Design And Construction of a Temperature Monitoring and Control System for High Livestock (Broilers) Production: A Case Study of The Federal Polytechnic Ilaro Poultry Farm

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Abstract- Livestock (Broiler chicken) are regarded as fast-growing bird. Temperature, humidity and feeds are the significant parameters contributing to their high production and growth. Therefore, environmental conditions of chicken house require regular temperature monitoring and control to guarantee the quality of poultry produce. However, increased carbon dioxide (CO_2) and very high temperature lead to various diseases and high mortality rate. The manual methods used to monitor environmental conditions in poultry have proved to be more tedious and time-consuming process. In this work, a device that is able to accurately monitored real-time temperature and controls the humidity automatically was developed. The model comprised of a temperature sensor that senses/read the environmental conditions, the Arduino microcontroller which manipulates the data readings and a liquid crystal display which displayed the output from the sensor comprehensively on screen. The result obtained shows the ability of the sensor in capturing the temperature value within the chicken cage for a given periods of time. Poultry farmers in the country especially medium and large-scale farmers will meet their production targets by implementing this system.

Indexed Terms- Livestock, Microcontroller, Mortality rate, Poultry, Temperature

I. INTRODUCTION

The intent of rearing domestic birds like chicken, geese, turkey, ducks, and quails for eggs, meat, as well as making used of their incidental products like feathers as unprocessed natural materials in industries is known as poultry farming (Stiles, 2017). Most poultry houses in Nigeria's rural areas are substandard and are handled by poorly capable operators who are not adequately disposed to use related or new methods to effectively manage poultry farming, which will adversely affect poultry production (FAO, 2018). This will be the reason why counties like Europe have a higher poultry production and consumption than under developed countries like Africa and Asia (Augère-Granier, 2019).

Several studies show that by the year 2030, poultry products demand across African continent especially in Nigeria will increase by 60% (World Economic Forum, 2019). Currently, present consumption across the continent is almost 100 MT respectively for both poultry meat and egg products while in Nigeria, 192.69 MT is consumed annually (Ritchie and Roser, 2019). An efficient, effective control and monitoring of various parameters like temperature is necessary for livestock growth and food safety (FAO, 2018).

Due to its revolutionary invention electronics has major role not only controlling and monitoring of environment but also acquires different physical status of animals like temperature, heart rate and other receptors. Temperature control becomes an important task in many of automatic operations. There are sensors, right from simple to smart sensors that are used for detecting the temperature. The environmental monitoring application, room temperature control are few of popular examples of temperature control. Now, with the advent of new technologies—hardware and software support—temperature can be controlled, monitored, and recorded.

Sami (2016) employed the concept of PWM for temperature control system using DTH11 temperature/Humidity sensor and the parameters readings from the environment was displayed LCD display. Also, recommended for incorporation of alarm system to enhance the functionality of the device.

Muhammad (2017) designed a PID controller and applied on digital laboratory platform, LabVIEW. It was recommended that Arduino-based hardware could produce suitable and appropriate results for temperature control.

Kiranmai and Rani (2018) proposed a temperature control device, and it turned into claimed that it is useful for Internet of things (IoT) associated applications. However, the real-time utility for such system was not tested.

Similarly, Singhala and Patel (2014) studied a fuzzy-based temperature control system that was completely simulation-based. The system suggested was very simple and effective but hardware implementation and realization remain as future scope of the work.

This proposed work demonstrates an application of control theory and hardware-based implementation. As such, the proposed model includes designing, construction and testing of a temperature control circuitry (hardware) based on program written on Arduino Uno. The results are displayed 16x2 LCD display.

II. METHODOLOGY

The designed system constitutes of hardware design and software programming. The hardware part consists of an embedded stand-alone controller that is based on 8-bit microcontroller (ATMega328), a temperature sensor (LM35), display unit (16x2 LCD) and a control fan. The software architechture consists of programming in Arduino IDE environment. Once the system is activated, the sensor will scan/read value of the parameters within the environment and send the corresponding analog values of the temperature to the controller. The controller will then decodes, manipulate and send the corresponding digital values to the display board, buzzer and at the same time the control fan will be activated.

