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FINAL YEAR PROJECT REPORT

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SMART EGG INCUBATOR BASED ON PID CONTROLLER

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A final year project proposal submitted to the department of Electrical and Electronic Engineering in partial fulfillment of the requirement for the award of a degree in electrical and electronics engineering.

DECLARATION:

This task is my original work, except the place due acknowledgement was made in the text, and to the high-quality of my understanding has not been formerly submitted to Murang'a University of Technology or any other group for the award of a Bachelor's degree in Electrical and Electronics Engineering.

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The project proposal has been submitted to the department of electrical and electronic engineering, Murang'a university of technology, with my approval as the supervisor.

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ABSTRACT

An incubator system stimulates the environmental conditions required for hatching operations within the specified range. To economically support chicken farmers, a flexible, simple and economical PID controller was proposed. This project will design and implement the PID controller for controlling temperature and humidity of the incubator. This project will use two devices to adjust the controller parameters that include Kp (proportional factor), Ki (integral factor) and Kd (Derivative factor). The system will consist of the main unit that will be represented by an Arduino mega board which include an *UNO* microcontroller, different sensors as humidity sensors and temperature sensors, heat source, humidity source, servo motor, LCD modules and keyboard.

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CHAPTER 1. INTRODUCTION.

1.1 BACKGROUND INFORMATION

An automated incubator Is an incubator that offers ultimate temperature and humidity with the required smooth amounts only. When matched with the unoriginal incubator that work on the general of timer-based controller that give these parameters the place was wanted with the required quantities (not smooth). An incubator system simulates the environmental conditions required for hatching operation within the specified range.

In a modern society like ours birds are reared for two reasons; as pets and as a source of food. As pets, they are needed for company of man and his comfort, but more seriously, we keep birds for the purpose of obtaining meat from them. The food referred here implies the meat we eat from them (which has become essential part of every home today) and the eggs hatched by them for either consumption by man or for continuity in life cycle of birds. [1]

Birds are very important to man necessitating the need to maximize its production. As a source of food , it is rearing in large quantities can sustain the economy of a country by providing adequate supply of eggs and meat for both domestic consumption and export to other neighboring countries who are in dire need with limited supply (Akinyosove, 2010).This was a way of generating income to the country thereby improving the economy of the nation . This was the more reason why attention should be given to adequate production of chicks in large quantities.

The act of rearing birds dates back to the history of man. Naturally in our society we depend solely on natural hatching of eggs under a hen. This takes a maximum of 12 to 15 eggs for a set of hatching which normally does not occur more than 3 times an year. This was highly inefficient and cannot meet up with the increasing need for eggs and meat in a society with a high and growing population like ours. Even though it was possible to separate the hen from chicks immediately after hatching, the hen was likely to stay upto 14 days before a new set of eggs are laid. This created a kind of discontinuity in meat production and such delay lead to shortage in protein requirement of the society. [2]

1.2 PROBLEM STATEMENT

In our rural areas, a lot of hens lay eggs in good numbers but only a few are hatched due to the low efficiency of natural hatching, especially during the heavy rains and due to diseases, which cause insufficiency in the no of chicks (Adewumi et al,2015). All these now make a conservative approach in poultry farming to ensure high productivity and minimize losses common to the primitive methods of poultry keeping (Abiola ,2009)

Then it was discovered that if you put a number of eggs in some form of box and heat was applied fairly evenly across the eggs, at the end of three weeks, a small percentage of the eggs would be able to hatch. And hence, most if not all incubators are built based primarily on the constant temperature hatching principle.

This automated incubator employed the electricity for its heating and turning of eggs thereby it eliminated the old method of opening the incubator to turn the eggs by slanting with hand opposite to the position which it had earlier been placed. This new model of incubator avoided manual labor from the poultry farmer to ensure high efficiency by constant closure of the incubator (guard against heat loss due to opening) and heat supply. This surely gave a healthy chick with a product of good incubating conditions. Day old chicks are in short supply in Kenya and some parts of east Africa due to inadequate number of hatchers and also due to the population increase there has been more demand but shortage in supply. Little attention has been paid and because of this, most local farmers adopt the traditional method of hatching birds. The need for mechanized form of hatching necessitated the design and fabrication of a smart egg incubator based on a PID controller. This would reduce drudgery of the traditional hatching method which are though quite efficient but are rather uneconomical in scale.

1.3 OBJECTIVES

In this paper, a smart incubator was implemented, the principal operation of this incubator relied on the monitored parameters that included the incubator relative humidity and incubator temperature. The essential issues of the lookup cover was to improve the economical, healthful and the rest for the consumer. The sensors that the gadget wanted are temperature and humidity sensor (DHT-11). The Arduino UNO board was the talent for the gadget controller. In 2005, Adhi Ksatria Theopaga, et. al. [1] recommended format and implementation of PID manipulate based toddler incubator.

