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RESEARCH ARTICLE OPEN ACCESS

Development of Egg Incubator with Reduced Errors Through Electronic Means

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ABSTRACT
Poultry is one of the most important source of protein, and its cost is appropriate with the low-income, it is characterized by fast multiplying, short life cycle and high production efficiency.[1]. The aim of this project is development of eggs incubator currently deployed for the purpose of reducing the proportion of errors that occur due to either person or the circumstances surrounding the eggs. Also to make it possible to put different types of eggs in the incubator, just after some adjustments in the device. These paper implies an experimental study, adjustments depends on the type of bird, in this project the tungsten lamb is use as alternative of mother heat, fan to provide the necessary ventilation, also some water for proper humidity. Metal cylinders connected by DC motor used for flipping eggs to make sure the heat was distributed, push buttons to enter some information from the user, LCD for the current status, the LCD and DC motor are connected to micro controller to make the process of flipping and monitoring the changes done automatically. In this project chicken eggs were chosen,16 veterinary eggs in meddle size were put inside the incubator, and monitored for 21days. In this work, 12 eggs hatched, 8 from them were in a good health but the others had fewer fluff than the others.
Index Terms—Egg incubator, tungsten lamb, Metal cylinders, DC motor, chicken eggs.

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I. INTRODUCTION

1. Background

Poor countries suffer from a deficit in getting enough food production that covers domestic need, the food demand is increasing at a high rates, under the high rates of population growth in those countries, and the relative improvement in their standard of lives. it is expected to increase the dangerous of food issue, caused by the higher prices of national trade, that lead to more competition between the local and imported products, which mean more pressure on poor countries to cope with the challenges. It is possible to solve those problem by creating good future plans and programs, one of them is provide the productive families with technical tools to improve their life. Smart eggs incubation one of these tools that increase the families income and rising egg production rates significantly in few days.

In general the eggs incubation is process that incubate eggs and providing the appropriate environmental conditions that make it hatch, either natural or industrial methods. The Natural ways mean certainly Incubate the mother bird eggs by placing them underneath to provide them with the necessary warmth and humidity.

There are many reasons for resorting the industrial hatching techniques the most important of them are:

(1) Lack of stability provision chicks, because the mother bird are not bleaching in the incubation period.

(2) Cannot assess the amount of eggs produced.

(3) Deficit on provision of the desired quantity and quality of eggs.

Because of these reasons and more, incubators ware used in an expanding, and it achieved a great success, where they were raised the rate of hatching from 30% to 70%. And 80% in some developed countries. Smart eggs incubator is a device that provide environmental conditions to eggs similar to the natural conditions that obtained from mother bird. these conditions are related to each other if there were any deficit in any of them this will lead to corruption of eggs, these conditions include: temperature, humidity, flipping, and good ventilation. temperature is the most important factor that affects the embryo growth, because the embryo in incubation period is so sensitive to the high temperature, even if it lightly increased, the maximum temperature which causes death is near to ideal temperature.

The humidity is not as the temperature risk where the embryo can lost about 11-14% of ideal Weight in that period the utility of humidity prevent the loss of water, also prevent the embryo from adhesion to the crust. flipping prevent cohesion of embryonic membranes and helps the embryo to get

his feed easily, also help in light distribution process. finally a good ventilation which means giving the embryo enough Oxygen and carbon dioxide.

2. OBJECTIVES:

(1) To make eggs incubator process not limited to professional people.
(2) To reduce the possibility of corruption of the eggs.
(3) Exemption from eggs flipping and make them be automatically.
(4) To incubate different type of eggs. To produce the largest number of improved chicks.

3. SCOPES:

Design a simple system which consists of three major parts, soft ware part, hardware, and mechanical part.
These component are connected together to create the smart eggs incubator, which can be used for different types of birds specified by the user by entering the type of bird after he entered his pass word.
The hardware part contains the micro controller, LCD, push buttons, digital temperature sensor, relay, power supply circuit, DC motor, power supply 12 v connecting to solar cell to make sure the device will not stop for any reasons.
The soft ware part contains the program of the micro controller PIC16f877a.
The mechanical parts consist of the box that have an isolating layer inside, iron cylinders, tungsten lamp, and a fan.

II. PROBLEM STATEMENT

The population growth is increasing in high rates that certainly lead to increase in the demand on food. In addition to the food crisis in poor nations resulting from the liberalization of national trade among the convention on international trade. That led to increasing the competition between the local and imported product, that mean more pressure on food requirement in the poor nation, in order to address these challenges the domestic production must encouraged at the level of whole country, community, and individuals. The aim of this study is to contribute to raising the financial level of the productive families and to implement the desired plans of poultry production in terms of quantity and quality.

