Design and Implementation of Smart-Controlled Poultry Farm Management System

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ABSTRACT

Bird mortality at a young age can be reduced by monitoring parameters like temperature and relative humidity in a poultry chick house. As the thermal environment becomes more stressful, the animal body perceives a risk to life and stops prioritizing production for survival. The health of the chicks can be ensured by using an efficient temperature and humidity control system that conserves energy by only using the heater or fan when absolutely necessary. Using a computer simulation, the work designs and simulates an automated poultry house weather control system with week selection switches that let the user select the age of the chicks. The selection informs the microprocessor of the control instruction to be used automatically. Proteus® is used to simulate the system, and it performs according to the design specifications, with precise temperature and humidity values used for control and results displayed on a 16*2 LCD.

Keywords: Arduino uno, smart-controlled, microcontroller, management system, poultry farm

1. INTRODUCTION

A poultry house is a facility where birds are housed in order to offer a healthy environment and maximize feeding efficiency. In order to achieve maximum efficiency in chicken production, the thermal environment must provide optimum comfort levels. When the temperature rises above a certain point, the body of the poultry birds will begin to require some physiological support[1].

Temperatures that are optimal allow chicken birds to transfer nutrients into growth rather than expending calories to regulate their body temperature. Poultry birds consume less feed and process it less efficiently in high-temperature environments[2].

Curtain drops are one of the most prominent methods for controlling the temperature environment of the poultry house in recent years. Another way is to reduce the bird's feed intake in order to reduce heat stress. Curtain ventilation, on the other hand, necessitates continual, 24-hour administration if the chicken house atmosphere is to be adequately controlled[1]. The use of automatic poultry temperature will assist in providing the birds with a more automated and less monitored thermal environment.

Every day in the modern period brings a new invention to the world. Every invention introduces us to a new school of thought, as well as new obstacles. The introduction of the wireless control allows systems to be watched and controlled. Monitoring is required for efficient control of a system when it is controlled automatically. Control is available through remote monitoring and controlling in poultry, house, hospital, and company, depending on the changing con Figure ration. This project is also a link in the chain. This system consists of a temperature sensor DHT22, an Arduino Uno with an AATMEL328P, a fan, a relay, and an LCD for efficient and accurate control and monitoring as well as simulation on proteus and hardware. Excessive bird mortality can be caused by poor temperature control in a poultry house during hot and humid weather. Many parameters, such as temperature, relative humidity, and air movement, must be monitored in a poultry house. As the thermal environment becomes more stressful, the animal body perceives a risk to life and stops prioritizing production and reproduction in favour of survival. As a result, the need for thermal environment control has emerged.

The goal of this project is to design and simulate an autonomous temperature management system for poultry. This is achieved through the design of a temperature monitoring and control device with ATMEL 328P (ARDUINO UNO) and a visual display (Liquid crystal display) to serve as the graphical user interface unit for temperature and humidity measurement display. The design and simulation were performed using proteus PCB design and circuit simulator software and evaluated to determine how efficient the developed system is.

2. RELATED REVIEW

Sneba. M. et al. presented a combination of wireless sensors and mobile system networks to regulate and monitor the following environmental factors in a chicken farm: temperature, relative humidity, and air impurity levels. Sensor modules such as the DHT22 measure temperature and relative humidity, while the MQ135 measures air pollution, and all of these measurements may be viewed online. Using a computer system, remote monitoring can be accomplished by acquiring sensor data and sending them to a smart phone that is linked to the internet [3].

Mohannad Ibrahim, et al. presented a method for developing a standardized environmental monitoring device at a low cost by utilizing utilizing a Raspberry Pi (R-Pi) single-board computer. The system was created in Python and can be managed and accessed remotely using an IoT platform. It collects data from sensors in the surrounding environment and uploads it straight to the internet, where it may be viewed at any time and from any location via the internet. According to the findings of the experiments, the system is capable of precisely measuring temperature, humidity, light level, and carbon monoxide concentrations. A seismic sensor is built inside the device to help detect earthquakes[4].

Rupali B. Mahale et al. discussed chicken farm monitoring in their research using GPRS and Wireless Sensors networks. This system keeps track of things like water and food levels, as well as temperature and humidity. It allows the person in control of a poultry farm to obtain information about the farm's internal environment at any time and from any location via GPRS network[5]. Palle, et al. presented temperature measurement and control, which are critical in a wide range of disciplines, including agriculture, science, engineering, and technology. It also becomes necessary to keep track of the current weather conditions in another location in real time [6].

