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Development of an IoT-Enabled Automatic Poultry Feeder and Cage Temperature Monitoring System Using Microcontroller Technology

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ABSTRACT

In general, chicken farmers still use conventional systems to feed the chickens they raise. They use their hands to sprinkle feed on the feed poles and walk along the cage where the cages for the chickens they raise are very large. Such activities for chicken farmers will take up time and energy. Feeding chickens can be made easier by using mechanical devices controlled by electronic equipment. The aim of this research is to design and create an IoT-based automatic chicken feeding tool. In designing this tool, we started by designing an IoT-based automatic chicken feeding tool. Where the Servo is a feed pusher in the pipe to spill animal feed into the feeder. The results of this research show the performance of Servo which functions to provide automatic chicken feed. The results of IoT testing which functions as a timer for giving chicken feed to this tool are quite accurate. This is proven by the difference between the time on the tool and the time on the laptop of only 1 second. And temperature monitoring can be seen on the LCD, if the temperature is above 30 degrees, the fan or fun will turn on, and if it is below 30 degrees, the light will turn on automatically.

Keywords: Prototype of Chicken Feeding Equipment; Microcontroller; Internet of Things; Servo Motor

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1. INTRODUCTION

The foundation of a sustainable economy is agriculture. Agriculture is essential for long-term economic prosperity. Agriculture used to be only concerned with growing crops and producing food. However, agriculture has evolved over the years to include processing, production, marketing and distribution of crops and livestock products. Chicken is the only type of poultry that has high commercial value because of the huge demand for chicken meat. Poultry farming is one of the agricultural activities that contributes significantly to development through job creation and improving nutrition and food. Today, agricultural activities serve as a basic source of livelihood, which increases GDP. There are various problems in the poultry farming sector that need to be resolved. Manual feeding and automation can be classified into two categories when comparing conventional chicken feeding methods with modern automation [1]. Chicken business is one of the major sources of protein for human consumption because the primary production of meat and eggs in poultry management is very important. Manual feeding schedules create difficulties in managing production costs effectively in chicken farming [2].

It has been proven that there is a direct relationship between the high cost of raising chickens and community participation in this farming system. This has led to a significant increase in the overall labor cost for this farming technique. Previously, farmers spread feed on the ground and caused the feed to be contaminated by feces and insects. This can cause chickens to consume unhealthy feed that is susceptible to germs and bacteria, which can result in chickens having unhealthy combs, eyes, beaks, neck feathers, legs, and spurs. In addition, sick chickens have no appetite, which prevents them from consuming enough nutrients and eventually leads to death [3]. Feed should be stored in containers that protect it and keep it fresh during the period between feedings. Despite providing unhealthy and nutritious chickens, excess feed that has been contaminated with feces and mixed with soil has resulted in various losses [4]. To prevent food waste, sufficient and fixed amounts of grain needed for chickens must be identified and handled effectively. The current system still lacks an automatic chicken feeding system even though solutions to monitor and regulate poultry farming operations and environmental conditions are available. Therefore, a system for an automatic chicken feeder is suggested and designed to provide feed efficiently and regulate the timing of chicken feeding. This system offers a practical alternative for automatic feeding without the hassle and sufficient amount of food to meet demand. The desired time can be determined by the user and saved to the embedded system. As a result, even when they are away from home, the chicken feeder will feed the chickens automatically and on time[5].

Technological developments have not escaped the world of livestock, one of which is chickens. Chickens with good and proper maintenance will definitely produce healthy chickens, including always paying attention to feeding patterns and cleanliness of chicken cages. Maintenance and feeding of chickens is important. In general, feeding of chickens is done manually, namely by pouring or sprinkling feed into a place that has been provided, this requires time and energy, especially since this activity is carried out in the morning, afternoon and evening [6-7].

In Tejorejo village, Ringinarum district, Kendal regency, many people, apart from working as farmers, also work as broiler chicken breeders. Tejorejo village is one of 12 villages in the Ringinarum district. As a village that has many broiler chicken breeders, the development of automatic feeding and temperature monitoring tools based on IoT can provide great benefits for the people of Tejorejo Village. In addition, the development of this tool can also be the beginning of the development of IoT technology in Tejorejo Village and open up opportunities for the development of other technologies that can help increase the productivity and welfare of the people in the village.

