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# Design of Temperature Monitoring and Control System in Smart Hen Coop Based on Internet of Things

**La Mema Parandy[1], Sidiq Syamsul Hidayat[2], Muhammad Robby[3], Rachael Al Azhar[4], Irfan Mujahidin[5], M. Cahyo Ardi Prabowo[6]**

Universitas Pembangunan Nasional "Veteran" Jawa Timur[1], Semarang State Polytechnic[2,3,4,5,6]

Correspondence Email: lamemaparandy@gmail.com[1]

**Abstract**

Every temperature error detected by the system would be notified to users by the Blynk application, and the system would attempt to stabilize the temperature in hen coop with a lamp and fan. Notification from the Blynk application is set to stop until the temperature returns to an ideal. The Blynk application is equipped with a reset button to reset the chicken age counter. This system used temperature and humidity sensors DHT22 to sense the temperature, which the data from the sensor output read by Arduino Uno. The data that Arduino Uno reads is sent to NodeMCU. Afterward, NodeMCU sent the data to the Blynk server; therefore, the Blynk application displayed the temperature and humidity data on the Blynk dashboard. This system is expected to facilitate users/breeders in monitoring the temperature in the hen coop. Therefore, users/breeders do not need to worry about chickens dying due to heat or cold stress. The waterfall method is used in this design of the system. This system was tested in a 70 x 70 x 130 cm sized hen coop and entirely tested the system each minute for 35 minutes.

**Keywords: temperature, smart hencoop, chicken, blynk.**

## INTRODUCTION

In this era of globalization, technology is growing and progressing rapidly. Computer technology significantly influences all spheres of life to help the process work more efficiently. Technology is reaching chicken farms, so the term brilliant chicken coop or Smart Hen Coop has emerged. Smart Hen Coop is a chicken coop that has an automatic system and can be monitored via a smartphone so that chicken farmers can monitor and control the system in the chicken coop directly without the need to visit the farm location as well as the ability to control the temperature in the chicken coop automatically so that the temperature is stable according to the needs of chickens of various ages. In addition to the temperature in the coop, which the system can control, real-time temperature and Humidity information can be displayed on an application called Blynk. Smart Hen Coop has two lights and two fans to stabilize the coop temperature. Chicken farming is one of the largest food suppliers, so it has good prospects to be developed both on a small and large scale.

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Broiler chicken is a superior breed that has high productivity. To be able to reach an age that is sufficient for harvesting, chickens need to be at the right temperature. Closed chicken coops have not provided the right solution when the transitional season arrives. Weather changes affect significant temperature changes. Without the help of a temperature control system, chickens can experience heat stress or heat stress, which can cause death in chickens, thus reducing farm productivity.

In general, the construction of chicken coops is established outside the farmer's house or far from the farmer's house. The layout of the chicken coop needs to be considered because the pungent odor of chicken feces in the coop can disturb the environment. This long distance is not efficient in cage operations. So, a way is needed to overcome the problems in the design of cage construction.

To overcome the problems in the design of chicken coops, a system is needed that can monitor the temperature in the cage according to the age of the chicken from a short or long distance. Therefore, research titled "Design of Temperature Monitoring and Control System in Smart Hen Coop Based on Internet of Things" was made as a solution option that could overcome these problems. Through a temperature monitoring and control system via a smartphone, broiler farm owners can monitor the temperature quickly.

Some researchers have conducted research with a study entitled Broiler Chicken Coop Temperature and Humidity Control Model Using ATMega328 Microcontroller and DHT11 Sensor by to monitor and regulate temperature and Humidity automatically. ATMega328 microcontroller is a system controller, and GSM Shield informs users about temperature conditions sent to mobile phones. Three temperature and humidity conditions, namely, hot temperature, dry Humidity, average temperature, normal Humidity, and cold temperature wet Humidity, are read by sensors on the system. The outputs of the system are a DC fan and light. The speed of the DC fan is regulated by applying PWM (Pulse weight modulation) control, which functions as a pulse width regulator presented in the form of a percentage (%). As a source of warmth, the lamp can be adjusted to dim and bright according to the temperature read by the sensor. The tool used is a dimmer driven automatically by a servo motor. When the temperature is reached in the predetermined temperature range and an increase in temperature is detected, the fan rotates automatically. When a decrease in temperature is detected, the lights turn on automatically. This system cannot be monitored via an application on an Android-based smartphone.

