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# The Prototype Design of Duck Egg Incubator Machine Using *Arduino* Uno R3 Microcontroller

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**Abstract**

In incubating duck eggs, traditionally it can be done using other poultry parents that are incubating the eggs. This method can be done by placing another egg together with the egg which is being incubated by the mother. In an effort to increase the productivity of the resulting ducklings, this research focuses on the development of a duck egg incubator prototype using Arduino Uno R3 microcontroller. The first step in temperature control is to determine the temperature set point (desired temperature value). The output in the form of heat is read by NTC 10K temperature sensor which then becomes an input. If the temperature input which is read is less or more than the specified temperature, the module relay works to turn on or turn off the incandescent lamp. The main source of heat generation in the incubator room is an incandescent lamp, so a relay module is used to control the on/off of the light. This is so that the temperature produced from the incandescent lamp is stable according to what is needed during the hatching process. To read the temperature, an NTC 10K sensor is used in order to provide temperature measurement information which can be processed by the microcontroller on Arduino. After testing the prototype, an incubator is produced which can work according to the working principle of an automatic egg incubator and can reach the target according to the expected goals. Automatic egg incubators can be used by duck poultry farmers to help incubate eggs.

**Keywords:** Arduino Uno R3, Ducks, Temperature, Prototype, Microcontroller

## I. INTRODUCTION

The use of technology by mankind begins with the conversion of natural resources into various kinds of tools. Along with the times, humans have succeeded in finding various kinds of technology which are useful to support human activities or work such as information technology, communication technology, food technology, and educational technology. Each of these technologies has its own role and benefits, provides new ways and provides many conveniences in carrying out human activities so that every human being today is dependent on technology. Unknowingly, every day we need technology to carry out our daily activities so that with the presence of technology, it is hoped that it will be able to bring a good influence on life.

In the traditional way of incubating duck eggs, this can be done by using another poultry mother that is incubating the eggs. This method can be done by placing another egg together with the egg which is being incubated by the mother. When the eggs have hatched, the chicks can be removed and then replaced with other eggs to be hatched. This can be done for three incubation periods. The egg capacity which can be incubated by the mother poultry is around 10-12 eggs. The success rate in incubating eggs using the traditional method (mother poultry) only reaches 50-60%. This is due to the behavior of the poultry parents that do not always incubate their eggs, as well as the temperature and humidity in the eggs which cannot be controlled by the poultry farmer.

Currently, many researchers are conducting research in the field of animal husbandry. The research aims to assist traditional poultry farmers in increasing their production. These studies resulted in various kinds of incubators at prices which can be reached by traditional breeders, so that it is expected to increase poultry production and improve the welfare of breeders. Research conducted by Supriyono (2014) succeeded in designing an *Arduino* Mega 2560-based automatic egg incubator using DHT11 as a temperature and humidity sensor and an egg rack which can move automatically. The box on this incubator is divided into two parts, a heat-producing box, and a box for placing eggs. The egg rack moves automatically with a forward and backward tilting system. The tests in this study used two incubators, manual egg incubators and automatic egg incubators. Experiments conducted on manual incubators obtained results of 86.67%, while on automatic incubators obtained results of 80%. A successfully designed automatic egg incubator has a success rate of 80%. The advantage of this incubator is a power supply circuit which is automatically connected to the battery to keep the machine running when the PLN electricity goes out. The drawbacks of this machine are the slow heating response and the egg rack rotation system which is too fast so that the eggs which hatch become abnormal or defective.

This study uses a NTC 10K temperature sensor which is used in a tool called temperature control thermostat XH-W3001. This sensor has a smaller error rate than the temperature sensor used by previous researchers with a temperature sensor of around 0.2°C. This study also uses a synchronous motor to rotate eggs with a sliding system. The sliding rack system has advantages compared to the tilted rack system because with the sliding system the eggs rotate 180° to the other side of the eggs so that the temperature and humidity in the incubator can be evenly distributed throughout the eggs.

