APPLICATION OF WIRELESS SENSOR NETWORK FOR MANUFACTURING AUTOMATIC DUCK EGG HATCHER MACHINE

Windarsyah[1)], Ihdalhubbi Maulida[2)], Ayu Ahadi Ningrum[3)], dan Mus'ab Salahuddin[4)]
[1, 2,3,4)]Universitas MUhammadiyah Banjarmasin
e-mail: windarsyah@umbjm.ac.id[1)], ihdal@umbjm.ac.id[2)], ayuahadi@umbjm.ac.id[3)]

Corresponding Author: Ihdalhubbi Maulida

ABSTRACT

The main problem with duck workers who want to incubate eggs is that eggs turn two times a day. It causes farmers still use conventional hatching to incubate eggs, usually done manually. This study aims to make an automatic duck egg incubator using a wireless sensor network. The making of the incubator uses a 5-watt incandescent lamp, 5V relay, DHT11, sound sensor, LCD I2C, Wifi ESP8266 01, and a pipe designed to perform egg turning assisted by a servo motor as a driver for the pipe. The average temperature for this automatic incubator sets at 39^o – 40^{o}C. The results of this research hatching machine can work as planned. In the first experiment, we should insert four eggs and managed to incubate them, and two eggs managed to come out of the eggshell. In the second experiment, we should insert four eggs and managed to incubate three eggs to come out of the eggshell. So the percentage of success in hatching eggs using an automatic duck egg incubator using this wireless sensor network is in the first experiment as many as 50% or two eggs and the second experiment as much as 75% or three eggs.

Keywords*: Wireless Sensor Network, Duck's Egg*

I. INTRODUCTION

INDONESIA'S rapid population growth every year significantly impacts the need for animal proteins such as eggs and meat. The factor of the rate of population growth in a country must be balanced with the food security sector. [1]. Several types of poultry do not have brooding properties, such as Arabic chicken, quail, and ducks which causes difficulties in breeding these birds [2]. This makes duck breeders have to manually incubate their duck eggs using a conventional egg incubator when turning the eggs and checking the temperature levels on the machine using a thermometer. We have to check the temperature on the device twice a day. If it doesn't turn over the egg, the heat obtained is uneven, resulting in the embryo dying and the egg whose position does not change, resulting in the yolk sticking to the shell and experiencing defects. We can utilize the Advances in electronic and computer technology to solve the problem of turning eggs and automatically regulating egg temperature. We can use the Internet of Things (IoT) [3]. We use a wireless sensor network to support this technology in the incubator for data collection to determine the conditions in the incubator. Wireless Sensor Network serves as a tool that connects several network points. Where this network point consists of several particular sensor points that can physically scan and send data to the network communication centre [4].

Related research regarding hatching machines is found in the case of free-range chickens but makes a difference in storage time [5], [6], [7], [8], [9], [10]. Based on the problems above, we use a wireless sensor network to build an automatic duck egg incubator in this study. The manufacturer of this hatching machine uses a 5-watt incandescent lamp that can be set on and off with a 5V relay to detect temperature, humidity, DHT11 sensors, and sound sensors in the machine to find out if there are eggs that have hatched, LCD and website as a condition data viewer. Temperature and sound detection results on the device, a pipe designed to perform egg turning later, assisted by a servo motor as a driver of the line. This tool will work to turn the egg automatically based on the program created on a microcontroller.

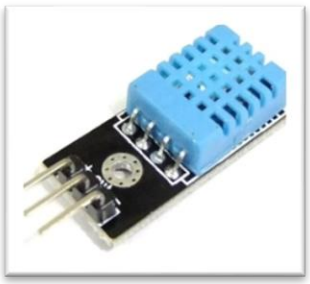
II. STUDY LITERATURE

A. Wireless Sensor Network

Wireless Sensor Network is a series of nodes in the form of sensors that can read natural phenomena in the form of vibration, heat, and sound, which are then sent by a server for data processing. Arduino, in its use, requires a chip that functions to program the Arduino bootloader [11]. Figure 1 shows an example of an Arduino Uno circuit. Figure 2 shows the figure of DHTI. The DHT11 sensor is a sensor for capturing temperature and humidity values

in series. The output of this sensor has a high degree of accuracy and is digital [12]. Figure 3 shows the figure of servo motor. A Servo motor is a device that functions as a converter of electrical energy into mechanical energy. The output of the magnetic field is in the form of torque, which generates a constant motor coil [13]. The sound sensor functions as a means of converting sinusoidal waves into electrical energy sensors [14].

