

Industrial Environment Monitoring Using IoT: A Comprehensive Review on Temperature and Humidity Control

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Abstract: *This project introduces an IoT-based Industrial Temperature and Humidity Monitoring System built using an ESP32 microcontroller and the Blynk platform. The system is designed to continuously track and display environmental conditions such as temperature and humidity in industrial environments. Maintaining optimal temperature and humidity levels is essential for preserving product quality, safeguarding equipment, and ensuring worker safety.*

A DHT11 sensor is used to capture temperature and humidity data, which is then processed by the ESP32. Leveraging its built-in Wi-Fi, the ESP32 sends this data to the Blynk cloud platform, enabling users to view live readings, analyze trends, and receive instant notifications when the readings go beyond set thresholds—all through the Blynk mobile app.

This automated setup removes the need for manual monitoring, providing a reliable and continuous supervision system. The stored data can further support predictive maintenance and system optimization. Due to its affordability, scalability, and efficiency, this solution can be implemented across industries such as manufacturing, warehousing, and pharmaceuticals. By integrating IoT, cloud connectivity, and mobile technology, the project offers a smart, real-time, and user-friendly approach to improving industrial automation and safety..

Keywords: IoT, ESP32, Blynk, Temperature and Humidity Monitoring, DHT11 Sensor, Industrial Automation, Cloud-Based Monitoring

I. INTRODUCTION

In industrial operations, maintaining the right temperature and humidity levels is vital for ensuring product quality, protecting sensitive machinery, and providing a safe and comfortable working environment for employees. Variations in environmental conditions can lead to equipment malfunction, product spoilage, or reduced efficiency, which in turn affects overall productivity. Traditionally, industries have relied on manual monitoring methods that require human supervision, periodic checks, and manual data logging. However, these conventional methods are inefficient, time-consuming, and prone to human error. They also fail to provide real-time updates or instant alerts during critical fluctuations, which may lead to delays in corrective actions.

To address these challenges, the integration of Internet of Things (IoT) technology offers a smart, automated, and efficient approach to industrial environmental monitoring. The proposed IoT-based Industrial Temperature and Humidity Monitoring System utilizes an ESP32 microcontroller and a DHT11 sensor to collect accurate environmental data in real time. The DHT11 sensor continuously measures temperature and humidity levels in the surrounding area. The ESP32, which comes with inbuilt Wi-Fi capability, processes the sensor data and transmits it to the Blynk cloud



platform. This setup eliminates the need for physical monitoring by enabling users to track environmental conditions remotely through the Blynk mobile application.

Using the Blynk interface, users can visualize real-time readings, monitor historical data trends, and set predefined threshold limits for both temperature and humidity. When any parameter exceeds the specified threshold, the system immediately triggers an alert or notification, allowing operators to take timely corrective measures. This feature not only enhances safety but also prevents potential losses caused by environmental deviations. The Blynk cloud further allows data logging, enabling long-term analysis for maintenance planning and performance optimization.

The system's ESP32 microcontroller offers several advantages, including low cost, compact design, high processing power, and reliable wireless connectivity. These features make it an ideal choice for IoT-based industrial applications. The system can be implemented in diverse sectors such as manufacturing units, warehouses, cold storage facilities, food processing plants, and pharmaceutical industries, where precise environmental control is critical.

In summary, this IoT-based Industrial Temperature and Humidity Monitoring System provides a reliable, real-time, and automated solution for monitoring essential environmental parameters. It significantly reduces manual intervention, enhances safety and operational efficiency, and supports data-driven decision-making. By combining IoT, cloud computing, and mobile technologies, the project demonstrates a modern approach to improving industrial automation and sustainable performance.

II. LITERATURE SURVEY

Patel et al. (2024) developed a cloud-connected temperature and humidity monitoring system using Arduino and Blynk, providing remote access and real-time data updates for warehouse environments.

Sharma and Lee (2024) designed a multi-sensor IoT framework integrating DHT22 and gas sensors to improve safety and environmental monitoring in industrial settings.

Chen (2023) proposed a Wi-Fi-enabled IoT system for temperature control in food storage, offering continuous data collection and real-time alert notifications.

Kumar et al. (2023) implemented an ESP8266-based industrial monitoring system capable of data logging and mobile notifications, ensuring timely detection of environmental changes.

Garcia and Martinez (2023) explored IoT-based temperature and humidity monitoring using Raspberry Pi and MQTT protocols, focusing on enhanced data reliability and scalability for smart factories.

Wang et al. (2022) developed cloud visualization dashboards that provided real-time monitoring and historical data analysis, improving industrial process efficiency.

Table1: Comparative review of smart temperature controlled fan system..

