IoT-Based Server Room Temperature and Humidity Monitoring

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Abstract

Monitoring the environmental conditions of server rooms is essential to ensuring optimal hardware performance, maintaining system reliability, and preventing device failure. This study proposes an Internet of Things (IoT)-based monitoring system for temperature and humidity control using a NodeMCU ESP8266 microcontroller combined with a DHT22 sensor. The system measures environmental conditions in real time and transmits the collected data over a Wi-Fi network to the Blynk platform for visualization and remote monitoring. Alerts are generated when temperature or humidity exceeds predefined thresholds, enabling preventive action to avoid equipment damage. The implementation demonstrated that the system effectively monitors server-room environmental parameters, provides accurate and real-time data visualization, and enhances the overall management of server-room conditions.

Keywords

Monitoring, NodeMCU, DHT22, IoT, Server Room

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Introduction

The Internet of Things (IoT) represents a transformative technological paradigm in which interconnected physical devices are capable of collecting, exchanging, and analyzing data through Internet-based communication. By enabling real-time data transmission and intelligent automation, IoT has significantly enhanced operational efficiency across multiple sectors, including industry, healthcare, agriculture, smart homes, and information technology infrastructure. In the domain of IT infrastructure, IoT plays a vital role in ensuring effective environmental management within critical facilities, particularly server rooms where continuous hardware reliability is essential.

A server room functions as the central hub for an institution's data storage, processing, and network operations. Because the server environment directly influences hardware performance and system availability, maintaining optimal environmental parameters—most importantly temperature and humidity—is crucial for operational sustainability. When temperature exceeds acceptable limits or humidity becomes irregular, hardware components are subjected to risks such as overheating, accelerated wear, short circuits, corrosion, or condensation. Yuhana (2022) highlights that inadequate environmental maintenance in server rooms can trigger severe operational disruptions, including system instability and unexpected downtime, which ultimately impede institutional productivity.

Given the critical importance of stable server-room conditions, continuous monitoring is a fundamental requirement. Institutions typically assign this responsibility to specialized units such as the Direktorat Sistem dan Teknologi Informasi (DSTI), which ensures that physical and digital infrastructure remains operational, secure, and efficient. Manual monitoring approaches are often insufficient because they rely on periodic checks rather than real-time data, making it difficult to identify fluctuations before they escalate into hardware failures. Therefore, an automated solution capable of continuous sensing and remote monitoring is essential to support proactive maintenance and to protect valuable organizational assets.

To address this need, IoT-based monitoring systems offer significant advantages by providing real-time sensing, remote accessibility, and automated alerts. This study proposes the development of an IoT-enabled environmental monitoring system designed specifically for server rooms. By integrating hardware sensors, microcontrollers, and cloud-based visualization platforms, the system allows institutions to track environmental changes accurately and respond promptly to potential risks. Such an approach is consistent with modern infrastructure management practices emphasizing automation, reliability, and data-driven decision-making.

The system developed in this research utilizes the NodeMCU ESP8266 microcontroller, a cost-effective and Wi-Fi-enabled module widely used in IoT applications due to its efficiency, flexibility, and low power consumption. To measure temperature and humidity, the DHT22 sensor is implemented because of its high accuracy and stability in monitoring environmental variables (Rachman, 2020). Sensor readings are transmitted wirelessly to the Blynk platform, which provides real-time visualization and remote access through mobile devices. This architecture supports continuous monitoring and rapid response during abnormal environmental conditions.

The implementation of this IoT-based monitoring system within the DSTI environment aims to enhance environmental oversight, reduce the risks associated with manual monitoring, and improve decision-making regarding server-room maintenance. By leveraging IoT technology, the institution can ensure that environmental conditions remain stable, thereby extending hardware lifespan, preventing system failures, and maintaining uninterrupted service availability. Ultimately, this study contributes to strengthening infrastructure reliability through intelligent, automated, and data-driven environmental management.

