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Design of a Prototype of an Internet of Things (IoT)-Based Chicken Coop Temperature Monitoring and Control System

M. Faiz Firdausi[1*], Iqbal Sabilirrasyad[2], Mas'ud Hermansyah[3]

[1,2] Faculty of Science, Technology, and Industry, Mandala Institute of Technology and Science, Indonesia
[3] Department of Information Technology, Jember State of Polytechnic, Indonesia
Corresponding Author: faizfirdausi@itsm.ac.id
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Abstract

Maintaining a stable temperature in a chicken coop is crucial for the success of poultry farming, particularly broiler and laying hens. Inadequate temperatures can cause thermal stress, decreased appetite, impaired growth, and even chicken mortality, all of which result in significant economic losses for farmers. In practice, temperature control in chicken coops is still largely done manually without an accurate and real-time monitoring system. Therefore, this study aims to design and develop a prototype of an Internet of Things (IoT)-based automatic temperature monitoring and control system to improve the efficiency and accuracy of chicken coop environmental management. This system uses a DHT11 sensor to read temperature, an ESP32 microcontroller for data processing, and automatically controls fans and lights based on specific temperature thresholds. Temperature information is displayed locally via an LED panel and remotely via the internet-connected Blynk application. Test results show that the system is able to respond to temperature changes quickly, accurately, and stably. This prototype demonstrates its potential as a smart and affordable solution to support digital transformation in the poultry farming sector through the implementation of IoT technology.

Keywords: IoT, ESP32, DHT11, LED Panel, Blynk App, temperature monitoring

1. Introduction

The poultry farming sector, especially broiler and laying hens, is a strategic component in fulfilling the animal protein needs of the Indonesian people (Pelafu et al., 2018). The growth in consumption of chicken meat and eggs shows an increase from year to year, in line with population growth and increasing public awareness of nutrition (Hanni et al., 2022). However, despite this potential, chicken farming productivity is significantly influenced by environmental factors, one of which is temperature. Suboptimal cage temperatures can lead to various serious problems, ranging from decreased appetite and metabolic disorders to increased thermal stress, to mass chicken mortality, ultimately resulting in direct economic losses for farmers (Putra et al., 2018).

Optimal chicken coop conditions need to be tailored to the characteristics of the chicks, including temperature adjustments based on their age. The ideal temperature inside the coop is as follows: 34°C for chicks aged 1–7 days, 30°C for chicks aged 8–15 days, 28°C for chicks aged 16–23 days, and 26.6°C for chicks aged 24–30 days (Aspari et al., 2024). In reality, temperatures in barns often fluctuate due to Indonesia's extreme and unpredictable tropical climate. This is especially true in conventional livestock farming systems, which are still common in rural areas. Temperature regulation is still done manually without accurate measuring instruments and automatic control systems, resulting in delayed and inefficient responses to temperature changes (Rahayu Hidayati Soesanto et al., 2024).

In the era of the Industrial Revolution 4.0, Internet of Things (IoT) technology offers new solutions for automated monitoring and control systems in various sectors, including livestock. IoT enables the integration of hardware (sensors, actuators) with internet networks, allowing temperature conditions in barns to be monitored in real time and controlled automatically or even remotely (Supriyanto et al., 2025). This is in line with the concept of smart farming which emphasizes efficiency, accuracy, and sustainability of information technology-based production.

Various previous studies have developed microcontroller-based automatic temperature control systems, but these are still limited to local systems without remote monitoring support. Furthermore, some systems do not provide real-time temperature information at the barn, making it difficult for farmers without smartphones or internet connections. Therefore, innovation is needed in the form of an integrated system that can not only automatically read and control temperatures but also display temperature information via a digital LED panel at the barn and send data to an IoT dashboard so farmers can access temperature information anytime and anywhere.

