Development of Semi - Automated Portable Box Poultry Brooder

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Abstract: Brooding is the period immediately after hatching when special care attention must be given to chicks to ensure their health and survival and the process by which heat is supplied to newly hatched chicks, until such time that their thermo-regulatory mechanism is functional. The objective of this research work is to make use of locally available materials to construct an automated poultry brooding system and to test the constructed brooder. The brooder was constructed in a symmetrical two sided roof (gambrel roof) structure of height 87cm, width 62cm, and breath of 62cm. Programmable Logical Controller was used as an environmental controller in order to direct the heater and humidifier in order to control the environment. The result of the tested brooder gives us an efficiency of 84.5% making use of the observed maximum temperature of the brooder. Therefore the brooder was constructed in a portable form for ease of handling and to help farmers brood their chicks.

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1. Introduction

The degree of hotness or coldness of a broader has really been the major necessity for day old chicks which has been a constraint to the farmers. According to Okonkwo et al (2007) majority of poultry farmers often uses a collection of kerosene bush lamps/stores or the combination of both to supply the heating requirements of hatcheries and box nurseries for brooding day old chicks. Though, the farmers are in the majority, they have their scope of operation seriously limited by the high cost of heating power or the total absence of it (Oluyemi & Robert, 2000).

Joan (2002) discussed one of the methods of using an infra-red heat lamp. These lamps are designed for higher infra-red heat lamp. These lamps are designed for higher infra-red energy output and a lower light output that can be prevailed by ordinary electric light bulbs. The infra-red energy passes through the air without heating it, the energy is absorbed and transform into heat, the litter is also heated and surrounding air is warmed by heat converted from the heated bodies. For brooding of small of batches of chickens (up to 50) a normal incanolescent low spotlight globe may be used but these are not as efficient as the infra-red lamp which is also similar to cold brooders which is another method, (Bolla, 2007).

According to Akinbobola (2008), the use of foster mother has been the modern method of brooding day old chicks from the first day of age till they are about six weeks old, involving provision of heat and other necessary care during their early growing period which is carried out in the poultry. Fakorede (2015) has observed that the development of poultry production in Nigeria has been indeed impressive but problem like inefficient management, exposure to disease (Zoonotic disease) and temperature regulation problem with the occurrence of stressful environment for chickens that are not yet acclimate due to the sudden problem listed afore cannot be ignored.

The chicken adjusts to increasing temperature by behavioral changes like hyperventilation or panting, and decreases in feed intake and this causing small production. Essential brooding should be given to the chicks from the time they are hatched up to the chicks from the time when their bodies can already control their heart requirement and are covered with feather (Durodola, 2015). Thus, the main problem is a controller, but also a design with faster warm-up phase and quicker response to disturbance with minimal overshoot when the poultry set point changes.

Adewumi et al (2013) has stated some of the problem associated with poultry brooding system, which includes inefficient management, exposure to disease (Zoonotic) and temperature regulation problems with successful environment among others. Therefore, there is need for agricultural engineers to be involved in the development of automated poultry brooding system in order to help in removal of human drudgery, to reduce farmer's exposure to zoonotic diseases and enhancement of proper management of poultry brooding system. The general objective of this research work is to construct automated poultry brooding system with specific objective of testing the constructed system in order to know the performance.

Origin of Poultry Domestication

The Domestication of the chicken dates back to at least 200BC according to Durodola (2015). The domestic chicken ancestry can be traced back to four species of world jungle fowl. Originally, poultry are breed for sports in form of recreation and as in cock fighting (Smith, 1995). However, the red jungle fowl (Gallus gallus or Gallus bankira) is the most commonly found wild species in the world today and is considered the main ancestor of the domestic chicken. Domestic chicken are simply classified as Gallus domestic and have provided us with eggs, fresh meats and feathers plus some truly horrible traditional medicine (Pennstation Extension, 2008).

Brooding Management

According to Achi (1992), brooding refers to the period immediately after hatching when special care attention must be given to chicks to ensure their health and survival and the process by which heat is supplied to newly hatched chicks, until such time that their thermo-regulatory mechanism is functional.