Ms. Minal Goswami and Mr. Kirit Bhatt discussed the design and development of the CC3200-based Claud IoT for humidity and temperature measurement. Texas Instruments' CC3200 was the first Simple Link WIFI internet-on-chip Launch Pad in 2014. The HRT393 sensor measures humidity and temperature. AT&TM2X Cloud technology sends measurements to its Cloud servers (HTTPS). Measurements of humidity and temperature taken in real time are represented visually. Energia integrated development environment (IDE)was used to create the software[7].

It was developed by K. Sravanth Goudet and co-workers to control and automatically monitor the environmental factors of poultry using a wireless sensor network and a mobile network. Sending SMS messages to the system allows you to keep tabs on the system's environmental characteristics. These variables are comparable to those associated with temperature and humidity. Any action taken by the system will be done without receiving any direction from a registered mobile number. Farm automation can therefore be modernized by utilizing this new method [8].

Using smart sensing technologies in the poultry business to monitor crucial environmental characteristics that are relevant to chicken production, such as air temperature, relative humidity, light, air speed, and air quality are discussed by Gerard Corkery et al in their paper (in particular CO_2 and NH_3 concentrations). The current state of industry practice is examined in relation to the measurement of these parameters and the impact of these factors on bird welfare. As a result, they investigated the poultry industry's use of smart sensing technology [9].

Siwakorn Jindart et al. have created a chicken management system that utilizes an embedded system and a smart phone. The author utilized a Paspberry Pi and an Arduino Uno to address the issue. This system should keep tabs on the humidity, temperature, climate quality, and the status of the filter fan switches in the poultry habitat. Formers appreciate how straightforward and convenient this technology is, since it allows them to successfully manage the poultry farm at any time and from any location [10].

3. MATERIALS AND METHODS

A Materials Poultry Housing System

In developing nations, improvements to poultry housing systems have concentrated on creating an environment that meets the birds' thermal requirements. Newly hatched birds have a limited ability to regulate their body temperature and require some additional warmth, especially in the first few days after hatching. Many emerging countries are located in tropical climates with little need for heating. Indeed, keeping the birds cool is a priority in many countries, particularly for meat hens. Many emerging countries are home to international chicken breeding and feed corporations, which have established large-scale commercial farms in a number of them.

The housing and equipment used allow for significant control over the climate provided to the birds, but such houses are expensive to build and operate, and they require a high turnover of birds to be viable. Medium- and small-scale commercial housing is popular in developing countries due to lower construction and operating costs.

Poultry Housing Temperature and Relative Humidity

The temperature of the chicks can be determined by observing them. They will huddle near the heat source if they are too cold. They will spread out away from the heat source if it becomes too hot. If there are drafts, they will congregate in groups to avoid the point where the cool air enters the heated area. Comfortable chicks will spread out uniformly throughout the brooding area, without huddling.

Poultry farmers Make necessary adjustments on noticing signs of overheating (panting and drowsiness) or chilling (huddling and loud chirping). Heat control is more important in cage brooding because the chicks cannot move to find a comfortable temperature. Extremes of relative humidity are extremely dangerous to birds. When the relative humidity falls below 30%, the chicks get more agitated and may become aggressive. Excessive wetness, on the other hand, can result in soggy litter, which is linked to high ammonia levels, poor air quality, gastrointestinal infections, and respiratory issues. The relative humidity should be between 40 and 60 percent in the ideal situation. When brooding in a warm chamber in a cold region, humidity control becomes extremely crucial. Water can be sprinkled on the walkways or floors to improve relative humidity. By the end of the growing season, humidity levels should be between 30 and 40 percent.

