Development of Chicken Egg Hatching Incubator Machine (Natasha-CEHIM)

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Abstract: This paper presents a development of egg incubator system for chicken eggs incubation. The chicken egg hatching incubator machine are equipped with DHT22 and PIR sensors that able to automatically regulate and monitor the temperature and humidity in the incubator to create the ideal condition to incubate chicken egg. The entire system will be controlled using Arduino Uno control system as the brain of the system which control and operate the motor and sensors to detect necessary environment condition which then produce output signal for incubate operation. A DHT22 sensor that act as input detects temperature and humidity in the incubator and send it to the Arduino to display the condition of the incubator on the LCD screen display. The function of egg incubator is to be able to hatch chicks from egg while the mother hen can be free to lay more eggs hence increase the production of chicken egg, reduce the manpower, reduce hatching time and give a better efficiency during operation.

Keywords: Chicken Egg Incubator, DHT22 Sensor, PIR Sensor, Arduino Uno, DC gear motor.

1. Introduction

Factory farming are known as raising farm animals indoors with conditions of extremely restricted mobility industrial. It is designed to produce the highest output at the lowest cost by using modern machinery. Egg incubator is one of the inventions that has been used in the poultry industries by some farmers to as the effective way to artificially performs the role that a broody hen for egg hatching. It is a mechanical device which regulates temperature and humidity at perfect levels therefore creating the ideal conditions which allows the chick to grow inside the fertilized egg, without the consent of the mother hen [1].

Poultry egg has been one the highest consumption food by human. This situation lead to demand for poultry egg has been rising since decades ago. Factory farming need to increase their production. According to A. M. King’ori [2], by using natural incubation, a broody hen could brooded between 14-16 eggs in one nest, however less than 10 eggs are hatched successfully. This analysis presents that the optimum incubation temperature of 37.8°C is the best embryo development and hatch ability. However, the incubation result shows that without egg turning, the percentage of egg hatching is low and it causes the hatched process delay a few days.

Other researchers [3] discuss that approximately after 21 days of incubation, chicken eggs will hatch. In their studies, all the collected eggs were individually marked with a pencil and had been incubated with a temperature of 37.5°C and relative humidity 55% with rotation. Based on the analysis, the first chick and the last chick hatched after 487.8 hours and 523.3 hours of incubation. Meaning that the chicken eggs had been hatched within 20.3 to 21.8 days.

Gusti Putu et al. [4] present the design and analysis of chicken egg incubator using Raspberry Pi. In their studies, the experiment is conducted for 23 days with the average temperature and relative humidity is 38°C and 51% respectively. As a result, four eggs successfully hatched while two eggs failed to hatch, due to the grown embryo failed to grow.

The biogas-powered poultry egg incubator was developed and analyzed by Ogunwande et al. [5]. The incubation period was set up in 22-23 days, with temperature setting between 37.6
to 39.9°C each. The relative humidity is fluctuating between 50.1 and 59.3% for the first 18 days, while the remaining days had between 36.0 to 37.5°C and 60.1 to 70.8% humidity. During the experiments, a semi-automated turning mechanism is used to turning of the eggs three times daily. 30 chicken eggs have been tested for 3 times on each incubation trial. The result shows that 23.9% of the fertile eggs were unhatched, 17.9% died at the embryonic stage, while 59.7% hatch rate with 35, 1 and 4 chicks hatched on day 21, 22 and 23 respectively.

This project presented the working principles of Natasha-CEHIM that is able to incubate eggs from chicken. The systems will automatically regulate the temperature and humidity of the incubator. The function of egg incubator can effectively able to hatch chicks from egg while the mother hen can be free to lay more egg. Farmer will be able to produce product consistently with large amount of eggs with the help of the incubator. Therefore, this system will be able to improve the traditional farming method to advance and modern farming method. Section 2 detailed the development of the hardware setup, while Section 3 had been discussed on the result and the performance of the developed system. Lastly, the conclusions of the developed system are made in Section 4.

2. Methodology
The development of the hardware setup will be discussed briefly in this section.

2.1 Natasha-CEHIM operating principles
A proper design is very important as they are related to one and other function as shown in block diagram in Figure 1. Sensing unit DTH22 sensor and Arduino Uno will be responsible to regulate the condition by controlling light bulb as heating element and humidifier to humidify in the incubator, while PIR sensor is used to detect the chicks that has been hatched. Turning unit is developed using the 12Vdc gear motor that is connected with a timer while the indicating unit is programmed to have trigger the buzzer and emergency flash light when PIR have sense movement in the incubator.