Broiler chickens are a type of chicken that is raised for meat consumption. The right and regular food needs of broiler chickens are key factors in the growth and health of the chickens [8-9]. However, in reality, feeding chickens manually can be a very time-consuming job and requires close supervision [10-11]. In addition, uncontrolled environmental temperatures can also affect the health of chickens and their growth.

Daily activities cause the feeding process to be not according to schedule, even forgetting to feed the chickens and forgetting to check the temperature in the chicken coop, whether the temperature is normal or too hot or even too cold [12]. Hot temperatures are a major concern because they can cause economic losses due to increased mortality and decreased productivity [13]. Along with the development of the times and technological advances, many electronic components support the creation of automatic tools. Therefore, the author created an automatic chicken feeding device and automatic temperature checker indoors, thus making it easier for chicken farmers to provide feed and check the temperature or automatically control the temperature of the cage [14-15].

Many studies have conducted research on automatic feeding and temperature control [16]. Automatic Chicken Feeder Monitoring System using NodeMCU based on the Internet Of Thing. A control tool that is able to provide chicken feed automatically according to a predetermined schedule, using Real Time Clock [17-18]. If the specified time has been met, the servo motor will move to open the feed container, and if the specified time has passed, the servo motor will close the feed container. Ultrasonic distance sensor to detect objects so that it can be used to determine the height of the feed [19-21].

The main goal is to increase time efficiency in feeding chickens and monitoring the temperature in the cage, by providing an automatic chicken feeder and temperature monitoring device to make it easier for farmers [22-23]. The results obtained from making an automatic chicken feeder and temperature monitoring device in the cage are that this device will feed the chickens every 08.00, 13.00 and 17.00, then the servo will automatically open the chicken feed container according to the specified time, and when the feed is full, the servo will automatically close the feed container [24]. This tool will continue to operate as long as the system is still running.

2. RESEARCH METHOD

To perfect the application to be created, a research method is needed to create a system that will later become software, which is used to be more efficient, environmentally friendly and can be easily used by anyone. In doing so, a system development is needed, which can mean compiling a new system to replace the old system as a whole or repairing the existing system. The old system needs to be repaired or replaced due to several reasons. The method used to create this application is the Research and Development (R&D)

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development method and for the system using the Prototype method [25]. In the design by preparing the prototype method:
The following are components for designing a prototype:
1. Arduino Uno; Arduino is a hardware that uses a Microcontroller as the main controller of the circuit.
2. ESP 32; ESP 32 is a WiFi Module on a chip that supports the development of application systems for the Internet Of Things ESP 32
3. Servo Motor; Servo Motor is a closed-loop servo mechanism that uses position feedback to control Movement at its final position.
4. LCD; LCD Display is hardware that is useful as a medium for displaying characters (images, letters, numbers or others) made of liquid crystal material.
5. DHT11 Temperature Sensor; DHT11 Temperature Sensor is a sensor module that functions to sense temperature and humidity objects that have an analog voltage output that can be further processed using a microcontroller.
6. 2 Channel Relay; Relay is an output that is used as a switch or switch to connect two other devices..

2.1. Stages in prototype development

The method used in system development is using a prototype, the stages in prototype development can be seen in the flow diagram below:

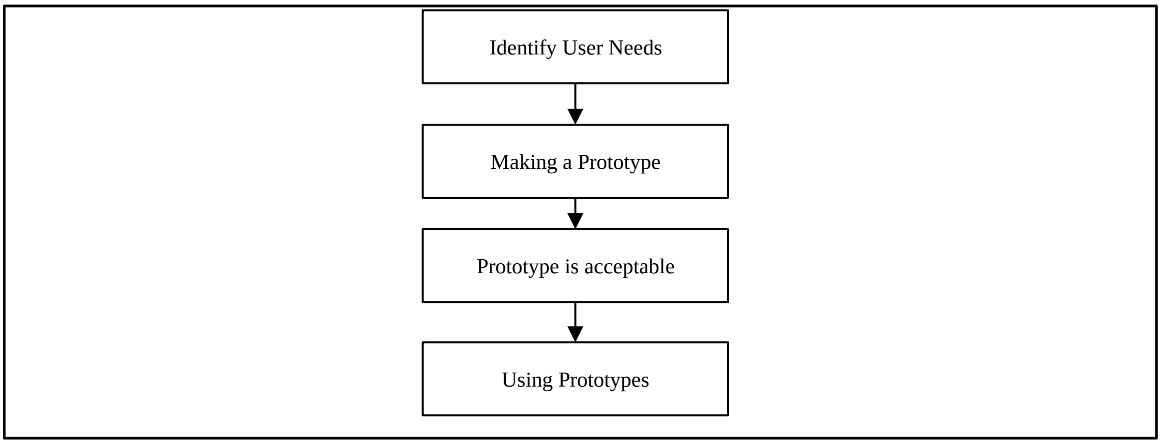

Figure 1. Prototype Developer Model Flowchart

Prototype evaluation development Figure 1 shows four steps in creating an evolutionary prototype [26]. The four steps are: Identifying user needs. The developer interviews users to get an idea of what is required of the system [27]. Creating a Prototype the developer uses one or more prototyping tools to create a Prototype. Determining whether the Prototype is acceptable, the developer demonstrates the Prototype to users to find out if it has provided satisfactory results, Using the Prototype into a system.

2.2. Component design system

The following is the design flow for the system tool for designing components in this system, namely using Fritzing, the results are IoT-based.

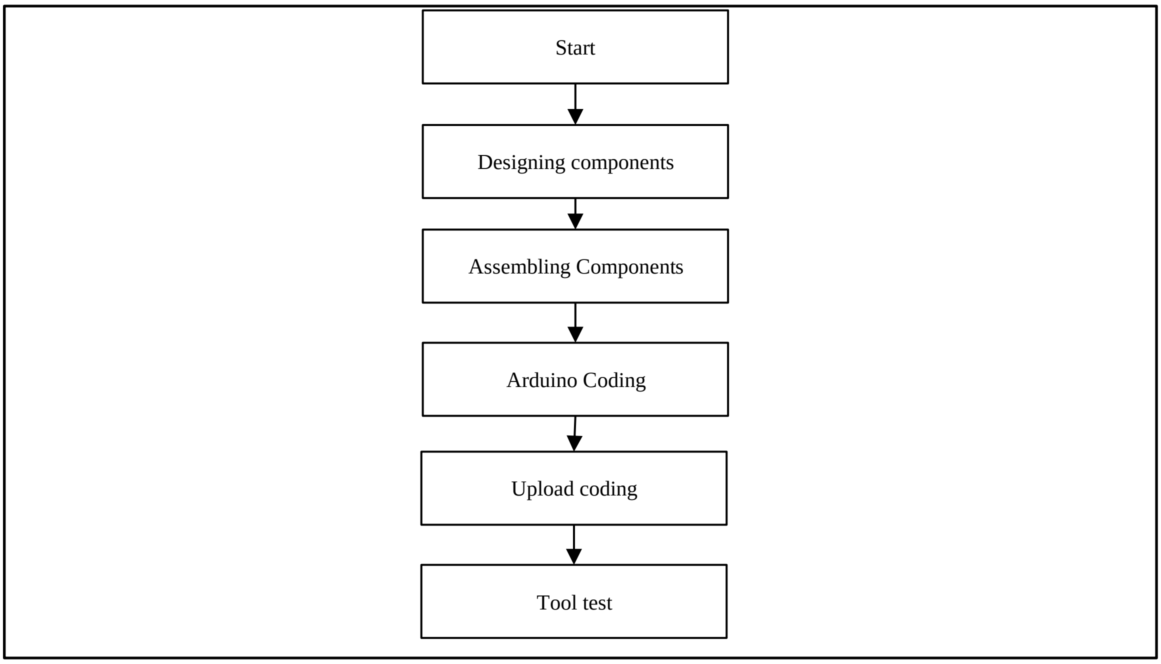

Figure 2. Flowchart of tool devices

The following is an explanation of Figure 2: (1) Designing components, The initial step taken is to design components, to design components in this system, namely using fritzing. The purpose of this planning is to minimize errors in making tools. (2) Assembling components, The next step is assembling components. Components are installed to the pins according to the specifications of the tool. Starting from analog pins, power pins and ground pins [28]. (3) Coding Arduino components, To code these components, Arduino IDE software is needed. In Arduino coding, the C++ programming language is needed. Every tool that is connected to Arduino must have its variables defined according to the connected pins so that later it can be easily coded if there is a branching condition [29-30]. (4) Upload Code, After the coding process is complete, the next step is the coding upload process. This step is done using Arduino IDE software. If an error occurs during the coding process, an error will occur during the coding data upload process and an error message will appear according to the problematic coding line. (5) Tool Testing, The next step is the tool testing process before the tool can be mass produced.