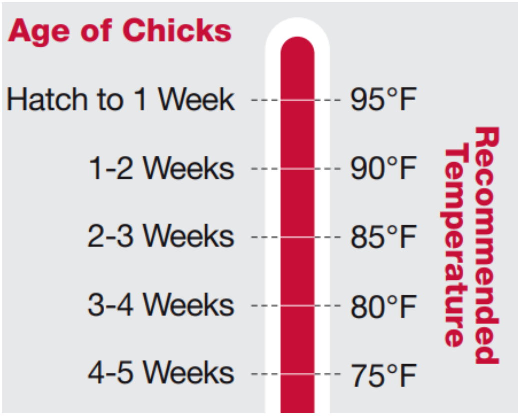

Figure 1. **Temperature chart for chicks [11]**

DT22-AM2302 Sensor

AM2302 outputs a digital signal that has been calibrated. It uses a proprietary digital signal collection approach as well as humidity sensor technology. ensuring the system's dependability and stability It has an 8-bit single-chip computer coupled to its sensing element. Every sensor in this model is temperature corrected and calibrated in a precise calibration chamber, and the calibration-coefficient is recorded in OTP memory as a form of program. When the sensor detects, it will quote the coefficient from memory. AM2302's small size, low power consumption, and high transmission distance (10m) make it suitable for a wide range of demanding application scenarios. The connection is relatively convenient because to the single-row packaging with four pins.

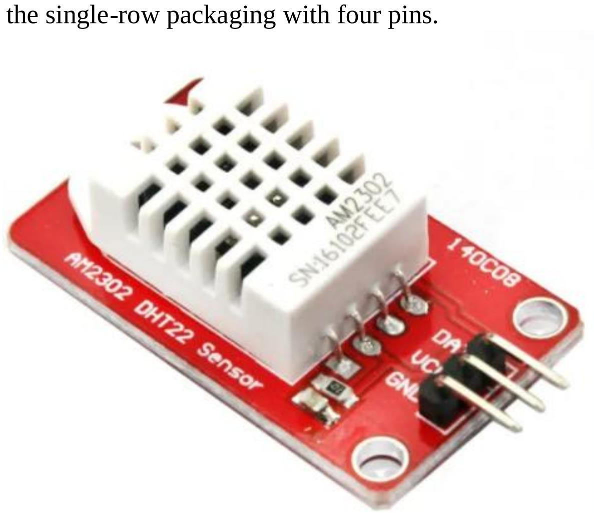

Figure 2. **DT22 AM2302 Sensor Diagram [12]**

ATMEL328P

ATMEL328P is a semiconductor integrated circuit that is modest in size. These integrated circuits are packaged in DIP packages. DIP stands for Dual Inline Package, which is a type of semiconductor IC package. Soldering this package to the strip board is a breeze. However, using a DIP socket makes it much easier to plug and unplug this chip from the development board. This is due to the low cost of the ATMEL328P. Aside from that, it's also quite simple to put together. A 5V power supply adapter, a 20Miz crystal oscillator, and two units of 22pF capacitors are the only additional components required to make this IC operate. As a result, it's ideal for the early stages of development.

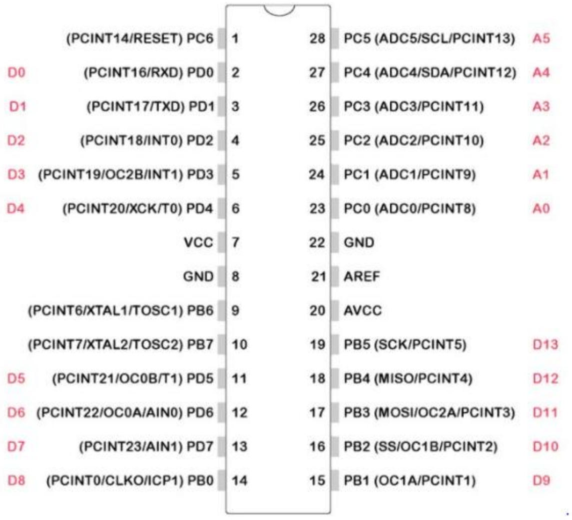

Figure. 3. ATMEL328P Pinout Diagram[13]

ARDUINO UNO

Arduino is a prototype platform built on open-source hardware and software that is simple to use. Arduino boards can receive inputs such as temperature from a sensor and convert them to outputs such as actuating a relay, turning on the heater, or turning on the coolant. It can direct your board by delivering a series of instructions to the board's microcontroller. The ATmega328P is used in the Uno, which is a microcontroller board. It contains 14 digital input/output pins (including 6 PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB cable or power it with an AC-to-DC adapter or battery.

