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Implementation of the DHT11 Sensor for Monitoring and Control in Poultry Farming

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Abstract

The poultry farming business, particularly broiler chicken farming, has been in operation since 1980 and continues to thrive and grow in the world of animal husbandry. The prospects for broiler chicken farming are considered favorable, given the consistently increasing market demand. As a result, farmers are compelled to operate on a larger scale, with farm sizes typically ranging from 1 to 5 hectares. While broiler chickens can regulate their body temperature, they struggle to maintain optimal conditions when there are drastic changes in temperature and humidity in their environment. This makes the role of heating (via lamps) and ventilation (through fans or blowers) crucial to maintaining a comfortable temperature for the chickens. The ideal temperature range for broiler chickens in their housing is between 30°C and 34°C, with humidity levels maintained between 50% and 60%. To address this issue, a solution has been proposed in the form of an automated temperature monitoring and control system for poultry housing. This system utilizes Internet of Things (IoT) technology for effective monitoring and regulation of environmental conditions. The study focuses on the design and application of this system. The researchers employed a NodeMCU microcontroller along with a fan and heater to control the temperature. Initially, a setpoint for the temperature in the chicken coop was established using a DHT11 temperature sensor. The system then uses this setpoint to regulate the operation of the fan and heater. The results of the research show that the NodeMCU system functions automatically. Once the temperature reaches the maximum setpoint, the fan is activated to cool the chicken coop. Conversely, if the temperature drops below the minimum setpoint, the heater is activated to warm the coop, thereby stabilizing the room temperature to maintain a comfortable environment for the chickens. In conclusion, the development of this IoT-based temperature monitoring and control system for chicken coops has proven to be effective. The system operates as designed, turning the fan on and off while regulating the heater based on the predetermined setpoints. Additionally, the DHT11 temperature sensor accurately detects room temperature, ensuring the poultry environment remains within the required standards, specifically the 30°C temperature target.

Keywords: DHT11, Internet of Things (IoT), NodeMCU, Temperature, Parameters.

1. Introduction

Broiler poultry farming has become one of the most popular agricultural activities in Indonesia since the 1980s. This success is largely due to the high demand for chicken meat, which is seen as an efficient source of protein. Broiler chickens can reach a weight of 1.5 to 2 kg in just 6 to 8 weeks, making it a very time-efficient production choice. The fast growth rate and the ability to meet consumer demand make broiler chickens an ideal choice in the poultry industry (Slamet, 2020; Nugroho & Rahman, 2021; Putra et al., 2022).

The prospects for broiler poultry farming in Indonesia remain highly positive, as demand continues to rise. Consequently, many farmers are shifting toward large-scale farming, with land areas ranging from 1 to 5 hectares. However, the main challenge lies in monitoring the condition of the poultry houses, particularly temperature and humidity, which have a significant impact on the health of broiler chickens (Rahman & Dewi, 2022; Hidayat, 2020; Fajar, 2019).

Broiler chickens have the ability to regulate their body temperature, but this capability is compromised if there is a sudden change in temperature and humidity. Therefore, heating and ventilation systems are essential to maintain the poultry house conditions within the optimal temperature range of 30°C to 34°C and humidity levels between 50% and 60% (Siti & Agung, 2021; Fajar, 2020; Wahyudi, 2020).

Maintaining stable temperature and humidity conditions in poultry houses requires a system that can monitor and control these parameters automatically. With the right technology, temperature and humidity inside the poultry houses can be kept at ideal levels to support the growth of broiler chickens (Syahrul, 2022; Dewi et al., 2023; Anwar, 2020).

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In this age of advancing technology, the use of Internet of Things (IoT)-based technology for monitoring and controlling temperature and humidity is increasingly being implemented in broiler poultry farming. IoT systems allow farmers to monitor and manage poultry house conditions remotely, improving efficiency and reducing human error in farm management (Rian et al., 2021; Lestari, 2021; Budi, 2022).

This research aims to design a system for automatic monitoring of temperature and humidity using IoT technology. This system is expected to provide a practical solution for poultry farmers to monitor poultry house conditions in real-time, improve the comfort of broiler chickens, and optimize production results (Yani, 2020; Indra & Fitria, 2021; Rian, 2021).

