NUEVA VIZCAYA STATE UNIVERSITY
College of Engineering

AUTOMATIC DUCK EGG INCUBATOR WITH MANUAL CANDLING SYSTEM

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By:

Aldrin Paul I. Policarpio

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APPROVAL SHEET

This thesis entitled "**AUTOMATIC DUCK EGG INCUBATOR WITH MANUAL CANDLING SYSTEM**" prepared and submitted by **ALDRIN PAUL I. POLICARPIO** in partial fulfilment of the requirements for the degree **BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING**

ENGR. SILVERIO V. MAGDAY JR., ECE

Adviser

Approved as partial fulfilment of the requirements for the degree BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING by the Oral Examination Committee.

JEL KRISTELL T. ALAMO, ECE	**LEIMAR N. AGSUNOD, ECE**
Member	Member
JIMMY CARTER B. NILO, MSECE	**ZARAH Z. VILLAR, ECE, MAT**
Member/Class Adviser	ECE department chair

RYAN VICTOR D. BAUTISTA, CpE, MIT

Research Coordinator

ACCEPTED as partial fulfilment of the requirements for graduation with the degree of **BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING**.

MARY B. PASSION, D.Eng. ME

Dean College of Engineering

Recorded

RAMIR R. HONGO

Registrar III

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DEDICATION

This research is wholeheartedly dedicated to all researchers who aspire to achieve their dream and the dream of their parents.

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ABSTRACT

Incubation is the one of processes in poultry by keeping the fertilized eggs warm to allow proper development of the embryo into a chick. It is important to control the temperature, humidity, ventilation, and egg turning. The common problem in incubation is the improper control of temperature which can cause damage to the development of the embryo and decrease poultry production. This consumes more labor and time for the owner. Moreover, it is difficult to monitor the incubator using manual monitoring which is very important in incubation. To overcome this problem, the researcher designed a low-cost Automatic duck egg incubator with manual candling system that uses an Arduino Uno Microcontroller for central command. It can maintain the temperature and humidity in it using the DHT 11 sensor, mist maker, and incandescent bulb. It can also rotate eggs in the tray automatically using the stepper motor. It can automatically adjust the appropriate temperature and humidity according to the number of days. The incubator uses a real time clock module which gives the current time and date. The incubator also has a built-in candling system for the manual monitoring of the progress of eggs. In this study, the researcher also compares the artificial incubation using the Automatic Egg Incubator with manual candling system with the natural or conventional way of incubation. Automatic duck egg incubator with manual candling system was able to give more effective result from 100% hatchability compared to 60% that the mother duck hatched as shown in the following pages.

Keywords: Microcontroller, Stepper Motor, Real Time Clock, Candling System

CHAPTER 1

THE PROBLEM AND ITS BACKGROUND

Introduction

Poultry farming is the raising of certain species of birds for the purpose of human use. To ensure that it continues to make positive and sustainable contributions to the society, it is essential that production and marketing are tailored to local conditions and associated value chains, maximize nutrient cycling and efficient utilization of all products (Arthur and Albers, 2003).

According to the research conducted by Grace Hussain (2021, August), poultry farming industry has caused birds to grow at alarming rates that impact their welfare in the process. One of the causes of it is the low hatchability rate of fertile egg. Poor results in hatching are commonly caused by the improper control of temperature or humidity. When the temperature or humidity is too high or too low for a long period of time, the normal growth and development of the embryo are affected.

Egg incubation is the most common way to artificially heat in an egg to support the hatching process. Problems occur during different weather conditions that affect the ambient temperature within the incubator which disturbs the cultivation process. Also, a device that can smartly control and adjust the incubating temperature in contrast with its surrounding is needed (Joe G. Berry, February 2017).

The general objective of this study is to design a low-cost Automatic Duck Egg Incubator with Manual Candling System that will help the poultry farmers to avoid losing many potential chicks that could've hatched in the incubator. Specifically, this research aims to: (1) create an automatic incubator with a controlled temperature and humidity inside;(2) compare the device to natural brooding way of incubation; and (3) construct a program that can integrate the module and microcontroller.

This Arduino-Based Automatic Egg Incubator valued a great assistance to a.) farmers to help the poultry farmers in providing a low-cost incubator for their hatchery; b.) community to compensate for the high demand in day-old chicks; and c.) future researchers, served as reference to their projects.

With these problems stated above, the researcher designed an artificial incubator that can maintain the humidity and temperature inside the incubator. The device can automatically rotate the egg to avoid the embryo to stick on the shell. In this device, we can set the humidity and temperature of the incubator according to the date or duration of egg to supplement the need of it. We can also monitor the progress of the egg according to the embryo growth through the built-in light for candling. The device can display the current date, humidity, temperature, and number of days of egg inside the incubator. The device will warn the management if the humidity and temperature is dropping to avoid rotten eggs.

The researcher constructed an Automatic Egg Incubator and Candling System that is capable of hatching 176 eggs simultaneously. These incubator uses an Arduino uno for the module integrator or microcontroller. The device can monitor the current humidity and temperature using a DHT 11 sensor. To increase the humidity of the incubator as we soften the shell of the egg the device uses a humidifier module to create an artificial mist. Also, the system uses a two 100 watts bulb to generate heat like the hen. A 12-volts fan will distribute the heat and mist to the entire incubator. To monitor the date and to implement the exact humidity and temperature according to the date of egg inside the incubator RTC (Real time Clock) DS1307 was used to display the values of the current temperature, humidity, and days of incubation, it uses the LCD I2C Module. To rotate the egg tray, there is an AC motor with a clockwise and counterclockwise rotation to avoid the embryo to stick on the eggshell. The bulb, humidifier, and a 12Volts fan module are connected to an electromechanical relay for switching. The AC motor uses a solid-state relay for total isolation to avoid a fly wheel effect and induced EMF (electromagnetic field).

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

Incubation

Incubation is the maintenance of uniform conditions of temperature and humidity to ensure the development of eggs or, under laboratory conditions, of certain experimental organisms, especially bacteria. The phrase incubation period designates the time from the commencement of incubation to hatching. It also is the time between the infection of an animal by a disease organism and the first appearance of symptoms.

Types of Incubation

1. Natural Incubation
2. Artificial incubation

Natural Incubation

Duck eggs may be hatched naturally by placing them under a broody duck or even a broody chicken hen. Muscovy ducks are very good setters, capable of hatching 12-15 duck eggs. The nest box should be located in a clean dry shelter, bedded with suitable litter. Feed and water should be available for the broody duck and for the ducklings when they hatch.

Artificial incubation

Artificial incubation is a process where duck eggs are kept in climate-controlled incubators until hatching occurs. It is widely practiced today and can be a rewarding experience for all involved if the right conditions are maintained.

Types of Artificial Egg Incubators

There are three types of Artificial egg incubators. They are:

1. Forced-Air Incubator
2. Still-Air Incubator
3. Conventional Incubator

1. **Forced-Air Incubator**

The forced-air egg incubator is one of the most common and widely used egg incubators. It makes use of a fan to spread the warm air all over the egg chamber. This consequently allows a greater number and at the same time a wider size range of eggs to be incubated at the same time, as the heat is distributed evenly inside the incubator.

Figure 2.1 Force-Air Incubator

2**. Still-Air Egg Incubator**

Contrary to the forced-air incubator, the still-air egg type of egg incubator has no air holes. Still-air incubators are harder and trickier to use, and it requires precision to set this kind of incubator. The radiant heat warms up the air, and since the air will not be able to circulate, it is very crucial to identify the correct placement of the eggs. In addition, the setting of still air incubators has to be exact (103^{o}F), otherwise, temperature and humidity anomalies might occur inside. Besides, still-air egg incubators need to be opened at least four times a day for fresh air to come in.

Figure 2.2 Still-Air Egg Incubator

3. **Convectional Incubator**

Another type of egg incubator makes use of convection. The convectional incubator relies on ventilation holes found at the top, side and bottom of the incubator. With these holes, warm air rises and pulls in from below cool air, providing an even warming area for the eggs. However, convectional egg incubators are prone to air drying, and so it is essential to carefully monitor the humidity.

Length of Incubation Periods

Incubation periods vary for different species of birds. In general, the larger the egg the longer the incubation period. However, there are individual differences. The incubation period may also vary with the temperature and humidity within the incubator. Average incubation periods for some species are:

Table 2.1 Length of Incubation Period

Poultry	Length of Incubation
Chicken	21 days
Duck	28 days
Peafowl	29 days
Ostrich	42 days
Quail (Coturnix)	16 days
Turkey	28 days

https://www.thepoultrysite.com/articles/artificial-incubation

Incubation Conditions

Temperature

Temperature is extremely important during incubation. Variations of more than one degree from the optimum will adversely affect the number of eggs that will successfully hatch. In sectional or home-type incubators the temperature will vary considerably between the top and the bottom of the egg. With these types of incubators, a temperature at the top of the eggs of 37.3°C for the first week, 37.8°C for the second week, and 38°C till hatching gives the best results with eggs of most species.

In modern commercial forced-draft incubators, a temperature of 36-37°C is maintained throughout the incubation period. Most operators find that in the very large machines some provision must also be made for cooling to maintain this constant temperature. Embryonic development produces considerable heat. If this heat is not dissipated, injury to the embryos may occur.

Humidity

Eggs lose water during the incubation period, and the rate of loss depends on the relative humidity maintained within the hatching chamber. Metabolic balance must be maintained throughout the incubation period. Thus, humidity outside a relatively narrow range will affect the number of successfully hatched eggs.

Optimum growth for most species requires a relative humidity of 60 percent until the eggs begin to pip, after which the relative humidity should be raised to 70 percent. Best results occur with turkeys when these humidity's are raised 2 to 3 percent. Under most Oklahoma conditions, moisture must be added to the hatching chamber to reach these relative humidity levels. This can be done by placing an open pan of water in the same area with the eggs. In sectional or convectional type incubators, it may be necessary to increase the water surface by suspending a piece of cloth from the water, providing wick action.

Relative humidity can be gauged by wrapping a wet cotton cloth around the bulb of a thermometer and suspending it in the hatching compartment. Due to evaporation, the "wet" bulb thermometer will have a temperature below that of a dry bulb thermometer in the same compartment.

Duck Incubation

Incubating and hatching chicken eggs can be applied to ducks, as long as the important differences between these two species are taken into account. Since duck eggs are larger than chicken eggs, setting trays must be designed to accommodate their larger size. Eggs from common ducks like Pekins require 28 days to hatch.

Eggs from Muscovy ducks hatch in about 35 days after setting. When larger numbers of duck eggs are to be hatched, large commercial incubators (setters) and hatchers are normally used. Pekin duck eggs are kept in a setter for 25 days and then transferred on the 25th day to a hatcher where they remain until they hatch on the 28th day. Eggs are automatically turned while in the setter. It is not necessary to turn eggs in the hatcher. Basic procedures and conditions for hatching duck eggs are as follows.

If the incubator is not already in operation, start the incubator and allow the temperature and humidity to stabilize a day or two before setting eggs. Set the temperature at 37.5°C (99.5°F) and relative humidity at 55% (84.5°F on wet bulb thermometer). Set ventilation as recommended by the incubator manufacturer. Eggs must be turned, either automatically or by hand, a minimum of 4 times a day. Most automatic turning devices are set to change the position of the eggs hourly.

Select eggs to be set by carefully inspecting and candling them at the time they are put in setting trays. Do not set eggs that are cracked, double yolked, misshapen, oversized, undersized or dirty. For best results, set eggs within 1-3 days from the time they were laid. There is an average loss of about 3% hatchability for eggs stored 7 days before setting, and about 10% loss for those stored 14 days. Always set eggs with the small end down, except in the case of small incubators that have no trays. If eggs have been stored in a cooler, take them out of the cooler the night before setting and allow them to warm to room temperature.

On the day of setting, put eggs in incubator, close the doors and allow the incubator to reach operating temperature. Check frequently to make sure the incubator is working properly the first day and continue checking thereafter at least four times a day.

At about seven days after setting, candle the eggs and remove any eggs that are infertile (clear) or have dead germ (cloudy).

At 25 days after setting (Pekin eggs), the eggs are transferred to hatching trays, and if eggs are hatched in a separate machine, moved to the hatcher. Candle and remove eggs with dead embryos. At the time of transfer, the temperature of the hatcher should be set at 37.2°C (99°F) and the humidity set at 65% (88°F wet bulb). As the hatch progresses, and eggs begin to pip, increase the humidity to 80% (93°F wet bulb), and increase ventilation openings by about 50%. As the hatch nears completion gradually lower the temperature and humidity so that by the end of the hatch the temperature is at 36.1°C (97°F), and the humidity is at 70% (90°F wet bulb). Vents should be opened to their maximum setting by the end of the hatch. Remove ducklings from the hatcher when 90-95% of them are dry.

Proper Water Loss During Incubation

As the duckling develops inside the egg there is a loss of water from the egg and an increase in the size of the air cell. If the duckling is developing normally, the air cell should occupy about one-third of the space inside the egg at 25 days of incubation (common ducks). Weight loss can also be used as a guide. Common duck eggs should lose about 14% of their weight at time of setting by 25 days.

Position and Turning of Eggs

Eggs should be placed in the incubation compartment large ends up for best results. However, a good hatch can be obtained if the eggs are placed on their sides. An extremely poor hatch will occur if the eggs are placed in the incubator small end up.

The eggs must be turned several times a day for best hatchability. This will ensure that the embryo will not stick to the shell. The turning should be repeated throughout the entire 24-hour day. However, the night turning may be eliminated as long as there is a late evening and an early morning turning. Eggs should be turned at least four times during each 24-hour period. In large commercial machines turning is mechanically done, controlled by a time clock.

The eggs should be turned through a 90-degree plane as gently as possible. Turning should continue until one to three days prior to hatching and or until the eggs has “pipped;” position or turning will then have no effect on hatching.

Figure 2.3 Position and turning of eggs

Egg Candling

Candling is the process of holding a strong light above or below the egg to observe the embryo. A candling lamp consists of a strong electric bulb covered by a plastic or aluminium container that has a handle and an aperture. The egg is placed against this aperture and illuminated by the light. Candling is done in a darkened room or in an area shielded by curtains.

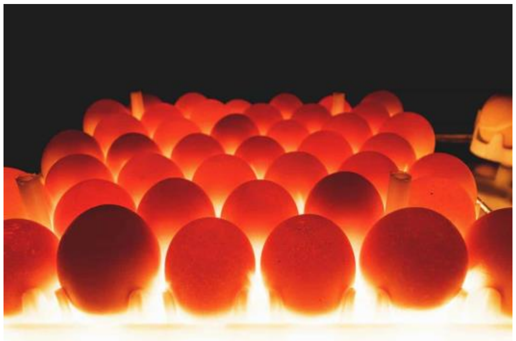

Figure 2.4 Egg Incubator

Determining the viability of the embryo

Under the candling lamp, the embryo appears as a dark shadow with the head as a dark spot. Healthy embryos will respond to the light by moving. Sometimes the movement is very sluggish, and it can take 30 to 40 seconds for the embryo to move when held under the candling lamp. This indicates the embryo is not healthy and the egg should be discarded.

They are well defined in a healthy embryo. After an embryo has died, the blood vessels start to break down. They then appear as streaks under the shell when viewed under the candling lamp. Candling will also reveal cracks in the eggshells. Eggs with cracked shells should be discarded.

Features of embryonated eggs visible during candling

Infertile eggs:

These are easy to detect, as the egg is clear.

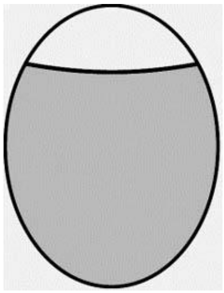

Figure 2.5 Infertile Egg

Early Death of Embryo

The embryo has developed for several days and then died. Candling will reveal a small dark area and disrupted blood vessels. Often deteriorating blood vessels will appear as a dark ring around the egg. Embryo is small and does not move.

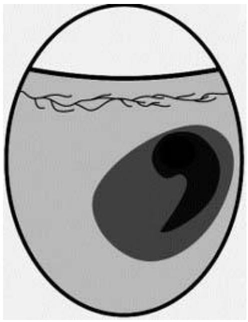

Figure 2.6 Early Death of Embryo

Late Death of Embryo

These are often difficult to tell apart from a viable embryo at the same stage of development. Look for the absence of movement and the breakdown of the blood vessels. Blood vessels may have started to break down. Embryo does not move.

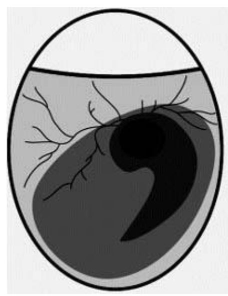

Figure 2.7 Late Death of Embryo

Viable Embryo

These move in response to the light and have well defined blood vessels. Mark the air sac and the inoculation site and then return the eggs to the incubator ready for inoculation. Strong healthy blood vessels. Embryo moves.

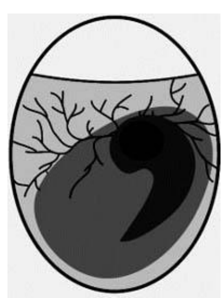

Figure 2.8 Viable Embryo

Electronic Components

Microcontroller

A microcontroller is embedded inside of a system to control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to decipher and apply the incoming data. It then uses its I/O peripherals to communicate and enact the appropriate action.

Arduino Uno Microcontroller

Arduino UNO is a microcontroller board based on the **ATmega328P**. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

Figure 2.9 Arduino Uno

Arduino Programming

Arduino is the general term for the open-source electronics platform, board, and program. It is a very flexible platform as it can be used to program most electronic-based designs. Massimo Banzani and David Cuartielles expanded on the Arduino device in 2005, building on Hernando Barragán's Wiring software. David Mellis went on to create the Arduino software, which was based on Wiring. Gianluca Martino and Tom Igoe soon joined the project. These Figure 2.13 Arduino Uno Figure 2.14 Arduino Logo 18 five became the initial Arduino platform creators. They achieved their objective of creating Arduino to be a simple and versatile device that can be linked to numerous components while keeping inexpensive for students and hobbyists with little funds. Since then, Arduino has grown in a variety of directions, with some expanding to have more capacity than the original, some becoming smaller and more compact, and yet others expanding to accept additional parts and components. The Arduino board is connected via USB to a programming device, often a computer, although smartphones have downloaded programs that may be used, where it connects to Arduino's Integrated Development Environment (IDE). On the IDE, the user writes code for the Arduino device, which is subsequently uploaded to the microcontroller, which executes the input code and produces an output. Text editors, debuggers, compilers, code completions, programming language support, and integration and plugins are all typical IDE features. The text editor is the heart of the IDE and is present in all of them since it is used to write and alter source code. Most will have language-specific syntax highlighting and a basic interface, while some may include additional features like drag and drop. Debugging tools help users by detecting and correcting problems in source code. They generally replicate real-world settings to evaluate functionality and performance. Compilers convert programming languages into codes or languages that computers can understand, such as binary code. For optimal speed, the compiler parses and optimizes the code. As it finds and inserts common code components, code completions function similarly to an automatic sentence completer or error repair. These save users time and decrease the possibility of making a mistake.

Figure 2.10 Arduino IDE

C++ language

C++ is a high-level programming language that was first developed in the mid-1970s. C++ is developed from the C++ programming language and contains an object-oriented feature that allows the programmer to construct objects inside the code. This simplifies and improves programming efficiency.

Incandescent Bulb

Incandescent bulbs are essentially electric resistance heaters. And because of the inefficiencies of producing electricity and transmission losses, even dedicated electric resistance heaters are far less efficient than using natural gas, propane or an air-source heat pump.

Figure 2.11 Incandescent Bulb

Arduino Uno R3

The Arduino Uno is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Figure 2.12 Arduino Uno R3

DHT 11 Sensor

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

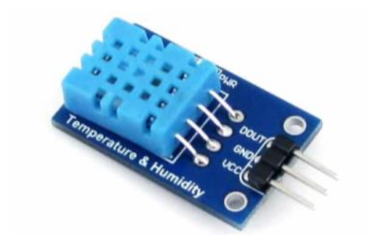

Figure 2.13 DHT 11 Sensor

LCD I2c 16X2

A Liquid crystal display is a form of visual display used in electronic devices, in which a layer of a liquid crystal is sandwiched between two transparent electrodes... not going to bore you with details but just watch the video to learn how to hook up basic-generic 16x2 liquid crystal display (i2c bus module version) with an Arduino.

Figure 2.14 LCD 16X2 2IC

Electro-Mechanical Relay Module

A relay is an electromagnetic switch operated by a relatively small current that can control much larger current.

