AUTOMATED SOLAR TRACKING SYSTEM FOR INCREASING SOLAR IRRADIANCE CAPTURE TO IMPROVE POWER GENERATION

By

Arnob Tarafder
19121103
Mohammad Mahir Abrar
19121113
Md. Arefeen Mondol
19121105
Niloy Roy Chowdhury
19121104

A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronics Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

Department of Electrical and Electronics Engineering

Brac University

December 2022

AUTOMATED SOLAR TRACKING SYSTEM FOR INCREASING SOLAR IRRADIANCE CAPTURE TO IMPROVE POWER GENERATION

By

Arnob Tarafder
19121103
Mohammad Mahir Abrar
19121113
Md. Arefeen Mondol
19121105
Niloy Roy Chowdhury
19121104

A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronics in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

Academic Technical Committee (ATC) Panel Member:

Dr. AKM Abdul Malek Azad

Professor, Department of EEE, BRAC University

Afrida Malik

Lecturer, Department of EEE, BRAC University

Mohammed Thushar Imran

Lecturer, Department of EEE, BRAC University

Department of Electrical and Electronic Engineering
Brac University
December 2022

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

Student's Full Name & Signature:

[Arnob Tarafder] [19121103]	**[Mohammad Mahir Abrar]** [19121113]
[Md. Arefeen Mondol] [19121105]	**[Niloy Roy Chowdhury]** [19121104]

Approval

The Final Year Design Project (FYDP) titled "Automated Solar Tracking System for Increasing Solar Irradiance Capture to Improve Power Generation" submitted by

1. Arnob Tarafder (19121103)
2. Mohammad Mahir Abrar (19121113)
3. Md. Arefeen Mondol (19121105)
4. Niloy Roy Chowdhury (19121104)

of Fall, 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 15/12/2022.

Examining Committee:

Academic Technical Committee (ATC): (Chair)

____

Dr. AKM Abdul Malek Azad
Professor, Department of EEE
Brac University

Final Year Design Project Coordination Committee: (Chair)

____

Dr. Abu S.M. Mohsin
Associate Professor, Department of EEE
Brac University

Department Chair:

____

Dr. Md. Mosaddequr Rahman
Professor, Department of EEE
Brac University

Ethics Statement

All the related research, software and hardware implementation on the project and prototype has been completed by us. No third party was involved in this project in any way. Additionally, every piece of information and data used in the project was meticulously gathered from dependable sources. We have taken great effort to avoid any form of plagiarism. The goal of this project was to increase power generation from a PV-based system while carefully considering how it would affect people and the environment.

Abstract

Numerous nations are investing in renewable and sustainable energy systems in response to the global issue in the production of fuel-based energy. Improving the power conversion efficiency of solar panels has become a difficult area of research for researchers. In order to improve power generation, this project details both the software and hardware implementation of an LDR-based dual axis tracking system, where both axes are powered by DS3218 servo motors. Every time the LDR sensors detect light, there is a 2-degree movement of the solar panel in the direction of the light. Additionally, a microcontroller-based monitoring system has been put in place to keep track of temperature, power, voltage, and current. The rated efficiency of the PV panel was calculated to be 25.13%, while the tracking system efficiency was calculated to be 36.64%, resulting in an efficiency improvement of 11.5% for the suggested tracking system.

Keywords: Dual-axis solar tracking; PV panel; LDR sensors; Servo motors; Microcontroller.

Acknowledgement

We would like to acknowledge and give our warmest thanks to Professor Dr. AKM Abdul Malek Azad, the chair of our committee, for his invaluable support and carefully reviewing the project. Additionally, we appreciate Afrida Malik and Mohammad Thushar Imran, lecturers at Brac University, who provided guidance and recommended numerous conventions to enhance the project. Last but not least, we would also like to express our gratitude to Md. Nahid Haque Shazon for his assistance throughout the project's initial phases.

Table of Contents

List of Tables

List of Figures

List of Acronyms

LDR	Light Dependent Resistors.
PV Panel	Photovoltaic Panel.
RTC	Real Time Clock
MPPT	Maximum Power Point Tracking

Chapter 1: Introduction- [CO1, CO2, CO10]

1.1 Introduction

The world's energy deficiency problems, particularly in third-world nations, are encouraging researchers to develop an alternate energy source to supplement conventional fossil fuels. Solar, nuclear, and wind power are examples of alternative energy sources. Solar energy is energy produced by harnessing the power of solar rays. It is the least polluting form of energy. The power collected by the world from the sun is around $1.8x10^{11}$ MW, which is several thousands of times greater than the earth's current consumption rate from all other commercial energy sources. The fundamental issue with solar energy is its diluted nature. Even in the hottest parts of the world, the available solar radiation flux hardly reaches 1 kW/m, which is insufficient for technological use. A solar tracker device, which assures the greatest intensity of sun rays reaching the surface of the panel from sunrise to sunset, can solve this problem. A solar tracker is a device that detects the sun's movement during the day and orients the PV panel towards the sun to keep the solar panel and the sun beam perpendicular for better energy conversion. Since conventional solar panels are typically built on fixed axes, solar energy is not optimally transformed into electrical energy. The output efficiency of conventional solar panels ranges from 15% to 20%, depending on the type of solar panel [1]. In compared to fixed solar systems, researchers found that using multi-axis sun tracking systems increases overall power output by 30% to 45 % [2]. It was also observed that on the same bright day, the energy production of a solar panel with a tracking system was 1742.88Wh while that of a solar panel without a tracking system was 829.6Wh [3]

1.1.1 Problem Statement

Bangladesh has a significant potential for using solar irradiation to create power due to its geographic position. The country absorbs an average of 4.0 to 6.5 kWh/m2 of solar radiation every day, capable of creating 1018 x 1018 J of energy [1]. Only 0.11 percent of this large amount of solar energy is utilized to meet the country's basic energy needs [4]. Furthermore, Bangladesh has an average of 6.5 sunny hours each day, with average solar irradiance ranging from 215 W/m2 in the north-west to 235 W/m2 in the south-west every day [5]. However, variations in solar radiation cause more than 40% of energy to be wasted [6]. The incidence angle of the sunlight must be perpendicular to the solar panel in order for it to generate its maximum output power. In most residential areas, however, solar panels are statically oriented on a roof and do not face the sun perpendicularly throughout the day. So, The solar panels will generate low output electricity when the sun's position changes. The main goal of this project is to create a solar tracker that will increase solar panel power output by maximizing solar irradiance collection.

1.1.2 Background Study

Solar trackers are the best option for maximizing land use since they produce more power in about the same amount of area as fixed-tilt systems.Due to increased direct solar radiation exposure, trackers produce more electricity than their stationary counterparts. Depending on the location of the tracking equipment, this range could range from 10 to 25 percent. Solar trackers come in a variety of forms, including single-axis/dual-axis trackers,tracking with or without using light dependent sensors, all of which can be the ideal fit for a particular jobsite. The sort of solar tracker that is most appropriate for a particular solar installation might depend on a number of factors, including installation size, local weather, degree of latitude, and power needs.

Several studies on various PV solar tracking systems have been carried out all over the world. Al-Mohamad, for instance, utilized a programmable logic controller (PLC) to manage a solar module that tracked the sun's rays [7]. It was demonstrated that by collecting and storing data about the sun's radiation and utilizing this knowledge to operate the photovoltaic module, the photovoltaic system's daily output power could be increased by more than 20% above that of a fixed module.

Three sun tracking systems were simulated by Alata et al., including: (1) azimuth/elevation sun tracking; (2) equatorial two-axis sun tracking; and (3) one-axis sun tracking with a tilted aperture equal to the latitude angle.[8].

Urbano et al. demonstrated a 5 Watt-PV module for a 2.6 kW stand-alone solar tracking system [9]. The tracking system was meant to track the sun's position in altitude and azimuth directions independently, and it was powered by two 12 V DC motors, each using 36 W and fed by a single electrolytic condenser charged by the PV module.

In Jordan, M. Abu-Khader et al. explored the use of multi-axis sun tracking devices in a variety of modes and displayed actual findings. In compared to fixed solar systems, the researchers found that using multi-axis sun tracking systems increases total power output by 30% to 45%. [5].

With a fixed mount solar system, Deepthi et al. offered a comparison of single-axis and dual-axis solar tracking [10]. Dual-axes solar tracking systems outperformed single-axis solar tracking systems during overcast days in this study, although they were more costly.

Tudorache et al. demonstrated a solar tracking PV system that uses a DC motor operated by an intelligent drive unit that gets input signals from specialized light intensity sensors [11]. The solar tracking panel produced roughly 57.55 percent more energy than the stationary system, according to the statistics.

Mosaddequr Rahman et al. proposed an automated microcontroller controlled solar tracker to track the sun [12]. Microcontroller calculates the sunrise and sunset times on each day using a set of equations and sends signals to the controlling motors to rotate the panels at predetermined time intervals by a fixed angle to track the sun.

In his study, H. Fathabadi proposed a brand-new, very accurate, offline, thoughtless dual-axis solar tracker that is widely applicable to solar concentrators and photovoltaic systems [13]. The tracker uses offline estimated data collected from solar map equations to determine the direction of the sun where the most solar energy is captured. It has been demonstrated experimentally that the solar tracker can capture between 19.1% and 30.2% additional solar energy depending on the season.

In their most recent work, Mohanad Alata et al. demonstrate the design and simulation of time-controlled step sun tracking systems that comprise azimuth/elevation sun tracking, equatorial two axis sun tracking, and one axis sun tracking with the tilted aperture equal to the latitude angle [14]. For modeling and controller design, the first order Sugeno fuzzy inference system is used.

Therefore, this project aims to design and implement a solar tracker system that can maximize the collection of solar irradiance to improve the power generation.

1.1.3 Literature Gap

Solar tracking, which involves directing a solar collector, reflector, or photovoltaic panel towards the sun, is a growingly popular renewable energy technique today. Many methods of tracking and prediction of irradiation were proposed to increase efficiency in the production of energy by photovoltaic cells.

Regardless of the fact that sensorless solar tracking devices have increased PV power output, these mainly use open-loop control. In order to do this, offline geographic estimates of the sun's course are needed. As a result, these functioned independently based on their geographic location, but new installation sites need calibration procedures.

The lack of information in the literature relates to the creation of sensor-based solar tracking systems. In particular, LDRs, which are frequently of the cadmium sulfide (CdS) type and detect visible light spectrum, are used as inputs to tracking algorithms in most sensor-based solar tracking systems. However, the LDR's shortcomings (such as light saturation and inefficiency in low visibility conditions) might deteriorate the solar tracking performance. When the light exposure of LDRs reaches a specific saturation level, LDR saturation occurs. The tracking algorithm receives nearly consistent voltage readings from the saturated LDRs as a result. According to Grace Reeseman, this causes tracking movements to be inaccurate and the first point of saturation to be maintained rather than moving to face the light [15].

Kuttybay et al. [16] addressed the primary drawback of LDR-based tracking systems, which is their inefficiency in low-visibility circumstances. According to Kuttybay et al, during cloudy days, a PV module may be pointed in the opposite direction from where the sun will be due to the weather's significant visible light scattering. Additionally, the majority of earlier studies in the literature focused exclusively on the technical elements of solar tracking systems with the hope of creating new designs or alternative tracking control methods.

Solar tracking systems have proven to be successful in boosting PV energy productivity, but because tracking systems are expensive, the energy benefits are not necessarily economical or beneficial, according to Vaziri Rad et al. [17]. Furthermore, Talavera et al. addressed how there are still limitations in the performance quantification with relation to the economic feasibility of PV technology when the solar tracking system is deployed [18].

1.1.4 Relevance to current and future Industry

According to SolarFeeds, a leading solar wholesaler, Bangladesh's solar capacity stands at 416 Megawatts. Despite the nation's high levels of sun irradiation, there is still much opportunity for development. The National Solar Energy Roadmap is a strategic strategy that the Bangladeshi government just unveiled. The goal of the strategy is to install 40 Gigawatts of solar power by 2041. The draft explicitly states that 40% of this expected capacity must come from rooftop solar installations. The implementation of solar tracking will propel Bangladesh's solar market to the next level while creating vast opportunities. As a solar installer or industry professional eyeing Bangladesh's budding solar market, one should be excited about the future.

1.2 Objectives, Requirements, Specification and Constraint

1.2.1. Objectives

Traditional solar panels are built on fixed axes and only receive direct sun beams during peak hours, resulting in inability to produce maximum possible energy throughout every sun hour. To resolve this problem the goal of the project is to:

- Build a solar tracker flexible for horizontal and vertical movement.
- Monitor the various parameters like current, voltage, temperature and light.

Core objective of this project is to:

- Track movement of the sun precisely throughout the day.
- Minimize the solar irradiance losses.
- Increase the power generation of solar panels.

1.2.2 Functional, Nonfunctional Requirements, Constraints

Functional Requirements:

- Load Profile calculation.
- Sizing PV Array.
- Project Implementation Location.
- Maintaining weight ratio of servo/stepper motor with the PV panel.

Non-Functional Requirements:

- PV panel type, such as polycrystalline PV panels in our case.
- Type of microcontroller, such as atmega32/atmega328/arduino uno/raspberry pi.

Constraints:

- In this scenario, budget may be an issue because a solar tracker requires additional investment. Solar panels are not so expensive these days, and installing more solar panels would be less expensive than adding a tracking system.
- Setting up a Solar panel requires a lot of space. So, outside solar parks, it will be quite difficult to implement this project on a bigger scale.

1.2.2 Specifications

System Level Specifications:

This is a datasheet for a dual axis solar tracker specification collected from **NEXTracker**, one of the world's leading solar tracker manufacturers.

Tracking Type	Dual Axis
String Voltage	1,500 V_{DC} or 1,000 V_{DC}
Typical Row Size	78-90 modules, depending on module string length
Drive Type	Non-backdriving, high accuracy slew gear
Motor Type	24V brushless Linear Actuator
Array Height	Rotation axis elevation 1.3 to 1.8m/ 4'3'' to 5'10''
Ground Coverage Ratio	Configurable. Typical Range 28-50%
Modules Supported	Mounting options available for virtually all utility-scale crystalline modules, First Solar Series 6 and First Solar Series 4.
Tracking Range Of Motion	Options for ±60° or ±50°
Operating Temperature Range	Self Powered: -30°C to 55°C (-22°F to 131°F) AC Powered: -40°C to 55°C (-40°F to 131°F)
Module Configuration	1 in portrait. 3 x 1,500 V or 4 x 1,000 V strings per standard tracker. Partial length trackers available.
Module Attachment	Self-grounding, electric tool-actuated fasteners.
Materials	Galvanized steel
Allowable Wind Speed	Configurable up to 225 kph (140 mph) 3-second gust
Wind Protection	Intelligent wind stowing with symmetric dampers for maximum array stability in all wind conditions
Foundation	Standard W6 section foundation posts

Table No-1: System Level Specification

Component Level Specifications:

Requirements	Component	Specification	Remark
Photovoltaic Cell	**Solar Panel (Polycrystalline silicon)**	**Maximum output power: 20 watts** **Operating voltage: 18.2 V** **Current: 1.10 A** **Short circuit current: 1.19 A** **Open circuit voltage: 22.2 V** **Size: 346mm * 230 * 17mm** **Crystal silicon type: polycrystalline silicon** **Solar cells Number: 36pcs** **Weight: 1.3 kg** **STC irradiance: 1000 w/m^2**	**Electricity Generation from the Sunlight**
Servo Motor	20KG Digital Servo High Torque	**Torque(4.8V): 16.5 kg-cm (229.1 oz/in)** **Torque(6.6V): 20.0 kg-cm (277.7 oz/in)** **Speed: 0.18 sec (4.8V) ¦ 0.16 sec (6.6V)** **Operating Voltage:4.8 ~ 6.6 DC Volts** **Weight: 60 g (2.12 oz)** **Bearing Type: Ball Bearing x 2** **Motor Type: DC Motor** **Gear Type: Copper & Aluminum** **Operating Temperature:-20?~60?** **Working frequence:1520µs / 333hz** **Size:40.7 x 20.5 x 39.5 mm (1.60 x 0.80 x 1.55 in)**	**For the axis rotation of the PV panel according to the signal .**
	Motor Driver (PCA9685)	**Frequency: 40-1000Hz.** **Channel number: 16 channel.** **Resolution: 12 bit.** **Voltage: DC 5-10V** **Size: 60*25mm** **Color: blue** **Net Weight: 12 g**	**For controlling speed and direction of motor**
Microprocessor	**Arduino Mega R3 2560**	**Operating Voltage 5V** **Input Voltage (recommended) 7-12V** **Input Voltage (limit) 6-20V** **Digital I/O Pins 54 (of which 15 provide PWM output)** **Analog Input Pins 16** **DC Current per I/O Pin 20 mA** **DC Current for 3.3V Pin 50 mA** **Clock Speed 16 MHz** **Length 101.52 mm** **Width 53.3 mm** **Weight 37 g**	**Received signal from LDR will be sent to the Servo motor**

Sensor	LDR Sensor (GL-5516)	Size: 5mm x 2mm Maximum Voltage: 150 Volt DC Maximum Wattage: 90mW Operating Temperature: -30 ~ +70 deg C Spectral Peak: 540nm Light Resistance (at 10 Lux): 5-10 Kohm Dark Resistance: 0.5 Mohm Response time: 20ms (Rise), 30ms (Down) Resistance Illumination: 4	Detect the light intensity
	DS18B20 Digital Temperature Sensor	The resolution adjustment range: 9-12 bit With convenient installation hole, aperture: 2.5 Temperature measurement range: -55~+125 Temperature measurement accuracy: 0.5 Working voltage: DC5V	For Temperature Measurement
	Current Sensor ACS712	Pin 5V power supply on board power indicator; The module can measure the positive and negative 20 amps, corresponding to the analog output of 100 mv/a; No test current through the output voltage is VCC / 2; PCB board size: 31 (mm) x13 (mm);	For Current Measurement
	Voltage Sensor	Voltage input range: DC 0-25V Voltage detection range: DC 0.02445V-25V Voltage Analog Resolution: 0.00489V DC input connector: Terminal cathode connected to VCC, GND negative pole	For Voltage Measurement
Power Supply	PA-1061	INPUT: 100-240V, 50-60hz 1.5A OUTPUT 12V DC 5A 60W 2.1x5.5mm connector Efficiency Level V	To supply power
Display	16*2 LCD Display	LCD display module with blue blacklight. Wide viewing angle and high contrast. Built-in industry standard HD44780 equivalent LCD controller. Commonly used in: copiers, fax machines, laser printers, industrial test equipment, networking equipment such as routers and storage devices. LCM type: Characters Can display 2-lines X 16-characters. Voltage: 5V DC. Module dimension: 80mm x 35mm x 11mm. Viewing area size: 64.5mm x 16mm	For monitoring the parameters

Table No-2: Component Level Specification

1.2.3 Technical and Non-technical consideration and constraint in design process

Technical Considerations:

- Detecting sunlight is the primary principle of the project, so adverse and gloomy weather conditions should be put under consideration while implementing the project.
- Power Supply to the controlling actuators whenever the project is running.
- Maintaining the weight ratio of the solar panel and standing with the actuators.

Non-Technical Considerations:

- Various data obtained from the temperature sensor.
- Materials used for making the mounting stand.
- Price variations for components in different market places.

Constraint:

- Arduino and Sensor Malfunction.
- Changing the model of servo motor due to the fragile structure of the gear. (from plastic gear of MG995 servo to Metal gear of DS Servo)

1.2.4 Applicable Compliance, Standards, and Codes

According to RENEWABLE ENERGY POLICY OF BANGLADESH :

- IEC 60904 describes procedures for the measurement of current-voltage characteristics (I-V curves) of photovoltaic (PV) devices in natural or simulated sunlight.

- IEC 61724-1:2021 outlines terminology, equipment, and methods for performance monitoring and analysis of photovoltaic (PV) systems. It also serves as a basis for other standards which rely upon the data collected. This document defines classes of photovoltaic (PV) performance monitoring systems and serves as guidance for monitoring system choices.

- IEC TS 61724-3:2016(E) defines a procedure for measuring and analyzing the energy production of a specific photovoltaic system relative to expected electrical energy production for the same system from actual weather conditions as defined by the stakeholders of the test. The energy production is characterized specifically for times when the system is operating (available); times when the system is not operating (unavailable) are quantified as part of an availability metric. The aim of this technical specification is to define a procedure for comparing the measured electrical energy with the expected electrical energy of the PV system.

- IEC TS 63049:2017(E) provides the minimum activities deemed necessary to implement an effective quality assurance program for the managing and reducing of risk in the installation and operation of photovoltaic (PV) systems. This document defines requirements for certifying that an entity has and uses a quality assurance program to prevent, or reduce errors and learns from any new errors in installation, operation and maintenance of a PV system.

1.3 Systematic Overview/summary of the proposed project

The current energy shortage issues that the globe, particularly the third world countries, are facing are pressuring researchers to find an alternate energy source that will substitute the traditional fossil fuel. Solar, nuclear, and wind power are examples of alternative energy sources. Utilizing the power of solar rays, sun energy is created. It is the cleanest energy source and has the lowest climatic impact. The power from the sun that is intercepted by the earth is roughly 1.8*1011MW, which is thousands of times more than the amount at which the earth now uses all other commercially available energy sources combined. The primary issue with solar energy is how diluted it is. The available solar radiation flux rarely reaches 1 KW/M, which is insufficient for technological use even in the hottest parts of the planet. A solar tracker device can solve this issue by ensuring that the panel surface receives maximum sun ray intensity from sunrise to dusk. This study suggests a biaxial solar tracker based on the equatorial mount principle that will work with all types of photovoltaic panels (PV, LCPV, and HCPV) and maintain their peak performance throughout the year with the least amount of energy consumption. This model's advantage is that it will be highly accurate with an acceptance angle of no more than one degree, enabling concentrated photovoltaic cells to maintain a perfect focus of direct sun energy throughout the day.

A. Capturing Sunlight by Sensors:

A photoresistor, also known as a light-dependent resistor (LDR), or photocell, is a light-controlled variable resistor. LDR is the abbreviation for this type of resistor. A photo resistor's resistance lowers as the intensity of the incoming light increases. Photoconductivity is the foundation of the LDR's operating concept. It only happens that the material's conductivity drops when light strikes its surface, stimulating electrons in the device's valence band to move into the conduction band. The primary function of the LDR in this project is to detect sunshine or other natural light and provide a signal to the actuator that controls the solar panel in order to rotate the panel towards the light.

B. Controlling the Actuators:

In this project, servo motors are employed as the actuator. Due to the dual axis tracking mechanism, both the horizontal and vertical axes will be rotated by two servo motors. One of the two dc servo motors is mechanically connected to the other's driving axle, allowing the former to move with the latter's axle rotation. The solar panel is driven by the axle of the prior servo motor. The two servo motors are placed in such a way that the solar panel may move both along the X and Y axes. Depending on the logic signal sequence, the servo motors can move the solar panel clockwise or anticlockwise.

C. Monitoring the Parameters:

After tracking sunlight, to monitor various parameters like voltage, current, light, and temperature from the solar panel, sensors are directly connected to the PV cell, whose output is linked to the Arduino microcontroller, and the results of those parameters are displayed on an LCD screen on a time basis.

1.4 Conclusion

This project aims to capture the best attainable amount of solar irradiance in every possible sun hour with the use of a solar tracking system in order to improve the power generation of solar panels. Use of a solar tracker helps to increase the conversion efficiency of producing electricity from sunlight to a noticeable amount in comparison to the conventional static solar panels. The overall efficiency with and without using solar tracker will be monitored and compared to the theoretical value for the project justification.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

Two design strategies are suggested that will produce the desired outcome for this project. As a result of using two different types of actuators, these two designs operate in different ways. The outcome of these designs will therefore be unique from one another.

2.2 Identify multiple design approach

The two designs that are chosen for this project are :

1. Solar Tracking System with Servo Motor
2. Solar Tracking System with Stepper Motor

2.3 Describe multiple design approach

Design-1:

In Figure-1, we propose a flexible sensor based design with servo motor for increasing solar irradiance capture to improve power generation.

There are three main constituents of the design: inputs (from LDR), controller (Adruino), and output (Servo Motor). Four Light Dependent Resistors (LDRs) are installed on a common plate with a solar panel. The quantity of light that a source sends fluctuates. Due to their intrinsic trait of decreasing resistance with increasing incoming light intensity, the resistance values of all LDRs are not always the same i.e. photoconductivity. Each LDR sends a signal to the Microcontroller, which is configured with the necessary programming logic. Based on the input signals from the LDRs, the microcontroller sends appropriate signals to the servo motor. One of the two dc servo motors is mechanically connected to the other's driving axle, allowing the former to move with the latter's axle rotation. The solar panel is driven by the axle of the prior servo motor. The two servo motors are placed in such a way that the solar panel may move both along the X and Y axes. Depending on the logic signal sequence, the servo motors can move the solar panel clockwise or anticlockwise.

After tracking sunlight, to monitor various parameters like voltage, current, light, and temperature from the solar panel, sensors are directly connected to the PV cell, whose output is linked to the Arduino microcontroller, and the results of those parameters are displayed on an LCD screen on a time basis.

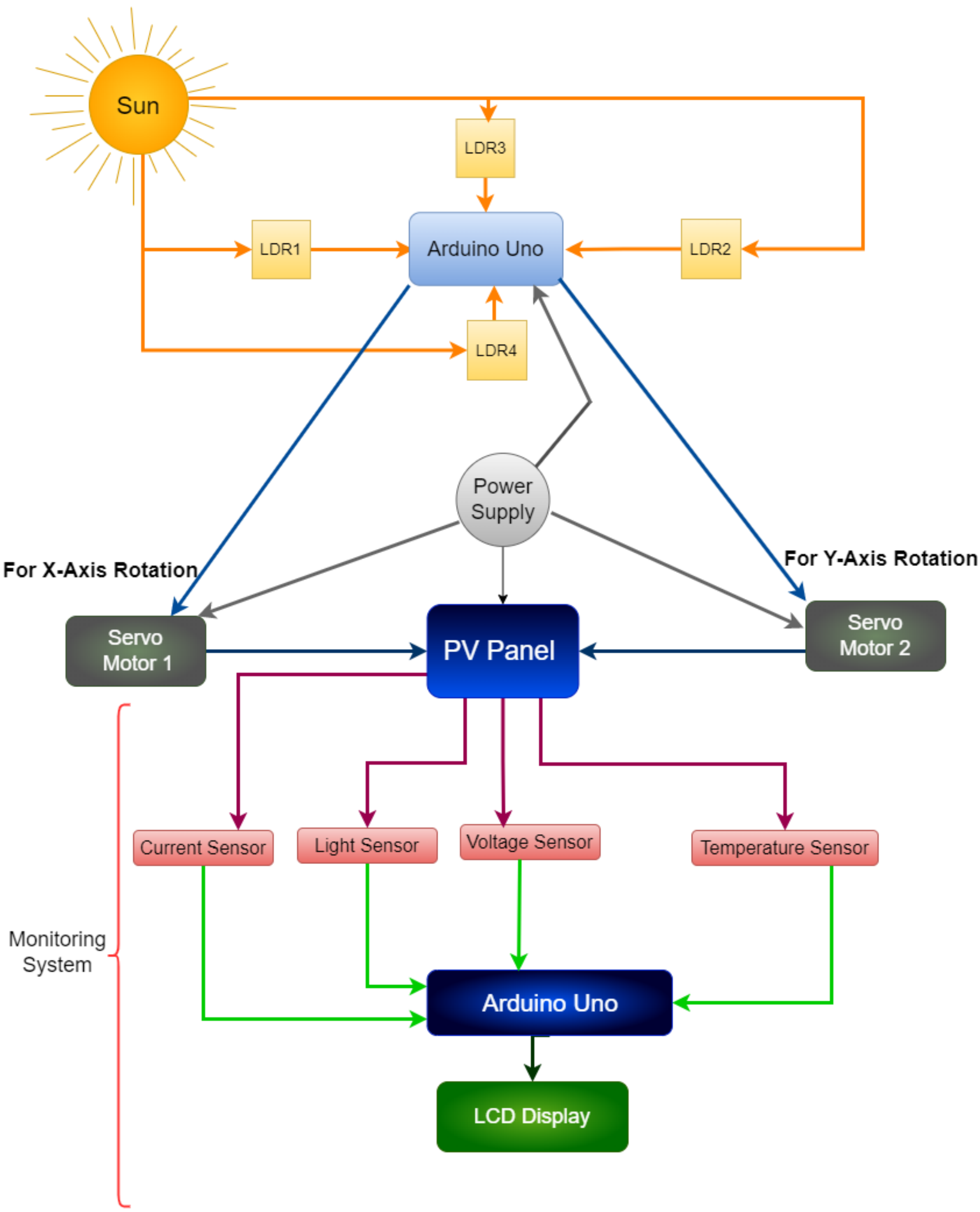

Figure-1: Block diagram of Design-1

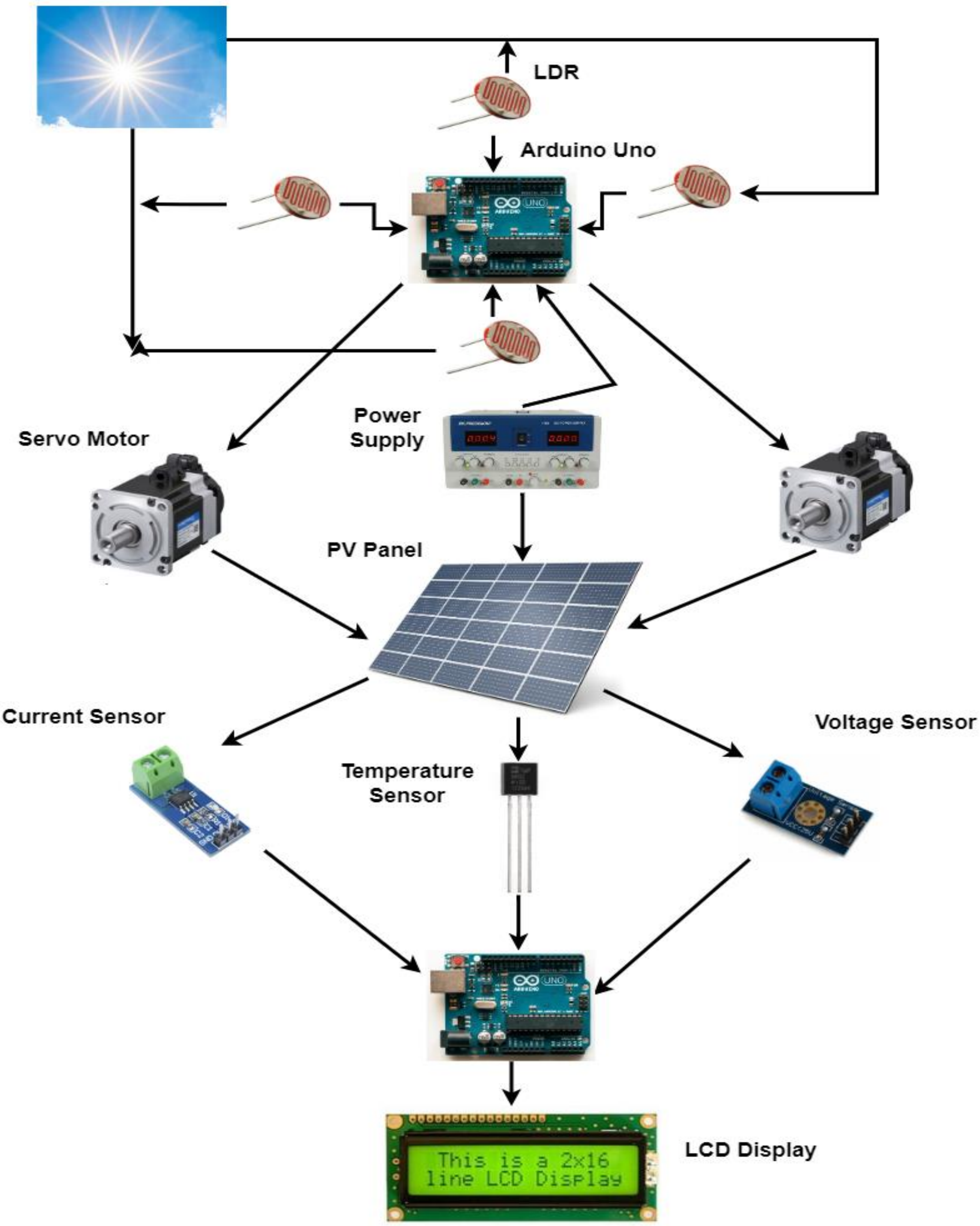

Figure-2: Overview of Design - 1

Design - 2:

In Figure-3, we propose a flexible sensor based design with Stepper motor for increasing solar irradiance capture to improve power generation. Here, the motors are controlled by two stepper motor drivers. These drivers have four different control options: position control, speed control, torque control, and tension control.