3. RESULTS AND DISCUSSION

System design is the initial stage of application design which includes process design depicted in a flowchart or ERD and interface design. This design is done to find out the general condition of the system. The following is the framework of the system that will be created.

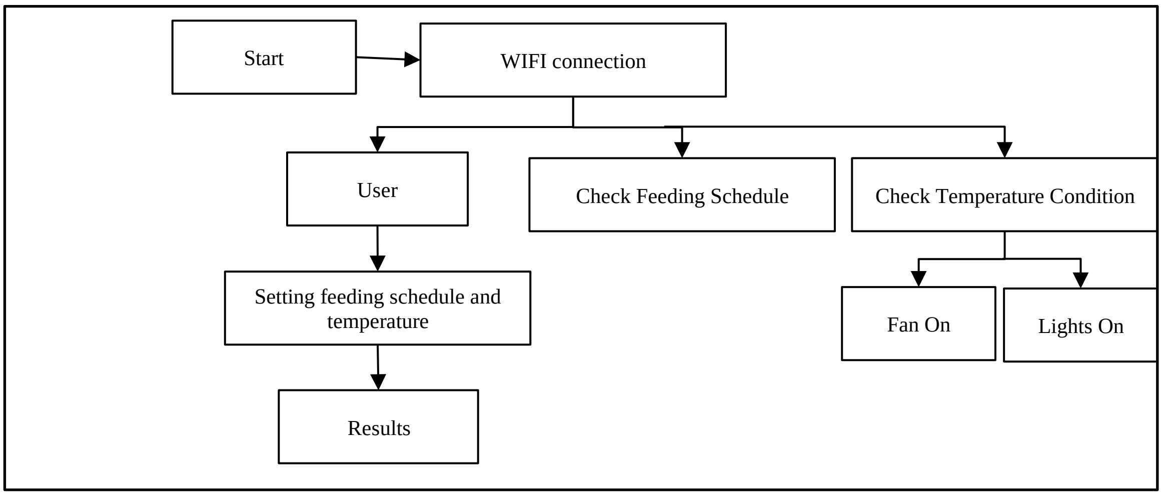

Figure 3. IoT-based temperature device system flow

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Based on the figure, it can be explained as follows: (a) If the temperature set in the database is running, the light or fan will turn on. (b) Arduino will request an API to the database to request a feeding schedule with a 1 minute interval, and the tool will run according to the feeding schedule.

3.1. Schematic Design

Schematic design is a description of the program that is created and described so that it is clear what the appearance of the program created will be like [31]. The following is a design for an Automatic Chicken Feeding Tool and IOT-Based Temperature Monitoring.

3.1.2. Tool Design (Schematic)

In designing tools (hardware), a fritzing application is needed. The use of this fritzing application functions to design electronic circuits [32].

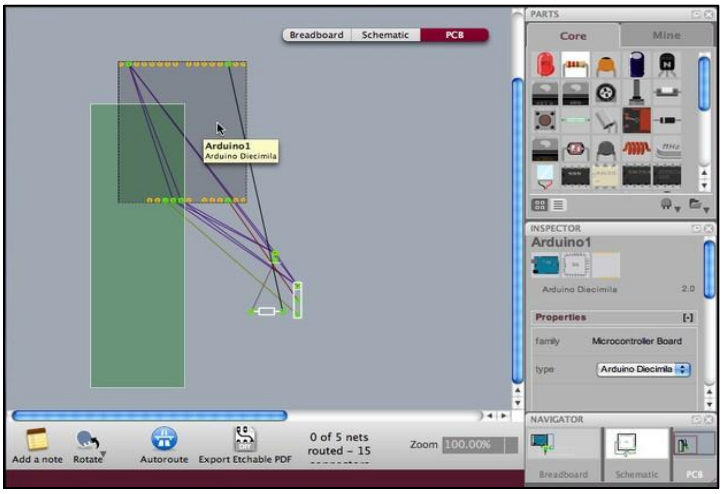

Figure 4. Create Fritzing Sketch view

3.1.3. Schematic component design

To design this tool, the application used is fritzing [33], the function of this application is to design a sketch or initial design of an electronic device in order to minimize errors. The component design can be shown as follows.