Another study was conducted by entitled Design of Microcontroller-Based Chicken Cage Temperature Control System. The microcontroller is used as the central controller in this system. The temperature is read the LM35 sensor, which is then displayed on the LCD. The outputs of this system are DC fans and incandescent lamps. IC L293D is a DC motor driver on the fan for DC motor rotation control. In addition, this circuit also has five automatic switches or relays. Different temperature limit ranges based on age and comfortable temperature for chickens are set on each relay. The design results of the chicken coop temperature setting automatically run well because the tool can work, and predetermined temperature limits maintain the temperature stability. The disadvantage of this research is that the DC fan is still switched on with an automatic switch, so the fan can be quickly damaged. The system that will be made will be turned on with a 220V AC dimmer as a speed regulator for fans and incandescent lamps so that they are not quickly damaged.

Efficiently managed farms are the goal of the research conducted by. The research is entitled Application of Wireless Sensor Network Based on the Internet of Things in Chicken Cages to Monitor and Control Chicken Farm Operations. This system uses a Wireless Sensor Network based on the Internet of Things. The livestock management in question is

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temperature regulation and automatic feeding and drinking water systems. The microcontroller used is ESP8266, which can connect to a Wi-Fi network. The actuator will control the temperature and Humidity in the chicken coop. The relay actuator runs when the sensor reads the temperature and Humidity. Data was sent in temperature (°C) and Humidity (%). In this study, the temperature conditions set are 32-36°C. When the temperature reaches 36 ° C, which means high temperature, the fan turns on, and the lights do not turn on. At 35°C, the temperature is considered stable, so the fan and lamp are not turned on. Temperature 34 - 32 ° C is considered low, so the fan does not turn on, and the lights are on. Although in this research, the system used is automatic and IoT-based, there are still shortcomings namely the temperature that is the reference is overall for both chicks and adult chickens, so that the ideal temperature needs for broiler chickens have not been achieved.

Some literacy journals taken as references still have shortcomings. In order for the system to be more optimal, the system is made IoT-based so that it can be monitored and controlled via a smartphone, replacing temperature and humidity sensors that have a lower error tolerance so that the data obtained is more accurate, adding Real Time Clock as a timer and reference for the age of the chicken so that the temperature range can be adjusted to the age of the chicken and a more specific temperature range so that the ideal temperature is reached in the broiler cage. It is hoped that the ideal chicken coop temperature can be achieved for chickens from hatching to harvest by being equipped with a system like the one above.

## METHOD

Waterfall Methodology is used in the research, which is a sequential and linear software development approach. Based on the flowchart in Figure 1 and Figure 2, the temperature and Humidity are read by the DHT22 sensor, which is then converted into electrical quantities in the form of voltage. The voltage output, via the data pin on the sensor, is then processed by Arduino. Temperature conditions need to be considered in the processing carried out in the temperature monitoring and control system shown in Table 1.

**Table 1. Temperature Requirements in Cages**

| No | Chicken Age | Ideal Temperature |
|---|---|---|
| 1 | 1 - 7 days | 31 - 35°C |
| 2 | 7 - 14 days | 29 - 32°C |
| 3 | ≥ 14 days | 26 - 29°C |

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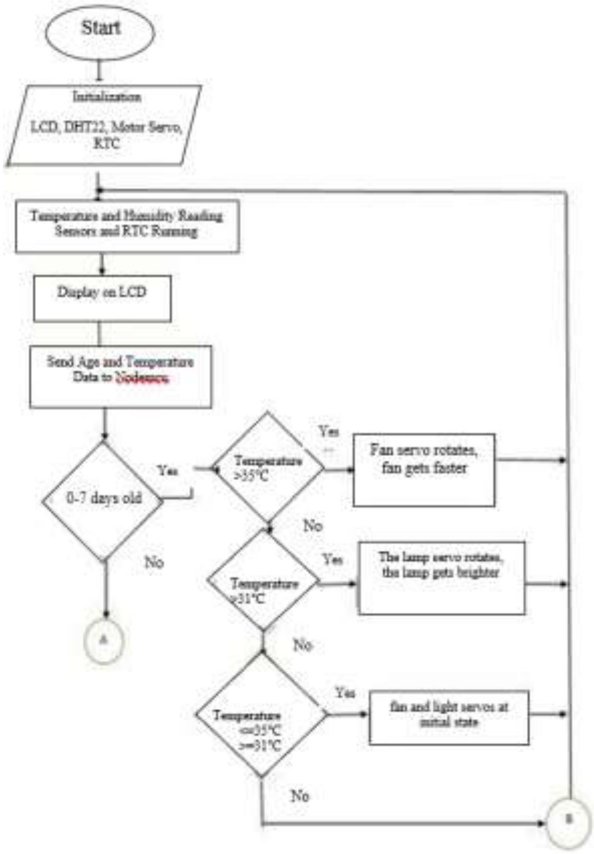