Figure 4. Arduino Uno Diagram [14]

The Relay Switch (2.6)

A relay is a mechanical switch that is used to turn on and off other circuits. Small currents in one circuit can control a much bigger current in another circuit, or multiple circuits can be switched at the same time. As shown in Figureure 2.5, there are three main types of contacts: ordinarily open (NO), normally closed (NC), and common (COM). They can also be single pole or double pole. When a tiny current passes through the relay's coil, it transforms into an electromagnetic switch that attracts the soft iron armature. The pivot transmits this movement to the contact operating the coil. When the magnetic field collapses, the armature can return to its previous position, allowing the contact to revert to their normal states. A relay has a maximum current rating and a nominal working voltage. In practice, however, its coil can only operate within a certain voltage range.

Resistor

A resistor is a two-terminal passive electronic component that acts as a circuit element by implementing electrical resistance. When a voltage V is applied across the terminals of a resistor, the current I flowing through the resistor is proportional to the voltage. This proportionality constant is known as conductance, G. The reciprocal of the conductance is known as the resistance R, because with a given voltage V, a larger value of R "resists" the current I as defined by Ohm's law.

A resistor's electrical functionality is defined by its resistance: common commercial resistors are manufactured across a range of more than 9 orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may necessitate consideration of the manufacturing tolerance of the selected resistor, depending on its specific application. In some precision applications, the temperature coefficient of the resistance may also be a concern. Practical resistors must also have a maximum power rating that exceeds the anticipated power dissipation of that resistor in a specific circuit.

B. Methodology

The block diagram of the developed system is shown in Figure. 5. It consists of the microcontroller unit with serve as the brain-box of the system, 12-volt battery unit that serve as a backup to the system, 5-volt regulator circuit that checks the power input in the system (microcontroller, week selection switches, and display unit), two load switching units that receive control signals from the microcontroller to switch between 12 volt Fan and Heater or both, the 12-volt DC fan, weak selection switches, the display unit, temperature and humidity sensor, and the 12 DC Heater.

A 12 volts battery is used as the main supply for the system and to directly power the 12 V heating element and fan. The microcontroller, week selection switches and Liquid Crystal Display (LCD) are powered with 5V according to manufacturers’ recommendations, which is the output of the voltage regulator LM7805 of the power supply section of the circuit. The power supply circuitry section as shown in the complete circuit diagram consist of two Capacitors of ratings 220uF each which serve as charge accumulators to prevent the regulator’s output voltage drop during power surges. Table1 presents the temperature chart of the chick in degree Fahrenheit and Celsius

