UNIVERSITY OF DAR ES SALAAM

COLLEGE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

DEPARTMENT OF ELECTRONIC AND TELECOMMUNICATION ENGINEERING

FINAL YEAR PROJECT

PROJECT TITLE: DESIGN AND IMPLEMENTATION OF AUTOMATIC SOLAR CROP DRYING SYSTEM.

A Project Report in Partial Fulfillment for the Award of Bachelor of Science in Electronic science and communication.

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Submission Date: Friday 30– 06 – 2023

DECLARATION

Statement of authorship and originality

I declare that this report and the work described in it are my own work, with any contributions from others expressly acknowledged and/ or cited

I declare that the work in this report was carried out in accordance with the Regulations of the University of Dar es salaam and has not been presented to any other University for examination either in Tanzania or overseas. Any views expressed in the report are those of the author and in no way represent those of the University of Dar es Salaam.

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DATE: ………………………………………………

This report may proceed for submission for assessment for the award of B.Sc. in Electronic Science and Communication at the University of Dar es Salaam

Supervisor Signature: ……………………………… Date: ………………………………………..

ABSTRACT

Solar drying systems are sustainable and energy-efficient alternatives for drying agricultural products. This project focuses on the design and development of a solar drying system that utilizes renewable solar energy to remove moisture from crops and enhance their shelf life. The system incorporates a solar collector to capture solar radiation, a drying chamber to house the crops, and control mechanisms to regulate temperature, airflow, and moisture content.

The design process involves addressing various challenges, including the variability of solar resource availability, temperature and airflow control, and moisture management. Considerations for crop-specific drying requirements and system durability are also taken into account. The system is designed to be cost-effective, scalable, and easy to maintain, ensuring practicality and feasibility for different applications.

Key components, such as light sensors (LDRs) and servo motors, are utilized to optimize the system's performance. The LDRs detect light intensity, allowing for precise control of the collector's movement to maximize sunlight exposure. The servo motors facilitate the adjustment of the collector's position, ensuring efficient energy absorption.

Through experimentation, data collection, and iterative improvements, the solar drying system is optimized to provide consistent and reliable drying results. The system's performance is evaluated based on parameters such as drying time, moisture content reduction, and energy efficiency. Comparative analysis against traditional drying methods demonstrates the benefits of solar drying, including reduced energy consumption and improved product quality.

This project contributes to the advancement of sustainable agricultural practices by harnessing solar energy for crop drying. The developed solar drying system offers an eco-friendly and cost-efficient solution that can be applied in various agricultural settings, contributing to food preservation, value addition, and increased income for farmers.

ACKNOWLEDGEMENT

I would like to thank Almighty God for giving me good health especially from when I started this final year project. Also, I would like to appreciate all those who provide their support from starting up and continue to provide their support up to completion of this project. The special gratitude I give to Dr. Godwin Mruma who is my Supervisor for his contributions in advising and encourag ing me by drawing some suggestion on performing day to day activities on performing project.

Furthermore, I would also like to acknowledge with much appreciation to my fellow students Asia Kivike and Grace Madibu for their contributions in conducting this project ,Their advice is much appreciated on performing this project. Also many thanks goes to Final Year Project Co- ordination Team for the work it has done from analysis of students' Titles, and solving problems facing challenges with FYP portal and other challenges related to Final Year Project.

LIST OF ABBREVIATIONS

Vcc – Common Collector Voltage

GND - Ground

FYP- Final year project

LDR- Lead Dependent Resistor

LCD- Liquid Crystal display

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CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Solar drying is the process that use solar energy to dry substances, especially food. This process use heat from the sun to remove the moisture content of crop substances. The crops is contained in an enclosed space, and the air in contact with it s heated by solar radiation. The solar radiation falling on the collector plate heats up the air inside it. The warm air rises and discharges into the collector. [The air, thus is circulated via convection.

The agriculture sector has been growing everyday either in its production or in the technology aspect. Drying of agriculture products using renewable energy such as solar energy is environmentally friendly and has less environmental impact. However it is a complex process with a lot of energy and it consume a lot of energy during the drying process.

The different type of solar dryers have been designed, developed and tested in different areas over the world. Basically there are three types of solar dryers, direct, indirect and combined. And In direct dryers the product is heated by direct solar radiation. The moisture in the grain is evaporated and removed by moving air. Since temperature control in drying using this type of dryer is difficult, a product can be dried too quickly giving or at too high a temperature resulting in a poor quality product. In indirect solar dryer, the product is dried by moving air heated outside the drying chamber. And in combined dryer, the product is dried both by direct radiation and by heated moving air.

The advantages of the solar dryer system, it have low operation and maintenance costs, it save time, it is labour saving and the less risk of the spoilage compared to sun dryer. The dryer also have some limitation like it can be performed only during sunny day unless the system is integrated with a conventional energy based system. Due to limitations is solar energy collection, the solar drying process is slow in comparison with dryer that use conventional fuel.

Among problems facing farmer in Tanzania during drying by using sun are damage to the crops by animals and birds, contamination by dirty and dust and Time consuming which may destruct farmers plan toward their products. Also if the farmer plans is to dry his/her crop after a certain time, the process may consume a lot of time than the day expected by a farmer thus it waste time.

There is need of automatic system that will assist farmer to dry their grains simultaneously by the heated air from the solar collector and system should perform automatic control if necessary toward yielding better crop dried in order to reduce such post-harvest losses and to enable farmer to increases the quality of their products by affordable drying methods. This action are equipped by using microcontroller and the system are powered by ATmega328 with the appropriate sensor are used to monitor and control the moisture contents, speed of the motor, and temperature of the heating chamber. The prototype of the system is developed and powered by solar photovoltaic energy generated from 10W solar panel with its charge controller.

1.2 PROJECT STATEMENT

Drying of grains properly is one challenge facing farmers in Tanzania. The problem destroy farmers plan of managing and preserving his/her crops for later uses. And if the drying is not done properly there will be loss to the farmer no matter how good the storage is. Many crop are seasonal and get spoilt quickly, to make their usage efficient, they can be dried and preserved so that it can be used over a long period.

Currently, the process of drying is done by exposing agriculture products directly to wind and sun then farmer manage and control all activities so as to get better dried product. This require both large amount of space, labour intensity and long drying time and shortage of time has led many problems faced by every farmer such as contamination, low crops quality.

This project solves that issue by reducing the time of the farmer postharvest using an Arduino UNO Microcontroller for the smart controlling action which needs to be implement for the drying process using sensor so as to get the required dried products and save time.

1.3 OBJECTIVES

1.3.1 MAIN OBJECTIVE

The main objective of this project is designing and implementing a solar dryer in which the crops are dried by the heated air from the solar collector.

1.3.2 SPECIFIC OBJECTIVE

- To collect requirement of the system.
- To design and develop a system to control the moisture content in dryer chamber.
- To design and develop a system to control direction of the collector to receive light.
- To design and develop a system to control the rotational motion of fan to push air to the dryer chamber.
- To design and develop a system to control a rotation movement of collector toward light.
- To simulate and implement the circuit.
- To evaluate performance of the system.

1.4 PROJECT SIGNIFICANT

The system helps to save time for the farmers since the drying process is completed within few hours and it is handy to use, it does not require any expertise on the operation as everything work automatically. The system also reduces cost since the material used are inexpensive to any farmer and only using solar energy, there are no additional electricity cost. Hence this system make work of the farmers easier, faster and high efficient in crops drying.

1.5 SCOPE AND LIMITATION

Scope

The system will monitor, control and remove the moisture contents from the crops after being harvested for preservation. At future times later, there are other scope that can be used with this work to improve the efficiency and effectiveness of the dryer system. The idea of using IOT for crops drying also can be implemented with this system. Other activities in drying such as crop drying using electrical power especially for areas that do not get sunlight for a long time or during the rainy season can be introduced with this system.

Limitation

- The system should be used in area that has a lot of sun and little rain.
- Control system using only hardware design may delay to reach the farmer compared by the one performed using buzzer where a text message send to a farmer wherever he/she is, to indicate the end of the drying process after completion.

CHAPTER TWO

2.0 LITERATURE REVIEW

This part includes an overview on researches and summary of the previous work related to solar crop drying system. On research done include the way previous projects implement and technology used in their implementation.

-Automatic solar dryer; In this aim to design dryer chamber that temperature to be maintained constant throughout the drying chamber and also removal of moisture content from the fruit. The dryer chamber is in simple form comprises of a wooden box with certain length and width, insulated at its base and preferably at the sides and covered with a transparent roof. This automation process when completed is informed to the farmer. Solar energy is utilized for dehydrating the fruits.

-Solar Power Automatic Grain Dryer; This aim to presents the design and development of an automatic solar powered grain dryer used to remove the moisture content from grains, post harvesting. The drying is achieved by allowing the heat from heat chamber to flow on to the conveyor belt with the help of exhaust fans present in the heat chamber. The objective of this is to make the work of the farmers easy, faster and high efficient in grain drying postharvest for storage. The designed mechanism takes less time to dry up grain using solar photovoltaic based drying as compared to traditional drying process. It also aim to reduce intensive labour experienced by the farmers.

Several dryers have been created and implemented and given specification as other, However with the solar dryer to be implemented in this design it will have a specification of being automatic, able to push air to the dryer with the help and fan and able to detects the intensity of light in to all axes so as it can receive maximum radiation during all the season

2.1 WORKING PRINCIPLE OF SOLAR DRYER SYSTEM

In this phase requirements are analysed and used in designing the system, as far as Solar crop drying System is concerned requirements involved all components used in designing microcontroller based system such components are as follow.

2.1.1 SOLAR PANEL UNIT

The power supply unit consists of a solar panel, battery and voltage regulator.

a) Solar panel

Solar panel is an assembly of photovoltaic cells mounted in a frame work for installation. They use sunlight as source of energy to generate electricity as DC current.