The incubator carried tow packets pinnacle and bottom. The first packet was used to area sensors and sensor display. The 2nd was used to put electric circuits, warmer, and fan. The warmth sensor used was a DHT-11 sensor, and the different warmth sensor for son was NTC sensor. These gadget vagaries the warmness and can be seen in the structure of the heat show on a presentation scheme. PID foremost factors are gotten via the usage of the Ziegler-Nichols 1st technique. By serving the plant via a unit-step input and the received output response provide the standards of Kp = 13,827, Ki = 0,576, and Kd = 82,962. Each assessment was used into the warming scheme and the create time accomplishment was four minutes forty-four seconds with regular factor at 32°C.

In 2007, Hitu Bansal, et. al.[2] proposed controlling of temperature and humidity for a toddler incubator the usage of microcontroller, in this task the surrounding temperature was determined by means of hotness sensors and was attuned by using controlling the current to the furnace. The operator can modify the incubator to manipulate the temperature. The alarm will toot if the warmness of the incubator improved above the edge value and the fan will be on and it rests on till the temperature decreased to the basis value. Also the alarm will toot if the heat of the incubator reduced beneath the edge price then the bulb will be on and it nevertheless on until the warmth improved to the required value. Additional oxygen can be taken in via an oxygen inlet piecing together where it was different with the clean air across the cleaning filter. As well as that the humidity can be amplified by the use of water steam bath or via saturated water on a heated element. In the backside phase of the incubator the air can be warmth by means of a light corms heat. The air passes over a vessel with dissolving water, so that its humidity rises. The earnest, steamy air then flows aloft into the baby section. The baby was being concerned for through unusual access doors named support ports. In 2010, Christina Tan, [3] proposed an integrated temperature, light and humidity monitoring system for the hospital environment. An intelligent, integrated heat, light and humidity checking system has been realistic with the use of exposed normal technology, marketable scheme and domestic matters which dynamically displays the ecological situations. A foremost goal for this system was to have it designed and realized as price efficient as likely. The scheme permits for a operator to input the wanted situations concerning a exact tolerant temperature, humidity and lighting supplies. The microcontroller then associates the ecological situations in contradiction of the customer input supplies, and actuators modify the sets until the wanted situations have been got. In 2012, S.K. Mousavi, et. al. [4] presented an incubator with fuzzy logic. In this work the authors study success fuzzy of three factors such as temperature, moistness and oxyge*n* that they have a real part in the incubation method in incubator. In this object they attempted to attain to the highest efficiency in expressions of total of born chickens which was born from eggs and have a system with exact control-finally the review the normal of reversion of these three fuzzy factors. In 2015, Sumardi Sadi,[5] designed Room Temperature Control System Prototype Industry Based Programmable Logic Controller Zelio SR2 B121 BD, in this project a trial mechanism based on the chamber hotness increases determined programmed by encoding the PLC, the. Rise in heat of the chamber and the rate of the heat surge can be observed using the LCD. The system worked from a temperature of 0 ° C to 90 ° C degrees. Chamber heat kit manufacturing customs three devices: first controller, Zelio Logic SR 121BD, second, Integrated Circuit (IC) and third, a 24 VDC power source. This made the scheme develops the data attainment abilities and management. In 2015, Hitu Mittal, et. al. [6] designed a design and development of an infant incubator for controlling multiple parameters. In this project a closed loop control system to adjust the hotness, wetness, light power by means of LEDs to escape the situation and the correct quantity of oxygen smooth inside a newborn incubator. A PID controller was be used for realizing the scheme. The closed loop control system was an arrangement of actuators and sensors that functions in one time to offer steady current surroundings in the incubator. Here a PID controller, was employed, the principal process of this scheme be contingent on the checked factors that contain the temperature and the virtual humidity in the incubator. [3]

1.4 PROBLEM JUSTIFICATION

This project was focused on designing and fabricating a smart egg incubator at low cost using available materials. The proposed smart egg incubator based on a PID controller was aimed at increasing the number of birds by hatching their eggs efficiently and effectively. Making this device affordable to the community will improve their economic viability with respect to eggs and poultry thus benefitting more as opposed to making losses. Thus, in general contributing to the economic growth of the country.