- Flowchart

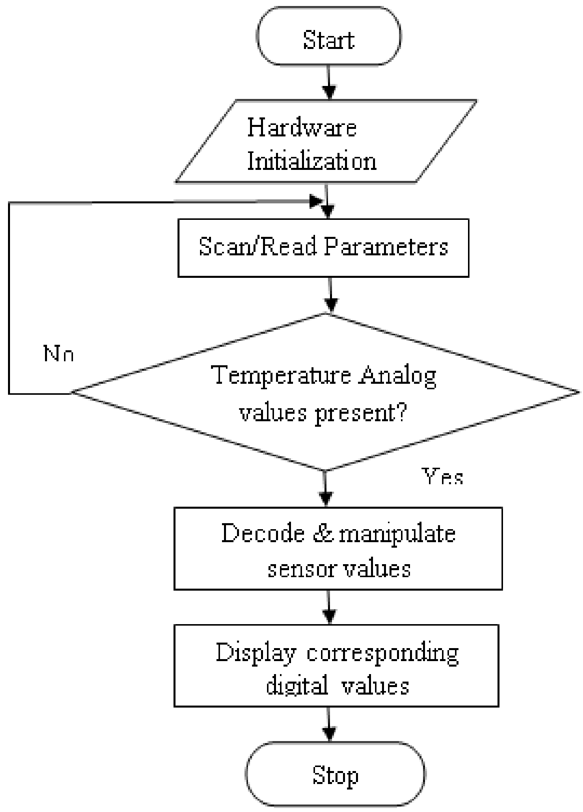
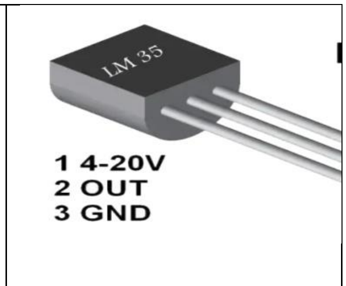
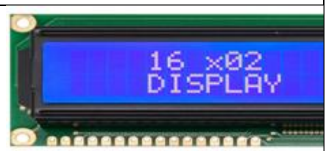
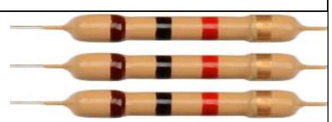
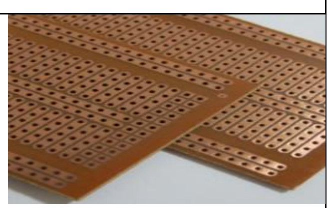


Fig. 1.0 System's Flowchart

- Materials Requirement

Table 1: Hardware Components

S/N	ITEM DESCRIPTION	PICTURE
1	Arduino Uno ATMEGA328 MICROCONTROLLER	

2	Temperature sensor (LM35) Measure between -55^{0}C -150^{0}C Operating voltage +5V	
3	5V Electronic Buzzer 40mA,100Hz 80dB at 20cm Sound Output	
3	Display WH1602J 16x2 character LCD Module	
4	Jumper wire MIKROE-512 Breadboard Jumper wire kit	
5	Resistor Carbon film Resistor 1K Ohm 1/2W	
6	Vero board 2.5mm Vero board circuit board	
7	Battery 9V Battery High Quality with its connector.	

- Design Procedure

Construction of the hardware was done on the vero board and interfaced with computer system for program coding. Block diagram and Data flow of the hardware implementation are shown in Figs. 2 below