In this system, a 12V solar panel will be used to capture sunlight that will be used as a source of energy. The basic importance of using solar energy in this project is because the energy is renewable and produces no environmental effects unlike other sources of energy. The diagram of solar panel is shown in the Figure 2. 1 below

Figure 2. 1:Solar panel

b) Battery

A 12V battery is employed for the purpose of storing charge that can be used as source of energy whenever there is insufficient supply of power from the solar panel like during the night or cloudy weather.

c) Voltage regulator

Due to voltage fluctuations at the source giving out unfixed voltage outputs, a voltage regulator used to maintain output voltage at a fixed required value. In this circuit design, a voltage regulator is needed to regulate a 12V supply from the solar panel to 5V supply that can be used by the microcontroller without causing damage to the controller. The Figure 2. 2 below show voltage regulator pinout

Figure 2. 2: L7805 Voltage regulator pinout diagram

Also Table 2. 1 shows the Pin detail of 7805 IC

Table 2. 1: Voltage regulator pin detail

Pin no.	Pin	Function	Description
1	INPUT	Input voltage (7V-35V)	In this pin the positive unregulated voltage is fed into the regulator
2	GROUND	Ground (0V)	The ground is given at this pin
3	OUTPUT	Regulated output, 5V	The output voltage 5V is taken out by this pin

2.1.2 SENSING UNIT

The sensing unit involves sensors necessary for collecting data from crops inside the dryer chamber and sending them to microcontroller. In this project there are three sensors that sends notification signals from the sensor circuit to the microcontroller. These are Temperature sensor that sense the temperature of the heating inside the heating chamber, Moisture sensor which detect the moisture from the wet harvested grains which are evenly layered down on the trays, and LDRs sensor which detects sunbeam and provide return signal to a microcontroller. The Figure 2. 3,Figure 2. 4, Figure 2. 5 show the Temperature, Moisture and LDRs sensor

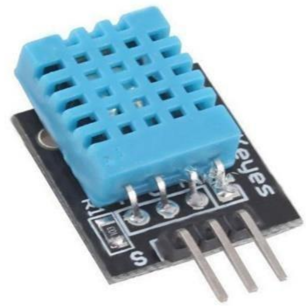

Figure 2. 3: Temperature sensor

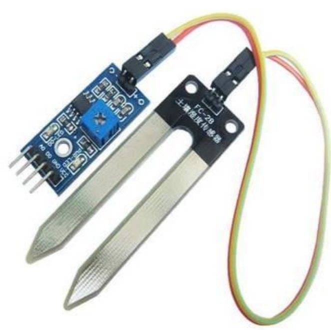

Figure 2. 4: Moisture sensor

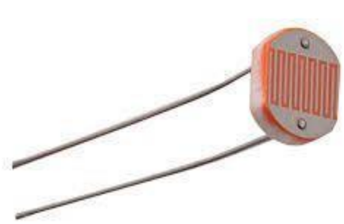

Figure 2. 5: LDR sensor

2.1.3 CONTROL UNIT

In this project the control part includes hardware device which are Microcontroller.

Arduino (Microcontroller)

After receiving the notification signals from the monitoring part, the microcontroller defines the signals according to the instructions programmed in it and sends the appropriate instructions to the specified devices for control mechanisms. Microcontroller controls the devices integrated with it such as LCD and motors. The microcontroller is shown in the Figure 2. 6 below

Figure 2. 6: Microcontroller

2.1.4 MOTION UNIT

a) DC motor

A motor is an electric device that converts electrical energy to mechanical rotation. The input to a motor is normally in DC form. The movement of fan will be aided with a total of 2 DC motors that will be operated by using a motor driver. Here below in the Figure 2. 7 show DC motor

Figure 2. 7: DC Motor

b) L298 Motor driver

A motor driver acts as an interface between the motor and the control unit. Usually, motors require high amount of current whereas microcontroller requires low current and in that sense they cannot be linked together hence the use of a motor driver. Thus, the function of the motor driver is to take low current control signal and turn it into high current signal that can drive a motor. In this case an L298 motor driver is used due to its features; High operating voltage up to 46V , Total DC current up to 4A , Over temperature protection using heat sinks . The Figure 2. 8 below represent the Motor driver

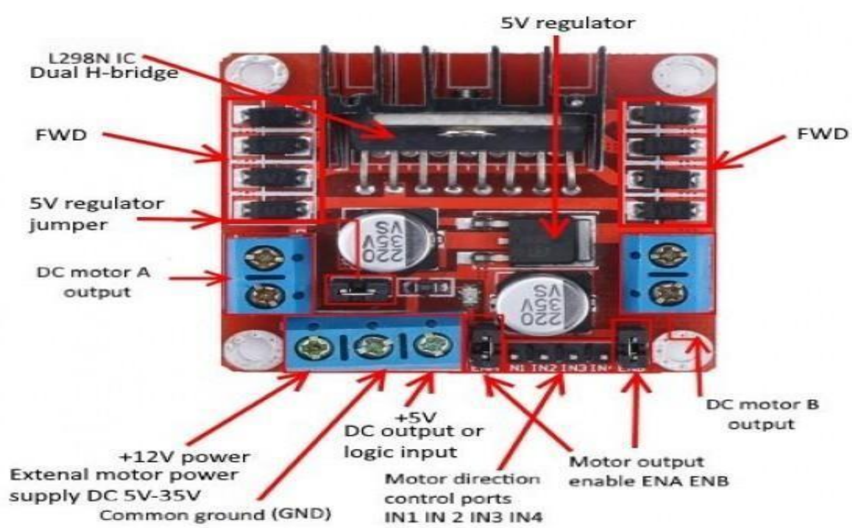

Figure 2. 8: L298N motor driver

2.1.5 COLLECTION UNIT

This part collects heat by absorbing sunlight. It is assembly consists of air flow channel enclosed by transparent glass(glazing) in order to absorb a well radiation and connected with a cylindrical reflector to minimize the convective heat losses from it.

A collector also tilted and oriented in such a way that it receives a maximum solar radiation during the desired season by using the sensor LDRs which detects sunbeam and provide return signal to a microcontroller, and the microcontroller converts analog values from LDR sensors into digitals and provides output channels to control the rotation of collector through servo motors.

2.1.6 DRYING CHAMBER

The drying cabinet part consists of trays inside in which crops are layered down in order to be dried. These drying trays are made up of an aluminium wire mesh to allow a well passage of the heated air directly to the crops from the collector through an air flow channel. Also an outlet vent is provided toward the upper end of the cabinet to facilitate and control the convection flow of air through the dryer as shown in the Figure 2. 9 and Table 2. 2 below

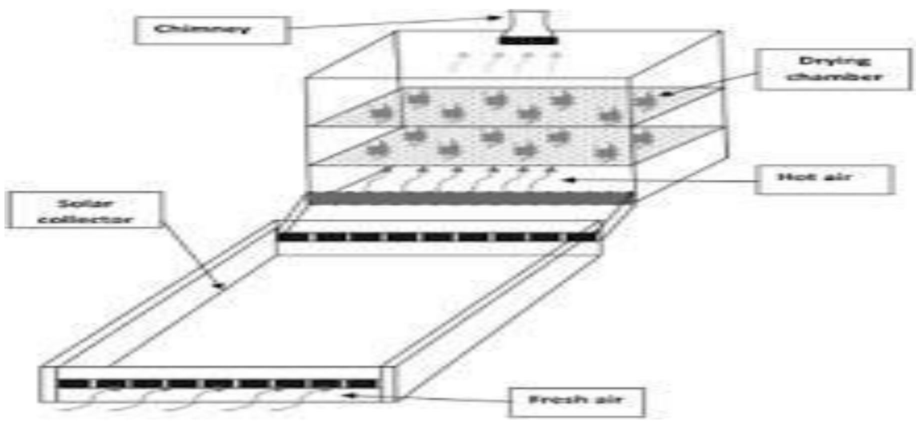

Figure 2. 9: Drying chamber with solar collector

Table 2. 2: Summary of Hardware requirements

Component	Specification
Arduino Board	UNO
Moisture Sensor	
Temperature & Humidity Sensor	DHT11
Lcd display	20x4
LDRs Sensor	
Solar panel	12V/5W

Resistors	220R
Terminal Blocks	2 Ways
Battery	12V
Voltage regulator	7805
Fan DC	
Motor Driver	L298 BOARD
Servo motor	5V

CHAPTER THREE

3.0 METHODOLOGY

This system is developed using a waterfall model where by one step will be accomplished after another. This model is direct to use through its step. The following are the procedures that will be used into developing this project.

Requirement gathering and analysis:

-All possible requirements needed for developing Smart Irrigation System will be captured and documented in requirement specification document, method used to obtain requirement on this system are Questionnaire and interview.

Design and simulation:

-After obtaining requirement from first phase system design is prepared, system design will involve specification of hardware and system requirements that helps in defining the overall system architecture of the system.

Circuit implementation and testing:

-From the overall architecture, system is then developed on small unit so as to allow unit testing to take place that is Sensor will developed separately before linking them to other devices.

Integration and testing:

- After unit testing has been done on all single units(devices), those unit are combined to form full solar crop drying system then integration testing is performed so as to test for any fault on the whole system.

Operational/deployment:

-Involves deploying the system to the farmer, in this step the system is completed to be used by customers if it has any fault customer should give feedback so as to be maintained on next step.

vi. Maintenance:

- It is done once farmer encounters any fault on using the system.

Advantage of this methodology

- Simple and easy to understand and use

- Easy to arrange tasks 10 - Clearly defined stages
- Phases are proceeded and completed one at a time
- Works well on projects where requirements are well understood

Disadvantage of this methodology

- No working software will be produced until later stages.
- Not good for complex projects
- Cannot accommodate changing requirements.

CHAPTER FOUR

4.0 SYSTEM DESIGN AND IMPLEMENTATION.

4.1 SYSTEM DESIGN

System design involves the overall system layout that described as block diagram, flowchart and circuit diagram.

4.1.1 BLOCK DIAGRAM OF THE SYSTEM

The following is a block diagram indicates how the system components are interconnected with each other, and how communication is directed from one component to another and components are grouped according to their categories. The Figure 4. 1 represent the block diagram of the system.