## II. THEORETICAL BASIS

### *A.* Control System Concept

According to Rif'an (2013:1) the control system is the relationship between the elements which form a certain configuration and produce the output or system response as planned and desired. According to Yudaningtyas (2017:2) control system is a system which has a relationship with each other between components which form a system configuration which provide the expected response or system output. According to Allu dan Toding (2018:2) [5], [6] control system is the process of setting or controlling one or several quantities (variables or parameters) which are at a certain price or range. Examples of physical variables or parameters are pressure, flow, temperature, level, pH, density, velocity and others. The control system is an arrangement of physical components or several system elements (subsystems) which are interconnected and have the goal of regulating or controlling a process so as to obtain the desired output.

### *B.* Manual and Automatic Control System

According to Allu dan Toding (2018:5) manual control system is control carried out by humans who act as operators. Meanwhile the automatic control system is control carried out by equipment which works automatically and its operations are under human supervision. According to Yudaningtyas (2017:4-5) manual control system is a control system carried out by humans. Generally, this is done in processes which do not undergo much change, such as sound control, radio, television light control, and control of the flow of water through faucets. An automatic control system is a control system carried out by a controller in the form of equipment or machines which replace human tasks. The manual control system is a control system carried out by humans with a process which does not experience much change, while the automatic control system is a system carried out by equipment which works automatically so that it can replace human tasks. The following is an example of a manual control system on a water tank:

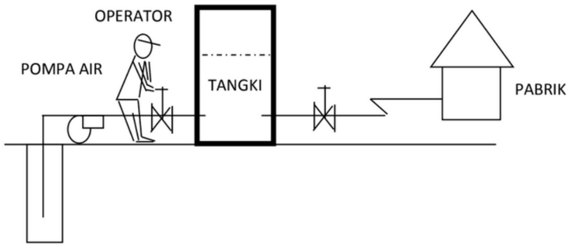


Figure 1. Example of an Allu and Toding Control System (2018:3)

The picture above shows that an operator is maintaining the level of a tank. If the tank height is less than it should be, the operator opens the inlet valve. If the height exceeds what it should be, the operator reduces the tap opening and so on. From the example of the control system above, it can be concluded that a control system performs measuring, comparison, and correction work. The system can run well if the system works ideally and simply. The control system above has problems. Those problems are process conditions which are more complex and difficult, measurements which are more accurate, and process distances which are difficult to reach. So it is necessary to modify the system. The following is an example of an automatic control system for controlling the water level in the tank:

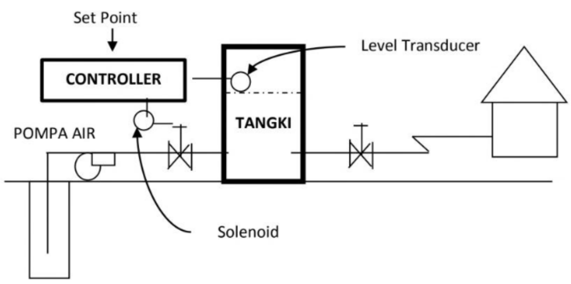


Figure 2. Automatic Control System (Allu and Toding 2018:4)

The image above replaces humans with controllers which function as substitutes for operators. This tool uses a solenoid valve to open and close the faucet automatically. So that this system can work ideally and simply and can replace human tasks. There are several benefits to using this automatic control system. These benefits are the smoothness of the process, the level of security, quality and economy. According to Sanjaya (2016:173) automatic control not only facilitates and improves the work performance of the installation, but also helps humans or replaces some of their tasks because it is impossible or unnecessary for them to do it themselves. This happens because awareness of human capabilities is very limited, time and opportunity are not possible, or because it can endanger the safety of their lives [8], [9].

*C.* Control System of Open Loop

According to Yudaningtyas (2017:5) open loop systems use driving equipment or actuators to control processes directly without using feedback. The output price of this system cannot be compared with the input price. This means that the output has no effect on the input price, or the variable being controlled cannot be compared with the expected price. According to (Allu dan Toding, 2018:5) open loop control system is a control system where the output quantity does not affect the input quantity, so that the controlled variable cannot be compared with the expected price. Open loop control system is a system whose output does not affect the control system and cannot be used as input (feedback input). For example, the washing machine only works based on a predetermined time control, there is no feedback whether the clothes being washed are clean or not, so the input in this case, the desired level of cleanliness of the clothes may be different from the desired output. Unclean clothes remain as output from the machine [10]–[12]. The washing machine cannot clean it again until it is clean. In an open control system there is no correction or feedback on errors. An overview of the open loop control system can be seen in the following figure:


Figure 3. Open Loop Control System (Allu and Toding 2018:6)

## III. RESEARCH METHODS

A. Object of research

Duck eggs are generally large and have a white shell color to bluish green. Duck egg shells are thicker than chicken eggs. The inner membrane is thicker and the pores in the egg shell are larger. Eggs which can produce new individuals or can hatch are called fertile eggs. Fertile eggs are eggs resulting from the mating of male and female or eggs resulting from fertilization of ovum and sperm. Infertile eggs are eggs without the mating of male and female. Knowledge of fertile and infertile eggs needs to be known by breeders who incubate eggs. Because infertile eggs can be used as other products such as salted eggs to reduce losses. In the science of hatching there are terms fertility and hatchability. Fertility is the percentage of eggs that shows the development of embryos from a number of eggs which are hatched. Knowledge about fertility is needed by breeders to determine the level of fertility in the brood stock which produces the eggs. The fertility formula is:

$$\text{Fertility} = \frac{\text{Fertile Eggs}}{\text{Hatched eggs}}\ x\ 100\%$$

Hatchability is the percentage of the number of eggs that hatch from the number of fertile eggs. The calculation of hatchability is needed to find out how much the hatchability is in the incubation process carried out by the brood stock. The formula for Hatchability is:

$$\text{Hatchability} = \frac{\text{Hatched eggs}}{\text{Fertile eggs}}\ x\ 100\%$$

B. Current System Flowchart

Every process of making or developing a system requires an analysis of the process flow of the system which is currently running. This aims to find out what deficiencies and problems are currently occurring in the system. Thus, in developing a new system, it can provide solutions to problems in the old system. The flowchart of the system flow which runs on duck egg hatching is:

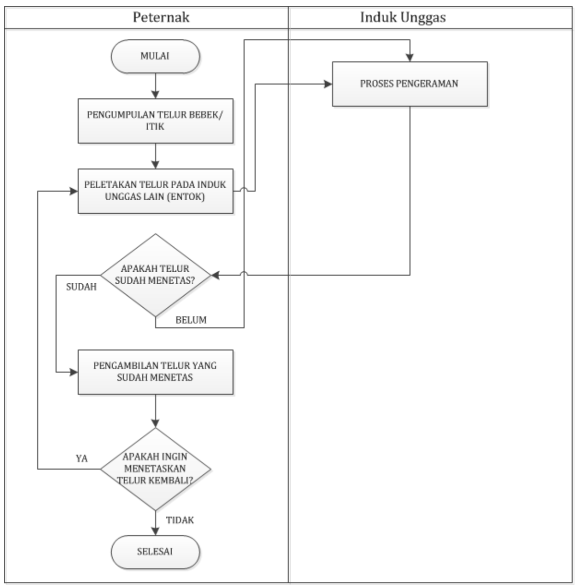


Figure 4. Flowchart of the Traditional Hatching System

Information:

**Duck Egg Collection**

The process of collecting duck eggs is carried out by breeders. Egg collection is done every day.

**Laying Eggs on Other Poultry Mothers (*Entok*)**

Egg laying is done by the breeder by laying the eggs one by one into the brood stock which is incubating the eggs.

**Incubation Process**

The incubation process is carried out by the brood stock with an incubation period of 28-30 days.

**Check the incubated eggs**

Checks are carried out to determine whether the incubated eggs have hatched or not. When the eggs have hatched, the ducklings are taken and placed elsewhere. If the breeder will incubate the eggs again, the eggs to be hatched are placed into the brood stock. This can be done continuously for up to three hatching periods.

## IV. RESULTS AND DISCUSSION

A. Analysis of Automatic Egg Incubator Design

Analysis of an automatic egg incubator design using engineering methods with literature studies and direct application in the field, as well as using several other research steps so that at the time of making the tool, the steps to be carried out have been determined. The steps for designing an automatic egg incubator can be seen in Figure 5.