Figure 2.15 Electro-mechanical Relay Module

Electro-Mechanical Relay Working

a solenoid is a helically wound coil with a hollow center along its longitudinal axis. Within this coil there is a free-floating plunger of magnetic material that retracts or extends along that axis — with a head to one of the hollow's ends.

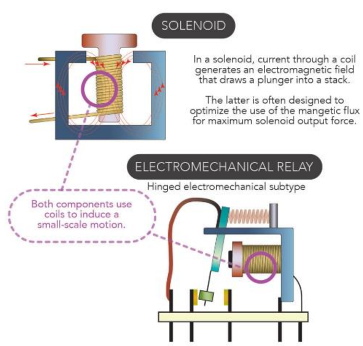

Figure 2.16 Electro-mechanical Relay Working

Solid State Relay

SSR, has no moving parts but instead uses the electrical and optical properties of solid-state semiconductors to perform its input to output isolation and switching functions. SR's provide complete electrical isolation between their input and output contacts with its output acting like a conventional electrical switch in that it has very high, almost infinite resistance when nonconducting (open), and a very low resistance when conducting (closed). Solid state relays can be designed to switch both AC or DC currents by using an SCR, TRIAC, or switching transistor output instead of the usual mechanical normally open (NO) contacts.

Figure 2.17 Solid State Relay

Solid State Relay Diagram

An SSR is a 4-terminal device having a pair of terminals for the input side and the other pair for the load/output side. There is an LED light source and a photosensitive device, like a phototransistor, inside a single case, separated by an air gap. The photosensitive switching element on the output side can also be a photodiode, thyristor, MOSFET, or a TRIAC depending on the nature of the load - AC or DC. SSRs with higher current capacity also have some additional circuitry along with the photo-sensitive device on the load side to increase the current output.

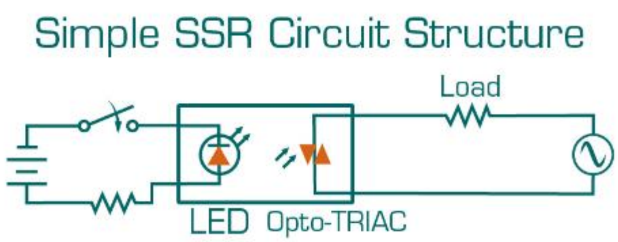

Figure 2.18 Solid State Relay Diagram

Stepper Motor

Stepper motors, due to their unique design, can be controlled to a high degree of accuracy without any feedback mechanisms. The shaft of a stepper, mounted with a series of magnets, is controlled by a series of electromagnetic coils that are charged positively and negatively in a specific sequence, precisely moving it forward or backward in small "steps".

Figure 2.19 Stepper Motor

Construction & Working Principle

The construction of a stepper motor is fairly related to a DC motor. It includes a permanent magnet like Rotor which is in the middle & it will turn once force acts on it. This rotor is enclosed through a no. of the stator which is wound through a magnetic coil all over it. The stator is arranged near to rotor so that magnetic fields within the stators can control the movement of the rotor. The stepper motor can be controlled by energizing every stator one by one. So, the stator will magnetize & works like an electromagnetic pole which uses repulsive energy on the rotor to move forward. The stator's alternative magnetizing as well as demagnetizing will shift the rotor gradually &allows it to turn through great control.

The stepper motor working principle is Electro-Magnetism. It includes a rotor which is made with a permanent magnet whereas a stator is with electromagnets. Once the supply is provided to the winding of the stator then the magnetic field will be developed within the stator. Now rotor in the motor will start to move with the rotating magnetic field of the stator. This is the fundamental working principle of this motor.

In this motor, there is a soft iron that is enclosed through the electromagnetic stators. The poles of the stator as well as the rotor don't depend on the kind of stepper. Once the stators of this motor are energized then the rotor will rotate to line up itself with the stator otherwise turns to have the least gap through the stator. In this way, the stators are activated in a series to revolve the stepper motor.

Figure 2.20 Inside a Stepper Motor

RTC DS1302

DS1302 real time clock module is a cheap module with high accuracy that can be used in different projects. This RTC module provides seconds, minutes, hours, day, date, month, and year information. In this module, date is set automatically based on whether the month is 29, 30 or 31 days and it is leap year or not. (That's only valid until the year 2100).

Figure 2.21 RTC DS1302

DS1302 RTC Module Pinout

This module has 5 pins:

- **VCC**: Module power supply – 5V
- **GND**: Ground
- **CLK**: Clock pin
- **DATA**: Data pin

RST: Reset (Must be HIGH for active mode / Active High)

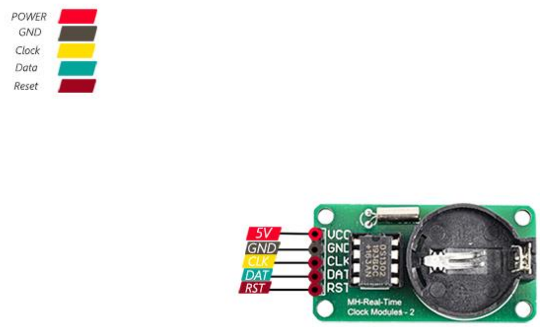

Figure 2.22 RTC DS1302 Module Pinout

12V Fan

A fan heater, also called a blow heater, is a heater that works by using a fan to pass air over a heat source (e.g. a heating element). These heats up the air, which then leaves the heater, warming up the surrounding room. They can heat an enclosed space such as a room faster than a heater without fan, but like any fan, creates audible noise.

Figure 2.23 12V Fan

Ultrasonic mist maker/Humidifier

In an ultrasonic mist maker/humidifier (also called an ultrasonic atomizer), a piezo atomizer disc/transducer (ceramic humidifier) works by transposing high-frequency sound waves into mechanical energy that is transferred into a liquid, creating standing waves. As the liquid exits the atomizing surface of the disc, it's broken into a fine mist of uniform micron-sized droplets, so the key component required for this little project is a (20-mm, 113-kHz) ultrasonic atomizer disc/transducer.

Figure 2.24 Ultrasonic Mist Maker/Humidifier

Operation of a Humidifier

The humidifier consists of a piezoelectric ceramic disc which is provided with current through two nickel electrodes. Since the ceramic is piezoelectric, it oscillates in the presence of electric current at ultrasonic frequency (So you do not hear the sound waves generated in water)

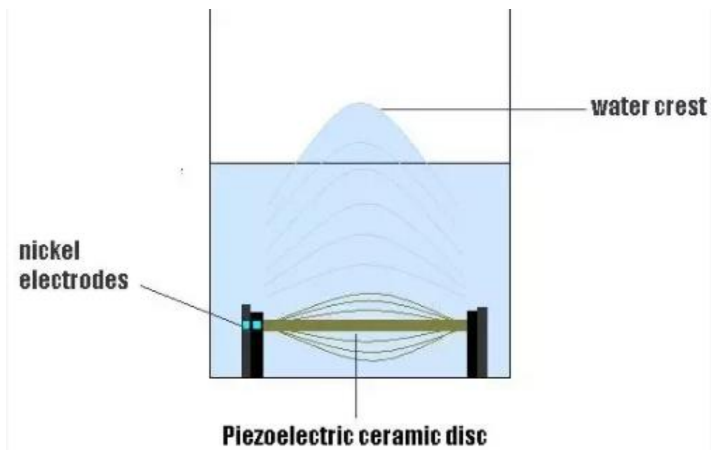

Figure 2.25 Ultrasonic Mist Maker/Humidifier Operation 1

The vibrating disc also causes capillary waves at the surface of water (ripples). The capillary wave keeps oscillating up and down due to surface tension and gravity. With the cavity imploding, a crossed capillary wave is formed at the surface and as a result at the crest of the wave, very minute droplets of water have enough energy to break off the surface tension and get out of water. As soon as these minute drops of water exit the surface, they are absorbed into the stream of air being blown by a fan and leave the humidifier as mist. The size of these aerosols would be smaller with increasing frequency. Moreover, if the capillary waves are oscillating at around half of the driving frequency, the atomization threshold will be approximately linear with the viscosity of water.

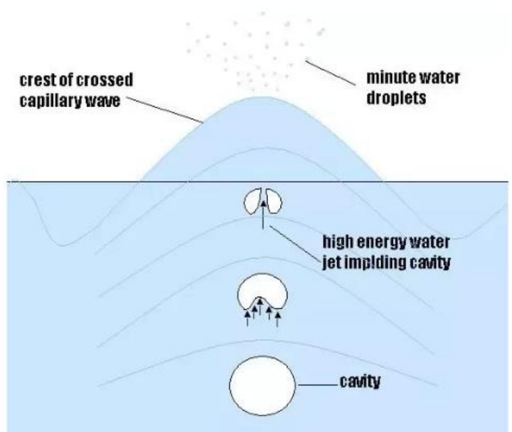

Figure 2.26 Ultrasonic Mist Maker/Humidifier Operation 2

Related Studies

Foreign

According to the study of Krista M. Noel, Carl P. Qualls, and Joshua R. Ennen et. al. “A comparison of artificial incubation and natural incubation hatching success of gopher tortoise (Gopherus polyphemus) eggs in southern Mississippi” found that Gopher Tortoise, Gopherus polyphemus, populations in southern Mississippi exhibit low recruitment, due in part to very low hatching success of their eggs. We sought to determine if the cause(s) of this low hatching success was related to egg quality (intrinsic factors), unsuitability of the nest environment (extrinsic factors), or a combination of the two. In 2003, hatching success was monitored simultaneously for eggs from the same clutches that were incubated in the laboratory and left to incubate in nests. A subset of randomly chosen eggs from each clutch was incubated in the laboratory under physical conditions that were known to be conducive to successful hatching to estimate the proportion of eggs that were capable of hatching in a controlled setting. Hatching success in the laboratory was compared with that of eggs incubated in natural nests to estimate the proportion of eggs that failed to hatch presumably from extrinsic factors. Laboratory hatching success was 58.8%, suggesting that roughly 40% of the eggs were intrinsically incapable of hatching even when incubated under controlled conditions. Hatching success in natural nests, 16.7%, was significantly lower than hatching success in the laboratory, suggesting that approximately 42.1% of eggs were capable of hatching but failed to hatch due to some extrinsic aspect(s) of the nest environment. Thus, the low hatching success of Gopher Tortoise eggs in southern Mississippi appears to be attributable to a combination of intrinsic (egg quality) and extrinsic (nest environment) factors.

According to the study of M. Leonor H. Reis and M. Chaveiro Soares et. al. "The Effect of Candling on the Hatchability of Eggs from Broiler Breeder

Hens”. In many commercial hatcheries candling is maintained as a routine operation if the removal of “clear” eggs at transfer can improve hatchability and chick quality. However, in the published literature, few data exist to support the benefits of this routine. A series of experiments was conducted to evaluate the influence of candling on hatchability and chick quality. Eggs from breeder flocks at seven different ages were used. Candling did not alter average hatchability when calculations were based on total number of eggs set (84.53 vs 84.07%, respectively, for candled and control eggs), as well as on the number of eggs with live embryos at 18 days of incubation (95.65 vs 95.89%, respectively, for candled and control eggs). There were no significant differences observed due to flock age. Average chick quality was slightly improved by candling when culls were expressed as a percentage of total settable eggs (0.84 vs 0.97% of culls). For flocks 63 weeks of age, a positive effect was also observed (0.93 vs 1.49% of culls).

According to study of Vahid Rezaeipour, Department of Animal Science, Qaemshahr Branch, Islamic Azad University, Qaemshahr et. al. “Effects of Egg Size and Different Levels of Humidity during Incubation Period on the Embryonic Development, Hatching Percentage and Chicks Yield of Broiler Breeder” According to the results, it was concluded that humidity of 82.5°F as well as the medium egg size showed a better impact on the incubation performance. The study was conducted in a completely randomized design with a 3×3 factorial arrangement. The treatments involved three levels of wet bulb humidity (°F WB) including 82, 82.5 and 83°F and three different egg sizes including small, medium, or large. Results: The main effect of humidity level on the total and fertile hatchability (%) as well as the weight of one-day-old chicks were significant. Treatment with humidity of 82.5°F enhanced total and fertile hatchability, while humidity of 83°F increased one-day-old chick weight. A better total and fertile hatchability (%), fertility (%), chick yield (%) was observed in medium egg size group. However, the chick weight was greater in large egg size group. The lowest embryonic mortality was belonged to medium egg size treatment.

Figure 2.27 A Picture of the Incubator

According to study of Frimpong Kyeremeh et. al. entitled "Arduino Microcontroller based EGG Incubator" shows the designed incubator with the temperature and humidity display and other parts. It has been used to successfully hatch 3000 Quail chicks at 94% hatchability rate, which is an improved efficiency over those reported in which achieved hatchability rates of 82.6% and 33% respectively. During the testing period, the system was monitored for a 24- hour period, recoding the temperature and the humidity levels in the incubator as displayed by the LCD screen, every two hours. This was to enable the determination of the rate of heat rise from the initial incubator temperature to the steady state temperature of 37.5°C. It was also to determine the correlation between ambient temperature and humidity levels and the that of the incubator. Finally, the monitoring enabled us to determine the duty cycle of the heaters in order to ascertain the power consumption of the incubator. Figure 2.27 shows the correlation between the ambient temperature and that of incubator. Firstly, it could be observed from the temperature graph that the temperature in the incubator increased from the initial of 30.5°C to 37.1°C in the first 2-hours. After this there was not much variation in the incubating temperature from the set point value (37.5°C). Even though the ambient temperature over the 24-hour period varied between a minimum of 24°C and a maximum of 34°C, the incubator inner temperature remained relatively constant, after the first 2-hours varying between

37.1°C and 38.1°C. This is an indication that heat lost by conduction through the walls of the incubator is minimal. Secondly, the ambient humidity over the testing period was between 40% and 73% while the internal humidity of the incubator varied between 53% and 70%, also an indication that the designed incubator is able to maintain the averaged relative humidity required for successful hatching. Also, for observed period, the duty cycle of the heater was 0.25 (25%). That is the heaters were in the ON state for only 25% of the observation period, which goes to confirm that the incubator has a good thermal capacity and also energy efficient. Effective turning mechanism made from metal (flat iron, angle iron and square pipe) and a gear coupled to a wiper motor and tray stands helps turning the eggs every three hours. This prevents the embryo from sticking to the shell and this avoids chick mortality.

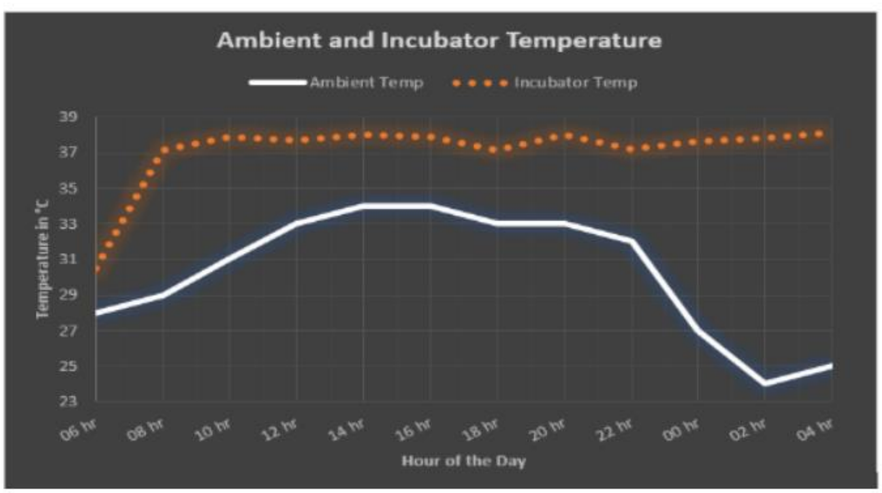

Figure 2.28 Relationship between Ambient Temperature and Incubator Temperature

According to study of Mathew Jun P Mariani, Ronald U Wacas , Rafael J Padre , Gerlie T Soriano , Venus B Elveña , Jayhan C Sarne et. al. entitled “cost-efficient microcontroller-based egg incubator” The microcontroller-based egg incubator was designed and constructed to give better poultry production for small-scale or for rural farmers. This study concludes that poultry producers scaled up the production without continuous monitoring and will lessen possible developmental growth problems that natural incubation causes. The integrated small-scale single microcontroller device streamlined the temperature control unit’s development and the carefully studied and engineered control of the incandescent lamps and fans. Turning mechanism, a new technical viewpoint is developed for the farmers, incorporating smart farming strategies that are cost-effective at their end. Furthermore, the study demonstrated that the microcontroller-based egg incubator is commendable for small-scale poultry producers. Further, for future works, the researchers highly recommend modifying the said design into a solar-powered microcontroller-based egg incubator.

Local

According to study of Herradura, Lhin Bianca G. Mariano, Krizzel Shayne S. Ogaco, Lean Rainier D. Orande, Josua M. Ojeda, Jerald Constantine M.

Santos, Rex Gabriel M.et. al. entitled “Egg Incubator Using Internet of Things (Arduino ESP8266) With Android Application” This project is to design and fabricate the system of an egg incubator that can incubate various types of egg and improve the production of more chicks for poultry farm, the project was the result of the collective ideas from the internet, industries, and poultry farm. Along with this is the android application that can monitor and control the incubator anywhere with an internet and WIFI connection. The project sheds the light on circuit constructed, the technological experience gained, and the usefulness of agricultural and biological value towards improving our economy and standard of living.

According to the study of Rene Andrin Villano, Ma. Lourdes Eugenio Velasco and Nenita L. de Castro et. al. “Duck Egg Production in the Philippines: Results from a Farm Survey” Two hundred and five duck (205) egg producers in four provinces (Iloilo, Nueva Ecija, Pampanga, and Quezon) of the Philippines, were surveyed in 2003 using a pre-tested questionnaire. They were asked about their sociodemographic and farm characteristics, their income sources and problems encountered in the production and marketing of duck eggs, as well as their access to capital and awareness of government programs and participation in extension services through farmers' organizations. Results showed that farm sizes, farm management practices, and performance in duck farming varied among the respondents across different areas covered by the study. Further, duck farmers in the Philippines generally lacked the technical know-how and access to capital and extension services and have encountered serious problems in production and marketing of duck products. One policy recommendation is that the training of extension workers to further enhance their technical know-how on duck raising and the provision of extension services to duck farmers can help avoid production constraints and improve productivity. Secondly, the emphasis on egg and "balut" production means that the prospects of the industry depend heavily on the future demand for "balut " and the ability of the duck sector to compete with other products in terms of price and product quality. This means that better understanding of the market demand for "balut" through research is as important as avoiding technical constraints in duck egg production.

According to the study of Eden Joy Bacalso and Noel Sobejana et. al. “Development and Construction of Poultry Egg Incubator Temperature and Humidity Controller (Peitch) With SMS Notification” In this study, a poultry egg incubator temperature and humidity controller with SMS notification was designed, constructed and tested to evaluate its performance. The major components of this design are the microcontroller, temperature and humidity sensor and GSM module. In addition to that, a monitoring system has also been developed so that the user can have seamless accesses and easily monitor the egg incubator. Most importantly, its purpose is to create an environment where the egg incubation process occurs in a more orderly and safe manner. The incubating chamber was generally maintained throughout the incubating period at a temperature range of 37 degrees Celsius to 39 degrees Celsius and an average relative humidity of 40-50 percent must be maintained for the first 18 days. Then 65-75 percent for the final days before hatching.

Synthesis

According to the studies mentioned above, the researchers use an Arduino Microcontroller and NodeMCU ESP8266 as main board. The researchers also identify the appropriate temperature and humidity in accordance with the eggs age. They also mentioned the importance of the incubators design. they also use DHT 11 Sensor to monitor the temperature and humidity of the incubator.

In conducting this study, the researcher come up with a consideration to enhance it by adding a stepper motor to automatically rotate the egg tray. It also used a mist maker to increase the humidity. To integrate all of it, the researcher used an Arduino Uno Microcontroller. The researcher also considered the proper insulation inside the incubator to maintain the temperature and humidity. The project has candling light built-in to it, to monitor the progress of the eggs. To identify the effectiveness of the study the device was compared to the conventional way or natural way of egg incubation.