There are three main constituents of the design: inputs (from LDR), controller (Adruino), and output (Stepper Motor). Four Light Dependent Resistors (LDRs) are installed on a common plate with a solar panel. The quantity of light that a source sends fluctuates. Due to their intrinsic trait of decreasing resistance with increasing incoming light intensity, the resistance values of all LDRs are not always the same i.e., photoconductivity. Each LDR sends a signal to the Microcontroller, which is configured with the necessary programming logic. Based on the input signals from the LDRs, the microcontroller sends appropriate signals to the servo motor. One of the two stepper motors is mechanically connected to the other's driving axle, allowing the former to move with the latter's axle rotation. The solar panel is driven by the axle of the prior stepper motor. The two stepper motors are placed in such a way that the solar panel may move both along the X and Y axes. Depending on the logic signal sequence, the stepper motors can move the solar panel clockwise or anticlockwise.

After tracking sunlight, to monitor various parameters like voltage, current, light, and temperature from the solar panel, sensors are directly connected to the PV cell, whose output is linked to the Arduino microcontroller, and the results of those parameters are displayed on an LCD screen on a time basis.

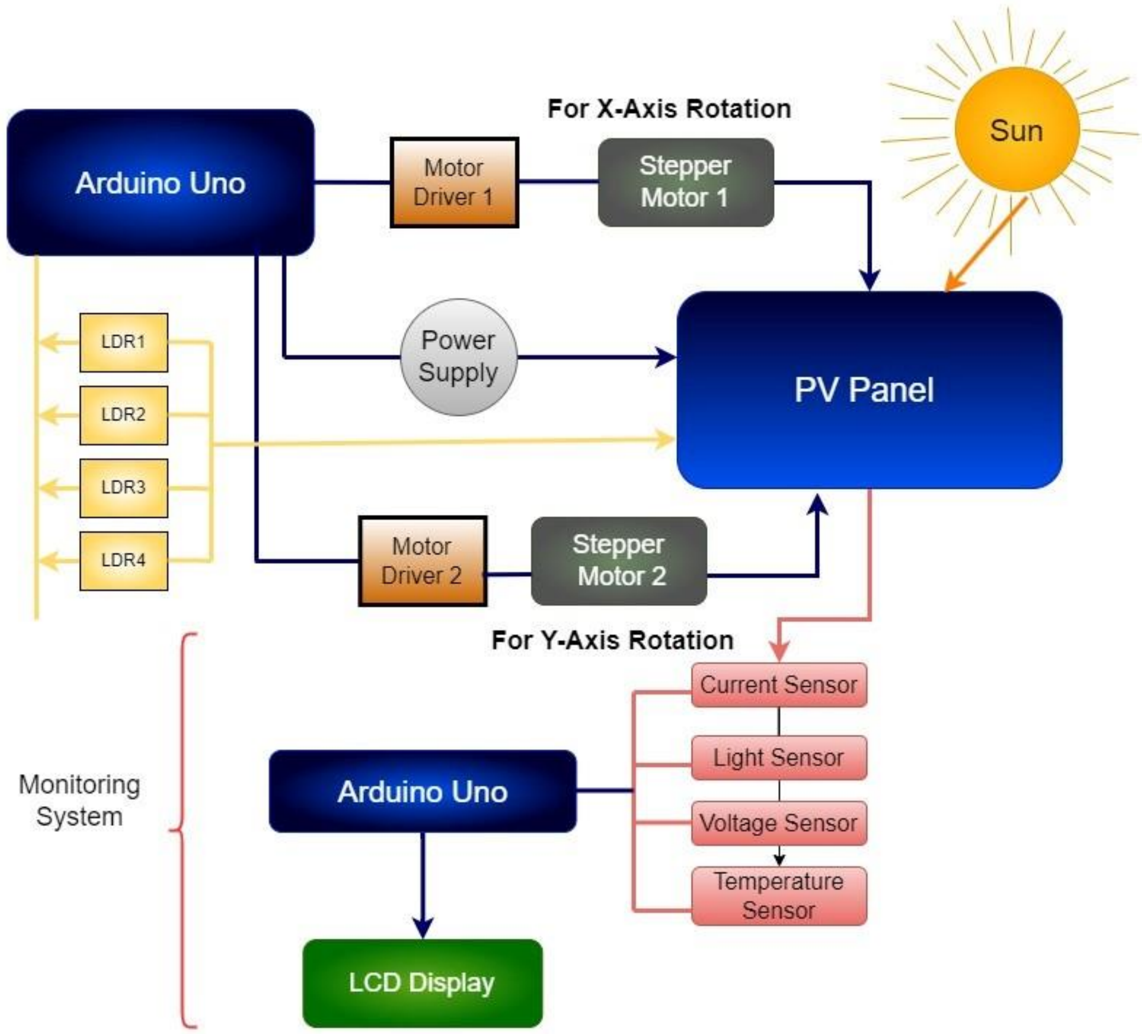

Figure-3: Block diagram of Design-2

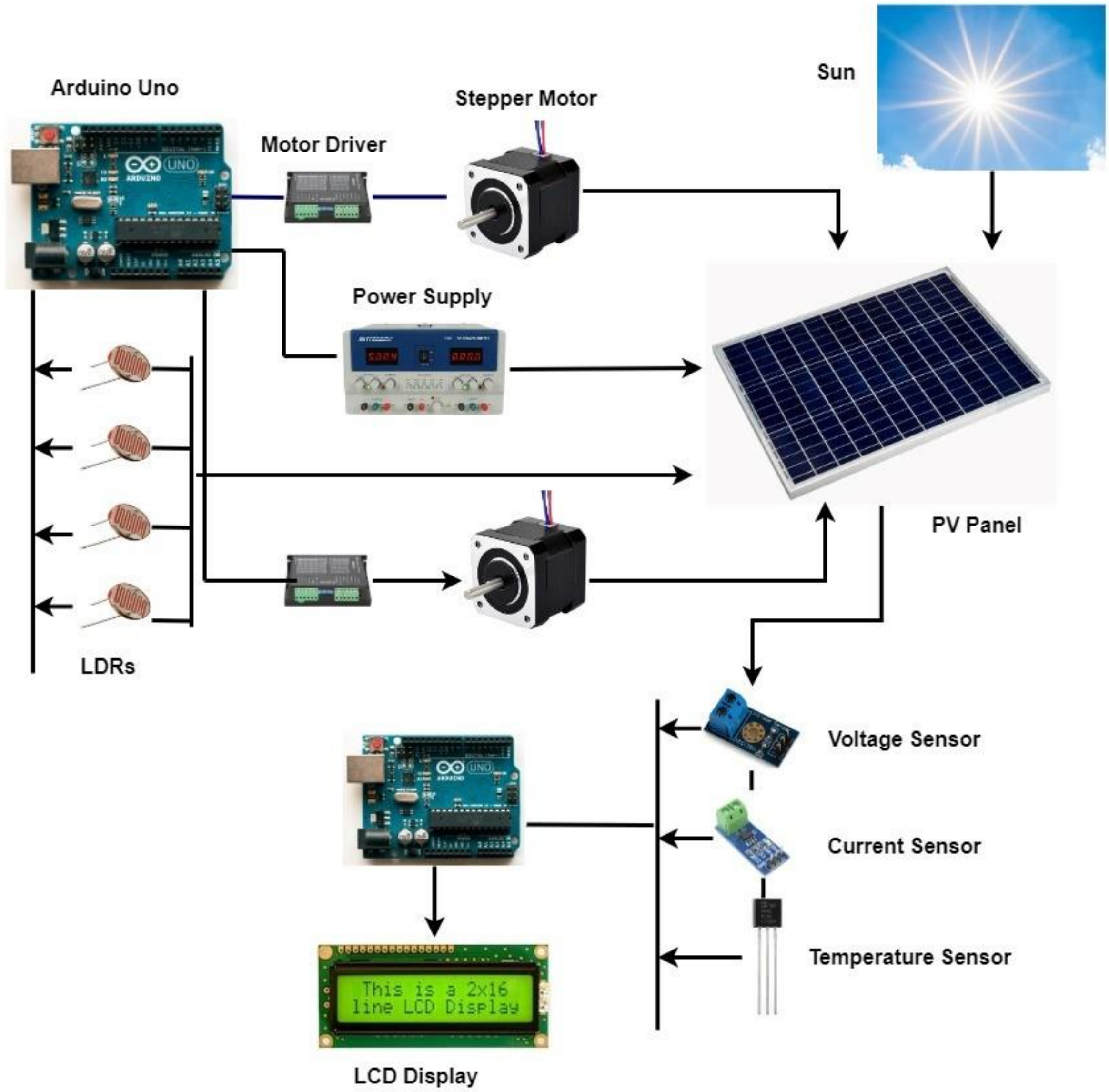

Figure-4: Overview of Design - 2

2.4 Analysis of multiple design approach

	Design 1	Design 2
Controlling Actuator	To rotate the solar panel two servo motors have been used.	To rotate the solar panel two stepper motors have been used.
Control system configuration	Design 1 is configured in a closed loop configuration with a feedback system.	Design 2 is configured in an open loop configuration with no feedback system.
Power consumption	Need relatively less power for angular rotation.	Consumes comparatively more power.
Efficiency	Design 1 has higher efficiency due to the closed loop feedback system and encoders.	Design 2 has relatively lower efficiency due to the open loop condition.
Operating speed	The Operating speed of design 1 is higher.	Design 2 operates at a lower speed.
Torque speed characteristics	Due to the servo motor, design 1 produces high torque at high speeds.	Due to the stepper motors, design 2 produces high torque at low speeds.

Table No-3 : Analysis of Multiple Design Approach

2.5 Conclusion

All the elements from the above table are taken into account to determine the most appropriate and superior design. The most suitable technique, taking all the variables into account, is Design-1, and its implementation will be more outstanding and well-founded.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction

Selecting and analyzing modern IT tools, hardware tools with the accordance and specifications of a project is a major part of an engineering project.

3.2 Select appropriate engineering and IT tools

Hardware Tools	**Software Tools**
Solar Panel	PVsyst
Servo Motor	Homer Pro
Motor Driver	Proteus 8 Professional
Power Supply	Arduino IDE
LCD Display	
Arduino Mega	
LDR Sensor	
Current Sensor	
Temperature Sensor	
Voltage Sensor	
Buck Converter	

3.3 Use of modern engineering and IT tools

PVsyst:

A PC software application called PVsyst 7.2 is applied to analyze, size, and analyze data for entire PV systems. It comprises substantial meteo and PV systems components databases as well as general solar energy tools and deals with grid-connected, stand-alone, pumping, and DC-grid (public transportation) PV systems.

The system's design is based on the following quick and easy process:

- Specify the desired power or available area
- From the internal database, choose the PV module.
- Choose the inverter from the internal database

PVsyst will suggest an array/system configuration so you can run a test simulation. The software incorporates a color-coded error/warning messaging system. If there is a mismatch, problem, or warning with your design, you will receive the appropriate frame-appropriate alert.

Homer Pro:

The HOMER Pro program is the industry standard for enhancing microgrid designs across all industries, from grid-connected workplaces and military bases to village electricity and island utilities. Evaluation of designs for both off-grid and grid-connected power systems is made easier with HOMER Pro, often known as HOMER (Hybrid Optimization of Multiple Energy Resources). One must choose several different configuration options while designing a power system. The first step in using HOMER is to choose and input data under the Design button to give the model inputs, such as components (such as generators, wind, and solar), component costs, and resource availability. Under the library button, you may also add additional parts, resources, and loads.

When you select the Calculate button, HOMER utilizes these inputs to simulate various system configurations, or component combinations, and it produces results that you can view as a list of viable configurations arranged by net current cost under the Results button. Additionally, HOMER presents simulation results in a wide range of tables and graphs that enable you to compare setups and assess their relative technical and economic benefits. The tables and graphs can be exported for use in presentations and reports.

The model can also be used to run sensitivity assessments to investigate the potential implications of changing variables on the cost-effectiveness of various system configurations, including resource availability and economic conditions. You give HOMER sensitivity values that cover a range of resource availability and component costs in order for it to conduct a sensitivity analysis. Using the range of values, HOMER simulates each configuration of the system. The outcomes of a sensitivity analysis can be used to pinpoint the variables that have the most effects on the conception and operation of a power system. The outcomes of the HOMER sensitivity analysis can also be used to respond to broad inquiries regarding available technological solutions for planning and policy decisions.

Proteus 8 Professional:

The PCB (printed circuit board) design, PCB circuit board construction, and real-time simulation of microcontrollers like the 8051 may all be done using the prototyping program Proteus 8. It can also be used to build the schematics for external electrical and electronic circuits. An exclusive tool set for automating electronic design is called the Proteus Design Suite. The program is primarily used by technicians and electronic design engineers to develop schematics and electronic prints for printed circuit board production. Proteus is an all-inclusive platform for product development, from idea to finished design. Its benefits include automatic PCB layout and wiring, intelligent principal layout, hybrid circuit simulation and accurate analysis, single-chip software debugging, and single-chip and peripheral circuit co-simulation.

Arduino IDE:

The Arduino Software (IDE), often known as the Arduino Integrated Development Environment (IDE), has a text editor for writing code, a message area, a text terminal, a toolbar with buttons for basic operations, and a number of menus. For uploading and interacting with programs, it establishes a connection with the Arduino hardware.

3.4 Conclusion

Choosing modern It tools and hardware are first and foremost objective to fulfill the criteria of this project. The above-mentioned tools are capable enough to establish all the functional and technical requirements.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

Two design strategies are suggested that will produce the desired outcome for this project. As a result of using two different types of actuators, these two designs operate in different ways. Servo motors are used as actuators in Design 1, while stepper motors are used in Design 2. As a result, each of these designs will provide a different result.

4.2 Optimization of multiple design approach

Design-1:

For this design in figure-5, we have used Arduino as it is cheaper and has a more user friendly interface.

In this design, LDRs are used as the main light sensors. The structure that supports the solar panel is attached using two servo motors. The microcontroller receives the Arduino program. The quantity of sunlight hitting them is detected by LDRs. Divided into top, bottom, left, and right are the four LDRs. The top and bottom LDRs are responsible for vertical rotation of the servo motor and the left and right LDRs are responsible for the horizontal rotation of the servo motor. As the built-in version of the proteus program lacked a solar panel component, a solar panel library was added to it for monitoring several parameters including current, voltage, and power. Additionally, the voltage divider circuit and current sensor are used to measure the voltage and current received from the solar panel. We may also acquire the power by customizing the programming in the Arduino IDE. On the LCD display, all of these values are shown, and we may use this information to get parameter data for comparison.

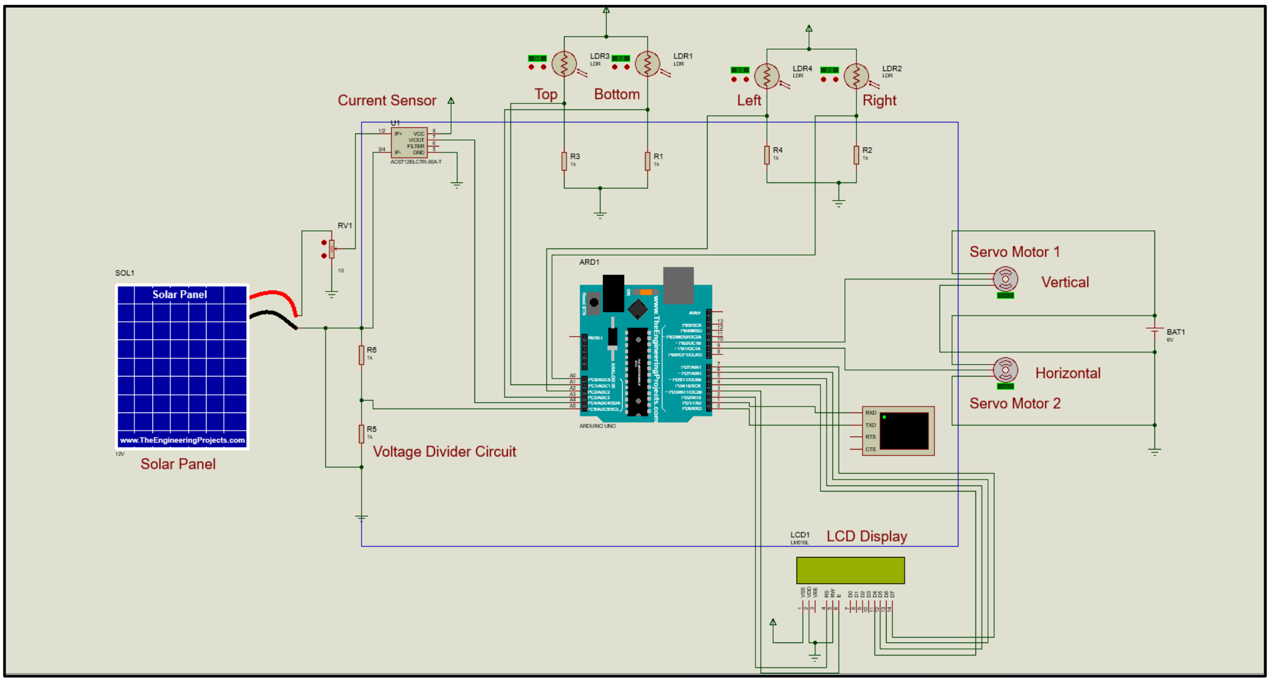

Fig-5: Simulation of Design 1

Rotation of Servo Motor:

The LDR Sensors are responsible for the majority of the sun tracking system's work (Light Dependent Resistor). The difference in light intensity of the LDR sensors determines the logic signals given to the controller. If one of the LDRs in a pair receives higher light intensity than the other, a difference in node voltages sent to the relevant Arduino channel will occur, allowing the appropriate action to be taken. The solar panel will then be moved by the servo motor to the position of the high intensity LDR that was programmed. Depending on the logic signal sequence, the servo motors can move the solar panel clockwise or anticlockwise.

In Figure-6, When light intensity of Top LDR is greater than Bottom LDR: (Vertical Motor Clockwise Rotation)

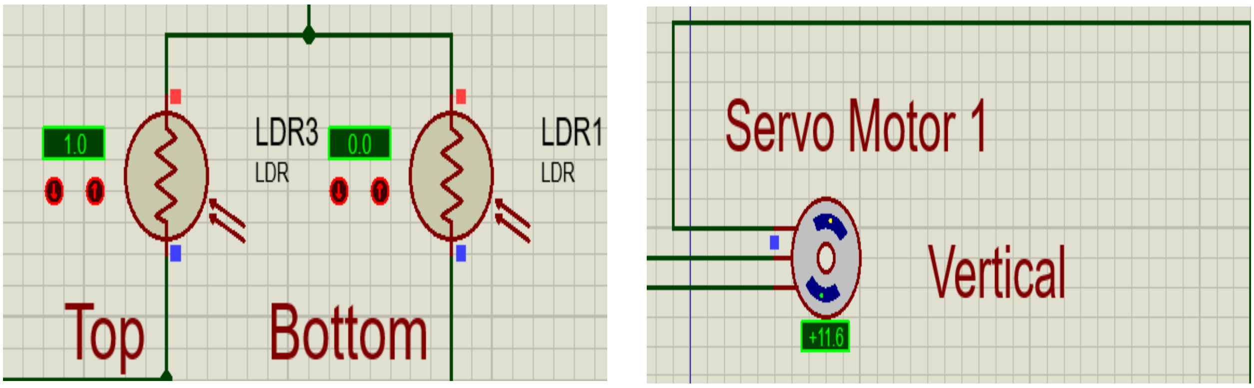

Figure-6: Comparison between Top & Bottom LDR Intensity

In Figure-7, When light intensity of Bottom LDR is greater than Bottom LDR: (Vertical Motor Anti-Clockwise Rotation)

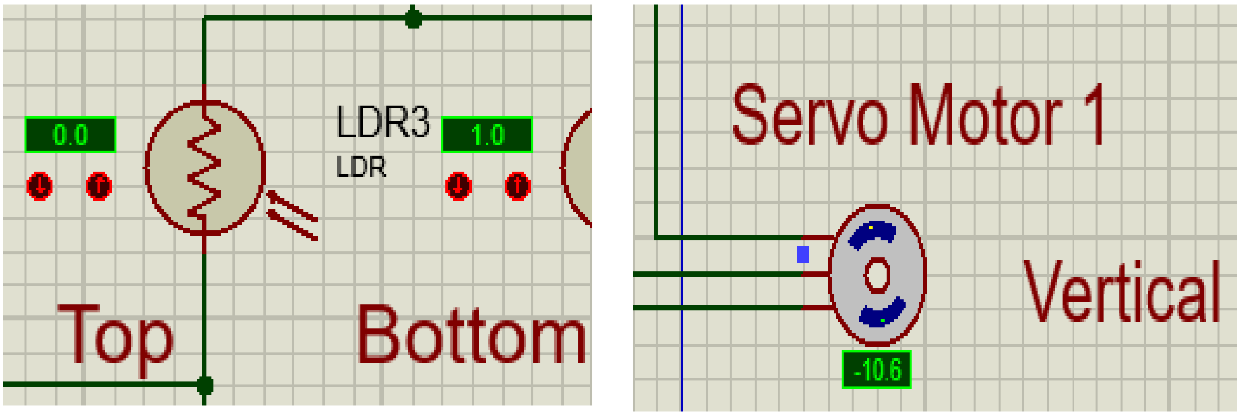

Figure-7: Comparison between Top & Bottom LDR Intensity

In Figure-8, When light intensity of Right LDR is greater than Left LDR: (Horizontal Motor Clockwise Rotation)

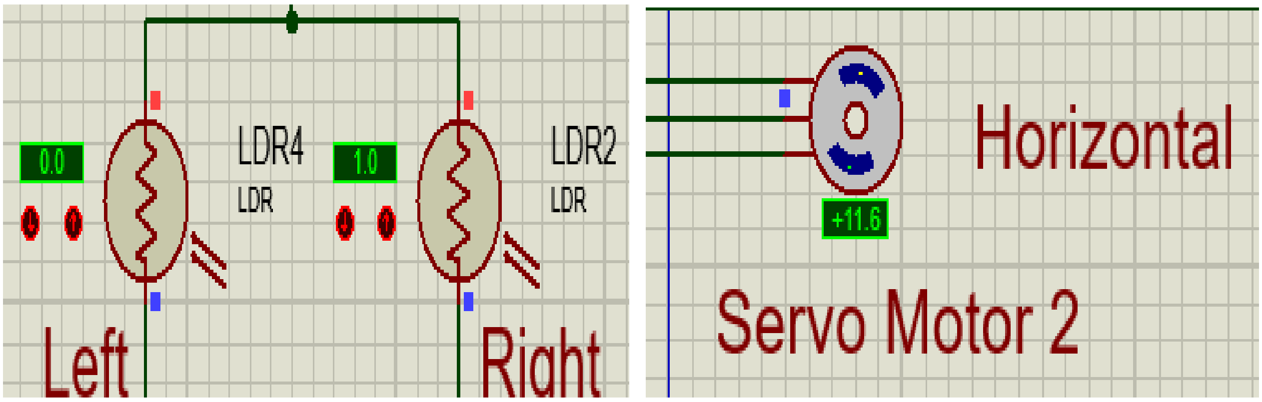

Figure-8: Comparison between Right & Left LDR Intensity

When both LDRs have same light intensity: (No movement of Motor)

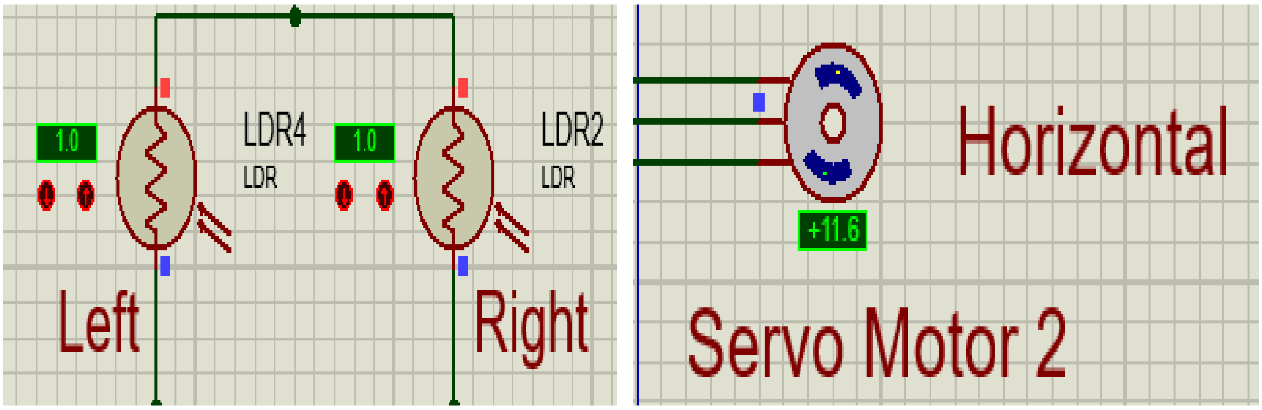

Figure-9: Two LDRs having save Light Intensity

When the light output of the right and left LDRs is equal, it is noted that the servo motor ceases to move. Therefore, one LDR's light intensity must be greater than the others in order for the servo motor to revolve in either a clockwise or counterclockwise direction.

In Figure-10, When light intensity of Left LDR is greater than Right LDR: (Horizontal Motor Anti-Clockwise Rotation)

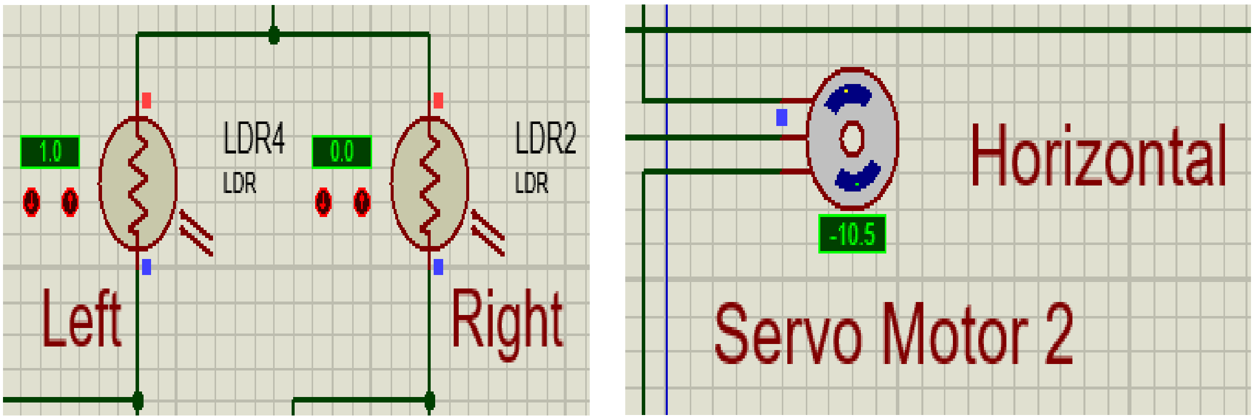

Figure-10: Comparison between Right & Left LDR Intensity

Monitoring System:

To monitor various parameters like voltage, current and power from the solar panel, current sensor and voltage divider circuit are directly connected to the PV cell, whose output is linked to the Arduino microcontroller. The results of those parameters are displayed on an LCD screen on a time basis. In our proteus simulation, we are unable to deliver sunshine to the PV panel, hence we are unable to consistently obtain the values of current, voltage, and power. As a result, we added a potentiometer to the PV cell, which is coupled to the current sensor to acquire values of current, voltage and power on a regular basis.