CHAPTER 2. LITERATURE REVIEW

"The Development of Quail Eggs Smart Incubator for Hatching System primarily based on Microcontroller and Internet of Things"

W.S. Mada Sanjaya1,2∗, Sri Maryanti3, Cipto Wardoyo4, Dyah Anggraeni1,2, Muhammad Abdul Aziz1,2, Lina

In this paper describe the improvement of quail eggs clever incubator for eggs hatching system. The incubator can manage the temperature, humidity, and reversal the quail eggs automatically primarily based on Arduino microcontroller. In addition, the incubator primarily based on Internet of Things (IoT) system the usage of VNC's software can help the farmers to control and monitoring the clever incubator from a distance. Marlina5, Akhmad Roziqin6, and Astuti Kusumorini7

Design and Implementation of a Microcontroller Based Egg Incubator with Digital Temperature study out. Anthony Obidiwe, Chukwugoziem Ihekweaba, Patrick Aguodoh. Computer Engineering Dept. Michael Okpara University of Agriculture, Umudike, Abia State Nigeria.

In this existing age of records technology, the manipulate and automation of devices, machines and structures are normally executed through mechatronic capacity with emphasis on gentle control. This was more often than not achieved by means of the use of programmed microcontrollers. The output of the sensor was fed into an ADC 0804 (Analog to digital converter) that converted the analog sign to an 8-bit parallel digital output. Port zero and port 1 of the 89C51 micro controller respectively received the 8-bit parallel data. [4]

CHAPTER 3. OVERVIEW OF THE SYSTEM

The system hardware consisted of a Microcontroller (main unit), DHT-11 sensor, LCD, servo motor, keyboard and other components (sound indication, fan and LCD indication)

2.1 P-I-D TEMPERATURE CONTROLLER

A PID control system is a system that uses the control of three term variable P, I and D parameters (P-proportional, I-integral and D-derivative.

P-I-D temperature controllers worked using a formula to calculate the difference between the desired temperature set point and current process temperature, then predicted how much power was used in subsequent process cycles to ensure the process temperature remains as close to the set point as possible. This controller combined proportional control with two additional attachments which helped the unit automatically compensate for changes in the system. These adjustments Integral and Derivative were expressed in time-based units, they are also referred to by their reciprocals, RESET and RATE, respectively. The proportional, integral and derivative term must be individually “adjusted” or tuned to a particular system using trial and error. It provided the most accurate and stable control and was best for systems with relatively small mass, those which reacted quickly to the changes in energy added to the process.

The P-I-D controller had a sensor which maybe a thermocouple or RTD and a temperature range.

This project used two devices to adjust the controller parameters that include Kp (Proportional factor), Ki (Integral factor) and Kd (Derivative factor). The system consisted of the main unit that was represented by an Arduino Mega board which included an UNO microcontroller, sensor with both humidity and temperature sensors, heat source, humidity source, servo motor, LCD modules, and keyboard. Fig. 1 shows a block diagram of a PID control system.

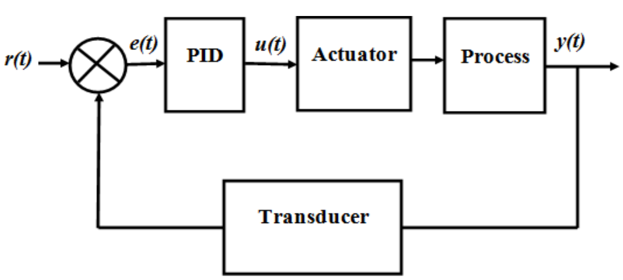


Figure 1 A block of diagram of PID controller

2.2 THE AUTOMATIC INCUBATOR

Due to the rapid advances in *technologies,* it was now possible to use various levels of smartness in agriculture fields. In this work, an automatic incubator supporting by PID controller was designed and implemented for the temperature and humidity managements. These automatic incubators are ones that can interrelate intelligently to provide comfort and safe living.

The programmed incubator needed tools and machineries that could expand manufacture productivity, produce quality, postharvest processes, and reduce their ecological influence. normally based on the error (e) amongst some costumers defined usual point and some measured process variable [9

The error signal e(t) was used to generate the fundamentals factors of the PID controller which included Kp (Proportional factor), Ki (Integral factor) and Kd (Derivative factor, with the signals results weighted and summed to form the control signal u(t) applied to the plant model.
The time response of the PID controller output was given by equation (1) [9].

$$u(t)=K_p\left(e(t) + \frac{1}{Ti}\int_0^t e(t)\,dt + T_d\frac{d}{dt}e(t)\right) \ldots\ldots 1 \quad e(t) = r(t) - y(t) \qquad \ldots\ldots 2$$

Where u (t) was the input signal to the multivariable processes, the error signal e(t) s defined as in equation(2), y(t) was the process output and r(t) *are* the reference input signal. The factor Kp was the proportional gain, Ti was the integral time constant and Td was the derivative time constant. The time response of the PID controller output in equation (1) can be written as:

$$u(t)=K_pe(t)+K_i\int_0^t e(t)+K_d\frac{d}{dt}e(t) \qquad \ldots\ldots.3$$

Where Ki= Kp/Ti was the integral gain and Kd=KPTd was the derivative gain. The tuning of a PID involves the adjustment of Kp, Ki and Kd to achieve the optimal gains of a system response.