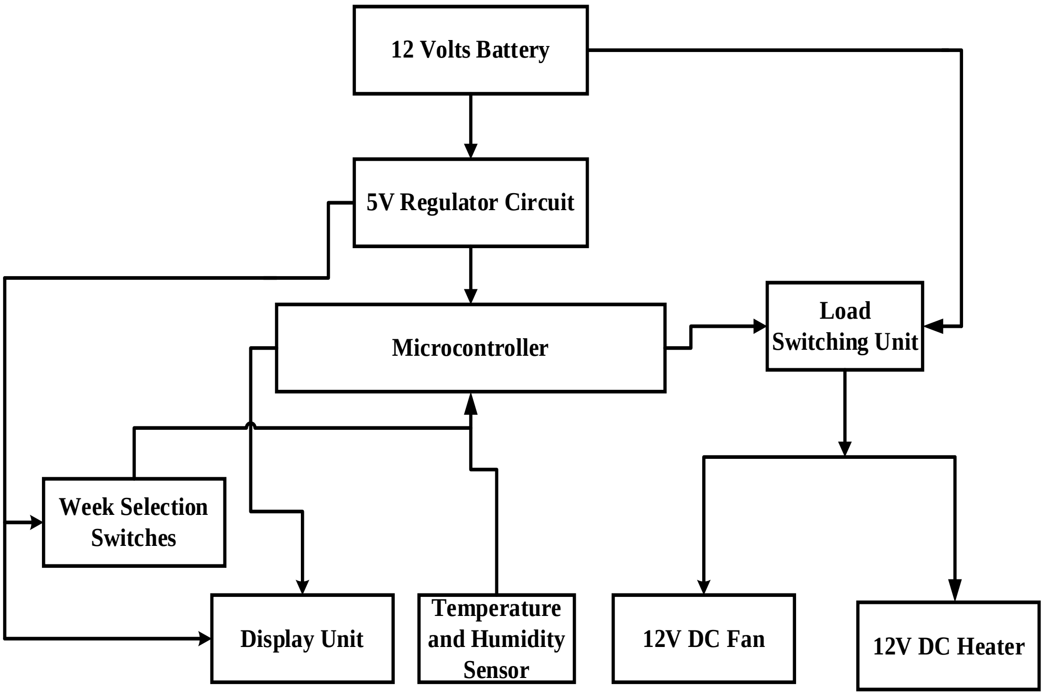

Figure. 5. Automated Poultry Atmosphere Control Block Diagram

Table 1: Temperature Chart of the Chick in Degree Fahrenheit and Celsius

Age (Weeks)	Temperature (^{0}F)	Temperature (^{0}C)
1	90-95	32-35
2	84-90	29-32
3	75-84	24-29
4	70-75	21-260.

Temperature-Controlled Smart Poultry Environment Control Working Principle

In the design, the temperature and humidity control are paramount for automation control, optimal feed utilization by the chicks and energy conservation to ensure optimal efficiency (meaning that the heater or fan is not turned on indefinitely). Efficient temperature and humidity control will enable energy conservation by turning the heater and or fan on intermittently when absolutely necessary. The week selection switches are designed in such a way that that the user can pick the age of the chicks in weeks and the selection automatically instruct the microprocessor on the instruction to use for control. The temperature and humidity of the poultry house are monitored by DT22 AM2302 Sensor and used to control when the heater or fan gets turned on or off.

The complete circuit diagram of the designed smart poultry is as shown in Figure. 6. The circuitry shows the interconnectivities between the components of the design. PWM signalsis generated in thebuilt-in Capture/Compare/PWM terminals of the microcontroller to automatically drive two transistor BC547 for switching the heating element and the fan respectively. The power supply to the heater and fan is controlled by varying the duty cycle of the PWM driver signals from the microcontroller to trigger the relay that switches the heater and fan on and off. Duty cycle of 100% operates the heater at its maximum power, 50 % duty cycle operates the heater and fan at half power and 0 % duty cycle puts the heater and fan off. Table 2 presents summary of the operation principle for the microcontroller circuit

Table 2: The Summary of the Operation Principle for the Microcontroller Circuit

Age in Weeks	Temperature (T) in ^{0}C	Humidity (H) in %	Fan	Heater
Week 1	32≤T≤35	55≤H≤60	Off	Off
	T≥35	H≤55	On	Off
	T≤32	H≥60	Off	On
Week 2	29≤T≤32	50≤H≤55	Off	Off
	T≥32	H≤50	On	Off
	T≤29	H≥55	Off	On
Week 3	24≤T≤29	45≤H≤50	Off	Off
	T≥29	H≤45	On	Off
	T≤24	H≥50	Off	On
Week 4	21≤T≤26	40≤H≤45	Off	Off
	T≥26	H≤40	On	Off
	T≤21	H≥45	Off	On

4. RESULT AND DISCUSSION

The system is simulated in proteus® circuit design and simulator software. The simulation is run with an Arduino programming language (code). Figure. 6,7,8 and 9 show the diagrams of the automated poultry farm management system complete circuit, the simulated circuit in standby mode, the result of simulation for week one, the result of simulation for week two, the result of simulation for week three, and the result of simulation for week four, respectively. The temperature range of the smart system is set between 32 and 35 degrees Celsius in week one, with the button labelled week 1. When the temperature rises above 35 degrees Celsius, the fan turns on and the heater turns off, allowing the system to cool and the humidity in the poultry farm to return to normal. Furthermore, when the temperature falls below 32 degrees Celsius, the fan is turned off, the heater is turned on, and the poultry farm is set to normal. In week two, the temperature range of the smart system is set between 29 and 32 degrees centigrade, with the button name week 2. When the temperature is greater than 32 degrees Celsius, the fan is turn On and the heater is turn Off, hence the system is cool down and the humidity of the poultry farm is set to norm. Also, when the temperature is less than 29 degrees Celsius, the fan is turn Off and the heater is turn On and the poultry farm is set to norm. the system's temperature range is adjusted to 24-29 degrees centigrade in week three, with the week 3 button. At temperatures over 29 degrees Celsius, the fan is activated, while the heater is turned off, allowing the system to cool down and the humidity to be maintained at a normal level. Decreased temperatures are also met by turning off the fan and turning on the heater, resulting in the poultry farm being adjusted to normal. Weekly temperatures are set between 21 and 26 degrees centigrade, using a button labelled week four on the smart system. For example, when the temperature rises over 26 degrees, the fan is activated and the heater is turned off, which allows the system to cool down and maintain a comfortable humidity. And when it's below 21 degrees Celsius, all fans are turned off and all heaters are on.