Figure 1. System flowchart in Arduino

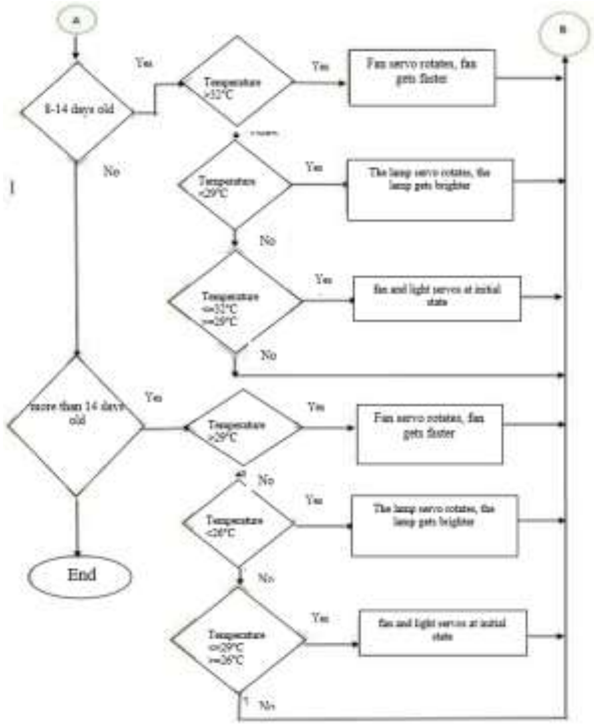


Figure 2. System flowchart in Arduino

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The temperature conditions in Table 1 are the temperature conditions that need to be considered in the cage. When the temperature is read by the storage system in Arduino Uno, the temperature data is displayed on the LCD, and the temperature data is automatically stored by Arduino Uno in external memory.

Temperature data from the DHT22 sensor and time data from the Real Time Clock (RTC) are continuously retrieved by the Arduino Uno. The age of the chicken is set based on the time data from the Real Time Clock (RTC) so that the age of the chicken can be by the planned program. The age of the chicken that has been set and the temperature read by the sensor is then processed by Arduino. The results of this Arduino processing are then sent to the LCD to be displayed and then processed to the servo motor so that the servo motor can be moved based on the provisions. When the servo moves, the dimmers on the lights and fans also move based on the servo's rotating angle. The lamp is used as a heater, and the fan is used as a cooler. The fan servo moves so that the fan dimmer rotates when the temperature is higher than the ideal temperature so that the fan rotation speed is controlled. If the temperature is lower, the lamp servo rotates so that the dimmer on the lamp also rotates. The lamp dimmer is set to be brighter. In addition to temperature settings made automatically and according to the age of the chicken so that the ideal temperature is obtained, the temperature can also be monitored remotely with the IOT (Internet of Things) system.