Figure 1: Manual Brooding management (www.farmtek.com)

Blake and Joseph (2001) cited in Fakorede (2015), discussed that there are four stages of natural brooding management. This includes 0 -1 week, 1 – 3 weeks, 3-6 weeks and after 6 weeks respectively.

Chicks Reactions to Temperature.

According to Hermes (2000) for small numbers of birds, heat usually is provided by heat lamps or light bulbs. When large numbers (200 or more) are brooded together, it may be more economical to use propane hovers. Many types of hovers are available if desired proper temperature must be maintained if the chicks are to thrive. During the first few weeks, chicks are cold blooded; that is, unable to maintain their body temperature. As they age, they become warm blooded; that is, able to maintain constant.

Edgar (2008) further discussed the second method that it relies on observing the chicks (Figure 6). If the chicks are all under the heat source, it is too cold; if they are all far away from the heat, it's too hot; if they are clumped away from the heat, it is drafty; if they are milling about in all areas of the pen, the temperature is correct. It was also recommended that when brooding in a small area, take care that both warm and cool areas are available to the chicks so they can move from warm to cool and back again at will. Otherwise, chicks can get chilled or over- heated when only cool or warm conditions are available.

2. Material and Methods

Construction Site

The research work was carried out at DIGITOUCH Nig, Ltd, Samonda, U.I. Road, Ibadan, Oyo State, Nigeria and Federal College of Agriculture Ibadan Nigeria. The materials used for construction, testing and evaluation takes into account cost implication for domestic use, portability, durability and ease of utilization of the cage (brooder).

Selection of Construction Materials

In selection of materials for construction, the following were taken into consideration;

1. *Durability of Material:* The durability of material should be considered during selection of construction materials since the brooder must withstand certain pressure to justify its construction.
2. *Availability of the Material:* Material chosen must be available before it is chosen. This favours ease of construction and ease of after-construction repairs.
3. *Strength of Material:* The material will be put through the test of tensile, compressive and other kind of stress during use, so the material chosen must be put through series of test.
4. *Portability*: of the Material: The machinability of material means the...
5. *Cost of the Material:* The cost of the material must be estimated in order to determine the overall cost of construction and marketing cost of constructed machine.

Materials for Construction:

1. Housing (wood & plastic)
2. Programmed integrated circuit (pic)
3. Microcontroller
4. Heater
5. SHT 11 sensor
6. Liquid crystal display
7. Fan
8. Button/switch
9. Bulb
10. Panel box