CHAPTER 3
METHODOLOGY

Methodology Flowchart

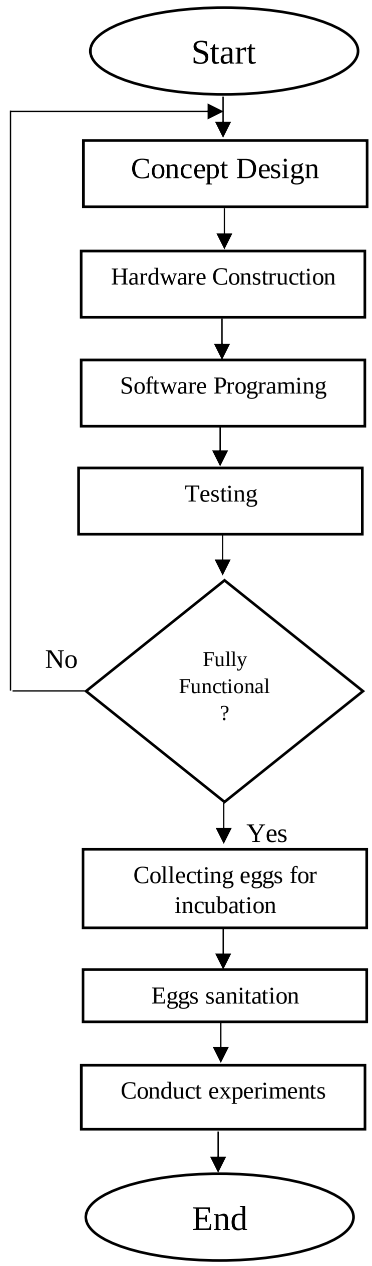

Figure 3.1 Methodology Flowchart

Methodology flowchart as shown in the figure 3.1 starts with conceptualization of the design and determine the purpose of the study, then gathered information about the project, it begins with hardware construction and if the prototype is ready the researcher will program the microcontroller to its purpose and functions. Next, testing of the prototype if it is fully functional then finalize the project, then collect fertile egg and sanitize before putting it to incubator. Finally, the researcher conducted experiments in the actual field if it compensates its purpose.

Conceptual Framework

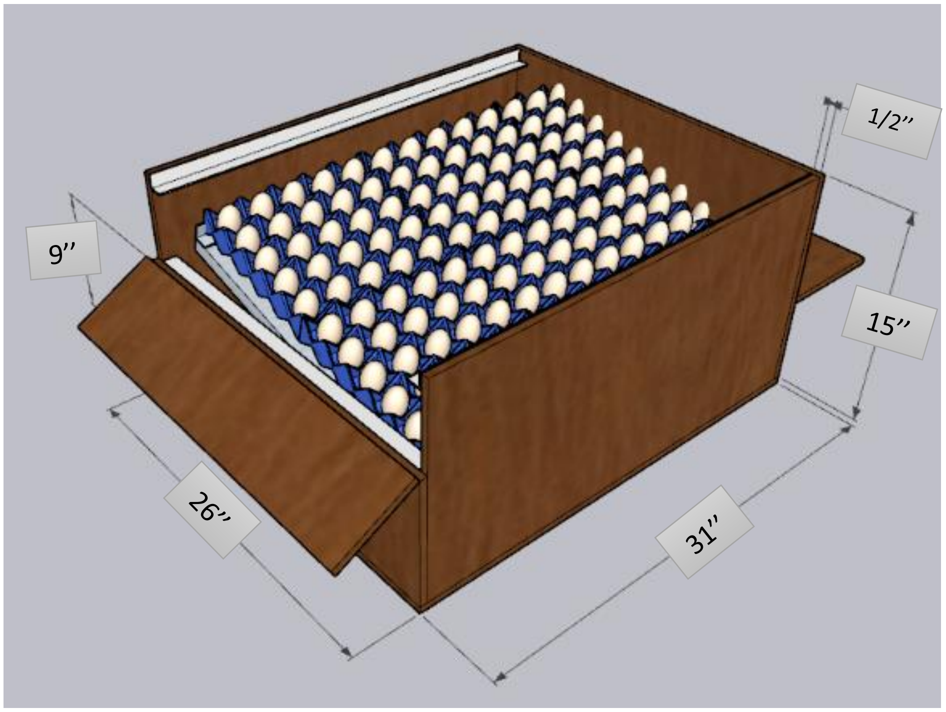

Figure 3.2 Prototype Dimensions

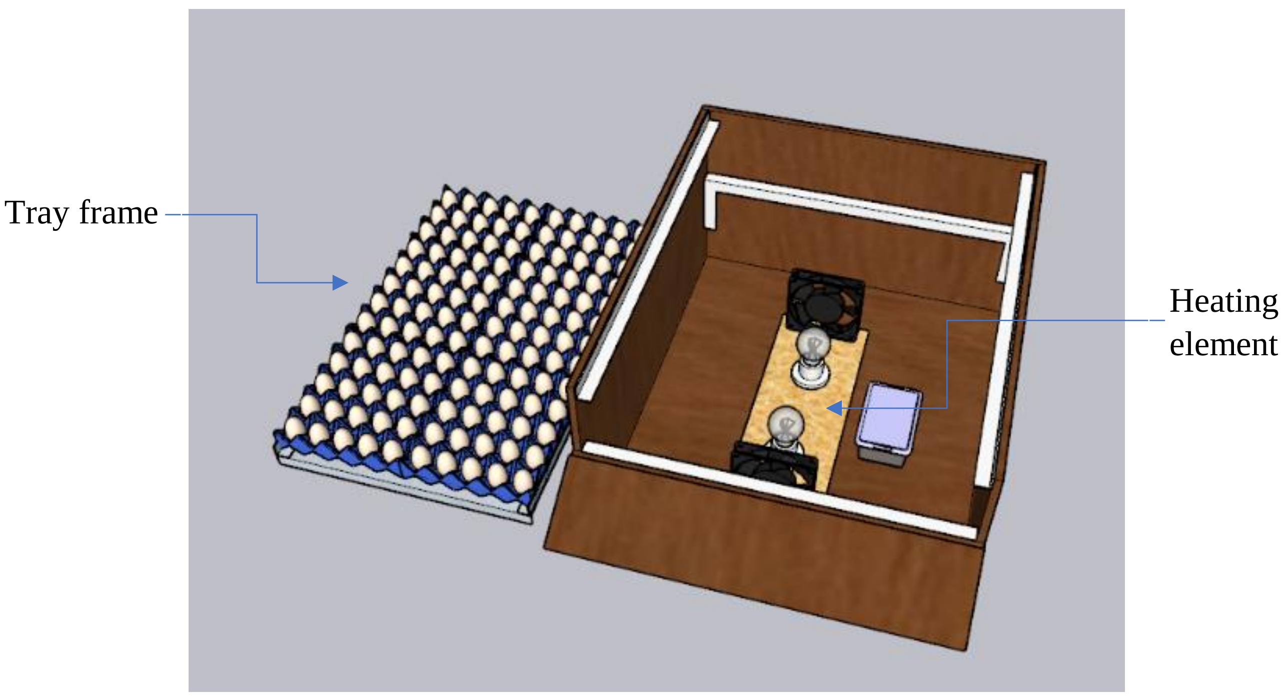

Figure 3.3 Prototype Design

The dimensions and construction of the project shown in the figure 3.2 has a volume of 12090 sq. inches. The incubator is made up of a half inch plywood to cover the electronic components and incubator. It has a quarter inch glass at the top for the egg candling which is supported by an aluminum angle bar. The incubator includes two tray which is capable of hatching 176 eggs, The two trays have also an aluminum angle support for egg turning. As shown in figure, you can open it in the side part where you can slide the egg tray.It has a 6-inches height opening and a hinge for opening and closing of the incubator.

The bottom part of the prototype shown in the figure 3.3, includes the heating element which is the bulb, mist maker for the increase of humidity and fan to distribute the heat and mist inside the incubator. The two bulbs have a 100 watts rating that can reach the desired temperature in just a second. The mist maker has a water container intended for a long duration of operation. The incubator can maintain its temperature and humidity for a long period of time. The egg tray is rotating to its desired angle with the help of the AC stepper motor which is attached to the brace of egg tray with an aluminum bar. It has a tube light also for egg candling.

System Block Diagram

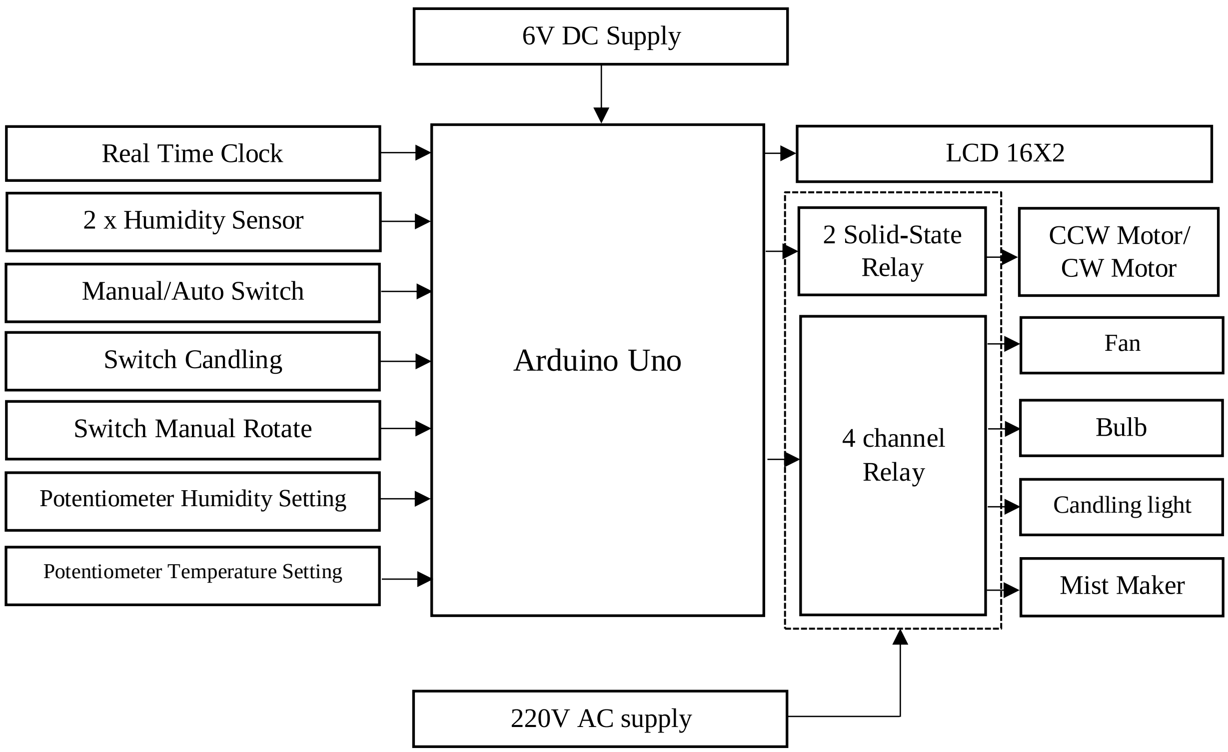

Figure 3.4 System Block Diagram

The system block diagram shown in Figure 3.4 starts with a 6 volts DC power supply which is connected to the Arduino Uno microcontroller. The Arduino Uno has an output voltage of 3.3volts and 5volts to supply the modules. The LCD 16x2 has an operating voltage of 5volts, the temperature and humidity sensor (DHT 11) have an input voltage of 3.3volts and the 4-channel relay module is connected to the Arduino Uno output voltage for control and a 220 volts AC supply is connected to the relay to power up the humidifier, fan, bulb, and a tube light. The AC stepper motor that has a clockwise and counterclockwise is connected to a two solid-state relay which is powered by the Arduino supply. It uses a solid-state relay for total isolation to compensate the back emf caused by the motor inductor and the capacitor which we call the flywheel effect. The project also has Real time clock DS1302 that has a supply of 5.5 volts. Two potentiometers were included in the input part which control the desired temperature and humidity for manual operation and the taggle switches has 4 functions which are (1) main switch; (2) for manual switch of tube light for egg candling; (3) for manual egg turning; and (4) for manual and automatic operation of setting humidity and temperature.

Component Placement layout

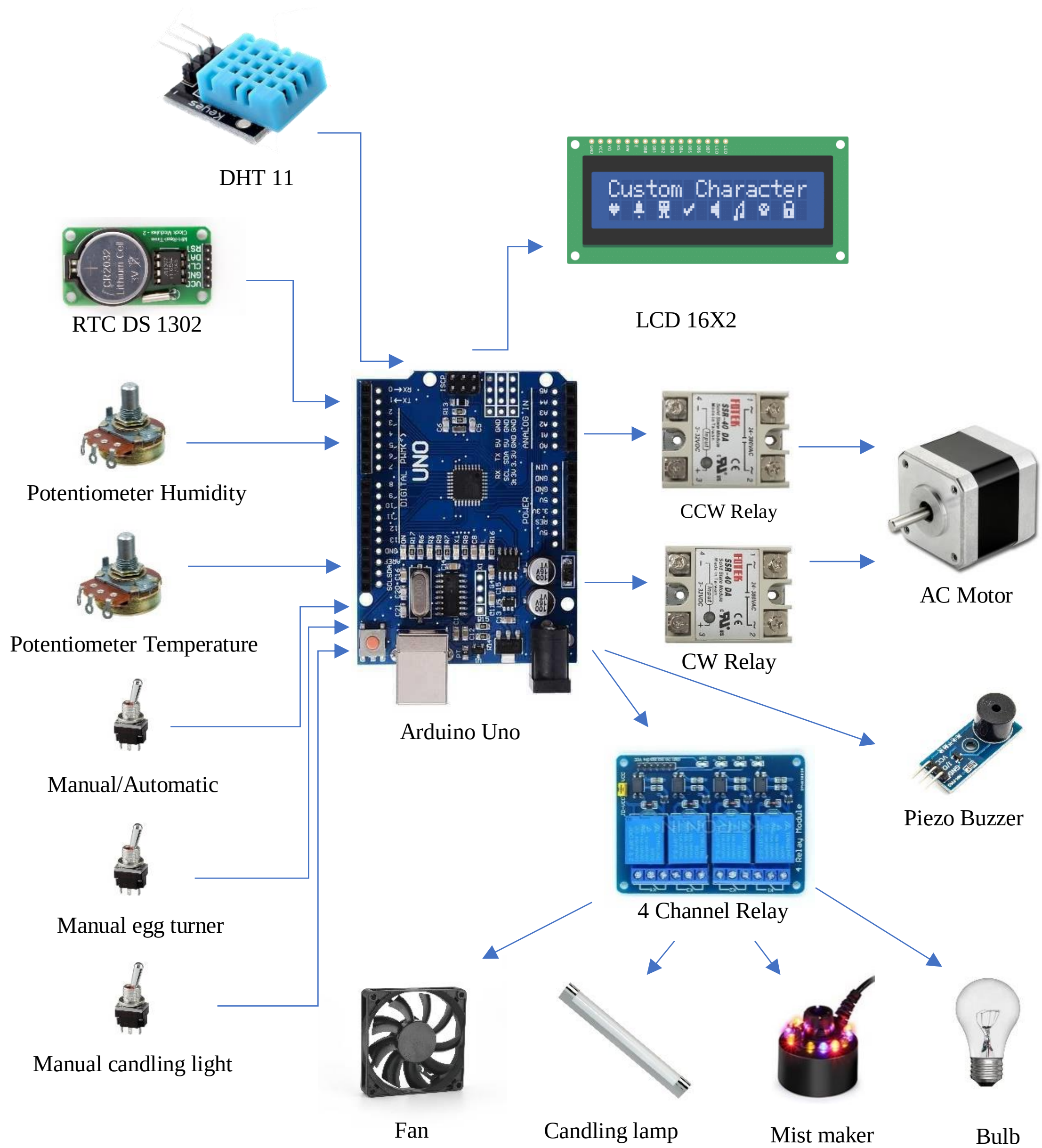

Figure 3.5 Component Placement Layout

The electronic component placement layout shown in Figure 3.5 is composed of three parts, first is the central unit or the Arduino uno microcontroller, second is the input module part, and last is the output module part. Input modules includes the following. RTC DS1302 (Real Time Clock) which gives the current time and date for the time cue of the device. DHT 11 for current time monitoring of the ambient humidity and temperature of the incubator. The four taggle switch has a function of first the main switch, second is for egg turning, third is for egg candling, and fourth is for the manual or automatic operation of the incubator. The two potentiometers are used for manual setting of humidity and temperature.

In the output module part, which includes the following. LCD that displays the number of days of incubation, current date, current temperature, and humidity the four-channel relay controls the mist maker which increase the humidity of the incubator, bulb to increase the temperature, tube light for egg candling and fan for distribution of mist and heat around the incubator. The solid-state relay controls the clockwise and counterclockwise rotation of the AC motor for egg turning.

Circuit Design

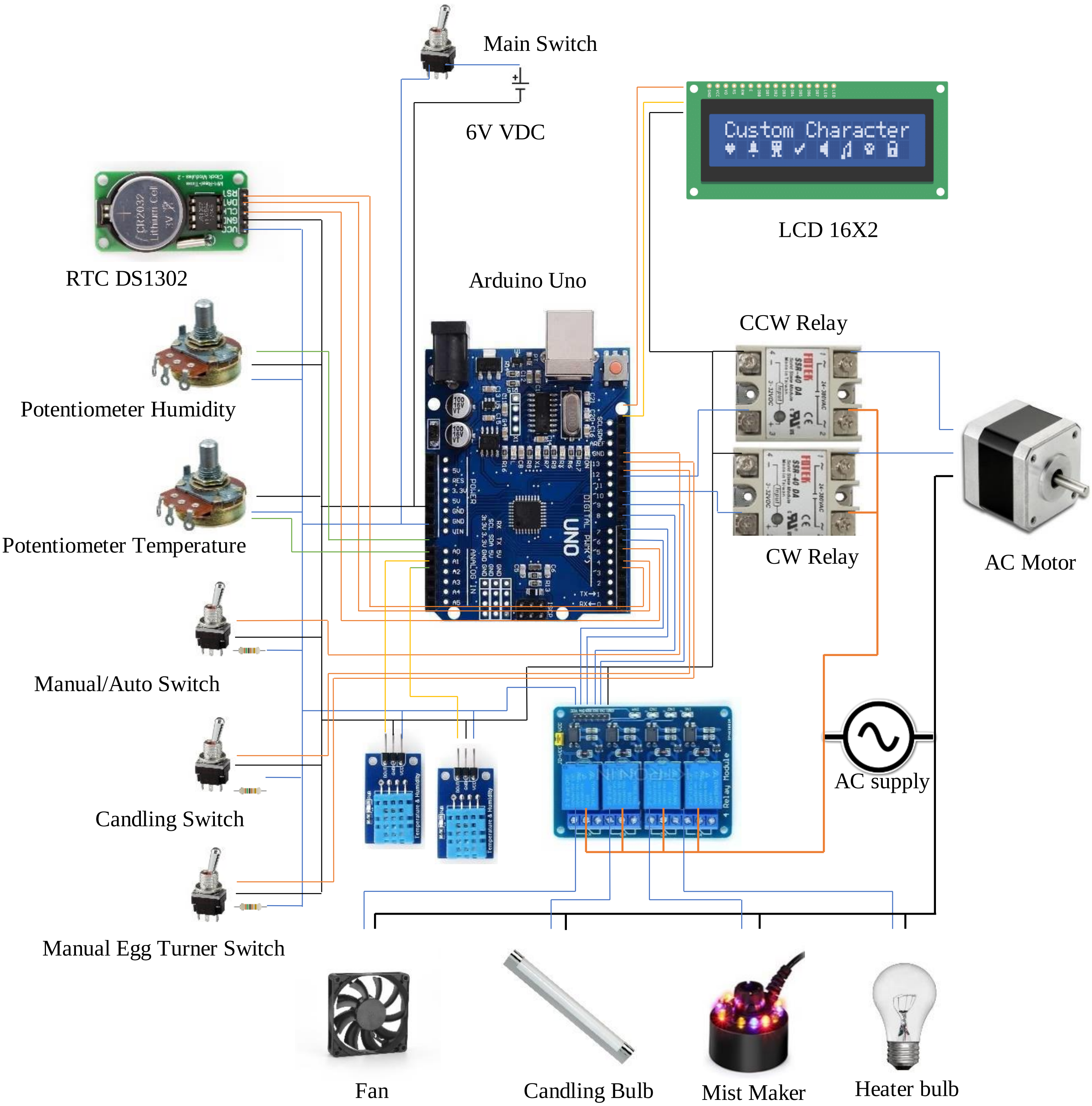

Figure 3.6 Circuit Design

In the circuit design shown in Figure 3.6, all the modules are connected to the Arduino Uno which is supplied by a 5volts. The two DHT 11 Sensor has a data pin which are connected to the A3 and A4 of the Arduino Uno board. The RTC DS1302 has a RST, DATA, and CLK pins that are connected to the D2, D3 and D4 of the Arduino respectively. The three taggle switch are connected to the pins D11, D12, and D13 of the Arduino, they have a 1k ohm resistor to avoid short circuit. The potentiometer is connected to the A0 and A1 of the Arduino.