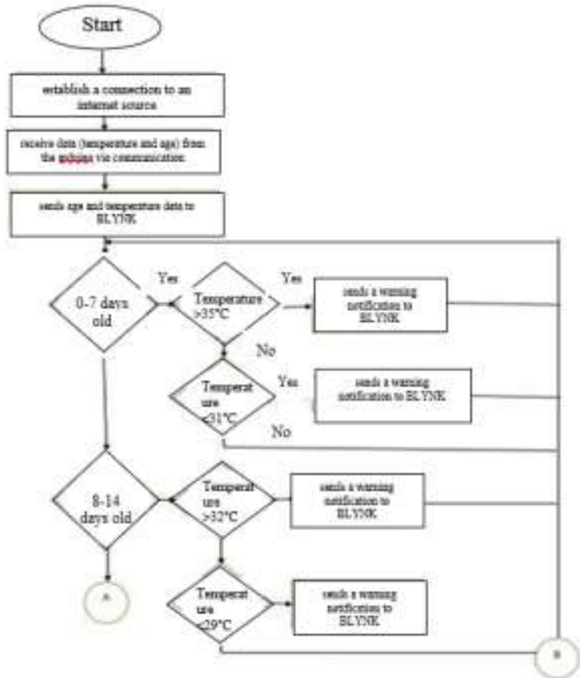


**Figure 3. Flowchart on NodeMCU**

The system flowchart on NodeMCU can be seen in Figures 3. and 4. The system works on NodeMCU when the sensor reads the temperature. The temperature data is sent to NodeMCU via serial communication. Then, the temperature data is sent to Blynk with internet hotspot. The hotspot used is still unable to use the hotspot login system, so the SSID and password can be used as an internet connection on this system.

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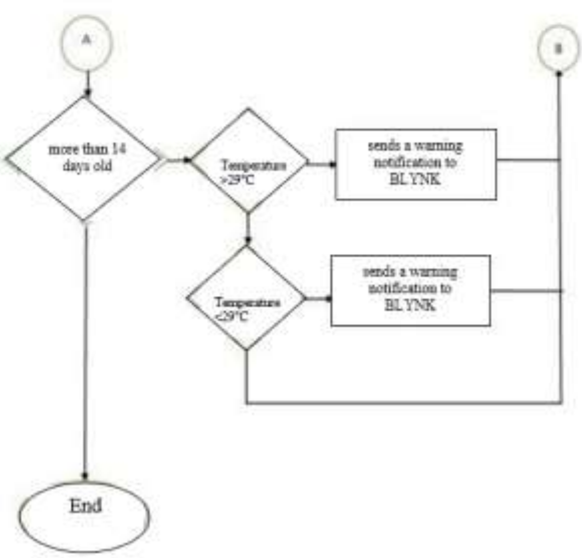


**Figure 4. Flowchart on nodemcu**

In this system, the hardware used in this temperature monitoring and control system is Arduino Uno, NodeMcu, DHT22 temperature and humidity sensor, Tiny RTC I2C Module, LCD 16x2 I2C Module, SG90 servo motor, fan, lamp, AC dimmer, and Smartphone. The hardware design of the whole system is shown in Figure 5.

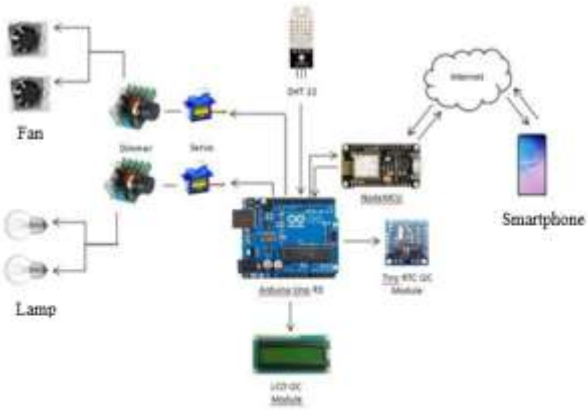


**Figure 5. Design Of Cage Temperature Monitoring and Control System**

Arduino Uno is the control center of all hardware, and NodeMCU is a link between Arduino and Blynk application. So that data can be received or sent, serial communication is used as communication between NodeMCU and Arduino Uno. LCD Display 16x2 is used so that time, Humidity, and temperature readings from sensors in real-time and the age of the chicken can be displayed on the drum. Real-time data in taking temperature and humidity data is generated by a Real-time Clock (RTC). In addition, the RTC is used as a reference for the age of the chicken. In this system, sixty seconds of RTC is considered one day of chicken age. DHT 22 as a temperature and humidity detection sensor in the chicken coop. 12 cm AC fan as a cooler for the chicken coop and two fans are used as a cooler for the coop. The first fan blows air into the cage, and the second is an exhaust fan, so the close-house chicken coop is not stuffy. AC 220V dimmer is used as a regulator of bright or dim lights and fast or slow fan motion, while the servo motor, as the system's output, is used as a dimmer drive connected

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to the lights and fans. And the last Smartphone as an internet network provider and system interface.