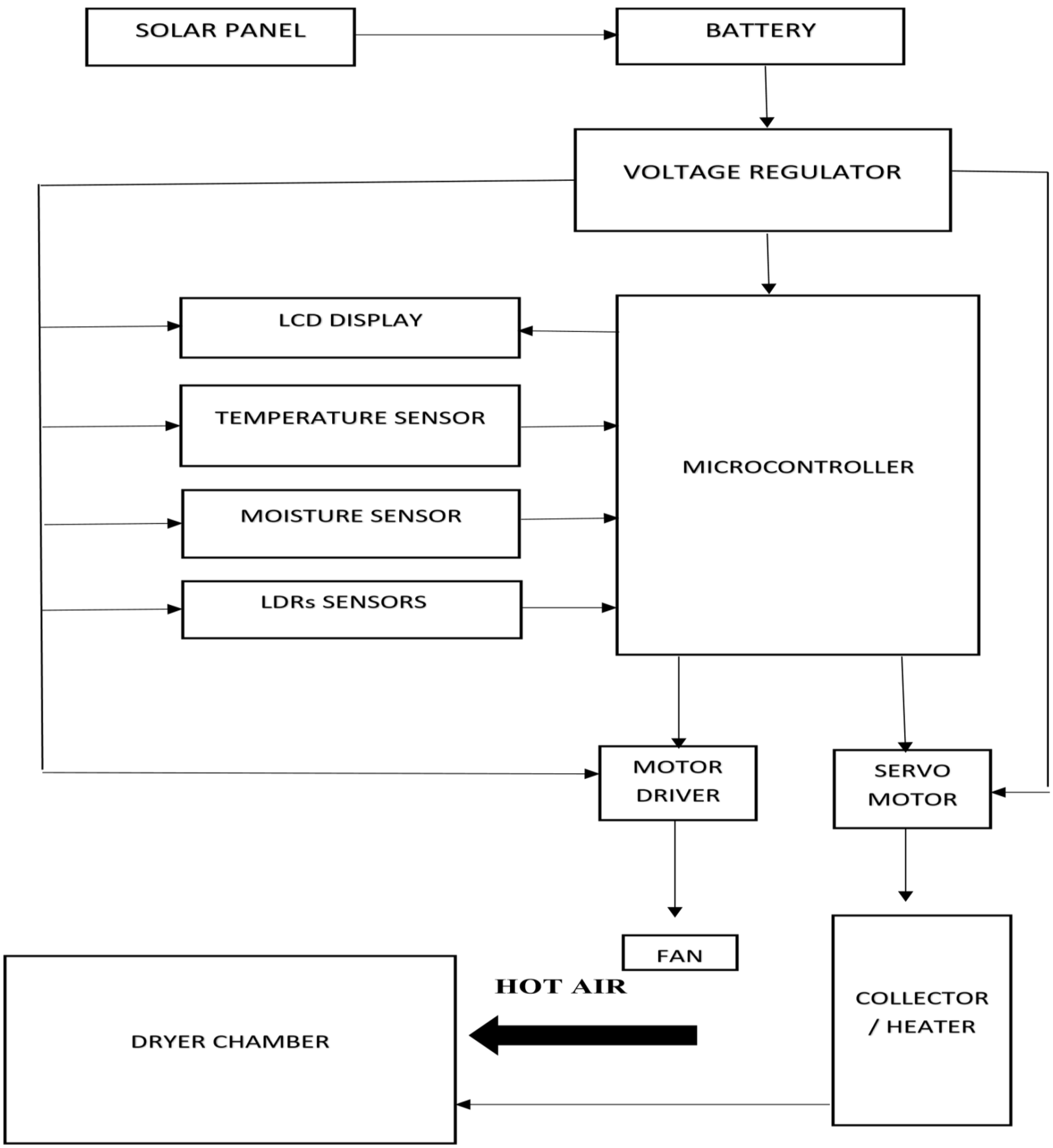

Figure 4. 1: Block diagram of the system

4.1.2 FLOW CHART OF THE SYSTEM

Flowchart involves all the processes involved from when devices are initialized, collection of data from sensors, sending them to microcontroller, displaying in LCD and applying necessary decisions according to the command set on microcontroller. As shown in the Figure 4. 2 below.

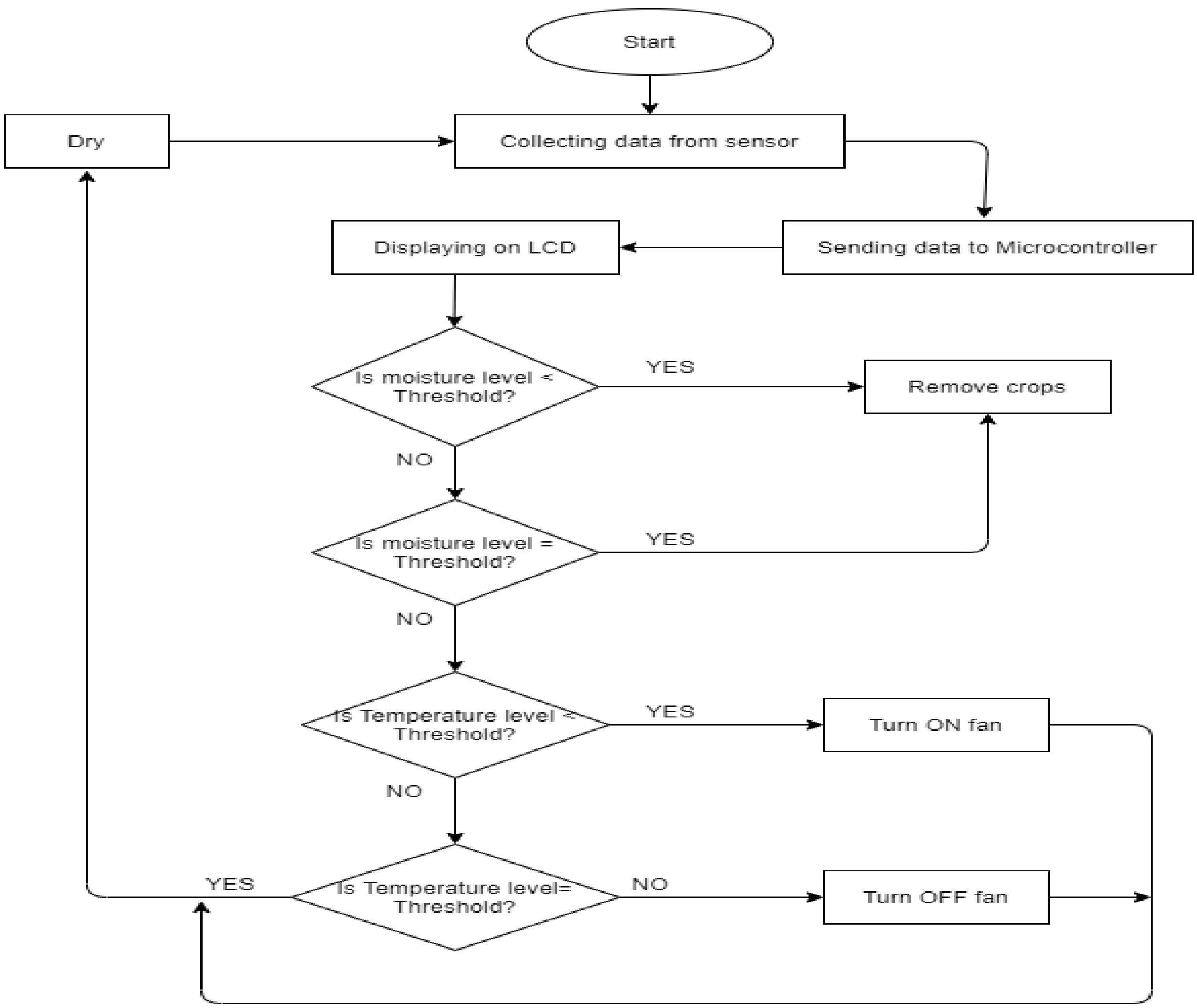

Figure 4. 2: Flow chart system

4.2 CIRCUIT DESIGN AND SIMULATION

4.2.1 CIRCUIT DESIGN

Here we creating a schematic or layout for an electronic circuit that will perform a specific function or set of functions. This involve selecting of appropriate electronic components such as resistors, capacitors, transistors and integrated circuits, and connecting them in a way that will achieve the desired behavior.

There are many software tools available for circuit design and simulation, I was using proteus due to its ability to co-simulate both microcontroller firmware and electronic circuits. This allows to simulate the entire system, including the microcontroller and any external circuits to tests its behavior under different conditions. The Figure 4. 3show the circuit diagram of the design

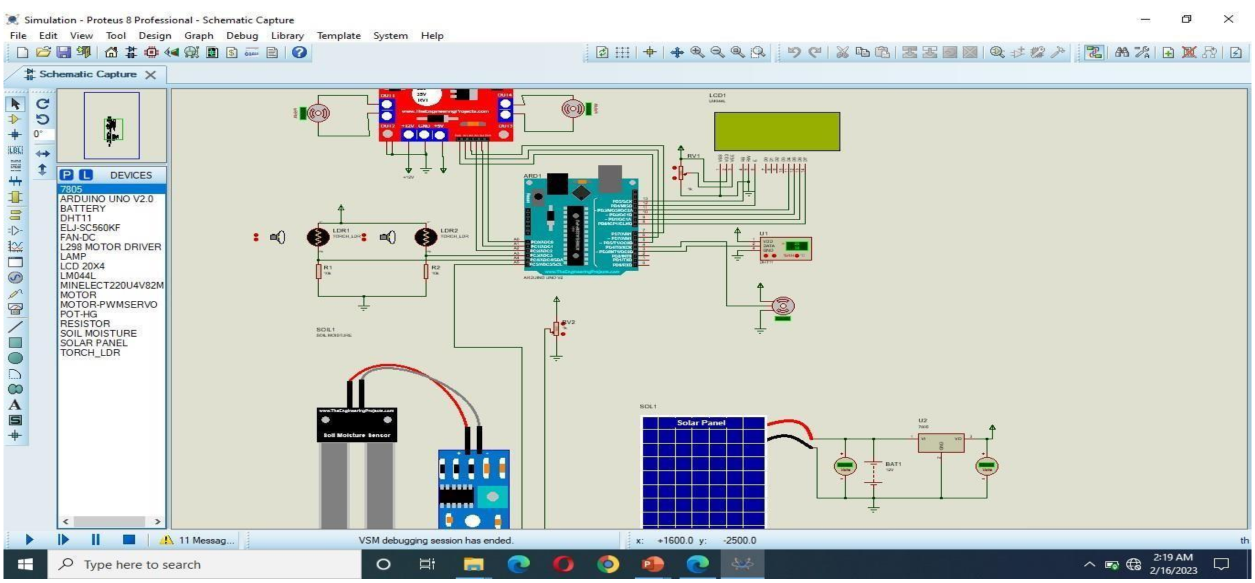

Figure 4. 3: Circuit diagram of the design

4.2.2 CIRCUIT SIMULATION

After designing circuit, we have to simulate the behavior of the circuit under different functionality and conditions, such as varying input voltages or component values in order to allows and identify the correct design flaws and optimize the circuit performance before building a physical prototype When codes are loaded to the microcontroller and circuit simulated the following output was obtained based on the specified conditions as follow:-

4.2.2.1 OUTPUT WHEN THE SYSTEM IS POWERED ON

When the system is powered ON, The output of the system depend on e initial conditions at the start of operation and it displays message to allow anyone to understand what kind of the system design circuit it is, as shown in the Figure 4. 4 below.