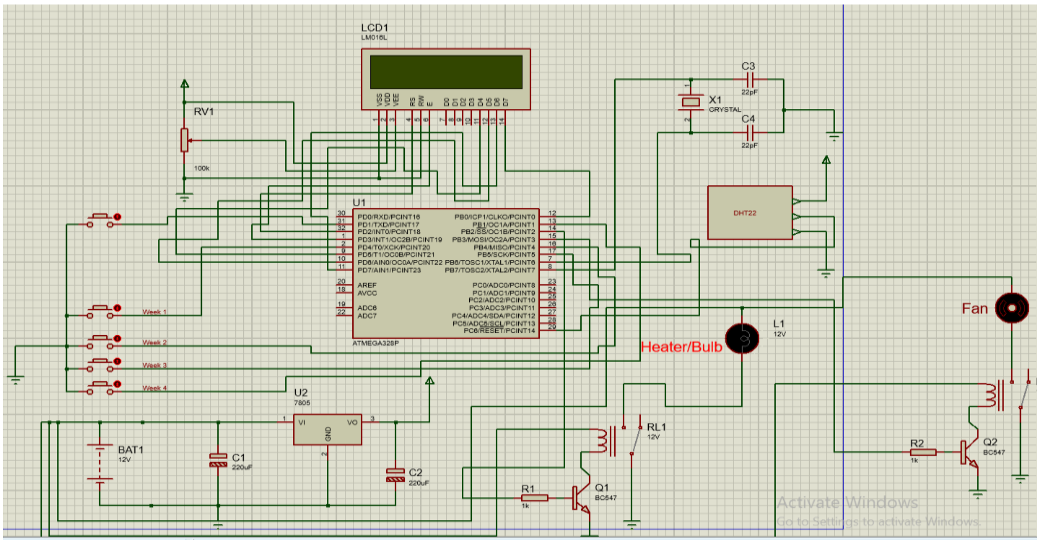

Figure6. Automated Poultry Farm Management System Complete Circuit Diagram

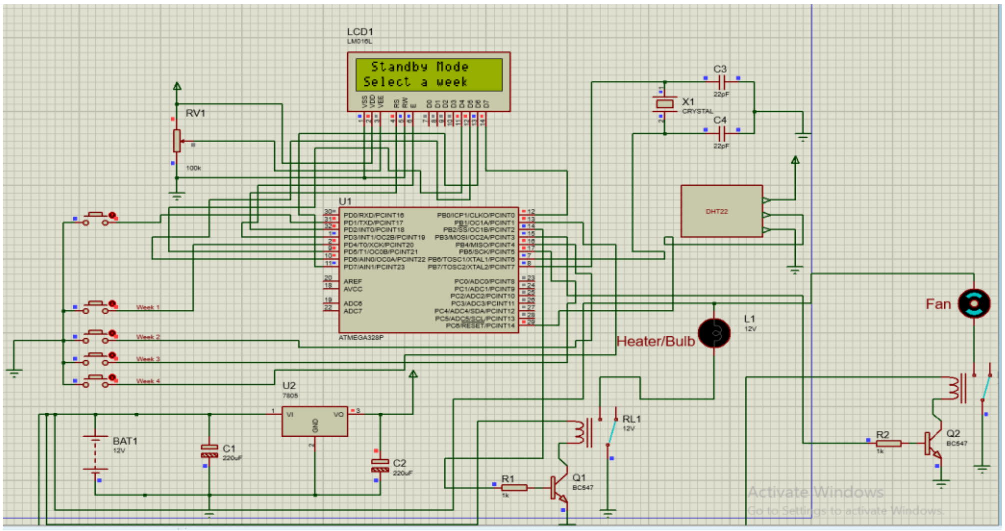

Figure 7. The Simulated Circuit in Standby Mode

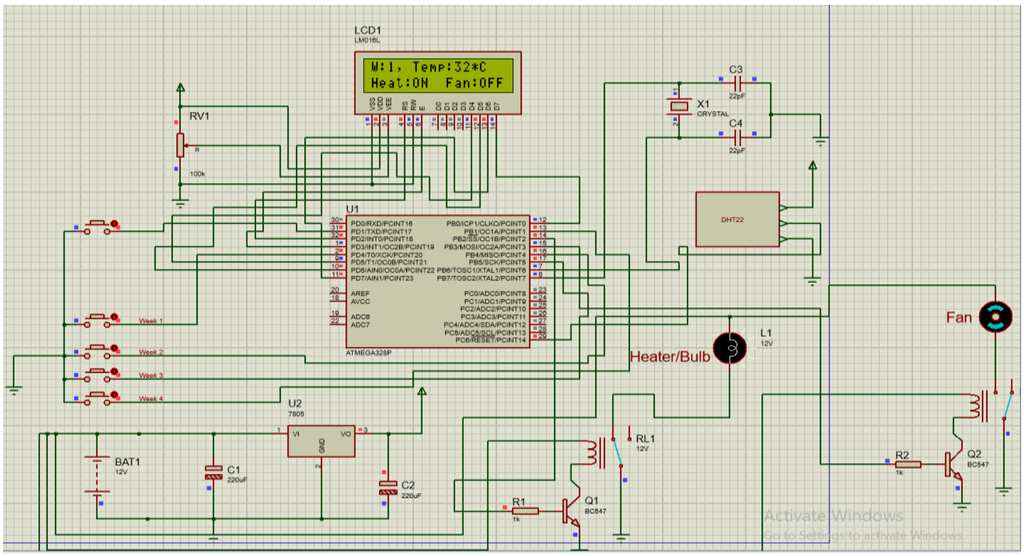

Figure 8. The Result of Simulation for Week one

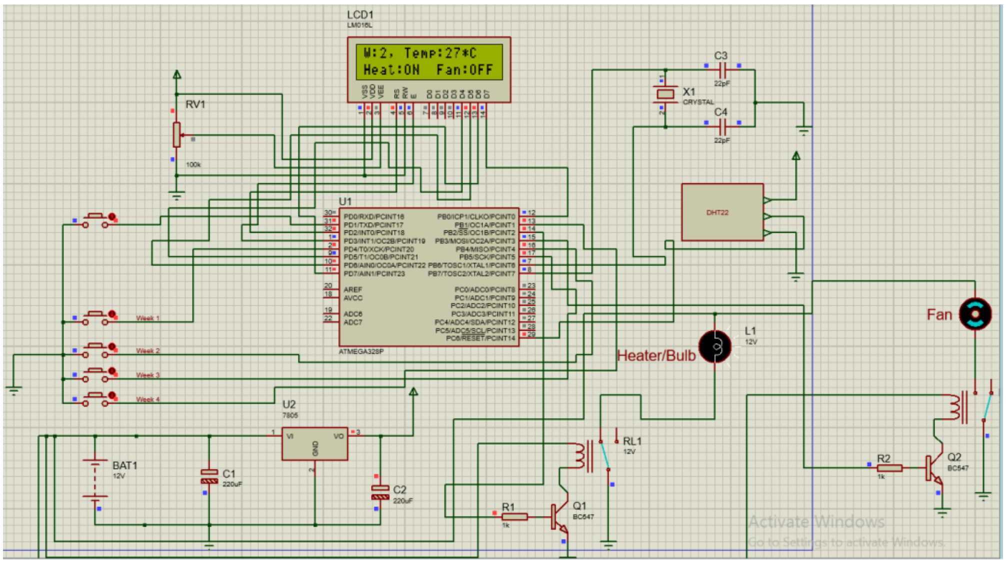

Figure 9. **The Result of Simulation for Week Two**