The schematic circuit shown in Figure 6. is a hardware schematic of the chicken coop temperature monitoring and control system. Hardware devices connected to Arduino include DHT22, LCD, RTC, servo motor, and NodeMCU. The wiring between Arduino and other hardware is more fully described below.

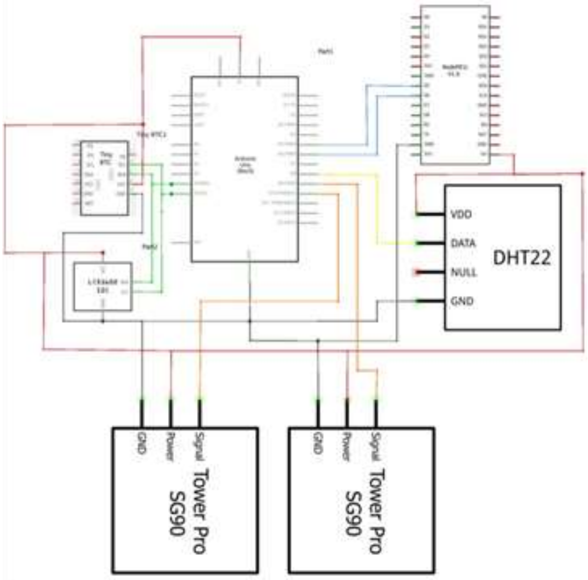


**Figure 6. Hardware Circuit Schematic**

Next is the design of the chicken coop, which is used to install hardware and system testing media. The overall height of the chicken coop is 130cm. 130cm high drum is divided into 30cm cage leg length, 30cm cage roof height, and 70cm cage body height. The length and width of the cage is 70cm.


**Figure 7. Chicken Cage Design**

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## RESULT AND DISCUSSION

**Figure 8. Hardware Packaging in A Box**

**Figure 9. The Dimmer and Servo Motor In The Box**

**Figure 10. Chicken Cage Making**

**Figure 11. Placement Of Hardware in The Cage**

This stage contains system testing, which consists of testing the DHT22 temperature and humidity sensor, the 16x2 character LCD, the Blynk application, and the entire system. DHT22 testing is done so that the level of sensitivity in detecting the temperature and Humidity of the environment and the accuracy of the temperature and humidity values produced in real time are known. Then, the magnitude value produced by the DHT22 sensor is compared with HTC-2 Temperature and Humidity. The results of temperature readings by Arduino Uno are displayed on a 16x2 LCD and Blynk application. The 16x2 LCD is expected to display temperature and humidity data and can display chicken age and time in real time. The display of temperature and humidity data on the LCD is compared with the display of temperature and humidity data on the Blynk application. This is done to see the difference in data displayed on the LCD and Blynk. Testing the Blynk application as an Arduino controller is done by pressing the reset button on the application.

The servo motor moves when the temperature detected by the sensor is higher or lower than the ideal temperature setting limit. The system that has been made can work well after testing the entire system directly.

**DHT22 Temperature and Humidity Sensor Testing**

Temperature and humidity information on the chicken coop is obtained from the DHT22 sensor. For the accuracy of the DHT22 sensor to be known, the sensor is tested together with HTC-2 Temperature & Humidity for 300 seconds. The DHT22 sensor and HTC-2 Temperature and Humidity are conditioned to the same environment. The results of the temperature and humidity readings of the DHT22 and HTC-2 Temperature and humidity sensors in the first 15 seconds and 300th second are shown in Table 2.

**Table 2. DHT22 Temperature and Humidity Sensor Testing**

| Time (Second) (sec | Image | HTC- Temperature & Humidity | | DHT22 | |
|---|---|---|---|---|---|
| | | Temperature (°C) | Moist | Temperatur (°C) | Moisture (%) |
| 0 |   | 28,5 | 59 | 28 | 62 |
| 15 |   | 28,5 | 59 | 28 | 63 |

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| | | | | | |
|---|---|---|---|---|---|
| 30 |   | 28,5 | 59 | 28 | 62 |
| 300 |   | 28,5 | 59 | 28 | 65 |