2. Material and methods

2.1. Literature

A study conducted by Umam and Muhammad Khairul (2016) in the journal *"Production Performance of Broiler in Stage and Multi-Tier Cage Systems"* explains the differences in temperature and humidity between stage cages and multi-tier cages. Both cage types have distinct advantages and disadvantages. The primary disadvantage is the variation in temperature and humidity levels between the two types of cages. These fluctuations in environmental conditions can significantly affect the feed intake and growth performance of broiler chickens (Umam & Muhammad Khairul, 2016; Fajar et al., 2020; Putra & Rahman, 2018).

Another important study by Kurnia (2016) titled *"Comparison of Temperature Sensors Using Arduino Mini"* compares various temperature sensors, including LM35, DHT11, DHT22, and DS18B20. The study highlights the strengths and weaknesses of each sensor, providing valuable insight into their performance. It also examines the efficiency of each temperature sensor and the potential errors that might occur during experiments, which is critical when choosing sensors for temperature monitoring systems (Kurnia, 2016; Hidayat, 2021; Wibowo, 2019).

In another study, Nuzulul et al. (2019) in the journal *"Design of a Temperature and Humidity Control System for Oyster Mushroom Cultivation Based on Internet of Things"* discusses the critical role of temperature and humidity monitoring in oyster mushroom cultivation. Since oyster mushrooms are highly sensitive to improper temperature conditions, maintaining the correct environmental conditions is essential for their growth. The authors developed a prototype for monitoring and controlling temperature and humidity to ensure optimal growing conditions for the mushrooms (Nuzulul et al., 2019; Wicaksono, 2020; Rahman & Dewi, 2022).

The research conducted by Umam and Muhammad Khairul (2016) emphasized that variations in temperature and humidity can have a direct impact on livestock, especially in broiler poultry. In their findings, the authors noted that significant temperature fluctuations can lead to increased feed intake or even stunted growth, depending on the environmental conditions. This suggests that more controlled cage systems are necessary for improving the efficiency of poultry production (Umam & Muhammad Khairul, 2016; Wahyudi, 2020; Fajar et al., 2021).

Further elaborating on the technical side, Kurnia (2016) compared several types of sensors and their suitability for use in agricultural monitoring systems. The results of this study are crucial for selecting the most accurate and reliable sensors for temperature measurements in farming environments. The comparison also provided a clear view of how sensor errors could affect long-term data collection, which is vital when integrating automated systems for environmental control (Kurnia, 2016; Wibowo, 2019; Syahrul, 2022).

Lastly, Nuzulul et al. (2019) focused on the application of IoT technology for environmental control in mushroom farming. By using IoT-based systems, the researchers demonstrated how real-time monitoring of temperature and humidity could enhance the cultivation process. This IoT solution helps maintain the required conditions for oyster mushrooms and can be adapted for other types of farming systems that require precise climate control (Nuzulul et al., 2019; Rian et al., 2021; Lestari, 2021).