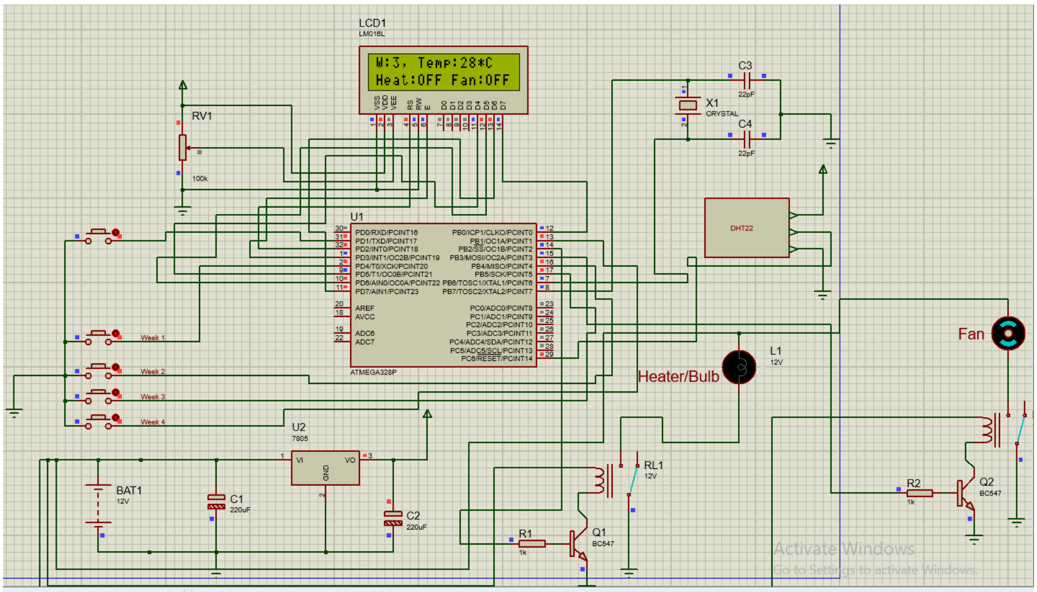

Figure. 10. The Result of Simulation for Week Three

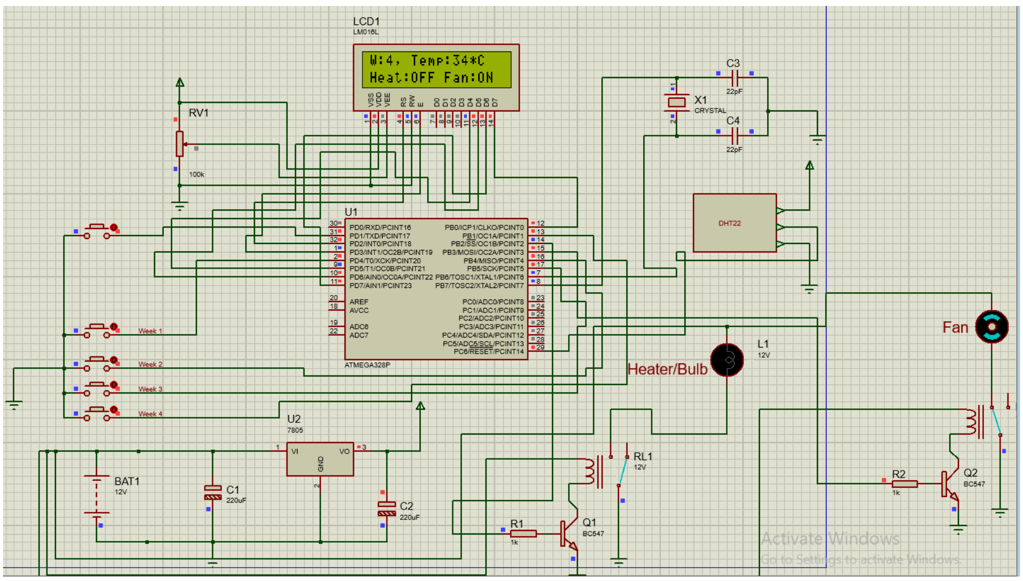

Figure 11.The Result of Simulation for Week Four

CONCLUSIONS

The project's performance fulfilled the design specifications, and the precise values of temperature and humidity at any moment in time are shown on the 16*2 LCD screen. Fans to guarantee temperature stability have been devised and fully implemented using the Arduino relay module and control of the heater. To prevent unexpected temperature increases from harming and killing poultry animals, it is advised that this project be used to measure the temperature of the environment in order to immediately respond to high temperatures by controlling it and keeping it at its usual temperature.

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