Table 1: **Bill of Engineering Materials and Evaluation (BEME)**

S/N	COMPONENTS		Quantity	AMT/UNIT	Amount (₦)
1	CAPACITOR 1000µF		2	150	300
2	CAPACITORS 10 µF		1	80	80
3	TRIAC		1	350	350
4	CAPACITORS 33PF		2	80	160
5	VARIABLE RESISTOR 103		1	150	150
6	SHT 11 SENSOR		1	7000	7000
7	LIQUIDCRYSTAL DISPLAY		1	2000	2000
8	DIODES		4	50	200
9	VOLTAGE REGULATOR 7805		1	710	100
10	RESISTORS 100Ω		1	80	80
11	RESISTORS 100KΩ		1	30	40
12	RESISTORS 1K Ω		2	50	100
13	RESISTORS 100 Ω		1	50	50
14	RESISTORS 10K Ω		1	50	50
15	TRANSFORMER		1	500	500
16	CRYSTAL 16MHZ		2	800	1600
17	WOOD FOR PACKING TRANSMITTER RECEIVER		(2 BY 4)X 3	1000	3000
18	PRINTED CIRCUIT BOARD			1500	1500
19	SOLDER		1 ROLL	1300	1300
20	SPRAY PAINT (BLACK)		2	550	1100
21	PLASTICS		3X12	1300	3600
22	SINGLE STRAND CABLE		8YARDS	100	800
23	FLEXIBLE CABLE		10 YARDS	70	700
24	DC MOTOR		1	1200	1200
25	OPTO ISOLATOR		1	2250	2250
26	SMALLEST SCREWS (FOR THE PANELS)	-	2 DOZENS	100	200
27	MEDIUM BOLTS (CASINGS CORNERS)	-	2 DOZENS	100	200
28	LONG BOLTS (TO BOLTS THEPLASTICS)	-	1 DOZEN	300	300
29	WHITE GLUE	-	1	200	200
30	SUPER GLUE	-	2	50	100
31	CONNECTOR		1 ROLL	950	950
32	PLUG CABLES	-	2	200	400
33	ON/OFF SWITCH		1	100	100
34	LIGHT EMITTING DIODES LED		8	50	400
35	CRYSTAL		1	1200	1200
36	HEATER		1	4000	4000
37	BC547		1	150	150
38	SIGNAL DIODE IN4148		1	50	50
39	TYRE FOR THE HOUSING		4	500	2000
40	RED BUTTONS		3	70	210
41	PIC 16F628 MICROCONTROLLER		1	2500	2500
42	FAN		1	800	800
43	CHOCKE RESISTORS		17	450	7650
44	VERO BOARD		1	120	120
45	LOCK FOR THE HOUSING		1	250	250
46	PLASTIC CASING		1	1200	1200
47	13A SOCKET Miscellaneous		1	150	150 8,360
	Total				**₦60,000**

Constructional Features

The brooder is constructed to house the day old chicks. It is developed purposely to enhance poultry production especially during the brooding stage. The essential Parts includes: Housing, Pic, Sensor, LCD, Fan, SHT 11, Heater and White led bulb.

Housing

This is the main structure that houses the birds. It is constructed by plywood wood and covered with plastic which is black inside and brownish in colour at the outer part in order to retain heat.

The Dimension of the structure is 62x62x87(cm) with Door 23x34(cm) and water tray which is made of plastic is 35x30x2(cm). Small holes are put around the box for ventilation and under the structure where four tyres for easy handling.

Plate 1: Housing Structure

Programmed Integrated Circuit (PIC)

This is the vital part of the brooder which the box encompass and it is located at one side electronic components (capacitors, resistors, transistors, diodes, and all electrical component) of the brooder are connected. It is programmed in such a way that the temperature remains as last temperature in the cage when there is power turn off & will start again from the last temperature when there is power turn on.

Heater

This is the part of the brooder that is use for supplying heat to the brooder in place of the bulb that has been used generally. The heater is 6x2(cm) in dimension amd connected/fixed to the Programmed Integrated Circuit Board (PICB) for controlling of the heater by switching it off when the temperature exceed the required temperature and switch it on when below the expected temperature at a particular moment by the use of the TRIAC, which is the electronic switch that regulates the temperature. The total number of heaters used is 20 pieces which is 5 heaters in 4 places and screwed to the structure (Brooder) but separated by an insulating material to the wood.

Plate 2: Heater

Sensor (Sht Ii)

This is the part of the brooder that does the work of sensing the heat generated from the heater and transferring it to the DHT11 which measures the temperature and humidity. The sensor is also attached to the PICB that does the control work.

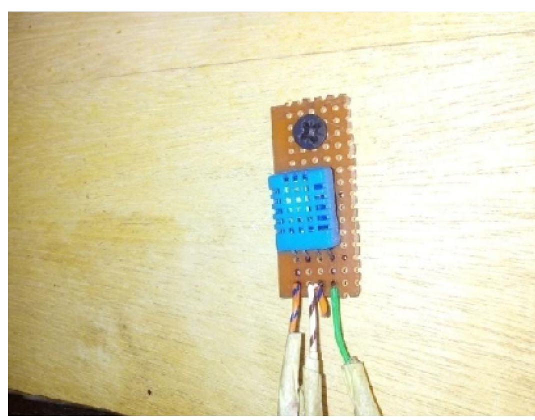

Plate 3: Sensor

Liquid Crystal Display (Lcd)

Liquid crystal display is another part of the brooder with screen size of 7x2.5(cm) and the dimension of the housing of the screen and panel is 11cm and 10cm for top and bottom length of the housing respectively, and with height 6.5cm in which the panel is also connected to the PICB and does the work of receiving the measured temperature and humidity by the DHT 11 and then display the temperature and humidity.