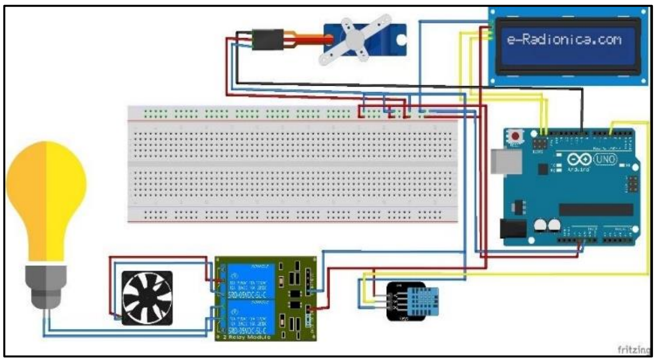

Figure 5. Overall temperature design components

The following are components of the above temperature prototype design:

(1) Arduino Uno, Arduino is a hardware that uses a Microcontroller as the main controller of the circuit. (2) ESP 32, Esp 32 is a WiFi Module on a chip that supports the development of application systems for the Internet Of Things ESP 32 (3) Servo Motor, Servo Motor is a closed-loop servo mechanism that uses position feedback to control Movement at its final position. (4) LCD, LCD Display is a hardware that is useful as a medium for displaying characters (images, letters, numbers or others) made of liquid crystal material. (5) DHT11 Temperature Sensor, DHT11 Temperature Sensor is a sensor module that functions to sense temperature and humidity objects that have an analog voltage output that can be further processed using a microcontroller. (6) 2 Channel Relay, Relay is an output that is used as a switch or switch to connect two other devices.

3.2. How the System Works

The design of the system workflow process is expected to be able to make the automatic chicken feed tool system and temperature monitoring that is made run well (Supriyadi, 2020). This system will work if the web server is given a feed schedule command that has been determined by the user, and will be managed on the wemos so that the servo will take data from the wemos connected to the web server, which will open and close the servo according to the predetermined schedule. And the LCD will display the temperature and humidity connected to the dht11 temperature sensor, and connected to the relay that will work if the temperature is above 30 degrees the fan will automatically turn on, and if the temperature is below 25 degrees, the lights will automatically turn on. Arduino Uno has received a voltage and current supply of 5 volts, the fan and lights get a voltage supply of 5 volts and the fan gets a voltage and current of 12 volts. Here is an explanation of how the system works:

The first step when the system gets a command from the web server, the system will confirm that the feed schedule is ready, then the system will run according to the command that has been set, where the esp8266 functions to process data to the servo that will open and close the feed according to the schedule. The temperature sensor will appear on the LCD, showing the temperature (degrees) and humidity. When the temperature detects below or above what has been set, the lights or fans will work automatically, the LCD will provide information on the temperature and humidity in the chicken coop, and turn on the fan automatically if the temperature detects that it is above 30 degrees and turn on the lights if the temperature detects that it is below 30 degrees.

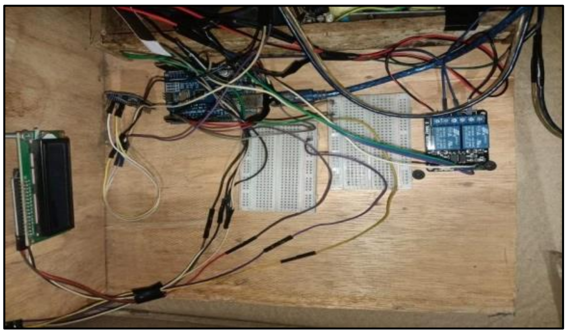

Figure 6. Components that have been assembled

In Figure 6, the hardware components after being assembled will explain several parts of the prototype circuit, as follows:

The temperature sensor data pin is connected to the Arduino port 7 using a male to female jumper cable. The temperature sensor GND pin is connected to the Arduino GND port using a male to female jumper cable. The temperature sensor VCC pin is connected to the Arduino 5V port using a male to female jumper cable. The Servo Data pin is connected to the Wemos d1 mini D1 port using a male to female jumper cable. The Servo GND pin is connected to the Wemos d1 mini GND port using a male to female jumper cable. The Servo VCC pin is connected to the Wemos d1 mini 5V port using a male to female jumper cable. The LCD SCL pin is connected to the Arduino SCL port using a male to female jumper cable. The LCD SDA pin is connected to the Arduino SDA port using a male to female jumper cable. The LCD GND pin is connected to the Arduino GND port using a male to female jumper cable. The LCD VCC pin is connected to the Arduino 5V port using a male to female jumper cable. The Relay GND pin is connected to the Arduino GND port using a male to female jumper cable. The Relay VCC pin is connected to the Arduino 5Volt port using a male to female jumper cable. The Relay Data 1 pin is connected to Arduino pin 8 using a female to female jumper cable. The Relay Data 2 pin is connected to Arduino pin 9 using a female to female jumper cable.

