

IOT-Based Weather Monitoring System

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Abstract: *The IoT-based Weather Monitoring and Reporting System developed in this work delivers real-time updates on key environmental parameters such as temperature, humidity, soil moisture, atmospheric pressure, and rainfall. It is particularly useful for scientists, researchers, and environmental analysts who need access to data from remote locations. Traditional SMS-based systems are limited by the number of recipients and slower transmission times. In contrast, the proposed IoT solution uses cloud-based connectivity, allowing instant and global access to data. The system includes both hardware and software components. An Arduino microcontroller forms the core, connected to various sensors including the DHT11 for temperature and humidity, BMP180 for pressure, and other sensors for rainfall and soil moisture. Data from these sensors is sent through the ESP8266 Wi-Fi module, powered by a USB Type B or 5V DC source. The system is integrated with both the Blynk platform for mobile application and the ThingSpeak website. Blynk offers a user-friendly interface and allows up to 30,000 SMS alerts, while ThingSpeak enables data logging with a daily limit of 8,000 entries. Sensor data is transmitted using authentication tokens for secure communication. This efficient and scalable setup supports climate research, disaster prevention, and smart environmental monitoring.*

Keywords: Weather Monitoring system, Internet of Things, ThingSpeak

I. INTRODUCTION

Climate change and environmental monitoring have gained significant attention in recent years. Individuals and organizations require real-time weather updates for specific locations, such as college campuses or office buildings [1-3]. In response to this need, an IoT-based weather station is presented in this work, designed to provide accurate and real-time environmental data. The system is equipped with various environmental sensors, including the DHT11 sensor, soil moisture sensor, and rain drop sensor, integrated with an Arduino Uno microcontroller. These sensors continuously monitor weather parameters and transmit data to an online web server via a Wi-Fi connection. The collected information is uploaded to the cloud, enabling real-time reporting and analysis. This paper also explores the application of IoT in next-generation environmental monitoring system and its potential role in developing smart cities. The proposed system aims to enhance localized weather tracking, offering valuable insights for urban planning and environmental sustainability.

The Internet of Things (IoT) has emerged as a revolutionary advancement [4-6] in the global information industry, transforming traditional communication paradigms. IoT enables interconnected devices to exchange information, facilitating seamless data acquisition and management. By leveraging IoT technology, the proposed system enhances environmental monitoring, offering a scalable and efficient solution for weather tracking in smart city development. The weather station consists of an Arduino Uno microcontroller connected to multiple environmental sensors. The collected data through the sensors is transmitted to an online web server, where it is stored and processed for real-time access. Users can retrieve weather updates via a cloud-based interface, ensuring timely and accurate information dissemination.

IoT technology enables intelligent sensing, tracking, monitoring, and management of environmental parameters. By integrating microcontrollers, wireless communication modules, and cloud computing, IoT facilitates seamless data



exchange between devices and users [7-8]. The proposed weather station exemplifies the potential of IoT in enhancing environmental awareness, contributing to sustainable development initiatives. The IoT-based weather monitoring system can be deployed in various settings, including office buildings, agricultural fields, and educational institutions. Its real-time data capabilities can assist in weather forecasting, disaster management, and resource optimization. Future enhancements may include the integration of machine learning algorithms for predictive analysis, expanded sensor networks for broader coverage, and enhanced connectivity through advanced communication protocols.

II. LITERATURE SURVEY

To predict weather conditions accurately has become a crucial challenge due to extreme climate states that adversely affect lives and property. Precise weather data is essential for enhancing weather prediction capabilities and building resilience against detrimental weather conditions. Developing countries like Uganda face challenges in acquiring timely and accurate weather data due to the scarcity of weather observation stations [9], primarily caused by the high cost of implementing automatic weather monitoring systems and limited funding for national meteorological services. To address these issues, an automatic weather monitoring station based on a wireless sensor network has been proposed. The plan involves developing three generations of automatic weather stations (AWS) prototypes, with the first-generation AWS being evaluated to improve subsequent versions. The study suggests enhancements in power consumption, data accuracy, reliability, and data transmission, ensuring a robust and cost-effective AWS that can be adopted by developing countries to improve weather forecasting.