Achieving of the required temperature and humidity was one of the main issues of this work, therefore, it's necessary to adopt a control for these parameters for providing its accurate amounts in the incubator. Here a PID controller was used for controlling the temperature and humidity in the incubator. The PID will control on the voltage that provide the temperature and humidity source by PWM (Pulse Width Modulation) machinery. That was achieved by using the microcontroller. [5]

2.3 ARDUINO MICROCONTROLLER(UNO)

An Arduino is an open-source platform based on both hardware and software that are both user-friendly. An Arduino hardware refers to the Arduino board that use variety of microprocessors and controllers equipped with digital and analog input and output pins that interface various expansion boards such as the GSM modules, GPS modules and many more other. The Arduino IDE makes it easy to write and upload a code into the board. This software used C++ programming language. Arduino. Arduino has several types depending on the amount of data it can process which includes Arduino UNO-which was the most commonly used type of Arduino board, Arduino MEGA and then Arduino NANO (Badamasi, Yusuf Abdullahi, *2014*). These are most available in the market. Additionally, Arduino simple, open source and flexible and this makes it suitable for beginners and researchers for making electronic circuits that need coding and hardware building. moreover, it was not limited to any operating system as Arduino IDE can run on windows, mac OS and Linux operating systems.

In this project the *UNO Arduino* was used. It was a high performance, low power microchip 8-bit AVR RWASC-based microcontroller combines 128KB WASP flash memory, 8KB SRAM, 4KB EEPROM, 86 general purpose I\O lines, 32 general purpose working registers, real time counter, six flexible timer/counter with compare modes, PWM, 4 USRAT's, byte oriented Two-Wire serial interface, 16 channel 10-bit A\D converter and a JTAG interface for on chip debugging. The device achieved a throughput of 16 MHZ and operates between 2.7-5.5 volts.

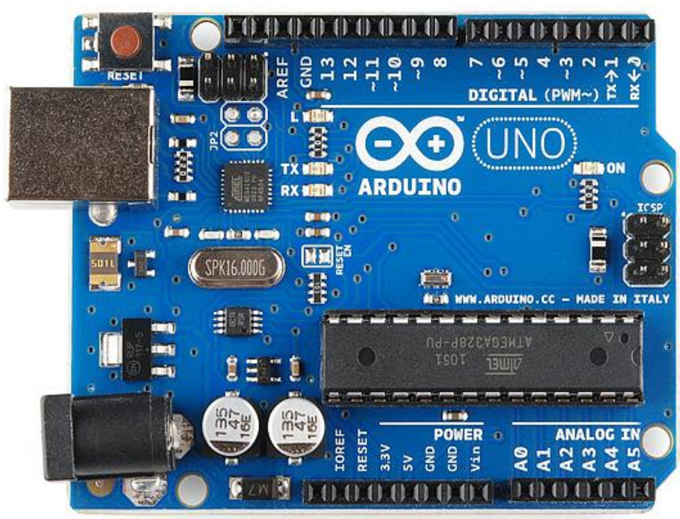


Figure 2 ARDUINO MICROCONTROLLER(UNO)

2.4 SERVO MOTOR

A servo motor is a rotary actuator or motor that allows for precise control in terms of angular position, acceleration and velocity. Basically, it has certain capabilities that a regular motor does not have consequently it makes use of a regular motor and pairs it with a censor for position feedback.

Figure 3 Servo motor

2.5 LIQUID CRYSTAL DISPLAY

The LCD was used for monitoring the PID output, the current humidity and temperature of the. The LCD size 20*4 that use IIC serial bus was used in this system. The LCD that used in this project was illustrated in figure below.

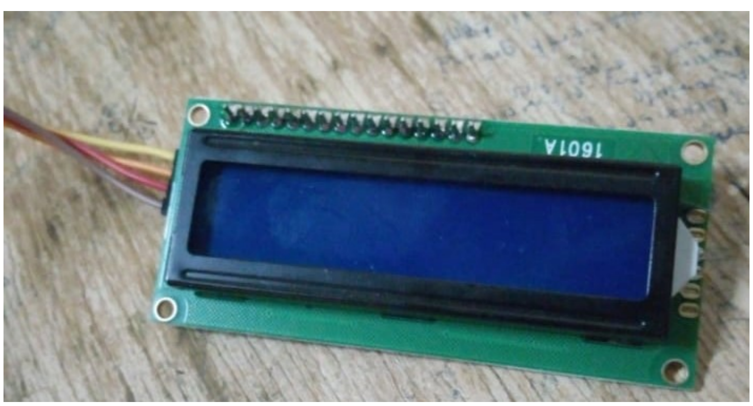


Figure 4 LCD

2.6 DHT-11 SENSOR

These sensors are the system motes that in charge for the measurements of humidity and surrounding temperature. The DHT-11 sensor for sensing the humidity *and the* temperature. Application of a committed digital unit's group technology and the surrounding temperature and air humidity detecting machinery, to ensure that the product has high reliability *and excellent* long standing solidity [11].