The output module includes the following connections. The LCD which has an input voltage of 5 volts, the SDA and SCL of the LCD was connected to the clock and data pins of Arduino. The device has a 4-channel relay to control the mist maker, bulb, fan, and candling light that were connected to the D5, D6, D7, and D8 pin of the Arduino and has a supply voltage of 240 VAC for the modules. To control the AC Stepper motor, the device uses a two solid-state relay which has a supply of 240 VAC that is connected to the D9 and D10 of the Arduino pin. The motor has a capacitor included to it and connected parallel to the clockwise wire and counterclockwise wire. For power dissipation a resistor was connected parallel to the solid-state relay to avoid damage in the Arduino board.

Process Flowchart

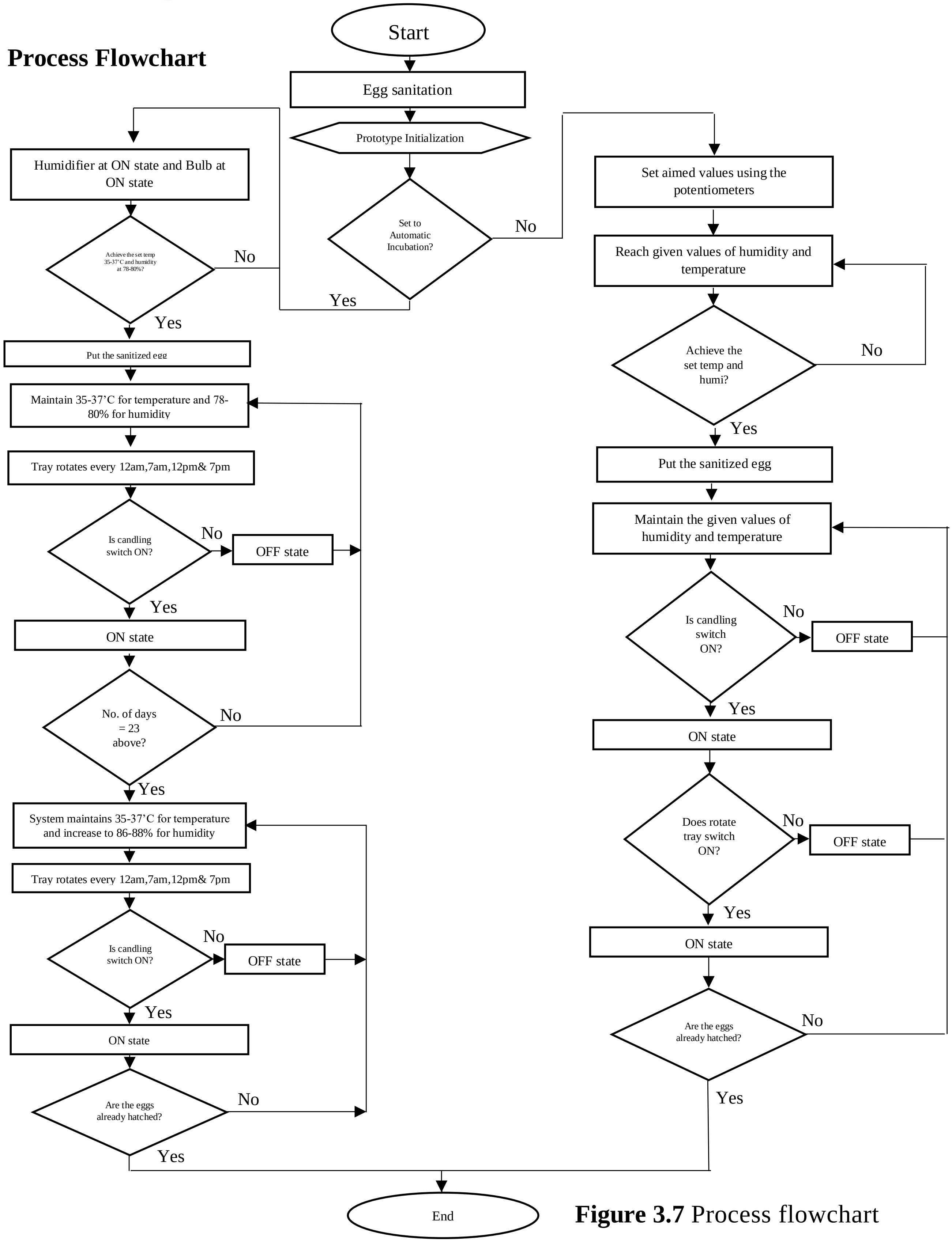

Figure 3.7 Process flowchart

The process flowchart shown in figure 3.8. The process starts with egg sanitation for preparation of incubation. Then, initialization of the prototype. Next, the system will ask if it uses a manual mode or Automatic mode. In automatic mode, the device will start to reach the 35-37’C for temperature and 78-80% for humidity. If the given values are reach, the management can now put the sanitized eggs inside the incubator. The incubator will maintain its temperature and humidity. In automatic mode the egg tray is set to rotate at a given time, but the candling light is still in manual operation. If the day counter reached the day 23 the humidity will increase up to 86-88% for the preparation of hatching. If the eggs are already hatched then, the process ends.

In manual mode, manually the management will set the temperature and humidity using the potentiometer. If the values are set the devices will reach and maintain it. Next is setting the egg inside the incubator. In manual mode the egg tray is manually turned ON and OFF. Finally, if the eggs are already hatched the process ends.

System Flowchart

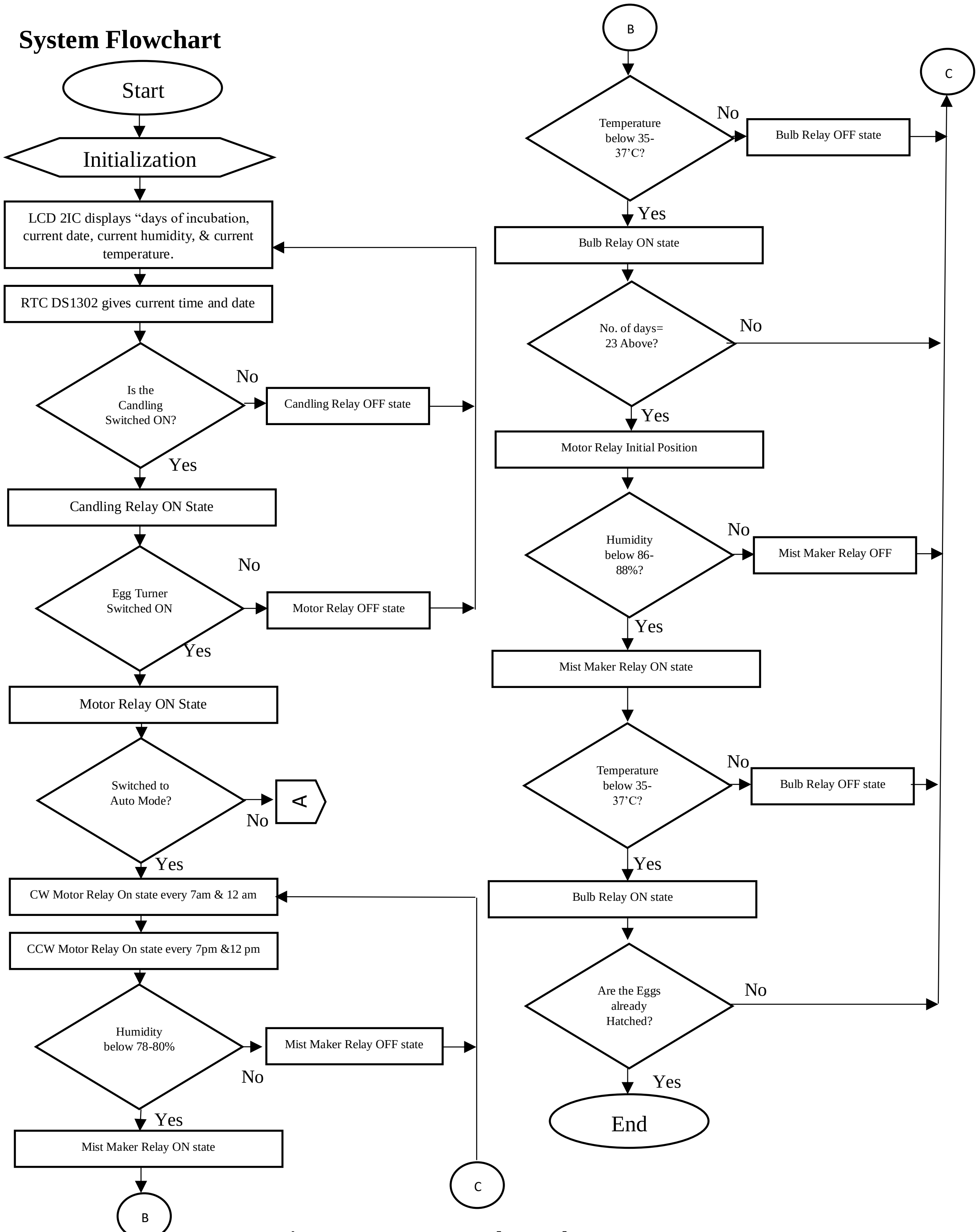

Figure 3.8 System Flow Chart

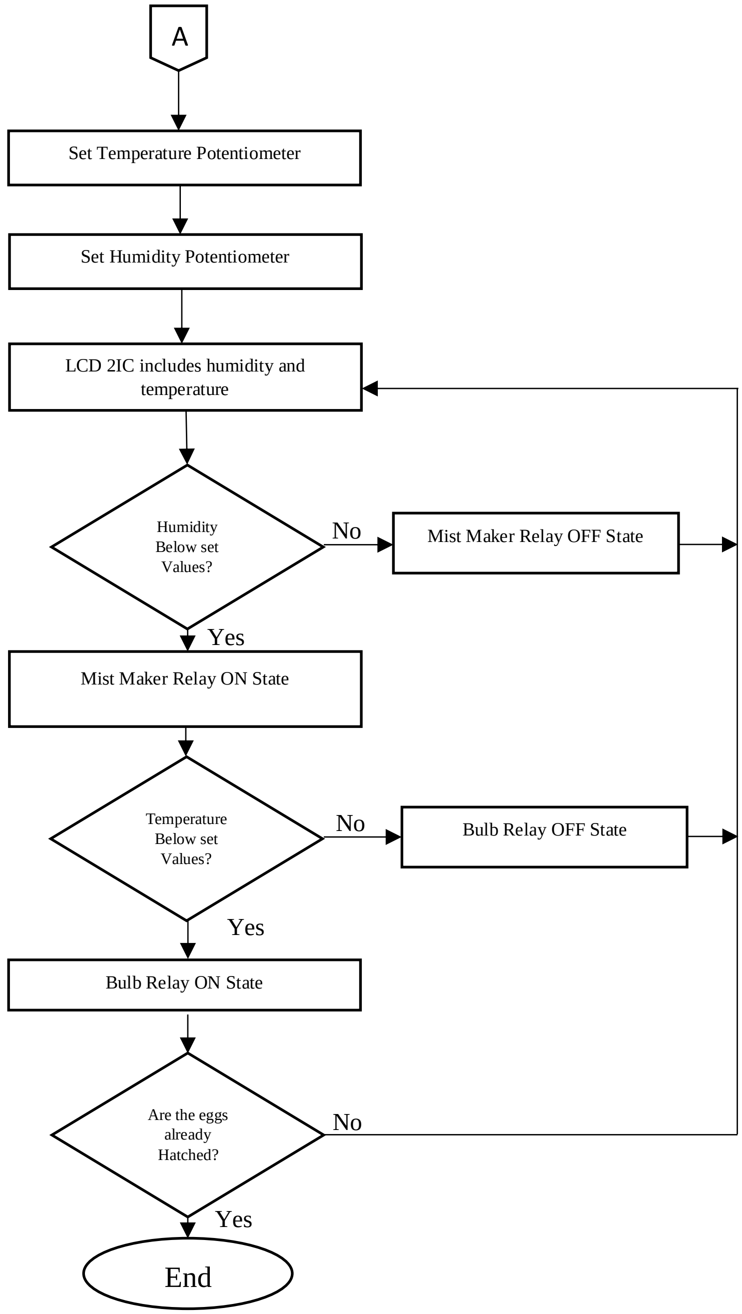

Figure 3.8 System Flow Chart

The system flowchart shown in Figure 3.8 shows the process which starts with the initialization of the Arduino microcontroller, the LCD 2IC 16x2 will displays the egg day of incubation, current date and current temperature and humidity of the incubator. The device has four taggle swich, two of which are the next in the process which are the tube light switch and egg turner switch. The system will ask if they are ON and then the Arduino will command the relay to turn ON. The next process is the switch for manual or automatic setting of humidity and temperature, it will monitor if the switch is at auto mode or manual mode. First the manual mode, the system gets the set humidity and temperature through the potentiometer settings and the Arduino will command the fan, bulb, and mist maker until it reaches the desired temperature and humidity of the user. Second, the auto mode which consists of two parts. The RTC DS1302 module will give the days render of the egg. The LCD 16x2 will display it and the DHT 11 sensor will also give the current temperature and humidity inside.

First, the system will ask if day is equal to 1-23 if yes, the egg tray will rotate clockwise and counterclockwise at time is equal to 7am, 12am, 7pm, and 12 pm. then the incubator will maintain the 36-37’C temperature and 77-78% humidity throughout days.

Second, if the day of incubation is 23 above the motor is at the initial state and no more egg turning method. The temperature will be maintained, and humidity will be increased to 87% as the egg will start to lose its water inside and also to soften the eggshells.

Program Flowchart

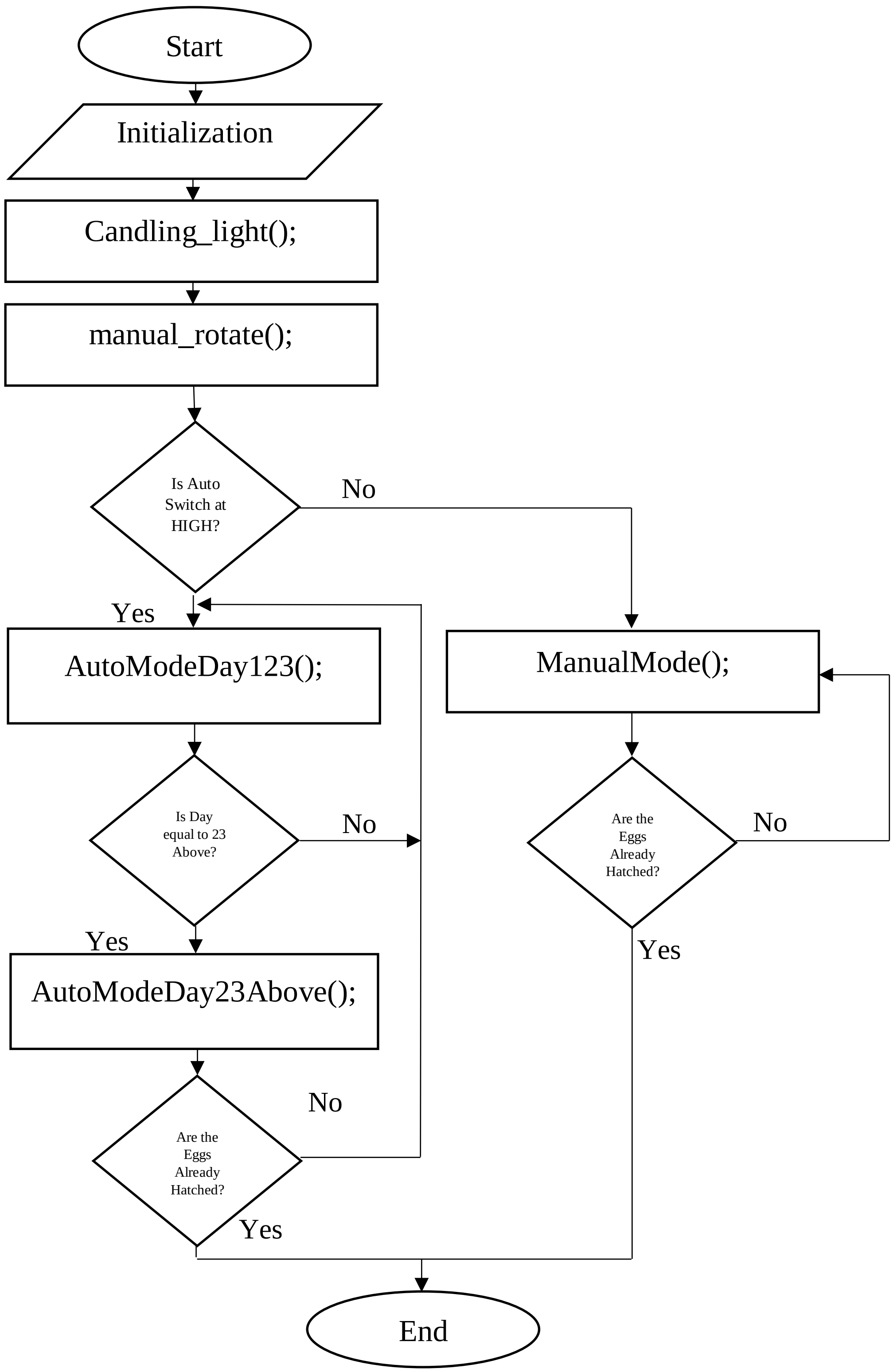

Figure 3.9 Program Flow Chart

The program flowchart shown in the figure 3.9 start with system initialization. Then, at the top of the chart is the manual switching of the candling light. Next to it is the manual switching of the egg turner which is the stepper motor. Then the system will ask if it is in the manual mode or automatic operation mode. If it is in the automatic operation mode it will ask the Real time clock if the day is below 23 or 23 above. below 23 day means it will maintain the temperature 35-37 degree Celsius and 78-80 percent humidity. 23 and above maintains the temperature 35-37 degree Celsius and 86-87 percent humidity through the DHT sensor. If the switch is at the manual mode, the system will ask for the values of the potentiometer in manual setting of the temperature and humidity. If the eggs are already hathed then, the process ends.