Another study presents an IoT-based weather monitoring system [10] that retrieves environmental parameters using sensors such as temperature, humidity, pressure, and rain sensors, along with an LDR sensor to measure light intensity. The system calculates dew point values and integrates an SMS alert mechanism that notifies users when sensing parameters exceed predefined thresholds. Additional functionalities include email and social media alerts. The system employs Node MCU ESP8266 along with various sensors for data collection. The research paper [11] introduces a low-cost live weather monitoring system utilizing an OLED display to showcase real-time weather conditions. The system is built on an ESP8266-EX microcontroller-based We Mos D1 board, programmed using Arduino, which retrieves data from the cloud. The use of the Thing Speak platform for cloud storage ensures efficient data visualization on both OLED displays and the cloud.

Further research proposes a system [12] that not only monitors but also predicts weather conditions, allowing individuals to plan their daily activities accordingly. This system integrates sensor data, bus mobility data, and deep learning technology to provide real-time weather updates at stations and buses. Weather forecasting is achieved using a friction model that processes data from vehicles such as buses, incorporating local information processing for improved accuracy. An IoT-based weather monitoring system [13] highlights how IoT technology facilitates real-time climate monitoring, providing accurate and efficient weather data. This system uses swarm algorithms to enhance prediction accuracy, making it more effective for climate awareness and forecasting. The project employs various sensors to collect climate-related information, which is then stored in the cloud and accessed via an Android mobile application using an API key.

A system is designed [14] to keep an eye on weather conditions in industries using sensors for temperature, gas, and humidity. It uses an LPC1768 microcontroller to gather sensor data and sends it to a program called LABVIEW, which stores it in an Excel sheet. Plus, it can send alerts straight to your phone via SMS with a GSM module. The sensors track temperature, gas, and humidity and the microcontroller sends data to LABVIEW and mobile via GSM. Embedded C programming is used with Keil uVision4 and JTAG for uploading code. The proposed work [15] introduces a weather monitoring system that tracks temperature, pressure, humidity, rainfall, wind speed, and wind direction using various sensors like rotary encoders and tipping buckets. The data is processed by a microcontroller and then shared wirelessly via Wi-Fi for continuous storage and access. This fully automated setup reduces human error and can be applied in fields such as agriculture, meteorology, and industry. The paper [16] reported the design and implementation of a low-cost, efficient, and accessible weather monitoring system using Internet of Things (IoT)



technology. The system employs various sensors—such as DHT11 for temperature and humidity, MQ135 for air quality, and rain sensors—integrated with microcontrollers like Arduino UNO and NodeMCU ESP8266/ESP32. Data collected from these sensors is transmitted via Wi-Fi to cloud platforms such as ThingSpeak or Blynk, where it can be monitored remotely through web dashboards or mobile applications.

The work reported in [17] presents a cost-effective and efficient approach to monitor weather and environmental conditions using IoT technology integrated with machine learning. It addresses the limitations of existing systems that provide generalized data and proposes a localized monitoring setup using sensors like DHT11 for temperature and humidity, BMP180 for pressure, and MQ135 for air quality. These sensors are connected to a NodeMCU microcontroller, which collects data and uploads it to cloud platforms like ThingSpeak. The data can then be accessed globally via web and mobile applications. The system also uses machine learning algorithms, such as linear and multiple regression, to analyze and predict weather patterns. The collected data is processed using tools like Arduino IDE and R Studio. The paper [18] discusses the development of an IoT-based weather monitoring system that provides real-time data on temperature, humidity, and rain probability. The system uses a NodeMCU ESP8266 microcontroller integrated with DHT11 temperature and humidity sensor, a rain sensor, and an OLED display to collect and show environmental data. The information is also uploaded to the Cayenne IoT platform, which allows for remote visualization and alerts when thresholds are exceeded.

III. SCOPE OF THE PROJECT

The scope of the IoT-Based Weather Monitoring System project is to design and develop a smart system that collects, monitors, and analyzes real-time environmental data using Internet of Things (IoT) technology. The system aims to provide accurate and continuous information about weather conditions such as temperature, humidity, atmospheric pressure, and rainfall.

The project focuses on integrating sensors with a microcontroller and cloud-based platform to enable remote monitoring and data access through a web or mobile interface. It is designed to assist users, especially farmers and researchers, in making informed decisions based on real-time weather insights.

Additionally, the system can be extended to include alerts and notifications for extreme weather conditions, helping in early warning and preventive measures. The platform ensures efficient data logging, visualization, and accessibility, making it a reliable solution for environmental monitoring and smart agriculture applications.