When the value of potentiometer is at 51% (Condition of current, voltage & Power):

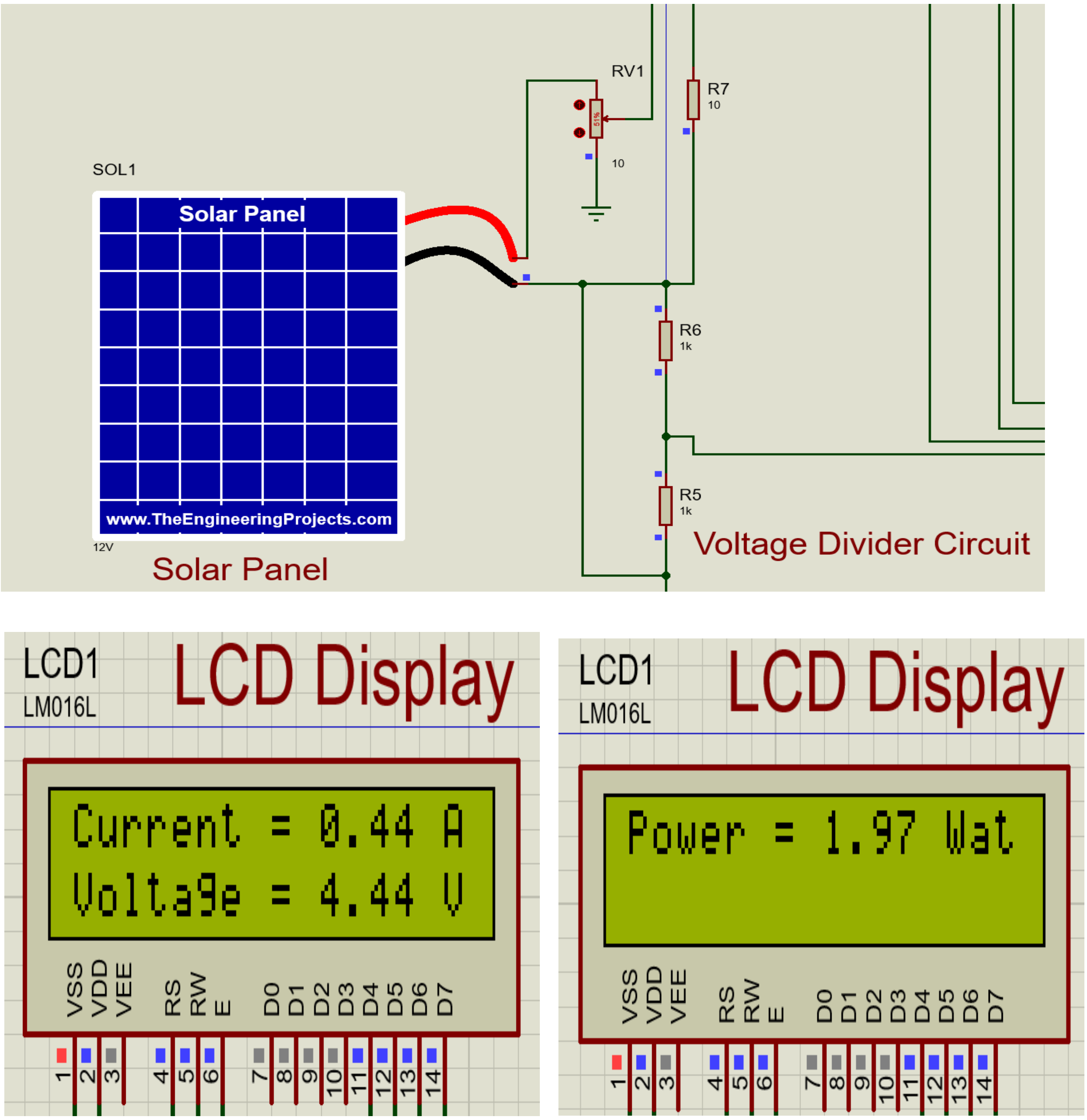

Figure-11: Test Case-1

Current = 0.44 A

Voltage = 4.44V

Power = 1.97 watt

When the value of potentiometer is at 60% (Condition of current, voltage & Power):

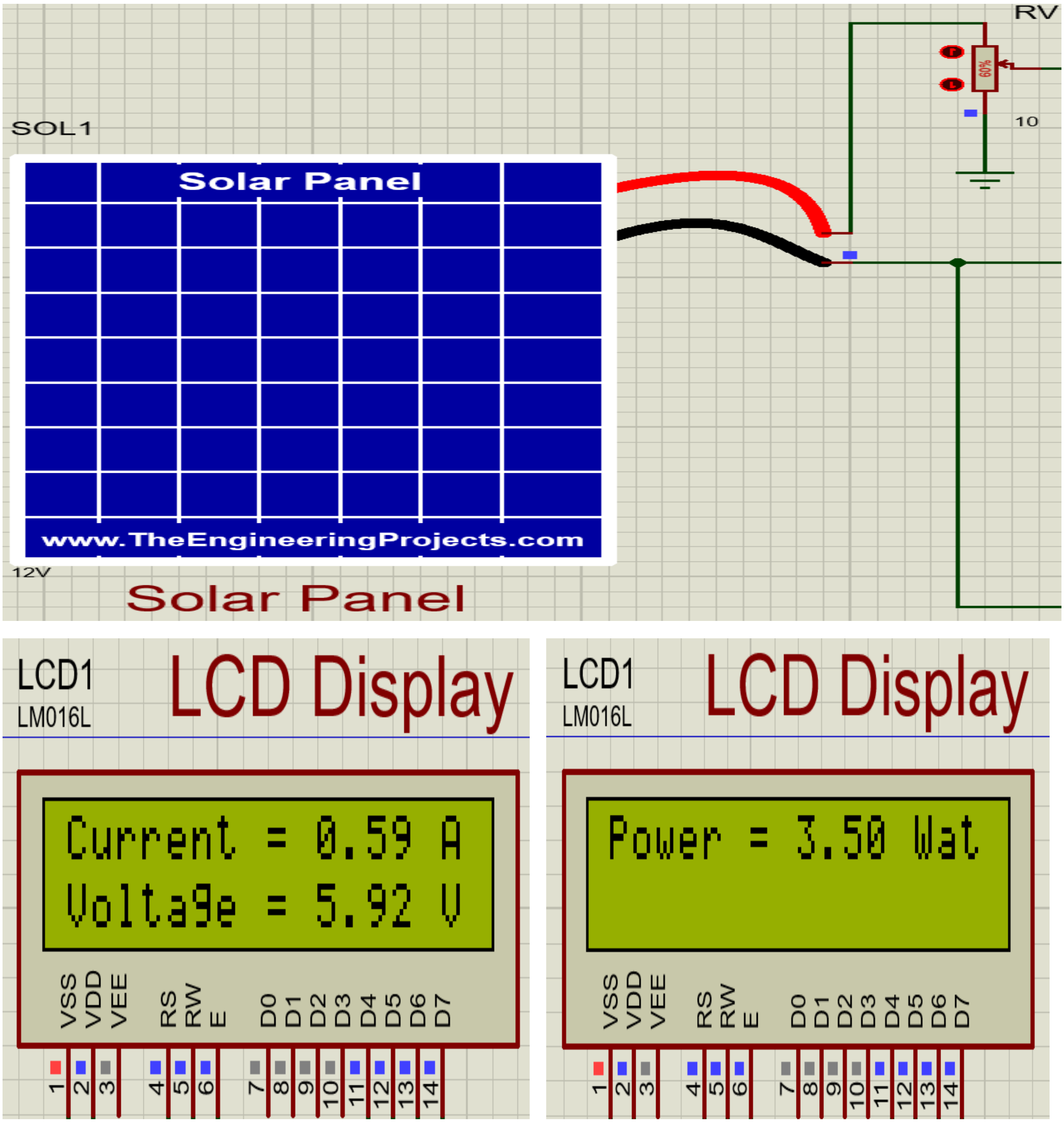

Figure-12: Test Case-2

Current = 0.59 A

Voltage = 5.92 V

Power = 3.50 watt

When the value of potentiometer is at 70% (Condition of current, voltage & Power):

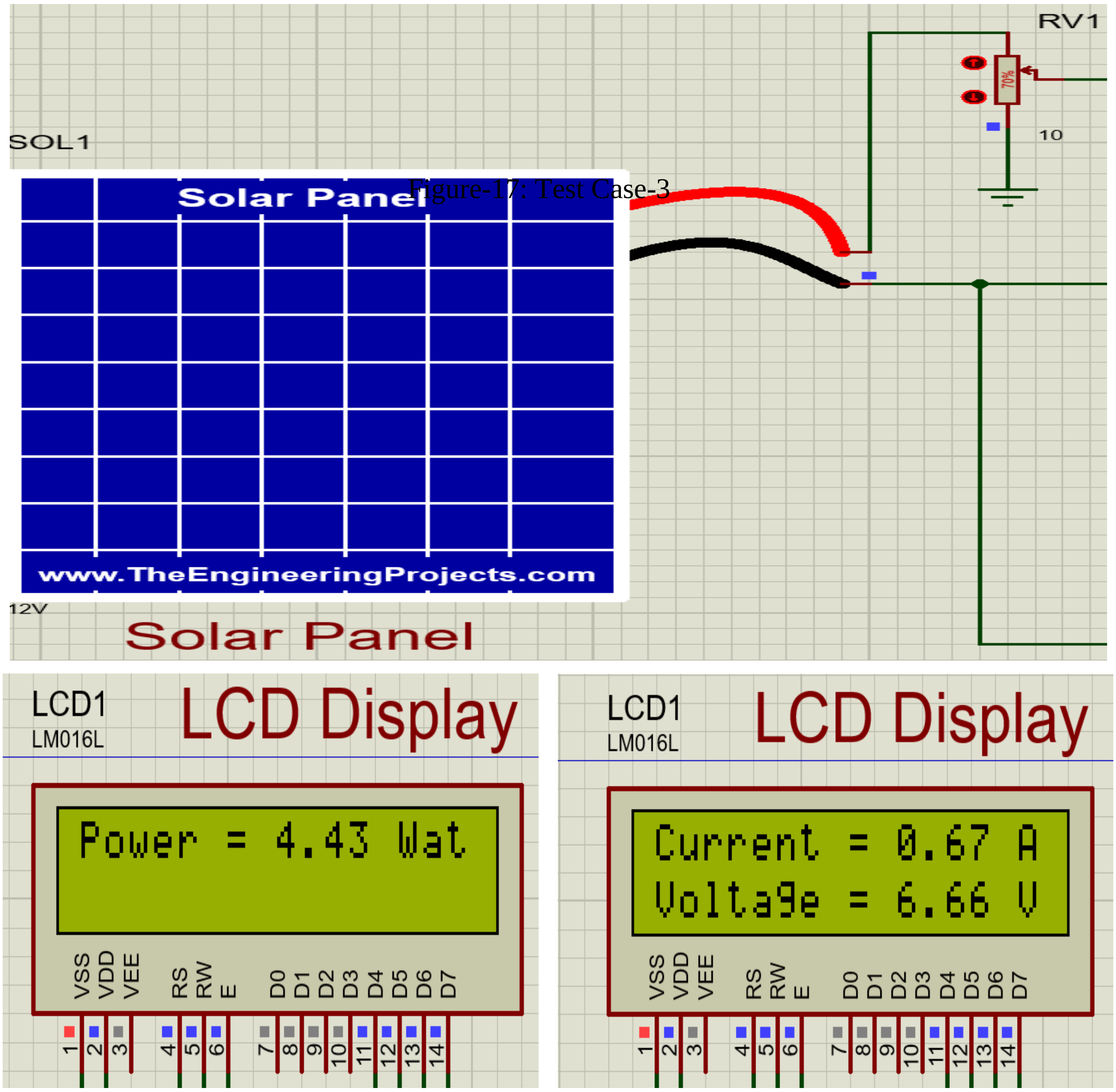

Figure-13: Test Case-3

Current = 0.67 A

Voltage = 6.66 V

Power = 4.43 watt

When the value of potentiometer is at Maximum Value (100%) (Condition of current, voltage & Power):

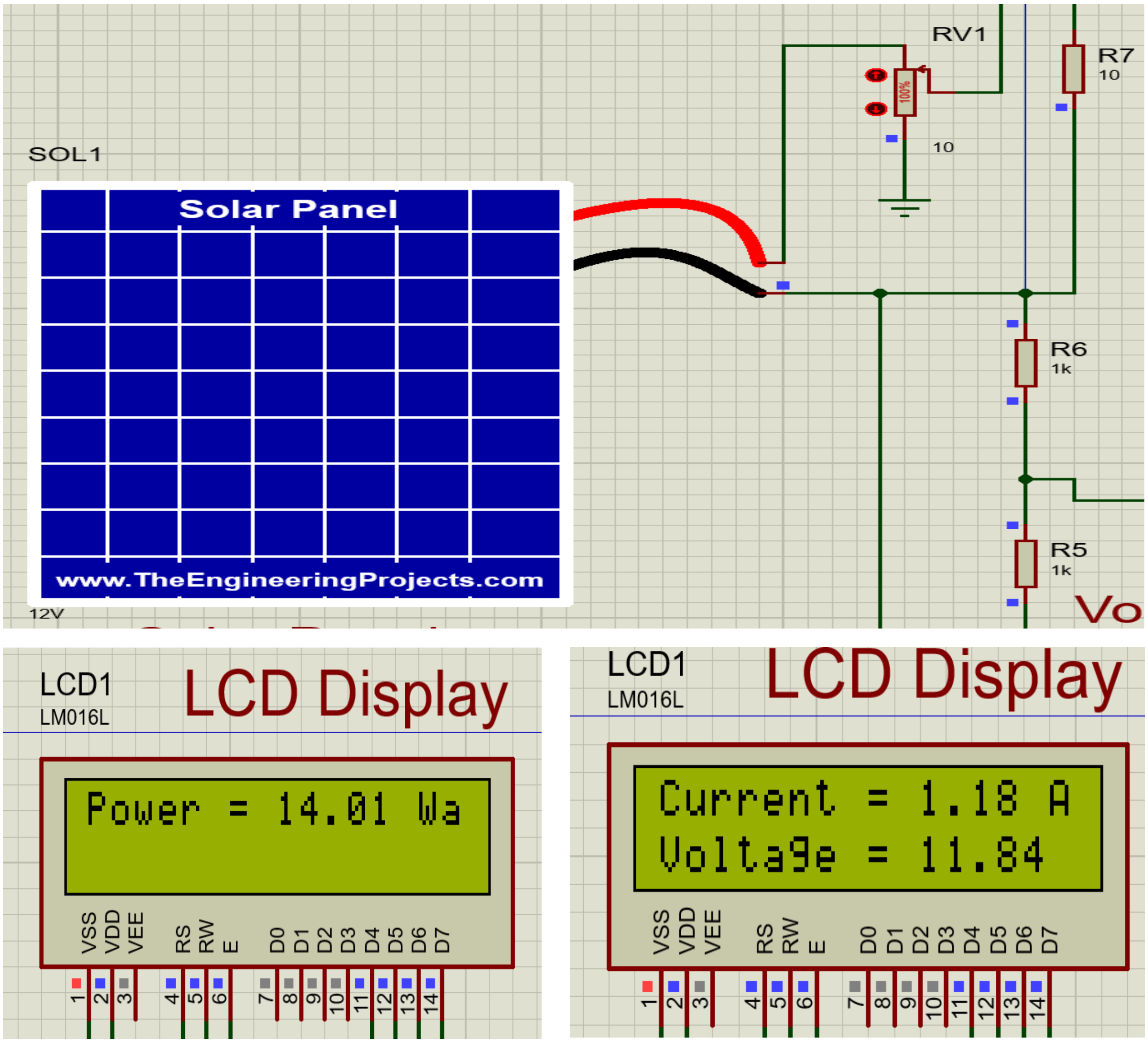

Figure-14: Test Case-4

Current = 1.18 A

Voltage = 11.84 V

Power = 14.01 watt

From the above observations, it can be concluded that current, voltage, and power values rise as the potentiometer value increases and it reaches the peak value at a particular time. After that the values of current, voltage & power start to fall.

Design-2:

For this design in figure-15, we have used Arduino Mega2560. We preferred mega due to more pins availability and a more user friendly interface.

In this design, LDRs are used as the main light sensors. Two stepper motors are fixed to the structure that holds the solar panel. The microcontroller has the Arduino program uploaded to it. The amount of light that strikes LDRs is detected. Top, bottom, left, and right make up the four LDRs. The top and bottom LDRs are responsible for vertical rotation of the servo motor and the left and right LDRs are responsible for the horizontal rotation of the servo motor. Two motor drivers (L293D) are used to control the speed and rotation of stepper motors.

As the built-in version of the proteus program lacked a solar panel component, a solar panel library was added to it for monitoring several parameters including current, voltage, and power. Additionally, the voltage divider circuit and current sensor are used to measure the voltage and current received from the solar panel. We may also acquire the power by customizing the programming in the Arduino IDE. On the LCD display, all of these values are shown, and we may use this information to get parameter data for comparison.

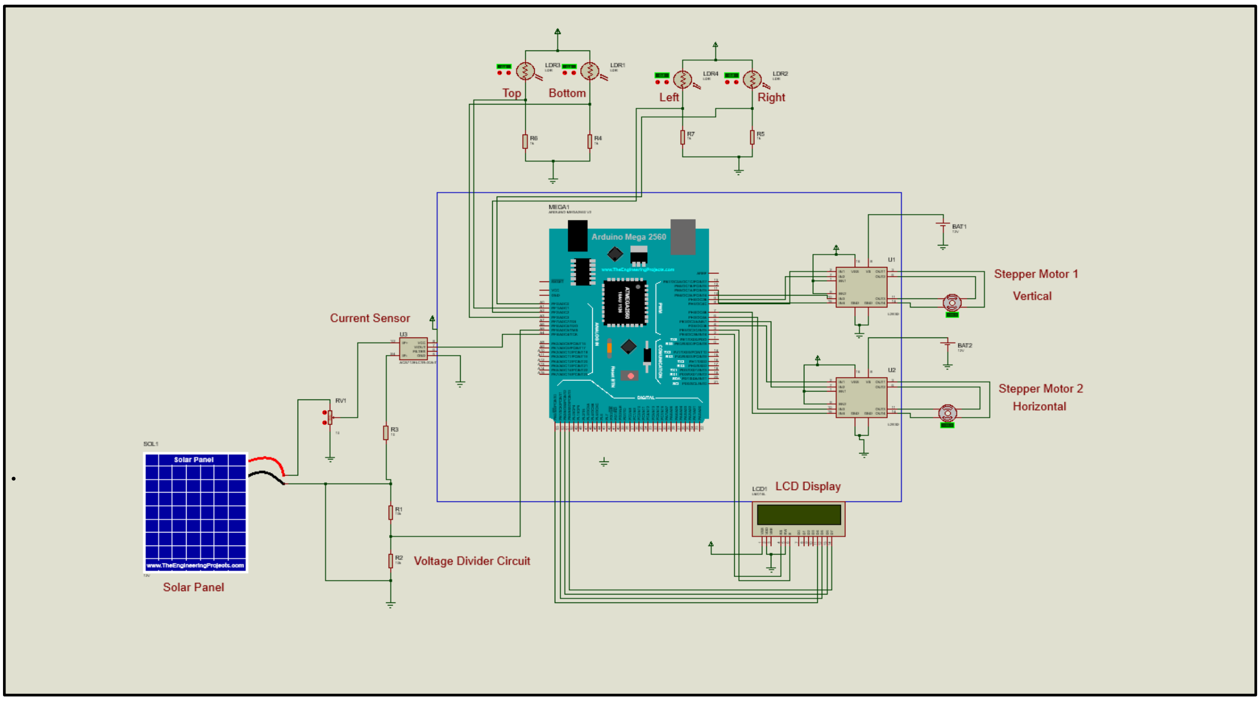

Figure-15: Simulation of Design-2

Rotation of Stepper Motor:

The LDR Sensors are responsible for the majority of the sun tracking system's work (Light Dependent Resistor). The difference in light intensity of the LDR sensors determines the logic signals given to the controller. If one of the LDRs in a pair receives higher light intensity than the other, a difference in node voltages sent to the relevant Arduino channel will occur, allowing the appropriate action to be taken. The solar panel will then be moved by the stepper motor to the position of the high intensity LDR that was programmed. Depending on the logic signal sequence, the stepper motors can move the solar panel clockwise or anticlockwise. Because of limitations in Proteus, half-stepping stepper motors are used in this design as proteus does not allow the usage of microstepping.

In Figure-16, When light intensity of Top LDR is greater than Bottom LDR: (Vertical Motor Clockwise Rotation)

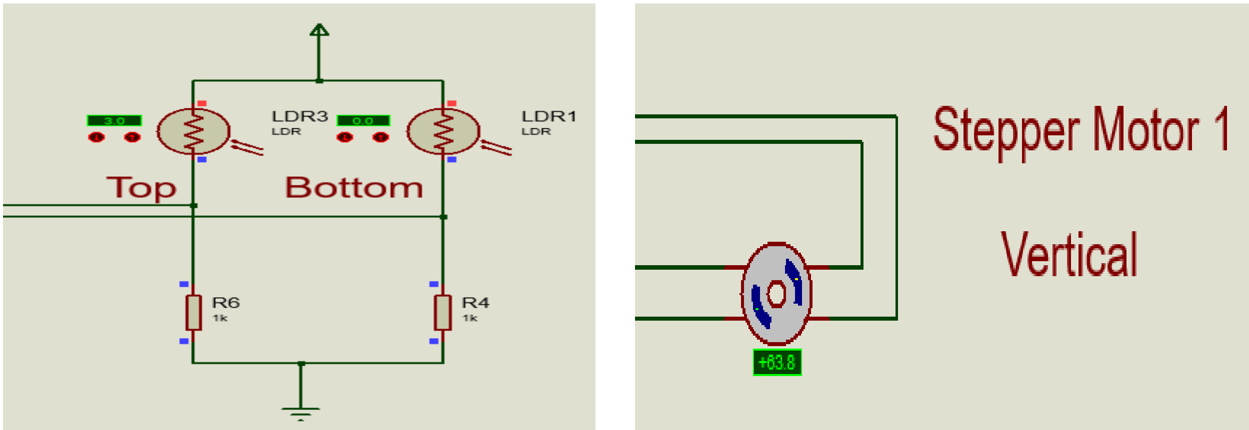

Figure-16: Comparison between Top & Bottom LDR Intensity

In Figure-17, When light intensity of Bottom LDR is greater than Top LDR: (Vertical Motor Anti-Clockwise Rotation)

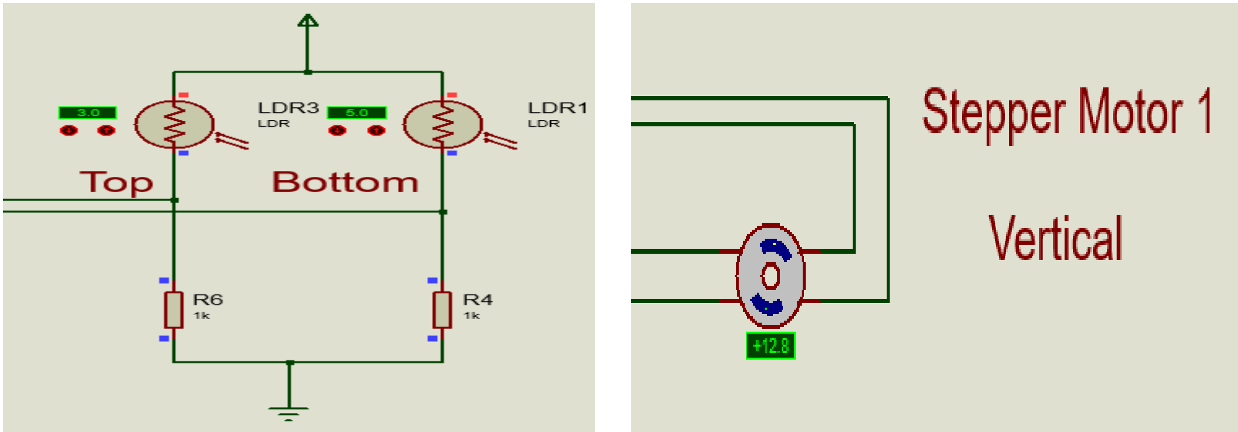

Figure-17: Comparison between Top & Bottom LDR Intensity

In Figure-18, When light intensity of Right LDR is greater than Left LDR: (Horizontal Motor Clockwise Rotation)

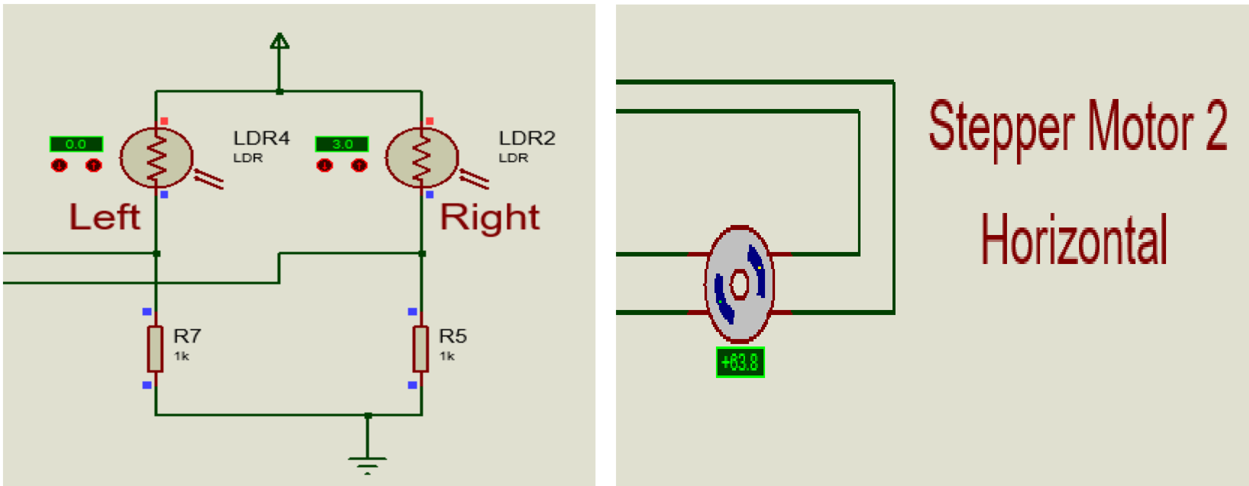

Figure-18: Comparison between Right & Left LDR Intensity

When both LDRs have same light intensity: (No movement of Motor)

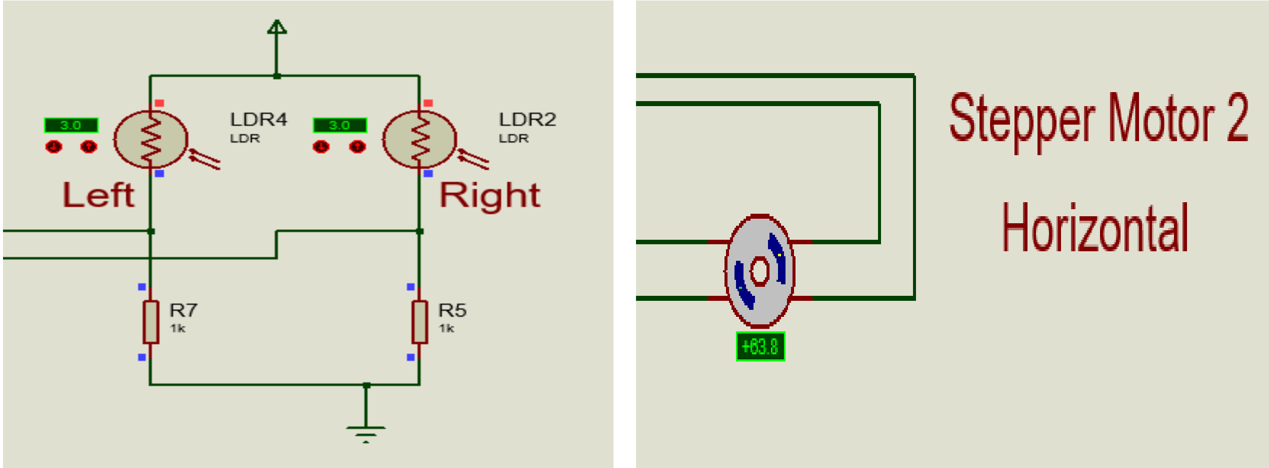

Figure-19: Two LDRs having save Light Intensity

When the light output of the right and left LDRs is equal, it is noted that the stepper motor ceases to move. Therefore, one LDR's light intensity must be greater than the others in order for the stepper motor to revolve in either a clockwise or counterclockwise direction.