Parts and Hardware Design

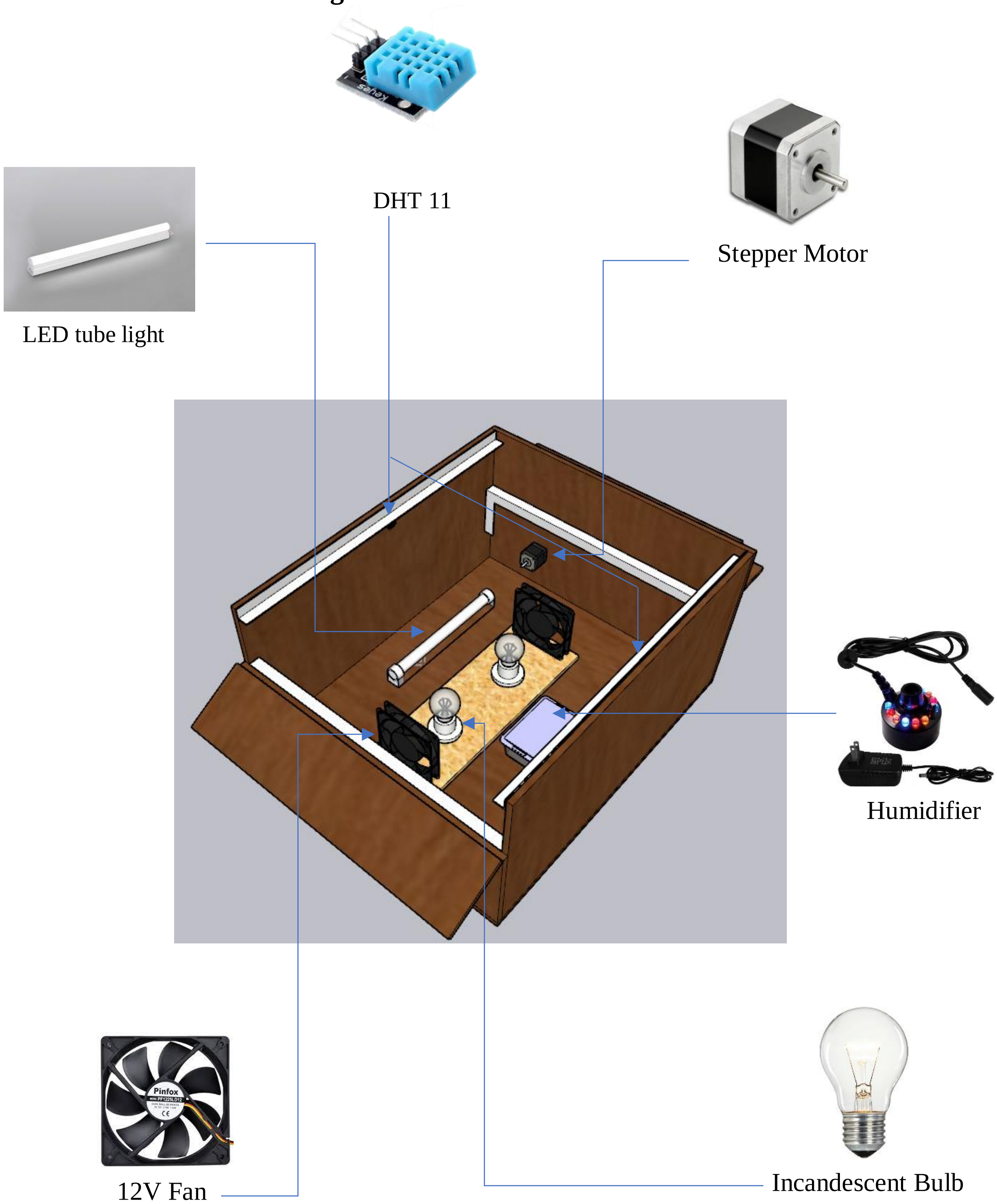

Figure 3.10 Electronic Component Placement

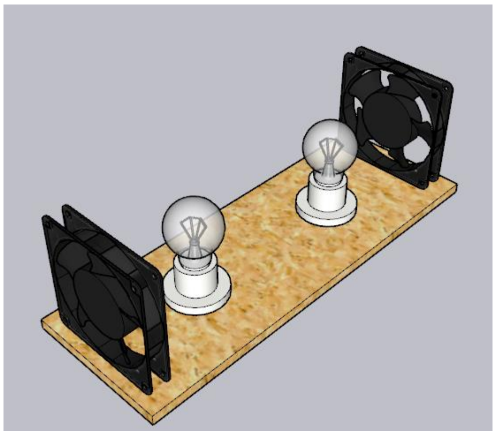

Figure 3.11 Bulb and Fan

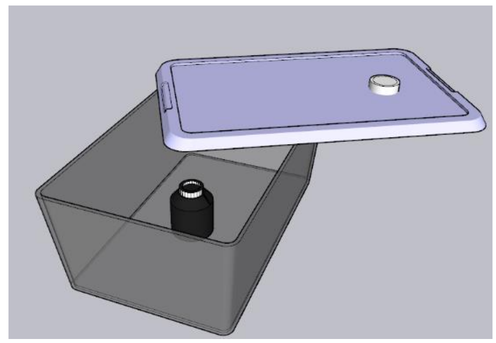

Figure 3.12 Mist Maker

The electronic component placement shown in Figure 3.10 Shows the inside part of the incubator. AC motor is attached to the frame and the connected to the brace of the egg tray to rotate it to approximately 40 degrees. The mist maker which increases the humidity of the incubator. The bulb that gives heat to the incubator and fan to distribute the mist and heat inside the incubator. To have an accurate reading of the temperature and humidity of the incubator we provide two DHT 11 sensor and get the average temperature and humidity. It also shows the tube light for candling. Figure 3.11 shows the construction of the bulb and fan for distribution of heat for its efficiency. Figure 3.12 shows the mist maker that are attached to the water container.

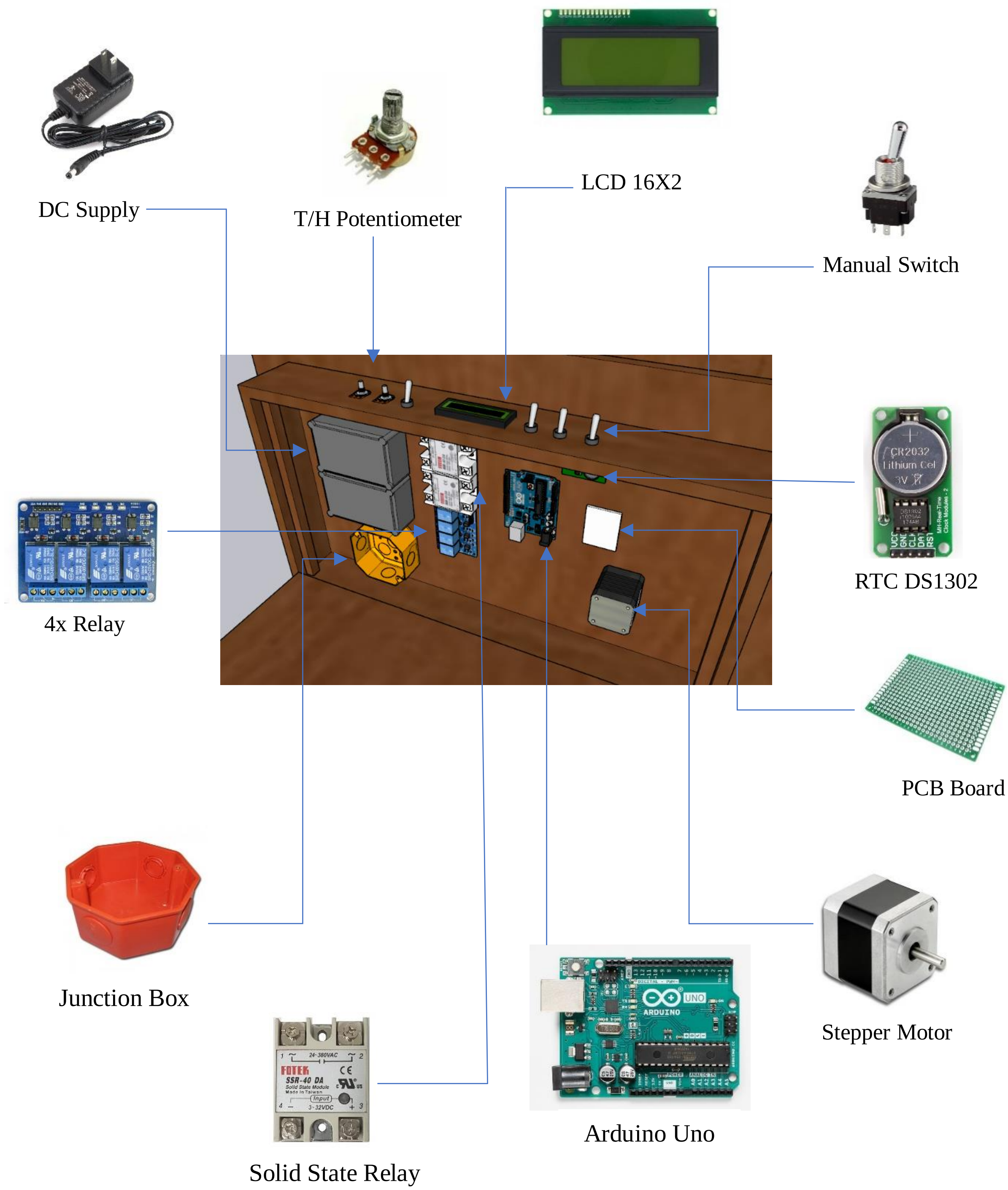

Figure 3.13 Control Unit Components

The control unit components that the central command; Shown in Figure 3.13. It consists of Arduino uno that can integrate with the module and can execute command. It has a junction box for AC power supply connections. There are three DC power supply that will power up the Arduino, the fan, and the mist maker. The four-channel relay is placed next to the solid-state relay that controls the bulb, mist maker, fan, and the tube light for candling. It has a solid- state relay which controls the counterclockwise and clockwise rotation of the motor. At the top we can see the potentiometer for manual setting of humidity and temperature. LCD 16x2 2ic that display data. Four taggle switch first is the main switch, switch for egg turning, switch for tube light for candling and for automatic and manual operation of the incubator. We can also see the RTC DS1302 that gives current time and date. The AC Motor is at the bottom that manipulate the egg tray. The PCB board where the distribution of power happens comes from the supply of the Arduino.

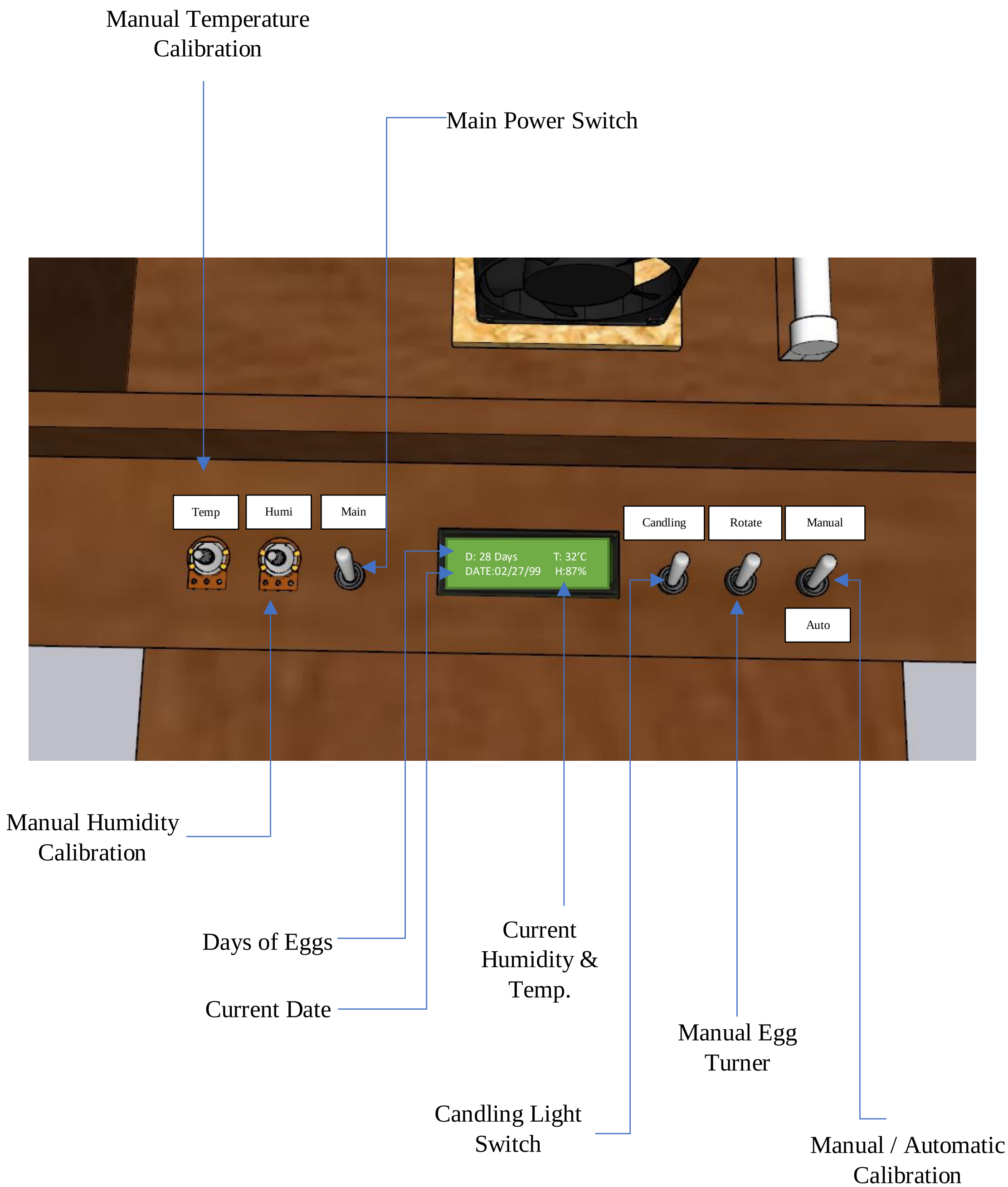

Figure 3.14 Controls and Data

The controls and data of the incubator are shown in Figure 3.14 which shows the potentiometer for the left is the manual setting of temperature. Next to it is the potentiometer for manual setting of humidity. Next to it is the taggle switch which is the main power switch. At the middle we have the LCD 2ic 16x2 that displays the days of incubation, current date and current humidity and temperature. The switch next to it is for candling light. Next is the switch for manual egg turning. Lastly, the switch for manual and automatic temperature and humidity setting.

Materials/Equipment Used

Arduino Uno

The Arduino Uno is the device's central processing unit, an open-source microcontroller board based on the Microchip ATmega328P microprocessor. The board has several digital and analog input/output pins that may be connected to various expansion boards and other devices.

Figure 3.15 Arduino Uno

DHT 11/22 Sensor

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed).

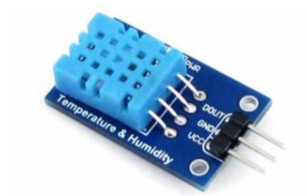

Figure 3.16 DHT 22 Sensor

Stepper Motor

The stepper motor was used to rotate the egg tray to avoid the sticking of embryo in the shell.

Figure 3.17 Stepper Motor

Real time Clock

This RTC module provides seconds, minutes, hours, day, date, month, and year information. In this module, date is set automatically based on whether the month is 29, 30 or 31 days and it is leap year or not.

Figure 3.18 RTC DS1302

LCD I2c 16X2

Liquid crystal display was used to display the current date, humidity, temperature and days of egg inside the incubator

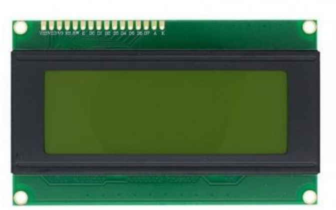

Figure 3.19 LCD 16X2 2IC

Electro-mechanical Relay Module

Electro-mechanical Relay was used to automatically switch the mist maker, heater bulb, candling light, and the 12-volt fan.

Figure 3.20 Electro-mechanical Relay Module

Solid State Relay

The solid state relay was used to swich ON and OFF the stepper motor clockwise and counter clockwise because it has a total isolation to the circuit.

Figure 3.21 Solid State Relay

Toggle Switch

Toggle Switch was used for manual operation of the incubator.

Figure 3.22 Toggle Switch

Potentiometer

The potentiometer was used for manual calibration of humidity and temperature.

Figure 3.23 Potentiometer

DC Power Supply

To give power to the circuit, fan, and mist maker a DC supply was used.

Figure 3.24 DC Power Supply

Junction Box

It is used to hide messy electrical connections along the incubator.

Figure 3.25 Junction Box

12V Fan

The fan was used to distributed heat and mist throughout the incubator.

Figure 3.26 12V fan

Incandescent Bulb

This bulb was to heat up and compensate the heat inside the enclosure.

Figure 3.27 Incandescent Bulb

Mist Maker

Mist maker functions was to increase the humidity inside the incubator.

Figure 3.28 Mist Maker

Tube Light

It served as the candling light for the eggs.

Figure 3.29 Tube light

PCB Board

PCB board was used to connect all the supply that comes from all the modules

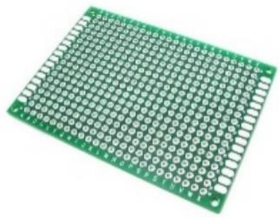

Figure 3.30 PCB Board

Diode

Diode was used to dissipate power in the motor cause by an eddy current or buck emf.

Figure 3.31 Diode

Resistor

Resistor was used to avoid short circuit in the circuit. It is connected to the taggle switch

Figure 3.32 Junction Box

Wires

This wire was used to extend the short ones and connect it to its respective place of connections.

Figure 3.33 Wires

½ inch Plywood

its serve as the frame to the incubator and to the electronic components in it.

Figure 3.34 ½ inch plywood

¼ inch Glass

The glass served as the top cover to allow the management to see the progress of the eggs.

Figure 3.35 1/4-inch Glass

Aluminum Angle bar

This material was used for the glass and egg tray reinforcement.

Figure 3.36 Aluminum Angle Bar

Bolts and Screws

Used to connect all the plywood and angle bars.

Figure 3.37 Aluminum Angle Bar

Bill of Materials

Table 3.1 Bills of Materials

Parts Name	Description	Unit Price	Quantity	Total Price
Arduino Uno	Operating voltage: 5V	P 350.00	1 pc	P 350.00
DHT 11/22 Sensor	Operating voltage: 3V	P 75.00	2 pcs	P 150.00
Humidifier	Operating Voltage:220VAC	P 280.00	1 pc	P 280.00
Fan	Operating Voltage: 12VDC	P150.00	3 pcs	P 450.00
LCD 16x2	Operating Voltage: 5VDC	P 150.00	1 pc	P 150.00
4 Channel Relay	Operating Voltage: 5VDC	P 160.00	1 pc	P 160.00
Plywood	¾ Inch	P 890.00	1 pc	P 890.00
Egg tray	12 eggs	P 115.00	3 pcs	P 345.00
Receptacle		P 35.00	2 pcs	P 70.00
Bulb		P 35.00	2 pcs	P 70.00
Angle Aluminium	6 meters	P 300.00	1 pc	P 300.00
Junction box		P 35.00	1 pc	P 35.00
Power supply	12VDC,6VDC	P 60.00	2 pcs	P 120.00
RTC DS1302		P 70.00	1 pc	P 70.00
Solid-state relay	40A	P 160.00	2 pcs	P 320.00
Stepper motor	AC	P 300.00	1 pc	P 300.00
Toggle switch		P 25.00	3 pcs	P 75.00
Potentiometer		P 30.00	2 pcs	P 60.00
Tempered Glass		P 450.00	1 pc	P 450.00
Enamel Paint	1 L	P 250.00	1pc	P 250.00
Spray Paint	Blue	P 100.00	2pcs	P200.00
Tube light	amber	P 90.00	3pcs	P270.00

Grand Total: P 5365.00

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CHAPTER 4

CONCLUSION

The Automatic Duck Egg Incubator with Manual Candling System has been used in the real-world situation so that we can compensate the 3 main objectives of the research as state in chapter 1.

(1) The Automatic Duck Egg incubator with Manual Candling system keeps the right temperature and humidity. It is stable compared to the fluctuating ambient level.

(2) The Automatic Duck Egg incubator with Manual Candling system can give more effective results to a 100% hatchability rate compared to 40% of the natural method..

(3) The prototype is fully functional, and it was able to perform the anticipated measurements and actions as with the programmed instructions on the microcontroller were able to feedback readings and automate the humidifier and heating element when needed. Also, at specified times the system was able to tilt the tray and turn on the candling light.

CHAPTER 5

RECOMMENDATION

Although the Automatic Duck Egg Incubator with Manual Candling System is proven functional and effective, the researcher recommends the following for future improvement:

1. Provide individual LED for every egg in candling system may help display much clearer embryo.
2. Place stepper motor at the top of the tray to avoid using a counterweight.
3. Include a reserve water tank outside the incubator and a hose connected to the water container in the mist to lessen the opening and closing of the incubator.
4. Create a box below the incubator to help the ducklings in maintaining its temperature and humidity during brooding period.
5. Put a top cover along the glass at night for the incubators to efficiency with dropping temperature caused by external temperature.

Appendix A

Definition of Terms

Arduino Uno. Arduino UNO is a microcontroller board based on the ATmega328P.

Candling. egg-grading process in which the egg is inspected before a penetrating light in a darkened room for signs of fertility, defects, or freshness.

Flywheel effect. is the continuation of oscillations in an oscillator circuit after the control stimulus has been removed. This is usually caused by interacting inductive and capacitive elements in the oscillator.

Incubator. is a device used to grow and maintain microbiological cultures or cell cultures. The incubator maintains optimal temperature, humidity and other conditions such as the CO2 and oxygen content of the atmosphere inside.

RTC. Real Time Clock

DHT Sensor. The DHT sensors are made of two parts, a capacitive humidity sensor and a thermistor.

EMF. Electric and magnetic fields (EMFs) are invisible areas of energy, often referred to as radiation.

Inductor. also called a coil, choke, or reactor, is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it.

Solid-State Relay. is an electronic switching device that switches on or off when an external voltage (AC or DC) is applied across its control terminals.

Prototype. a first full-scale and usually functional form of a new type or design of a construction

Analog Pin. Analog input pins allow an application to examine the voltage levels present on a pin as an analog signal.

Digital Pin. is a circuit designed to receive a binary signal transmitted from an industrial sensor and translate that input into a reliable logic signal for a programmable logic controller (PLC) or industrial controller

Programming.is a set of instructions to facilitate specific actions.

Electromechanical Relay. is a type of relay which function using a magnetic field produced by an electromagnetic coil when a control signal is applied to it.