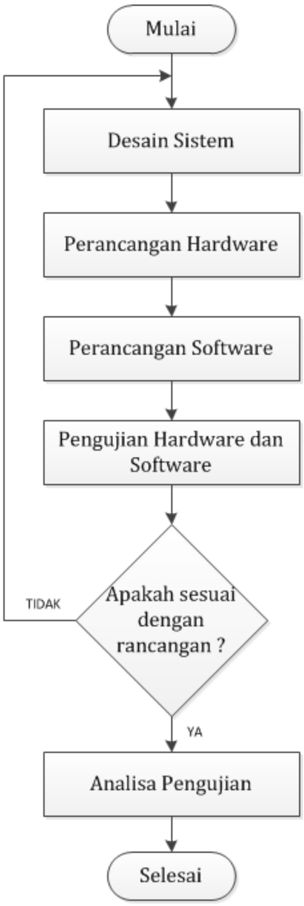


Figure 5. Flowchart of Tool Design Steps

B. System Design

System design is done by pouring thoughts and system design on solutions to existing problems. System design is carried out using system modeling tools such as system design and tool specifications designed. The design specifications of the automatic egg incubator are:

1. The type of eggs hatched are duck eggs.
2. The specified temperature ranges from 37°C to 38°C.
3. The specified humidity is 60%.
4. The egg turning system is 180° automatically every 3 hours.
5. The observation process is done manually.
6. The process of filling the water in the tub is done manually.
7. The egg capacity in the incubator is 24 duck eggs.

The system design can be seen in the following block diagram:

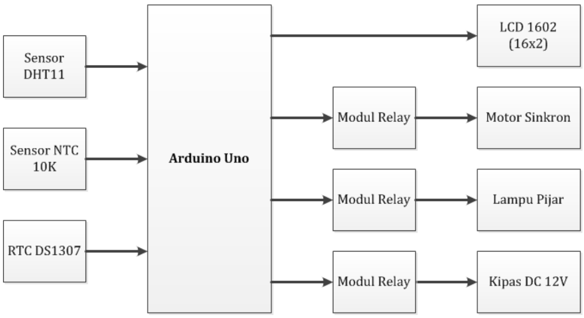


Figure 6. Block Diagram of an Egg Incubator System

C. NTC 10K Temperature Sensor

The design of an *Arduino* Uno-based automatic egg incubator uses a 10K NTC temperature sensor. The following is the configuration of NTC 10K temperature sensor pin with the pin on *Arduino* Uno R3:

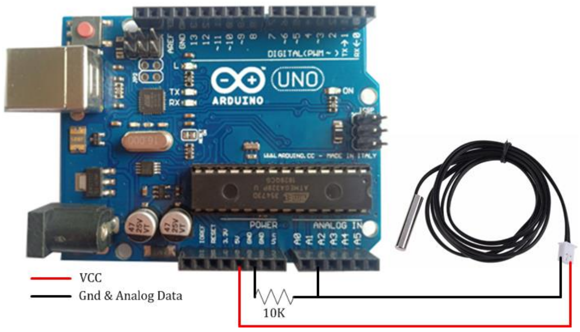


Figure 7. NTC 10K Pin Configuration with Arduino Uno R3

In figure 7, NTC 10K Sensor has 2 wires. One of the wires connects to the 5v pin on *Arduino*. One other cable is connected to ground and to the analog pin so that the sensor can be monitored.

D. Tiny RTC DS1307

The Tiny RTC DS1307 has 4 pins to communicate with the *Arduino*. The SCL pin functions as a clock channel for data communication between *Arduino* and RTC. Meanwhile, SCL functions as a data channel for data communication between *Arduino* and RTC. RTC pin configuration with *Arduino* R3 can be seen in the following figure:

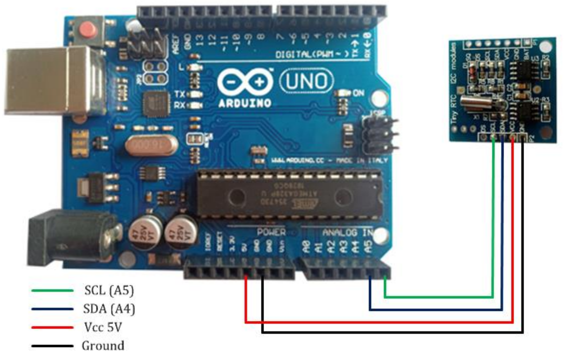


Figure 8. Tiny RTC DS1307 Pin Configuration with Arduino Uno R3

E. Overall System Testing

After testing each hardware is complete, do the next step. The next step is testing the system as a whole. Testing is done by incubating duck eggs. In hatching duck eggs with an incubator, there are several steps which must be taken:

1. In the first 4 days, the eggs are not rotated and are placed vertically with the blunt end of the egg at the top (the air hole in the egg is at the top).
2. After the 4th day, the eggs are laid horizontally and the eggs begin to rotate.
3. The first observation is done on the 4th day or the 5th day to find out which eggs are fertile and infertile. Infertile eggs are removed from the machine.
4. Subsequent surveillance is carried out once a week or on the 7th, 14th and 21st days.
5. On the 25th day, the eggs stop turning. On the 25th day, the eggs usually start to crack or hatch.
6. Separate or remove the baby ducks or DOD (Day Old Duck) after DOD feathers have dried (approximately 3 days).

## V. CONCLUSION

How to make an egg incubator using *Arduino* is to enter the program into *Arduino* so that it can control temperature sensors, humidity sensors and synchronous motors as desired. After that, trials are carried out on the overall design of the egg incubator, both input, output and control system so that it could work properly. The incubator can work according to the working principle of an automatic egg incubator and has reached the target according to the expected goals. Automatic egg incubators can be used by ducks to incubate eggs. In order for the humidity generator to run automatically, a humidity generator that can be controlled by *Arduino* is needed.

## REFERENCES


[1] D. Supriyono, “Rancang Bangun Pengontrol Suhu dan Kelembaban Udara Pada Penetas Telur Ayam Berbasis Arduino Mega 2560 Dilengkapi UPS,” hal. 12, 2014.

[2] M. Rif’an, “Bahan Ajar Sistem Kendali Kontinyu,” 2013.

[3] E. Yudaningtyas, *Belajar Sistem Kontrol*. UB Press, 2017.

[4] N. Allu dan A. Toding, “Nicolaus Allu 2018 Sistem Kendali (Teori dan Contoh Soal Dilengkapi Dengan Penyelesaian Menggunakan Matlab.pdf.” CV BUDI UTAMA, 2018.

[5] I. A. Rozaq, “Efisiensi Energi Smart Home ( Rumah Pintar ) Berbasis Remote Relay Dan Ldr ( Light Dependent Resistant ),” *Simetris*, vol. 8, no. 1, hal. 363–368, 2017.

[6] M. dwisnanto Putro, “Perancangan Shading Device Pada Smart Home,” *E-journal Tek. Elektro dan Komput.*, 2014.

[7] M. Sanjaya, *Panduan Praktis Pemrograman Robot Vision Menggunakan Matlab dan IDE Arduino*. CV. ANDI OFFSET, 2016.

[8] M. C. Kusumastuti dan S. A. Irwandi, “Investigasi Empat Faktor Kontingensi Sebagai Variabel Moderating Terhadap Partisipasi Pemakai Dan Kepuasan,” vol. 2, no. 2, hal. 139–150, 2012.

[9] S. Suhu, S. Cahaya, D. S. Hujan, S. R. U. A. S. St, D. J. M. St, dan M. Eng, “Rancang Bangun Rumah Pintar Otomatis Berbasis,” vol. 5, no. 1, 2016.

[10] S. R. U. . S. Steven Jendri Sokop, Dringhuzen J. Mamahit, “Trainer Periferal Antarmuka Berbasis Mikrokontroler Arduino Uno,” *E-Journal Tek. Elektro dan Komput. vol.5 no.3 (2 016), ISSN 2301-8402*, vol. 5, no. 3, hal. 13–23, 2016.

[11] M. Grabowski dan G. Dziwoki, “The IEEE wireless standards as an infrastructure of smart home network,” *Commun. Comput. Inf. Sci.*, vol. 39, hal. 302–309, 2009.

[12] F. Masykur dan F. Prasetiyowati, “Aplikasi Rumah Pintar ( Smart Home ) Pengendali Peralatan Elektronik Rumah Tangga Berbasis Web,” *J. Sains, Teknol. dan Ind.*, vol. 3, no. 1, hal. 51–58, 2016.