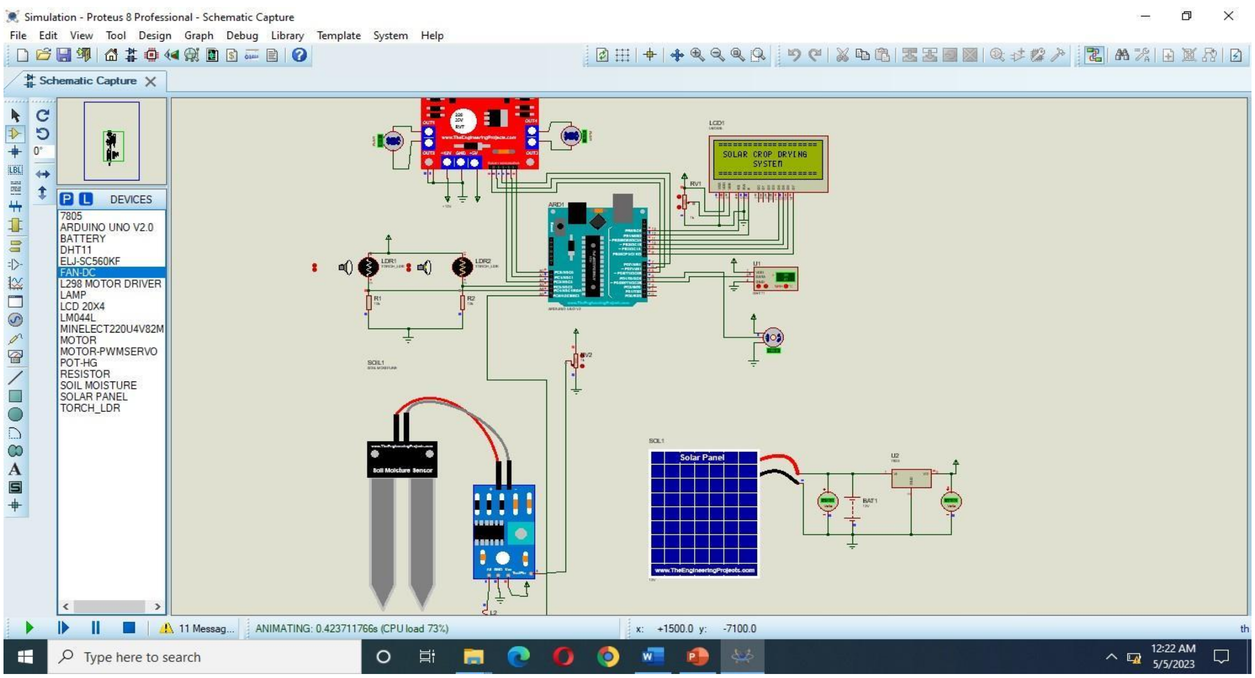

Figure 4. 4: System when power ON

4.2.2.2 OUTPUT WHEN MOISTURE LEVEL GREATER THAN THRESHOLD

The approximate percent of moisture value for most crops are 14-16%, if the crop moisture level is greater than the threshold amount, the system starts to dry crops in order to reduce the moisture contents on it. Its result is shown in the Figure 4. 5 below

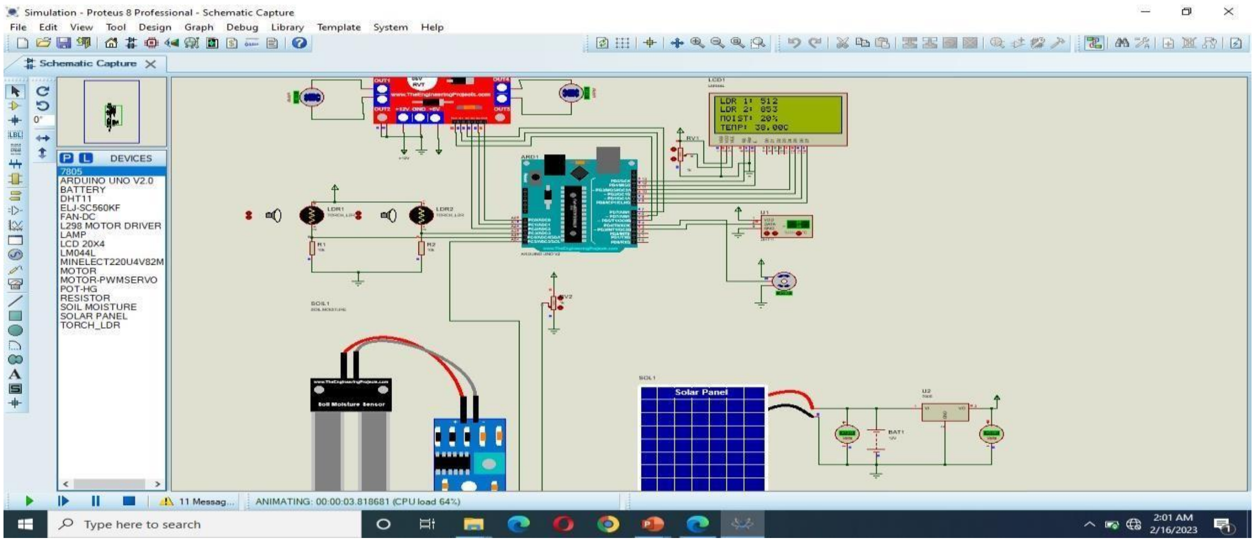

Figure 4. 5: Result when moisture greater than threshold

4.2.2.3 OUTPUT WHEN MOISTURE LEVEL EQUAL TO THRESHOLD

When the crop moisture reaches/ equal to the normal range, the system automatically stops to dry crops and it displays message to inform user that crops are already been dried so we have to remove and replace it with other as shown in the Figure 4. 6 below:

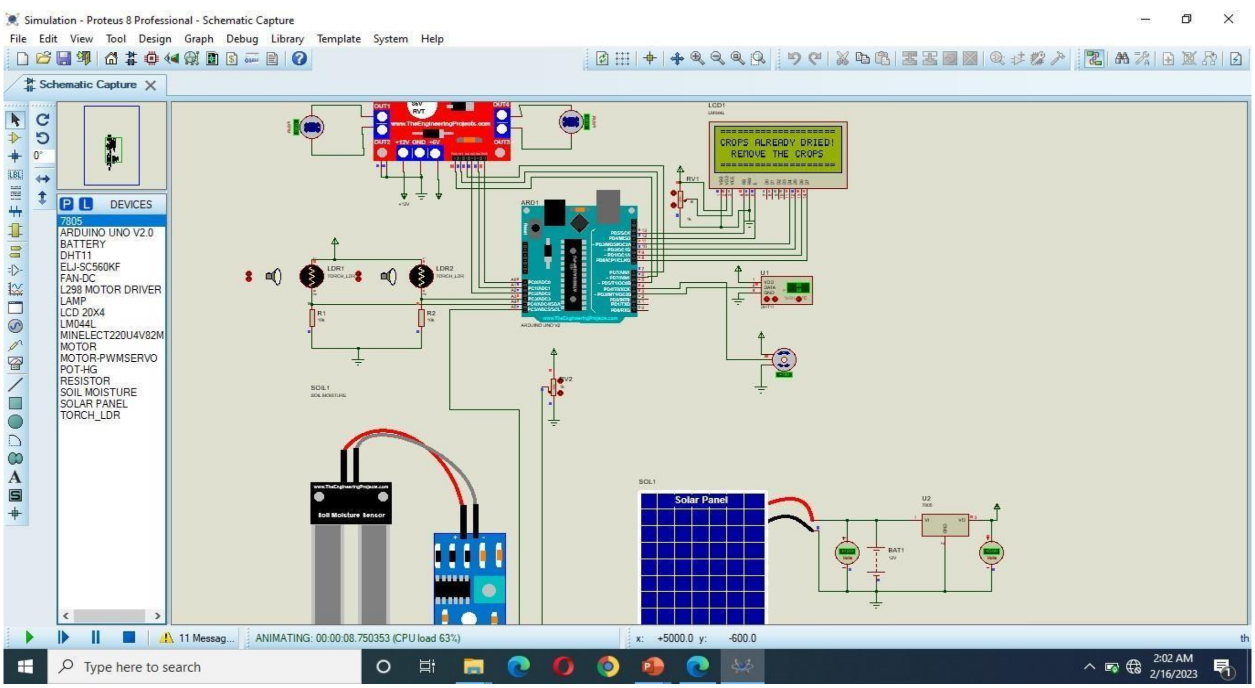

Figure 4. 6: Result when moisture is equal to threshold

4.2.2.4 OUTPUT WHEN TEMPERATURE LEVEL IS ABOVE, BELOW OR EQUAL TO THRESHOLD

The temperature inside the dryer is approximately to be 35-42 degree centigrade and it is controlled by movement of the fan. If the temperature is less than the normal range, fan will start to rotate automatically in order to push the hot air inside the dryer.