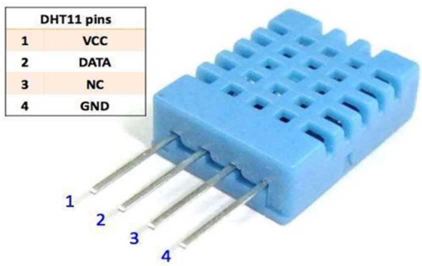


Figure 5 DHT-11 Sensor

2.7 ACTUATORS

There are many actuators in this system which included relay, *heat source and fan*. *Each* was controlled from *the microcontroller* throw a driving circuit Fig. *6*, illustrates the driving circuit.

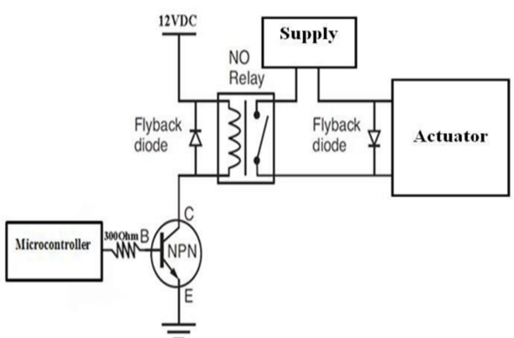


Figure 6 The driving Circuit

Figure 7 The Fan

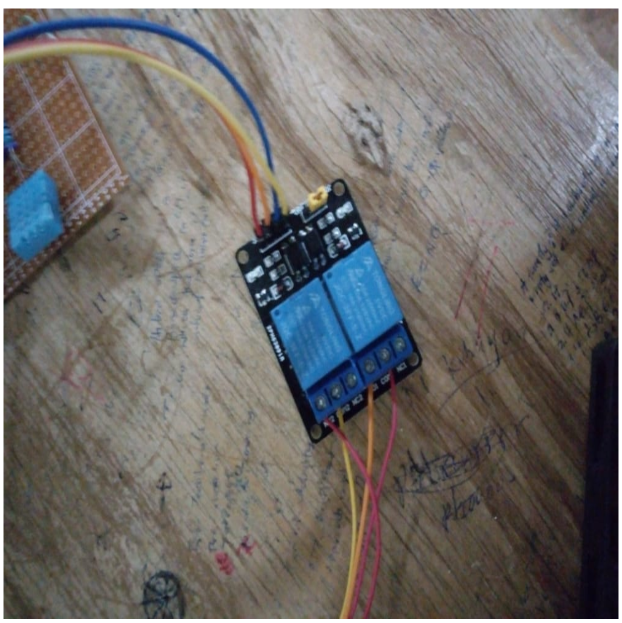


Figure 8 Relay

CHAPTER 3. METHODOLOGY

3.1 THE CONTROLLER PROTOCOL

We described the controller protocol as following, after power up, the microcontroller got the data from the sensors, then evaluated the humidity and temperature data, then the microcontroller checked the data according to the determined threshold values *a*nd sent the control signals to the required actuator to be active. These threshold values were chosen according to required environmental parameters. The actuators response was in a smooth manner, because the controller was not on/off, its PID controller. The PID controller achieved by programming the microcontroller. The Arduino board which contained UNO microcontroller was programmed using IDE software that utilizes C++ language. There were light indication and sound alarm to tell the customer the changes *in states* as high and low parameters. Fig*ure*, shows flowchart of the system contro1ler. [6]