The most ideal temperature to hatch chicken egg is commonly known to be 37.5°C. By having the temperature too high or too low will greatly effect on the growth of the egg. Setting the temperature high above ideal temperature but not to high enough to kill the embryo, will resulting the egg to hatch sooner than normal hatching time. This might be a solution for faster production. On the other hand, by setting the temperature too low, below ideal temperature but not low enough to kill the embryo will resulting the egg to hatch slower than normal hatching time.

The flowchart of the condition control process of Natasha-CEHIM is shown in Figure 2. Based on Figure 2, when the system is powered by 240VAC from the direct domestic electrical power source, the LCD will display the temperature reading and trigger either the yellow, green or red LED based on the condition setting in the controller. Humidifier will turning off if the humidity in the machine more than 80%.

In incubation process, it is very important to ensure the embryo does not stick to one side. Hence, the daily turning process of the eggs is needed. The eggs are turned every 4 hours, 5 times a day. The egg turner process function for 18 days before completely stop at the last 3 days of incubation. This is because the last 3 days of incubation is a hatching phase, which the eggs does not need to be rotated. The egg turning...
process is shown in Figure 3. The DC motor is only continuously rotating clockwise or counterclockwise, so 2 limit switches are added to the circuit serve as a stop switch to control the position of the motor. The switches are placed on each side of the egg turning motor on the egg turning tray as shown in Figure 4. When the motor rotates, and the plastic plate hit one of the switches, the motor will stop moving. The motor then rotates again after the next 4-hour interval. However, the motor rotates a different direction from the previous rotation and stop when the plastic plate is hitting another limit switch. This process continuously until the 18th day of incubation.

After 18th day of the incubation process, the PIR sensor will capture the motion for every 2 seconds. When there is no motion detected, flashlight and a buzzer is turned off. However, if the chick detected, the flashlight will light up and a buzzer will turn on. If there are no motion detected until 22th day, the machine will stop the process as shown in Figure 5.

![Fig. 3 - The egg turning process](image)

![Fig. 4 - The egg turning unit in incubator](image)

![Fig. 5 - The indication process](image)

### 2.2 Electrical Design

The electrical design for the chicken egg hatching incubator machine in this project are divided into two parts. The first part as shown in Figure 6 is the connection of condition in incubator control where the DTH22 sensor is used to sense the condition in the incubator and give input to Arduino Uno. The Arduino Uno is used as processing unit. DHT22 sensor is used to sense temperature and humidity in the incubator and Arduino Uno will trigger lightbulb and humidifier to regulate the suitable condition to incubate in the incubator. The temperature and humidity in the incubator as well as time of incubation will appear on the LCD that’s connected to the Arduino.
3. Results and Discussion

This section elaborates the process and result of Natasha-CEHIM by merging both hardware and software parts. The hardware part is developed and assembled to make sure the connection and components are well functioning. The software is further developed and programmed into the hardware part to ensure that the incubator is in desired condition.

3.1 Sensing Unit

Since this project consists of two types of sensors, the development and testing used two different programs to design. DTH22 sensors is used to sense and detect the temperature and humidity in the incubator while passive infrared sensor is used to sense motion of hatch chicks in the incubator.

Figure 8 shows the LCD display with the DHT22 program on the LCD. It displays “Temperature” with the value of the temperature on the first row, “Humidity” with the value of humidity level on the second row, “Time” follow by the time taken since the machine has turn ON on the third row, and lastly, “Days” indication day countdown before hatching on the forth row. This sensor is responsible as input to indicate the temperature and humidity in the incubator.

Led inserted in the program is function to indicate the ideal range of temperature for incubation. When the temperature in the incubator is too low for incubation, yellow led light up and light bulb turn on while when the temperature is too high, red led light up and light bulb turn off. The green led will light up when the temperature in the incubator are in ideal range temperature state that is between 37°C and 38°C. Table 1 shows the temperature configuration for Natasha-CEHIM.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Led Light-Up</th>
<th>Light Bulb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 37°C</td>
<td>Yellow</td>
<td>Turn ON</td>
</tr>
<tr>
<td>Between 37°C and 38°C</td>
<td>Green</td>
<td>Turn ON</td>
</tr>
<tr>
<td>Higher 38°C</td>
<td>Red</td>
<td>Turn OFF</td>
</tr>
</tbody>
</table>

Fig. 8 - LCD display. (a) When incubator turn on (b) Indicate the temperature, humidity, and time in the incubator.
3.2 Natasha-CEHIM’s Performance

Figure 9 shows the Natasha-CEHIM prototype. The eggs are taken from two different sources with the same chicken breed. The brown egg is taken from a local factory farming company in Bukit Gambir call Indra Farming and the white eggs are taken from a neighboring who is farming chicken in their housing area.