2.2. Methods

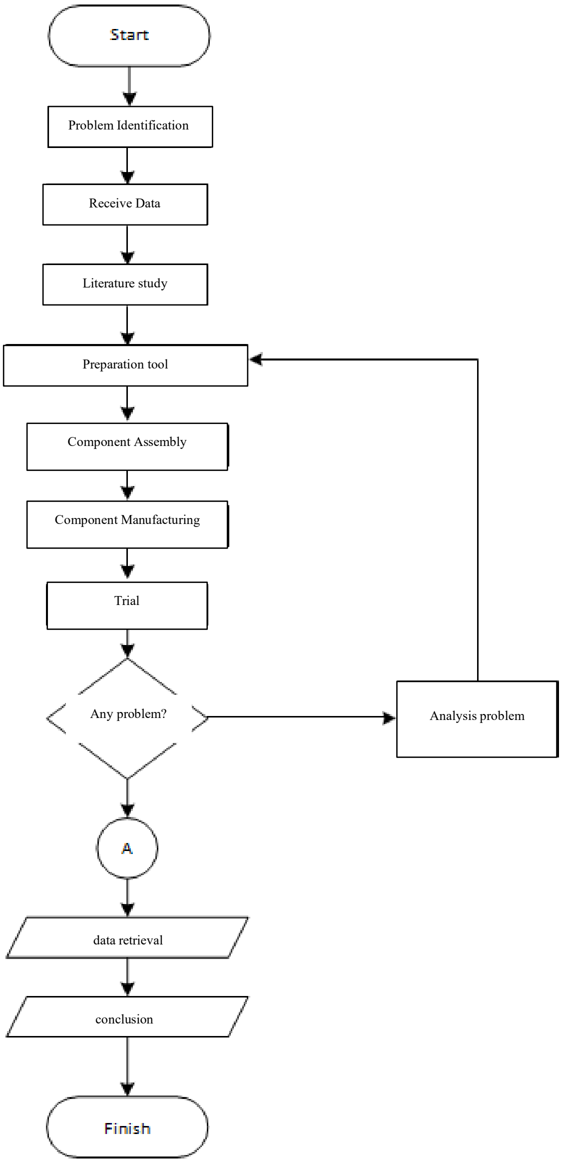

Figure 1. flowchart

This research begins with identifying the problems within the environment. After that, a literature review is conducted using existing sources to gather relevant information. Following the problem analysis, data collection is carried out based on the identified issues. The next steps involve preparing the necessary equipment and materials, then proceeding with assembling the components to create the system. Afterward, testing is performed to ensure that the system functions as expected. If the system operates as desired, data collection begins, followed by the conclusion. However, if the system does not meet expectations, an analysis of the failure causes is conducted, and improvements are made to the design before retesting and proceeding with data collection and conclusion (Nugraha et al., 2024; Nugraha & Sugianto, n.d.; Rian et al., 2021).

The block diagram above shows that the power supply functions to convert 220V AC into 12V DC. The output from the power supply is used to supply the Buck Converter and fan. The lamp is powered by an AC source. The Buck Converter is responsible for stepping down the 12V DC to 5V DC, which is supplied to the NodeMCU. The system works by using a DHT11 sensor to detect the temperature and humidity inside the poultry house. The data is then read by an Arduino and sent to the NodeMCU, which transmits the information to a web server for monitoring and to a relay to control the fan. If the temperature inside the poultry house is too high, the relay activates the fan; if the temperature is too low, the relay turns on the incandescent light (Kurnia, 2016; Fajar et al., 2020; Lestari, 2021).

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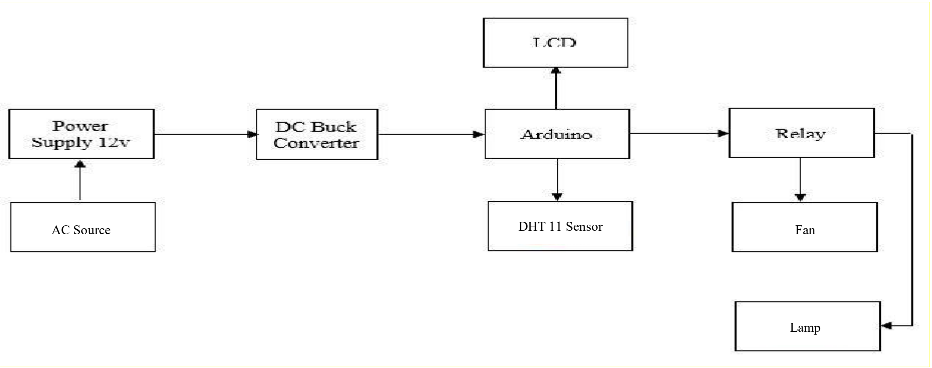
The system design and methodology have been carefully planned to ensure efficient monitoring and control of environmental parameters. The use of IoT-based systems for poultry house management has become an essential approach to automate temperature and humidity control, as it significantly improves farm management. This setup not only provides real-time monitoring but also ensures that corrective actions are taken immediately when the environmental conditions are outside the optimal range for poultry health and productivity (Syahrul, 2022; Dewi et al., 2023; Indra & Fitria, 2021).