The following are tools that have been assembled and put into a box to make it easier to test products and so on, the components can be shown below.

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Figure 7. Components have been put in the box

3.3. Testing and Analysis

Testing and analysis of this system is a test of the entire system which aims to determine whether the system works according to the planning that has been made, namely the Prototype of Automatic Chicken Feeding Tools and IoT (Internet of Things)-based Humidity Temperature Monitoring [34].

The testing method for this research begins with testing the DHT11 circuit, testing fans and lights, testing LCDs, testing servo motors. The last test is testing the entire system to work well or not, because this greatly affects the system that will be run [35].

3.3.1. DHT11 Sensor Testing

The DHT11 temperature and humidity sensor testing is carried out to determine the output condition of the DHT11 sensor, along with the output voltage when the sensor reads the temperature and humidity of the chicken coop. Here is Figure 8. Location of the DHT11 Sensor in the chicken coop.

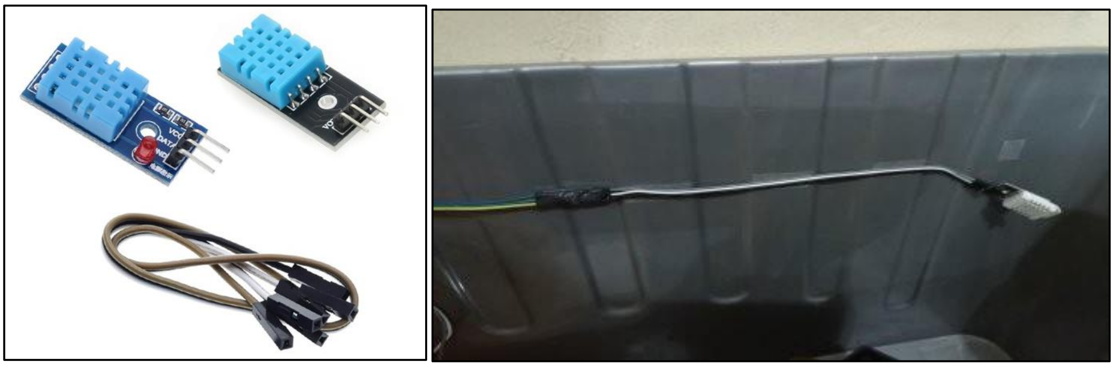

Figure 8. DHT11 sensor in the chicken coop

Based on Figure 8. The location of the DHT11 sensor shows that the sensor will read the temperature and humidity in the chicken coop. When detecting the temperature and humidity of the chicken coop is shown in table 1.

Table 1. DHT 22 Sensor Output Measurement

Humidity sensor measurement results	Input Voltage (Volt)	Voltage Read (Volt)	Error (%)
50 ºC	5 Volt	3,2 5 Volt	0,36%
45 ºC	5 Volt	3,2 5 Volt	0,36%
58 ºC	5 Volt	3,2 5 Volt	0,36%
58 ºC	5 Volt	3,2 5 Volt	0,36%
56 ºC	5 Volt	3,2 5 Volt	0,36%

Table 1 shows the humidity measurement results of the DHT 22 sensor output of 3.2 Volt DC. The voltage used to supply the DHT11 Sensor is 5 Volts. The ideal output has a voltage value of 5 Volts. However, due to the module tolerance value, Pin Error on humidity the tolerance deviation is:

$$60°C = \frac{3{,}2 Volt - 5 Volt}{5\, Volt} \times 100 = 0{,}36\ \%$$

$$= |-0{,}36\%|$$

$$= 0.36\% \tag{1}$$

3.3.2. LCD (Liquid Crystal Display) Testing

The purpose of this LCD circuit testing is to determine whether or not the component is functioning [36]. The LCD itself functions as a place to display text or data that is entered or sent from the temperature sensor.

Figure 9. LCD test results

Shows the results of the LCD output experiment used in the design of automatic temperature and humidity monitoring and chicken feeders. The image above shows the results of monitoring the temperature and humidity of the chicken coop.

3.3.3. Servo Motor Testing

The test is carried out by programming the servo motor control in active conditions. The condition of the chicken feed container when the servo motor is on, the feed door is open, namely at 45 degrees. The condition of the chicken feed container when the servo motor is off, the feed door is closed, namely at 90 degrees.