Paper / Project	System Architecture	Cost	Ease of Implimentation	Performance	User Experience	Limitations
Patel et al. (2024)	Arduino + DHT11 Sensor + Blynk Cloud	Low	Easy	Good real-time monitoring	Simple mobile dashboard	Limited scalability and data storage
Sharma and Lee (2024)	DHT22 + Gas Sensors + IoT Gateway	Moderate	Moderate	High accuracy and safety alerts	Enhanced multi-sensor integration	Increased complexity and cost
Chen (2023)	ESP32 + Wi-Fi + Cloud Dashboard	Low	Easy	Fast real-time response	User-friendly interface with alerts	Limited to small-scale applications
Kumar et al. (2023)	ESP8266 + Cloud Server + Mobile App	Low	Easy	Reliable data logging and alerts	Accessible via mobile notifications	Limited to small-scale applications



Garcia and Martinez (2023)	Raspberry Pi + MQTT Protocol Cloud	Moderate	moderate	Stable and scalable performance	Interactive visualization via cloud	Higher power consumption
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III. PROPOSED METHODOLOGY

The proposed IoT-based Industrial Temperature and Humidity Monitoring System using ESP32 and Blynk is developed to continuously sense, analyze, and display environmental parameters in real time. The methodology integrates both hardware and software components to ensure efficient data collection, cloud communication, and remote monitoring.

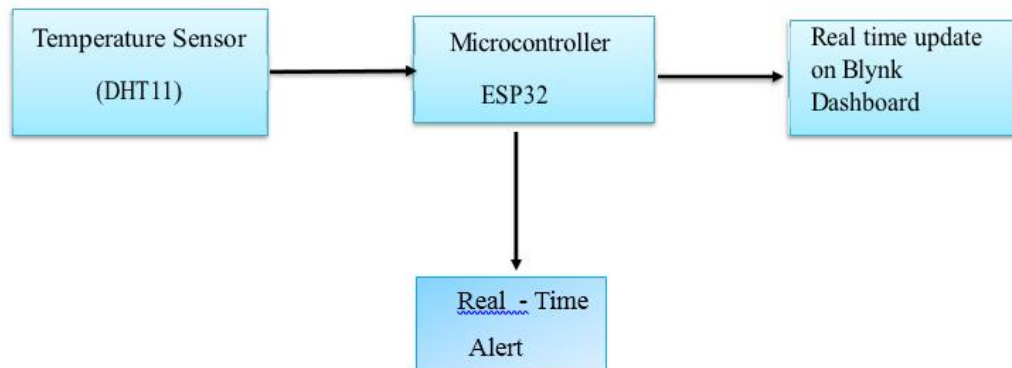


Figure1: Block Diagram of Smart Temperature controlled Fan System

The overall methodology is divided into six major stages: system design, hardware configuration, software implementation, data transmission, cloud connectivity, and testing. Each stage contributes to achieving accurate measurement, seamless connectivity, and reliable performance within industrial settings.

In the system design stage, the focus is on selecting efficient and cost-effective components. The ESP32 microcontroller serves as the main controller due to its integrated Wi-Fi and Bluetooth features, eliminating the need for extra communication modules. The DHT11 sensor is chosen to measure temperature and humidity because of its low power requirement, simple interface, and sufficient accuracy for industrial applications.

During the hardware configuration phase, the DHT11 sensor is interfaced with the ESP32 through jumper connections. A regulated 3.3V power supply ensures stable operation of the microcontroller. The compact design allows the entire setup to be easily installed and powered using either a USB connection or a standard adapter, making it suitable for continuous industrial use.

The software development stage utilizes the Arduino IDE for programming the ESP32. The Blynk library is integrated to enable real-time cloud communication. Wi-Fi credentials and the unique Blynk authentication token are programmed into the system, allowing the ESP32 to connect securely with the Blynk cloud platform. Once deployed, the ESP32 automatically sends temperature and humidity readings to the cloud at regular intervals.

In the data transmission phase, sensor readings from the DHT11 are processed and uploaded to the Blynk cloud in real time. The Blynk mobile application presents this data through interactive widgets such as gauges, graphs, and numerical displays. This enables users to remotely monitor industrial environmental conditions from anywhere using their smartphones.

An alert system is also integrated to notify users when temperature or humidity values exceed predefined threshold limits. This feature enhances workplace safety by prompting immediate action to prevent damage to equipment or materials.

The testing and validation phase involved evaluating sensor accuracy, Wi-Fi connectivity, and system response time under varying environmental conditions. Results confirmed stable communication, precise readings, and quick data updates, validating the system's reliability for industrial use.



Finally, the system is designed with scalability and flexibility in mind. Additional sensors for parameters like air quality, gas concentration, or pressure can be easily integrated in the future, expanding its monitoring capabilities. Overall, this methodology ensures a smart, efficient, and low-cost IoT-based solution that provides real-time environmental supervision, enhances industrial safety, and supports data-driven decision-making.

IV. CONCLUSION

The IoT-based Industrial Temperature and Humidity Monitoring System using ESP32 and Blynk was successfully designed, implemented, and tested. The developed system continuously monitors environmental parameters such as temperature and humidity using the DHT11 sensor and transmits real-time data to the Blynk mobile application through the ESP32's built-in Wi-Fi. This enables users to remotely observe industrial conditions at any time, ensuring continuous and efficient environmental supervision.

During testing, the system demonstrated high measurement accuracy, stable wireless connectivity, and fast data updates on the mobile interface. The incorporated alert notification feature effectively warned users when temperature or humidity exceeded the predefined limits, allowing immediate corrective measures and improving overall safety and efficiency.

In conclusion, the system proved to be reliable, cost-effective, and user-friendly, making it highly suitable for various industrial applications. Its real-time monitoring and automated alert capabilities provide a robust solution for enhancing industrial automation, safety, and environmental management.

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