III. LITERATURE REVIEW

The past two centuries have seen a significant rise in the world's population, known as the "population explosion". On the past October the population of the globe reached to seven billion people. This is the first time in whole human history the population reaches to this high figure and frightening as well, because it will not stop at this point, where the United Nations experts expected that the rapid increase of the population will continue to arrive after 34 years only to nine billion people in the year 2045, then to 14 billion at the end of the current century.[2]

In order to keep up with developments and to achieve economic balance and stability of individuals in their places, some countries developed some plans to promote business craft of all kinds.

Egg incubation is a process that keeps eggs warm under specific temperature and humidity so that the embryo inside the egg will hatch after a specific duration. This duration is called brooding days.

IV. EMBRYONIC DEVELOPMENT

Several divisions occur within the egg, the cluster of cells in the blastoderm begins to multiply by successive divisions. and stops if the egg comes out due to change in environmental conditions that surround the eggs, when there is appropriate temperature and humidity, the cells start to divide again, in most references the temperature required for the divisions is greater than 20 ˚c. The egg will grow quickly because of these divisions, the diameter of eggs become within 24 hours about 12mm, and in 48 hours about 24mm. And some differences begin to appear, these differences become more and more pronounced. Gradually the various cells acquire specific characteristics of structure and cell grouping or layer. These cell groupings are called the ectoderm, mesoderm and endoderm. These three layers of cells constitute the materials out of which the various organs and systems of the body develop. From the ectoderm, the skin, feathers, beak, claws, nervous system, lens and retina of the eye, linings of the mouth and vent develop. The mesoderm develops into the bone, muscle, blood, reproductive and excretory organs. The endoderm produces the linings of the digestive tract and the secretary and respiratory organs. Development from a single cell to a pepping chick is a continuous, orderly process.[3]

The development of body organs start as the following:

Day1
18 hours: Appearance of alimentary tract
19hours: Beginning of brain crease
20hours: Appearance of vertebral column
21hours: Beginning of formation of brain and

nervous system.
22hours: Beginning of formation of head
23hours: Appearance of blood island
24 hours: Beginning of formation of eyes.

Day2
24hours: Embryo begins to turn on left side.
24hours: Blood vessels appear in the yolk sac.
24hours: Major developments visible under microscope.
25hours: Beginning of formation of veins and heart.
30hours: Second, third and fourth vesicles of brain clearly defined, as is the heart, which starts to beat.
35hours: Beginning of formation of ear pits.
36hours: First sign of amnion.
46 hours: Formation of throat.

Day3
Beginning of formation of beak, wings, legs and allantois.
Amnion completely surrounds embryo.

Day4
Beginning of formation of tongue.
Embryo completely separates from yolk sac and turns on left side.
Allantois breaks through amnion.

Day5
Proventriculus and gizzard formed.
Formulation of reproductive organs — sex division.

Day6
Beak and egg tooth begin to form.
Main division of legs and wings.
Voluntary movement begins.

Day7
Digits on legs and wings become visible.
Abdomen becomes more prominent due to development of viscera.

Day8
Feathers begin to form.

Day9
Embryo begins to look bird-like
Mouth opening appears.

Day10
Beak starts to harden.
Skin pores visible to naked eye.
Digits completely separated.

Day11
Days 10 to 12 tend to run together. No different changes visible on these days.

Day12
Toes fully formed.
Down feathers visible.

Day13
Scales and claws become visible.
Body fairly well covered with feathers.

Day14
Embryo turns its head toward blunt end of egg.

Day15
Small intestines taken into body.

Day16
Scales, claws and beak becoming firm and horny.
Embryo fully covered with feathers.
Albumen nearly gone and yolk increasingly important as nutrient.

Day17
Beak turns toward air cell, amniotic fluid decreases and embryo begins
preparation for hatching.

Day18
Growth of embryo nearly complete.

Day19
Yolk sac draws into body cavity through umbilicus.
Embryo occupies most of space within egg except air cell.

Day20
Yolk sac completely draws into body cavity.
Embryo becomes chick, breaks amnion and starts breathing air in air cell.
Allantois ceases to function and starts to dry up.

Day21
Chick hatches.

V. INCUBATORS TYPES

Incubator is the device which provides environmental conditions similar to the real environment, and it is able to incubate various type of egg.
There are several kinds of them in supermarkets and these are some of them:

1. Manual egg incubators

This provides an easy and affordable way to incubate eggs. A manual incubator can use charcoal, kerosene or gas to heat and retain eggs in the hatching chamber where the eggs are placed. Eggs are turned manually; temperatures and humidity regulation is also manual. Different

capacities are available ranging from 50 up to 300 eggs.