Methodology

This research applies the Design Science Research Method (DSRM) as the methodological framework. DSRM provides a structured approach for problem identification, system design, development, evaluation, and communication of results (Nabyla & Sigitta, 2019). The method consists of six sequential stages (Setiyani, 2021):

Problem Identification and Motivation

This stage identifies relevant and significant issues that require resolution. The researcher collects data, conducts a literature review, and interacts with stakeholders to understand the existing problem specifically, the absence of an automated temperature and humidity monitoring system for the server room.

Objectives of the Solution

After identifying the problem, the objectives of the proposed solution are established. The system aims to monitor server-room temperature and humidity in real time, transmit data through Wi-Fi, and allow remote access through the Blynk platform.

Design and Development

This stage involves planning and building the monitoring system. The tools include a NodeMCU ESP8266 microcontroller, a DHT22 temperature-humidity sensor, and the Blynk application for data visualization.

Demonstration

The developed system is demonstrated to show how it can address the identified problem by collecting sensor data, transmitting it over a wireless network, and displaying the results in real time.

Evaluation

Evaluation assesses the extent to which the system meets its predefined objectives. System performance is verified based on stability, data accuracy, and the success of real-time monitoring capabilities.

Communication

The final stage disseminates research findings to practitioners and relevant stakeholders, presenting the research process, results, and practical implications.

Results

Configuration Results

After configuring the ESP8266 to connect to the Wi-Fi network and read data from the DHT22 sensor, the Serial Monitor confirmed successful execution. The configuration ensured proper network connectivity, stable sensor communication, and accurate data reading. The displayed output validated that each procedure from initialization to data transmission was executed correctly.

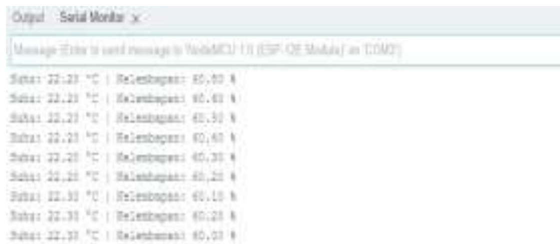

Figure 1. Serial Monitor Output

Network Topology

The implemented network topology integrates several interconnected components to support stable communication and data flow. The Internet provides global connectivity, while the public core router links the local network to external servers. The core switch functions as the primary data distribution unit, directing traffic between major devices, including servers and computers.

Access switches extend network access to additional devices.Access points enable Wi-Fi connectivity for wireless devices, including the ESP8266 module and smartphones. The ESP8266 retrieves sensor data and transmits it to the Blynk server for processing. The smartphone functions as a real-time monitoring interface, displaying environmental data through the Blynk application.

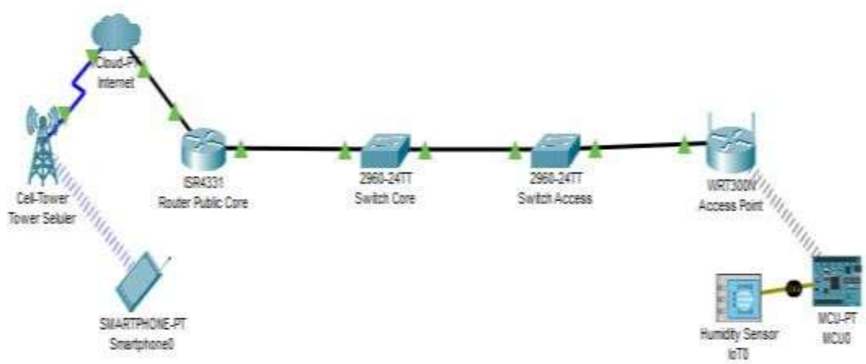

Figure 2. Network Topology of the Monitoring System

Installation Results

Following configuration and integration of the NodeMCU ESP8266 and DHT22 sensor with the Blynk application, real-time temperature and humidity data were successfully displayed. The ESP8266 connected to the Wi-Fi network using the designated SSID "Oppo" and password "asti2503" to enable communication with the Blynk server.

