed Mini Weather Alert System uses an ESP32 microcontroller integrated with sensors such as DHT11/DHT22 for temperature and humidity measurement, BMP280 for atmospheric pressure monitoring, and a rain sensor for rainfall detection. The measured data is transmitted through Wi-Fi to an IoT cloud platform such as Thing 3Speak or Blynk, where users can monitor live environmental conditions through a mobile application or web dashboard.

Whenever environmental conditions exceed predefined safety limits, the system automatically generates alert notifications through the cloud platform. This feature enables users to take immediate action during extreme weather conditions. The proposed system is compact, cost-effective, energy-efficient, and easy to deploy, making it suitable for smart agriculture, educational institutions, weather research, and smart city applications.

The primary objective of this work is to design and implement a reliable IoT-based weather monitoring system capable of collecting real-time environmental data and providing instant alerts to improve weather awareness and public safety.

1.1 Objectives

- To develop a low-cost IoT-based weather monitoring system.
- To monitor temperature, humidity, rainfall, and atmospheric pressure in real time.
- To transmit sensor data to the cloud using Wi-Fi.
- To provide instant alerts when weather parameters exceed threshold values.
- To enable remote monitoring through mobile and web applications.
- To improve environmental awareness using IoT technology.

Literature Survey comparison				
Author	**Year**	**Technology used**	**limitation**	**Advantages**
Sharma et al.	2022	ESP8266, DHT11, ThingSpeak	Low-cost cloud monitoring	Low-cost cloud monitoring
Patel & Kumar	2023	ESP32, Rain Sensor, Blynk	Real-time mobile alerts	Higher hardware cost
Reddy et al.	2021	Arduino Uno, GSM	SMS notification	No cloud visualization
Proposed System	2026	ESP32, DHT11, BMP280, Rain Sensor, Blynk/ThingSpeak	Low-cost, real-time monitoring, cloud access, instant alerts	Future work includes AI-based forecasting

1.2 Scope of the Project

The proposed system can be used in agricultural fields, educational institutions, industries, smart homes, smart cities, and environmental monitoring stations. It provides continuous weather monitoring with remote access through the Internet. The system can be upgraded by integrating additional sensors such as wind speed, UV index, air quality, and GPS modules. Artificial intelligence and machine learning techniques can also be incorporated in future versions for weather prediction and anomaly detection.

2. PROPOSED SYSTEM

2.1 Literature Survey

Recent advancements in Internet of Things (IoT) technology have significantly improved the efficiency of weather monitoring systems. Researchers have developed several smart weather monitoring solutions that collect environmental data using sensors and transmit it to cloud platforms for real-time analysis. These systems help users monitor weather conditions remotely and receive timely alerts during extreme environmental situations.

Sharma et al. (2022) proposed an IoT-based weather monitoring system using the ESP8266 microcontroller and DHT11 sensor to monitor temperature and humidity. The collected data was uploaded to the Thing Speak cloud platform for real-time visualization. The study demonstrated that IoT technology enables continuous monitoring with low implementation cost.

Patel and Kumar (2023) designed a smart weather station integrating multiple sensors, including temperature, humidity, atmospheric pressure, and rainfall sensors. Their system utilized the ESP32 microcontroller with Wi-Fi connectivity to transmit environmental data to a mobile application. The proposed model improved data accuracy and enabled instant weather alerts through cloud services.

Reddy et al. (2021) developed a wireless weather monitoring system using Arduino Uno and GSM technology. The system was capable of sending SMS alerts whenever abnormal weather conditions were detected. Although reliable, the GSM-based solution incurred additional communication costs and lacked real-time cloud visualization.

Singh et al. (2024) introduced an intelligent IoT weather monitoring platform integrated with machine learning algorithms for weather prediction. Historical environmental data collected from sensors was used to forecast future weather conditions with improved prediction accuracy. The system demonstrated the potential of combining IoT with artificial intelligence.

Despite these advancements, many existing weather monitoring systems either require expensive hardware, consume high power, or provide limited remote accessibility. Therefore, there is a need for an affordable, portable, and energy-efficient weather monitoring system capable of providing real-time alerts through cloud connectivity. The proposed Mini Weather Alert System addresses these challenges by integrating ESP32, environmental sensors, Wi-Fi communication, and cloud-based monitoring into a compact and cost-effective solution.