AC. Alternating Current

DC. Direct Current

Microcontroller.is a compact integrated circuit designed to govern a specific operation in an embedded system

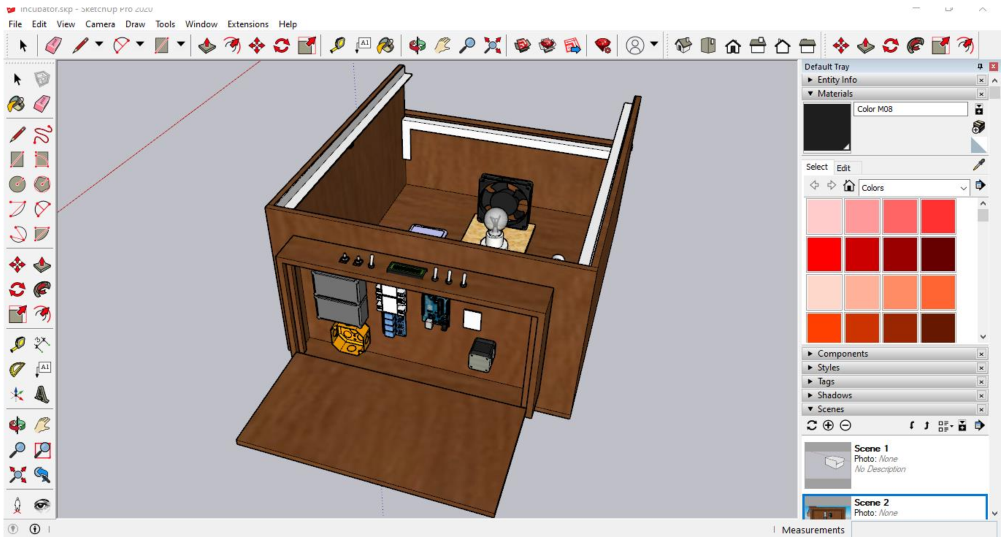
Back emf. the system in the coil of an electric motor that opposes the current flowing through the coil when the armature rotates.

Capacitor. is a device that stores electrical energy in an electric field.

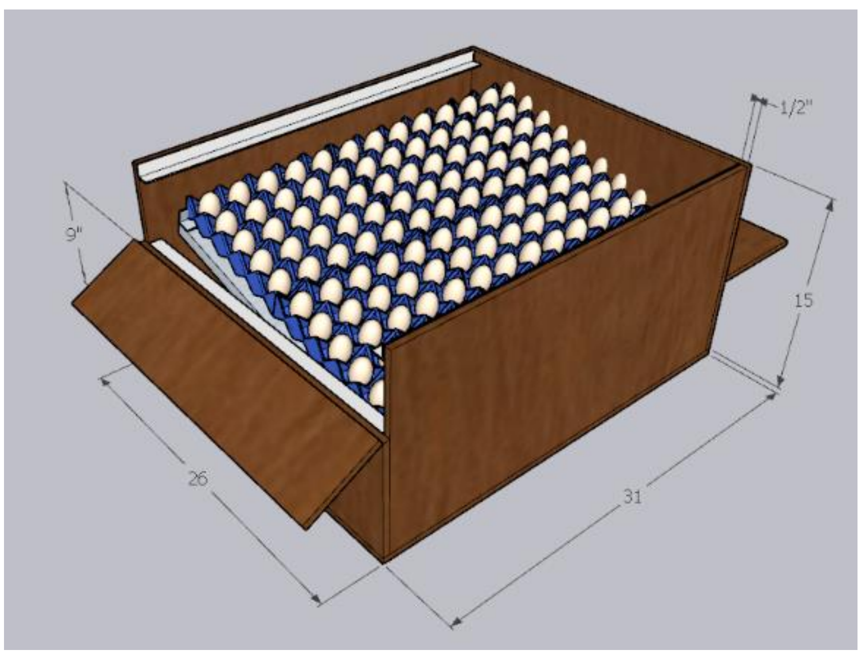
Appendix B

Procedure in Creating the Prototype

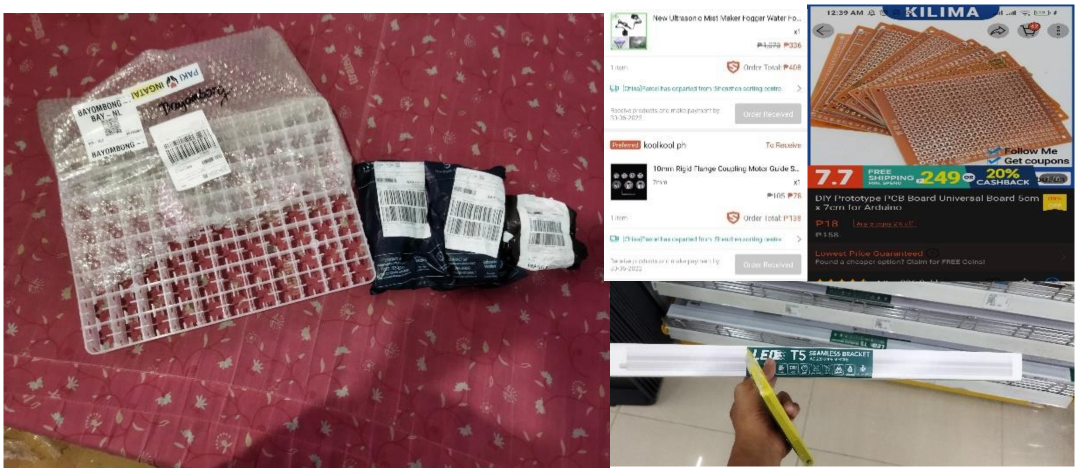
Step 1: 3D Design using Sketchup



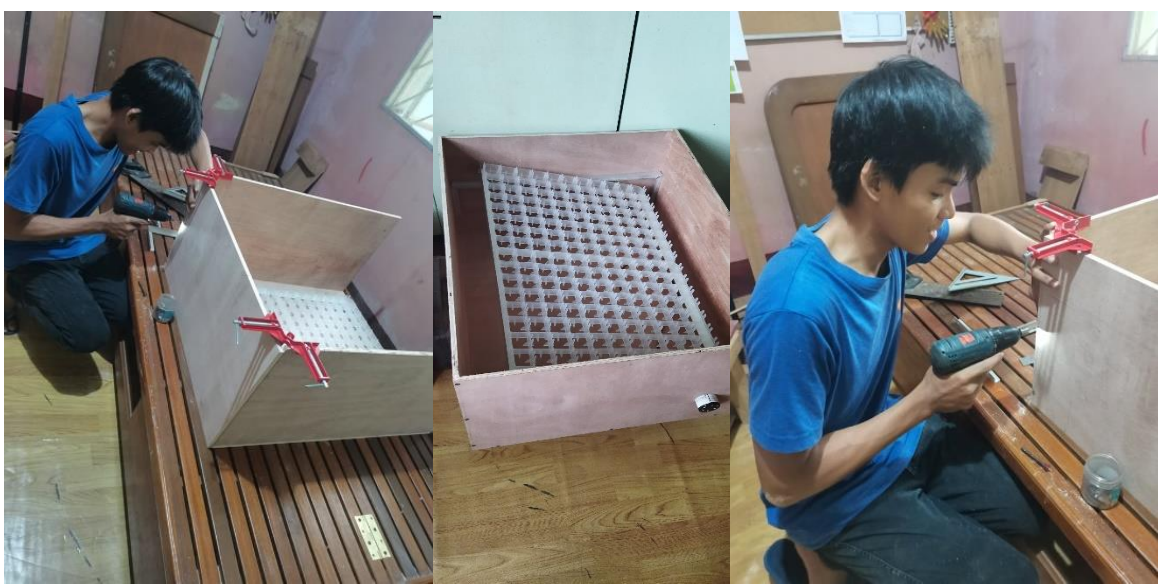
Step 2: Prototype dimensions



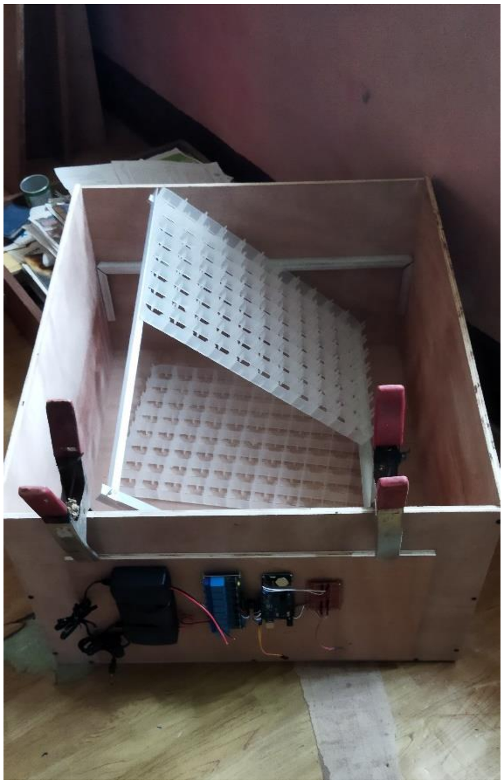
Step 3: Colleting parts and materials

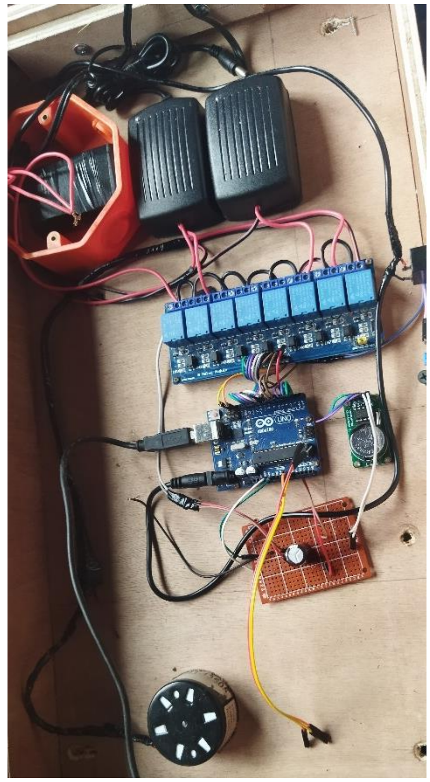


Step 4: Hardware construction

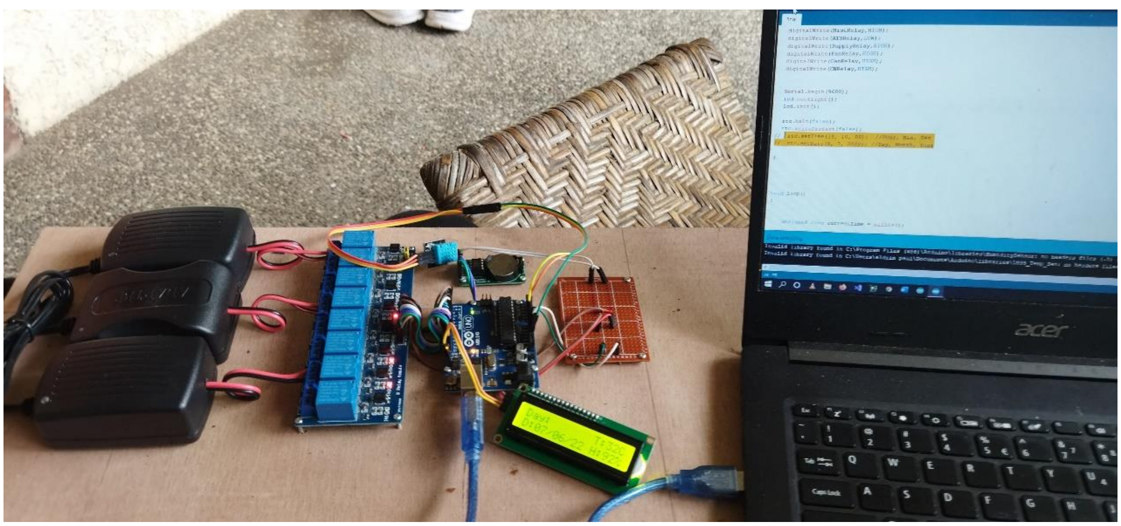


Step 5: Electronic component layout

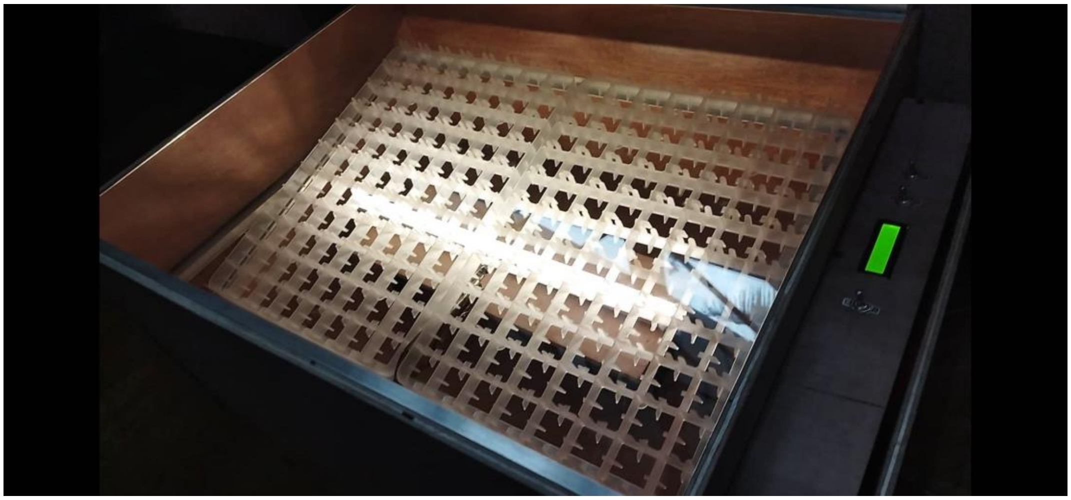


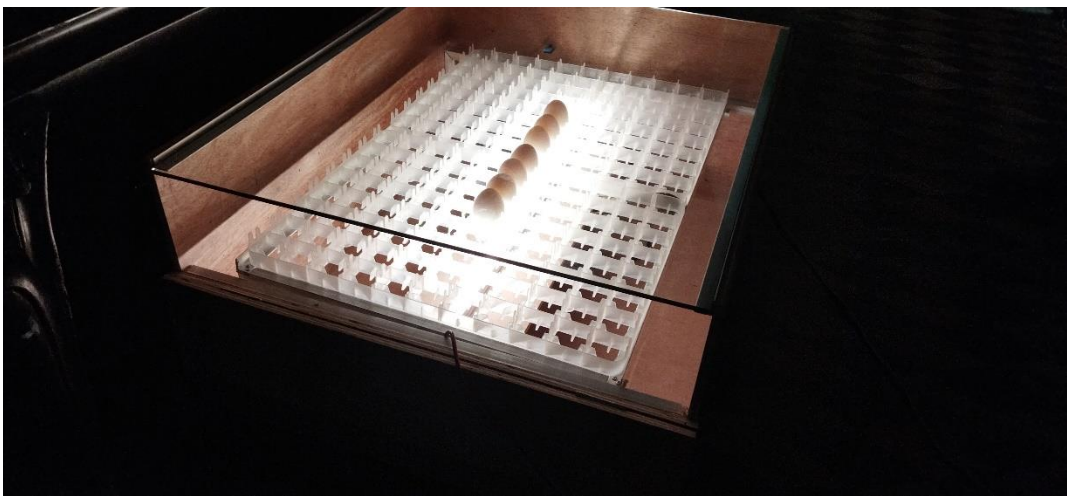


Step 6: Software Programming



Step 7: After many testings, the prototype is ready for egg incubation.





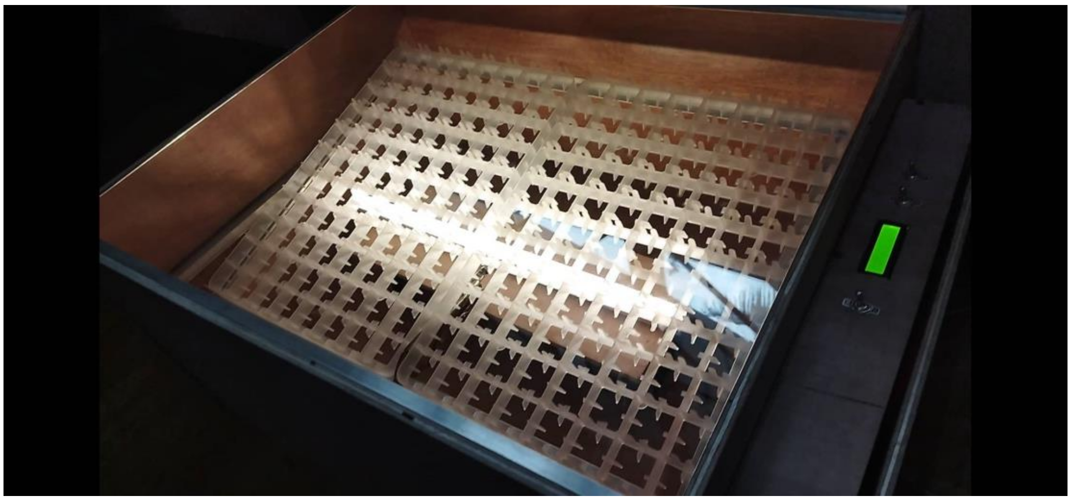
Appendix C

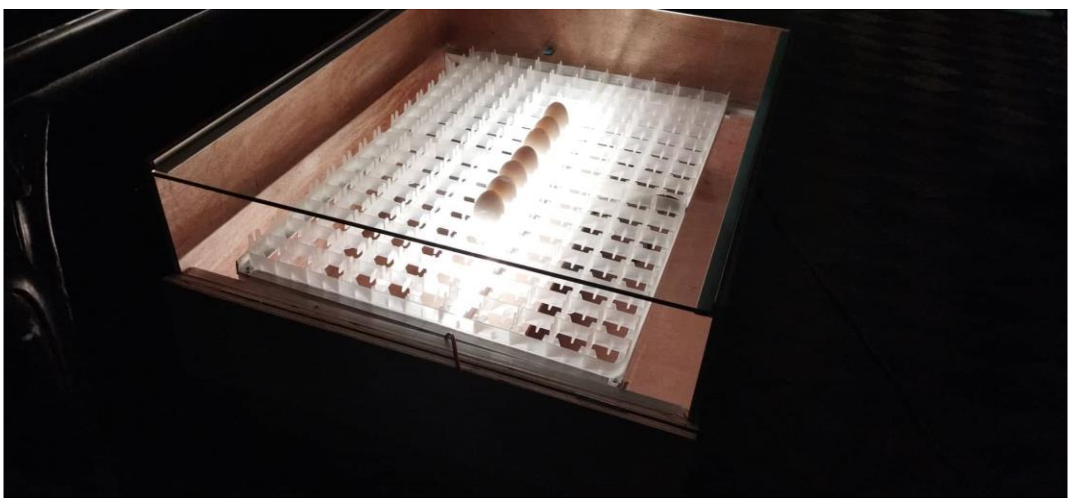
Incubation Period

The researcher come up with an idea which is to compare the natural incubation of egg and artificial incubation using the Automatic Egg Incubator with Candling System. The researcher used a duck egg to incubate which has a 28 and more days to hatch. The mother duck has 12 eggs. I put 7 eggs in the artificial incubator. Here is some picture during the incubation.

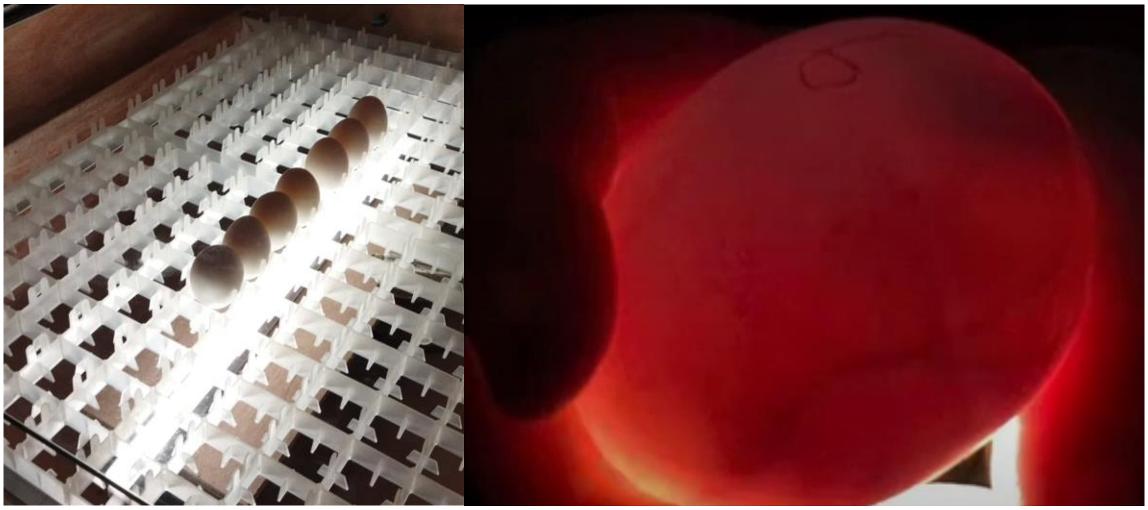
Day 1: Cleaning and sanitizing the duck egg

Day 1: Setting incubators temperatures to 36-37’C and humidity to 78 % and putting the egg inside of it. As we can the egg is very clear and as the light passes through it the egg is translucent.