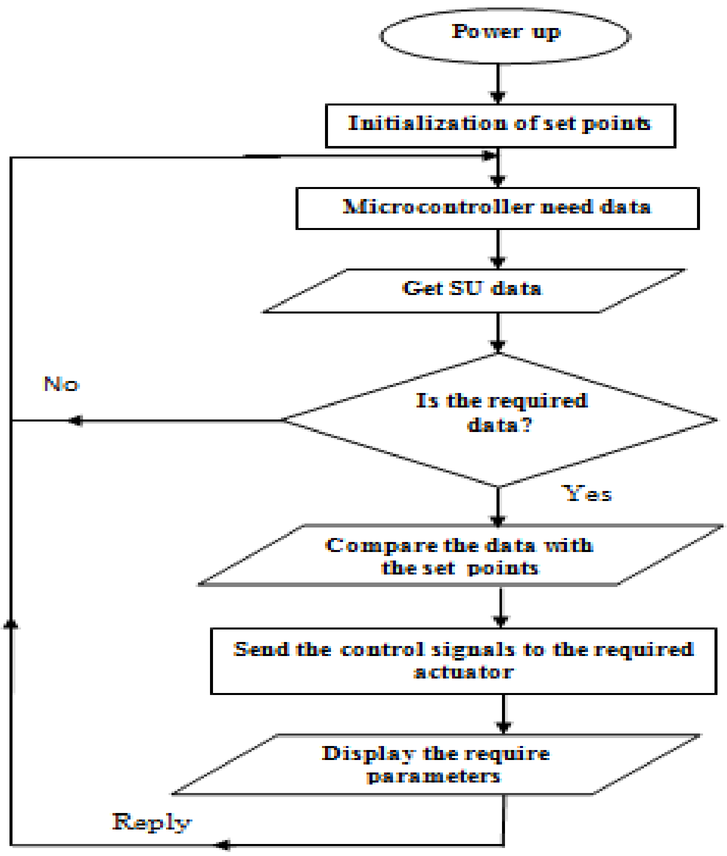


Figure 9 System controller Flowchart

CHAPTER 4. DESIGN AND IMPLEMENTATION

The proposed system was applied on actual environments for measuring required data included the incubator humidity and temperature.

4.1 PID FACTORS AND ITS OUTPUT

The optimal values PID factors that included P, I and D was adjusted by many methods depending on the application, here *these factors* are chosen by the *trial-and-error* methods. [7]
The optimal values of these were found as P=1, I=0.5 and D=0.1 as shown in Fig*ure below:-*

(A)

(B)

(C)

Figure 10 PID Parameters, (A) P-Factor,
(B) I-Factor, (C) D- Factor

There were two modes for adjusting the PID output, the first was manual and the second was auto. The output of the PID changed the applied voltage for the humidity and heat source by PWM technology. Its *output c*hanges from 0 to 255 depending on the required humidity andtemperature. Fig*ure* shows The PID output.

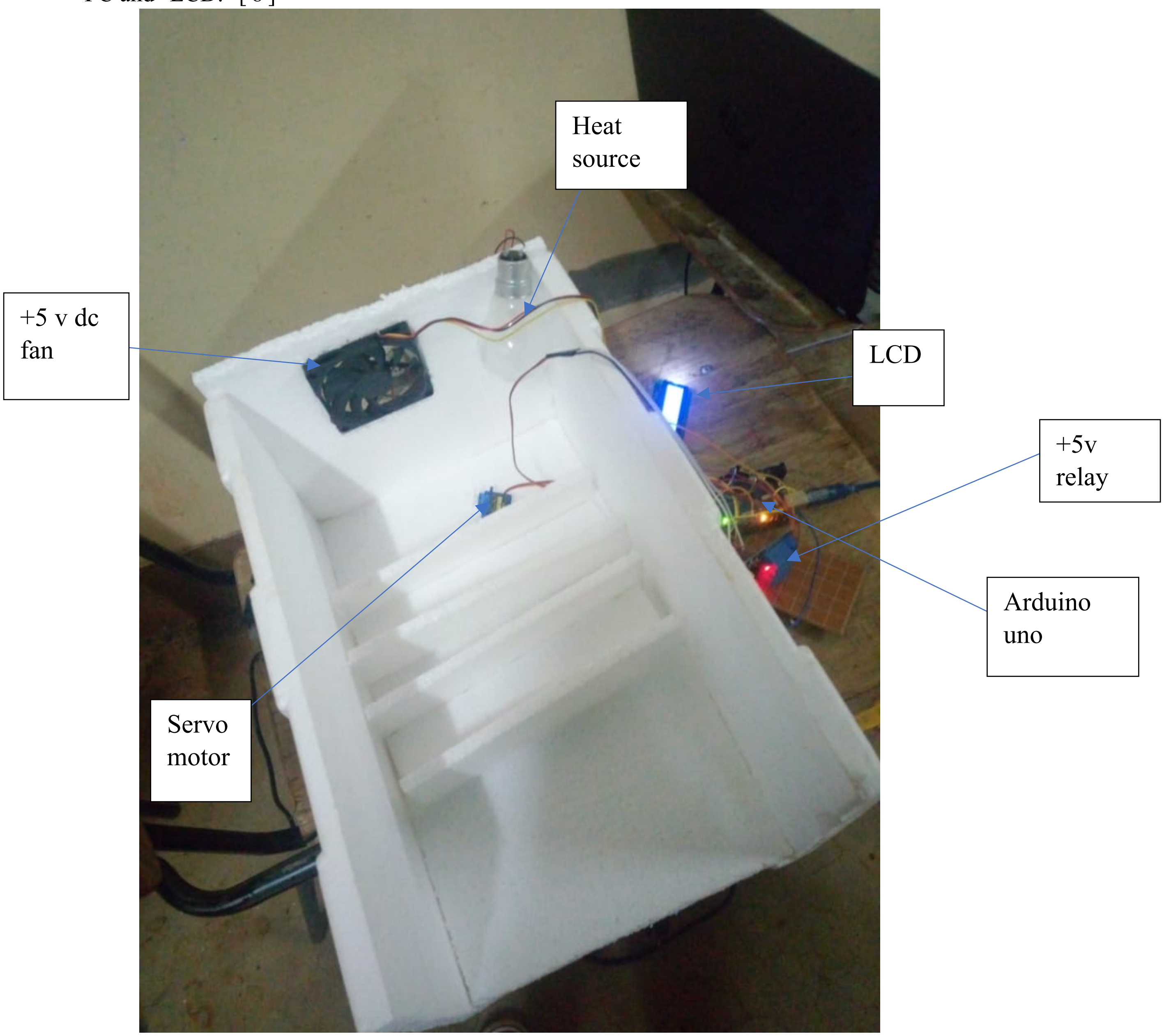
(A)