However there has been complains on the output of these kind of incubators. The average hatching rate as reported by farmers range between 50 and 60% with good management. However the use of thermometer to regulate temperature and placing water next to the eggs to regulate humidity has improved performance for most farmers.

2. Electrical egg incubators

This kind of incubators requires a constant power supply if the eggs are to be hatched. Any breakdown in the power supply as is usually frequent in Kenya causes the eggs to lose their hatching value and must be destroyed. The incubators can be manual, automatic or semi-automatic. The automatic type comes with a hatching tray, thermostat to control accurate incubation temperature and hygrometer to control humidity during egg hatching. The egg tray has an egg turning system for turning eggs automatically. An air circulation system which ensures that air is circulated evenly in the incubator and that eggs hatch at the same time.

3. Solar egg incubators

The solar incubator uses solar energy to hatch eggs. They are meant to be use where electricity is not reliable. A solar panel connected to a battery system with charge controller insures 24-hour power supply.[3]

4. The Mini Eco

The Mini Eco holds 10 hens‟ eggs (or equivalent) and provides the fine temperature control to ensure consistent and reliable hatches. Temperature is monitored on a purpose built liquid-in-glass thermometer and although factory set, the electronic temperature control allows fine tuning of the temperature setting if required.

5. The Mini Advance

It provides automatic egg turning with auto stop 2 days prior to hatching, countdown to date-of-hatch and temperature alarm on its digital display to know the status of hatch. Eggs are turned by rotating egg disks. Two disks are available, one for 7 eggs of all sizes up to duck (supplied as standard) with a second small egg disk holding 12 eggs up to the size of pheasant available as an optional extra.[4]

VI INCUBATION CONDITION

There are some circumstances that affect duration and incubation success, these circumstances Normally surround the eggs when the mother bird breed them, the following table shows incubation period, and environmental condition that should be for several type of eggs:

Birds	incubation period	Temp (F.)	Humidity (F.)	Do not turn After	Humidity Last 3 days	Open vent More
Chick en	20 – 22	21	100	85-87	90	18th day
Duck	26-28	28	99	84-86	90	25th day
Goose	25-28	28	100	85-86	90	25th day
Ostric h	35-45	35-37	100	85-86	90	30th day
Parrot	17-31	28-34	99	86-88	90	25th day
Pigeo n	10-18	28	100	85-87	90	24th day
Quail	21-23	23-28	100	86-88	92	20th day
Swan	33-36	28-30	99	84-86	90	25th day
Turke y	28	23-24	100	86-87	90	20th day

Table 1: Show incubation period of different type of birds.

VI. METHODOLOGY

1. Project development:

This project consists of three parts; the first part is the software part, which is the program that controls all other aspects. The hardware is the part that contains the electronic circuit of ARDUINO, and the part that related to. The mechanical parts is contain the other parts which are not electronic parts. The following figure shows the flow chart of project development.

Figure 3-1: shows the flow chart of project development.

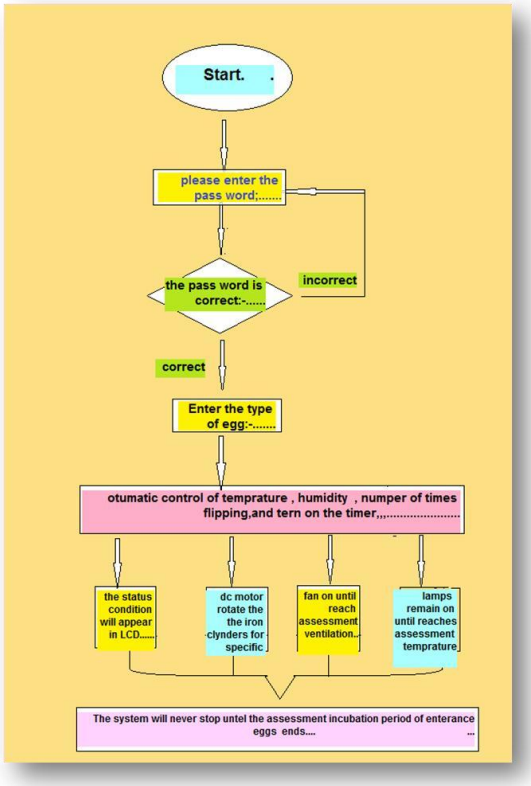


Figure3-2:Box scheme explain the main idea of project.