Plate 3.4: Liquid Crystal Display Screen (LCD)

Fan

This is another essential part of the brooder; the fan is 12x12 in dimension. The fan performs two functions, which are; circulation of the heat in the brooder cage to prevent segmentation of heat and also disperses heat by blowing out air through the holes around the structure.

Plate 5: Fan

Button/Switch

The button is a part of the brooder cage which is located at the external part of the brooder, mainly to perform the function of controlling of the brooder. There are three buttons in the structure; START, STOP and RESET. The start button is to put the brooder into work. The stop button is to hault the work of the brooder and the reset button is to clear the readings on the LCD screen and reset the brooder to start working again. The switch on the brooder is to ON/OFF the brooder after being plug to the socket by three gang plug for supplying of current to the brooder and there is also an electronic switch inside the brooder cage on the PICB for regulating the temperature by switching off the circuit automatically to when it is higher than what programmed and switching it on when the temperature is below what is expected.

Plate 6: BUTTONS

Bulb

The bulb which is the part of the brooder cage illuminates the brooder house when dark and it is connected to the PICB. The white led bulb which is eight in number is used for lightening to disallow transferring of heat from another source more than the heater, in order not to disrupt the programmed heat that the PIC may not have the power to control.

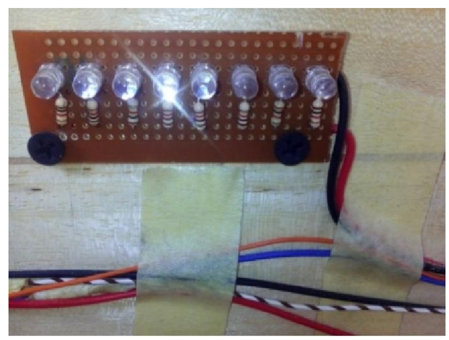

Plate 7: Bulb

Panel Box

This is a metal box that serves as an encampment or housing to the panel and the microcontroller in the box. It is sized as Length – 11cm at the top, Breadth – 10cm at the bottom and the Height – 6.5cm.

Plate 8: Panel Box

Composition Of The Circuit Diagram

1. The panel(printed C.B)
2. Triac (Electronic switch) Converter
3. Resistor
4. Capacitor
5. Diode
6. Analog-to-Digital (A/D)

The Panel (Printed Circuit Board)

A flat board made of non-conducting material, such as plastic or fiberglass, on which chips and other electronic components are mounted, usually in predrilled holes designed to hold them. The components on a printed circuit board-or, more specifically, the holes that hold them—are connected electrically by predefined conductive metal pathways that are printed on the surface of the board. The metal leads protruding from the electronic components are soldered to the conductive metal pathways to form a connection.

Triac (Electronic switch)

It is a switch on the PICB for regulating the temperature by switching off the circuit automatically to when it is higher than what programmed and switching it on when the temperature is below what is expected.

Resistor

A component of an electric circuit that resists the flow of direct or alternating electric current. Resistors can limit or divide the current, reduce the voltage, protect an electric circuit; or provide large amounts of heat or light.

Capacitor

It is also called a condenser and is an electric circuit element used to store charge temporarily. It consists in general of two metallic plates separated and insulated from each other by a dielectric.

Diode

A diode is a specialized electronic component with two electrodes called the anode and the cathode. Most diodes are made with semi conductor materials such as silicon, germanium, or selenium. Some diodes comprised of metal electrodes in a chamber evacuated or filled with a pure elemental gas at low pressure. Diode is use as rectifiers, signal limiters, voltage regulators, switches, signal modulators, signal mixers, signal demodulators, and oscillators.