Through this research, a prototype of an IoT-based chicken coop temperature monitoring and control system was designed, which combines temperature sensors, an ESP32 microcontroller, fans and lights as actuators, and temperature display media via LED panels and IoT applications (such as Blynk). This system is expected to be a practical, affordable, and applicable solution in improving the environmental management of chicken coops that are intelligent and adaptive to temperature changes. By considering the urgency of livestock health, potential economic losses due to extreme temperatures, and the demands of digital transformation in the livestock sector, this research is relevant and important to be developed as a step towards implementing smart technology on a small to medium scale farm in Indonesia.

2. Methods

The prototyping method is an approach to software development that begins with the creation of an initial model of a system or product. This initial model serves as the basis for user evaluation and testing, with the goal of clarifying the understanding of the system to be developed. Through this prototype, developers can explore user needs more deeply, detect design flaws, and make adjustments based on the feedback received. The development process is carried out iteratively until a final product is produced that better aligns with user expectations (Aspari et al., 2024). With this approach, errors can be minimized early in development and potential risks can be mitigated during the process. The prototyping method flow is shown in Figure 1.

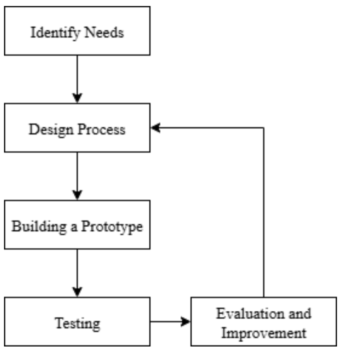

Figure 1. Prototype Method Development Flow
Source: Researcher 2025

a. Identify Needs
This initial stage aims to explore and formulate detailed system requirements. In the context of this research, the primary requirement is to provide a system capable of monitoring chicken coop temperatures in real time and automatically controlling them to maintain temperature stability. These requirements include hardware (such as temperature sensors, microcontrollers, and actuators) and software (web-based or mobile monitoring platforms) (Ningrum et al., 2023).

b. Design Process
Once the requirements are determined, the initial system design is carried out. This stage aims to ensure the system can be built according to the identified functional and non-functional requirements (Tarigan et al., 2019). The design process includes:
   1) System block diagram and electronic circuit schematic.
   2) User interface (UI) design for temperature monitoring.

c. Building a Prototype
At this stage, the design that has been made is implemented in the form of a functional prototype (Septian et al., 2025). This prototype consists of:
   1) Assembling components such as the DHT11 sensor, ESP32, and relay.

2) Programming the microcontroller to read temperature, send data to the server, and activate the fan/heater.
3) Developing a monitoring dashboard to display temperature data in real time.

d. Testing
Prior to evaluation, the prototype system is tested to ensure all functions are functioning properly. Testing is performed repeatedly to ensure the system operates according to the desired scenario (Arrosyidah et al., 2023). These testing stages include:
1) Testing temperature readings by sensors.
2) Testing connections and data transmission via the internet.
3) Testing the system's response in automatically activating actuators (fans/heaters) based on specific temperatures.

e. Evaluation and Improvement
Test results are evaluated to identify deficiencies or discrepancies with initial requirements. If issues or opportunities for improvement are identified, refinements are made to the prototype design or implementation. This evaluation can also involve end users (e.g., chicken farmers) to obtain direct feedback.

3. Results and Discussion

The research results were analyzed using a prototyping approach, which includes needs identification, design, prototype development, and system evaluation and improvement. Each stage is described in detail to demonstrate how the system was developed to meet its primary objective: automatically monitoring and controlling chicken coop temperatures using Internet of Things (IoT) technology. The discussion also covers the system's effectiveness in maintaining ideal temperatures for chickens and the challenges encountered during testing.

a. Identify Needs
At this stage, field observations were conducted at several small- and medium-scale broiler chicken farms. It was found that cage temperature significantly impacts chicken growth and health. Farmers still rely on manual temperature monitoring methods, such as using analog thermometers, without an automated temperature control system. Based on this, the need for a system capable of:
1) Monitoring the cage temperature in real time
2) Automatically controlling the cage temperature based on the ideal temperature threshold (around 28°C – 32°C).
3) Remotely accessing temperature data via an internet connection.