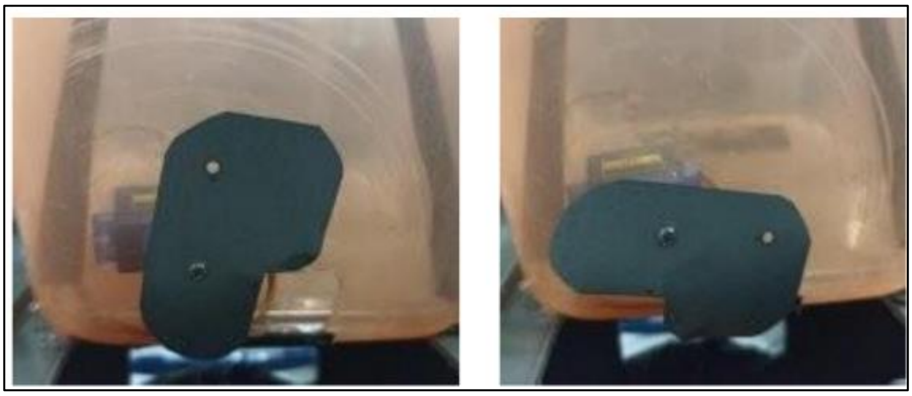
Figure 10. Test results on the servo motor in closed and open conditions

Used in the design of Automatic Humidity Temperature Monitoring and Chicken Feeders. The image on the left shows the servo motor opening when it is on, while the image on the right shows the results of the servo motor when it is in the closed condition.

3.3.4. Overall System Testing

Overall System Testing is carried out after testing each part of the final project tool circuit [37]. The purpose of this test is to find out how the servo or automatic chicken feeder and IOT-based temperature and humidity monitoring works using Arduino Uno, whether it has met the desired goals.

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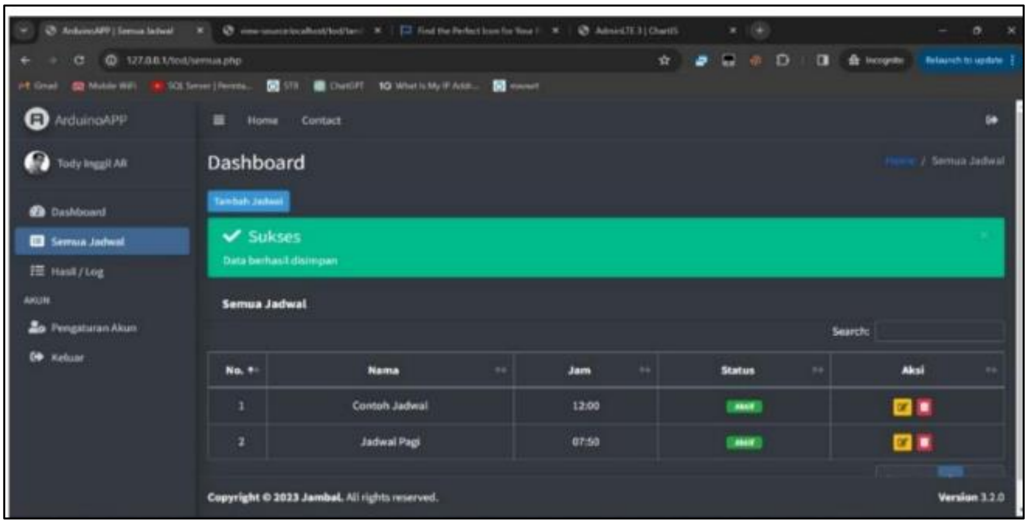

Figure 11. IOT final project system using Arduino Uno

The following are the results of the temperature prototype tool experiment with time management for 4 days from Monday to Thursday, which can be shown in Table 2 as follows.

Table 2. Automatic Chicken Feed for 4 days on August 5 - August 8, 2024

Day	hour	temperature and humidity	Motor Servo
Monday, August 5, 2024	09.15	35%, 60	Running
	13.20	36%, 63	Running
	15.35	37%, 62	Running
Tuesday, August 6, 2024	09.34	34%, 65	Running
	13.23	36%, 63	Running
	17.30	35%, 60	Running
Wednesday, August 7, 2024	09.34	37%, 62	Running
	13.23	34%, 65	Running
	17.30	33%, 66	Running
Thursday, August 8, 2024	09.34	30%, 62	Running
	13.23	32%, 65	Running
	17.30	30%, 66	Running

3.3.5. Wifi Testing

The test is carried out with parameters in the form of distance transmitted to the Web server, which will later be in the form of information with IoT technology to control using Wifi signals.