In Figure-20, When light intensity of Left LDR is greater than Right LDR: (Horizontal Motor Anti-Clockwise Rotation)

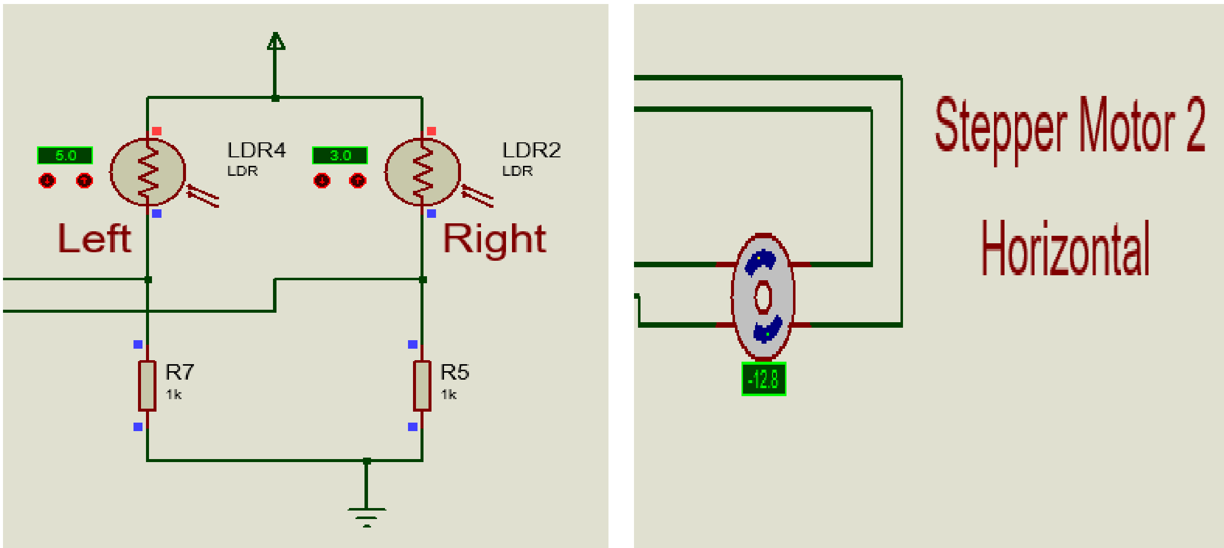

Figure-20: Comparison between Right & Left LDR Intensity

Monitoring System:

A current sensor and voltage divider circuit are directly connected to the PV cell, whose output is connected to the Arduino microcontroller, to monitor different solar panel parameters like voltage, current, and power. On an LCD panel, the outcomes of such parameters are displayed. We are unable to provide sunlight to the PV panel in our proteus simulation, hence we are unable to reliably obtain the values of current, voltage, and power. To measure current, voltage, and power on a regular basis, we connected a potentiometer to the PV cell, which is attached to the current sensor.

When the value of potentiometer is at 50% (Condition of current, voltage & Power):

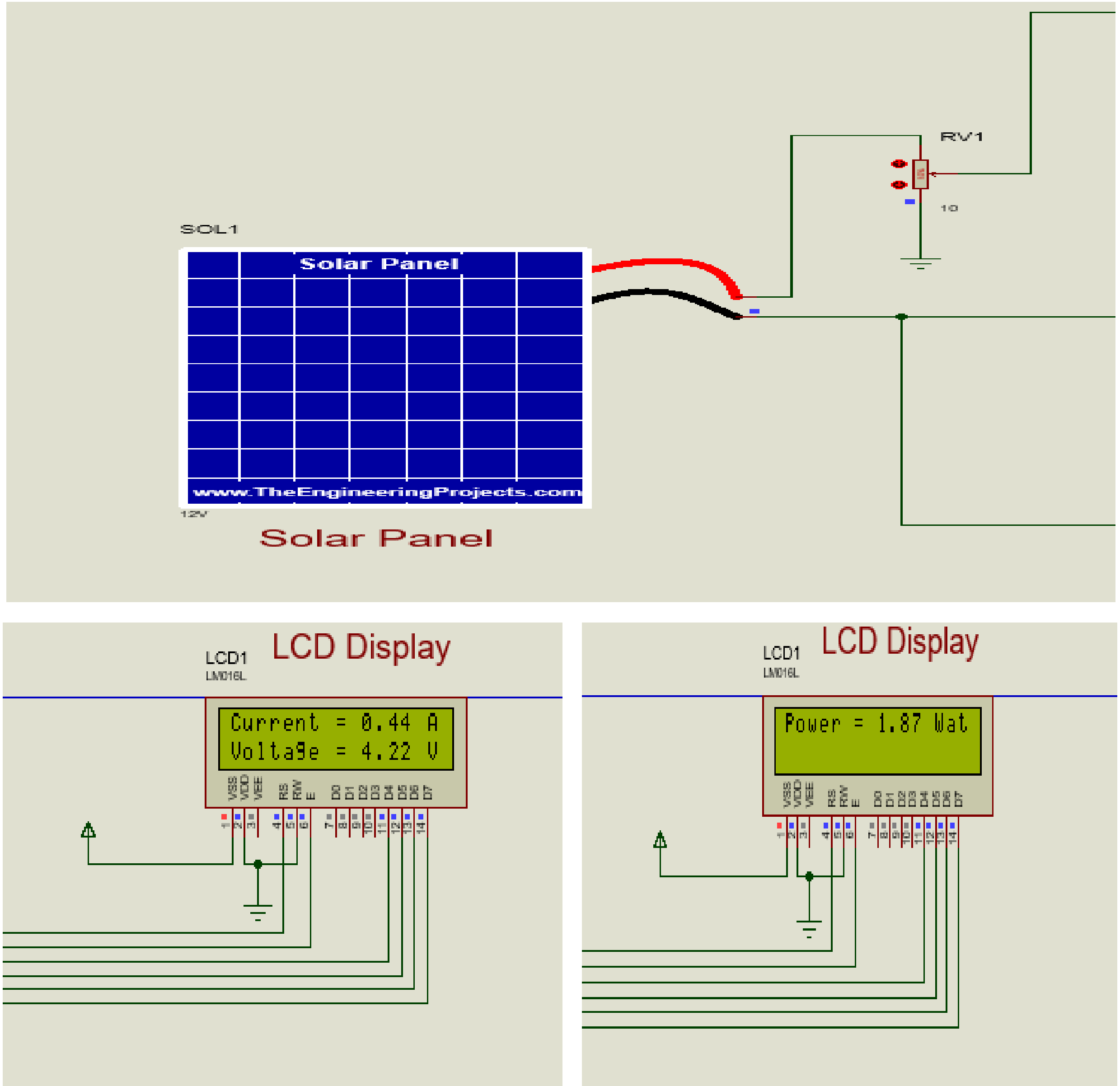

Figure-21: Test Case-1

Current = 0.44 A

Voltage = 4.22 V

Power = 1.87 watt

When the value of potentiometer is at 60% (Condition of current, voltage & Power):

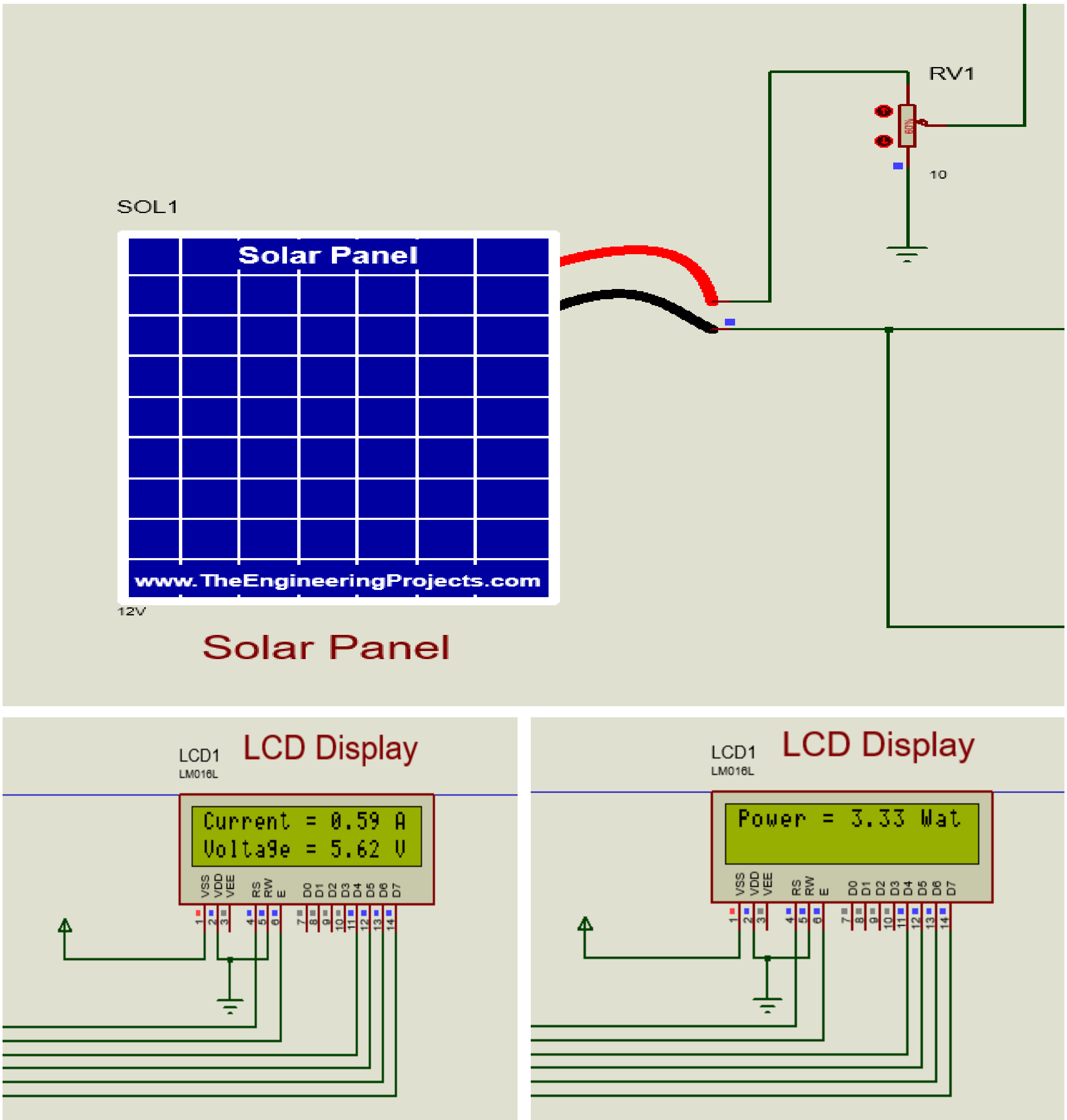

Figure-22: Test Case-2

Current = 0.59 A

Voltage = 5.62 V

Power = 3.33 watt

When the value of potentiometer is at 70% (Condition of current, voltage & Power):

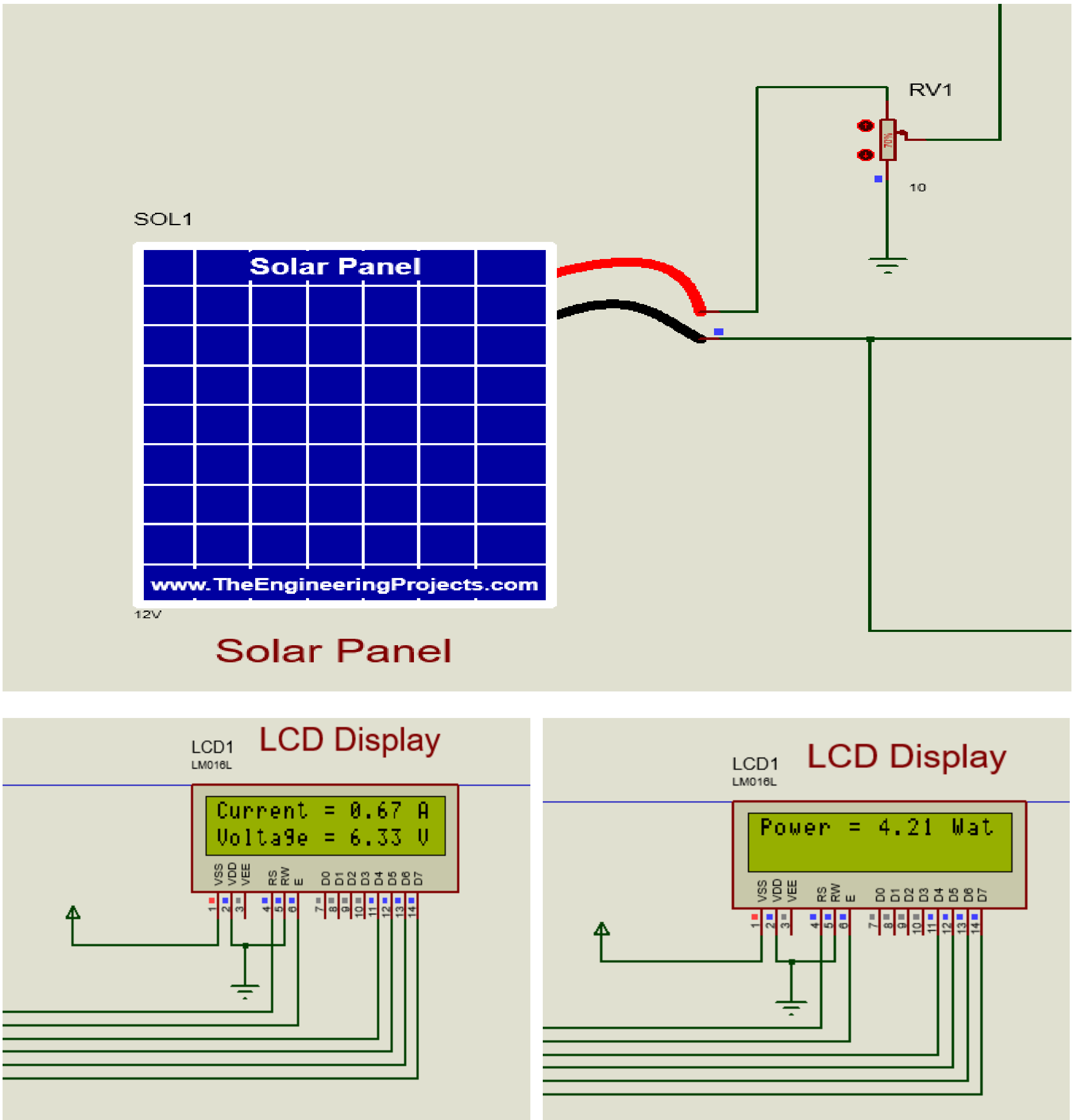

Figure-23: Test Case-3

Current = 0.67 A

Voltage = 6.33 V

Power = 4.21 watt

When the value of potentiometer is at Maximum value (100%) (Condition of current, voltage & Power):

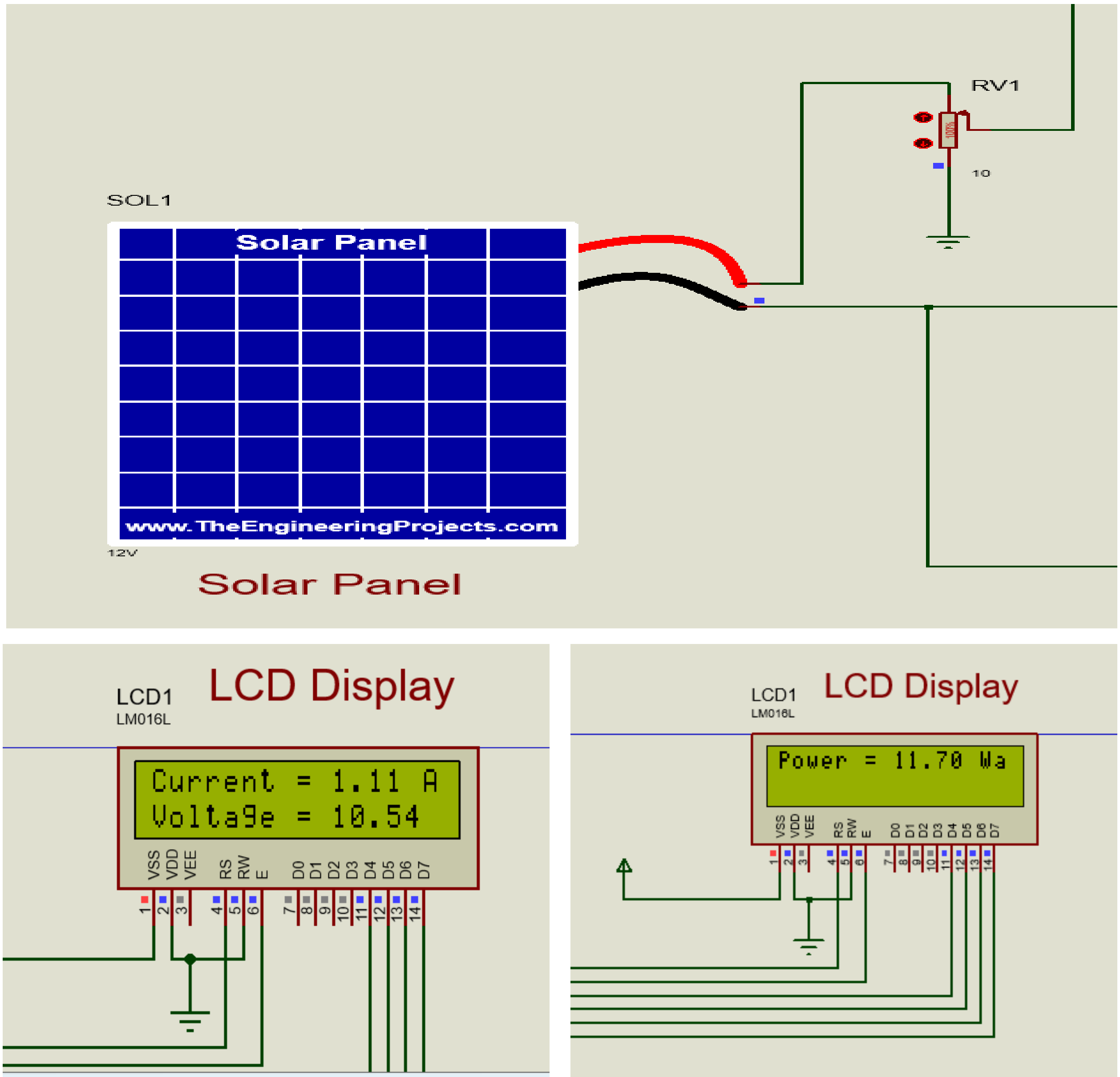

Figure-24: Test Case-4

Current = 1.11 A

Voltage = 10.54 V

Power = 11.70 watt

From the above observations, it can be concluded that current, voltage, and power values rise as the potentiometer value increases and it reaches the peak value at a particular time. After that the values of current, voltage & power start to fall

4.3 Identify optimal design approach

SWOT Table of Design 1:

Strength	Weakness
1. High efficiency and accuracy 2. Precise positioning 3. High output power relative to their size. 4. Encoder utilization provides higher accuracy 5. Well suited to varying load applications.	1. Mechanically complex. 2. Bearing Failure 3. Require tuning to stabilize feedback loop.
Opportunities	**Threats**
1. Expansion into Renewable Energy business. 2. Decreasing Gap between Electricity Supply & Demand.	1. Winding and Cable Failure

SWOT Table of Design-2:

Strength	Weakness
1. High reliability and longer lifespan 2. Repeatability of movement.	1. Low efficiency and accuracy 2. No feedback for specifying potential missed steps. 3. Extremely noisy. 4. Not suitable for high speed rotation. 5. High current consumption
Opportunities	**Threats**
1. Low maintenance cost	1. Driver failure 2. Short circuit

SWOT Analysis of Design -1

Strength:

1. High Efficiency and accuracy: For intricate systems that demand exact feedback, servo motors are preferable. A servo motor is the best option for some applications that demand high accuracy, such as CNC machinery. With efficiencies of between 80 and 90%, servo motors are more effective than stepper motors.

2. Precise positioning: Additionally, servo motors offer precise positioning. The number of pulses in a servo motor is used to control the rotation angle. A proportional number of pulses are sent out each time the servo motor rotates one angle, and they are compared with the pulse the servo motor received. The system can determine how many pulses are simultaneously given to the servo motor and withdrawn in this way. By doing so, it is possible to precisely control the motor's rotation and achieve placement that is more accurate than stepper motor.

3. High output power relative to their size: The servo motor produces tremendous power while being small and light. Power Rated: 200 W (1/4 HP) Size of Motor Frame: 60 mm (2.36 in.) In both the Continuous Duty Region and the Limited Duty Region, a servo motor controls the current based on the status of the load.

4. Encoder utilization provides higher accuracy: Servo motors provide position and speed feedback that uses encoders to sense positional error in a system and offer intended performance of the machine. Stepper motors occasionally have errors that might go undetected.

5. Well suited to varying load applications: Solar panels can have variable diameters thanks to load profile calculations, and servo motors are suited for varying loads due to their lower size and low energy consumption.

Weakness:

1. Mechanically complex: Servo motors have a resolver or an encoder as well as a gearbox. As a result, servo motors are mechanically more complex and expensive than stepper motors as a result of the entire configuration.

2. **Bearing Failure:** Servo motor bearing failure occurs frequently and can be caused by a variety of factors. Naturally, bearings deteriorate with time and frequent use. These bearings might also become out of alignment due to improper motor installation or reinstallation. Unusual noise, such as growling or screaming while the engine is running at high speeds, is a surefire symptom of bearing failure.

3. Require tuning to stabilize feedback loop: In order to reduce the servo system's response time, settling time, and overshoot, the motion controller's gains must be tuned. The objective of servo tuning is to reduce (but not always eliminate) the error between the commanded position (or speed) or torque (or other value) and the actual value attained.

Opportunities:

1. Expansion into Renewable Energy business: Due to the increased efficiency of servo motors, combining solar trackers with PV panels opens up a wide range of new business prospects. Products can be sold, distributorship is an option, solar projects can be developed and owned, or aftermarket products can be sold in a product-oriented solar company. The business opportunities for the service sector would also improve.

2. Decreasing Gap between Electricity Supply & Demand: Servo motors produce more energy with less energy input. Therefore, building a solar tracker with a servo motor can enhance the quantity of electricity generated.

Threats:

1. Winding and Cable Failure: Bad winding is the most common cause of servo motor failure. Due to water contamination or more gradually over time as a result of natural vibration while the motor operates, these copper coils inside the motor may get compromised. Similar to how the motor can fail or experience voltage spikes that shut it down, the system's power, control, or feedback wires can degrade with time.

SWOT Analysis Of Design -2

Strength:

1. **High reliability and longer lifespan:** Since a stepper motor is more simpler to control and doesn't require a complicated encoder, it is more dependable. The bearing life, which can last for tens of thousands of hours, determines the operational life of stepper motors. This equals around 4.8 years assuming the motor operates for one eight-hour shift every day. Depending on user application and how severely the motor is worked, motor lifetime may vary.

2. **Repeatability of movement:** One of the best aspects of the stepper motor is its repeatability. After making a full detour, the stepper motor has the capacity to revert to its starting point. This characteristic of these motors makes them more precise and the best choice for applications where exact speed is essential. To provide extremely

precise positioning and speed control, the motor works by precisely synchronizing with the pulse signal produced by the controller to the driver.

Weakness:

1. **Low efficiency and accuracy:** Poor positional accuracy might come from stepper motors oscillating around their target or having a different angular position increase after each microstep when using standard stepper drivers. Stepper motors must always have a sufficient current buffer to maintain stable operation and prevent stalling. To ensure dependable performance at peak torque, the current margin has been modified. Pulses cause stepper motors to rotate in unison. Stalls are brought on by sudden overloads or abrupt changes in speed that induce a breakdown of synchronization, causing the motor to stop while still drawing its maximum current. Significant power is lost when current is adjusted to a constant value.

2. **No feedback for specifying potential missed steps:** The motor will function flawlessly if it has the ideal weight on its shaft. However, if the load is heavy, the motor will try to move quickly, which could result in the motor skipping the step. Because the system lacks a feedback pathway to monitor this change, the motor will initially run a little bit outside of the adjustment it had in its original state. Additionally, if this modification is not noticed, the program will start to fail. Because of this, a motor's precision may suffer from a lack of feedback, however this issue can be solved by using an external encoder.

3. **Extremely noisy:** When a motor is operating with variable torque, torque ripple can cause the machine to vibrate a lot and make noise. The main source of noise and

vibration from a stepper motor is torque ripple if the motor is not running at resonance.

4. **Not suitable for high speed rotation:** Stepper motors have more internal magnetic poles than servo motors because they rotate the motor in small increments by adjusting the current, as opposed to servo motors. Due to their increased susceptibility to counter-electromotive force, ordinary stepper motors are less suitable for high-speed operation.

5. **High current consumption:** Stepper motors reduce energy efficiency and increase heat losses by using current at maximum load anytime the stator poles are energized. Therefore, if efficiency is important, stepper motors are not the optimal motors.

Opportunities:

1. **Low maintenance cost:** The stepper motor is a brushless type of motor. This type of motor requires less maintenance than other motors since the brush doesn't need to be changed frequently.

Threats:

1. **Driver failure:** A stepper motor's common issue is driver failure. The stepper motor driver will malfunction if the power supply does not regulate the peak voltage. The appropriate clamp diodes must be chosen for the task. The chosen diode must be compatible with the stepper motor's speed switch. The element regulates the peak voltage the power source sends to the motor. The switching characteristics of the clamp diode of a stepper motor must match those of the output transistors' switching time.

2. **Short circuit:** Complete motor failure is one of the main issues with a stepper motor. The power supply is sending too much current to the gadget, which is the root of this issue. This stepper motor issue is brought on by a short circuit in the wiring from the power source to the motor. This short circuit will occur in some applications.

Comparison between Design-1 and Design-2:

	Design-1	**Design-2**
Precise Positioning	The servo motor regulates the number of pulses to control the rotation angle. A comparable number of pulses are sent out each time the servo motor rotates one angle; these pulses are then compared with the pulse the servo motor received. The system will then be aware of how many pulses are simultaneously sent to the servo motor and withdrawn from it. By doing so, it is possible to precisely control the motor's rotation and achieve precise positioning.	By adjusting the pulse count, the stepper motor may also adjust the rotation angle. Step angle is equal to one pulse. The system will not be able to determine how many pulses are simultaneously given to the stepper motor and withdrawn because there is no feedback signal. The motor cannot determine its location as a result, and the position accuracy is insufficient.
Incremental angle	Lower incremental angle (11.37 degree) resulting in higher accuracy.	Higher incremental angle resulting (25.5 degree) in lower accuracy.
Time Delay	Servos outperform stepper motors in terms of acceleration and deceleration by a few milliseconds. Servo motors can handle more than 1000 RPM speed, that's why in simulation delay between two consecutive pulses is 4.3 sec.	In the Stepper motor delay between two consecutive pulses is 4.6 sec. And stepper motors operate at less than 1000 RPM. However, once the RMPs cross over this 1000 RPM limit, the torque performance of the stepper motor decreases drastically.
Energy Consumption	Servo motors draw only the required current for the motion profile and the load. Since the current is proportional to temperature, this results in increased service life and lower power consumption for the servo motor.	Since current is proportionally related to temperature, stepper motors can only run at maximum current, which reduces their lifespan and increases their power consumption.
Control Mechanism	Operate in closed loop hence have an internal feedback.	Operate in open loop hence no feedback and thus are more error prone.

Encoder	Given that servo motors have built-in encoders that meet the standards for high efficiency, dependability, a broad range of resolution, and high temperature resistance.	An optical encoder needs to be adjusted for greater efficiency, precision, and dependability because servo motors lack built-in encoders. As optical encoders are costly, their use will raise the cost of the entire design.
Motor Driver	No motor driver required in proteus simulation as servo motors consume less current.	Require motor driver in proteus simulation as stepper motor consumes more current.
Cost	BDT: 7,900	BDT: 11,064

Table No-4: Result Comparison

Numerous uses are possible for servo motors. In addition to the data given above, servo motors are being utilized increasingly often in industrial settings to replace traditional AC motors, stepper motors, as well as hydraulic and pneumatic systems. Particularly where performance and efficiency are required, as in applications involving renewable energy. As a result, design 1 with a servo motor is best for this project.

4.4 Performance evaluation of developed solution

Data Collection from Simulation-1:

Here in table 5, with the help of different sensors corresponding data of current, voltage and power has been measured. Potentiometer, in this design has been used as the solar irradiance amount. As we know there is a proportional relationship of current with solar irradiance and the provided table also shows the same result.

Potentiometer	Current (A)	Voltage (V)	Power (watt)
50%	0.44	4.44	1.97
60%	0.59	5.92	3.50
70%	0.67	6.66	4.43
80%	0.81	8.12	6.63
85%	0.89	8.88	7.88
90%	0.96	9.62	9.25
100%	1.18	11.84	14.01
		Total	47.67

Table No-5: Different Parameter Values for Design 1

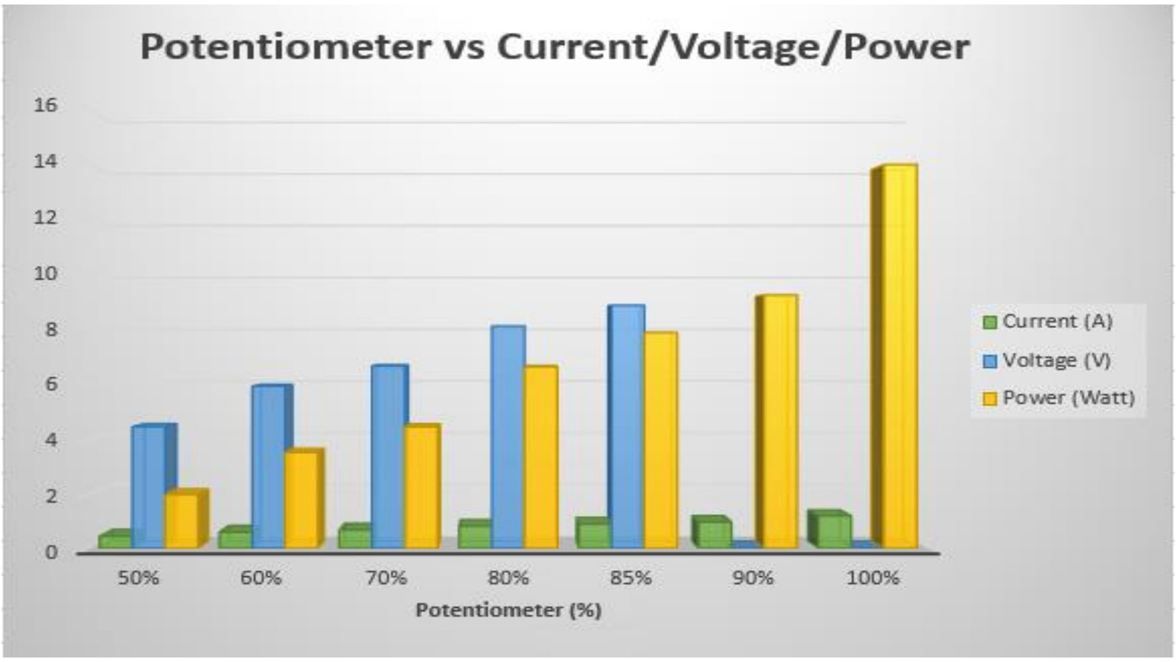

Figure-25 : Graphical Representation of different parameters for design-1

In table 6, the variation of angular rotation of both the vertical and horizontal servo motor with respect to light intensity are shown. It is evident that when the top LDR value is raised, the vertical motor's angular values continue to rise in a clockwise direction. Now, it is noted that there is no change in the angular rotation of the vertical motor as the values of the bottom LDR are increased to the same value as the top LDR. However, the angular values of the vertical motor continue to change in an anticlockwise direction as soon as the values of the bottom LDR cross the values of the top LDR. Similarly, It is evident that when the right LDR value is raised, the horizontal motor's angular values continue to rise in a clockwise direction. Now, it is noted that there is no change in the angular rotation of the horizontal motor as the values of the left LDR are increased to the same value as the top LDR. However, the angular values of the horizontal motor continue to change in an anticlockwise direction as soon as the values of the left LDR cross the values of the right LDR.

