

Research Article

An Internet of Things (IoT)-Based Room Temperature and Humidity Monitoring System Using ESP8266 and DHT22 Sensors

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Abstract: Monitoring room temperature and humidity is an important aspect to maintain comfort and environmental quality in the room. This research was conducted with the aim of implementing an Internet of Things (IoT)-based room temperature and humidity monitoring system using an ESP8266 microcontroller and a DHT22 sensor. The system was designed to be able to read temperature and humidity data in real-time, then send it to the ThingSpeak platform via the internet network. The research method includes hardware design, software development, and system performance testing in closed room conditions. Testing was carried out by collecting data at several observation times to see the stability of sensor readings and the data transmission process. The test results showed that the system could run well and stably, with an average temperature of 30.9 °C and an average humidity of 81.9%, and the data was successfully displayed in real-time on the ThingSpeak dashboard without significant data loss. Based on these results, the developed system can be used as a simple and applicable IoT -based room temperature and humidity monitoring solution.

Keywords: DHT22 Sensors; ESP8266; Humidity Monitoring; Internet of Things; ThingSpeak.

1. Introduction

Monitoring indoor temperature and humidity is an important factor in maintaining occupant comfort, health, and the performance of electronic equipment [1]. Unstable environmental conditions not only risk damaging electronic devices, but can also reduce the quality of items stored indoors.

The development of Internet of Things (IoT) technology allows environmental monitoring processes to be carried out automatically and in real time. Through IoT technology, data obtained from sensors can be collected, processed, and sent via the internet network so that it can be accessed remotely using web-based applications or dashboards. In its application, the ESP8266 module is widely used as a Wi-Fi microcontroller because it has a relatively low cost, efficient power consumption, and ease of integration in IoT systems. Meanwhile, the DHT22 sensor is capable of measuring temperature and humidity simultaneously with a sufficient level of accuracy for room monitoring needs [2]. The combination of the use of the ESP8266 and the DHT22 sensor has been implemented in various monitoring system prototypes that are able to present environmental data in real time through online platforms such as ThingSpeak [3].

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The real-time temperature and humidity monitoring system based on the Internet of Things (IoT) has been widely implemented in various applications, such as server rooms or storage warehouses. However, the implementation of such systems in public spaces, such as workspaces, classrooms, or public areas, remains relatively rare. Triwulanda (2025) highlights that the use of IoT technology with the NodeMCU ESP8266 microcontroller and DHT22 sensor can provide real-time data on temperature and humidity to maintain optimal environmental conditions, particularly in spaces requiring intensive monitoring, such as server rooms. Although several previous studies have demonstrated the success of real-time temperature and humidity monitoring, the evaluation of these systems' performance in public spaces has been limited. Therefore, this study aims to address this gap by implementing an IoT-based temperature and humidity monitoring system in various public spaces.

2. Literature Review

Monitoring indoor temperature and humidity requires sensors capable of providing data with high accuracy and stability. The DHT22 sensor is a digital sensor widely used in IoT applications because it can measure temperature and humidity from 0-100%. This sensor utilizes a resistive element to measure humidity and a thermistor for temperature, then converts these measurements into digital signals that can be read by a microcontroller [4].

The ESP8266 is a Wi-Fi-enabled microcontroller module that enables real-time data transmission over the internet. This module allows data capture from sensors, processing, and sending to a monitoring platform directly without the need for an additional computer. In addition, the ESP8266 is compatible with various IoT platforms such as Node-RED, ThingSpeak, and Blynk, making the data visualization process easier [5].

In IoT system development, the ability to send data in real-time allows users to monitor environmental conditions remotely and provide alerts if temperature or humidity parameters exceed the set limits. Several studies have shown that the combination of ESP8266 and DHT22 sensors is used for temperature and humidity monitoring in various environments, including server rooms, laboratories, and public spaces. This system operates with a microcontroller reading sensor data, processing it and sending it to a server or cloud simultaneously, so that monitoring can be carried out continuously [6].

3. Research Methods

Research System

This research develops an Internet of Things (IoT)-based indoor temperature and humidity monitoring system, which enables real-time environmental monitoring. Through IoT, sensors and microcontrollers are connected to an internet network so that data can be collected, processed, and sent simultaneously to users or online servers. The DHT22 sensor was chosen because it can read temperature and humidity digitally simultaneously, making it suitable for indoor environmental monitoring applications. The ESP8266 microcontroller acts as the main processing unit and sends data to the IoT platform. Sensor data is sent in real-time to ThingSpeak, an IoT platform that provides data storage, graphic visualization, and remote access through a web dashboard or application. This approach makes it easy for users to

monitor room conditions remotely easily and accurately. A similar system with the ESP8266 and DHT22 has been used in previous research for temperature and humidity monitoring with real-time data delivery [7].