• Functional Scope:

1. The functional scope of the IoT-Based Weather Monitoring System defines the main operations and services provided by the system. The system is designed to monitor environmental conditions and provide real-time weather data to users such as farmers, researchers, and weather analysts, helping improve decision-making and environmental awareness.
2. One of the primary functions of the system is real-time data collection, where sensors are used to measure environmental parameters such as temperature, humidity, atmospheric pressure, and rainfall. This data is continuously captured from the surroundings.
3. Another important function is data transmission, where the collected data is sent from the sensors to a microcontroller and then transmitted to a cloud server or database using IoT technology for storage and processing.
4. The system also includes a data visualization module, where users can view weather data through a web or mobile interface in the form of graphs, charts, or dashboards. This makes it easier to understand weather patterns.
5. An additional feature is alert and notification generation, where the system can notify users in case of extreme weather conditions such as high temperature, heavy rainfall, or sudden climate changes.
6. The system supports data logging and historical analysis, allowing users to store past weather data and analyze trends over time for better planning and forecasting.



7. Administrators or system managers are responsible for maintaining the system, managing sensor configurations, updating system settings, and ensuring proper functioning of the platform.

• Non-Functional Scope:

1. The non-functional scope of the IoT-Based Weather Monitoring System describes the quality requirements that ensure the system operates efficiently, accurately, and reliably.
2. Usability is an important aspect of the system. The interface is designed to be simple and user-friendly so that users with basic technical knowledge can easily access and understand weather data.
3. Performance and reliability are critical requirements. The system must provide real-time data updates with minimal delay and ensure continuous monitoring without system failures.
4. Accuracy is another key requirement. The sensors used in the system must provide precise and consistent measurements to ensure the reliability of weather data.
5. Security is essential to protect the system and data from unauthorized access. Proper authentication and secure data transmission methods must be implemented.
6. Scalability is important so that the system can support additional sensors, users, and expanded monitoring areas in the future.
7. Maintainability and flexibility are also required. The system should allow easy maintenance, updates, and integration of new features such as advanced analytics, mobile applications, or AI-based weather prediction.

IV. METHODOLOGY / APPROACH

The development of the IoT-Based Weather Monitoring System follows a Linear Sequential Model, ensuring that each phase is completed systematically before moving to the next. This structured approach helps in achieving accuracy, reliability, and efficient system performance.

Step 1: Problem Analysis & Requirement Gathering

The first step involves identifying the need for real-time environmental monitoring and understanding the limitations of traditional weather observation methods.

The requirements of the system are defined, including monitoring parameters such as temperature, humidity, atmospheric pressure, and rainfall. The need for remote access, real-time data updates, and alert mechanisms is also established.

Step 2: System Architecture & Design

In this phase, the system design is prepared by converting requirements into a technical framework. The system follows an IoT-based architecture consisting of the following components:

Sensor Layer: Includes sensors such as temperature, humidity, and pressure sensors to collect environmental data.

Processing Layer (Microcontroller): Uses devices like Arduino or NodeMCU to process sensor data and control data transmission.

Communication Layer: Utilizes Wi-Fi or other communication protocols to send data to a cloud server.

Application Layer (Frontend): A web or mobile interface developed using HTML, CSS, and JavaScript to display data to users.

Data Layer (Cloud/Database): Stores collected data securely for real-time access and historical analysis.

Step 3: Development & Modular Implementation

In this stage, the system is developed in separate modules to ensure organized implementation and easy troubleshooting:

- Sensor Integration Module: Connects and calibrates sensors for accurate data collection.



- Data Transmission Module: Implements IoT protocols to send data from the microcontroller to the cloud platform.
- Data Visualization Module: Displays real-time weather data using graphs, dashboards, and charts.
- Alert System Module: Generates notifications when weather parameters exceed predefined thresholds.
- Data Storage Module: Stores historical data for future analysis and reporting.

Step 4: Testing & Quality Assurance

The system is thoroughly tested to ensure proper functioning and reliability.

- Unit Testing: Individual components like sensors and microcontroller functions are tested separately.
- Integration Testing: Ensures smooth communication between sensors, microcontroller, and cloud services.
- System Testing: Verifies the complete system for real-time data accuracy and performance.
- User Interface Testing: Ensures that the dashboard is responsive and easy to use across devices.