Top LDR (Lux)	**Bottom LDR (Lux)**	**Right LDR (Lux)**	**Left LDR (Lux)**	**Vertical Motor**		**Horizontal Motor**	
				Clockwise Rotation (Degrees)	**Anti clockwise Rotation (Degress)**	**Clockwise Rotation (Degrees)**	**Anti clockwise Rotation (Degress)**
1	0	1	0	11.37	-	11.37	-
2	0	2	0	22.37	-	22.37	-
3	0	3	0	33.37	-	33.37	-
3	1	3	1	33.37	-	33.37	-
3	2	3	2	33.37	-	33.37	-
3	3	3	3	33.37	-	33.37	-
3	4	3	4	-	22.37	-	22.37
3	5	3	5	-	11.37	-	11.37
3	6	3	6	-	0.37	-	0.37

Table No-6: Motor Rotation With Respect to Irradiance

Data Collection from Simulation-2:

Here in table 7, with the help of different sensors corresponding data of current, voltage and power has been measured. Potentiometer, in this design has been used as the solar irradiance amount. As we know there is a proportional relationship of current with solar irradiance and the provided table also shows the same result.

Potentiometer	Current (A)	Voltage (V)	Power (watt)
50%	0.44	4.22	1.87
60%	0.59	5.62	3.33
70%	0.67	6.33	4.21
80%	0.81	7.73	6.29
85%	0.89	8.43	7.49
90%	0.96	9.14	8.79
100%	1.11	10.54	11.70
		Total	43.68

Table No-7: Different Parameter Values for Design 2

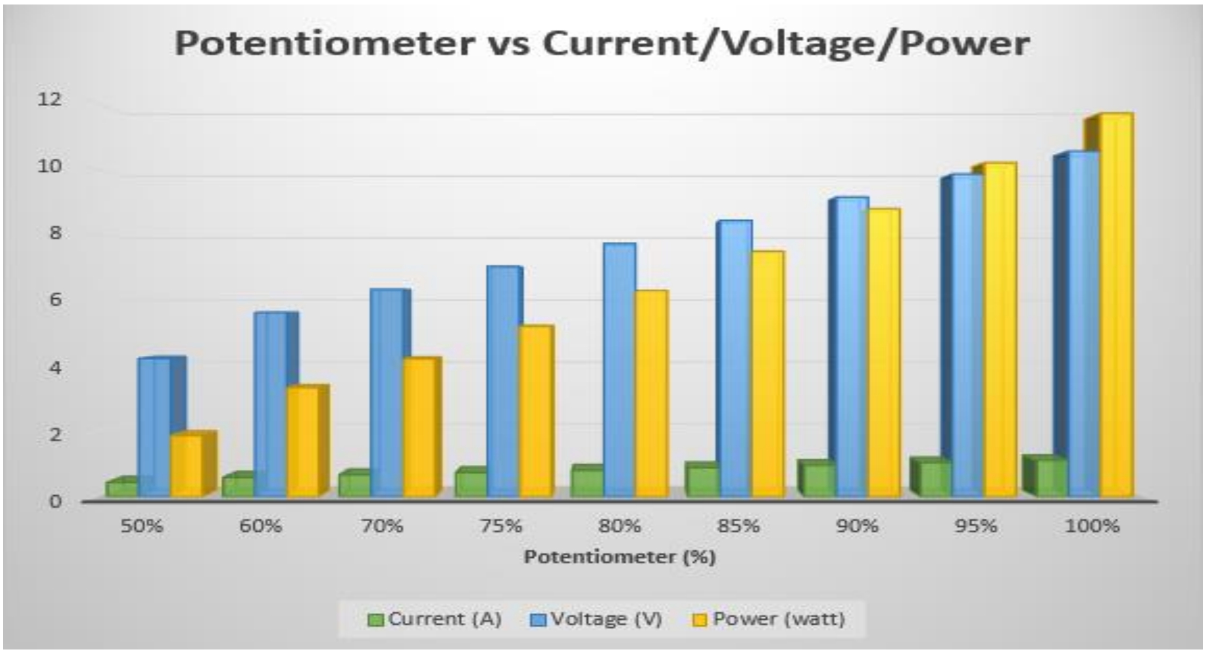

Figure-26: Graphical Representation of different parameters for design-2

In table 8, the variation of angular rotation of both the vertical and horizontal stepper motor with respect to light intensity are shown. It is evident that when the top LDR value is raised, the vertical motor's angular values continue to rise in a clockwise direction. Now, it is noted that there is no change in the angular rotation of the vertical motor as the values of the bottom LDR are increased to the same value as the top LDR. However, the angular values of the vertical motor continue to change in an anticlockwise direction as soon as the values of the bottom LDR cross the values of the top LDR. Similarly, It is evident that when the right LDR value is raised, the horizontal motor's angular values continue to rise in a clockwise direction. Now, it is noted that there is no change in the angular rotation of the horizontal motor as the values of the left LDR are increased to the same value as the top LDR. However, the angular values of the nile horizontal motor continue to change in an anticlockwise direction as soon as the values of the left LDR cross the values of the right LDR.

Top LDR (Lux)	**Bottom LDR (Lux)**	**Right LDR (Lux)**	**Left LDR (Lux)**	**Vertical Motor**		**Horizontal Motor**	
				Clockwise Rotation (Degrees)	**Anti clockwise Rotation (Degress)**	**Clockwise Rotation (Degrees)**	**Anti clockwise Rotation (Degress)**
1	0	1	0	12.8	-	12.8	-
2	0	2	0	38.3	-	38.3	-
3	0	3	0	63.8	-	63.8	-
3	1	3	1	63.8	-	63.8	-
3	2	3	2	63.8	-	63.8	-
3	3	3	3	63.8	-	63.8	-
3	4	3	4	-	38.3	-	38.3
3	5	3	5	-	12.8	-	12.8
3	6	3	6	-	-12.3	-	-12.3

Table No-8: Motor Rotation With Respect to Irradiance

4.5 Conclusion

The tables above compare the rotation angles and output parameters of servo motors with stepper motors. The best design is chosen by comparing the values from the data that was collected through simulation. The total generated power for design 1 is 47.67 watt, as shown in Table 5. On the other hand, Design 2's output power value, which is 43.68 watt, is shown in Table 7. When comparing the two numbers, it is clear that design 1, a solar tracker with a servo motor, produced 9% greater output power than a solar tracker with a stepper motor.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction

The proposed design's implementation was demonstrated in the previous chapter, and an ideal solution was identified using some software simulation. Here, a prototype for the implementation of the optimal design is presented. In addition, various difficulties had to be overcome in the past in order to produce the necessary prototype. This chapter presents a thorough review of the final design prototype.

5.2 Completion of final design

The prototype's simulation design is shown in the figure-27. Due to a software restriction, it was not possible to provide the solar panel with actual sunshine. As a result, a potentiometer was employed, and by altering its value, the values of the required parameters were obtained. Arduino Uno was used in proteus software as well. However, in real life more pins are needed for the implementation of the hardware system for which Arduino Mega is used.

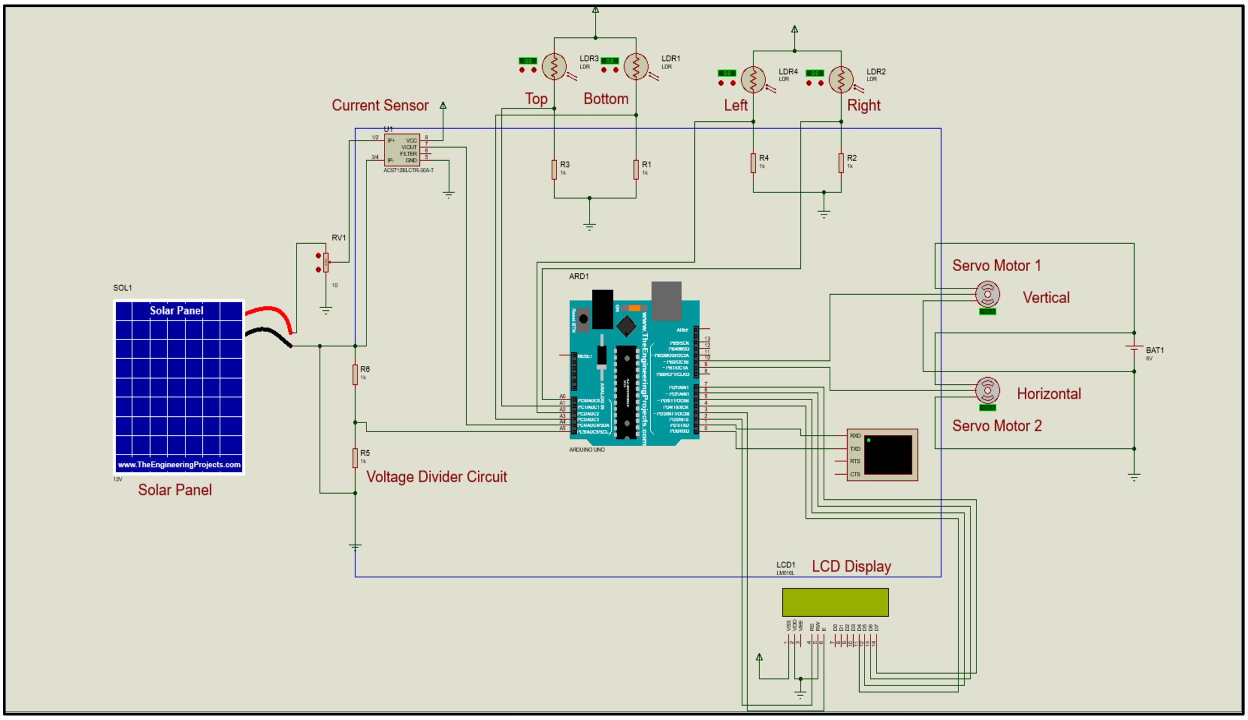

Figure-27: Proteus Simulation of the project prototype

Actuator Subsystem:

The circuit connection of one actuator is shown in figure 28. Two LDRs' light output will be compared by one servo motor rotating. Here, two 10 ohm resistors are utilized for each of the two LDRs that are placed on the breadboard. The Arduino's analog signal pin, 5V pin, and ground pin are linked to the LDRs through the breadboard. On the breadboard, the grounds of servo motors and LDRs are shorted together. Additionally, the power required by the servo motor and LDRs is shorted together in the breadboard. Pin 9 of the PWM pins sends a signal to the servo motor. Here, a laptop is used as a power source to power the Arduino. The servo motor will rotate to clockwise direction if the light falls on the left LDR and the motor will move anti-clockwise direction when light falls on the right LDR.

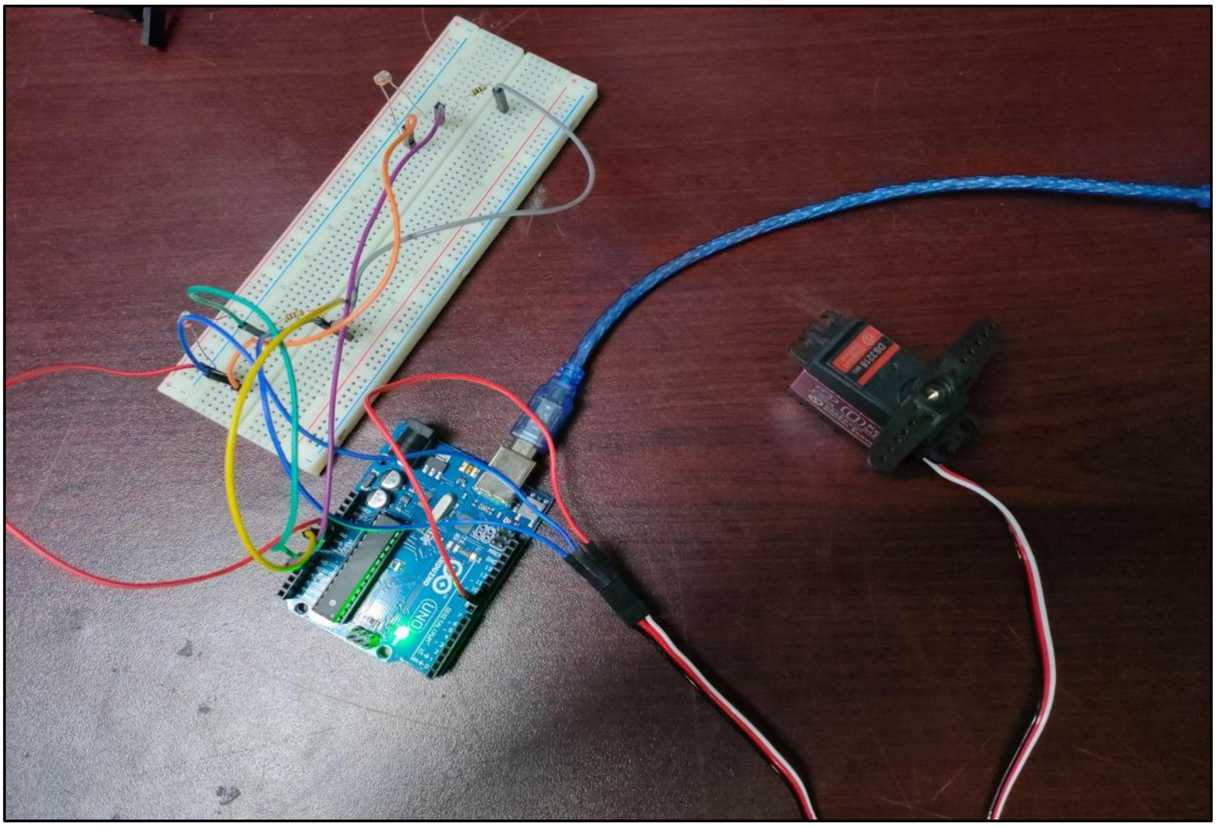

Figure-28: Breadboard model of Actuator Rotation using LDR

Since breadboards take up a lot of space, they are replaced for the project's convenience in the actual prototype design by a small bus bar.

Tracking Subsystem:

The movement that will assist the solar panel in moving in the direction of the sun's path is shown in figures 29 and 30. In Figure 28, the panel is seen rotating horizontally, for the prototype it rotates 90 degrees in both the clockwise and counterclockwise directions. Figure 29, on the other hand, shows the model responsible for the panel's vertical movement. To precisely receive the sunlight, the solar panel in the prototype structure is originally tilted at a 45 degree inclination. The solar panel moves vertically 90 degrees when sunlight strikes as it begins to move at 45 degrees and stops at 135 degrees. After receiving sunlight, the angle increases by 2 degrees each time in both the vertical and horizontal directions.

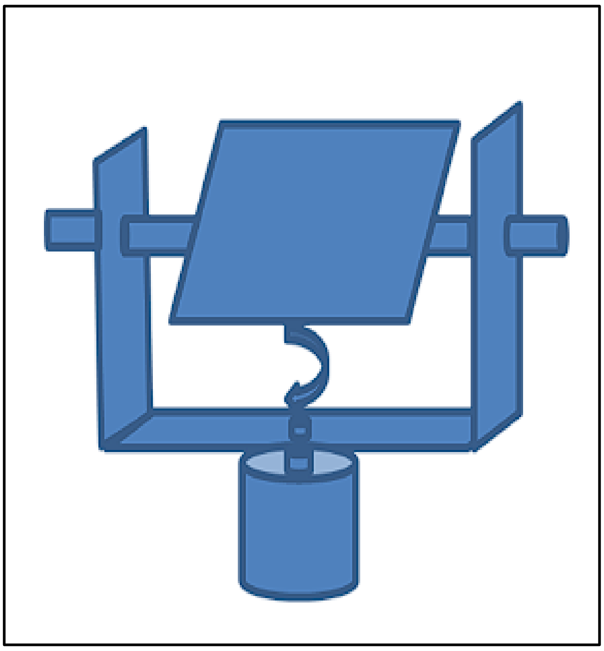

Figure-29: Horizontal Rotation

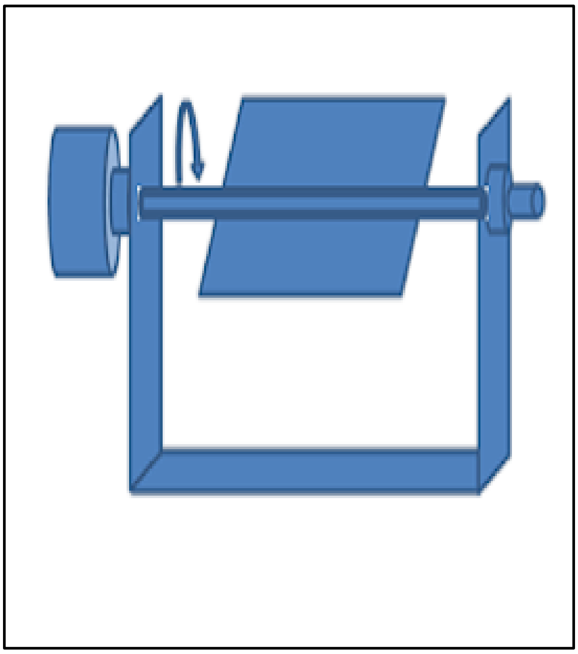

Figure-30: Vertical Rotation

Overview of the Solar panel with the mounting Stand:

The hardware layout of the solar panel in the mounting stand is shown in Figure 31. The stainless steel mounting stand on which the solar panel is attached is easily noticeable. The bearing that supports the structure's overall weight is rotated by the servo motor at the bottom. The bearing aids in rotating the solar panel to the required angle horizontally in accordance with the instructions provided in the Arduino, whereas the left servo motor visible in this image turns the motor vertically. Additionally, four LDR sensors are positioned on a plate that receives sunlight for the system at the top of the solar panel. The solar panel moves in the direction of greater light intensity based on the solar irradiance that the LDR sensors detect.

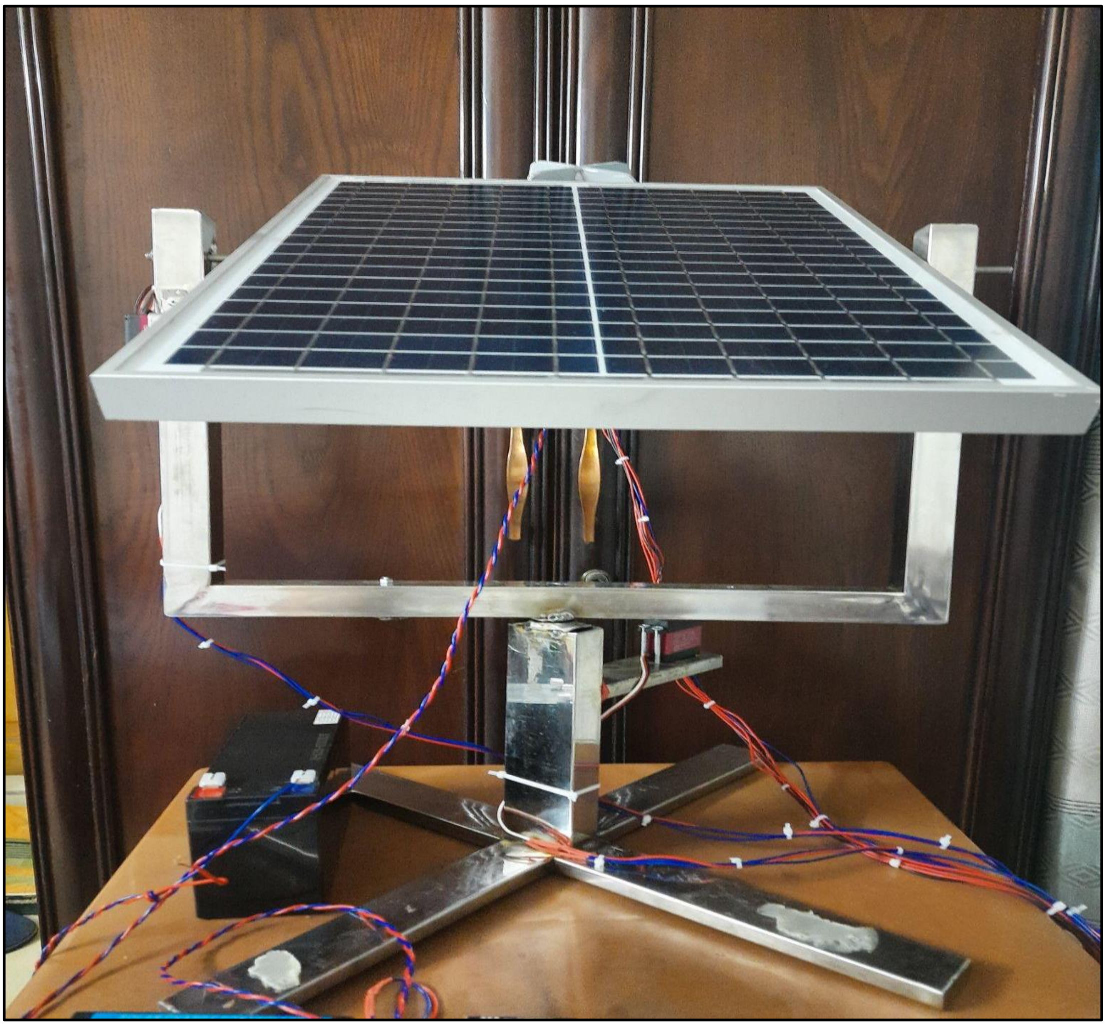

Figure-31 : Overview of Solar Panel with mounting stand

MPPT Charge Controller:

Figure-32 shows an MPPT (Maximum Power Point Tracking) charge controller. A MPPT solar charge controller is a charge controller that incorporates the MPPT algorithm to maximize the current flowing from the PV module into the battery. To precisely match the PV module to the battery, the MPPT is a DC to DC converter that works by receiving the DC input from the PV module, turning it to AC, and then converting it back to a different DC voltage and current. In this project it is used to recharge the rechargeable battery, which will then supply current and voltage to the entire system. The extra voltage that the solar panel achieves is utilized by the MPPT charge controller to provide more current to charge the rechargeable battery because a 12V solar panel can operate at voltages of up to 18.2V.

Figure-32: MPPT Solar Charge Controller

Buck Converter:

Buck converter that steps down the dc to dc voltage is depicted in figure 33 and 34. In this project, the entire monitoring and controlling subsystem is powered by a single 12 V battery. Two buck converters have been employed in order to prevent power sag or surge problems. The servo motors are powered by buck converter 1. The DS3218 servo that was used in this project requires 4.8 to 6.8 volts to function. In the buck converter-1, after entering 12.6V as the input, it is stepped down to 5 volts. The motors are then coupled together parallelly in order to operate the axis rotations with both motors receiving the same 5V. Similarly, buck converter-2, which likewise accepts 12 v as input and outputs 5 v, has been used to power the sensors and the Arduino board.

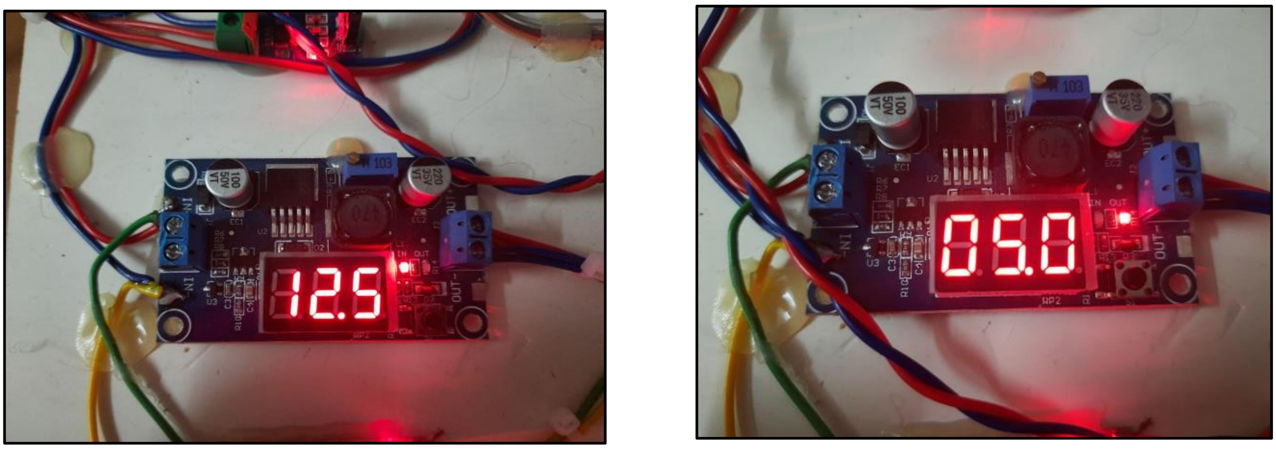

Figure-33: Buck Converter 1

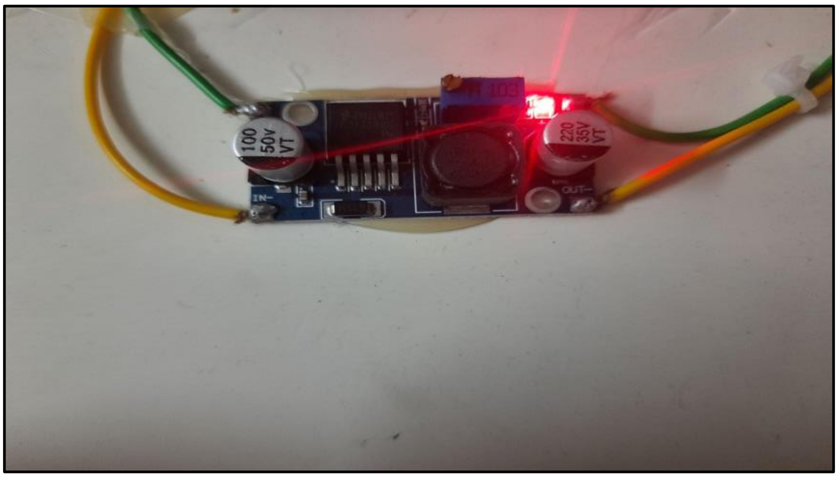

Figure-34: Buck Converter 2

Monitoring Subsystem:

Current Sensor:

The Allegro ACS712ELCTR-30A bi-directional hall-effect current sensor chip, which is the foundation of this current sensor board, detects positive and negative flowing currents in the range of minus 30 Amps to positive 30 Amps. In our situation, the solar panel's rated current is 1.18 Amps. The maximum current the current sensor can detect is 1.18 Amps.

Voltage Sensor:

The supply voltage range for the voltage sensor is 0.0245V to 25V. The resistor divider theory is the basis for this module. The input voltage can be reduced by five times with this module. The input voltage of this module cannot be greater than 5Vx5, or 25V, as the maximum analog input voltage for an Arduino or microcontroller is typically 5V.

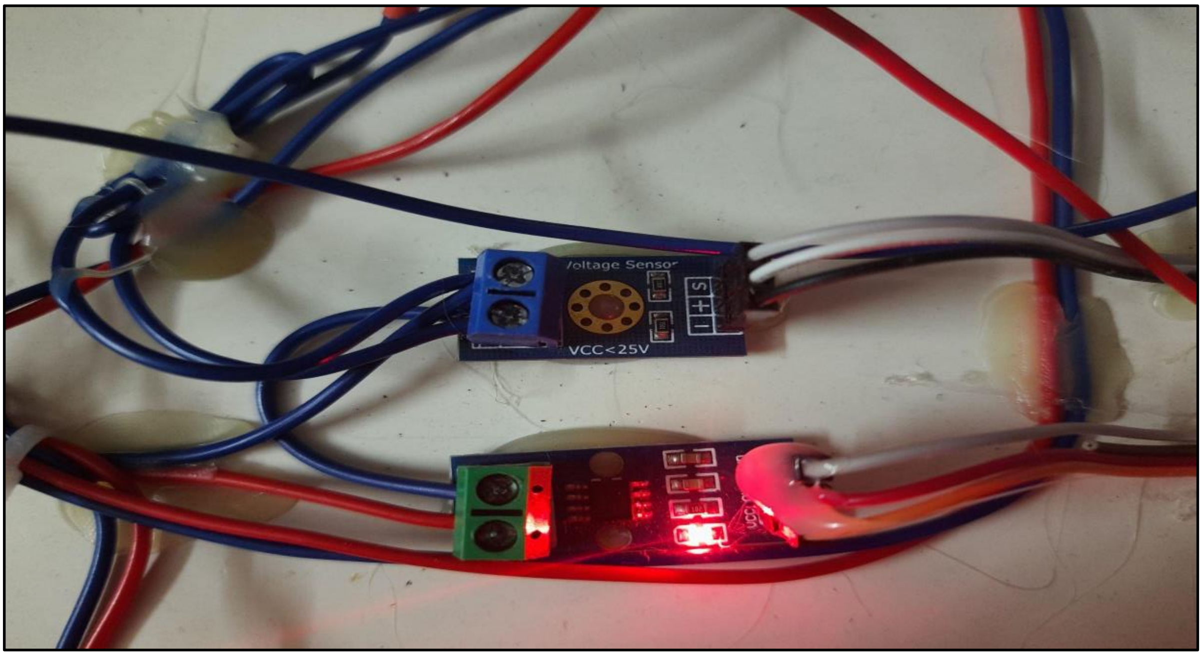

Figure-35 : Current and Voltage Sensor

Overall Controlling and Monitoring System:

The project's overall controlling and monitoring system is illustrated in Figure 36. In this case, the current sensor, voltage sensor, and LCD display serve as the monitoring components and arduino mega serves as the controlling unit. Two buck converters were used to step down the voltage from the battery, one of which supplies power to the servo motors and the other supplies power to the arduino, sensors, and LCD display to run the entire system. An MPPT charge controller was also used to maximize the voltage obtained from the solar panel. The servo motors are designed to move the panel when LDR sensors detect light, thus the relevant codes are programmed into the Arduino Mega, which also gets the data from the LDR sensors through an analog pin. The system as a whole runs on a 12V battery, but the servo motors can only run at 4.6V. Buck converters, which step down the 12V voltage to rotate the motor, were utilized to supply the servo motors with the necessary voltage. These two buck converters get their power from the MPPT charge controller's DC supply port rather than the battery itself. The MPPT charge controller, which receives the DC input from the PV module, converts it to AC, and then converts it back to a different DC voltage and current, is linked to the solar panel. The battery is charged using the additional voltage and current that the MPPT receives above the nominal rate.