Hardware System Design

The hardware is designed to be simple yet reliable, consisting of a DHT22 sensor, an ESP8266 microcontroller, and a stabilized 3V power supply. The DHT22 sensor is connected to the ESP8266 digital pins to periodically read temperature and humidity data, then the ESP8266 processes and sends the data via Wi-Fi to Thingspeak. The 3V power supply ensures stable operation of the sensor and microcontroller. If needed, this design follows the principle of an IoT-based monitoring system that uses the ESP8266 as the main node for sending sensor data to an online server [8].

Table 1. Component Specifications.

Component	Specification	Function
DHT22	Temperature: -40 80°C, Humidity: 0-100%, Digital output	Measuring temperature and humidity
ESP8266	Voltage 3.3V, Wi-Fi	Processing and sending sensor data
Power supply	3V stable	Provides energy for sensors and microcontrollers

The developed monitoring system uses a DHT22 sensor as an input component to measure indoor temperature and humidity, and an ESP8266 microcontroller that acts as the main processing unit and data transmitter. The DHT22 sensor is connected directly to the ESP8266 and operated with a 3 V voltage source, so the system can work simply, efficiently, and without the need for additional supporting devices. All components are designed to be well integrated and function optimally in supporting the process of temperature and humidity data collection and real-time data transmission to the ThingSpeak platform.

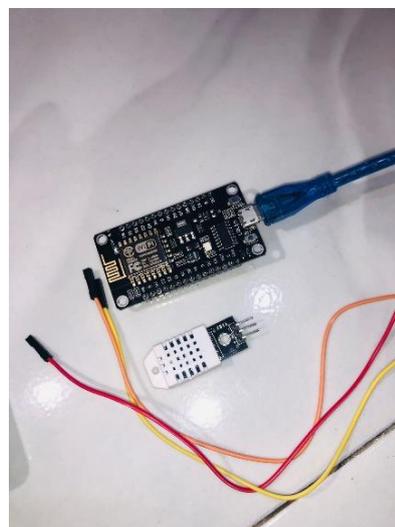


Figure 1. Implementation of the tool.

Thingspeak Software Development and Integration

The software was developed using the Arduino IDE, with a program that reads data from the DHT22 sensor, processes the raw data, and converts it into a format that can be sent via the HTTP protocol to Thingspeak. The ESP8266 periodically reads sensor data and uploads it to the platform, allowing the data to be stored, analyzed, and visualized in real-time graphs on the dashboard. Using Thingspeak facilitates remote monitoring because it provides graphing facilities, setting update intervals, and direct visualization [9].

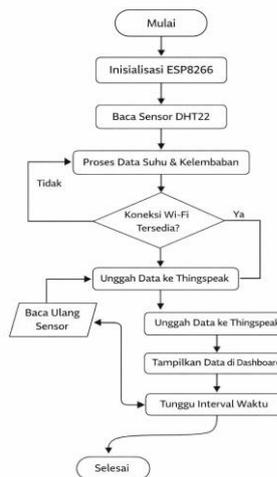


Figure 2. Flowchart of the IoT system for monitoring temperature and humidity.

Testing and Calibration

Testing was conducted to ensure all components function as designed and produce accurate data. The DHT22 sensor was tested under various temperature and humidity conditions, and the ESP8266 was tested for Wi-Fi connection stability and data transmission capability to Thingspeak. Data received on the dashboard was analyzed to evaluate sensor consistency, data transmission reliability, and the suitability of values to real-time environmental conditions. Test results showed that the system can monitor temperature and humidity continuously and in real-time with good accuracy [8][9].

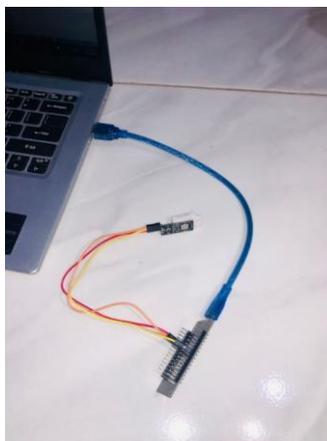


Figure 3. Device test.

Data Analysis

The collected data was analyzed descriptively to determine the average, maximum and minimum values, and the stability of real-time data transmission to Thingspeak. This analysis was used to assess system performance under real-world conditions and ensure the DHT22 sensor provides consistent and accurate data. With Thingspeak, data can be visualized directly through graphs, making it easier to make decisions regarding room temperature and humidity settings [7][9].

4. Results and Discussion

IoT System Implementation and Performance

The room temperature and humidity monitoring system in this study was realized by combining the DHT22 sensor, the ESP8266 microcontroller, and the ThingSpeak platform as an Internet of Things (IoT) tool. The DHT22 sensor plays a role in measuring the temperature and humidity of the air in the room, then the measurement data is processed by the ESP8266 before being sent to the ThingSpeak platform via a Wi-Fi connection. The ThingSpeak platform is used as a data storage medium as well as information visualization in the form of graphs and numerical values that can be accessed directly through a web-based dashboard [10].