The results of this identification form the basis for developing system requirements specifications. These requirements specifications are presented in Table 1.

No.	Tool Name	Total
1	ESP32 DevKitC V4 WROOM-32U ESP-32U	1
2	Breadboard 400 Point Hole Solderless PCB Bread Board	1
3	DHT11 Temperature and Humidity Sensor Module	1
4	Relay Module 12vdc 1 channel	1
5	LCD 1602 Green + i2C Module	1
6	Fan DC 12V 24V 4x4 cm / Kipas DC 12 Volt 24 Volt	1
7	Baterai 9V Rechargeable Li-ion	1
8	Lampu LED	1

Table 1. Identify Needs
Source: Researcher 2025

b. After the system requirements have been successfully identified, the next stage is the design process, which aims to design the overall system architecture, both in terms of hardware and software. At this stage, the system workflow is designed, the main components such as the DHT11 temperature sensor and ESP32 microcontroller are selected, and the system block diagram is compiled. The system block diagram design can be seen in Figure 2.

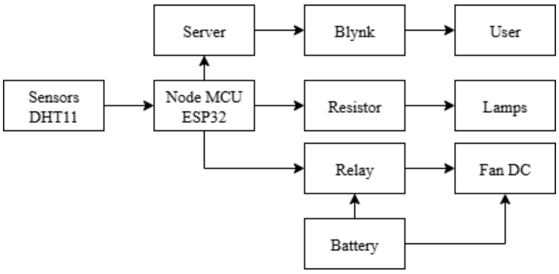

Figure 2. Block Diagram System
Source: Researcher 2025

Figure 2 shows the flow of an IoT-based monitoring and control system using a NodeMCU ESP32. The DHT11 sensor is used to measure temperature and humidity, and the data is then sent to the NodeMCU ESP32. This information is forwarded to the server and the Blynk application for real-time user monitoring. Furthermore, the NodeMCU also controls output devices such as lights via resistors and DC fans via battery-powered relays. This system allows users to monitor environmental conditions and control electronic devices automatically or manually through the application.
Next, the electronic circuit is built on a breadboard and consists of physical connections between components. The hardware circuit design can be seen in Figure 3.

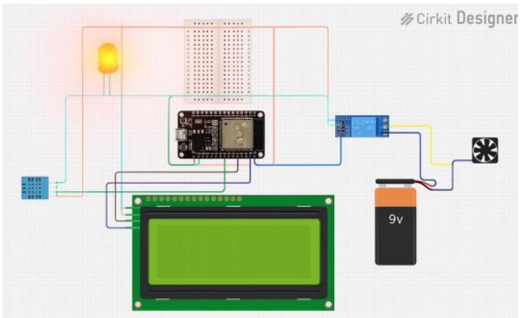

Figure 3. Hardware Network Design
Source: Researcher 2025

Additionally, a user interface and programming logic were designed to control how the system reads temperature data, sends it to an IoT-based server, and activates actuators such as fans or heaters based on the actual temperature conditions in the chicken coop. This design served as a crucial foundation for building a prototype that met the research needs and objectives. A detailed display of the interface design is shown in Figure 4.

Figure 4. Interface Design System Using Blynk
Source: Researcher 2025

Figure 4 shows the Blynk application interface for an IoT-based chicken coop temperature monitoring and control system. The current temperature is detected at 26.9°C. The fan and light statuses are displayed as active (ON), indicating that the system automatically turns them on according to the temperature setting. Users can also set minimum and maximum temperature limits, set at 20°C and 35°C, respectively. Additionally, manual control options are available to turn the fan and light on or off directly through the app.

c. Building a Prototype
At this stage, the process of developing a prototype for an Internet of Things (IoT)-based chicken coop temperature monitoring and control system is underway. The design and prototype results can be seen in Figure 5.