The general idea of this project is a smart incubation; if you push the start button the device will ask the user about his name just for security purposes, and the type of eggs, after entering the type of egg the system will change the temperature and humidity depending on type of eggs.
And the motor starting to rotate the iron cylinders in order to flip the eggs. According to the table.

Mechanical part design:

The first part is the box of incubator, the first thing to be observed is the size of the box, it should be appropriate for the amount of eggs in order not to put eggs over others because this will block the heat and the ventilation (In this project the box is expanded to contain 36 egg). The second thing the box should be painted inside with isolation material to prevent heat dissipation. It is possible to use an old oven or old cupboard with several shelves, also can use the plastic box or cork box or any things that can saves temperature and incubators humidity. The following picture show different types of boxes.

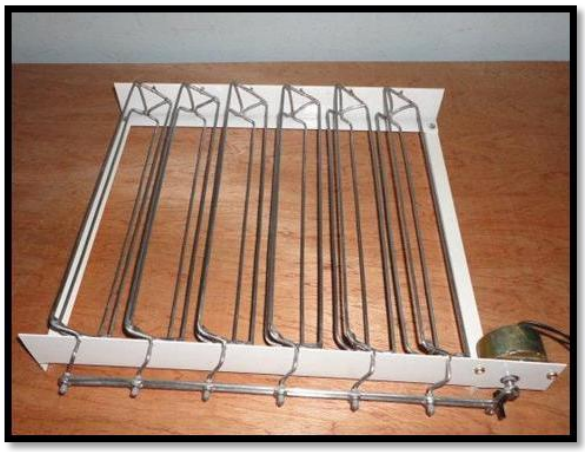
Figure: 3-3, 3-4 insulation layer inside the box.

The second section is the eggs flipper; it is simply a set of rulers in which the eggs are situated between them, in order to be flipped. The most important thing in this section is the process to flip eggs that must be around the vertical axis at the angles (+45,-45).

Figure 3-4,3-5: Some types of boxes.

There are many ways to design the roller all of them are correct as long as they flip the eggs from angle 90˚to +45˚,and from 90˚ to -45˚.The must easier way to make ruler by using metal wires like the one that used in clothes hunger ,to put the eggs inside them, the base is made of aluminum plate and flex them like the following pictures

Figure: 3-6, 3-7 eggs flipper design from clothes hunger.



The length of this turner is 44 centimeter, the width is 32 centimeter, and the height is 6.5 centimeter. The turner can be occupied by 60 -63 chicken eggs. [4]

Turner arm is produced as follows:

- Placed the motor in terminal of the base.
- Must end turner arms with oval-shaped ring.
- One twisted wire is inserted through the ring the other side of it are wilding with the motor as follows:

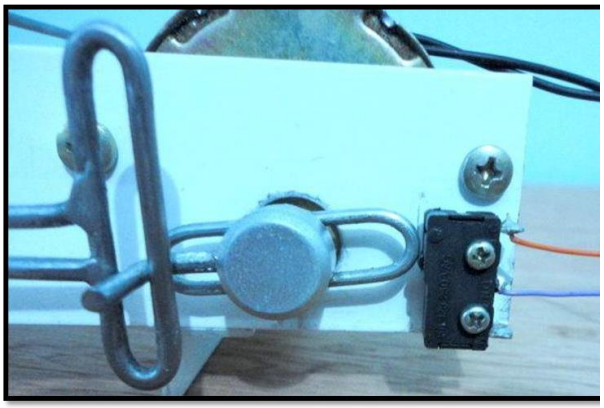


Figure 3-10: the form of roller, and eggs stack inside the roller.

1. The Hardware

Is the parts that contain the electronic pieces whether inputs or out puts, or power supply. The must be central unit to control all this component (in this project ARDUINO UNO is used, it is connect to lamp circuit ,fan circuit, LCD, keypad , and dc motor circuit. Above diagram shows that the system in general consists of input, output, and control unit.

2. Input parts:

❖ **Power supply.**

❖ **Keypad :**

This project used 4*4 keypad ,but we will talk about the most common types of Keypad (3*4 &4*4 keypad),most important thing is to connect they with ARDUINO ,the key pad concept is a matrix of X &Y switches ,so if the Keypad contain 3*4 keys that's mean there are 3 column by 4 rows ,also if the Keypad have 16 wired that mean 4 column by 4 rows and so on , the following picture shows (3*4 keypad) and (4*4 keypad) :