Gambar 1. Block diagram

3. Results and discussion

3.1. Result

3.1.1. DHT11 Sensor Testing

The DHT11 temperature sensor is used to detect the temperature and humidity inside the poultry house. The sensor was tested 10 times, starting from 11:00 AM to 8:00 PM, with data being collected every hour. During the testing, two measuring instruments were used, namely a thermogun and a hygrometer, to compare the readings.

Testing was conducted to evaluate the accuracy and performance of the DHT11 sensor under different environmental conditions in the poultry house. The hourly data gathered during the experiment was analyzed to assess the sensor's consistency in measuring temperature and humidity throughout the day, using the thermogun and hygrometer as reference tools.

Tabel 1. DHT11 testing with a Thermogun measuring instrument

No.	Time testing (WIB)	Sensor DHT11 (°C)	Thermogun (°C)	Persentase Temperature Error(%)
1	11:00	33,7°C	33,5°C	0,5%
2.	12:00	34°C	33,9°C	0,3%
3.	13:00	33,8°C	33,7°C	0,3%
4.	14:00	33,3°C	33,3°C	0%
5.	15:00	33,2°C	33,1°C	0,3%
6.	16:00	32,9°C	32,7°C	0,5%
7.	17:00	32°C	31,9°C	0,31%
8.	18:00	31,5°C	31,3°C	0,5%
9.	19:00	31°C	30,9°C	0,31%
10.	20:00	30,1°C	30,3°C	0,6%

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Table 2. Humidity Testing using a Hygrometer

No.	Time testing (WIB)	Sensor DHT11 (%RH)	Hygrometer (%RH)	Persentase Humidity Error (%)
1.	11:00	56,90%	57,00%	0,18%
2.	12:00	58,00%	58,00%	0%
3.	13:00	59,00%	60,00%	1,6%
4.	14:00	61,00%	61,00%	0%
5.	15:00	61,80%	62,00%	0,32%
6.	16:00	63,00%	64,00%	1,57%
7.	17:00	65,80%	66,00%	0,30%
8.	18:00	67,60%	68,00%	0,59%
9.	19:00	68,90%	69,00%	0,14%
10.	20:00	69,70%	70,00%	0,42%

3.1.2. Fan Testing

The fan used in this system is installed on one side of the poultry house to ensure that the airflow is evenly distributed throughout the space. This setup aims to optimize the cooling effect of the fan, allowing the air to circulate evenly across the entire area inside the poultry house.

The fan operates using a 12V DC power supply, which requires a relay module and a power supply adapter to function. The relay module is responsible for controlling the activation of the fan based on the temperature conditions inside the poultry house. This ensures that the fan operates only when necessary.

The system is designed to maintain the optimal temperature for the chickens. When the temperature drops below 30°C, the fan is turned off to conserve energy and avoid overcooling the environment. The fan will remain off until the temperature reaches the designated threshold.

When the temperature reaches between 30°C and 34°C, the fan is automatically turned on, ensuring that the cooling system is active to maintain a comfortable environment for the poultry. This automated process helps regulate the temperature efficiently and consistently without the need for manual intervention.

Table 3. fan test

No.	Temperature (°C)	Information Fan
1.	33,7	ON
2.	34,1	ON
3.	33,8	ON
4.	33,3	ON
5.	33,2	ON
6.	32,9	ON
7.	32	ON
8.	31,5	ON
9.	31	ON
10.	29,9	OFF

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3.1.3. Incandescent lamp testing

The incandescent light in this system functions as a room heater or as a controller for the temperature and humidity inside the poultry house. Its primary role is to help maintain the desired environmental conditions, particularly when the temperature drops below the optimal range for the chickens.

The operation of the light is automated based on the temperature settings configured in the NodeMCU. When the temperature reaches the predetermined value, the system triggers the output, activating the incandescent bulb as a heating source to regulate the temperature.