(B) 

Figure 10 The PID output.

4.2 TEST THE INCUBATOR

This test was performed for a suggested environments for showing the operation of the incubator. The set points that included the temperature was set to be 37C and humidity was set to be 62%. The results are displayed by PC and LCD. [8]



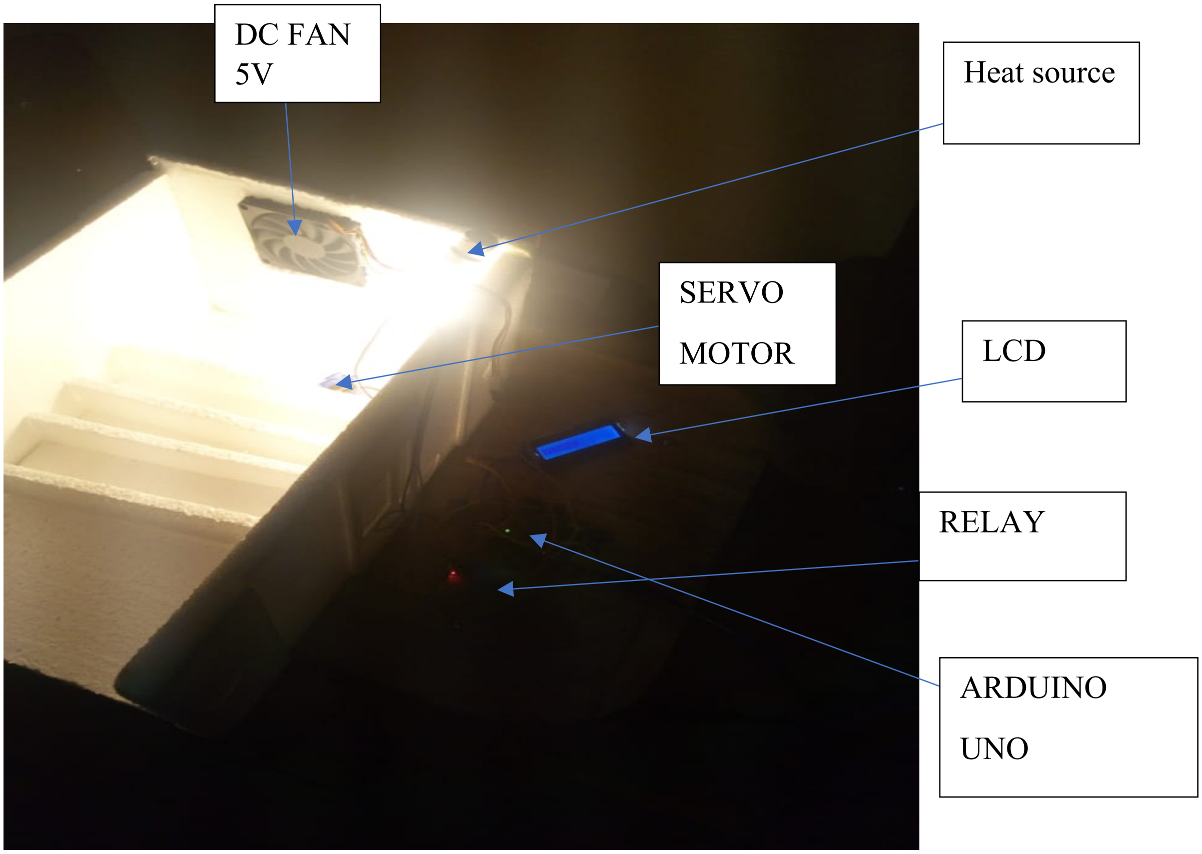


Figure 11 The incubator

The LCD interfacing with the microcontroller to displayed the sensed values and the PID output. Fig *below*, shows the LCD, which displays the required parameters *f*or different states according to required threshold values of the humidity and temperature.