2.2 System Architecture

The system consists of an ESP32 microcontroller connected to various environmental sensors including DHT11, BMP280, and a rain sensor. These sensors continuously collect weather data such as temperature, humidity, atmospheric pressure, and rainfall. The ESP32 processes the collected information and transmits it to a cloud platform through Wi-Fi. Users can access live weather information using a smartphone or computer. Whenever abnormal environmental conditions occur, the cloud platform generates alert notifications and the buzzer produces an audible warning.

2.3 Hardware Components

- ESP32 Development Board
- DHT11 Temperature and Humidity Sensor
- BMP280 Pressure Sensor
- Rain Detection Sensor
- OLED Display (Optional)
- Buzzer

- Breadboard
- Jumper Wires
- Power Supply

2.4 Software Components

- Arduino IDE
- Embedded C/C++
- Blynk IoT Platform
- ThingSpeak Cloud
- Wi-Fi Communication Protocol

2.5 Methodology

The development of the Mini Weather Alert System begins with connecting environmental sensors to the ESP32 microcontroller. The sensors continuously measure temperature, humidity, atmospheric pressure, and rainfall. The ESP32 reads the sensor values and compares them with predefined threshold values. The collected data is transmitted through Wi-Fi to the cloud platform, where it is stored and displayed graphically. If any weather parameter exceeds the safe operating range, the ESP32 activates a buzzer and the cloud platform sends an instant notification to the user. This process repeats continuously to ensure real-time environmental monitoring.

2.6 Working Principle

The DHT11 sensor measures temperature and humidity, while the BMP280 sensor records atmospheric pressure. The rain sensor detects the presence of rainfall. The ESP32 collects sensor readings and uploads them to the cloud through Wi-Fi. Users can monitor the weather conditions remotely through a mobile application or web dashboard. During abnormal weather conditions, alert notifications are generated automatically to ensure timely response.

2.7 Experimental Results and Discussion

The proposed Mini Weather Alert System was tested under different environmental conditions to evaluate its performance. Experimental observations showed that the DHT11 sensor measured temperature with acceptable accuracy for small-scale weather monitoring applications. The humidity readings remained stable throughout the testing period, while the BMP280 sensor accurately monitored atmospheric pressure variations. The rain sensor successfully detected rainfall and activated the alert mechanism immediately.

The ESP32 maintained stable Wi-Fi communication with the cloud platform, allowing continuous data transmission without significant delays. The Blynk/Thing Speak dashboard displayed real-time environmental data and graphical trends that could be monitored remotely using a smartphone.

The developed system demonstrated low power consumption, reliable wireless communication, and effective alert generation. The experimental results indicate that the proposed system is suitable for smart agriculture, educational laboratories, environmental monitoring, and smart city applications where continuous weather monitoring is required.

2.8 Advantages

- Low implementation cost.
- Real-time weather monitoring.
- Wireless cloud connectivity.
- Instant alert notifications.
- Low power consumption.
- Portable and compact design.
- Easy installation and maintenance.
- Remote monitoring using smartphones.
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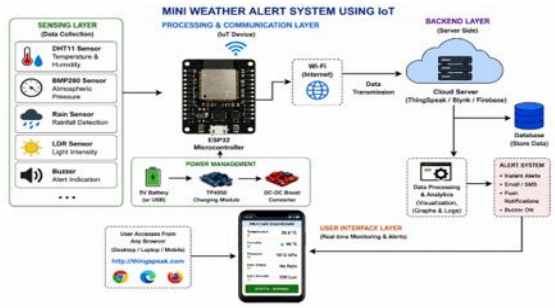
2.9 Future Scope

Future improvements include integrating artificial intelligence for weather prediction, adding wind speed and air quality sensors, improving battery efficiency using solar power, and incorporating GPS for location-based weather monitoring. Machine learning algorithms can also be used to analyze historical weather data and improve forecasting accuracy.



3. CONCLUSIONS

The Mini Weather Alert System using IoT provides an efficient, low-cost, and reliable solution for real-time environmental monitoring. By integrating ESP32 with temperature, humidity, atmospheric pressure, and rainfall sensors, the system continuously collects weather data and transmits it to a cloud platform through Wi-Fi. Users can remotely monitor environmental conditions and receive instant notifications whenever abnormal weather conditions occur. The experimental results demonstrate that the proposed system provides accurate sensor measurements, reliable cloud communication, and timely alert generation. Due to its affordability, portability, and ease of implementation, the proposed system is suitable for applications in agriculture, smart cities, educational

institutions, industries, and environmental monitoring. Future enhancements involving artificial intelligence and additional sensors can further improve the accuracy and capabilities of the system.

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