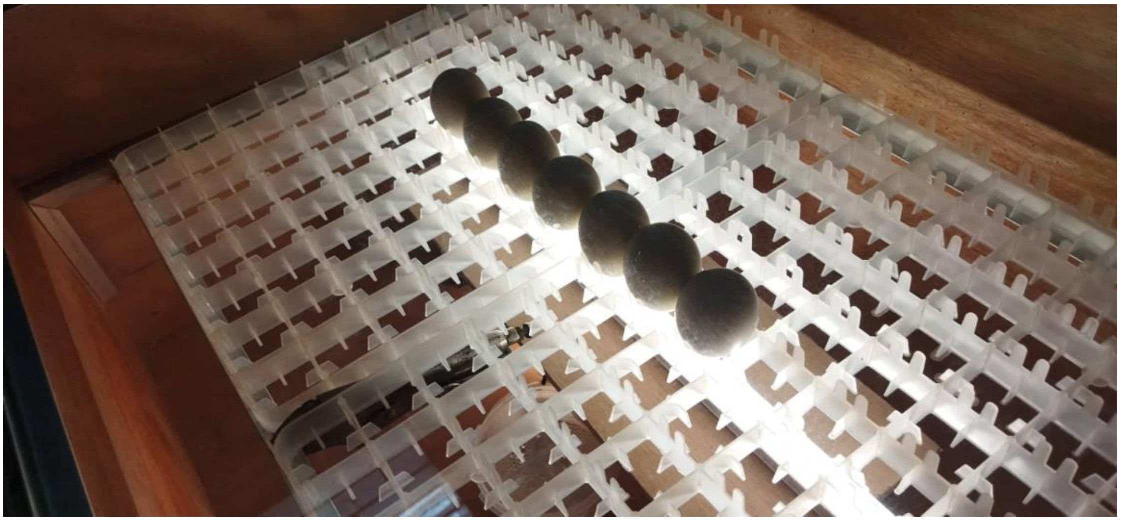


Day 14: Egg candling, as shown in the



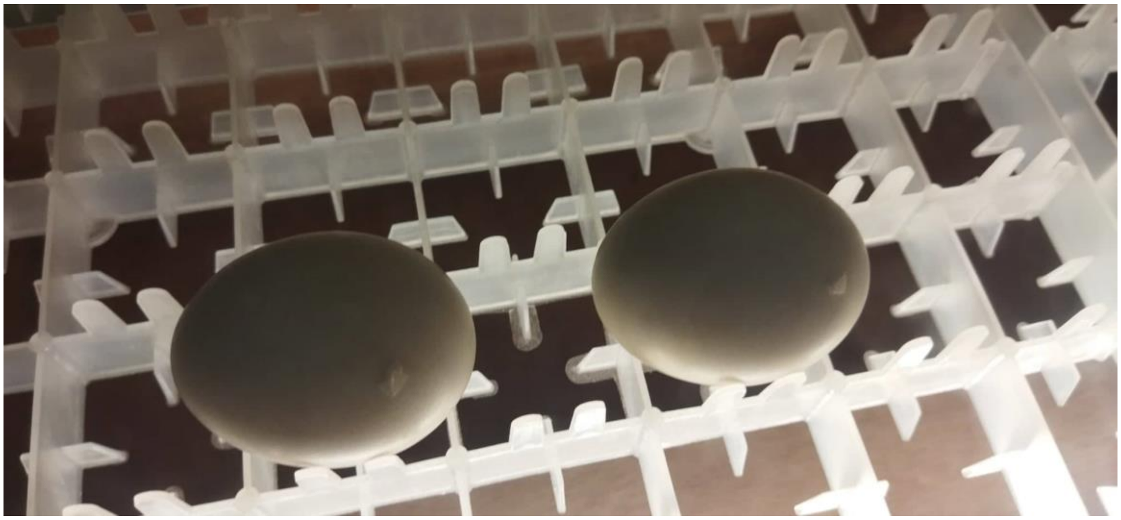
Day 14: Eggs that comes from the mother duck. Egg candling using the light that comes from the sun.

Day 23: the incubator stops the egg turning and increasing the humidity to 86-87%.as we can see in the picture that the becomes dark as the embryo develop.



Day 25: Egg candling using a flashlight. As shown in the picture we can see the head of the duck inside the eggs.

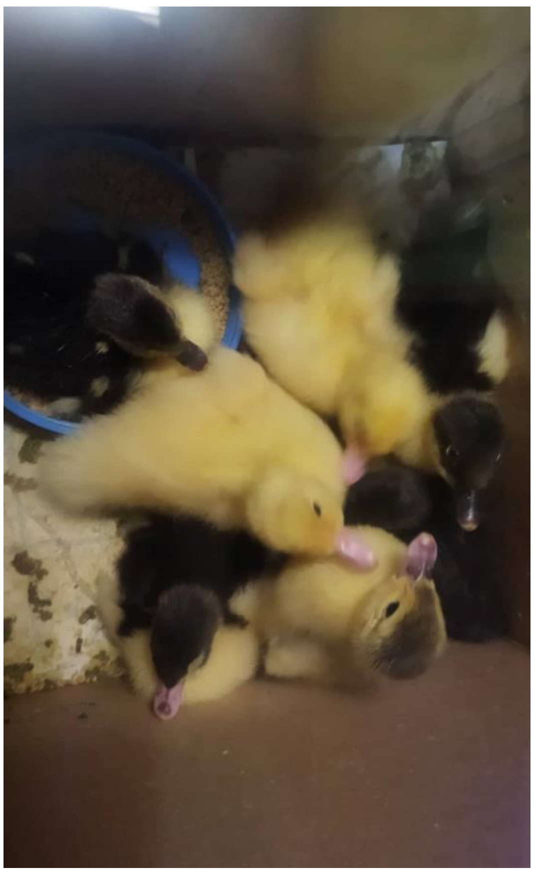
Day 26: the pip or the cracking of the shells



Day 26: I try to open one of the egg because I hear a sound of a duckling an luckly the duckling is still alive.

Day 26: two hours later two of the eggs are already hatched and another four hours later the other two are hatched also, so I transferred them to a container with a tangled wood.

Day 27: All the egg are hatched 7 out of 7 eggs. But they are still in the incubator for brooding



DAY 28: The eggs that is in the mother is still unhatched.

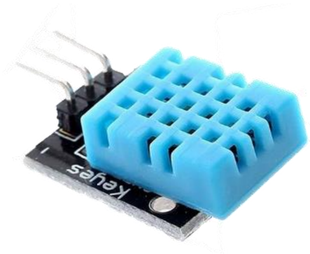
Day 29: two of them are hatched and 3 are rotten eggs. 2 out of 3 for the natural incubation.

Appendix D

Data Sheets

Arduino Uno SMD R3

Parameters	**Description**
Operating Voltage	5V
Input Voltage	7V-12V
Clock Speed	16Mhz
Size	68.6 mm x 53.4 mm
Analog Input Pin	6 pins
Digital I/O Pins	14 pins
Flash Memory/SRAM	32KB
USB Connector	USB type B



DHT11 Sensor

Parameters	Description
Operating Voltage	3.5V to 5.5V
Operating Current	0.3 mA (Measuring) 60uA(standby)
Output	Serial Data
Temperature Range	-40 C to 80 C
Humidity Range	0% to 100%
Resolution	16-bit
Accuracy	_+ 0.5C and _+1%

LCD 2ic 16x2

Parameters	Description
Operating Voltage	5V
Interface	I2C

Backlight	Blue
Contrast Adjust	Potentiometer
Backlight Adjust	Jumper
Pin Definition	GND VCC SDA SCL
SDA (Data)	Analog input pin 4
SCL (Clock)	Analog input pin 5

Electro-mechanical Relay

Parameters	**Description**
Operating Voltage	3.75VDC-6VDC
Quiescent Current	2mA
Current when the relay is active	70mA
Relay max contact voltage	250VAC or 30VDC
Relay Maximum current	10A

Stepper Motor

Parameters	Description
Operating Voltage	5VDC
Number of Phases	4
Stride Angle	5.625 deg/ 64
Pull in Torque	300 gf.cm
Insulated Power	600VAC/1mA/1s
Coil	Unipolar 5 lead coil

12V Fan

Parameters	Description
Operating Voltage	12V 0.20 A

Speed	3000 RPM
Blades	7 blade cooling fans
Material	Hard plastic
Noise	Very Low
Size	(80 x 80 x 25mm)

Ultrasonic Mist Maker/Humidifier

Parameters	**Description**
Operating Voltage	70V (max)
Operating Power	2.5W (normal use 1.5W)
Operating frequency	105kHz (+5kHz)
Diameter	20mm

Appendix E

Source Code

```
 #include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,20,4);

#include <SimpleDHT.h>
 int pinDHT11 = A0;
 SimpleDHT11 dht11;
 byte temperature1 = 0;
 byte humidity1 = 0;

 int pinDHT12 = A1;
 byte temperature2 = 0;
 byte humidity2 = 0;

#include <DS1302.h>
  DS1302 rtc(2, 3, 4);  //(rst,data,clk)
  Time t;
int days=0;

#define POTENTIOMETER_PIN1 A2
#define POTENTIOMETER_PIN2 A3

const int CCWRelay=6;
const int CWRelay=5;
const int FanRelay=7;
const int CanRelay=8;
const int BulbRelay=10;
const int MistRelay=9;

int autopin=13;

#define buttonPin1 12
#define buttonPin2 11
int buttonState1 = 0;
int buttonState2 = 0;

int Stval;
int Shval;

int tempAve;
int humAve;
void setup() {

  pinMode(CCWRelay,OUTPUT);
```

```
  pinMode(CWRelay,OUTPUT);
  pinMode(BulbRelay,OUTPUT);
  pinMode(MistRelay,OUTPUT);
  pinMode(FanRelay,OUTPUT);
  pinMode(CanRelay,OUTPUT);

  digitalWrite(CCWRelay,LOW);
  digitalWrite(BulbRelay,HIGH);
  digitalWrite(MistRelay,HIGH);
  digitalWrite(FanRelay,HIGH);
  digitalWrite(CanRelay,HIGH);
  digitalWrite(CWRelay,LOW);

  pinMode(buttonPin1, INPUT);
  pinMode(buttonPin2, INPUT);

  pinMode(POTENTIOMETER_PIN1,INPUT);
  pinMode(POTENTIOMETER_PIN2,INPUT);

  pinMode(pinDHT12,INPUT);
  pinMode(autopin,INPUT);

  Serial.begin(9600);
  lcd.backlight();
  lcd.init();

  rtc.halt(false);
  rtc.writeProtect(false);
//  rtc.writeProtect(true);
  rtc.setTime(14, 46, 00);  //Hour, Min, Sec
  rtc.setDate(30, 7, 2022); //Day, Month, Year

}

void loop() {
    int val=(digitalRead(autopin));
      candling_light();
      manual_rotate();

    if (val == HIGH)
    {
      if (days<=23)
      {
        Serial.println("MEOW");
        AutoModeDay123();
      }
      else
```

```
        {
         Serial.println(t.sec);
         AutoModeDay23Above();
        }
      }

      else{

        ManualMode();
      }


}

void candling_light(){

      buttonState1 = digitalRead(buttonPin1);

      if (buttonState1 == HIGH) {
        digitalWrite(CanRelay, LOW);
      }

      if(buttonState1 == LOW) {
        digitalWrite(CanRelay, HIGH);
      }
}

void manual_rotate() {

      buttonState2 = digitalRead(buttonPin2);

      if (buttonState2 == HIGH) {
        digitalWrite(CCWRelay, HIGH);
        digitalWrite(CWRelay, LOW);
      }

      if(buttonState2 == LOW) {
        digitalWrite(CCWRelay, LOW);
      }
}
void ManualMode(){

 //////////// (Day Counter) /////////////
      t = rtc.getTime();
      lcd.setCursor(0,0);
      lcd.print("Days:");
      lcd.print(days);
```

```
     if(t.hour == 00 && t.min == 00 && t.sec == 00){
//     if(t.sec == 00){
        days++ ;
      }

 ///////////// DHT & LCD //////////////////
    {
    int err= SimpleDHTErrSuccess;
    if ((err = dht11.read(pinDHT11, &temperature1, &humidity1, NULL))
!=SimpleDHTErrSuccess){
    }
    }
    {
     int err2= SimpleDHTErrSuccess;
     if ((err2 = dht11.read(pinDHT12, &temperature2, &humidity2, NULL))
!=SimpleDHTErrSuccess){

      tempAve=((temperature1+temperature2)/2);
      humAve =((humidity1+humidity2)/2);

      lcd.setCursor(11,0);
      lcd.print("T:");
      lcd.print(tempAve);/////////////
      lcd.setCursor(15,0);
      lcd.print("C ");

      lcd.setCursor(11,1);
      lcd.print("H:");
      lcd.print(humAve); //////////////
      lcd.setCursor(15,1);
      lcd.print("%");

      }
      }

/////////// POTENTIOMETER //////////////

      Serial.print(analogRead(POTENTIOMETER_PIN1));
      int tval=(analogRead(POTENTIOMETER_PIN2));
      Serial.print("       ");
      Serial.print(analogRead(POTENTIOMETER_PIN2));
      int hval=(analogRead(POTENTIOMETER_PIN1));


     if(tval<=100){
       lcd.setCursor(0,1);
       lcd.print("S:");
```

```
  lcd.print("28C");
  Stval=28;
  }

else if(tval>100 && tval<=200){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("29C");
  Stval=29;
  }
else if(tval>200 && tval<=300){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("30C");
  Stval=30;
  }
else if(tval>300 && tval<=400){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("31C");
  Stval=31;
  }
else if(tval>400 && tval<=500){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("32C");
  Stval=32;
  }
else if(tval>500 && tval<=600){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("33C");
  Stval=33;
  }
else if(tval>600 && tval<=700){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("34C");
  Stval=34;
  }
else if(tval>700 && tval<=800){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("35C");
  Stval=35;
  }
else if(tval>800 && tval<=900){
```

```
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("36C");
  Stval=36;
  }
else if(tval>900 && tval<=995){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("37C");
  Stval=37;
  }
else if(tval>995){
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print("38C");
  Stval=38;
  }

if(hval<=70){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("76%  ");
  Shval=76;
  }

else if(hval>70 && hval<=140){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("77%  ");
  Shval=77;
  }
else if(hval>140 && hval<=210){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("78%  ");
  Shval=78;
  }
else if(hval>210 && hval<=280){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("79%  ");
  Shval=79;
  }
else if(hval>280 && hval<=350){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("80%  ");
```

```
  Shval=80;
  }
else if(hval>350 && hval<=420){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("81%  ");
  Shval=81;
  }
else if(hval>420 && hval<=490){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("82%  ");
  Shval=82;
  }
else if(hval>490 && hval<=560){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("83%  ");
  Shval=83;
  }
else if(hval>560 && hval<=630){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("84%  ");
  Shval=84;
  }
else if(hval>630 && hval<=700){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("85%  ");
  Shval=85;
  }
else if(hval>700 && hval<=770){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("86%  ");
  Shval=86;
  }
else if(hval>770 && hval<=840){
  lcd.setCursor(5,1);
  lcd.print("|");
  lcd.print("87%  ");
  Shval=87;
  }
else if(hval>840 && hval<=910){
  lcd.setCursor(5,1);
  lcd.print("|");
```

```
     lcd.print("88%  ");
     Shval=88;
     }
    else if(hval>910 && hval<=980){
     lcd.setCursor(5,1);
     lcd.print("|");
     lcd.print("89%  ");
     Shval=89;
     }
    else if(hval>980){
     lcd.setCursor(5,1);
     lcd.print("|");
     lcd.print("90%  ");
     Shval=90;
     }

    Serial.print("       ");
    Serial.print (Stval);
    Serial.print("       ");
    Serial.println(Shval);


     if (humAve <=Shval){
        digitalWrite(MistRelay,LOW);
        digitalWrite(FanRelay,LOW);
    }
    if(humAve>=Shval){
         digitalWrite(MistRelay,HIGH);
     }
    if (tempAve<=Stval){
        digitalWrite(BulbRelay,LOW);
        digitalWrite(FanRelay,LOW);
    }
    if(tempAve>=Stval){
         digitalWrite(BulbRelay,HIGH);

     }
    if(tempAve>=Stval && humAve>=Shval){
     digitalWrite(FanRelay,HIGH);
    }
}

void AutoModeDay123()
{

//////////// RTC (Day Counter) ////////////
    t = rtc.getTime();
```

```
    lcd.setCursor(0,1);
    lcd.print("D:");
    lcd.setCursor(2,1);
    lcd.print(rtc.getDateStr(FORMAT_SHORT));
    lcd.setCursor(0,0);
    lcd.print("Days:");
    lcd.print(days);
    if(t.hour == 00 && t.min == 00 && t.sec == 00)
//     if(t.sec == 00){
    {
    days++ ;
    }

 /////////// DHT11(day1-23)///////////////
     {
     int err= SimpleDHTErrSuccess;
     if ((err = dht11.read(pinDHT11, &temperature1, &humidity1, NULL))
!=SimpleDHTErrSuccess){
     }
     }
     {
     int err2= SimpleDHTErrSuccess;
     if ((err2 = dht11.read(pinDHT12, &temperature2, &humidity2, NULL))
!=SimpleDHTErrSuccess){

     tempAve=((temperature1+temperature2)/2);
     humAve =((humidity1+humidity2)/2);

     lcd.setCursor(11,0);
     lcd.print("T:");
     lcd.print(tempAve);
     lcd.setCursor(15,0);
     lcd.print("C ");

     lcd.setCursor(11,1);
     lcd.print("H:");
     lcd.print(humAve);
     lcd.setCursor(15,1);
     lcd.print("%");

       if (temperature1 <= 35){
     digitalWrite(BulbRelay,LOW);
     digitalWrite(FanRelay,LOW);
     }

      if(temperature1 >=37){
      digitalWrite(BulbRelay,HIGH);
```