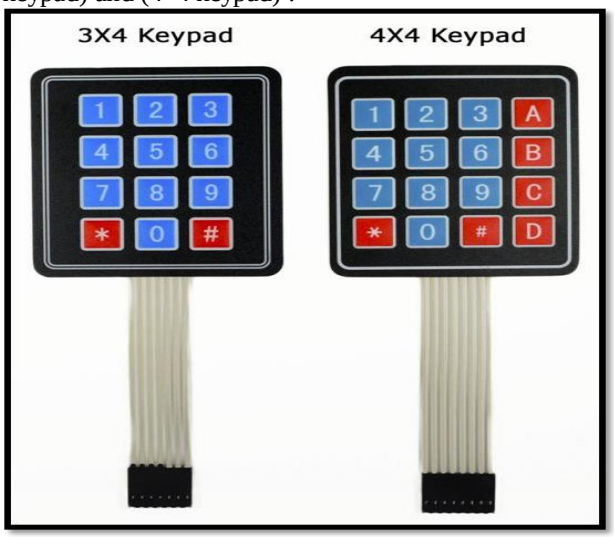


Figure 3-11: different types of most common Keypad (12 pins & 16 pins)

How to connect KEYPAD to ARDUINO?

To connect 16 pins key pad to ARDUINO that's mean we well connect 4 column and 4 rows together, every switch has two switches inside ,these switches connecting together as matrix ,every switch are the intersection of rows by column that's brought out single pin ,so there are 8 pins out in 16 pins keypad as following figure shows:

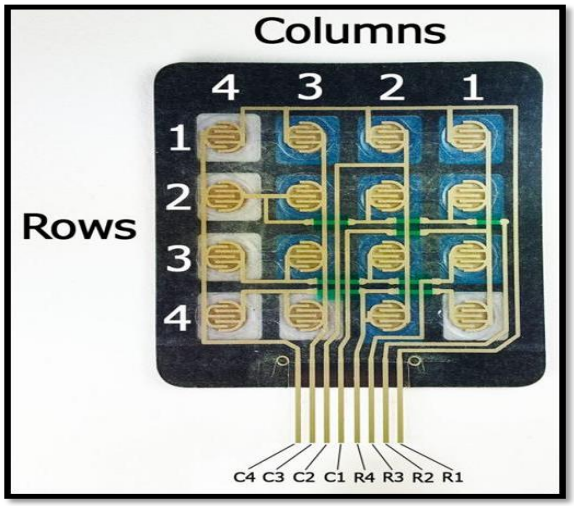


Figure3-12: The total of pins in 4*4 key pad

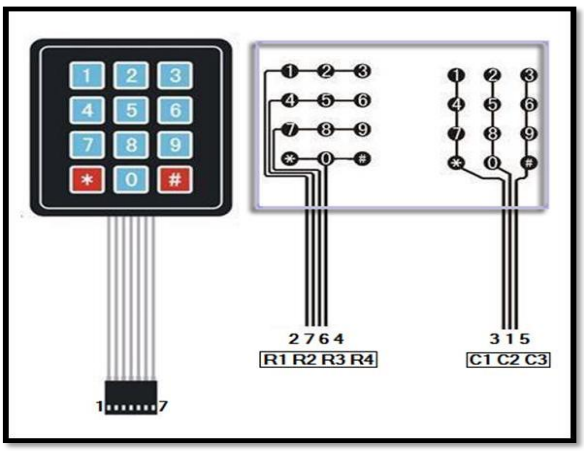


Figure3-13: The total of pins in 3*4 key pad.

For the project we working on C1 C2 C3 C4 for column,& R1 R2 R3 R4 for rows ,by pressing C1R1 bottom for example makes the switch close the circuit which make the current flow over it, that's happen in all switches ,the following picture explain this:

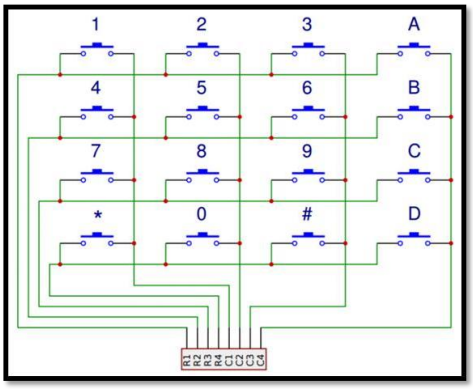


Figure3-14: Explain how to set up pins.