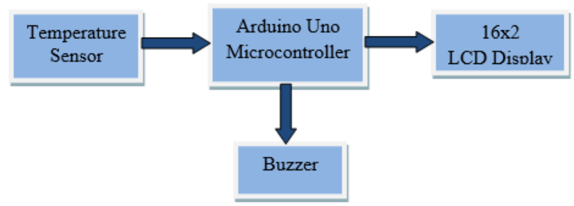


Figure2 Block Diagram

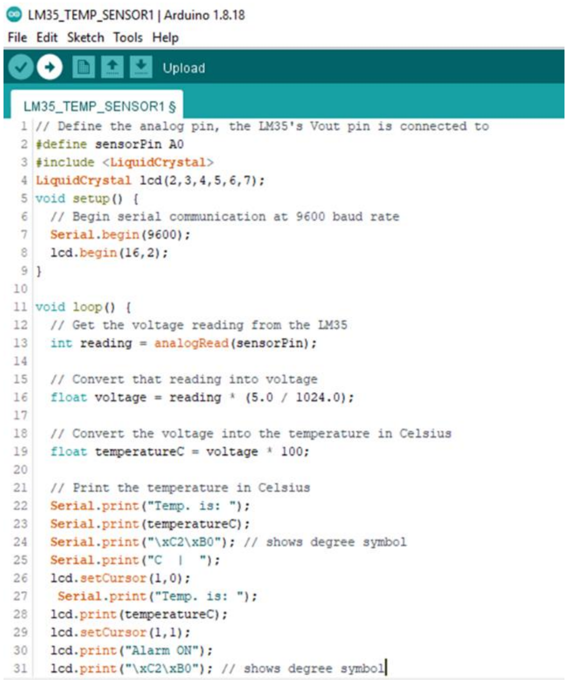
- Hardware Configuration

Table 2: Pins configuration of the Components

Temp sensor (LM35) Arduino Uno Pins Pins	Display LCD (16x02) Arduino Uno Pins Pins
VCC 5V	VDD 5V
GND GND	VSS GND
Data A0	RS digital---2
	R/W GND
	E digital---3
Buzzer - terminals Arduino Uno - Pins	DB0-DB3 -----
Positive (+ve) terminal digital ---8	DB4 digital---4
Negative (-ve) terminal GND	DB5 digital---5
	DB6 digital---6
Battery (9V) -terminals Arduino Uno -Pins	DB7 digital---7
Positive (+ve) terminal Vin	LED (A) + 5V
Negative (-ve) terminal GND	LED (K)- GND

- Software Programming

Having done with the hardware setup, a program (or set of instructions) is required to drive the microcontroller on Arduino chip. Software development was done using built-in C language in Arduino IDE environment. The instructions (codes) are written in Arduino IDE environment, compiled and uploaded into ATmega328 microcontroller. The code used in this work is described in figure 3.0.



LM35_TEMP_SENSOR1 | Arduino 1.8.18

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LM35_TEMP_SENSOR1 §

```
// Define the analog pin, the LM35's Vout pin is connected to
#define sensorPin A0
#include <LiquidCrystal>
LiquidCrystal lcd(2,3,4,5,6,7);
void setup() {
  // Begin serial communication at 9600 baud rate
  Serial.begin(9600);
  lcd.begin(16,2);
}

void loop() {
  // Get the voltage reading from the LM35
  int reading = analogRead(sensorPin);

  // Convert that reading into voltage
  float voltage = reading * (5.0 / 1024.0);

  // Convert the voltage into the temperature in Celsius
  float temperatureC = voltage * 100;

  // Print the temperature in Celsius
  Serial.print("Temp. is: ");
  Serial.print(temperatureC);
  Serial.print("\xC2\xB0"); // shows degree symbol
  Serial.print("C  |  ");
  lcd.setCursor(1,0);
   Serial.print("Temp. is: ");
  lcd.print(temperatureC);
  lcd.setCursor(1,1);
  lcd.print("Alarm ON");
  lcd.print("\xC2\xB0"); // shows degree symbol
```

Figure 3.0 Program Code

RESULT AND DISCUSSION

Experimental setup was carried out, many temperatures values measurement was recorded using suitable display device. A brief discussion of a sample displays observed was presented here. However, the system generated two outputs: first was automatic displaying of the temperature value on LCD display and second was that upon reception of either a very high or low temperature value, the controller sent signal to buzzer for alarm. LCD display produces the temperature readings as well as the status of the buzzer. In Fig. 2.0a, it can be notice that 35 degree centigrade is being displayed along with status of buzzer by the LCD display device. Actually, the status a buzzer depends on the threshold value set in the program. 35 degrees centigrade and above was set as the threshold value, and that is why for 35 degrees centigrade the LCD displays "Alarm ON". Similarly, another threshold value was set for temperature value below 15 degrees centigrade, for example at 10 degrees centigrade, the buzzer will still activate and the LCD displays "Alarm ON" as shown in Fig. 2.0b.

Figure 2.0 a System's Hardware Layout

Figure 2.0 b System's Hardware Layout

CONCLUSION

Temperature monitoring and control device can be made from low-cost locally available components. Normal temperature of the broiler's cage was considered and setup in the program to be between 28ºC to 33ºC. The temperature readings is displayed on the LCD, When the temperature rise above the threshold value or fall below the threshold value, cooling fan or electric warmer will operate according to the program instruction. The hardware device was tested and certified to achieve its aim. This system can be utilized in livestock rearing generally for higher production. Various types of sensors such DTH11 can be used to monitor and control temperature and humidity. GSM technology can also be incorporate to receive and send the changes in these parameters.

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