When the temperature inside the dryer is greater than the threshold value, fans stops to rotate in order not to allow the increase of hot air in the dryer and avoid crops to be burned.

If the temperature value is equal to the normal range, the system starts to dry the crops. The Figure 4. 7 show the result for Temperature sensor

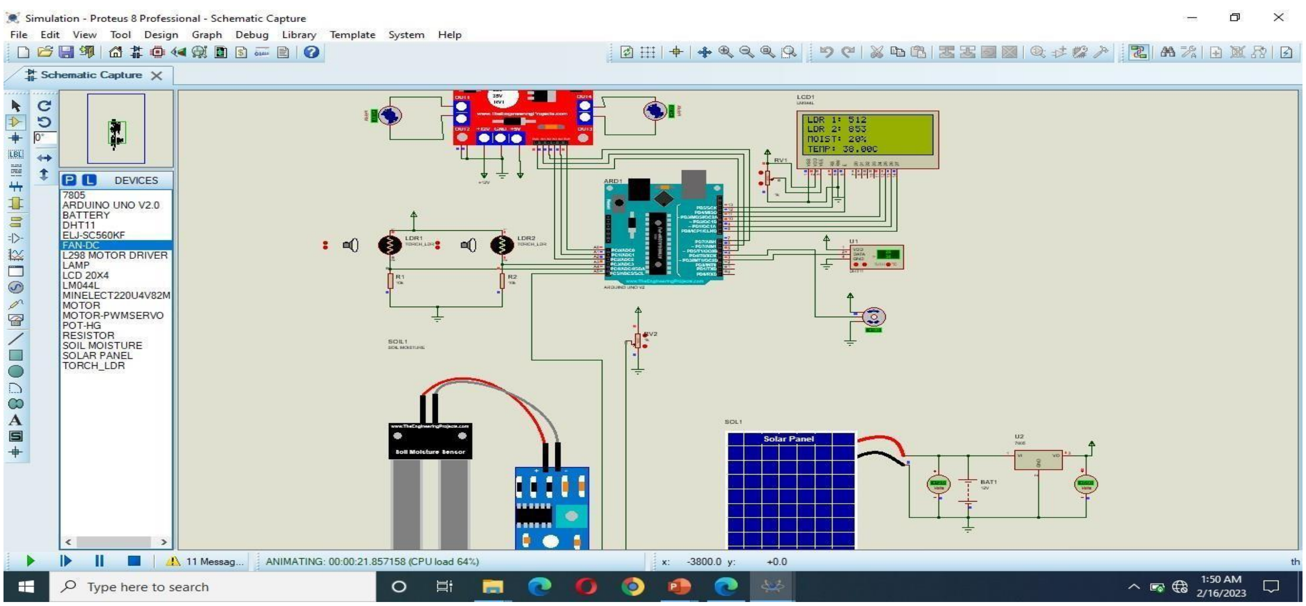

Figure 4. 7: Result for Temperature sensor

4.2.2.5 OUTPUT WHEN LDR1 IS GREATER OR LESS THAN LDR2

LDR (Light Dependent Resistor) exhibit a change in resistance, which can effects their performance when an LDRs is exposed to sunlight , the resistance of the sensor decrease due to the increase in light levels. The nearest light into ldr1 results to increase in its value and decrease in the value of ldr2, while the nearest light into ldr2 results to increase in its value and decrease in the value of ldr1. In the Figure 4. 8 below show the result for LDRs sensor

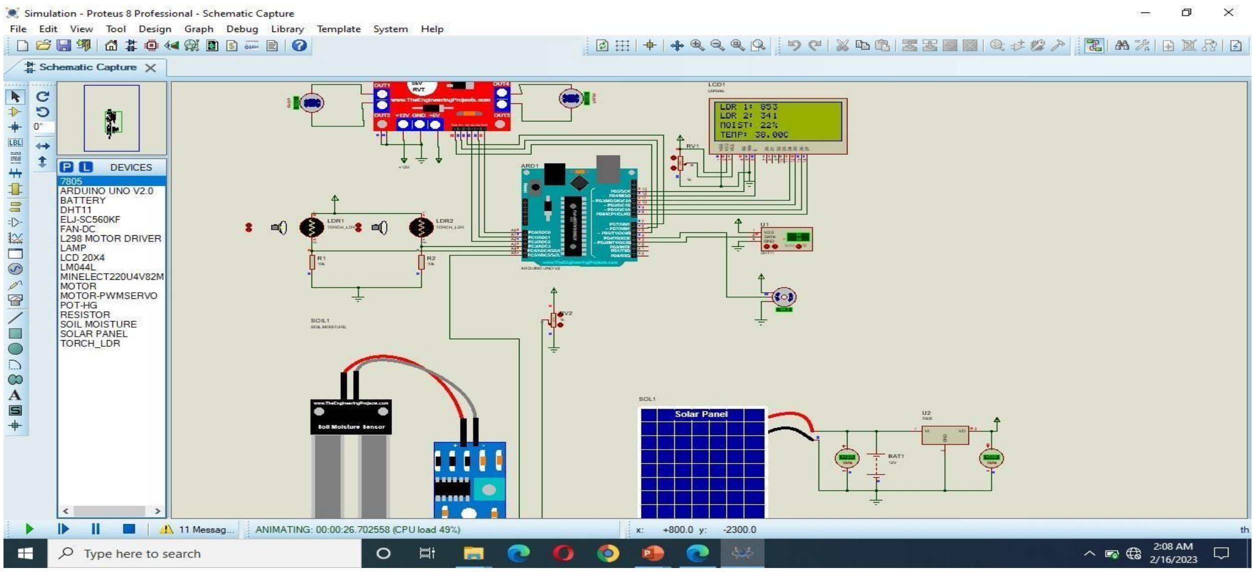

Figure 4. 8: Results for LDR sensor

4.3 SYSTEM IMPLEMENTATION AND TESTING

4.3.1 SYSTEM PROTOTYPE

System prototype was created by creating and testing different system modules, final all modules were integrated, First, I was dealing with the process of designing the printed circuit board in proteus. The proteus software were used for schematic drawing, printed circuit board design and three-dimensional visualization of my system circuit board. Here below is PCB designing steps and I have noted that all of the above item should be available in the software library so that all the task can be done effectively.

4.3.2 STEPS FOR PCB DESIGN IN PROTEUS

1. Schematic Design: First, create a schematic diagram of your circuit in Proteus. This can be done using the built-in schematic editor or by importing a schematic from an external source.
2. Component Placement: Once the schematic is complete, place the components onto the virtual PCB board. You can drag and drop the components to the desired location.

3. Routing: Connect the components by routing the traces between them. Proteus provides various tools for routing such as manual routing, auto routing, and interactive routing.
4. Copper Pouring: After routing, add copper pours to the PCB board. Copper pours act as ground planes, which help in reducing electromagnetic interference (EMI) and provide better signal integrity.
5. Design Rule Check: Proteus provides a Design Rule Check (DRC) feature that helps you to identify and correct any potential design errors or violations.
6. Gerber Generation: After completing the PCB design, generate Gerber files which can be sent to a PCB manufacturer for production.
7. PCB Fabrication: Send the Gerber files to a PCB manufacturer for fabrication.
8. PCB Assembly: Once the PCBs are fabricated, you can assemble the components onto the PCBs using the necessary tools and equipment.
9. Testing: Test the PCBs for functionality and make any necessary modifications or changes to the design if needed.

4.3.3 BASICS PARTS OF PCB DESIGN AND MANUFACTURING

4.3.3.1 SCHEMATIC CAPTURE

Schematic capture is the process of creating a graphical representation of an electronic circuit using symbols and diagrams. It is typically the first step in the electronic design automation (EDA) process and is used to create a visual representation of the circuit that can be used to simulate, analyze, and test the circuit's functionality.

The schematic capture process involves the following:

1. Component selection: Select the electronic components that will be used in the circuit and add them to a library or database.
2. Symbol creation: Create graphical symbols that represent the electronic components in the circuit. These symbols typically include information such as the component name, value, and pin assignments.

3. Symbol placement: Place the symbols onto a schematic diagram in a logical and organized manner.
4. Wiring connections: Connect the pins of the symbols with lines or wires to represent the electrical connections between the components.
5. Annotation: Add text labels and annotations to the schematic to provide additional information about the circuit.
6. Design rules: Specify design rules and constraints to ensure that the circuit meets electrical and physical requirements.
7. Simulation: Use simulation tools to test and verify the functionality of the circuit design.

Schematic capture is an essential part of the electronic design process, and it is used to create a visual representation of the circuit that can be used to guide the layout and manufacturing of the printed circuit board (PCB). Schematic capture tools are widely available as part of EDA software packages, and they can be used by both novice and experienced designers to create high-quality electronic designs.