Fig*ure*. 1 Arduino Uno



Fig*ure*. 2 DHT 11 Sensor

Fig*ure*. 3 Servo Motor

Fig*ure*. 4 Sound Sensor

B. Egg Incubator

Figure 5 shows the process starting from a reversal that occurs every 8 hours, and then the DHT11 sensor takes temperature and humidity data on the engine. If the engine temperature is > 40°, the light will turn off, and if the temperature is < 39°, the light will turn on. The following process is data collection. Sound, if the sensor detects a sound only once, it means that no eggs have hatched and returned to the egg-turning process. If the sensor detects sound several times, an egg has hatched.

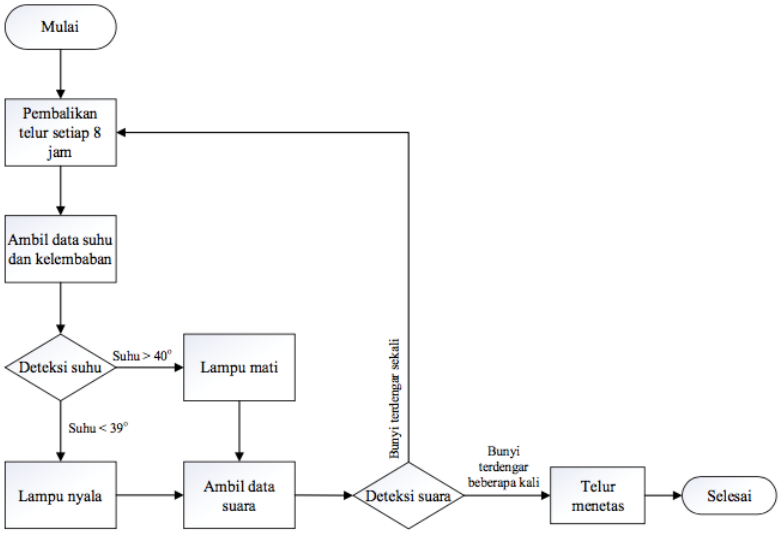


Figure. 5 Egg Incubator Flowchart

III. RESEARCH METHOD

This study uses the waterfall method in the problem-solving approach. Which consists of several steps, namely:

1. Data collection and Analysis
   Table 1 describes the steps in data collection on the incubator.

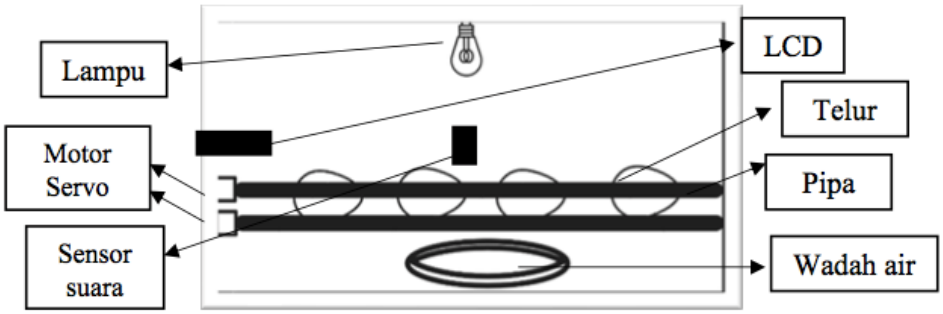
Table 1. Data Collection Process

Step	Description
1	The sampling data process.
2	Collect temperature and humidity.
3	Collect the data sensor.
4	Sent to the server.
5	Display to the website and the LCD.

2. System Design
   2.1 Device System

The design of the hatching machine box uses acrylic glass with a length of 29.7 cm, a height of 21 cm, and a width of 21 cm by attaching the pipe to the servo motor, which rotates 180o so that the eggs placed on the line on the servo motor will rotate. The heating temperature will be evenly distributed. The Servo motor is programmed every 8 hours.

The machine set 5 Watt lamp to regulate the heat temperature between 38^0 - 40^0C, and under the pipe, there is a place filled with water to control the humidity in the machine. The sound sensor is near the egg, while the LCD is at the top of the box.



Fig*ure*. 6 Device System

In Figure 9, the servo motor attaches to the pipe. The servo motor will rotate 180o so that the secured line also rotates, and the pipe will place on the egg. When the tubes turn, the heat flow will automatically flow through the eggs evenly. Every 8 hours, the egg will rotate by the servo motor, giving one 5-watt incandescent lamp to provide heat. Under the pipe is placed a container filled with water as a humidifier in the machine. The ideal temperature used to incubate eggs is 39-40oC. The egg store is near the sound sensor, and the LCD locates in the front of the box.