That's to set –up buttons in keypad but how the ARDUINO knows which switch has turn on, the answer comes as four parts:
If no buttons has pushed, every column pins will be set high, and every rows pins sets in low:

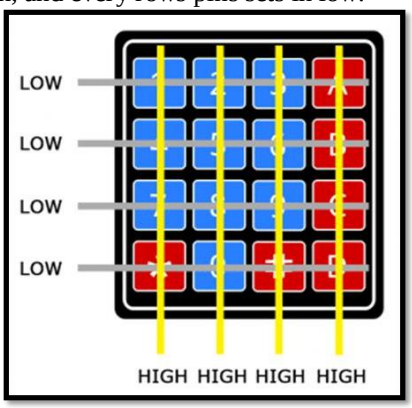


Figure3-15: When did not pushed any button

Second step, if we pressed a button, then the column pins will pulled out to low, so the current will flow from high to low.

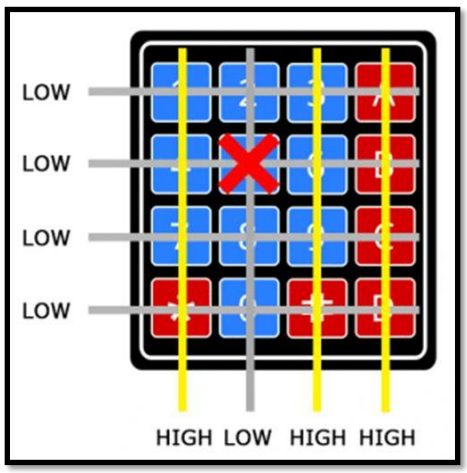


Figure3-16: the column pins pulled out to low after press it.

Now the ARDUINO knows which column has pressed, because the current flow from high to low but it doesn't know which row that has the pins, then it will automatically start switching every rows to find witch row pins high.

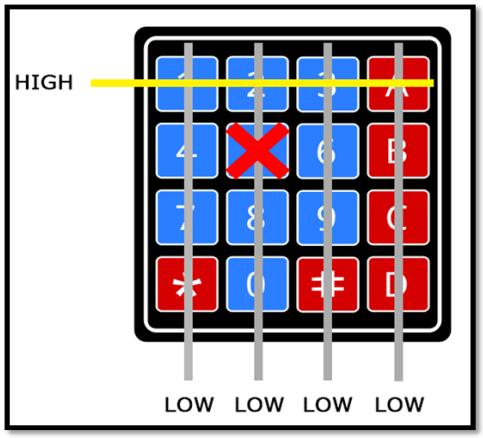


Figure3-17: ARDUINO knows which row has the pins.

When the column pin back again to high, the ARDUINO will find the button.

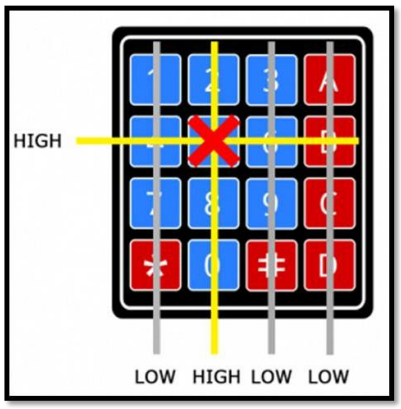


Figure3-18: When the pin back to high again.

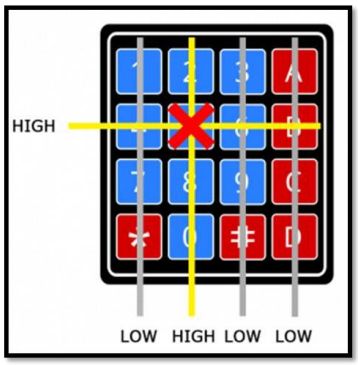


Figure3-19: Connecting keypad ARDUINO.

DHT22 (humidity and temperature sensor): is a small sensor that can measure temperature and relative humidity, the question here is about why it just measure the relative humidity not the real humidity? What the different between them? the real humidity is the ratio of the water vapor in the air, and the alternative humidity regardless temperature, measuring in (g/m3),but the (RH) relative humidity is the ratio of real humidity of water vapor in the air and the maximum amount, the (RH) take temperature in account.

DHT22/AM2302 Specifications:

Operating voltage	**3.3 – 5.5 V**
Operating current	**Measuring: 0.5 mA, standby: 15 µA**
Humidity measuring range	**0 – 99.9 % RH ± 2 % RH**
Temperature measuring range	**-40 – 80 °C ± 1 °C**
Sampling period	**2 seconds**
Body dimensions	**25 x 15 x 7 mm, ⌀ 3 mm mounting hole**
Pin dimensions	**7 mm length, 2.54 mm spacing**
Advantage	**More accurate**

Table (3-1):DHT22 specifications.
Connecting DHT22 to ARDUINO:

First thing we need to connect A 10 kΩ pull –up resistor between signal line and 5v, as figure below:

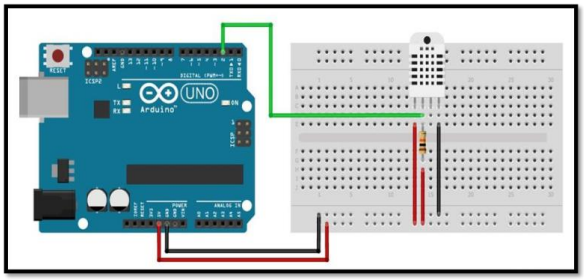
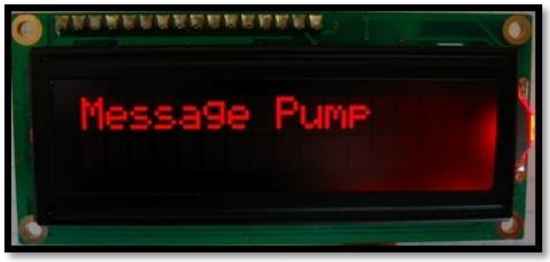


Figure3-14:make sure the level of signal always being high by put pull –up transistor between

The output part is contain of:

LCD 2x16 :
This component responsible for interfacing with user, also it displays the changes that happen to the system, 2x16 character LCD with backlighting. Note, screen is all black, but to display characters the crystals move to allow the backlighting to show through.



LCD displays come in many sizes most often named by the number of rows and then the length of the display line. For example a 1x16 LCD display will have one row of sixteen characters and a 4x20 LCD display will have four rows with twenty characters.To connect LCD with ARDUINO first thing connect GRD and VCC of LCD to ARDUINO, then connect SDA and SCL pins of LCD to UNO ARDUINO (this project used UNO ARDUINO)SDA pin connecting to A4, and SCL pin to A5 that's just in UNO ARDUINO, connecting different types of ARDUINO with LCD is according to the following table:

Table(3-2):connecting SDA pins and SCL pins to ARDUINO

Arduino	SDA Pin	SCL Pin
Uno	A4	A5
Nano	A4	A5
Mini	A4	A5
101	SDA	SCL
Zero	SDA	SCL
Leonardo	2	3
Micro	2	3
Due	20	21
Mega	20	21

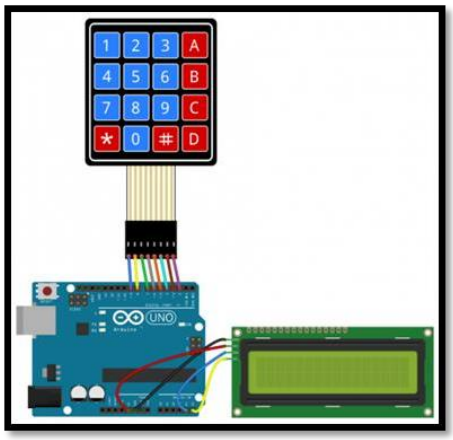


Figure3-20: Connecting LCD to ARDUINO

DC MOTOR: is a motor that runs on DC voltage. The toy cars and robots may have one or more DC motors to move their wheels or arms. It was used in this project to flip eggs by moving eggs ruler between angle 90˚ and 45˚ forward and backward. We can control the speed of motor by controlling the input voltage to the motor we can do this by using PWM signal, depending of motor size we connect the PWM of ARDUINO with a transistor or the gateof MOSFET then control the speed of DC motor by controlling the PWM output, see the following figure.

Figure3-21: connecting DC motor with ARDUINO.

H Bridge DC motor: To controlling the direction of DC motor we need to change the direction of current flow in the DC motor , in H bridge method we use four switching elements transistors or MOSFETs, the DC motor most be at the centre of bridge as H letter shape ,the direction of current flow will change immediately if two of switch elements are set on.

Figure 3.22: processor fan and 16 w lamps.

Fan & lamp: It is responsible for provide the incubator with necessary ventilation , processor DC fan is suitable for this project.
All previous components are connected as follow:

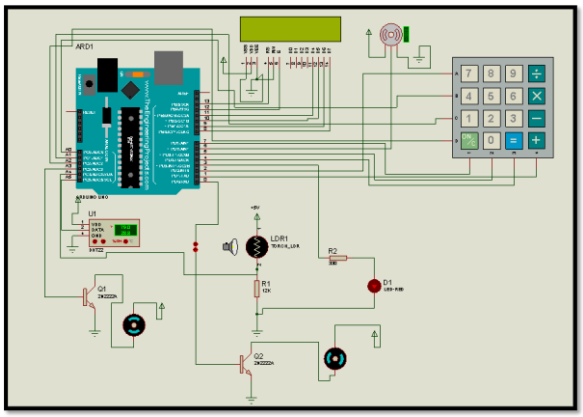


Figure 3.23:connecting all component (inputs and outputs) together.