V. ADVANTAGES

1. Real-Time Weather Monitoring: The system provides continuous and real-time updates of environmental conditions such as temperature, humidity, and atmospheric pressure, helping users stay informed at all times.
2. Improved Decision Making: Accurate weather data enables farmers and users to make better decisions regarding irrigation, sowing, and harvesting activities.
3. Time-Saving and Automation: The automated data collection process eliminates the need for manual weather observation, saving time and effort.
4. Early Warning System: The system can generate alerts for extreme weather conditions such as heavy rainfall, high temperature, or sudden climate changes, helping users take preventive actions.
5. Remote Accessibility: Users can access weather data from anywhere through a web or mobile interface, making monitoring convenient and efficient.
6. Data Logging and Analysis: The system stores historical weather data, allowing users to analyze trends and patterns for better planning and forecasting.
7. Cost-Effective Solution: Compared to traditional weather monitoring systems, the IoT-based system is relatively low-cost and easy to deploy.
8. Scalability and Flexibility: The system can be easily expanded by adding more sensors or integrating with other smart agriculture technologies.

VI. APPLICATIONS

1. Smart Agriculture: Farmers can use the system to monitor real-time weather conditions such as temperature and humidity, helping them make informed decisions about irrigation, sowing, fertilization, and harvesting. This improves crop productivity and reduces losses.
2. Weather Forecasting and Analysis: The system can be used to collect and analyze environmental data over time, helping in identifying weather patterns and supporting basic forecasting activities.
3. Disaster Management: The system provides early warnings for extreme weather conditions such as heavy rainfall, storms, or high temperatures. This helps in taking preventive measures and reducing damage to crops and property.
4. Environmental Monitoring: It can be used by researchers and environmental agencies to monitor climate conditions and study environmental changes over time.
5. Smart Irrigation Systems: The data collected can be integrated with automated irrigation systems to optimize water usage based on real-time soil and weather conditions.
6. Industrial and Urban Monitoring: Industries and smart cities can use the system to monitor environmental conditions for safety, pollution control, and efficient resource management.
7. Educational and Research Purposes: The system serves as a practical learning tool for students and researchers in the fields of IoT, environmental science, and data analysis.



VII. CONCLUSION

In today's era of rapid technological advancement, the IoT-Based Weather Monitoring System demonstrates how modern technology can enhance traditional methods of environmental observation and agricultural practices. By providing real-time, accurate, and easily accessible weather data, the system helps users make informed decisions and improve overall efficiency.

The integration of sensors, IoT technology, and cloud-based platforms ensures continuous monitoring, data accuracy, and remote accessibility. This project not only reduces manual effort but also enables better planning and risk management, especially in agriculture and environmental monitoring.

Overall, the system contributes to the development of smart and sustainable solutions by promoting automation, data-driven decision-making, and efficient resource utilization, making it a valuable tool for future smart farming and environmental applications.

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REFERENCES

- [1] Bahga, Arshdeep & Madiseti, Vijay. Internet of Things: A Hands-On Approach, Universities Press, 2015.
- [2] Monk, Simon. Programming Arduino: Getting Started with Sketches, McGraw-Hill Education, 2016.
- [3] Richardson, Matt & Wallace, Shawn. Getting Started with Raspberry Pi, O'Reilly Media, 2012.
- [4] Rajaraman, V. Fundamentals of Computers, Prentice-Hall of India, 2014.
- [5] Sommerville, Ian. Software Engineering, 10th Edition, Pearson Education, 2015.
- [6] World Meteorological Organization (WMO). Guide to Meteorological Instruments and Methods of Observation, 2018.
- [7] Ministry of Electronics and Information Technology, Government of India. Digital India Initiative, 2015.
- [8] Arduino Official Documentation – <https://www.arduino.cc>
- [9] Raspberry Pi Foundation – <https://www.raspberrypi.org>
- [10] ThingSpeak IoT Platform Documentation – <https://thingspeak.com>
- [11] Adafruit Learning System (Sensor Guides & IoT Tutorials) – <https://learn.adafruit.com>
- [12] DHT Sensor Documentation (Temperature & Humidity Sensors) – <https://www.dhtsensor.com>
- [13] MySQL Developer Guide – <https://dev.mysql.com/doc>
- [14] GeeksforGeeks – IoT, Embedded Systems, and Web Development Concepts – <https://www.geeksforgeeks.org>
- [15] TutorialsPoint – IoT, Arduino, and Web Technologies – <https://www.tutorialspoint.com>