2.2 Device Design

The device design creates from a series of tools such as Arduino, breadboard, 16x2 LCD, DHT11, sound sensor, wifi esp8266 01, servo motor, and relay.

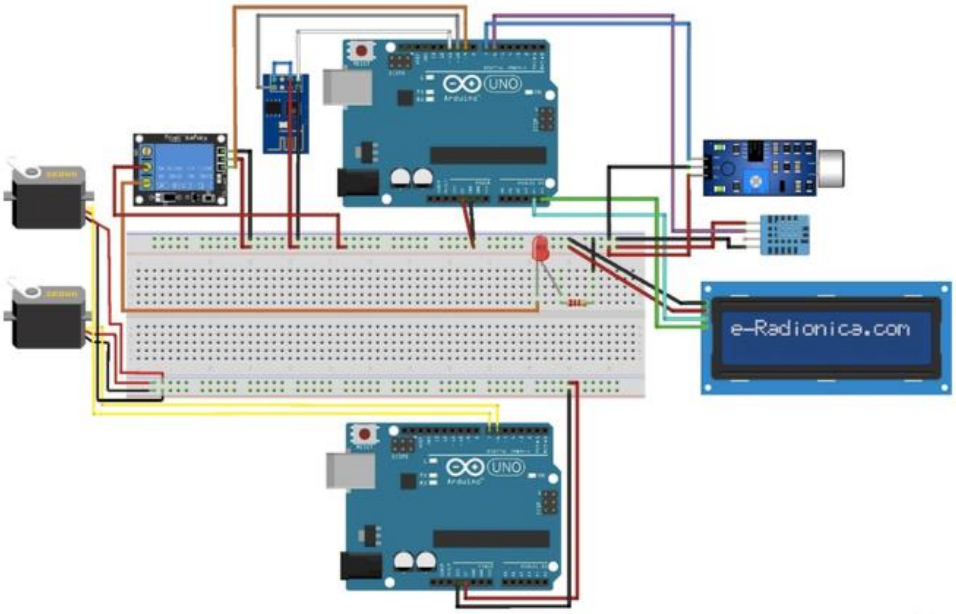


Figure. 7 Device Design

3. Device Building
4. Device Testing
   Before making a series of incubators, ensure all the tools can function adequately first. Table 2 shows the testing process of each device. The tools needed in the testing process are as follows:
   a. Arduino Uno
   b. Laptop
   c. Software Arduino IDE
   d. Jumper Cable
   e. USB Cable
   f. Breadboard

Table 2. Testing Process

No	Device	Testing Process
1	DHT11	Make observations on changes in temperature and humidity obtained from DHT11 through the serial monitor on the Arduino IDE.
2	LCD 16x2 I2C	Check if the LCD can display temperature and humidity data.
3	Sound Sensor	It is bringing an object that can make a sound close and then observing it on the Arduino IDE serial monitor to see if the sensor can detect the sound that is generated.
4	Relay	Connect the electric cable that is electrified and connected to the lamp. Later we can see if the relay can disconnect and continue the electric current.
5	Wifi ESP8266 01	Check whether the data can be sent or not.

5. Implementation
   This stage is the stage for implementing the devices that have gone through the trial process in the field.

IV. RESULT AND DISCUSSION

This section discusses the testing process and discussion of research results. Tools that have been assembled as a whole according to the initial planning of making tools and testing them to incubate eggs.

3.1 Testing Result

3.1.1 DHT11 Sensor

When testing, the DHT11 sensor can function adequately. Namely, when you want to increase the temperature, the sensor is brought closer to the fire, and the data reading by the sensor improves. Likewise, when you want to cool the sensor's temperature, you get it closer to the ice. The number on the sensor also decreases, and the humidity increases.

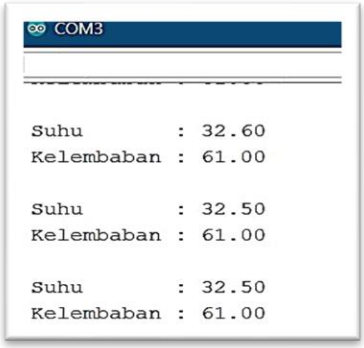


Figure. 8 DHT11 Result

3.1.2 LCD 16x2 12C

At the time of testing, the LCD can function correctly. The maximum number of characters on the first line LCD is 16 characters, including spaces, and the second line also has 16 characters, including spaces.