(A)

(B)

Figure 12 Displaying results by LCD

CHAPTER 5. EXPECTED RESULTS

5.1 A SYSTEM EVALUATION

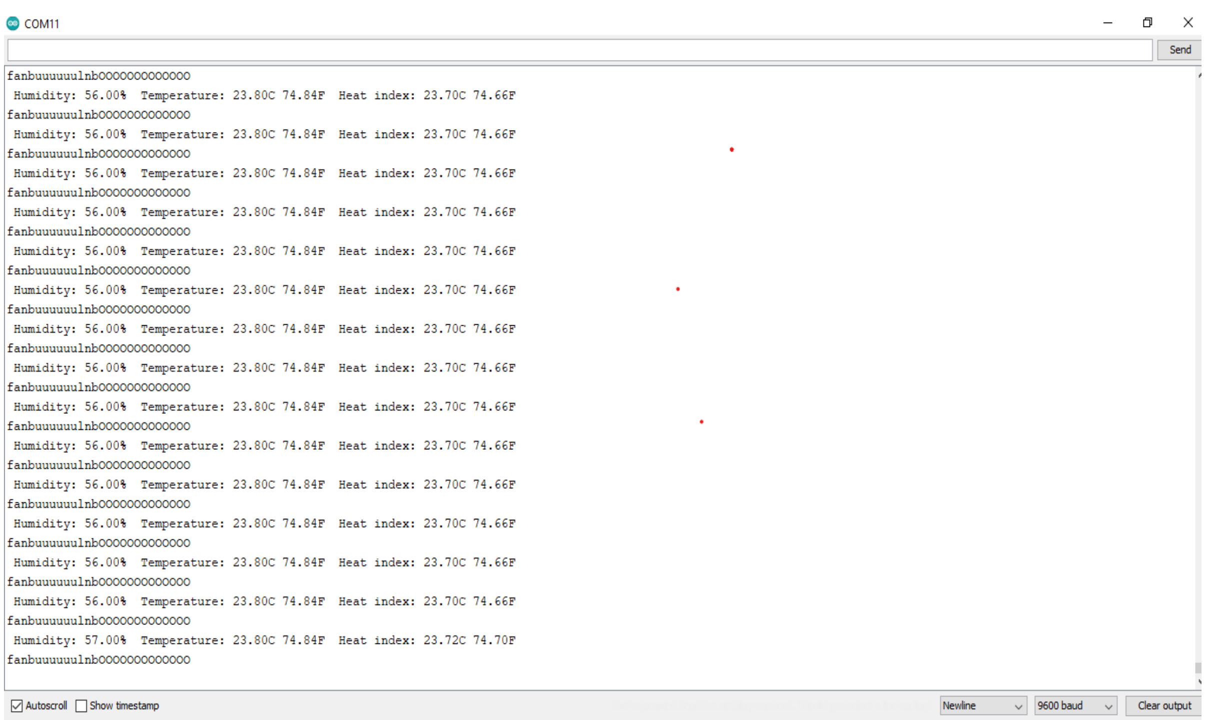
The system was tested in different environmental as shown in the previous terms. The main advantage of this system achieved in the power and cost saving.

The maximum required power of system controller was shown in Table 1. From the power tables, its noted that the maximum total current drawn by the controller was148mA.

Table 1 MAXIMUM TOTAL CURRENT

The system controller power requirements.		
Component	Current (mA)	Voltage (VDC)
Arduino uno	50	5
DHT-11 Sensor	8	5
L*CD*	*30*	5

Also, noted the maximum level voltage was 5VDC, that show the system can be operated with small DC batteries with low power requirements.



CHAPTER 6. PROJECT TIME PLAN

Table 2 Project Time plan

ACTIVITY	MAY	JUN	JUL	AUG	SEPT	OCT	NOV
DOCUMENTATION							
PROPOSAL WRITING							
RESEARCH							
DESIGN AND CODING							
HARDWARE CONFIGURATION AND TESTING							
-							
-							
-							
FINAL PRESENTATION							

Table 3, illustrates the cost of the system controller

Table 3: COST OF THE SYSTEM CONTROLLER

The system controller cost	
Component	Cost (*Kshs*)
Arduino *Uno*	*150*0
LCD	*600*
DHT-11	*800*
Connectors	*300*
Relay	*100*
Push Button	*100*
Heating element	*100*
Fan 5v	*800*
I2c	*300*
Servo Motor	*400*
Total	*5000*

CHAPTER 7. CONCLUSION

In this paper, a PID controller was implemented and applied to achieve smart incubator. It needed low cost and power when compared with classical systems. *Also,* the controller economical in power consumption. This controller had this advantage since, the system motes needed low power. Finally, the system had the simplicity that favored the customer.

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