The implementation results show that the system is capable of continuously reading temperature and humidity according to the specified data transmission interval. The data received by ThingSpeak is visualized in the form of a graph of temperature and humidity changes over time, allowing users to dynamically monitor the condition of the room environment. Presenting data in this graphical form makes it easier to observe patterns and trends of temperature and humidity changes over a certain time period, and shows the system's response to changes in environmental conditions [11].

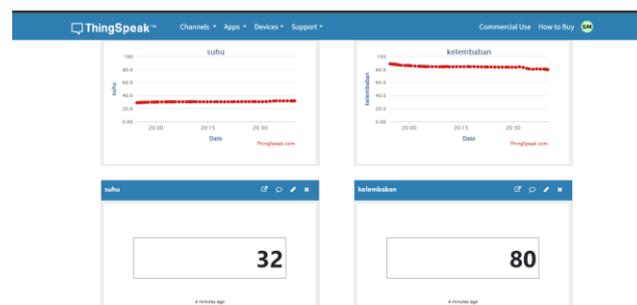


Figure 4. Display of room temperature and humidity monitoring graph on the ThingSpeak platform.

System performance evaluation was conducted by considering the stability of sensor readings and the reliability of the data transmission process to the IoT platform. Based on the test results, the temperature and humidity data sent by the ESP8266 can be received and displayed properly on the ThingSpeak dashboard without any significant data loss. This indicates that the data acquisition, processing, and data transmission processes run consistently. In addition, the system is able to update data in real-time with relatively short intervals, making it suitable for use in Internet of Things (IoT)-based environmental monitoring applications [12].

The data transmission time test results show that the ESP8266 is capable of transmitting data to ThingSpeak stably. The response time for data transmission is relatively constant, indicating that the system has good communication performance in supporting real-time room temperature and humidity monitoring.

DHT22 Sensor Testing and Analysis Results

The DHT22 sensor was tested to assess its ability to consistently read room temperature and humidity throughout the system's operation. Testing was performed by observing sensor readings over a period of time under the same room conditions. The temperature and humidity data obtained were then analyzed based on the pattern of changes in values and the stability of the sensor readings. This approach was used to evaluate sensor performance without comparing it with other reference measuring instruments [13].

Based on test results, the DHT22 sensor is capable of producing relatively stable temperature and humidity data with small fluctuations in ambient conditions that do not experience significant changes. When changes in room conditions occur, such as increases in temperature or humidity, the sensor responds with gradual changes in values. This indicates that the DHT22 sensor has good capabilities in continuously monitoring room environmental conditions.

Table 2. Data from the temperature and humidity readings from the DHT22 sensor.

No	Time	Temperature (°C)	Humidity (%)
1	20:23	30.6	83.6
2	20:35	31.9	80.4
3	20:40	31.3	79.2
4	20:44	30.3	83
5	20:50	30.2	83.4

Based on the data listed in Table 2, the average room temperature during testing was recorded at 30.9°C, while the average humidity reached 81.9%. These values indicate that the room's environmental conditions were relatively stable throughout the observation period. Changes in temperature and humidity occurred consistently without significant fluctuations, enabling the system to maintain measurement stability throughout operation.

In addition, the data sent by the ESP8266 microcontroller to the ThingSpeak platform is consistent with the values obtained directly from the DHT22 sensor. Temperature and humidity information is displayed in real-time graphs, which facilitates continuous monitoring of room conditions. The alignment between sensor data and visualizations on the ThingSpeak dashboard confirms that the ESP8266 and DHT22-based monitoring system can function reliably and stably, supporting Internet of Things (IoT)-based environmental monitoring applications [14].

6. Conclusion

Based on the design stages, system realization, and testing that have been carried out, it can be concluded that the Internet of Things (IoT) based room temperature and humidity monitoring system using the ESP8266 microcontroller and DHT22 sensor was successfully

implemented and can measure a temperature of 30.9 °C and humidity of 30.9 °C. 81.9% . The measurement data is then sent to the ThingSpeak platform via Wi-Fi to support remote monitoring. The integration between the DHT22 sensor, ESP8266, and the IoT platform is seamless, enabling the system to operate stably and continuously.

Test results show that the DHT22 sensor is capable of consistently detecting changes in room temperature and humidity over a specific observation period. The resulting data demonstrates a pattern of changes consistent with the room's environmental conditions, both under relatively stable conditions and when temperature and humidity changes occur. This demonstrates that the DHT22 sensor has a sufficient level of reliability for application in IoT-based indoor environmental monitoring systems.

In addition, the sensor reading data sent by the ESP8266 and displayed on the ThingSpeak dashboard shows consistent values, indicating that the data processing and transmission processes are running smoothly. Connectivity testing also shows that the ESP8266 is able to send data to the ThingSpeak platform stably with a relatively short response time without significant data loss. Thus, the implemented room temperature and humidity monitoring system can be declared suitable for use as a simple, reliable, and easy-to-operate Internet of Things (IoT)-based environmental monitoring solution for real-time monitoring of room environmental conditions.

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