Table 2 shows the Natasha-CEHIM’s summary performance that has been made since Oct 12, 2018. There are several motors that has been used during incubation as well as range of temperature. This is because initial 12Vdc motor that is use in the first experiment are low in current and move 360-degree. Hence, the motor does not run during the incubation. Next, to assign rotation angle of 180-degree, stepper motor is used in the incubation testing. Unfortunately, the stepper motor is low in a toque, thus unable to move the turning tray full 180 degrees.

The variety of temperature range are due to recommendation to incubate from range 39°C to 40°C from a local farmer whom is expert in egg breeding. This has contradicted of an ideal incubation temperature from theory that is 37°C to 38°C to determine the right ideal temperature for incubation, all three range of incubation testing is been made. The incubation is unsuccessful for Test 1, due to the high in temperature (39°C – 40°C) is unsuitable to incubate chicken egg. The eggs seem to be died halfway through the incubation because there is a present of fetus. The incubation temperature is lower down to 38°C to 39°C for the second test. Test 2 are able to incubate till hatched twelve chicken eggs. Lastly, the incubation temperature is lower to 37°C to 38°C in Test 3. The incubation able to obtain seventeen chicks. The incubation was unable to fully hatch all twenty eggs due to three eggs crack during the incubation process.

The ideal temperature of incubation is determine based on the results. The most ideal and suitable temperature for chicken egg incubation is form range 37°C to 38°C. The amount of chicken egg incubates fixed to 20 eggs by reason of the dc motor was unable to push the all 25 eggs with the egg turning tray smoothly. Other than that, by decreasing the number of incubation eggs from Indra Farming, will able to give equal number of incubation from both egg suppliers.

The number of performances for each experiment had been made can be conclude in a graph form to distinguish the improvement of the incubator performance as shown in Figure 9. The percentage performance of Natasha-CEHIM can be seen increased from 0% to 85%.
Table 2 - Summary of testing development of Natasha-CEHIM

<table>
<thead>
<tr>
<th>No. of Testing</th>
<th>Condition</th>
<th>Observation</th>
</tr>
</thead>
</table>
| Test 1         | Date: Oct 12 until Nov 3  
No of egg: 20  
Temperature control: 39°C – 40°C  
Motor: 2 x 12Vdc Motor | • Egg is turning 360 works for 9 days before the motor does not run.  
• The rest of 12 days turning egg manually  
• Temperature range recommended by farmers  
• Humidity stay the same  
• Result: Unsuccessful incubation chicken egg  
• Percentage of egg hatched: 0% |
| Test 2         | Date: Nov 3 until Nov 23  
No of egg: 20  
Temperature control: 38°C – 39°C  
Motor: 2 x 12V Stepper Motor | • Egg turning 180 degree using stepper for 13 days and use DC geared motor for 5 days  
• 8 eggs unsuccessful incubation  
• Humidity stay the same  
• Result: 12 chicks hatched  
• Percentage of egg hatched: 60% |
| Test 3         | Date: Nov 23 until Dec 18  
No of egg: 20  
Temperature control: 37°C – 38°C  
Motor: 12Vdc High Toque Geared Motor | • Wire net corrode and collapse  
• Egg turning rotate 180 degree for 18 days  
• 3 eggs creak before 21 day  
• Humidity stay the same  
• Result: 17 chicks hatched  
• Percentage of egg hatched: 85% |
4. Conclusion

In conclusion, this project has been successfully developed, and able to hatch at least 17 chicken eggs. The Natasha-CEHIM incubate for 21 days, turn eggs for 18 days and indicate by turning on the buzzer and flash light when present of chicks is detected. The performance of the incubator is analyzed by the quantity of chicken egg hatched. Moreover, the chicken egg hatching incubator is successfully designed to have condition control, egg turning, and indication capability. In short, Natasha-CEHIM can help to decrease the demand of poultry egg by incubate many eggs at the same time and facilitate human task efficiently.

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References