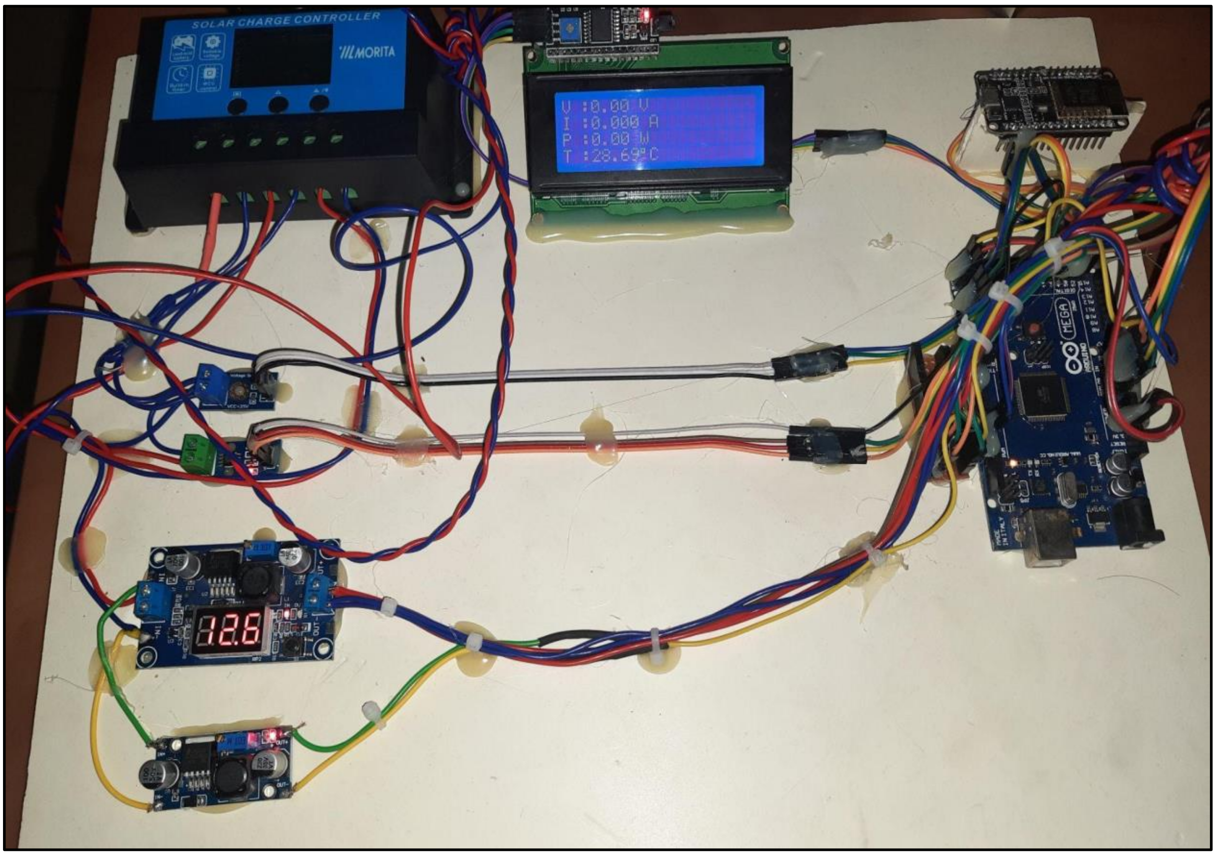

Figure 36 : Controlling and Monitoring System

Main Prototype Design:

Figure 37 illustrates the project's main prototype design, which combines all of the subsystems. Sunlight detection is carried out by the solar panel, which also includes an LDR and a mounting stand. According to the amount of sunlight the LDRs get, one of the two servo motors at the bottom turns the panel in a horizontal direction, while the other servo motor rotates the panel in a vertical direction. The parts placed into the cardboard are in charge of regulating the panel's movement and keeping an eye on variables like current, voltage, and power.

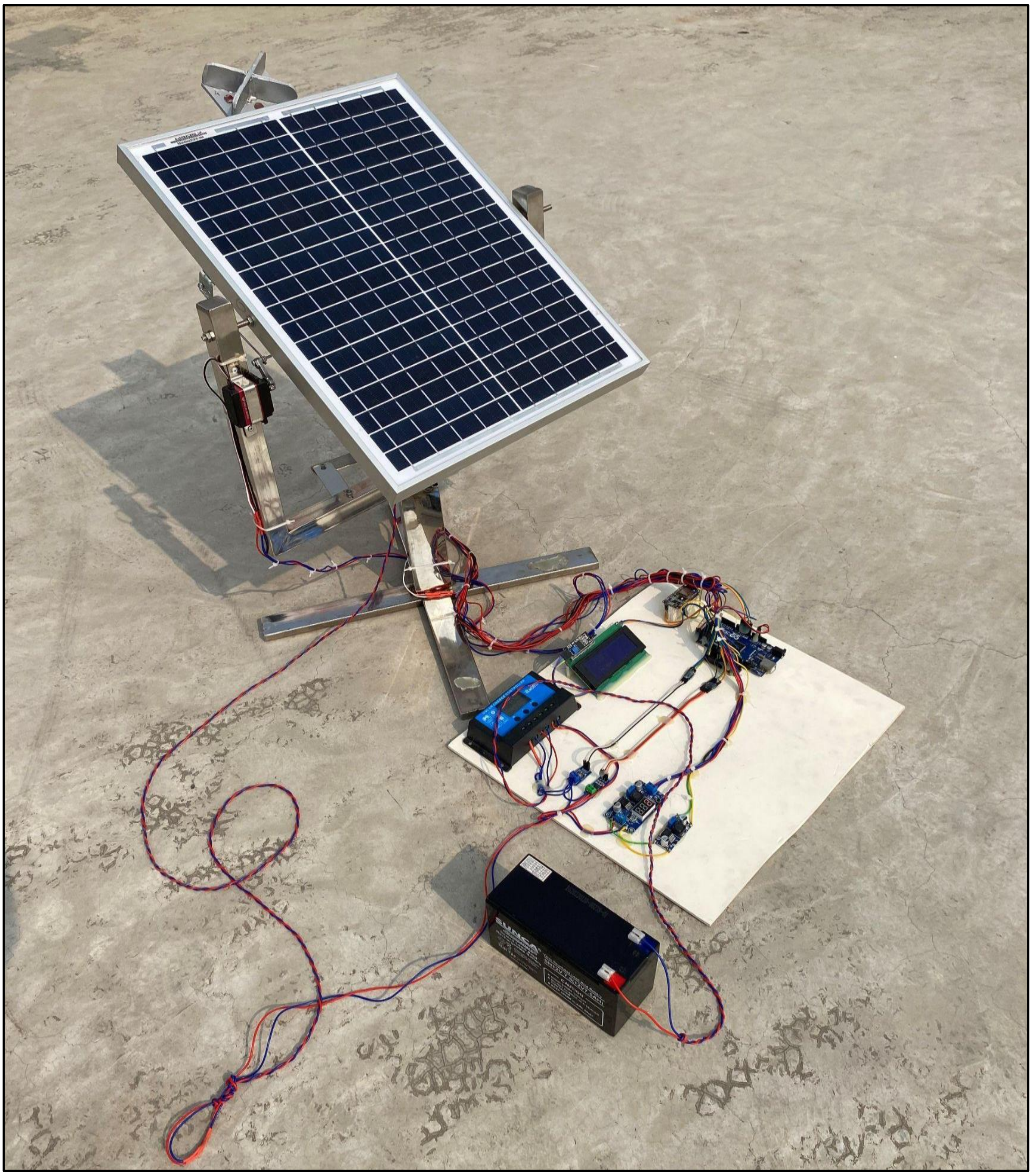

Figure 37: Tracking System

5.3 Evaluate the solution to meet desired need

Some tests were made throughout the day to evaluate the proposed system's effectiveness.

Table 9 compares the voltage, current, and power when using a fixed photovoltaic panel (PV) with when utilizing the proposed system at various times of the day. The table shows that as the sun continues to get brighter, the values of current, voltage, and power rise over time for both the fixed panel and the proposed system. At 1:00 pm of the day, the power reaches its peak. However, it should be highlighted that the tracking system's results exceed those of the fixed panel, proving that a higher output power may be obtained with a tracking system.

Time (Hours)	**Fixed PV**			**With Tracking**		
	Voltage (V)	**Current (A)**	**Power (W)**	**Voltage (V)**	**Current (A)**	**Power (W)**
9:00 am	3.92	0.25	0.98	4.02	0.33	1.32
10:00 am	4.17	0.31	1.29	4..45	0.40	1.78
11:00 am	5.50	0.47	2.59	6.95	0.61	4.24
12:00 pm	6.8	0.70	4.76	7.05	0.73	5.14
1:00 pm	7.3	0.75	5.47	8.5	0.79	6.71
2:00 pm	6.1	0.66	4.026	7.5	0.75	5.62
3:00 pm	4.46	0.43	1.917	6.12	0.56	3.42
4:00 pm	3.21	0.29	0.93	4.36	0.41	1.78
Total			21.963			30.01

Table No-9 : Comparison

Data Analysis:

In order to compare which system offers better performance, the tested data for the fixed solar panel and the proposed system are represented graphically in figures 38, 39, and 40. The comparison graph of current between the fixed panel and the proposed system is shown in Figure-38. It has been noted that the solar panel equipped with a tracking system produces more current than the stationary panel. The comparison graph of voltage between the fixed panel and the suggested system is shown in figure 39. The graph shows that the output voltage from a solar panel equipped with a tracking system is higher than that from a solar panel that is fixed in place. Finally, figure 40 shows the power graph produced by a solar panel with a tracking system and stationary solar panel. The graph shows that the power generated by a solar panel equipped with a tracking system is more than the power generated by a fixed panel.

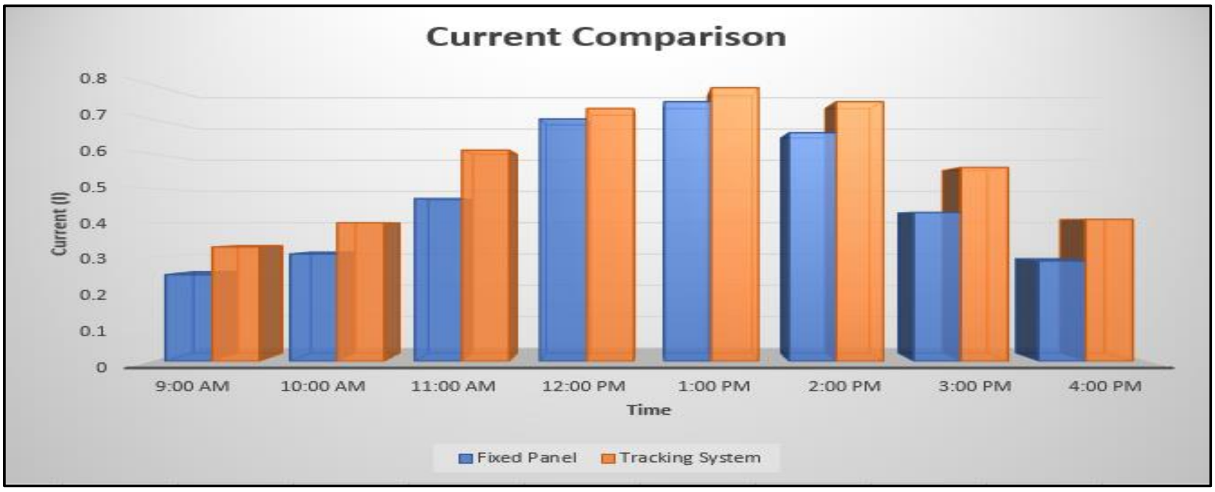

Figure-38: Comparison of current between fixed panel & Tracking System

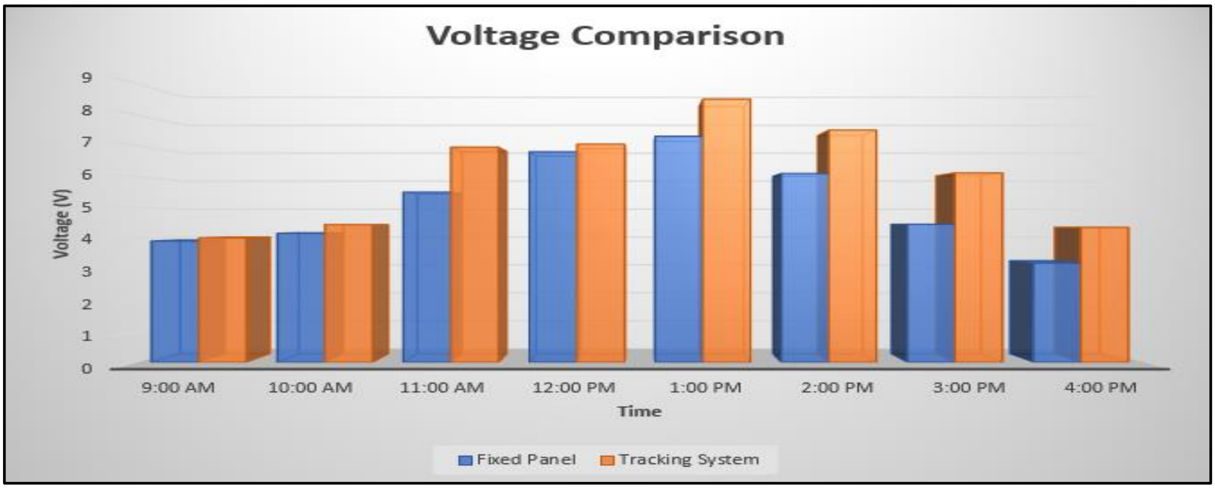

Figure-39: Comparison of voltage between fixed panel & Tracking System

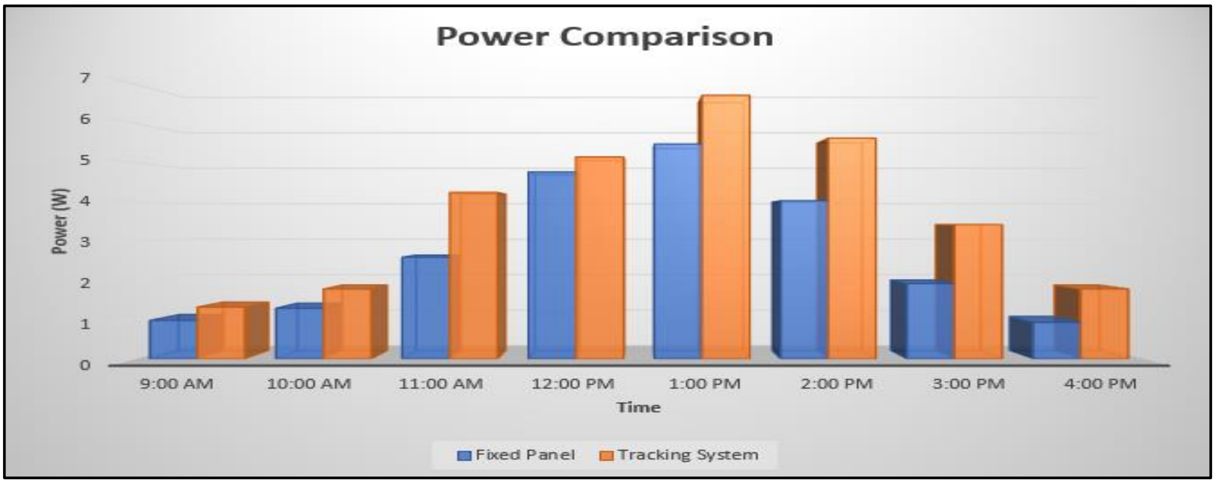

Figure-40: Comparison of power between fixed panel & Tracking System

Rated solar panel efficiency calculation:

In order to determine the solar panel's maximum efficiency, the ratio of panel power to solar power must be divided by the panel's square meter area, which must then be multiplied by 100 to obtain a percentage. The solar panel's rated values are: output power 20 watt, area 0.07958 m^2, and standard irradiance capture 1000 w/m^2, according to table 2. Finally the efficiency calculation gives the rated solar panel efficiency which is 25.13%.

Efficiency $= \frac{Solar\ Cell\ Output\ Power\ Max.in\ Watt}{Solar\ Cell\ Radiation\ Flux\ in\ Watt/meter^2 * Solar\ Cell\ Surface\ Area\ in\ meter^2} * \ 100\%$

$$= \frac{20\ watt}{1000\ watt/m^2 * 0.07958\ m} * 100\%$$

= 25.13%

Efficiency with solar tracking system:

In order to determine the tracking efficiency, the ratio of the power difference between tracking system and fixed system to power obtained from a fixed panel, which must then be multiplied by 100 to obtain a percentage. From table 9, data obtained from 8 hours of prototype testing, total power obtained from the tracking system is 30.01 watt and total power obtained from the fixed system is 21.963 watt. Finally, the efficiency calculation gives the solar tracking efficiency 36.64%.

$$= \frac{Total\ Power\ Obtained\ By\ Tracking\ System - Total\ Power\ Obtained\ By\ Fixed\ Panel}{Total\ Power\ Obtained\ By\ Fixed\ Panel} * \ 100\%$$

$$= \frac{\mathbf{30.01 - 21.963}}{\mathbf{21.963}} * \ 100\%$$

= 36.64%

Validation of Proposed Project:

Tables 5 and 9 allow for evaluation of the simulated data obtained through simulation and the tracking data collected. A potentiometer was used to determine the solar intensity in the proteus simulation because it was not possible to provide direct sunlight. According to the simulated data, current, voltage, and power all increase as the potentiometer value rises. The data obtained from a realistic situation is shown in Table 9, which demonstrates that the tracking data has the same pattern as the simulated data. As the sun continues to shine brighter throughout the day, current, voltage, and power increase. Therefore, the overall concept of the proportionate relationship between irradiance and current generation has been validated in both simulated and real life scenarios. According to the efficiency calculations performed for the rating and tracking systems, the rated efficiency was 25.13% and the tracking system efficiency was 36.64%, yielding an 11.5% improvement in efficiency for the suggested tracking system.

5.4 Conclusion

This chapter has been focused on the design overview of the prototype and data analysis of the tracking system. Through the tested data it's visible that a tracking system in a real day light scenario provides more power than a stall PV system. The proportional relationship between irradiance and current in both simulated and real life scenarios has been validated in this section.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

Impact analysis is the process of foreseeing the outcomes that a breakdown in business operations may have and how teams may collaborate to address these issues. The project's relevance, acceptability, political expediency, viability, and adaptability will all be determined by the sustainability study, on the other hand.

6.2 Assess the impact of solution

Health:

Typical power plants that use fossil fuels such as natural gas, oil, and coal presently provide the bulk of the world's electricity. One of the major consequences of continuing to use fossil fuels as primary energy sources is environmental pollution, which has a significant negative impact on human health[19]. The release of carbon dioxide into the atmosphere as a result of the use of fossil fuels has a considerable influence on climate change. It's absorbed by the atmosphere and stays there for decades, reflecting heat back to the earth and warming it continually. Climate change has a variety of negative implications for public health. It aids the spread of infectious illnesses, exacerbates droughts and famines, and makes natural calamities worse. Introducing solar parks with tracking systems can help to reduce these risks. Solar trackers do not generate electricity using carbon-emitting fuels, hence they do not contribute to air pollution. Solar tracker systems will ultimately supplant nonrenewable carbon-burning energy sources, eliminating the need of coal and oil, both of which release huge quantities of CO2.

Safety:

A solar tracker system's PV solar array, inverter, motor, battery and other important portions are all energy-conducting components. This raises concerns regarding the implementation of solar parks with tracker systems. When these parts come into contact with electricity created by the sun, electric shock or arc-flash might occur, causing catastrophic injury. Even in low-light conditions, systems can create enough voltage to cause harm. For photovoltaic (PV) tracker systems, the presence of a high voltage at the PV string terminals and cables connecting the string and inverters as long as the PV panels are lit is a significant and widely discussed safety issue[20]. The presence of these electrified conductors on the dc side of the PV tracker system can be harmful to anybody conducting maintenance.

Legal:

Bangladesh Power Division will produce a list of off-grid prospective regions based on financial and technical study, according to the Ministry of Power's "Guidelines For The Implementation Of Solar Power Development Program." Loads for communities, marketplaces, health centres, information centres, communication centres, and other facilities may be available in these regions. To deliver electricity to such locations, a power distribution system based on solar PV generation will be created. It is important to note that the financial competence of the people in certain places will be assessed prior to the start of any initiatives.Mini grid projects with a capacity of up to 250 kW will not require a waiver certificate or license, but entrepreneurs will be required to notify the Commission by letter. A license for a minimum of 20 years with the option to renew every year may be awarded for the installation and operation of solar micro grid projects.

6.3 Evaluate the sustainability

The global search for alternative fuel sources that are both sustainable and environmentally acceptable is being driven by the depletion of existing fuels and their negative environmental effect. Technology improvements have hastened efforts to find an alternative energy source to traditional ones, and the efficiency of absorbing energy from renewable sources is constantly rising. Solar energy is already receiving major investment from governments and corporations worldwide. As a result, technology advances and the cost of operating solar energy reduces with time. As a result, assessing the strengths and shortcomings, as well as showcasing the available options and challenges, is crucial in raising awareness among policymakers, governments, and corporations, and shifting energy investment toward solar energy.

SWOT Analysis:

Strengths	**Weaknesses**
• Rich & Limitless Solar Resource. • Investing in Clean Energy. • Environmental Friendly. • Higher Accuracy.	• High initial installation cost • Require more Maintenance. • Higher mechanical complexity • Lesser reliability for cloudy weather conditions.
Opportunities	**Threats**
• Expansion into Renewable Energy business • Decreasing Gap between Electricity Supply & Demand.	• Health Risk. • Political decisions against renewable energy.

6.4 Conclusion

It is essential to examine the entire effect analysis and project sustainability as well as to highlight the opportunities and challenges in order to increase awareness among decision-makers, governments, and businesses and shift energy investment toward solar energy.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

A project plan is a document often represented as a Gantt chart that outlines each step needed to complete a project. It acts as a roadmap by outlining the project phases, important project tasks, their start and end dates, interdependencies, and project milestones.

7.2 Define, plan and manage engineering project

EEE400P:

Task	Description	Start Date	End Date	Duration(days)
Research For Topic	Find Complex Engineering problem	03/02/2022	11/02/2022	9
	Research paper and journals	12/02/2022	19/02/2022	8
Project Concept Note	Tentative problem statement and objective	15/02/2022	20/02/2022	6
	Multiple Design Approach	21/02/2022	24/02/2022	4
	Specification, Requirements and Components.	21/02/2022	24/02/2022	4
	Applicable Standard Codes.	25/02/2022	26/02/2022	2
	Final Concept Note	27/02/2022	24/03/2022	26
	Preparing Slides	06/03/2022	09/03/2022	4
	Progress Presentation.	10/03/2022	10/03/2022	1
	Modifying Problem Statement and Title.	02/04/2022	04/04/2022	4

Project Proposal	Methodology and Project Plan.	04/04/2022	08/04/2022	8
	Budget, Expected outcome and Impact.	04/04/2022	10/04/2022	7
	Sustainability, Ethical Consideration	11/04/2022	16/04/2022	6
	Risk management analysis and safety consideration .	11/04/2022	16/04/2022	21
	Final Project Proposal.	02/04/2022	22/04/2022	3
	Proposal Slides	20/04/2022	22/04/2022	1
	Progress Presentation (Mock)	23/04/2022	23/04/2022	1
	Final Presentation	28/04/2022	28/04/2022	1

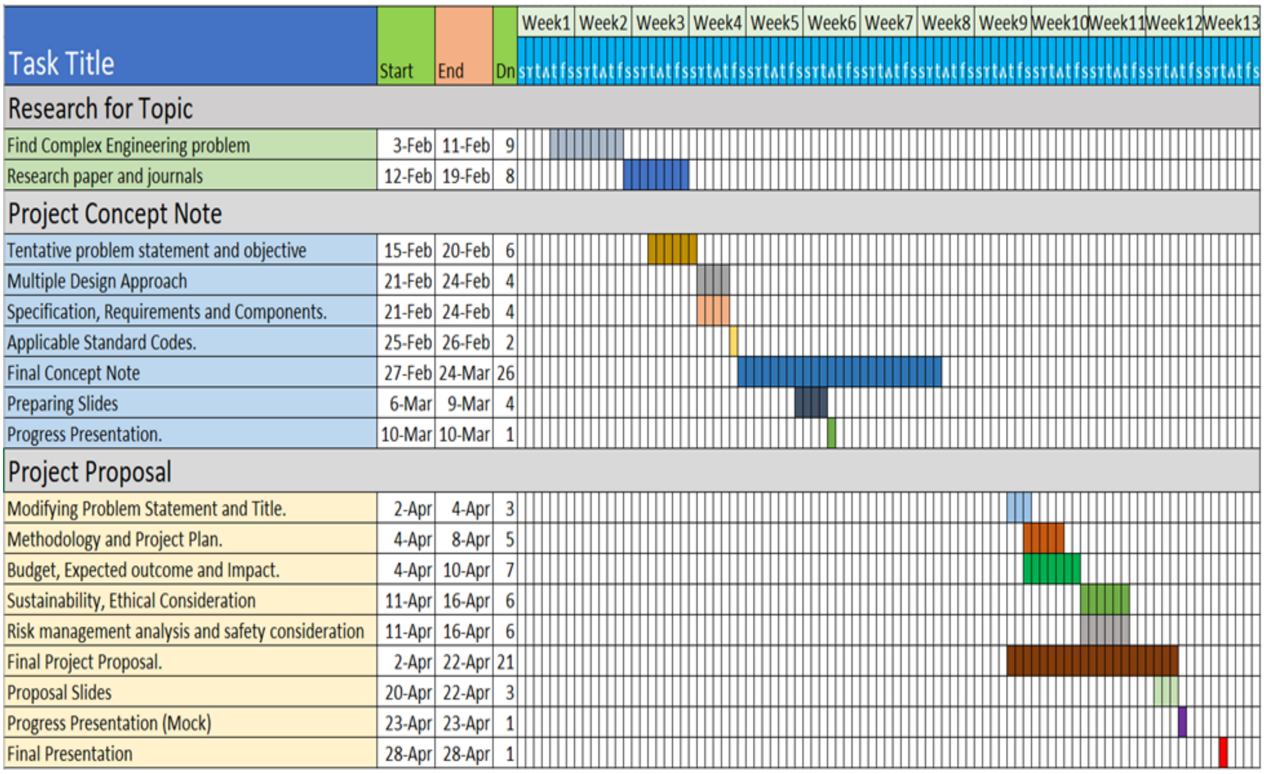

Figure-41 : Gantt Chart For EEE400P

EEE400D:

Task	Start Date	End Date	Duration (days)
Research for Design/Simulation	9/6/2022	23/6/2022	14
Selection of Engineering Tools	9/6/2022	16/6/2022	7
Design structure for Simulation (Without Monitoring System)	17/6/2022	23/6/2022	7
Simulation For Tracking (Without Monitoring system)	23/6/2022	29/6/2022	7
Slide Preparation	27/6/2022	29/6/2022	2
Progress Presentation	30/6/2022	30/6/2022	1
Design structure for Simulation (With Monitoring System)	2/7/2022	25/7/2022	23
Simulation For Tracking (With Monitoring system)	15/7/2022	25/7/2022	10
Data Collection and Result Analysis	25/7/2022	27/7/2022	2
Identifying Appropriate Solution	25/7/2022	31/7/2022	6
Validating Optimal Solution	1/8/2022	4/8/2022	3
Impact of Optimal Solution	5/8/2022	9/8/2022	4
Draft Report	26/7/2022	10/8/2022	14
Final Report	11/8/2022	17/8/2022	12
Slide Preparation	18/8/2022	24/8/2022	6
Final Presentation	25/8/2022	25/8/2022	1

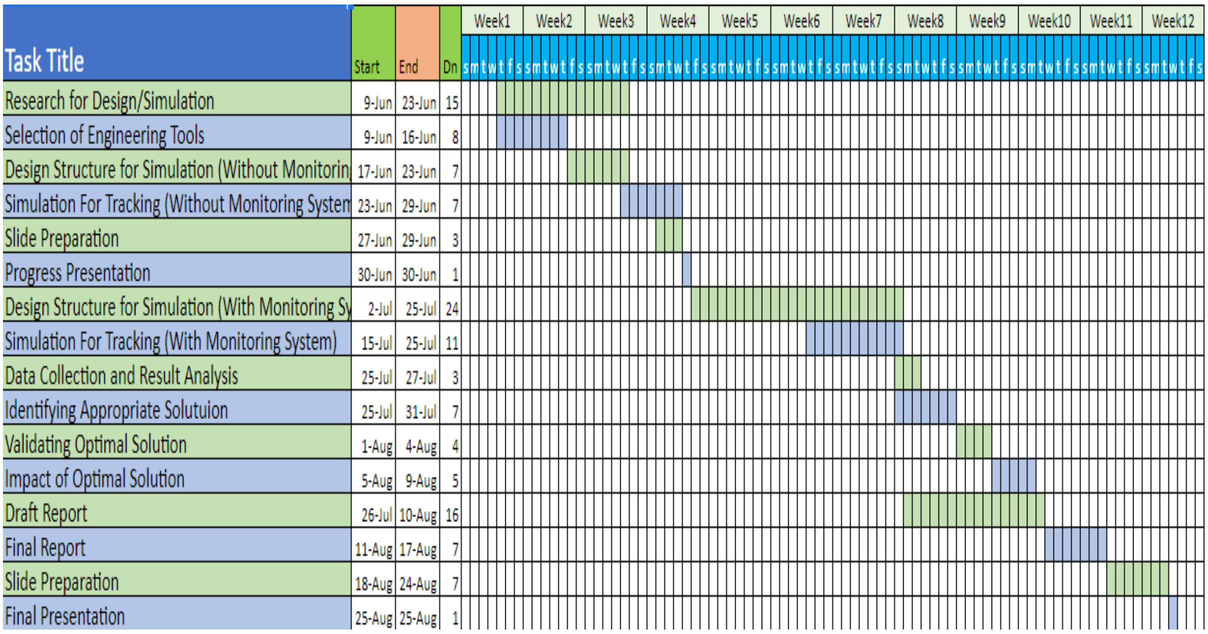

Figure-42 : Gantt Chart For EEE400D

EEE400C:

Task	Start Date	End Date	Duration(Days)
Selecting and Comparing Components	30/09/2022	05/10/2022	6
Collecting Components	07/10/2022	12/10/2022	6
Research	30/09/2022	02/11/2022	32
Mounting Stand Development	15/10/2022	29/10/2022	14
Actuator Part Development	17/10/2022	31/10/2022	14
Prototype Development	20/10/2022	15/11/2022	25
Prototype Testing	16/11/2022	20/11/2022	5
Prototype Debugging	21/11/2022	30/11/2022	10
Progress Presentation Slides	29/10/2022	01/11/2022	3
Progress Presentation and Prototype Demonstration	02/11/2022	02/11/2022	1
Project Report	11/10/2022	15/12/2022	65

Draft Project Report Submission	15/12/2022	15/12/2022	1
Final Project Report Submission	21/12/2022	21/12/2022	1
Final Presentation	22/12/2022	22/12/2022	1

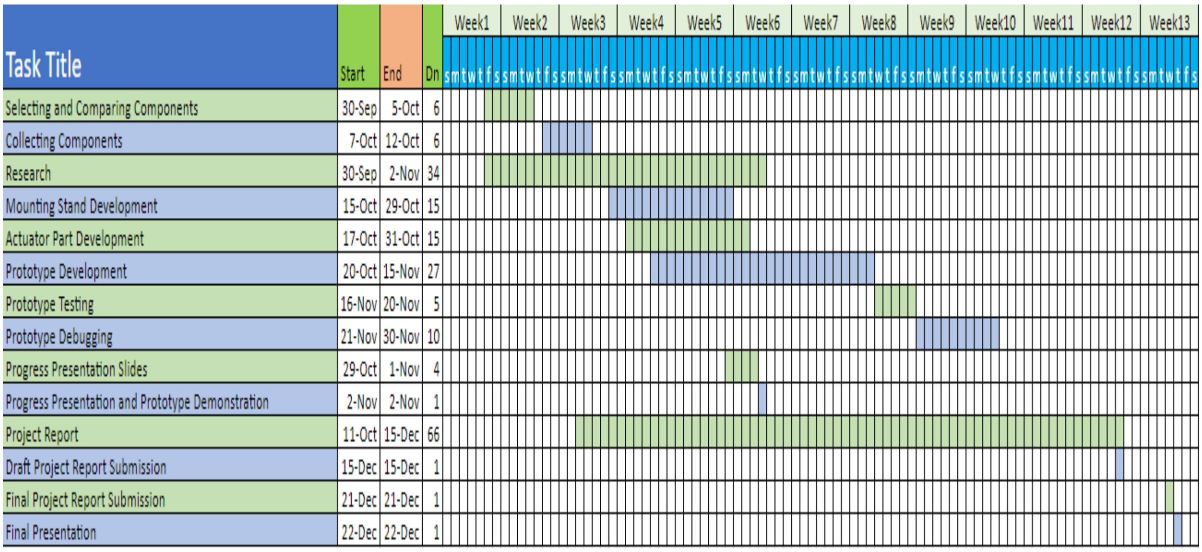

Figure-43 : Gantt Chart For EEE400C

7.3 Evaluate project progress

Determining and analysing future risk events along with a backup/contingency plan is an essential part of every engineering project. In this project the risk events that we have put under consideration are weather conditions/absence of daylight, sensor malfunction, solar panel overheating, effects of shading on solar panels and motors malfunction. Each and every risk event mentioned is associated with a significant amount of performance drop. For example weather conditions, motor and sensor malfunction can shut down the whole system, on the other hand a research of a well known solar energy company, SOLENERGY, shows that solar panels shading and overheating on solar panels can cause up to 12.5-20% power drop. In table 9, incorporation of contingency plans with associated risk events and management responsibility are being shown.

Risk Event	Management	Contingency Plan
Weather conditions/Absence of daylight.	Having knowledge about monthly/season change of sunpath angels.	Sizing backup batteries for autonomous days operation. For example: Two days of autonomy means your batteries would be large enough to supply continuous energy for a full two days without charging.
Sensor Malfunction	Testing sensors while installing and weekly inspection.	Keeping backup sensors.
Solar panel overheating	Regular monitoring of temperature.	Introducing cooling systems, for example: Active air conditioning systems generate airflow using fans or other devices.
Effects of shading on Solar Panels	Having the knowledge about shading problems and loss due to shading problems.	Module-level power electronics, bypass diodes, and various stringing configurations (MLPEs)
Motors Malfunction	Knowledge about Troubleshooting Servo/stepper motors and their driving system	Keeping backup motors in hand.

7.4 Conclusion

This part is the overview of the overall roadmap of the timeline followed for this solar project.

Besides the risk events have been also evaluated along with the contingency plans.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

An economic analysis is necessary to assess a project's costs and benefits. Economic analysis helps us determine how financially viable a project is. However, the primary goal of such study is to comprehend the type of response a product is receiving, such as revenue generation. Additionally, economic analysis is a very helpful tool for a better understanding of any business outcome.

8.2 Economic Analysis

Economic analysis gives us advice on how to effectively allocate resources to produce more money from any product. We can determine how effective a product or business is by applying economic analysis to acquire a better grasp of how much profit a business or product is making. Due to increasing direct exposure to the sun's rays, trackers produce more electricity than their stationary counterparts. Depending on where the tracking system is located, this increase could range from 10 to 25%. Bangladesh has an average of 6.5 sunny hours each day, with average solar irradiance ranging from 215 W/m2 in the north-west to 235 W/m2 in the south-west every day. However, variations in solar radiation cause more than 40% of energy to be wasted.Our system comes with a solution to both monitor and control the system automatically which is heavily cost effective compared to the current manual system. On the other hand the government of Bangladesh is currently promoting a number of different renewable energy initiatives, including solar-powered transportation, rooftop solar systems, solar cold storage and dryers, and battery charging stations. The government of Bangladesh has already focused on solar mini-grid and solar micro-grid technologies, as well as solar smart grid technology. Currently there are 30 solar parks in Bangladesh. So, implementing a solar tracking system on a larger scale will both be effective and feasible in the current economic scenario.

8.3 Cost benefit analysis

Cost-benefit analysis is used to determine whether a project is feasible. A cost-benefit analysis is a component of economic analysis that, if done correctly and with accurate assumptions, has the advantage of providing a reliable, quantitative guide for decisions connected to the future of the product. To be cost-effective, the project doesn't have to be finished for the absolute lowest price. The effectiveness, performance, and durability of the parts and sensors employed in the project are the most crucial aspects. There were many different components and sensors available on the market to finish the prototype design, making it difficult to choose the one that was best in terms of price and performance. The component that is both cost-efficient and effective must be chosen if we want to get the finest results. Even yet, there are benefits and drawbacks to each of the components chosen for the prototype design. This governance procedure is necessary to ensure consumer satisfaction with the final product. Design-1 in this project is based on a servo motor system, whereas Design-2 is based on a stepper motor system. The servo motor was chosen because it performs better, even though stepper motors are less expensive.

Components	Price (Tk.)	Strength	Weakness
Arduino Mega	2150	1. More memory space 2. Bigger size & more I/O pins 3. Speedy communication	1. available only for 8-bits not for 32 bits 2. Clock speed is limited to 20 MHz
Servo Motor	2000	1. High output power considering the weight and size of the motor. 2. Encoder determines accuracy and resolution. 3. Servo motors achieve high speed at high torque values.	1. Gear boxes are often required to deliver power at higher speeds. 2. Overload that is sustained can harm servo motors.
Motor Driver	550	1. High level functionality and better performance. 2. The circuit is easy to operate.	1. Driver failure due to voltage fluctuation

Evaluate economic and financial aspects

No	Component	Quantity	Price(Taka)	Link
1	Solar Panel	1	850	
2	Servo Motor	2	4000	Purchase Link
3	MPPT	1	550	Purchase Link
4	Arduino Mega2560 R3	1	2150	Purchase Link
5	LDR Sensor	4	20	Purchase Link
6	Temperature Sensor	1	250	Purchase Link
7	Current Sensor	1	250	Purchase Link
8	Voltage Sensor	1	120	Purchase Link
9	Standard LCD 16x2	1	170	Purchase Link
10	12V 7.5A Battery	1	1100	
11	Mounting Stand	1	3500	
	Total Cost		**12960**	

8.4 Conclusion

An economic and financial perspective is necessary to comprehend how the project will function in the future. While the financial analysis determines the required resources, the economic analysis aids in project maintenance and sustainability. Only the system's productivity and performance fall short of what is required for a project to be long-term viable.

Chapter 9: Ethics and Professional Responsibilities CO13, CO2

9.1 Introduction

A professional code of conduct that mandates adherence to the highest moral standards is applied to engineers. When carrying out their obligations as engineers, they must put the safety, health, and welfare of the public first.

9.2 Identify ethical issues and professional responsibility

The project aims to create a solar tracker that will increase solar panel power output by maximising solar irradiance collection. Engineering initiatives today are designed to make people's life easier. Every project must consider ethical and professional responsibilities in addition to technological advancements. Professional and ethical responsibilities were properly considered whilst this project was being developed. The context is as follows:

A. Price

B. Environmental Safety

C. Disposal of solar waste and battery waste.

9.3 Apply ethical issues and professional responsibility

Price : While making this project the price of the solar tracker was kept in mind because solar trackers are slightly more expensive than their stationary counterparts, as they are regarded as complex systems with moving parts and solar energy growth is not supposed to be at the price of people's fundamental rights.

Environmental Safety: The use of solar tracker is ecological friendly. The use of this solar tracker neither results in a net decrease in overall greenhouse gas emissions, nor it aggravates global climate change.

Disposal of Solar Waste and Battery Waste : Batteries and solar waste disposal are both given careful consideration. Heavy metals including silver, lead, arsenic, and cadmium can be found in solar panel waste, and at certain concentrations, they may qualify as hazardous waste. Battery waste, on the other hand, describes the depleted batteries that are thrown in the trash and wind up in landfills where they deteriorate and leak. Groundwater, surface water, and soil are all contaminated by chemicals released by battery deterioration. Therefore, after removing the frame and junction box, these procedures often comprise crushing, shredding, and milling to recycle battery and solar waste. Glass, aluminum, and copper may be recovered via these operations, while the remaining materials, including the silicon solar cells, may be burned.

9.4 Conclusion

The emphasis of this section is on recognizing, confronting, and resolving ethical dilemmas when they occur in practice. When carrying out their obligations as engineers, they must put the safety, health, and welfare of the public first.

Chapter 10: Conclusion and Future Work

10.1 Project Summary/Conclusion

This project aims to capture the best attainable amount of solar irradiance in every possible sun hour with the use of a solar tracking system in order to increase the power generation of solar panels. Use of a solar tracker helps to increase the conversion efficiency of producing electricity from sunlight to a noticeable amount in comparison to the conventional static solar panels. In this project, servo motors were used to build the entire tracking system. MPPT charge controllers, buck converters, and sensors were incorporated in a way to validate the overall power distribution and monitoring system. Afterwards, going through some data analysis made from the test result of the prototype, it has been found that power generation per hour of the tracking system increases in comparison to the non-tracking system.

10.2 Future work

Determining and analyzing future events along with a backup/contingency plan is an essential part of every engineering project.

A. Cleaning System

Due to the increase in soiling rate, which surpasses 20% in desert locations, PV installations' performance may eventually decline [21]. The solar panels mounted atop the tracker can be organically cleaned by the effects of rain or tracking (particles that fall as the tracker moves). Unfortunately, this method of cleaning falls short, especially in desert regions where the soiling phenomena is more prevalent. Thus, the necessity to create further remedial and cost-effective cleaning techniques. There are various cleaning methods that can be used to enhance the PV panels' electrical performance, including: The GECKO robot that uses a telescopic arm to clean PV panels is accompanied by a vehicle. For solar panels, ECOPPIA is a dry cleaning method that conserves water and eliminates up to 99% of the dust. The treads on SOLARWASH are designed to improve the contact surface and guarantee up to a 25% increase in output.

B. Cooling System

Under conditions of high irradiance, the operating temperature of a PV panel can reach 60 °C to 80 °C. Voc will fall at a rate of 0.1%/°C as PV cell temperature rises, while Isc will only marginally increase [22]. Numerous studies have demonstrated that a rise in PV cell temperature would reduce its efficiency. Additionally, Irwan [23] noted that the impact of high temperature is the reason why the energy generation from the PV ray is not as high as anticipated. Therefore, a cooling system is important because it can help to decrease the operating temperature, hence improving the output power generated.

C. Backup RTC System

An alternative RTC system can be put in place in the event of LDR failure. The RTC system will begin operating if for any reason the LDRs are unable to detect sunlight. An algorithm will be configured in accordance with the SWERA Solar Map data, and the solar panel will shift to a specific degree after a predetermined amount of time. In order to guide the solar tracking system in determining the location of the sun for the daily, monthly, and seasonal movements, an RTC (Real Time Clock) is required. Thus, the developed solar tracking system is made efficient through the use of both RTC and sensor-based tracking systems. In order to follow the sun, a time-based algorithm has been successfully applied to a number of months.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1 Identify the attribute of complex engineering problem (EP)

EP	Attributes	Checkbox
P1	Depth of Knowledge Required	√
P2	Range of conflicting requirements	√
P3	Depth of Analysis required	√
P4	Familiarity of issues	
P5	Extent of applicable code	√
P6	Extent of stakeholder involvement and needs	√
P7	Interdependence	

11.2 Provide reasoning how the project address selected attribute (EP)

Depth Of Knowledge Required(P1): This project satisfies Engineering fundamentals, Engineering Specialist, Engineering Design and literature reviews for background research.

Range of conflicting requirements(P2): Includes conflicting issues like vice versa condition in price and performance.

Depth of Analysis Required(P3): This attribute has been fulfilled by including Multiple design approaches, Comparison between prices, Pros and cons and Budget analysis.

Extent of applicable code(P5): Protocols from IEC, IEEE and Renewable Energy Policy of Bangladesh have been included.

Extent of stakeholder involvement and needs (P6): This project increases the demand for solar tracking systems among coastal and rural residents as it generates more power than the fixed panels while also expanding market possibilities for solar panel manufacturers.

11.3 Identify the attribute of complex engineering activities (EA)

EA	Attributes	Checkbox
A1	Range of Resources	√
A2	Level of interactions	√
A3	Innovation	
A4	Consequences for Society and Environment	√
A5	Familiarity	

11.4 Provide reasoning how the project address selected attribute (EA)

Range of Resources(A1): This project persuades the conditions of range resources by completing the needs and demands of stakeholders, proper budget planning and availability of components in the market.

Level of Interactions(A2): This project completes the attribute by considering money issues according to the stakeholders and also by making affordable for the consumers . Also availability of free land should be in thought.

Consequences for Society and Environment (A4) : By recognizing positive and negative impacts on society and the environment, this project has met the conditions of repercussions for society and the environment. In terms of positive impact, this initiative will be extremely useful to residents of coastal areas while also lowering fossil fuel usage. On the other hand, the project's recycling mechanism for PV panels poses a risk.

References

1. S. Panchal,O. Navalkar, P. Jadhav, & N. Malekar, “Automated Solar Tracking System for Efficient Energy Utilization,” VIVA-Tech International Journal for Research and Innovation, 1(2), 1-5, 2019.

2. M. M. Abu-Khader, O. O. Badran, and S. Abdallah, “Evaluating multi-axes sun-tracking system at different modes of operation in Jordan,” Renewable and Sustainable Energy Reviews, vol. 12, no. 3, pp. 864–873, 2008.

3. G. Mehdi, N. Ali, S. Hussain, A. A. Zaidi, A. Hussain Shah, and M. M. Azeem, “Design and fabrication of automatic single Axis Solar Tracker for solar panel,” 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), 2019.

4. S. Hossain and M. M. Rahman, “Solar Energy Prospects in Bangladesh: Target and current status,” Energy and Power Engineering, vol. 13, no. 08, pp. 322–332, 2021.

5. M. A. Mondal and M. Denich, “Assessment of renewable energy resources potential for electricity generation in Bangladesh,” Renewable and Sustainable Energy Reviews, vol. 14, no. 8, pp. 2401–2413, 2010.

6. M. Alam, M. A. Dewan, S. Shafiul Bashar, M. S. Miah, and A. Ghosh, “A microcontroller based dual axis tracking system for solar panel,” 2019 3rd International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE), 2019.

7. A. Al-Mohamad, “Efficiency improvements of photo-voltaic panels using a sun-tracking system,” Applied Energy, vol. 79, no. 3, pp. 345–354, 2004.

8. M. Alata, M. A. Al-Nimr, and Y. Qaroush, “Developing a multipurpose sun tracking system using fuzzy control,” Energy Conversion and Management, vol. 46, no. 7-8, pp. 1229–1245, 2005.

9. J. A. Urbano, Y. Matsumoto, R. Asomoza, F. J. Aceves, A. Sotelo and A. Jacome, "5 Wp PV module-based stand-alone solar tracking system," 3rd World Conference on Photovoltaic Energy Conversion. Proceedings of, 2003, Vol.3 pp. 2463-2465, 2003.

10. S. Deepthi, A. Ponni, R. Ranjitha, & R. Dhanabal, "Comparison of efficiencies of single-axis tracking system and dual-axis tracking system with fixed mount," International Journal of Engineering Science and Innovative Technology, 2(2), 425-430, 2013.

11. Tudorache, T., Oancea, C. D., & Kreindler, L. Performance evaluation of a solar tracking PV panel. University" Politehnica" of Bucharest Scientific Bulletin, Series C: Electrical Engineering, 74(1), 3-10, 2012.

12.H. M. Moniruzzaman, M. Patwary and M. Rahman, "A three level solar panel system with an automated solar tracker," *2014 3rd International Conference on the Developments in Renewable Energy Technology (ICDRET)*, pp. 1-7, 2014.

13. H. Fathabadi, "Novel high efficient offline sensorless dual-axis solar tracker for using in photovoltaic systems and solar concentrators," *Renewable Energy*, vol. 95, pp. 485–494, Sep. 2016.

14. M. Alata, M. A. Al-Nimr, and Y. Qaroush, "Developing a multipurpose sun tracking system using fuzzy control," *Energy Conversion and Management*, vol. 46, no. 7–8, pp. 1229–1245, May 2005.

15. Reeseman G. Overcoming ldr saturation in a sun tracking solar panel system; 2020.

16. N. Kuttybay, A. Saymbetov, S. Mekhilef, M. Nurgaliyev, D. Tukymbekov, G. Dosymbetova, A. Meiirkhanov, and Y. Svanbayev, "Optimized single-axis schedule solar tracker in different weather conditions," *Energies*, vol. 13, no. 19, p. 5226, 2020.

17.M. A. V. Rad, A. Toopshekan, P. Rahdan, A. Kasaeian, and O. Mahian, "A comprehensive study of techno-economic and environmental features of different solar tracking systems for residential photovoltaic installations," *Renewable and Sustainable Energy Reviews*, 05-Jun-2020.

18. D. L. Talavera, E. Muñoz-Cerón, J. P. Ferrer-Rodríguez, and P. J. Pérez-Higueras, "Assessment of cost-competitiveness and profitability of fixed and tracking photovoltaic systems: The case of five specific sites," *Renewable Energy*, 26-Nov-2018.

19. Y. Z. Alharthi, M. K. Siddiki, and G. M. Chaudhry, "Economic Analysis and environmental impacts of a hybrid PV system in arid climate considering different types of solar trackers," *Smart Grid and Renewable Energy*, 19-Oct-2018.

20. E. Khodadadi*, "*Investigating the Impact of Renewable Energy Development on World Economy,*"3rd International Congress on Engineering, Technology & Innovation, Darmstadt-Germany,2021*.

21. B. Laarabi, O. M. Tzuc, D. Dahlioui, A. Bassam, M. Flota-Bañuelos, and A. Barhdadi, "Artificial neural network modeling and sensitivity analysis for soiling effects on photovoltaic panels in Morocco," *Superlattices and Microstructures*, 28-Dec-2017.

22. Catalin GP, Sebastian VH, Theodor DM, Nelu-Cristian C. Efficiency Improvement of Photovoltaic Panels by Using Air Cooled Heat Sinks. Energy Procedia. 2016; 425-432.

23. Irwan Y.M., Syafiqah Z., Amelia A.R., Irwanto M., Leow W.Z., Ibrahim S. Design the Balance ofSystem for Low Load Application. Indonesian Journal of Electrical Engineering and ComputerScience. 2016; 4(2): 279-285.

Appendix

Related Code:

```
#include <Servo.h>

#include <OneWire.h>

#include <DallasTemperature.h>

#include <Robojax_AllegroACS_Current_Sensor.h>

#include <LiquidCrystal_I2C.h>


LiquidCrystal_I2C lcd(0x27, 20, 4);


//Voltage Sensor part

const int VIN     = A4;

const float VCC   = 5;

const int MODEL   = 0;


Robojax_AllegroACS_Current_Sensor robojax(MODEL, VIN);  //Defining current sensor


#define ONE_WIRE_BUS 2

OneWire oneWire(ONE_WIRE_BUS);


DallasTemperature sensors(&oneWire); //Temperature sensor


Servo myservo1;  //Horizontal servo

Servo myservo2; //Vertical Servo


#define sun1 A0  //Bottom LDR
```

```
#define sun2 A1 //Top LDR

#define sun3 A2 //Right LDR

#define sun4 A3 //Left LDR


#define servo1 9    //PWM pin for Horizontal motor

#define servo2 10   //PWM pin for vertical motor


unsigned long previousMillis = 0;

const long interval = 1500;


//Defining variables for servo angle


int pos = 0, qw = 0, angle1 = 180, asd = 0;

int angle2 = 90;


//Defining variables for voltage calculation


#define ANALOG_IN_PIN A5

float adc_voltage = 0.0;

float in_voltage = 0.0;

float R1 = 30000.0;

float R2 = 7500.0;

float ref_voltage = 5.0;

int adc_value = 0;

float tempC, II;
```

```
void setup() {
  Serial.begin(9600);
 Serial1.begin(9600);
 lcd.init();
 lcd.backlight();

  pinMode(sun1, INPUT); //Bottom LDR
  pinMode(sun2, INPUT); //Upper LDR
  pinMode(sun3, INPUT); //RIght LDR
  pinMode(sun4, INPUT); //Left LDR

//Initial position of motor

  Servo1_Control('=', angle1);
  delay(500);
  Servo2_Control('=', angle2);
  delay(500);

  float Power = (in_voltage * II); //Power calculation

  lcd.setCursor(0, 0);
  lcd.print("V :");
  lcd.print(in_voltage, 2);
  lcd.print(" V      ");
  lcd.setCursor(0, 1);
  lcd.print("I :");
```

```
  lcd.print(II, 3);
  lcd.print(" A      ");
  lcd.setCursor(0, 2);
  lcd.print("P :");
  lcd.print(Power, 2);
  lcd.print(" W     ");
  lcd.setCursor(0, 3);
  lcd.print("T :");
  lcd.print(tempC, 2);
  lcd.print((char)223);
  lcd.print("C     ");
}

void loop() {
  int aa, ab, ac, ad;
  sensors.requestTemperatures();
  tempC = sensors.getTempCByIndex(0);

  //Voltage Calculation

  adc_value = analogRead(ANALOG_IN_PIN);
  adc_voltage  = (adc_value * ref_voltage) / 1024.0;
  in_voltage = adc_voltage / (R2 / (R1 + R2)) ;

  II = robojax.getCurrentAverage(300);
  II = II * 1.5;
```

```
  if (in_voltage < 2.50) {
    in_voltage = 0;
    II = 0;
  }

//Light detection

  int val1 = analogRead(sun1);   //Bottom LDR
  aa = val1;
  if (val1 > 950) {
    val1 = 1;
  }
  else {
    val1 = 0;
  }

  int val2 = analogRead(sun2);  //Top LDR
  ab = val2;
  if (val2 > 150) {
    val2 = 1;
  }
  else {
    val2 = 0;
  }
  int val3 = analogRead(sun3);  //Right LDR
  ac = val3;
```

```
if (val3 > 200) {
  val3 = 1;
}
else {
  val3 = 0;
}
int val4 = analogRead(sun4);  //Left LDR
ad = val4;
if (val4 > 390) {
  val4 = 1;
}
else {
  val4 = 0;
}

Serial.print(aa);
Serial.print("\t");
Serial.print(ab);
Serial.print("\t");
Serial.print(ac);
Serial.print("\t");
Serial.print(ad);
Serial.print("\t");
Serial.print(val1);
Serial.print("\t");
Serial.print(val2);
```

```
Serial.print("\t");

Serial.print(val3);

Serial.print("\t");

Serial.println(val4);



if (val1 == 1)

{

  if (angle1 >= 180) {

    angle1 = 180;

    Servo1_Control('=', angle1);

  }

  else {

    Servo1_Control('+', angle1);

  }

  delay(2);

}


if (val2 == 1)

{

  if (angle1 <= 0) {

    angle1 = 0;

    Servo1_Control('=', angle1);

  }

  else {

    Servo1_Control('-', angle1);
```

```
  }
  delay(2);
}

if (val3 == 1)
{
  if (angle2 >= 180) {
    angle2 = 180;
    Servo2_Control('=', angle2);
  }
  else {
    Servo2_Control('+', angle2);
  }
  delay(2);
}



if (val4 == 1)
{
  if (angle2 <= 0) {
    angle2 = 0;
    Servo2_Control('=', angle2);
  }
  else {
    Servo2_Control('-', angle2);
  }
```

```
  delay(2);
}

float Power = (in_voltage * II);
unsigned long currentMillis = millis();
if (currentMillis - previousMillis >= interval) {
  previousMillis = currentMillis;
  lcd.setCursor(0, 0);
  lcd.print("V :");
  lcd.print(in_voltage, 2);
  lcd.print(" V      ");
  lcd.setCursor(0, 1);
  lcd.print("I :");
  lcd.print(II, 3);
  lcd.print(" A      ");
  lcd.setCursor(0, 2);
  lcd.print("P :");
  lcd.print(Power, 2);
  lcd.print(" W     ");
  lcd.setCursor(0, 3);
  lcd.print("T :");
  lcd.print(tempC, 2);
  lcd.print((char)223);
  lcd.print("C     ");
}
if (asd >= 30) {
```

```
    String asdfg = "#" + String(aa) + "@" + String(ab) + "@" + String(ac) + "@" + String(ad) +
"@" + String(in_voltage) + "@" + String(II) + "@" + String(Power) + "@" + String(tempC) +
"*";
    Serial.println(asdfg);
    Serial1.println(asdfg);
    asd = 0;
  }
  else {
    asd++;
  }
}

// Servo horizontal control function

void Servo1_Control(char Status, int value1s)
{
  myservo1.attach(servo1);

  if (Status == '-')
  {
    for (angle1; angle1 > value1s - 2; angle1--)
    {
      myservo1.write(angle1);
    }
  }
  else if (Status == '+')
```

```
  {
    for (angle1; angle1 < value1s + 2; angle1++)
    {
      myservo1.write(angle1);
    }
  }
  else if (Status == '=')
  {
    myservo1.write(angle1);
  }
  delay(200);
  myservo1.detach();
}

// Servo vertical control function

void Servo2_Control(char Status, int value1s)
{
  myservo2.attach(servo2);

  if (Status == '-')
  {
    for (angle2; angle2 > value1s - 2; angle2--)
    {
      myservo2.write(angle2);
    }
```

```
  }
  else if (Status == '+')
  {
    for (angle2; angle2 < value1s + 2; angle2++)
    {
      myservo2.write(angle2);
    }
  }
  else if (Status == '=')
  {
    myservo2.write(angle2);

  }
  delay(200);
  myservo2.detach();
}
```

Logbook:

FYDP (P) Summer 2022 Summary of Team Log Book/Journal

Project Title:

Automated Solar Tracking System for Increasing Solar Irradiance Capture to Improve Power Generation.