The DHT22 sensor was initialized to collect environmental data, which was transmitted to Blynk via Wi-Fi. Widgets, such as gauges, were configured to visualize sensor readings in real time. This confirmed the system's capability to deliver continuous and accurate monitoring.

Figure 3. Real-Time Output on the Blynk Application

Discussion

The results of the testing process indicate that the IoT-based monitoring system successfully performs real-time detection and reporting of temperature and humidity levels within the server room environment. The integration of NodeMCU ESP8266, the DHT22 sensor, and the Blynk platform enables seamless data collection and visualization, ensuring that environmental changes can be monitored continuously. This capability is essential for server-room management, where even minor fluctuations in environmental conditions can significantly impact hardware performance and system reliability. Furthermore, the system demonstrated stable operation during various test scenarios, including normal, elevated, and low temperature and humidity conditions.

Visualization through the Blynk interface provided users with clear insights into environmental trends. The weekly monitoring graph showed temperature levels consistently between 21°C and 23°C and humidity between 60% and 65%. According to Chen, Zhang, and Liu (2022), these ranges fall within the recommended thresholds for maintaining optimal server performance, where temperatures below 24°C and humidity levels between 40%–60% help minimize the risks of condensation, corrosion, and thermal stress. The system's accurate reporting demonstrates that the environmental controls within the DSTI server room are functioning effectively and maintaining conditions within the acceptable operational envelope.

The findings also align with previous studies emphasizing the importance of stable environmental conditions in preventing hardware failures. Smith et al. (2019) reported that fluctuations outside recommended thresholds may lead to increased component degradation, reduced processing efficiency, and unexpected system downtime. The stability observed in this study suggests that the existing cooling and humidity control mechanisms in the DSTI server room are performing reliably. Additionally, the IoT-based monitoring system enhances these controls by offering continuous oversight, enabling administrators to detect anomalies early before they escalate into system-wide failures.

Environmental consistency has also been linked to long-term hardware durability. Jones and Wang (2020) highlighted that maintaining precise environmental parameters increases the lifespan of server components and reduces operational costs associated with repairs and replacements. The monitoring system developed in this study supports these principles by allowing administrators to respond promptly when temperature or humidity levels begin approaching threshold limits. This capability is especially valuable in institutional environments where uninterrupted network services are critical to daily operations.

Beyond detecting abnormalities, the IoT-based system enhances decision-making by providing historical data that can support maintenance planning. Patterns in temperature and humidity fluctuations can be used to evaluate the effectiveness of air-conditioning units, identify potential ventilation issues, and optimize energy consumption. The use of Blynk's data logging features allows administrators to analyze environmental conditions over extended periods, enabling predictive maintenance strategies that align with modern IT infrastructure management practices.

Overall, the research confirms that implementing an IoT-based environmental monitoring system significantly improves situational awareness and risk mitigation within server rooms. The system complements existing environmental control units by enabling real-time monitoring, remote accessibility, and early warning capabilities. These improvements contribute to minimizing the risk of overheating, condensation, and hardware degradation, thereby ensuring the continued reliability of DSTI's server infrastructure. Future enhancements may include integrating automated alert notifications, machine learning–based anomaly detection, and additional sensors such as smoke, airflow, and vibration to create a more comprehensive server-room monitoring ecosystem.

Conclusion and Recommendations

Based on the design, implementation, and testing of the IoT-based monitoring system integrated with the Blynk application, the following conclusions were reached:

1. The system successfully monitors temperature and humidity in the server room through an integrated IoT-based network.
2. The device utilizes NodeMCU ESP8266 and a DHT22 sensor, enabling accurate and real-time environmental data collection.
3. The implemented network topology adopts a star configuration, where all devices connect through a central access point or switch.
4. Sensor data are transmitted to the Blynk platform and visualized using real-time widgets that provide an intuitive interface for monitoring server-room conditions.

The system enhances environmental management efficiency and provides reliable data to support preventive maintenance and infrastructure sustainability.

Disclosure Statement

The authors declare no conflicts of interest associated with this research.

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Biographical Notes

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