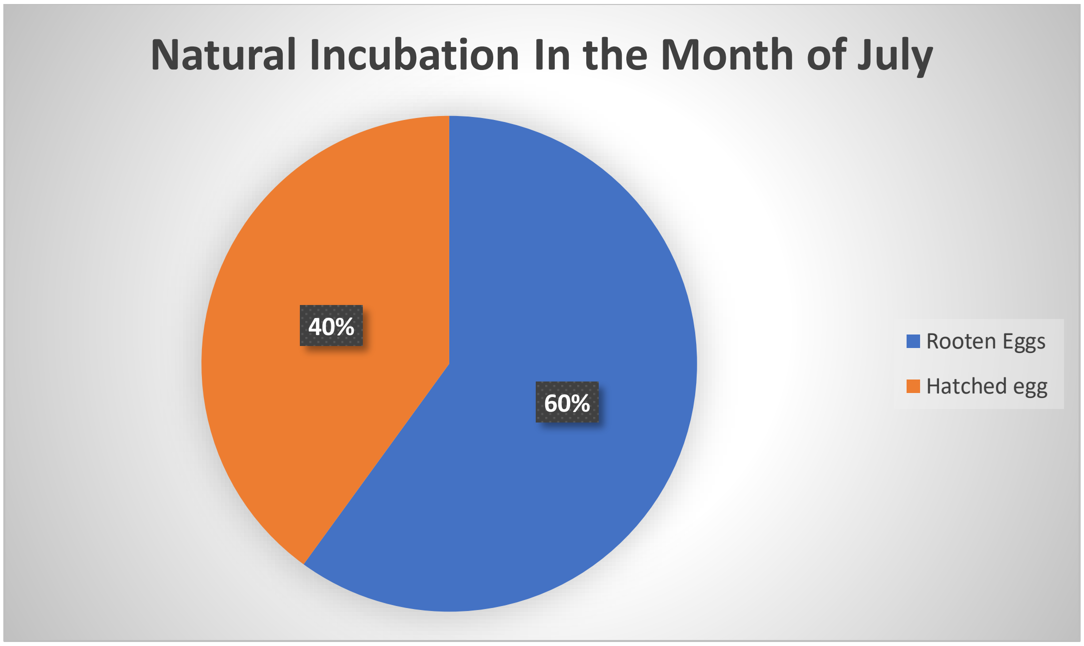
```
}

  if (humidity1 <=78){
digitalWrite(MistRelay,LOW);
digitalWrite(FanRelay,LOW);
}

  if(humidity1 >=80){
 digitalWrite(MistRelay,HIGH);

}
  if(humidity1 >=80 && temperature1 >= 37 ){
 digitalWrite(FanRelay,HIGH );
}

}
}
////////// AUTO-ROTATE ////////////////
t = rtc.getTime();
 if(t.hour == 00 && t.min == 00 && t.sec == 00){
   digitalWrite(CCWRelay,LOW);
   digitalWrite(CWRelay,HIGH);
   }
    if(t.hour == 00 && t.min == 00 && t.sec == 07){
   digitalWrite(CCWRelay,HIGH);
   digitalWrite(CWRelay,LOW);
   }

 if(t.hour == 03 && t.min == 00 && t.sec == 00){
   digitalWrite(CCWRelay,LOW);
   digitalWrite(CWRelay,HIGH);
   }
    if(t.hour == 03 && t.min == 00 && t.sec == 06){
   digitalWrite(CCWRelay,HIGH);
   digitalWrite(CWRelay,LOW);
   }
 if(t.hour == 06 && t.min == 00 && t.sec == 00){
   digitalWrite(CCWRelay,LOW);
   digitalWrite(CWRelay,HIGH);
   }
    if(t.hour == 06 && t.min == 00 && t.sec == 07){
   digitalWrite(CCWRelay,HIGH);
   digitalWrite(CWRelay,LOW);
   }
 if(t.hour == 12 && t.min == 00 && t.sec == 00){
   digitalWrite(CCWRelay,LOW);
   digitalWrite(CWRelay,HIGH);
```

```
      }
       if(t.hour == 12 && t.min == 00 && t.sec == 07){
      digitalWrite(CCWRelay,HIGH);
      digitalWrite(CWRelay,LOW);
      }


     if(t.hour == 15 && t.min == 00 && t.sec == 00){
      digitalWrite(CCWRelay,LOW);
      digitalWrite(CWRelay,HIGH);
      }
       if(t.hour == 15 && t.min == 00 && t.sec == 07){
      digitalWrite(CCWRelay,HIGH);
      digitalWrite(CWRelay,LOW);
      }

    if(t.hour == 18 && t.min == 00 && t.sec == 00){
      digitalWrite(CCWRelay,LOW);
      digitalWrite(CWRelay,HIGH);
      }
       if(t.hour == 18 && t.min == 00 && t.sec == 06){
      digitalWrite(CCWRelay,HIGH);
      digitalWrite(CWRelay,LOW);
      }
    if(t.hour == 21 && t.min == 00 && t.sec == 00){
      digitalWrite(CCWRelay,LOW);
      digitalWrite(CWRelay,HIGH);
      }
       if(t.hour == 21 && t.min == 00 && t.sec == 07){
      digitalWrite(CCWRelay,HIGH);
      digitalWrite(CWRelay,LOW);
      }
    if(t.hour == 23 && t.min == 00 && t.sec == 00){
      digitalWrite(CCWRelay,LOW);
      digitalWrite(CWRelay,HIGH);
      }
       if(t.hour == 23 && t.min == 00 && t.sec == 07){
      digitalWrite(CCWRelay,HIGH);
      digitalWrite(CWRelay,LOW);
      }
}


 void AutoModeDay23Above()
 {

//////////// RTC (Day Counter) /////////////
```

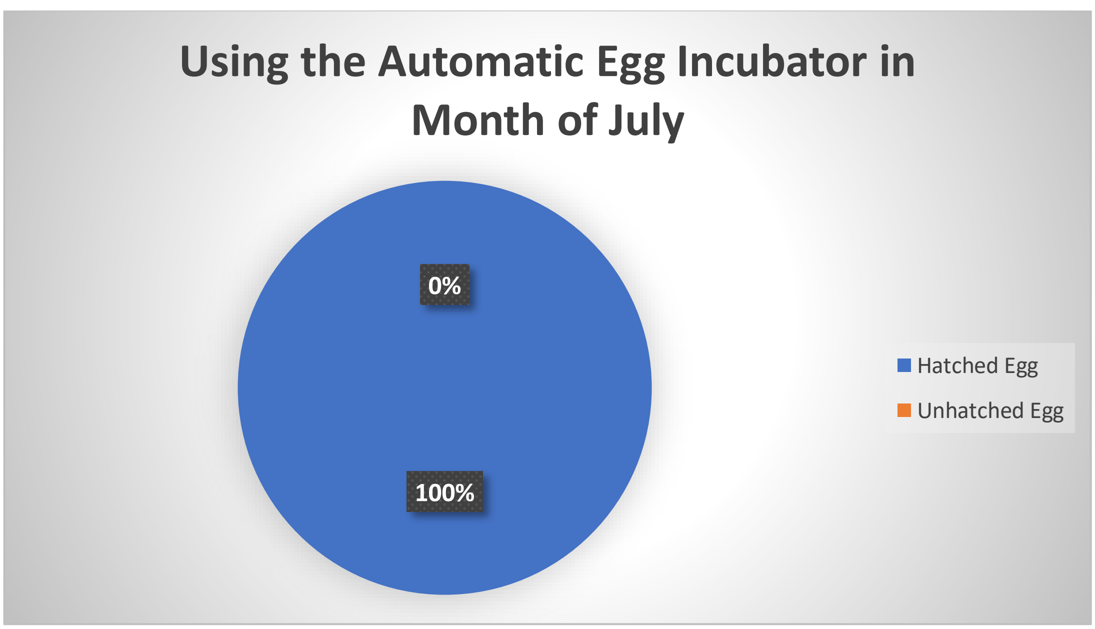
```
      t = rtc.getTime();
      lcd.setCursor(0, 1);
      lcd.print("D:");
      lcd.setCursor(2,1);
      lcd.print(rtc.getDateStr(FORMAT_SHORT));
      lcd.setCursor(0,0);
      lcd.print("Days:");
      lcd.print(days);
      if(t.hour == 00 && t.min == 00 && t.sec == 00)
//      if(t.sec == 00){
      {
      days++ ;
      }

 //////////// DHT11(23Above)////////////////
       {
       int err= SimpleDHTErrSuccess;
       if ((err = dht11.read(pinDHT11, &temperature1, &humidity1, NULL))
!=SimpleDHTErrSuccess){
       }
       }
       {
       int err2= SimpleDHTErrSuccess;
       if ((err2 = dht11.read(pinDHT12, &temperature2, &humidity2, NULL))
!=SimpleDHTErrSuccess){

       tempAve=((temperature1+temperature2)/2);
       humAve =((humidity1+humidity2)/2);

       lcd.setCursor(11,0);
       lcd.print("T:");
       lcd.print(tempAve);
       lcd.setCursor(15,0);
       lcd.print("C ");

       lcd.setCursor(11,1);
       lcd.print("H:");
       lcd.print(humAve);
       lcd.setCursor(15,1);
       lcd.print("%");

          if (temperature1 <= 35){
       digitalWrite(BulbRelay,LOW);
       digitalWrite(FanRelay,LOW);
       }

        if(temperature1 >=37){
```

```
 digitalWrite(BulbRelay,HIGH);
}

  if (humidity1 <=86){
digitalWrite(MistRelay,LOW);
digitalWrite(FanRelay,LOW);
}

  if(humidity1 >=88){
 digitalWrite(MistRelay,HIGH);

}
  if(humidity1 >=88 && temperature1 >= 34 ){
 digitalWrite(FanRelay,HIGH );
}
}
}
```

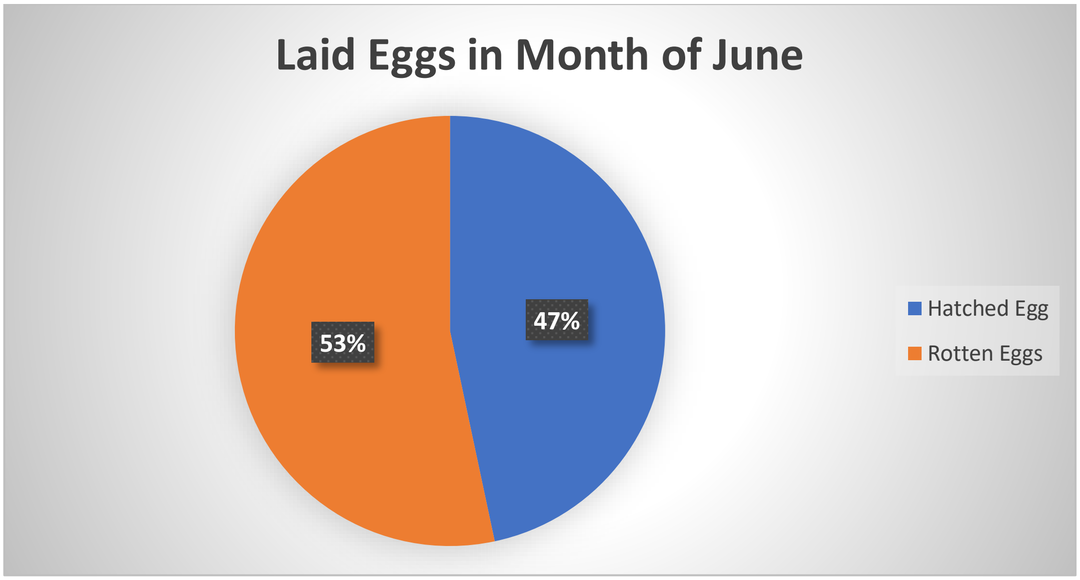
Appendix F



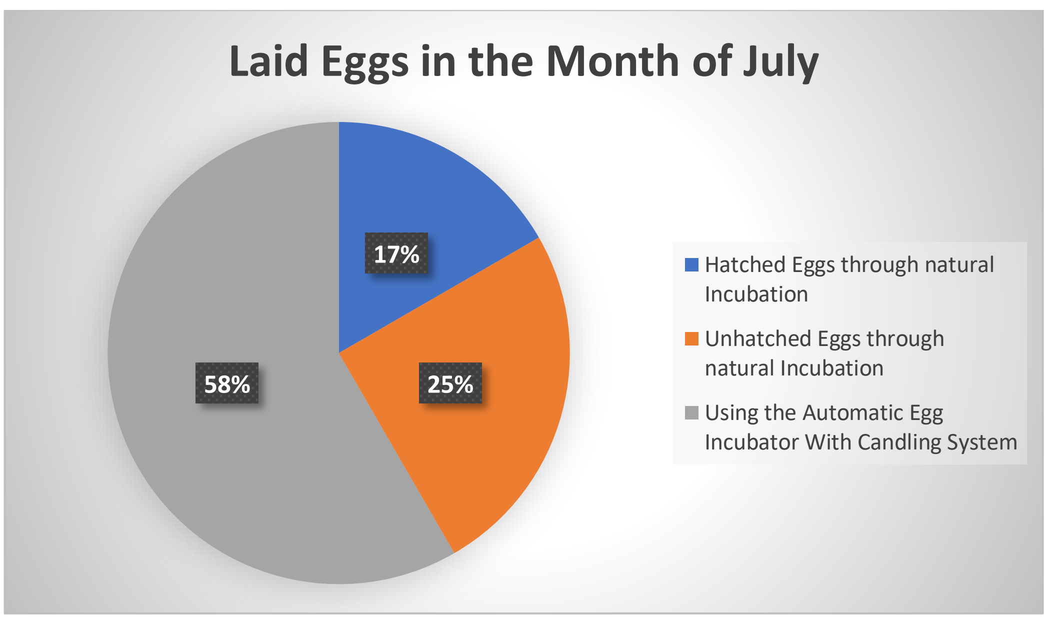
This figure shows the hatched eggs and rotten eggs through the process of natural incubation in month of July.



This figure shows the hatched eggs through the process of artificial incubation in month of July.



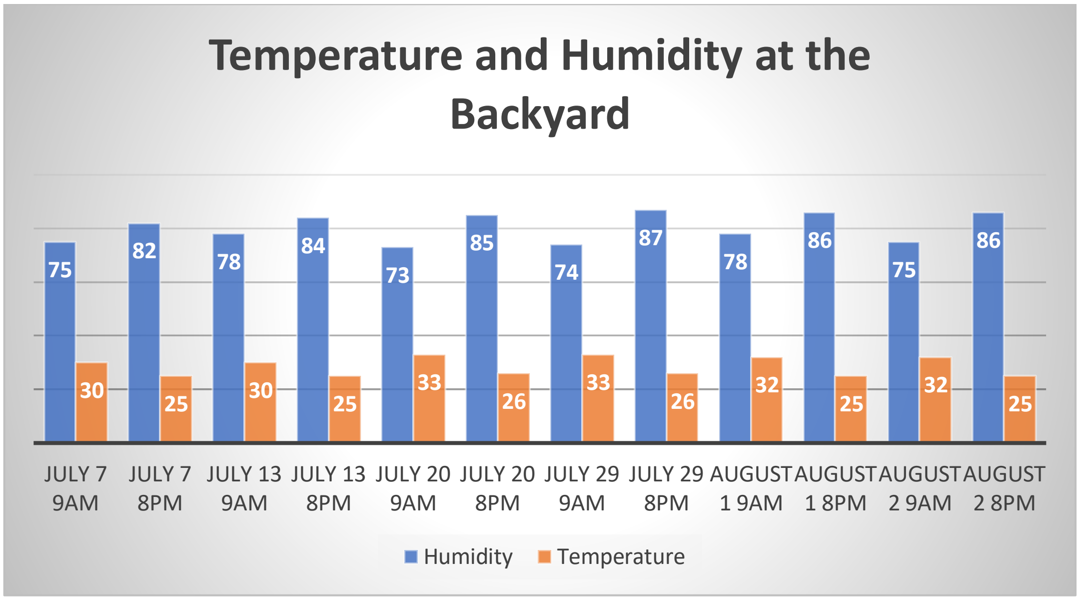
This figure shows the hatched eggs and rotten eggs through the process natural incubation in the month of June before building the prototype.



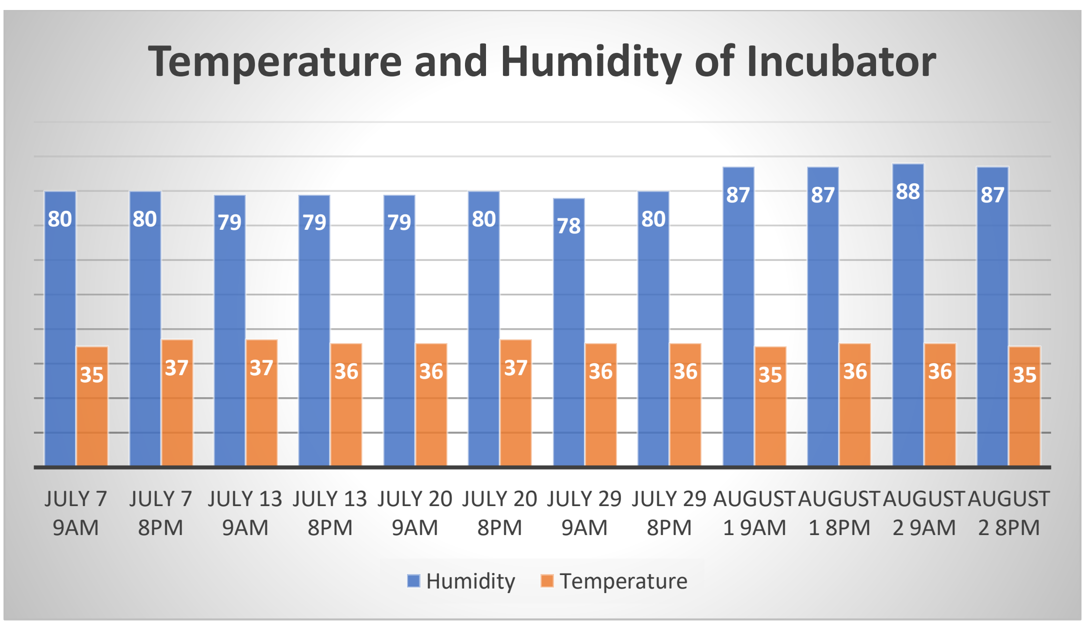
This figure shows the overall hatched eggs and rotten eggs in the month of July.

Appendix G

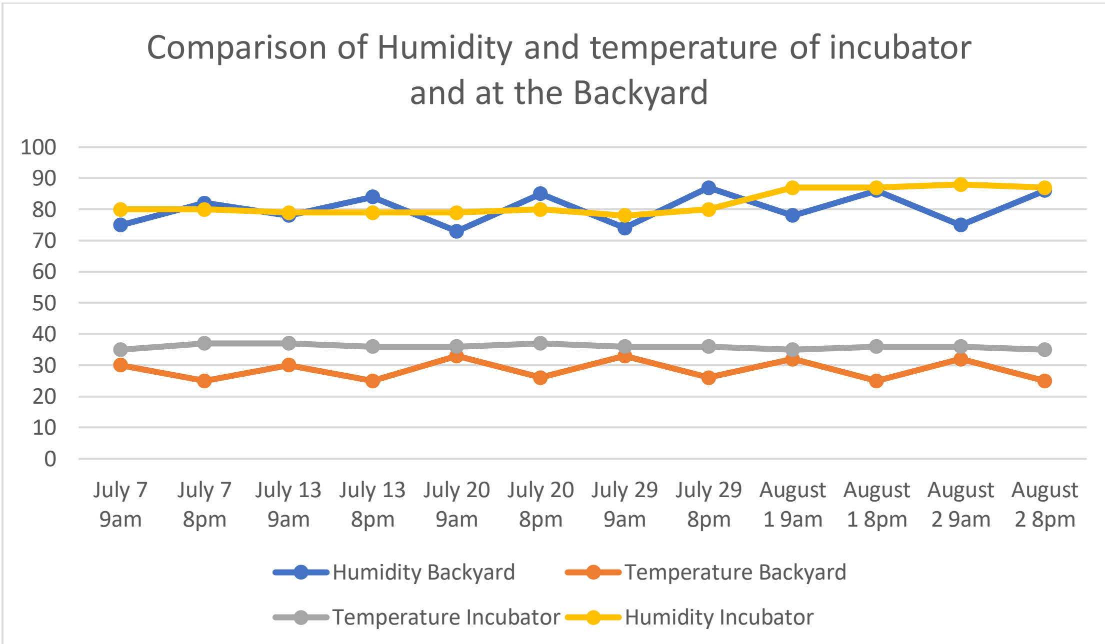
Comparison of temperature and humidity of incubator and at the backyard



This figure shows the ambient humidity and temperature at the backyard from day 1 to day 28.



This figure comes from the automatic settings of incubator from day 1 to day 28.



This figure shows the comparison of humidity and temperature inside the incubator and ambient temperature and humidity.

NUEVA VIZCAYA STATE UNIVERSITY
College of Engineering

Curriculum Vitae

ALDRIN PAUL I. POLICARPIO

Brgy. San Jose Sur Mallig,Isabela

09475161912

paulicarpio27@gmail.com

PERSONAL INFORMATION

Date of Birth	February 27, 1999
Place of Birth	Cauyan, Isabela
Age	23
Gender	Male
Civil Status	Single
Citizenship	Filipino
Height	171 cm
Weight	56 kg
Father’s Name	Aldwin R. Policarpio
Mother’s Name	Amelita I. Policarpio

EDUCATIONAL BACKGROUND

Primary	San Jose Sur Elementary School 2005-2011
Secondary	San Jose National High School 2011-2015
Tertiary	Saint Mary’s University 2015-2019 Nueva Vizcaya State University 2019-Present

SEMINAR ATTENDED

17 August 2015	Transmission Media and GSM Network
19 August 2015	Introduction to Arduino and Workshop
22 September 2016	Breadboarding and PCB Lay outing
24 September 2016	Manufacturing Process Flow
19 October 2017	LED Manipulation using Arduino Seminar
19 September 2019	Occupational Safety Seminar
19 September 2019	Calculator Techniques

11 October 2019	Why ECE Seminar
11 October 2019	Processing Microchips
11 October 2019	ECE's as Health Care Technology Manager
12 October 2019	The Role of ICT in Disaster Risk Management
12 October 2019	Tech-Entrepreneurship
12 October 2019	Electronics Plan Preparation
23 November 2019	Arduino Microcontroller
31 January 2020	On-Job-Training Orientation

Personal Reference

Silverio B. Magday, ECE
Professor
Nueva Vizcaya State University
Dupax Del Norte, Nueva Vizcaya

Jimmy Carter B. Nilo, ECE, MSECE
Associate Professor III
Nueva Vizcaya State University
Bambang, Nueva Vizcaya
0926-334-784

Aldrin Paul I. Policarpio
Researcher