Table 3. WiFi Testing

Distance	Barrier	WIFI condition
2 Meter	Without Barriers	Connected
4 Meter		Connected
6 Meter		Connected
8 Meter		Connected
10 Meter		
2 Meter	With Barrier	Connected
4 Meter		Connected
6 Meter		Connected
8 Meter		Connected
10 Meter		

Table 3. Shows the Results of WiFi Testing using the internet from a smartphone. With a distance of 2 meters to 10 meters with and without obstacles.

3.3.6. Delivering Tool Results Effectively

Confidence intervals are used as a surefire way to analyze data before presenting the results of tool design. By integrating the concept of confidence intervals in the analysis, a data analyst can provide more complete and relevant information. Confidence intervals help in presenting the results of the analysis more effectively using the tool. Confidence interval graphs or tables can be used to communicate the final results clearly as follows.

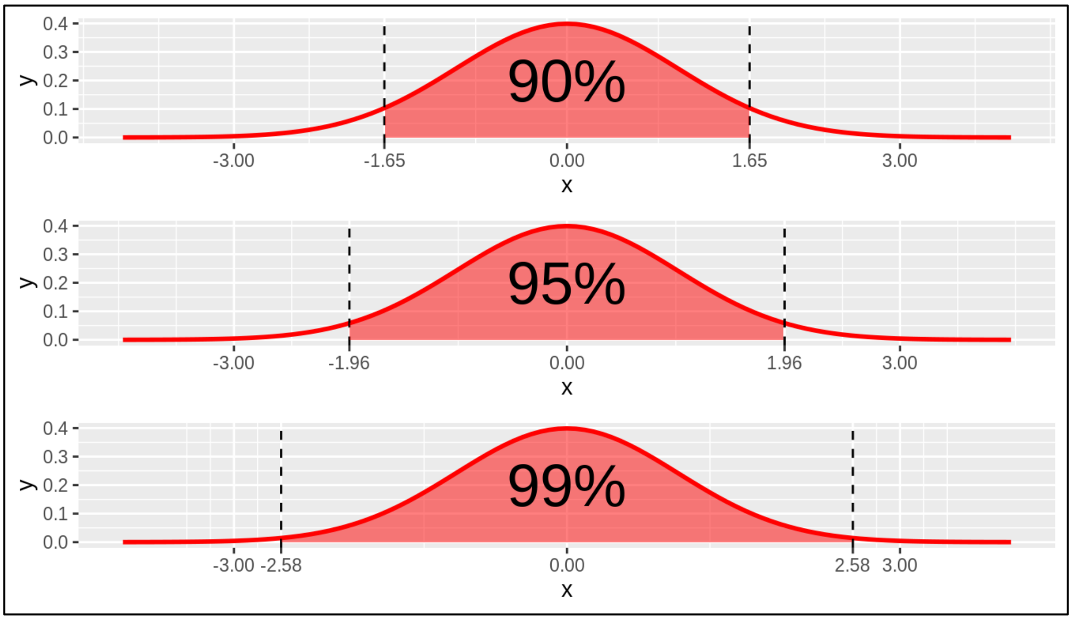

Figure 12. Test tool confidence interval graph

4. CONCLUSION

After the design and testing process in this study, the following conclusions were obtained: The design process for monitoring temperature and humidity and automatic chicken feeders based on IoT includes Arduino Uno and Wemos D1 Mini which are used as input then the DHT11 sensor as a temperature and humidity detector displayed on the LCD, then Servo as a driver of the chicken feed container automatically and Relay connected to the fan and lights as a cooler or automatic room heater according to the temperature sensor. The device used to access the chicken feed schedule input data is on the Web Server. WiFi testing uses the internet from the Server. With a distance of 2 meters to 10 meters with and without barriers, the test results remain connected. The servo will automatically provide a feed schedule according to the commands set by the user that have been inputted on the Web Server, and can be edited or deleted. The relay will run an automatic system as a heater or cooler in the form of a fan or lamp that takes data from the temperature sensor, where if the temperature is below 25 degrees, the lamp will turn on automatically and if the temperature is above 30 degrees, the fan will automatically turn on.

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