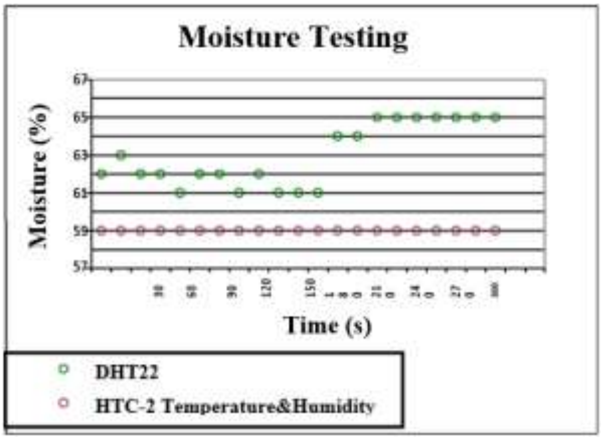


**Figure 12. Humidity comparison chart between DHT22 and HTC-2 Temperature & Humidity sensors**

Based on the test comparison results of the DHT22 and HTC-2 Temperature and humidity sensors in Table 2, no temperature changes occur. The temperature from reading the ambient temperature from the first 15 seconds to the 300th second is only a 0.5°C difference. The reading of the DHT22 sensor is 28°C, and the temperature indicated on the HTC-2 Temperature & Humidity is 28.5°C. Thus, the sensor error value is ± 0.5°C.

Based on the results of the humidity comparison between the DHT22 sensor and HTC-2 Temperature & Humidity, a graph is obtained as in Figure 12. The result of the test is that the Humidity displayed on the HTC-2 Temperature & Humidity from the first 15 seconds to the 300th second is always the same, namely 59%, while the reading of the DHT22 sensor changes. Humidity began to stabilize at the 210th second to the 300th second.

**16x2 Character LCD Testing**

Testing the 16x2 character LCD is done so that the age of the chicken, time, temperature, and Humidity are displayed on the chicken coop. The temperature and humidity values displayed on the LCD are the results of readings taken by Arduino Uno with the DHT22 sensor, while the time displayed on the LCD is the result of readings taken by Arduino Uno with RTC DS1307. The 16x2 character LCD test results are shown in Table 3.

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**Table 3. LCD Display Testing Results**

| LCD Display | Description |
|---|---|
|   | Chicken age, time, temperature and humidity data are displayed on the LCD Display. |

**BLYNK Testing**

The Blynk application is said to function if the age of the chicken can return to zero days after pressing the reset button and the temperature and Humidity can be monitored from a smartphone. The things displayed on Blynk are the age of the chicken, the temperature limit based on the age of the chicken, the temperature status of the cage, the temperature value, and the Humidity. In addition, on Blynk, there is a reset button to restore the calculation of chicken age. This functions when the chickens have been harvested and will start raising chickens again. The test results of the Blynk application are shown in Table 4.

**Table 4. Blynk App Test Results**

| LCD Display | Description |
|---|---|
|   | In the application there is an LCD as a display of the age and the temperature limit based on the age of the chicken. At below the LCD there is a reset button that functions to return the age of the chicken to zero days. Next to the reset button there is a notification icon so that notifications can be given to the user's mobile phone. At the very bottom of the app are the temperature and humidity values in the cage. |
|   | View of the Blynk app when the reset button is pressed. The button is coloured green because it is being pressed. |
|   | Display after the reset button in the app is pressed. The age returns to zero days. |

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| | |
|---|---|
|  | Blynk notification display when the temperature is above the predefined limit. |
|  | Blynk notification display when the temperature is below a predefined limit. |
|  | Blynk notification display when the temperature is within the predefined limit. |

**Servo Testing**

The servo is a dimmer drive connected to the lights and fans. Testing is carried out in the age range of chickens 0 - 7 days or the first week. The ideal temperature requirement for first-week chickens is 31 - 35°C. In the fan servo, for every one °C temperature error, the servo rotates 20°. While in the lamp servo, for every one °C temperature error, the servo rotates 30°. For testing, the temperature sensor is heated with a hairdryer. Test results can be seen in Table 5.

**Table 5. Servo Test Results**

| Temperature(°C) | Moisture | Servo Lights | Servo Fan | Image |
|---|---|---|---|---|
| 32 | 47 | Normal position | Normal position |  |
| 48 | 41 | Not rotating | Rotate to the |  |

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| | | | | |
|---|---|---|---|---|
| | | | right | |
| 28 | 58 | rotate to the right | not rotating |  |

Based on Table 5, at a temperature of 32°C, the ideal temperature in the first week of chicken age, the lamp and fan servo are in the normal position. Then, at a temperature of 48°C, above the ideal temperature conditions in the first week of chicken age, the lamp servo does not rotate, and the fan servo rotates to the right. This means that the fan rotates quickly at that temperature, and the lamp does not turn on brightly, so the cage temperature decreases quickly. Then, at 28°C below the ideal temperature requirement in the first week of chick age, the lamp servo rotates to the right, and the fan servo does not rotate. This means that at that temperature, the lamp is the brightest, and the fan rotates slowly so that the temperature of the chicken coop is ideal.