Software design:
The source program of the project is written by C language, look at the appendix.

VII. PROJECT RESULT AND DISCUSSION

1. Result:

In this project chicken egg was chosen,16 veterinary eggs in meddle size ware put inside the incubator, and monitored them tell the 21th day, the result ware 12 eggs hatched, 8 from them ware in a good health but the others ware had fewer fluff than the others.

2. Discussion:

In general, incubators is very necessary project individual or in general, that because it save time and effort, also because it doesn't need much money to start it, so it is perfect project for employer families, and decrease the range of unemployment if the governments exploit projects like this very well, must important advantage of this incubator that it provide the effort of flipping eggs every day, also guarantee the safety of eggs that because of no need to open the incubator door throughout the incubation period. In this project 4 eggs observed had fewer fluff than other chicks, few fluff is always produces from two possibilities:

Non- adjusted hatching elements (temperature, humidity, ventilation) in incubator. Lack of vitamin B in kicks body, that's return to lack of basic materials in blackberries of mothers. Because the good number of kicks that hatched in a good health, that mean these results were not produced from the first possibility, these results back largely to second one.

3. Challenges:

There are several problems that could lead either to lack of hatching eggs or to corruption eggs, these problems may be caused by a change in temperature or humidity, or caused by problems in eggs themselves. most important things facing the technical during the supervision of the hatching process from beginning to hatch chicks as follow:

Dead embryos at the start of hatching or early embryonic tunnel:

1-Sterilization the eggs early.
2- Exposure the eggs to irregular temperature in early days of hatching.
3-Extend the storage period.
4- Exposure eggs to high temperatures during storage.
5-The eggs themselves have an infectious disease from mother.

Dead embryos at the end of hatching, or late embryonic tunnel: Those happen because:

1-Shortages in some food inside the eggs.
2-The eggs themselves have an infectious disease from mother.
3-Irregular heat in hatching machines.
4-Bad ventilation in hatching machines.
5-Irregular flipping eggs in incubator.

Dead of chicks because inability to out of the crust:

1-The most important reasons for this problem is:
2-Low humidity in incubator for allowable.
3-High ventilation and thereby increase the evaporation rate.
4-Very high heat, even for a limited period.

Earlier hatch:

1-That happen because:
2-Very small eggs.
3-High temperature throughout the incubation period.

Long time between first hatch and last one:

The most important reasons for this situation are:
1-Irregular heat in incubator sometimes high and sometimes low.
2-Use different ages of eggs some old and some other fresh eggs.

Low hatching rate with distorted chicks: The most important causes of this problem are:
1-Fluctuating temperature during breeding period.
2-Irregular flipping.
3-Exposure the eggs to cold when check them.
4-Lay eggs in incubator rollers upside down. low humidity in all breeding period.

To avoid these problems and others must follow these steps:
1-Adjust breeding elements of temperature, humidity and ventilation.
2-Attention to hygiene and sterilization.
3-Laying eggs in the incubator the pointed end in the bottom and the wide end in the top.
4-Non-breeding eggs resulting from infected birds with one of epidemic diseases.
5-Good Sterilization for eggs before placing it inside device.
6-Adjust the criteria sterilization.
7-Take out chicks from incubator as soon as them become dry.
8-Hatching fresh eggs, and in medium weight.
9-Hatching eggs in same or converged ages.

VIII. CONCLUSION

The smart incubator look very simple put it

has big incoming for individual and for countries, for individual it is good solution to increase the revenue of families, because no much money or effort needed also it doesn't need a huge area to implement it. In this project an Aluminum box is chosen because it doesn't need insulator, then a small slot as the same size of computer fan have been made, also lambs and two shelves have been installed to accommodates 16 eggs in a middle size, then the flipping rulers connected to DC motor and the DC motor to ARDUINO, also humidity and temperature sensor to ARDUINO, then the ARDUINO programmed to controlling all previous component, for 21 days(the period of chicken eggs hatching), the result is 12 eggs hatched 8 chicks in a good health, but 4 of chick has few fluff.

IX. RECOMMENDATION

This study strongly recommended to use Alternative energy sources to guarantee the system work without any interruption, also it is very necessary to insure that the eggs is in the same age, because that make some eggs hatch before the other, if eggs are fertilized and was checked before put them in incubator that will decrease the ratio of getting disease, should be putting eggs in incubator upside- down that increase hatching rate, smart incubator should be provided to every productive family in order to raise their income.

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