➢ Here, I started routing the tracks as per the schematic design using Proteus ISIS schematic capture tool by dragging and drop the components from the component library to make circuit as shown in the Figure 4. 9 below;

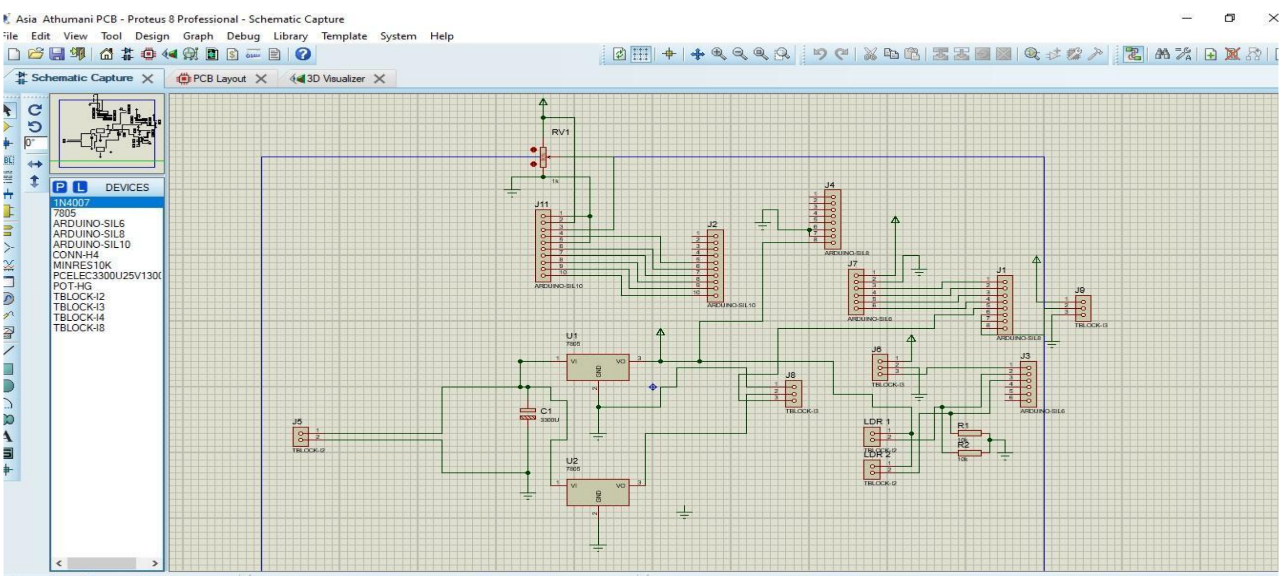

Figure 4. 9: Schematic design of PCB

4.3.3.2 PCB LAYOUT

PCB layout is the process of creating the physical layout of a printed circuit board (PCB) using specialized software. The layout defines the placement and routing of the electrical components on the board, as well as the physical shape and size of the board itself. The PCB layout process involves several steps, including:

1. Component placement: Place the electrical components onto the board in a logical and organized manner, taking into account their size, shape, and electrical connections.
2. Routing: Connect the components together by routing traces, or lines, on the board. Traces can be routed manually or automatically using auto routing tools.
3. Power and ground planes: Define power and ground planes on the board to provide a low impedance path for current flow and to reduce noise and EMI.
4. Signal integrity analysis: Perform signal integrity analysis to ensure that the design meets the electrical and timing requirements of the circuit.
5. Design rule checking: Use design rule checking (DRC) tools to ensure that the design complies with the manufacturer's design rules and constraints.
6. Gerber file generation: Generate Gerber files, which are used to manufacture the PCB.
7. Manufacturing: Send the Gerber files to a PCB manufacturer for fabrication.
8. Assembly: Once the PCB is fabricated, the components can be assembled onto the board.

PCB layout is a critical step in the PCB design process, and it requires a high degree of expertise and attention to detail. Specialized software is used to create the layout, and designers must follow best practices and guidelines to ensure that the layout meets the required electrical and physical specifications.

➢ After creating the schematic, On the side of PCB layout in order to design the printed circuit board I was specify the board dimension of the PCB design in proteus, Then after I placed all the components of the schematics onto the PCB board by selecting the “place component” icon from the toolbar. I was connect the components with the track by clicking on the “connect” icon from the toolbar or “Auto connect” option to automatically connect the components. The Figure 4. 10 below represent the PCB layout

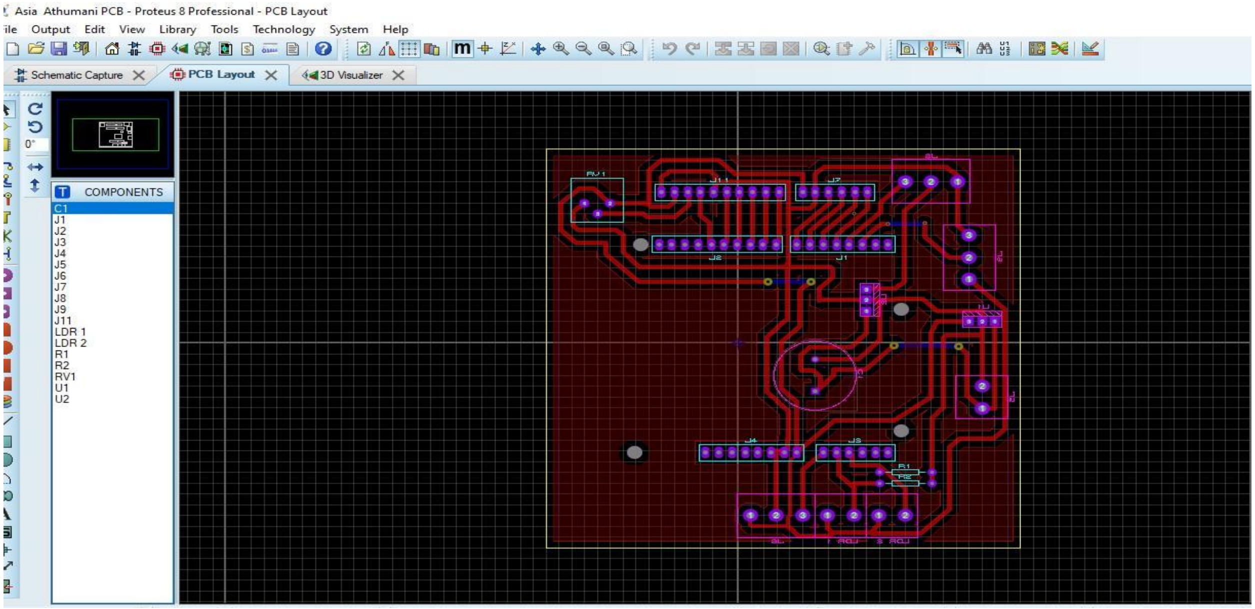

Figure 4. 10: PCB layout

4.3.3.3 3D VISUALIZATION FEATURE

The 3D visualization feature in PCB design software allows designers to create a three-dimensional (3D) model of the printed circuit board (PCB) layout. This feature provides a virtual view of the PCB, which can help designers to visualize the physical layout of the board and identify potential design issues before the board is manufactured.

The 3D visualization feature allows to:

1. View the PCB layout from different angles: Designers can rotate and zoom in on the 3D model to view the PCB from different angles, providing a more realistic view of the board's physical layout.
2. Verify component placement: The 3D visualization feature can help designers to verify the placement of components on the board, ensuring that they are placed in the correct location and orientation.
3. Detect design errors: Designers can use the 3D visualization feature to identify potential design errors, such as components that are too close together or traces that cross each other.

4. Optimize board layout: By viewing the PCB layout in 3D, designers can optimize the layout to improve signal integrity, reduce EMI, and ensure that the board fits into the intended enclosure.
5. Communicate design intent: The 3D visualization feature can help designers to communicate their design intent to stakeholders and team members, providing a clear and accurate view of the physical layout of the board.

The 3D visualization feature is an essential tool in PCB design software, and it can help designers to create high-quality PCB layouts that meet the required specifications and performance criteria.

➢ I visualize the three-dimension view of the printed circuit board that I designed, and I can rotate, zoom and pan it using my keyboard, also I can change a rendering options and adjust the camera setting to get the best view of my PCB as shown in the Figure 4. 11 below;

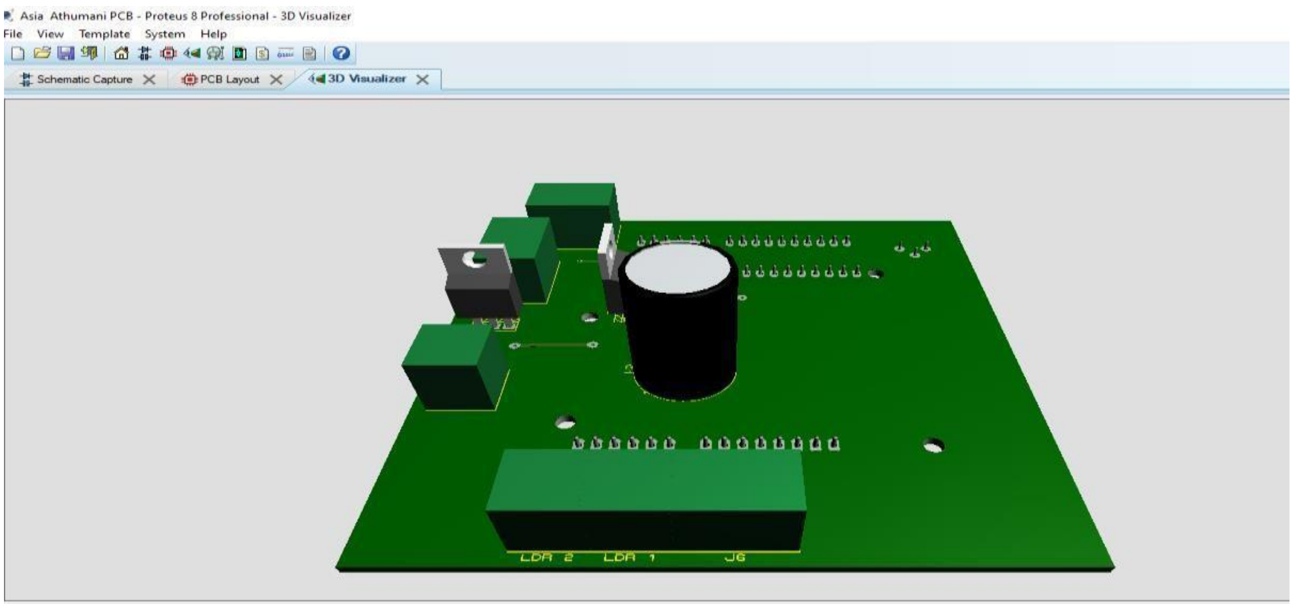

Figure 4. 11: 3D visualization

4.3.3.4 PCB MANUFACTURING

PCB (Printed Circuit Board) manufacturing is the process of creating PCBs, which are the foundation of many electronic devices. PCBs are made up of thin layers of copper sheets laminated onto a non-conductive substrate such as fiberglass, and are used to connect electronic components together. There are a variety of techniques and technologies that can be used in PCB manufacturing, depending on the specific needs of the design and the desired level of quality and precision. Some common technologies include surface-mount technology (SMT), through-hole technology (THT), and ball-grid array (BGA) packaging.

After making and confirming the design, I printed and manufacturing it to get real physical design then solder the components on the PCB and integrate it into my Arduino Microcontroller. The Figure 4. 12 show the manufactured PCB.