**Overall Testing**

Direct testing consists of testing temperature and humidity control, testing direct monitoring with a smartphone, and testing the overall system in the chicken coop. This test is done to know that the system functions as a whole. The test results can be seen in Table 6.

**Table 6. Overall System Test Results**

| Day | Temperature | Moisture | Servo Lights | Servo Fan | Lamp | Fan | Status | App View |
|---|---|---|---|---|---|---|---|---|
| 0 | 36 °C | 36 % | Not rotating | Rotate to the other | Dim | Rotate fast | Hot temperature |  |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | ight | | | | |
| 1 | 35 °C | 37 % | Not rotating | Not rotating | Dim | Rotate slow | Stable temperature |  |
| 2 | 35 °C | 38 % | Not rotating | Not rotating | Dim | Rotate slow | Stable temperature |  |

Testing was carried out from day 0 to day 35. On day 0, the temperature was 36°C. Based on Table 1, the appropriate temperature for chickens aged 0 - 7 days is 31 - 35°C. So the temperature of 36°C is more than the predetermined limit, so a notification appears that the temperature is above 35°C. Then, the fan servo rotates so that the dimmer rotates, and then the fan rotates fast, so the temperature drops to a predetermined temperature. On day 1, the temperature is at 35°C, meaning that the temperature is ideal, then the fan servo rotates in the opposite direction so that the fan returns to slow rotation so that the temperature does not drop quickly. Day 2 to day seven is between 31 - 35°C, meaning the temperature remains stable. If the temperature is stable, no notification appears in the application.

Entering the eighth day, the temperature is 32°C. Based on Table 1, the ideal temperature for chickens aged 8-14 days is 29-31°C. Then the temperature stabilized, the fan and lamp servo did not move and the lights and fans remained normal. From day 9 to day 14, the temperature remains at 30°C, meaning that the temperature is still stable, the fans and lights are still regular, and the application does not appear notifications.

On the 15th day, the temperature was at 32°C. Based on Table 1, the ideal temperature for chickens aged more than 14 days is 26-29°C. Since the temperature on day 15 was up to 32°C, the app sent an alert that the temperature was above 29°C. The fan servo rotates so that the fan dimmer rotates and the fan rotates quickly. From day 16 to day 21, the temperature remained at 29°C. On the 22nd day, the temperature rises to 30°C, so the application notification appears that the temperature is above 29°C. The fan rotates quickly again so that the temperature returns to ideal. From day 15 to day 20, the temperature is still higher than 29°C. So, the fan continues to spin fast. The temperature began to drop on day 21 to 27°C and

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rose again to 30°C on day 22. The temperature dropped again on day 23 to 29°C and remained within the ideal temperature range until day 35.

## CONCLUSION

Several conclusions can be drawn based on the testing of the temperature monitoring and control system in Smart Hen Coop. Smart Hen Coop is a brilliant chicken coop that can stabilize the temperature inside according to the needs of the chickens based on their age. The monitoring system of Smart Hen Coop can be accessed through LCD or Blynk application on a Smartphone. When the temperature read by the Arduino Uno exceeds the predetermined limit, the fan will rotate quickly, the lights will become dim, and the notification on the application will inform that the temperature has exceeded the ideal limit. Conversely, if the temperature read by the Arduino Uno is lower than the limit, the fan will spin slowly, the lights will become bright, and the notification on the application will indicate that the temperature is below the ideal limit. However, there are some obstacles, such as a delay when resetting the age of the chicken with an uncertain delay time, a temperature difference of about 0.5°C between the readings of the DHT22 sensor and HTC-2 Temperature and Humidity, and a significant difference in humidity readings between the DHT22 sensor and HTC-2 Temperature & Humidity. In addition, the DHT22 sensor is placed too close to the lamp, making it difficult for the temperature to drop.

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