This setup allows for automatic adjustment of the room's temperature by switching the light on or off, depending on the environmental conditions. If the temperature falls below the set point, the light turns on to provide additional heat to the room, ensuring the temperature remains within the comfortable range for the poultry.

The integration of the incandescent light as a heating element ensures that the poultry house maintains a stable and controlled environment. This automated process reduces the need for manual temperature monitoring, making the system more efficient and reliable in maintaining optimal conditions for the chickens.

Table 4. Incandescent lamp testing

No.	temperature (ºC)	Information Incandescent lamp
1.	33,7ºC	ON
2.	34,1ºC	OFF
3.	33,8ºC	ON
4.	33,3ºC	ON
5.	33,2ºC	ON
6.	32,9ºC	ON
7.	32ºC	ON
8.	31,5ºC	ON
9.	31ºC	ON
10.	30,1ºC	ON

3.2. Discution

Based on several research findings, the control system functions effectively. The DHT11 sensor performs efficiently by quickly displaying data, which is then transmitted to the Internet of Things (IoT) via the NodeMCU. The NodeMCU processes the input signal and sends a command signal to the controller, allowing it to execute the actions based on the set point determined in the system.

The research carried out by the author represents an innovation compared to previous studies, particularly in the use of a microcontroller. Unlike earlier studies that utilized the Arduino Uno, this study employs the NodeMCU. The decision to use the NodeMCU was made due to its practicality and faster monitoring capabilities, making it a more suitable option for the system.

This study introduces improvements in terms of the technology used for monitoring and controlling temperature and humidity. The shift to the NodeMCU microcontroller offers more efficient data processing and easier integration with IoT platforms, which enhances the overall performance of the system.

One of the key advancements in this research is the incorporation of IoT, enabling remote monitoring and control of environmental parameters in the poultry house. This allows for real-time tracking of temperature and humidity conditions, ensuring that the poultry house environment remains optimal for the chickens' growth and health.

The scope of this research includes specific limitations, such as the use of the NodeMCU microcontroller. The DHT11 sensor serves as the primary input for detecting temperature and humidity, while the outputs of this system include a fan and an incandescent light bulb. The system's ability to control these outputs based on environmental conditions ensures that the poultry house maintains the desired temperature and humidity levels.

The testing conducted in this study focuses on the design and development phase, where the components and system are assembled and tested for functionality. The research aims to assess the effectiveness of the system in controlling environmental conditions, which ultimately contributes to better management of the poultry house.

4. Conclusion

To maintain the desired temperature inside the poultry house, it is essential to ensure the proper balance between the size of the poultry house and the number of fans installed. This balance is crucial for efficient air circulation and temperature control. A suitable ratio ensures that the cooling system can effectively regulate the temperature based on the size of the area that needs to be cooled.

The temperature inside the poultry house can be significantly influenced by sudden external temperature changes. Fluctuations in the weather or external environmental conditions can affect the internal temperature, making it necessary to account for these variations when designing the cooling and heating systems. The system is designed to adapt to these changes to maintain stable conditions inside the poultry house.

In this study, the system was tested 10 times under different temperature conditions to evaluate its performance. Each test was conducted with varying temperature settings, ensuring that the system could handle fluctuations and maintain the desired temperature within the poultry house. The tests aimed to simulate real-world conditions, providing a comprehensive assessment of the system's capabilities.

The system was specifically tested under three distinct temperature ranges: below 30°C, between 30°C and 34°C, and above 34°C. These temperature ranges were chosen to represent different scenarios that could occur within the poultry house. The system's ability to respond effectively to each of these conditions was crucial for determining its reliability and efficiency.

Throughout the testing process, the system was able to perform as expected, successfully regulating the temperature according to the predefined set points. The fans were activated or deactivated based on the temperature, and the heating system was triggered when the temperature dropped below the set point. This ensured that the internal conditions remained within the optimal range for poultry health and productivity.

Overall, the results of the tests demonstrated that the system was capable of maintaining the desired temperature conditions inside the poultry house. The system functioned effectively, even with varying temperature conditions and external environmental factors. This indicates that the design and implementation of the system were successful in achieving the intended goal of temperature regulation for poultry management.

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