	Final Year Design Project (P) Summer 2021		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Arnob Tarafder (19121103)	arnob.tarafder@g.bracu.ac.bd	01765597349
Member 2	Mohammad Mahir Abrar (19121113)	mohammad.mahir.abrar@g.bracu.ac.bd	01827225252
Member 3	Md. Arefeen Mondol (19121105)	md.arefeen.mondol@g.bracu.ac.bd	01790732926
Member 4	Niloy Roy Chowdhury (19121104)	niloy.roy.chowdhury@g.bracu.ac.bd	01865003327
ATC Details:			
ATC 3			
Chair	Dr. AKM Abdul Malek Azad	a.azad@bracu.ac.bd	
Member 1	Md. Nahid Haque Shazon	nahid.haque@bracu.ac.bd	
Member 2	Afrida Malik	afrida.malik@bracu.ac.bd	

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
03.02.2022 (**FYDP Committee** **Speaker: Mohaimenul Islam**)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Introduction of FYDP-P (EEE 400P)		N/A.
10.02.2022 (**FYDP Committee** **Speaker: Dr. Md. Mosaddequr Rahman**)	1. Arnob 2.Mahir 3.Arefeen 4.Niloy	Introduction to Engineering Design Process		N/A
12.02.2022 (**ATC Panel**)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Md. Nahid Haque Shazon 3. Afrida Malik. **Students:** 1.Arnob 2.Mahir 3.Arefeen **Absent:** 1. Niloy	1. Basic ideas on logbook and concept note preparation.		1. Paper/Journal reading on relevant topics. 2. Study on how to identify complex engineering problems.
15.02.2022 (Group meeting)	1. Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Divided the papers among ourselves to study	1. All Group Members. Progress: Completed	
17.02.2022 (**FYDP Committee** **Speaker: Dr. Abu S. M. Mohsin**)	1. Arnob 2.Mahir 3.Arefeen 4.Niloy	Complex Engineering Problem Identification		
18.02.2022	1. Arnob 2.Mahir	1.Prepared draft on researched idea.	1. Arnob & Niloy 2. Mahir & Arefeen	

(Group Meeting)	3.Arefeen 4.Niloy	2. Prepared Logbook.	Progress: 1. Partially completed. 2. Completed.	
19.02.2022 (**ATC Panel**)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Md. Nahid Haque Shazon 3. Afrida Malik. **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Brief about how to modify the title, problem statement and objective. 2. Tentative date of submitting concept note, project proposal and presentation.		1. Update the title and objective, modify the problem statement. 2. Research on statistical data. 3.Study the Characteristics curve of PV Panel. 4. Determining the feasibility of the project.
19.02.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Studied about Complex Engineering Problems.		
20.02.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Modified the Title, Problem Statement and Objective	1. Everyone Progress: Completed	
22.02.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Research on multiple design and advantage/disadvantage of them	1.Everyone Progress : Completed	
24.02.2022 (**FYDP Committee** **Speaker: Dr. Abu S. M. Mohsin**)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	How to Identify a Complex Engineering Design Project and Fulfill CO Criteria		
24.02.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Drew the block diagrams for multiple designs. 2. Determining applicable codes and protocols	1. Arefeen & Niloy 2. Arnob & Mahir Task 1 & 2 : Completed.	
26.02.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Prepared overall draft concept note & updated the logbook.	Task 1: Everyone Progress: Completed	

1.3.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Modifying according to the feedback.	Task: Everyone Progress: Partially completed	
3.3.2022 (**FYDP Committee** **Speaker: Mohaimenul Islam**)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Review of Project Proposal Preparation.		
3.3.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Modifying according to the feedback.	Task: Everyone Progress: Partially completed	
6.3.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Modified according to the feedback. 2.Prepared Slide.	Task1: Niloy and Mahir. Task2: Arnob and Arefeen Progress: Completed	
10.3.2022 (Progress Presentation)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy			1. Mention the motor speed and torque speed. 2. Why are we only using tracking system?
17.3.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Modified according to the feedback.	Task: Everyone Progress: Partially completed	
23.3.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Modified according to the feedback.	Task: Everyone Progress: Completed	
24.3.2022 (**FYDP Committee** **Speaker: Rakibul Hasan**)	1.Arnob 2.Mahir 3.Arefeen Absent: Niloy for sickness.	Report Writing and Presentation Techniques		
02.4.2022 (**ATC Panel**)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Md. Nahid			1. Complete the project proposal with at least the thing we have mentioned in the concept note. 2. Submit it once within 1/2 days and before the next ATC meeting.

	Haque Shazon 3. Afrida Malik 1.Arnob 2.Mahir 3.Niloy Absent: Arefeen (Due to technical difficulties)			
02.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Divided some papers among ourselves to study multiple designs.		
03.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Started working on the project proposal. 2. Studied some papers regarding solar irradiance. 3. Did some background research to update the project concept note.	Task 1 : Everyone Task 2 : Arnob, Mahir Task 3 : Arefeen & Niloy Progress:Completed	
04.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Modified the title and problem statement. 2.Prepared flowchart	Task 1: Arnob, Mahir & Arefeen Progress:Completed Task 2 : Arefeen & Niloy. (Partially Completed)	
05.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1.Methodology 2.Specification, Components	1.Niloy & Arefeen 2. Arnob & Mahir Progress:Completed	
6.4.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	Budget Allocation for design 1	Task: Everyone Progress:Completed	
7.04.2022 (**FYDP Committee** **Speaker: Mohaimenul Islam,** **Dr. Abu S. M. Mohsin**)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	Project Safety, Sustainability and Environmental Impact		
7.04.2022	1. Arnob 2. Mahir	1.Referencing 2.Expected Outcome	1.Everyone 2.Arnob & Mahir	

(Group Meeting)	3. Arefeen 4. Niloy	3.Project Planning	3.Arefeen & Niloy Progress:Completed	
9.04.2022 (ATC Meeting)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Md. Nahid Haque Shazon 3. Afrida Malik Student: 1. Arnob 2. Mahir 3. Arefeen 4. Niloy			1. Submit the powerpoint slides on 17th April. 2. Submit the draft of project proposal on 21st April. 3. Modify some of the parts in project proposal. 4. Add explanation regarding complex engineering problems and activities.
10.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Budget allocation for design 2. 2. Made planning (date) for EEE400D and EEE400P.	Task 1: Arnob and Mahir Task 2: Arefeen and Niloy. Progress:Completed	
12.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Prepared Gantt Chart for EEE400P, EEE400D, EEE400C.	Task 1: Everyone.	
13.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Went through some papers for the sustainability part. 2. Prepared Impact for the proposal.	Task 1: Arnob and Arefeen Task 2: Mahir and Niloy Progress: Task 1: Partially Completed. Task 2: Partially Completed.	
15.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Prepared the sustainability part. 2. Prepared the impact	Task 1: Arnob and Arefeen. Task 2: Mahir and Niloy. Progress:Completed	
16.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Divided some papers among us for ethical consideration, risk management and analysis, safety consideration.	Task 1: Everyone.	

17.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Prepared ethical consideration. 2. Prepared safety consideration. 3. Started preparing powerpoint slides.	Task 1: Arnob and Mahir Task 2: Arefeen and Niloy. Task 3: Everyone. Progress: Task 1 and 2: Completed. Task 3: Partially completed.	
18.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Completed the risk management and analysis part. 2. Completed preparing the slides.	Task 1: Everyone. Task 2: Everyone. Progress:Completed	
20.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Added explanation about the complex engineering problems and activities.	Task 1: Problems : Arnob and Arefeen. Activities: Mahir and Niloy. Progress:Completed	
21.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Checked the overall project proposal for modification. 2. Modified some of the parts of the proposal. 3. Added some references.	Task 1/2/3: Everyone. Progress:Completed	
21.04.2022	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	Draft Project Proposal Submission		
23.04.2022 (ATC Meeting)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Md. Nahid Haque Shazon 3. Afrida Malik Student: 1. Arnob 2. Mahir 3. Arefeen 4. Niloy	Mock Presentation		1. Add cleaning and cooling system in future part of conclusion. 2. Provided SWERA report data of Bangladesh. 3. Feedback on draft proposal and slide presentation.

26.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Checked the overall project proposal. 2. Modified the page numbers.	Task 1: Everyone Task 2: Mahir & Arnob. Progress : Completed	
27.04.2022 (Group Meeting)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy	1. Added SWOT analysis for alternative design. 2. Modified the references.	Task 1: Arefeen & Niloy. Task 2 : Arnob & Mahir. Progress : Completed	
28.04.2022 (Final Presentation)	1. Arnob 2. Mahir 3. Arefeen 4. Niloy			Feedback on 1. Variation of sun hours.. 2. Stakeholders.

FYDP (D) Summer 2022 Summary of Team Log Book/Journal

Group - 11

Project Title:

Automated Solar Tracking System for Increasing Solar Irradiance Capture to Improve Power Generation.

	Final Year Design Project (P) Summer 2021		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Arnob Tarafder (19121103)	arnob.tarafder@g.bracu.ac.bd	01765597349
Member 2	Mohammad Mahir Abrar (19121113)	mohammad.mahir.abrar@g.bracu.ac.bd	01827225252
Member 3	Md. Arefeen Mondol (19121105)	md.arefeen.mondol@g.bracu.ac.bd	01790732926
Member 4	Niloy Roy Chowdhury (19121104)	niloy.roy.chowdhury@g.bracu.ac.bd	01865003327
ATC Details:			
ATC 3			
Chair	Dr. AKM Abdul Malek Azad	a.azad@bracu.ac.bd	
Member 1	Afrida Malik	afrida.malik@bracu.ac.bd	
Member 2	Mohammed Thushar Imran	thushar.imran@bracu.ac.bd	

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
02.06.2022 (**FYDP Committee Meeting;l)** **Speaker: Md. Rakibul Hasan**)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Introduction of FYDP-D (EEE 400D)		N/A.
06.06.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Went through some papers for design and simulation.	Task 1 : Arnob, Mahir, Arefeen, Niloy.	
08.06.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Discussion on various tools.	Task 1 : Arnob, Mahir, Arefeen, Niloy.	
09.06.2022 (**ATC Panel Meeting 1**)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on how the sessions will be conducted. 2. Template of the logbook and design report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed. Task2: Partially Completed.	1. Submit a revised time frame for the semester. 2. Collect some relevant papers on simulation. 3. Get information on relevant tools
12.06.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Revising the time frame for the semester	1 : Arnob, Mahir, Arefeen, Niloy.	
14.06.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Discussion on various tools	Task 1 : Arnob, Mahir, Arefeen, Niloy.	
18.6.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Went through some papers for design and simulation	Task 1 : Arnob, Mahir, Arefeen, Niloy.	
20.6.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Designing the proteus layout Tracking system	Task 1 : Arnob, Mahir, Arefeen, Niloy. Partially Completed	
21.6.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Designing the proteus layout tracking system.	Task 1 : Arnob, Mahir, Arefeen, Niloy.	

			Progress: Partially Completed	
23.6.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Coding for tracking system. 2. Designing the layout. 3. Report writing	Task 1. Arefeen and Niloy. Task 2. Mahir and Arnob. Task 3. Arnob, Mahir, Arefeen Progress : Task1: Partially Completed. Task2: Partially Completed. Task 3: Partially Completed.	
24.6.2022 (Group Meeting)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Solving issues regarding coding for design 1	1. Arnob, Mahir, Arefeen, Niloy. Progress : Partially Completed	
25.6.2022 (ATC Panel Meeting 2)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Add table of content 2. Redo background research and citation. 3. Change the multiple design approach. 4. Description of modern IT tools. 5. Add the gantt charts 6. Study on motor drivers	Task 1: Mahir Task 2: Arnob Task3: Arnob, Mahir, Arefeen,Niloy Task 4: Arnob Task 5: Niloy Task 6: Arnob, Mahir, Arefeen,Niloy Progress: Task 1: Partially completed Task 2: Completed Task 3: Partially completed Task 4: Completed Task 5: Completed Task 6: Partially completed	1. Add description and block diagrams for multiple design 2.Add a risk management matrix for risk management and contingency plan. 3.Give specification in tabular method for both system level and component level specification. 4.Only follow IEEE reference format
27.6.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Multiple Design with stepper motor. 2. Gantt chart preparation.	Task 1. Arefeen, Mahir, Arnob Task 2. Mahir, Niloy Task1: Completed	

			Task 2: Completed	
29.6.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Slide Preparation.	Task: Arnob, Mahir,Arefeen, Niloy Progress: Completed	
30.6.2022 (FYDP Committee Meeting- 2 : Progress Presentation)	FYDP Committee 1. Mohammed Belal Hossain Bhuian 2. MD. Rakibul Hasan. 3. Abu Hamed M. Abdur Rahim 4. Afrida Malik **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Feedback On Multiple Design. Advised to go through papers based on a tracking system using no light dependent sensors and using solar maps.	Task: Arnob, Mahir,Arefeen, Niloy Progress: Completed	
3.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Fixing problem of rotation angle of servo motor 2. Going through papers for multiple design approaches. 3.Modifying Budget	Task 1: Arefeen, Mahir. Task 2: Arefeen, Mahir, Arnob, Niloy. Task 3: Arnob, Mahir. Progress: Task 1: Completed Task 2: Partially Completed. Task3: Completed.	
5.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Simulation Design of the monitoring system 2. Drawing the design overview diagram of design 1 3. Going through papers for multiple design approaches.	Task 1: Arnob, Arefeen. Task2: Mahir Task3: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Completed Task 2: Completed Task 3: Partially Completed.	
7.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Coding for monitoring system 2. Description about modern IT tools. 3. Details about functional requirements.	Task 1: Arefeen, Niloy Task 2: Arnob, Mahir. Task3: Arnob, Mahir. Progress: Task 1: Completed Task 2: Completed	

			Task 3: Completed.	
13.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Debugging of code for monitoring system 2. Modifying Ethical consideration and risk management. 3. Logbook Update	Task 1: Arefeen Task 2: Mahir, Niloy. Task 3: Arnob , Mahir, Arefeen. Progress: Task 1: Completed Task 2: Partially Completed Task 3: Completed.	
15.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Verification of motor rotation & collecting values of parameters. 2. Logbook Update	Task 1. Arefeen, Arnob, Mahir. Task 2. Mahir, Niloy Progress: Task 1: Completed Task 2: Completed	
20.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Troubleshooting of servo motor rotation. 2.Taking revised data.	Task 1. Arefeen, Arnob, Mahir. Task 2. Mahir, Niloy Progress: Task 1: Completed Task 2: Completed	
23.7.2022 (ATC Panel Meeting 3)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Pointinting out different mistakes of report and fixation. 2.Focus on stepper motors for multiple design approaches.	Task1: Arnob, Mahir, Arefeen, Niloy Task2: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Completed Task 2: Partially Completed	1. Logbook need to be modified. 2.Redo Table of content 3.Give numbers for figures and table 4.Maintain alignment 5.Focus on servo/stepper controller differences, drive system, control mechanism of actuators.
25.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Modification of logbook. 2. Redo Table of content.	Task1: Arnob, Mahir Task 2: Niloy, Arefeen Progeress: Task 1: Completed Task 2: Partially Completed	

27.7.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Modification for report writing. 2. Study on servo/stepper controller differences, drive system, control mechanism of actuators.	Task1: Arnob, Mahir Task 2: Niloy, Arefeen, Arnob, Mahir. Progeress: Task 1: Completed Task 2: Partially Completed	
30.7.2022 (ATC Panel Meeting 4)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students: (Absent)** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy **Reason:** There was an industrial tour of EEE 431/432 course on this day. We should have joined the meeting but due to our own misunderstanding and inconvenience, We didn't join the meeting without our ATC panel's permission.			
1.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Study on servo/stepper controller differences, drive system, control mechanism of actuators. 2.Designing the proteus layout tracking system for multiple designs.	Task 1: Arnob, Mahir Arefeen, Niloy. Task 2: Arefeen, Arnob, Mahir. Progress: Task 1: Partially Completed Task 2: Partially Completed	
2.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir		Task 1: Arefeen Task 2: Arefeen, Arnob, Mahir.	

	3.Arefeen 4.Niloy	1. Coding for tracking system for multiple designs. 2. Designing the layout for multiple designs.	Progress: Task 1: Partially Completed Task 2: Partially Completed	
3.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Coding for tracking system for multiple designs. 2. Designing the layout for multiple designs. 3. Adding system specification. 4.Risk Management Matrix 5.Redoing ethical consideration	Task 1: Arefeen Task 2: Arefeen, Arnob, Mahir. Task 3: Mahir Task 4: Arnob Task 5: Niloy Progress: Task 1: Partially completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Completed	
4.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1.Drawing the design overview diagram of design 2. 2. Fixing problem of rotation angle of stepper motor 3. Logbook update	Task 1: Mahir, Arnob Task 2: Arefeen, Niloy Task 3: Arnob Progress: Task 1: completed Task 2: Partially Completed Task 3: Completed	
5.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Fixing errors of report 2. Logbook update	Task 1: Arefeen, Arnob, Mahir. Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
6.8.2022 (ATC Panel Meeting 5)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Received feedback on design report. 2. Study on motor drive of servo and stepper motor. 3. Control Mechanism of servo and stepper motor.	Task 1: Arnob, Mahir Task 2: Arnob, Mahir. Task 3: Niloy, Arefeen Progress: Task 1: Completed Task 2: Partially Completed Task 3: Partially Completed	1. Add table numbers 2. Explanation on bar chart. 3. Describe the bar charts and tables with some words. 4. In budget replace servo and stepper with design 1 and design 2. 5. Correction on Ethical Consideration. 6. In Risk Management write

				management procedures instead of responsibility.
9.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Added the table numbers. 2. Explained the bar charts. 3. Description on bar charts and tables	Task 1: Niloy Task 2 : Arnob Task 3 : Arefeen and Mahir Progress: Task 1: Completed Task 2: Completed Task 3: Completed	
11.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Corrected the ethical consideration and risk management part. 2. Stepper Motor Simulation	Task 1: Niloy Task 2: Arefeen, Mahir and Arnob Progress: Task 1: Completed Task 2: Partially Completed	
12.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Updated logbook. 2. Updated the design report. 3. Discussion on control mechanism of motors.	Task 1: Niloy and Mahir. Task 2 : Mahir and Arnob. Task 3: Arnob, Mahir, Arefeen and Niloy. Progress: Task 1: Completed Task 2: Completed Task 3: Partially Completed.	
13.8.2022 (ATC Panel Meeting 6)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen	Task 1: Complete stepper motor simulation Task 2: Study control mechanism of servo motor Task 3: Study control mechanism of stepper Motor Task 4: Understand the	Task 1: Arefeen, Mahir and Arnob Task 2: Arnob, Mahir Task 3: Arefeen, Niloy Task 4: Arnob, Arefeen, Mahir, Niloy Progress:	1. Add Table Title 2. Add data table for design 2 3. Add comparison for both designs 4. Swot analysis for both designs.

	4.Niloy	code of both simulation designs.	Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	5. Finish impact and include summary.
15.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Stepper Motor Simulation Task 2: Debugging Code	Task 1: Arefeen and Arnob,Niloy Task 2: Arefeen, Arnob, Mahir Progress: Task 1: Partially Completed Task 2: Partially Completed	
16.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Stepper Motor Simulation Task 2: Debugging Code	Task 1: Arefeen and Arnob,Niloy Task 2: Arefeen, Arnob, Mahir Progress: Task 1: Completed Task 2: Completed	
18.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Study control mechanism of servo motor Task 2: Study control mechanism of stepper Motor Task 3: Understand the code of both simulation designs.	Task 1: Arnob, Mahir Task 2: Arefeen, Niloy Task 3: Arnob, Arefeen, Mahir, Niloy Progress: Task 1: Completed Task 2: Completed Task 3: Completed	
19.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Completing swot analysis for design 1 Task 2: Completing swot analysis for design 2 Task 3: Completing impact Task 4: Completing summary	Task 1: Arnob, Mahir Task 2: Arefeen, Niloy Task 3: Arnob, Arefeen, Mahir, Niloy Task 4: Arefeen Progress: Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	

20.8.2022 (ATC Panel Meeting 7)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Study on how a servo is giving a precise output Task 2: Measure the time delay of both systems. Task 3: Study about the pin diagram of motor drivers.	Task 1: Niloy, Arefeen, Mahir, Arnob. Task 2: Arefeen, Arnob, Mahir, Niloy Task 3: Arnob,Mahir,Niloy, Arefeen Progress: Task 1: Completed Task 2: Completed Task 3: Completed	1. Correct Cost Analysis 2. Add the cost of an optical encoder for a stepper motor. 3. Keep the both swot analysis on the same page.
24.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Improvement of Result analysis table Task 2: Adding Comparison Table for multiple design approach	Task 1: Arefeen, Arnob, Mahir, Niloy Task 2: Arnob,Mahir,Niloy, Arefeen Progress: Task 1: Completed Task 2: Completed	
25.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Correction for cost table Task 2: Study about Pin Diagrams of motor driver	Task 1: Arefeen, Arnob, Mahir, Niloy Task 2: Arnob,Mahir,Niloy, Arefeen Progress: Task 1: Completed Task 2: Completed	
26.8.2022 (Group Meeting)	**Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Slide Preparation Task 2: Logbook Update	Task 1: Arefeen, Arnob, Mahir, Niloy Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
28.8.2022 (ATC Panel Meeting 8)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	Task 1: Add time delay to the report. Task 2: Study on Operating Principle of servo and stepper motor. Task 3: Add conclusion to the slide.	Task 1: Niloy, Arefeen, Mahir, Arnob. Task 2: Arefeen, Arnob, Mahir, Niloy Task 3: Arnob,Mahir,Niloy, Arefeen Progress: Task 1: Completed	1. Fix the formatting errors. 2. Correct the punctuations. 3. Add reference number 16

			Task 2: Completed Task 3: Completed	

FYDP (C) FALL 2022 Summary of Team Log Book/Journal

Project Title:

Automated Solar Tracking System for Increasing Solar Irradiance Capture to Improve Power Generation.

	Final Year Design Project (C) Fall 2022		
Group-3			
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Arnob Tarafder (19121103)	arnob.tarafder@g.bracu.ac.bd	01765597349
Member 2	Mohammad Mahir Abrar (19121113)	mohammad.mahir.abrar@g.bracu.ac.bd	01827225252
Member 3	Md. Arefeen Mondol (19121105)	md.arefeen.mondol@g.bracu.ac.bd	01790732926
Member 4	Niloy Roy Chowdhury (19121104)	niloy.roy.chowdhury@g.bracu.ac.bd	01865003327
ATC Details:			
ATC 3			
Chair	Dr. AKM Abdul Malek Azad	a.azad@bracu.ac.bd	
Member 1	Afrida Malik	afrida.malik@bracu.ac.bd	
Member 2	Mohammed Thushar Imran	thushar.imran@bracu.ac.bd	

Date/Time/ Place	Attendance	Summary of Meeting Minutes	Responsible	Comment by ATC
29.9.2022 (**FYDP Committee)** **Speaker: Dr. Abu S.M. Mohsin**	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	Introduction of FYDP-C (EEE 400C)		N/A.
1.10.2022 (Group Meeting-1)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1.Visiting different electronics shops and comparing prices.	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed	
2.10.2022 (Group Meeting-2)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Went through some papers for design.	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed	
4.10.2022 (Group Meeting-3)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Ordering Components	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed	
6.10.2022 (ATC Meeting-1)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir (Had some issues regarding camera) 3.Arefeen 4.Niloy	1. Discussion on how the sessions will be conducted. 2. Template of the logbook and design report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed. Task2: Partially Completed.	1. Submit a revised time frame for the semester. 2. Submit a revised budget for the components. 3. Study about why using a temperature sensor. 4. Get information on relevant equipments

8.10.12 (Group Meeting-4)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1.Get information on relevant equipment.	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed	
10.10.12 (Group Meeting-5)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Revising time frame and gantt chart for EEE400C.	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1:Completed	
11.10.12 (Group Meeting-6)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Collecting components. 2. Updating Budget and component specification.	Task 1: Arnob, Mahir, Arefeen, Niloy Task 2: Arnob, Mahir, Arefeen. Progress: Task 1: Partially Completed Task 2: Completed	
12.10.12 (Group Meeting-7)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Study about why using a temperature sensor. 2. Logbook update.	Task 1: Arnob, Mahir, Arefeen, Niloy Task 2: Arnob Task 1: Partially Completed Task 2: Completed	
14.10.12 (Group Meeting-8)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Study about why using a temperature sensor. 2. Research on the structural stand of the solar tracker	Task 1: Arnob, Mahir, Arefeen, Niloy Task 2: Arnob, Mahir, Arefeen. Progress: Task 1: Completed Task 2: Partially Completed	
16.10.2022 (ATC Meeting-2)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on the overall progress of components and report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	1. Gather some more ideas about the mounting stand and the overall prototype.

17.10.2022 (Group Meeting-9)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Went through some papers for design.	Task 1: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed	
19.10.2022 (Group Meeting-10)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Updating Report 2. Updating Logbook 3. Went through some papers for design.	Task 1: Arnob, Mahir, Arefeen, Niloy Task 2: Arnob Task 3: Arnob, Mahir, Arefeen, Niloy Progress: Task 1: Partially Completed Task 2: Completed Task 3: Partially Completed	
20.10.2022 (ATC Meeting-3)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on the overall progress of components and report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	1. Add MPPT solar charge controller to the future work. 2. Test the motors. 3. Give an update on the mounting stand.
22.10.2022 (Group Meeting-11)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1.Bought some wood for the structure	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	
23.10.2022 (Group Meeting-12)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1.Tried to make the mounting structure.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	

25.10.2022 (Group Meeting-13)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Testing the motor. 2. Research on the mounting stand.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed Task2: Partially Completed	
26.10.2022 (Group Meeting-14)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Report update 2. Logbook update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed Task2: Completed	
27.10.2022 (ATC Meeting-4)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on the overall progress of components and report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	1. Add some graphs for the performance evaluation found from simulation. 2. Submit a draft slide for progress presentation.
31.10.2022 (Group Meeting-15)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1.Testing the motor rotation with the LDR sensors. 2. Preparing Slide	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed. Task 2: Completed	
3.11.2022 Progress Presentation **(FYDP Committee)**	1.Arnob 2.Mahir 3.Arefeen 4. Niloy **FYDP Committee:**			Asked a query about if the motor we were using enough for carrying the load.

	1. Taiyeb Hasan Sakib **2. Dr. Abu S.M. Mohsin**			
11.11.2022 (Group Meeting-16)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Testing the motor rotation with the LDR sensors 2. Report Update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed. Task 2: Partially Complete	
12.11.2022 (Group Meeting-17)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Assembling Motor and Solar Panel with the mounting stand. 2. Report Update 3. Logbook Update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Task 3: Arnob Progress: Task1: Partially Completed. Task 2: Partially Complete Task 3: Completed	
13.11.2022 (ATC Meeting-5)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on the overall progress of prototype and report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed.	1. Fix formatting issues of report. 2. Add Page Numbers for Index 3. Study about the arrangement of the position of the LDR sensors. 4. Measure the movement angle of the solar panel 5. Number the group meetings in the logbook.

15.11.2022 (Group Meeting-18)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Study about the arrangement of the position of the LDR sensors. 2. Measure the movement angle of the solar panel	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed. Task 2: Completed	
16.11.2022 (Group Meeting-19)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Fixing issues and updating the report. 2. Logbook Update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2: Arnob Progress: Task 1: Partially Complete Task 2: Completed	
17.11.2022 (ATC Meeting-6)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy	1. Discussion on the overall progress of the prototype such as measurement angle, LDR data and report.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed	1. Measure the movement angle of the solar panel 2. Take the LDR data 3.Implement the sensors.
19.11.2022 (Group Meeting-20)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Research and discussion about the implementation of the sensors.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed	
21.11.2022 (Group Meeting-21)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Implementing the current and voltage sensors with the prototype.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed	

23.11.2022 (Group Meeting-22)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Implementing a MPPT charge controller along with a power supply to power up the overall system. 2. Adding a buck converter to reduce voltage from the battery.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
27.11.2022 (Group Meeting-23)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Testing some data for the functionality. * Faced display and sensor malfunctioning issues along with structural problems in the mounting stand.	Task 1 : Arnob, Mahir, Arefeen, Niloy Task 1: Partially Completed	
28.11.2022 (Group Meeting-24)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Fixing display issues. 2. Fixing sensor issues	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
29.11.2022 (Group Meeting-25)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Assembling the sensors with the tracking system. 2. Making some functional videos	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
30.11.2022 (Group Meeting-26)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Report Update 2. Logbook Update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2: Arnob Progress: Task 1: Completed Task 2: Completed	
1.12.2022 (ATC Meeting-7)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik. 3. Mohammed Thushar Imran	1. Discussion on the overall progress of the prototype and the issues of the mounting stand.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed	1. Fix the mounting stand issue.

	Students: 1.Arnob 2.Mahir 3.Arefeen 4.Niloy			
3.12.2022 (Group Meeting-27)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Went to see Munir sir regarding the issues of the mounting stand. 2. Bought a bearing and other components for fixing the stand issue.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Partially Completed Task 2: Completed	
4.12.2022 (Group Meeting-28)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Fixing the mounting stand	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed	
6.12.2022 (Group Meeting-29)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Redoing and reassembling the whole electrical part.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed	
7.12.2022 (Group Meeting-30)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Report Update 2. Slide Preparation 3. Logbook update	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Task 3: Arnob Progress: Task1: Partially Completed. Task 2: Completed Task 3: Completed	
8.12.2022 (ATC Meeting-8)	**ATC Members:** 1. Dr. AKM Abdul Malek Azad (Chair) 2. Afrida Malik.	1. Mock Presentation 2. Discussion on updating and modifying slides.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed.	1. Give the figure name in slides. 2. Include CO and EP in the slide 3. Include risk management and sub points of future work.

	3. Mohammed Thushar Imran **Students:** 1.Arnob 2.Mahir 3.Arefeen 4.Niloy		Task 2: Completed	
10.12.2022 (Group Meeting-31)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Tested data for PV panel in fixed construction.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed.	
11.12.2022 (Group Meeting-32)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Tested data for PV panel in tracking construction.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed.	
14.12.2022 (Group Meeting-33)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Report Update. 2. Slide modification. 3. Logbook Update.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Task 3: Arnob Progress: Task1: Completed. Task 2: Completed Task 3: Completed	

15.12.2022 Final Presentation **(FYDP Committee)**	1.Arnob 2.Mahir 3.Arefeen 4. Niloy **FYDP Committee:** **1. Tashfin Mahmud** **2. Dr. Abu S.M. Mohsin** **ATC Committee** Mohammed Thushar Imran			Asked a query about the efficiency increase of our proposed.
19.12.2022 (Group Meeting-34)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Efficiency calculation for the rated panel 2. Efficiency calculation for the tracking system.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Progress: Task1: Completed Task 2: Completed	
20.12.2022 (Group Meeting-35)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. Report Update. 2. Slide modification. 3. Logbook Update.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Task 3: Arnob Progress: Task1: Completed. Task 2: Completed Task 3: Completed	

22.12.2022 (Group Meeting-36)	1.Arnob 2.Mahir 3.Arefeen 4. Niloy	1. FInal Report Update. 2. Final Slide modification. 3. Logbook Update.	Task 1 : Arnob, Mahir, Arefeen, Niloy. Task 2 : Arnob, Mahir, Arefeen, Niloy. Task 3: Arnob Progress: Task1: Completed. Task 2: Completed Task 3: Completed	