Figure. 9 LCD Display

3.1.3 Sound Sensor

At the time of testing, we can conclude that the sensitivity level of this tool is low because the sound produced is very close to the sensor, but the sensor is very slow in detecting the sound produced. Sensor readings are 0 and 1. If one means the sensor detects sound, and if 0 means the sensor does not detect sound.

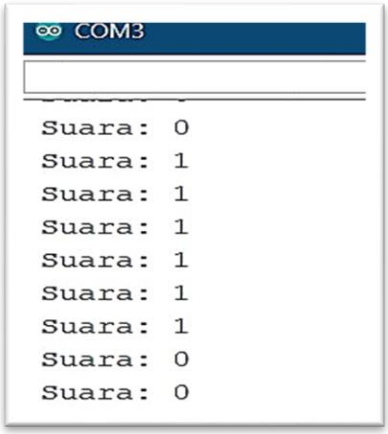
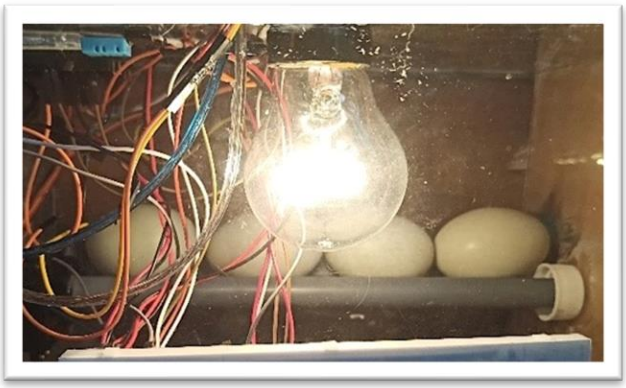


Fig. 10 Sound Sensor Detection

3.1.4 Relay

The relay can function appropriately, as proven when the temperature detected by DHT11 is >40oC. The relay can disconnect the electric current from the power cable to the lamp, and when the detected temperature is <39^{o}C, the relay automatically flows electric current to the light.



Fig*ure*. 11 The Relay Transmits Electricity to The Lamp

3.1.5 Wifi ESP8266

When testing, wifi esp8266 01 sometimes works and sometimes doesn't. This is caused by a loose cable whose installation is swapped between tx and RX. Then the laptop used as a server must be on the same network with wifi so that data can be sent.

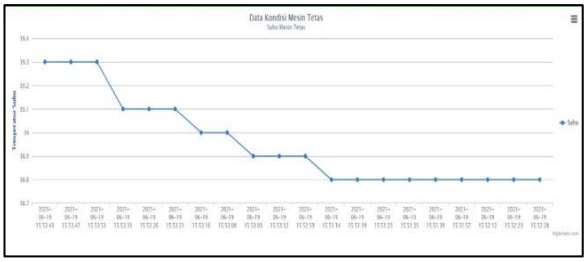
```
Suhu        = 39.00C
Kelembaban = 41.00%

AT+CIPSTART="TCP","192.168.43.71",80
AT+CIPSEND=66
GET /mushab/simpan_suhu.php?data=39.10 HTTP/1.1
Host: ip_host

AT+CIPSTART="TCP","192.168.43.71",80
AT+CIPSEND=69
AT+CIPCLOSE
 Suara: 0
```

Figure. 12 The process of Sending Data to The Database

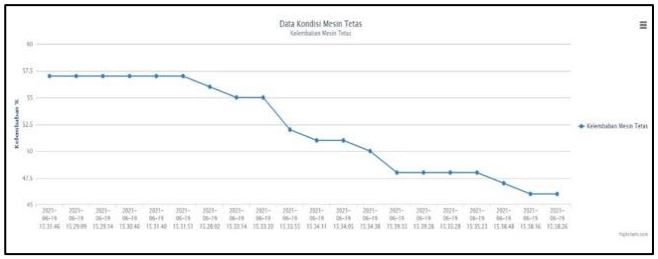
3.2 Testing Result all Component

After all the tools have been installed and connected in a box, attach the Arduino to electricity using a USB cable and a cellphone charger head. Next, enter the egg and place it on the pipe, then close the box door and start testing the automatic incubator for hatching. Then turn on the laptop and run the XAMPP application so that the data readings by the sensor can be sent to the database, and the data can be viewed on the website.

Fig*ure*. 13 Website Display



Fig*ure*. 14 Temperature Visualization



Fig*ure*. 15 Humidity Visualization

3.3 Discussion

Figures 16 to 21 show the results. The first test used four duck eggs with a temperature setting 39^{o} - 40^{o}C. Based on Figure 16 shows day five at the time of incubation, where all the eggs have embryos. The picture shows that we can see the egg embryos.