The fundamental property of a diode is its tendency to conduct electric current in only one direction. When the cathode is negatively charged relative to the anode at a voltage greater than a certain minimum called forward break over, then current flows through the diode. If the cathode is positive with respect to the anode, is at the same voltage as the anode, or is negative by an amount less than the forward break over voltage, then the diode does not conduct current. This is a simplistic view, but is true for diodes operating as rectifiers, switches, and limiters. The forward break over voltage is approximately six tenths of a volt (0.6 V) for silicon devices, 0.3 V for germanium devices, and 1 V for selenium devices. (Margaret, 2015).

Analog-to-Digital (A/D) Converter

Transforms analog information such as audio signals or measurements of physical variables (for example, temperature, force, or shaft rotation) into a form suitable for digital handling, which might involve any of these operations: (1) processing by a computer or by logic circuits, including arithmetical operations, comparison, sorting, ordering, and code conversion; (2) storage until ready for further handling; (3) display in numerical or graphical form; and, (4) transmission.

Design Procedure

The acquired components were brought together, assembled and soldered on a board to make the programmed Integrated circuit (pic) and was placed in the constructed box.

In the design and fabrication of the automated of poultry brooding system, the following procedural steps are used to achieve the aims and objectives of the research work.

Step 1; Measure and the mark out the size to be used on the wood and plastic material.

Step 2; Cut out the measured and marked size on the wood and plastic which are;

1. Height – 87cm
2. Width – 62cm
3. Height of door – 34cm
4. Width of door – 23cm
5. Length of Trusses – 40cm
6. Height of Trusses – 25cm
7. Angle of Trusses – 51^{o}
8. Size of LCD Screen – 7cm by 2.5cm
9. Length of panel box – 11cm at the top
10. Breadth of panel box – 10cm bottom
11. Height of panel box – 6.5cm

Step 3; Join the cut out size of the wood with nail to form the box to be used.

Step 4; Connect using cable the microcontroller to the power button and connect the power button to the source of power.

Step 5; using cable for the joining of the circuits join the LCD Screen to the microcontroller.

Step 6; Connecting the TRIAC to the Microcontroller using a cable and then the Heater to the TRIAC.

Step 7; The SHT111 sensor also is connected to the microcontroller using another cable wire.

Step 8; using another cable connect the fans to an internal switch and the switch is then connected to the microcontroller to which the fans will be controlled.

Step 9; Connect wire to the plug from the PIC.

3. Results

Performance test

The average result on the performance test on the brooder is shown in the table 2 below. However, plate 2 shows the picture of the working performance of the brooder.

Table 2: **Range of Temperature and Relative humidity of the brooder**

S/N	Period	Temperature(^{O}c)	Relative Humidity (%)
1	Morning	33-35	21-27
2	Afternoon	32-35	29-30
3	Night	32-35	27-30

Test result efficiency

Efficiency = Output x 100 (Ajav and Adewumi, 2013)

Input

Efficiency = Observed maximum temperature x 100

Required maximum temperature

= 35x 100

41

= 0.85 X 100

= 85.4%

Therefore, the efficiency of the machine is 85.4%.

4. Conclusions and Recommendations

The automatic brooder was constructed with the use of available materials for ease of production of new set of brooder. The automatic brooder is portable and easy in handling and can be operated without the need of special training on its operation (that is, it does not require much technical knowledge to be operated).

The overall capacity of the brooder is 20 chicks with maximum temperature of 35°c and 30% of relative humidity which gave efficiency of 85.4%. The automatic brooder can be successfully carried out with an efficiency of 90%after when it is been modified.

Based on the observation made during the course of testing the automatic brooder, the following recommendations were put forth for further work on the machine so as to obtain a higher efficiency:

1. There is need to provide power supply backup for stable supply of voltage to the brooder.
2. Droppings space should be made in the brooder for ease of managing the brooder.
3. The brooder should be evaluated in rainy and harmattan season.
4. At the end of the operation, the brooder should be cleaned and dis-infected.

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