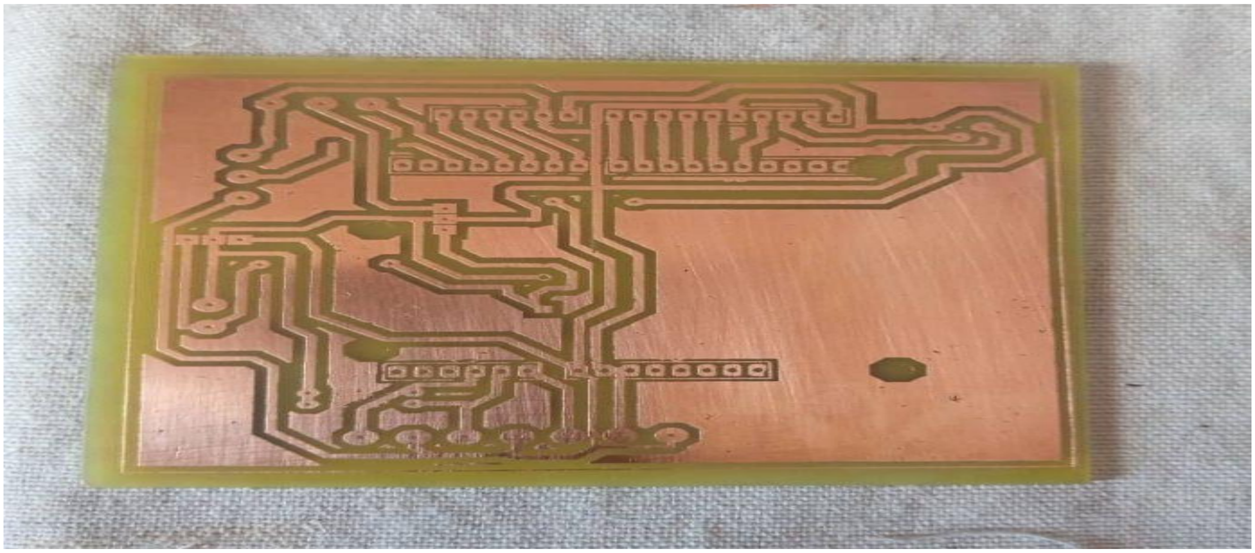

Figure 4. 12: PCB manufacturing

4.4 CABLE CONNECTIONS

4.4.1 Connecting Arduino board with Motor driver

Motor driver is connected with Arduino according to Table 4. 1 below;

Table 4. 1: Connecting Arduino board with Motor driver

ARDUINO BOARD PORT NUMBER	**MOTOR DRIVER**
3	IN 1
4	IN 2
5	IN 3
6	IN4

5V	VCC
GND	GND

4.4.2 Connecting Arduino board with Servo motor

Servo motor is connected to Arduino so as to keep collector moving to follow the direction of sunlight and the connection is shown in the Table 4. 2 as follow,

Table 4. 2: Connecting Arduino board with Servo Motor

ARDUINO BOARD PORT NUMBER	**SERVO MOTOR**
GND	Pin1
Vcc	Pin2
5	Pin3

4.4.3 Connecting Arduino board with LCD

LCD which used in this project is I2C 20*4 and Table 4. 3 show the connection of Arduino board with LCD

Table 4. 3: Connecting Arduino board with LCD

ARDUINO BOARD PORT NUMBER	LCD PIN
13	RS
12	E
8	D7
9	D6
10	D5

11	D4
GND	K, V_{SS}, RW
Vcc	A, V_{DD}

4.4.4 Connecting Arduino board with LDRs SENSOR

The Table 4. 4 below show the connection of Arduino board with LDRs sensor

Table 4. 4: Connecting Arduino board with LDRs sensor

ARDUINO BOARD PORT NUMBER	LDRs SENSOR
Vcc	Pin1
2	Pin2
Vcc	Pin1
3	Pin2

4.4.5 Connection of Arduino board with DHT11

Temperature and Humidity sensor (DHT 11) has three terminals from which one is for data to pass to pin of Arduino and others to Vcc and GND . The Connection with Arduino board with DHT 11 is shown in the Table 4. 5 below

Table 4. 5: Connecting Arduino board with Temperature Sensor (DHT 11)

ARDUINO BOARD PORT NUMBER	TEMPERATURE SENSOR (DHT 11)
Vcc	Pin1
GND	Pin2

1	Pin3

4.4.6 Connecting Arduino board with Moisture Sensor

Moisture sensor has three terminals from which one is for data to pass to pin analog pin of Arduino and others to Vcc and GND. The Connection with Arduino board with Moisture sensor is shown in the Table 4. 6 below

Table 4. 6: Connecting Arduino board with Moisture sensor

ARDUINO BOARD PORT NUMBER	MOISTURE SENSOR
Vcc	Pin1
5	Pin2
GND	Pin3

4.5 SYSTEM TESTING

System testing is the process of testing an integrated system to verify that it meets the specified requirements and functions as intended. It is a crucial step in the software development lifecycle that ensures the quality and reliability of the system. The objective of system testing is to evaluate the system's performance, functionality, and compatibility with other systems and to identify any defects or issues that may affect its operation System testing can be performed using different techniques, including functional testing, performance testing, security testing, and compatibility testing. It can be automated or done manually, depending on the complexity of the system and the available resources.

The overall system which contains basic components like, Arduino board with microcontroller, moisture sensor, temperature and Humidity (DHT11) sensor, LDRs sensor, Motor driver and Servo motor is shown in the Figure 4. 13 below,

Figure 4. 13: System Testing

4.6 SOLAR DRYER DESIGN

Designing a solar dryer system involves considering various factors such as the type of dryer, drying capacity, climate conditions, and materials to be dried. Here's a general outline for designing a solar dryer system:

1. Determine the drying requirements: Define the specific needs of the drying process, including the type and quantity of materials to be dried, desired moisture content, and drying time.

2. Choose the drying method: Select the appropriate drying method based on the characteristics of the materials. Common methods include natural convection, forced convection, and hybrid systems.

3. Solar collector design: Design a solar collector to capture and convert solar energy into heat. The collector should be optimized for maximum solar radiation absorption and minimal heat loss. Options include flat-plate collectors, evacuated tube collectors, or parabolic trough collectors.

4. Drying chamber design: Determine the size and layout of the drying chamber based on the drying capacity and material characteristics. Consider factors such as air circulation, temperature control, and moisture removal. The chamber should be insulated to minimize heat loss.

5. Air circulation system: Design an efficient air circulation system to distribute the heated air evenly throughout the drying chamber. This can be achieved through natural convection or forced convection using fans or blowers.

6. Temperature and humidity control: Incorporate temperature and humidity control mechanisms to maintain optimal drying conditions. This can include thermostats, hygrometers, and automated control systems to regulate airflow and temperature.

7. Moisture removal system: Include a mechanism to remove the moisture-laden air from the drying chamber. This can be achieved using vents, exhaust fans, or dehumidifiers.

8. Backup heating system (optional): In regions with insufficient solar radiation, consider integrating a backup heating system such as electric heaters or biomass burners to ensure continuous drying operations.

9. Safety features: Incorporate safety features such as temperature sensors, overheat protection, and emergency shut-off mechanisms to prevent any accidents or damage.

10. Monitoring and control: Implement a monitoring and control system to track and adjust the drying process. This can include sensors for temperature, humidity, and airflow, as well as a control panel for manual or automated adjustments.

11. Maintenance and cleaning: Ensure the design allows for easy maintenance and cleaning of the system components, including the solar collector, drying chamber, and air circulation system.

12. Cost analysis: Evaluate the cost-effectiveness of the system, considering the initial investment, operational costs, and potential savings from reduced energy consumption.

3D printing can be a useful tool in the design and prototyping process of my solar dryer system. Since It allows for the creation of complex and customized components with precision. Here are the necessary steps that I used for designing my 3D solar dryer system:

1. Define the drying requirements.

2. Research and gather information.

3. Conceptualize and design using CAD software.

4. Select appropriate 3D printing materials.

5. Prototype and test individual components.

6. Integrate sensors and controls using 3D-printed housings or brackets.

7. Optimize airflow and heat transfer with custom 3D-printed elements.

8. Design structural support and enclosures.

9. Iterate and refine the design based on testing and feedback.

10. Combine 3D-printed components with traditional manufacturing methods, if needed.

11. Document the design and assembly process.

12. Conduct a cost analysis.

While 3D printing can be a valuable tool in the design process, it also, there is the limitations of the technology, such as material properties, print size, and printing time. It's often necessary to combine 3D-printed components with traditional manufacturing methods for a fully functional solar dryer system. The Figure 4. 14 below show the 3D design Solar dryer system