Fiureg. 16 Day 5th

Figure. 17 Day 12th

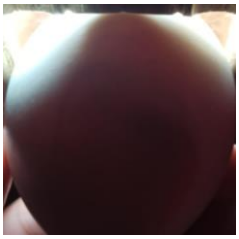


Figure. 18 Day 15th

Figure. 18 Day 21st

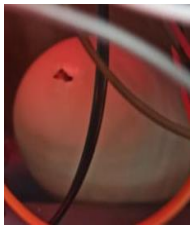


Figure. 19 Day 26th

Figure. 20 Day 30th

Figure 17 shows an image of an egg on the 12th day. It shows that the seed in which all the eggs began enlarged and filled the whole egg. Figure 18 shows the 15th day of the embryo in all the eggs starting to form ducklings. Figure 19 shows an image of an egg on the 21st day. It shows that the root in all the eggs that have formed ducklings filled the whole egg. Figure 20 shows photos of the 26th and 27th days. Three eggs have started

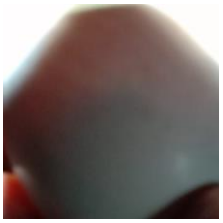
to hatch. Figure 21 shows the images on day 29 and day 30. One duckling managed to come out of the eggshell usually.

Table 3. Hasil Pengujian Pertama

Testing using four eggs			
Hatch			Not Hatch
Two eggs (50%)			One egg
Normal	Defec-tive	Died	25%

Table 3 shows the results of the first test. The temperature incubator was stable when the eggs were inserted until the ducklings managed to come out of the eggshell, which was 39-40^{o}C. Eggs that fail to hatch are caused by a power outage in one day so that the incubator does not turn on and the temperature in the machine becomes cold, which causes egg embryos that cannot survive at that temperature. The percentage of successful eggs hatching in this first test was 50% because there were only two eggs that managed to become ducklings until they came out of the eggshell, namely on the 28th day, there was one duckling, and on the 30th day, there was one more duckling that succeeded. Hatched out of the eggshell, one egg failed to hatch because the embryo died, and one egg hatched, but the duckling died.

Figure. 21 Day 4th



Fiureg. 22 Day 10th

Figure. 23 Day 21th

Figure. 24 Day 26th

Figure. 25 Day 29th

Figures 21 to 25 show the results of the second test using four duck eggs with the temperature set at 39^{0} – 40^{o}C. On the 4th day, all the eggs have embryos. It can be seen in the picture that the egg embryos have started to appear. On the 10th day, the eggs' seeds began to enlarge and fill the whole egg. On the 21st day, the eggs' embryos formed ducklings and filled the entire egg. On the 26th and 27th days, three eggs started to hatch. On the 28th day, there was one duckling; on the 29th day, two ducklings usually managed to come out of the eggshell.

Table 4. The Result of The Second Testing Process

Testing using four eggs

Hatch			Not Hatch
Three eggs (75%)			One egg
Pengujian (4 butir)			
Normal	Defec-tive	Died	25%
3	-	-	
75%	-	-	

Table 4 shows the results of the second testing process. The Temperature incubator is stable from the beginning when the eggs are inserted until the ducklings manage to come out of the eggshell, which is 39o-40oC. The percentage of successful eggs hatched in this second test was 75%, or as many as three eggs that managed to become ducklings to come out of the eggshell. Namely, on the 28th day, there was one duckling. On the 29th day, two more ducklings were hatched. Successfully hatched out of the eggshell, one egg failed to hatch because the embryo in the egg died.

V. CONCLUSION

Based on the test results, the use of DHT11 was beneficial for maintaining temperature stability in the incubator because if there were a temperature change, the box would immediately stabilize and remain at a temperature of 39^0 - 40^0C. The sound sensor cannot be used optimally because of the low sensitivity of the sensor in detecting if it detects a sound. The tool can run the comprehensive test according to the initial plan. Namely, the servo and the pipe can perform egg turning automatically, the relay which functions to decide and transmit electric current to the lamp properly, and DHT11 can maintain temperature stability in the incubator until the eggs become chicks.

The website page displays temperature and humidity data in the form of graphs and descriptions of the graph data so that it can be easier to monitor temperature and humidity conditions in incubators. In the first test, the percentage of successful hatching of eggs was 50%. It shows that hatching two eggs from 4 eggs, and in the second test, the rate of success of hatching eggs was 75%. It shows that hatching three eggs from 4 eggs.

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