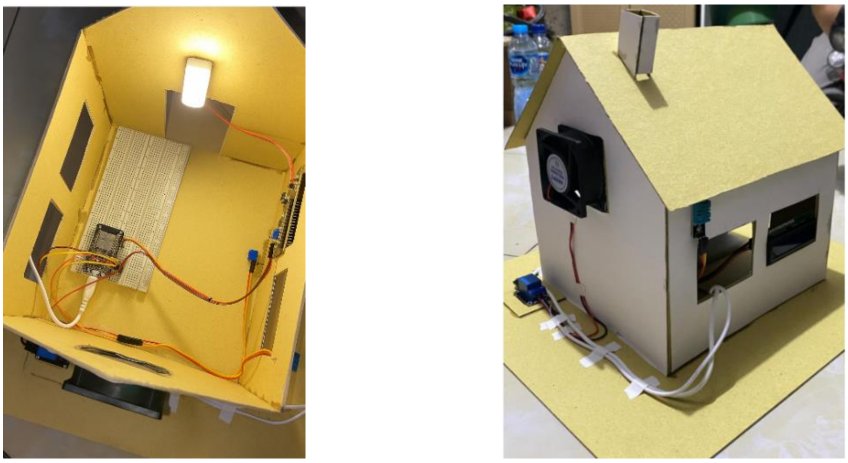

Figure 5. Design Results and Prototype
Source: Researcher 2025

d. Testing
After the design and implementation process is complete, the next step is to test the system to ensure all components are functioning as intended. Testing is conducted to evaluate system performance in three main aspects: temperature readings by sensors, connectivity and data transmission via the internet, and the system's automatic response in activating actuators (fans or heaters) based on specific temperatures. Details of the test results can be seen in Table 2.

No.	Test Type	Test Description	Test Results	Status
1	Temperature reading by sensor	The DHT11 sensor reads temperature under various environmental conditions.	The sensor successfully reads the temperature in real-time with an accuracy level of ±1°C.	Success
2	Connection and data delivery via the internet	Sending temperature data from ESP32 to Blynk platform via Wi-Fi	Data is successfully sent to the IoT server (e.g. Thingspeak) periodically without significant delays.	Success
3	System response in activating the actuator	The system was tested at a maximum temperature of 35°C and a minimum of 20°C to activate the actuator.	The fan actuator is active when the temperature is > 30°C, the heater is active when the temperature is < 20°C, according to the setting logic.	Success

Table 2. System Test Results
Source: Researcher 2025

e. Evaluation and Improvement
After conducting a series of tests, the IoT-based automatic temperature monitoring and control system demonstrated quite good performance in reading temperatures, sending data to an

online platform, and activating actuators according to the specified temperature threshold. However, several aspects need to be evaluated and improved to enhance system reliability. First, there is a slight delay in sending temperature data to the server, especially when the internet connection is unstable. This can be improved by adding a local data buffer or temporary storage feature when the connection is interrupted. Second, the response of the fan or heater to the temperature threshold still needs improvement because the system sometimes activates the device late. To address this, programming logic settings and sensor calibration can be adjusted to be more responsive. Finally, protecting electronic components from dust and humidity in the chicken coop environment is also a concern, so it is recommended to design a casing or additional protection to increase the system's durability for long-term use.

4. Conclusion

Based on the design and testing results, it can be concluded that the prototype of the Internet of Things (IoT)-based chicken coop temperature monitoring and control system was successfully built and functions according to the research objectives. The system is able to read the coop temperature in real time using a DHT11 sensor and processes the data through an ESP32 microcontroller. Automatic response to temperature changes is demonstrated by activating the fan at high temperatures and the heating lamp when the temperature drops below a predetermined threshold. Temperature information is displayed locally via an LED panel, facilitating direct on-site monitoring, as well as remotely via the Blynk application, allowing farmers to monitor coop conditions anytime and anywhere. Test results show the system has a fast and accurate response rate to fluctuations in environmental temperature. Thus, this prototype provides a practical and efficient solution to support automatic chicken coop temperature management and has great potential for implementation in modern livestock systems that adopt the concept of smart farming. This system can also be further developed by adding a humidity sensor and a cloud-based notification system to increase its functionality and scalability.

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