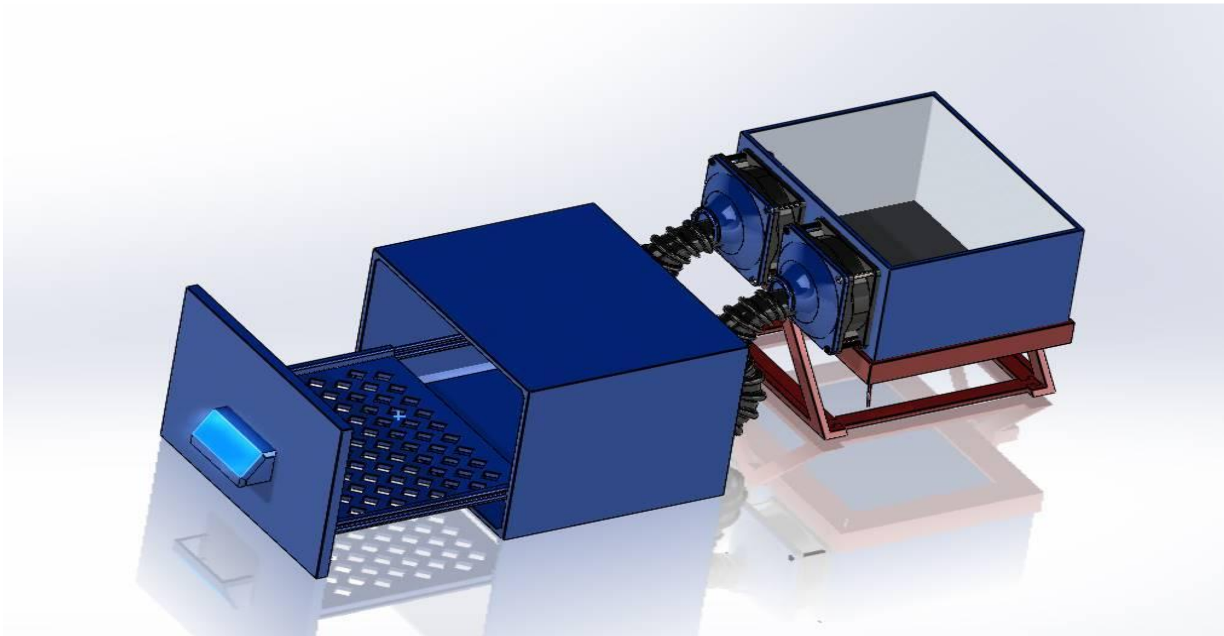

Figure 4. 14: 3D design Solar dryer system

CHAPTER 5.0

5.1 RESULTS AND ANALYSIS

5.1.1 OUTPUT WHEN THE SYSTEM IS POWERED ON

When a solar dryer system is powered on, there are some visible output displayed. The primary function of a solar dryer system is to facilitate the drying process using solar energy, and the outputs are typically experienced internally within the system Hence it displaying values to provide information about the system's operation. These displays can vary depending on the design and complexity of the system. Here are a few examples of possible outputs that could be displayed into my solar dryer system. The Figure 5. 1 represent the result when the system is powered ON.

1. Temperature: The system include temperature displays that shows the current temperature inside the drying chamber. This allows users to monitor and adjust the drying conditions as needed.

2. Moisture level: The system also displays the percentage moisture to provide information about the moisture content within the drying chamber. This display allows users to monitor and adjust the drying conditions to achieve the desired moisture level for their specific product.

3. LDRs value: The displayed LDR sensor value can provide an indication of the collector's rotation. For example, when the collector is rotating, the light intensity falling on the two LDR sensor may change, causing the LDR sensor value to fluctuate. Users can observe the displayed values to infer the collector's rotational activity.

Figure 5. 1: Result when system is powered ON

5.1.2 OUTPUT WHEN LOW/HIGH MOISTURE DETECTED

When a solar dryer system detects low moisture levels in the drying chamber, it display the outputs (REMOVE THE CROPS) to inform the user about the condition. This display indicate that the crop moisture value corresponds to the low moisture condition.

If a solar dryer system detects high moisture levels in the drying chamber, it typically indicates that the crop being dried has not reached the desired moisture content and requires further drying. In such cases, the system may display outputs or indicators to notify the user and prompt them to take appropriate action. The Figure 5. 2 and Figure 5. 3 below show the result when LOW and HIGH moisture detected.

Figure 5. 2:Result for LOW Moisture level

Figure 5. 3: Result for HIGH Moisture level

5.1.3 OUTPUT WHEN LOW/HIGH TEMPERATURE DETECTED

Maintaining the appropriate temperature inside the dryer chamber is crucial for effective crop drying in a solar dryer system. If low or high temperatures are detected, the fans in the system can be controlled effectively to regulate the temperature. The system can effectively control the fans based on temperature readings to maintain optimal drying conditions. This may involve adjusting the fan speed, activating or deactivating specific fans, or employing variable fan control mechanisms Here's how it could work and see the Figure 5. 4 and Figure 5. 5 below showing when LOW and HIGH Temperature detected into the drying chamber.

1. Low temperature detection: If the temperature falls below the desired range of 35-45 degree centigrades, the system can activate the fans to increase airflow and heat distribution. This helps raise the temperature inside the chamber.

2. High temperature detection: Conversely, if the temperature exceeds the desired range of 35-45 degree centigrades , the system can adjust the fan speed or activate additional cooling mechanisms, such as dampers or vents, to reduce the temperature and prevent overheating.

Figure 5. 4: Result when LOW Temperature detected

Figure 5. 5:Result when HIGH Temperature detected

5.1.4 OUTPUT FOR LDRS SENSOR

When the two LDR sensors measure the light intensity falling on them, detecting different levels of light based on the collector's position. The solar dryer system analyzes the readings from the LDR sensors to determine the appropriate position for the collector. This calculation takes into account the desired sunlight exposure and energy absorption. The system generates output signals that control the servo motor's movement. These signals adjust the motor's rotation angle to position the collector accurately and the servo motor receives the output signals and adjusts its position accordingly. It rotates the collector to align with the desired angle for optimal sunlight exposure.

The solar dryer system may include a feedback mechanism by displaying the output value to verify the collector's position. This can be accomplished by comparing the readings from the LDR sensors with the expected values and providing feedback on the alignment.

By using the outputs from the LDR sensors to control the servo motor, the solar dryer system ensures that the collector is positioned correctly to maximize sunlight exposure and enhance the drying process. In the Figure 5. 6 and Figure 5. 7 shown below represent when LDRs sensor detect sun light.

Figure 5. 6: Result when LDR 1 detected

Figure 5. 7:Result when LDR 2 detected

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

Solar drying system is a sustainable and effective way to dry various products. It offer several advantages over traditional drying methods and can help reduce post-harvest losses and improve food security. To achieve effective design and monitoring control of the system especially for the one who encounter a lot of problem during and after drying crops, farmer should use the system for better result to prevent losses and problem after harvesting so as they can preserve their grain for long period.

The system prototyping and testing of the project has been designed and developed until to get some result, However can be improved and modified so that it can be developed and implemented in more advance and better application, Also for the future improvement the system and input circuit can be modified so that it can control many other features as possible.

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International Research Journal of Modernization in Engineering Technology and Science

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Sanjay Sharma, R.A. Ry& V. K. Sharma. “Comparative Study of Solar Dryer for Crop Drying”, Center for Energy Studies, IIT, Delhi.

Dr. Drick E. mainer: This paper is described the different types of drying method used for drying grains and also how much amount of heat is safe for grain (2005).

Javed Ali: This paper describse the various types of dryer in the Indian food industry and what can be done to minimize the losses of food grain with the help of various scientific drying method or different scientific storage structure (2000).

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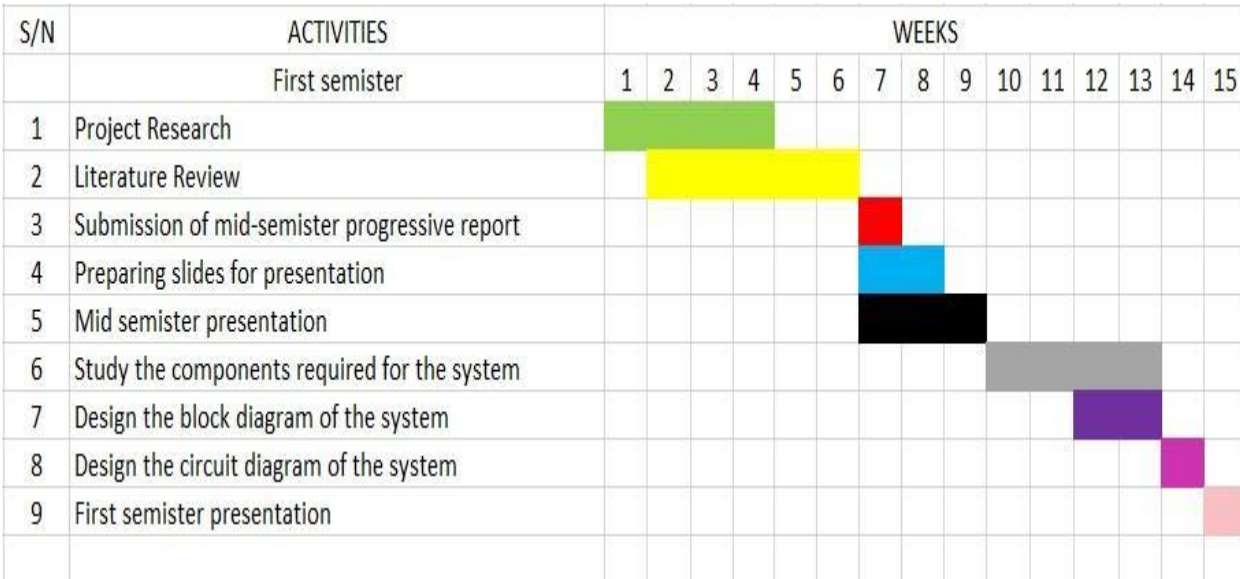
APPENDIX A: PROJECT SCHEDULE

The table below is showing project time schedule for all activities taking place;

Semester 1-Schedule



S/N	ACTIVITIES	WEEKS														
	First semister	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Project Research															
2	Literature Review															
3	Submission of mid-semister progressive report															
4	Preparing slides for presentation															
5	Mid semister presentation															
6	Study the components required for the system															
7	Design the block diagram of the system															
8	Design the circuit diagram of the system															
9	First semister presentation															

Semester 2-Schedule

S/N	ACTIVITIES	WEEKS														
	Second semister	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Literature review															
2	Simulation of whole system															
3	Building the prototype and testing															
4	Mid semister presentation															
5	System redesign and testing															
6	Prototype finishing and coding															
7	Submitting of final report															
8	Final oral presentation and demonstration															

APPENDIX B: PROJECT BUDGET

The components budget is shown in the Table 6. 1 below

Table 6. 1: Project budget

ITEM	COST
Microcontroller(Arduino)	25,000/=
Temperature sensor	15,000/=
Moisture sensor	12,000/=
Sensor LDRs	4,500/=
DC fan	16,000/=
Servo motor	20,000/=
Solar panel	15,000/=
12V Battery	15,000/=
Voltage Regulator	2,000/=
LCD Display	27,000/=
Other components	15,000/=
Voucher	20,000/=
Transportation	20,000/=
Aluminium wired mesh	5,000/=

Transparent glass	6,000/=
Cylindrical reflector	2,000/=
Wood pieces	15,000/=
TOTAL	224,500/=