DESIGN AND FABRICATION OF

SOLAR PANEL WITH SUN POSITION TRACKING

A MINI PROJECT REPORT

Submitted by

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For the award of degree

Of

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In

MECHATRONICS ENGINEERING

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ENGINEERING AND TECHNOLOGY

(An Autonomous Institution)

(Approved by AICTE and Affiliated to Anna University, Chennai)

ACCREDITED BY NAAC WITH 'A' GRADE

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BONAFIDE CERTIFICATE

Certified that this Industrial project report **"DESIGN AND FABRICATION OF SOLAR PANEL WITH SUN POSITION TRACKING"**is the bonafide work of **"N. THARUN SRI RAM (18EUMT106), S. VENUPRASATH (18EUMT112), K. TANSIN (18EUMT104) , S. SUBBIAH (18EUMT112)"** who carried out the project work under my supervision.

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This Industrial project work report is submitted for the Autonomous Project Viva-voce examination held on _____________

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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At this juncture, we take the opportunity to convey our sincere thanks and gratitude to the management of the college for providing all the facilities to us.

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ABSTRACT

In this present world an issue we all face together is power/energy shortage. The Traditional energies we use such as petroleum, diesel cause pollution and is also limited. The world is shifting towards renewable energy resources that do not cause harm to the environment and is also available in abundance.The most popular renewable energy that we use is solar energy.

Conventional solar panels has certain disadvantages such as location, Sun availability, Installation area, Reliability etc.conventional solar cells and solar panels operate between an minimum sunlight. Hence the conventional solar panels make up for this problem by increasing the size and number of solar panels.This results in a large investment as solar panels are costly.

Our Product is designed in such a way that instead of the solar panels being setup in a fixed area like conventional models , our product moves the solar panel in direction of the sunlight so as to obtain maximum sunlight which converts it to electricity so as to increase the effeciency.The solar tracker moves in a direction where the intensity of the sunlight is maximum with the help of the LDR sensor.By this method we are increasing the effeciency from the conventional method , and also very minimum electricity is used for their movement.

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CHAPTER - 1

INTRODUCTION

1.1 INTRODUCTION

The Main problem faced by many countries especially the third world countries is power shortage and energy requirement.This is pushing the researchers to find a way to produce more energy and that too in an environmentally friendly way.The alternative energy sources include solar, nuclear and wind. Solar energy is the energy generated by harnessing the power of the solar radiation. It is the cleanest source of energy which can pollute the climate the least. The power from the sun intercepted by the earth is many thousands of times larger than the present consumption rate on the earth from all other in-use commercial energy sources. . This problem can be rectified by a device solar tracker which ensures maximum intensity of sun rays hitting the surface of the panel from sun-rise to sunset.

Automatic solar tracker increases the efficiency of the solar panel by keeping the solar panel aligned with the rotating sun. Solar tracking is a mechanized system to track the sun's position that increases power output of solar panel 30% to 60% than the stationary system. Available solar trackers in the market are much costly to integrate with solar panel system . In the developing countries where cost is one of the major issues to integrate technologies this method can be a less costly way of incorporating this technology.

1.2 OBJECTIVE OF PROJECT WORK

The main objective of the project is to design and fabrication of Solar panel with sun position tracking system. The LDR sensors sense the movement of the sunand send the information to the Arduino, and the servo motors are moved according to the output of the controller.

In the minimal and maximal intensity of sunlight, the code programmed into the Arduino adjusts the tracker in such a way as to get the maximum intensity of the sunlight.

1.3 ORGANISATION OF CHAPTERS

1. Introduction:

The concept of producing a solar tracker with minimum cost and maximum efficiency is explained here.

2. Literature Review:

Research on various journal is made to know different technologies implemented in Solar tracking system.

3. System Design:

In this chapter the existing system design is illustrated along with all the ways in which this more efficient system is proposed.

4. Design Calculation:

Here the selection of components has been made according to the calculation values of Solar tracking system and the panel selection has been verified.

5. Bill of Materials And Design:

In this chapter all drawings of the material with parts and sub assemblies along With bills of materials are listed

6. Cost Estimation:

The overall cost estimation is made including all factors like purchase of required items, labor cost etc.

7. Conclusion:

This chapter wraps all the benefits of the machine being manufactured.

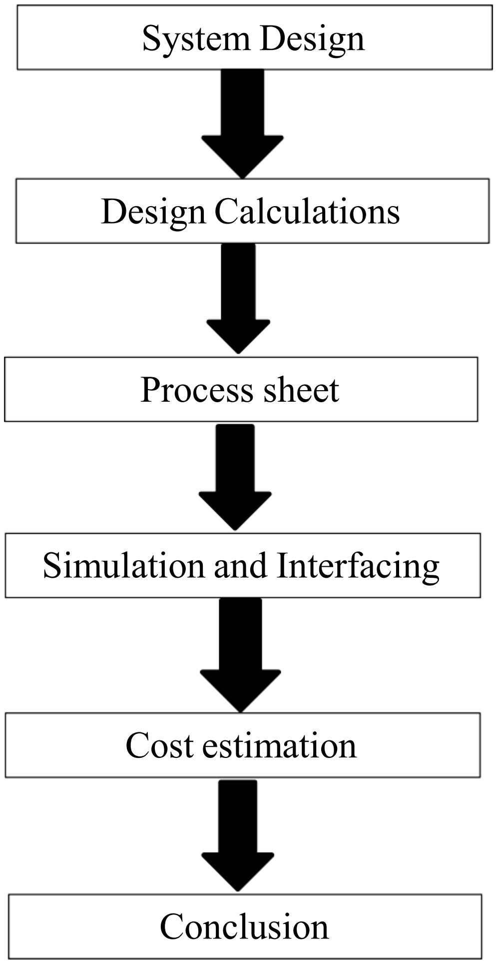

FIG 1.3 Organisation of chapter

1.4 CONCLUSION

The objective of this project work has been framed into chapters for the Development of Solar panel with sun position tracking system.Programming, assembly process and design calculations along with photos have been included in the following chapters.

CHAPTER- 2

LITERATURE REVIEW

2.1 INTRODUCTION

Before starting this project, it is important to research existing machines and the technologies used in them. This will help us understand any existing problems and try to find solutions for these problems in such a way that it can be implemented in our project. Going through the literature also helps us understand the practical outcomes of the project and how to attain the required outcomes.

2.2 RESEARCH ON VARIOUS JOURNALS

C. J. Nwanyanwu 1 Works and Service Department, Federal School of Surveying, Oyo, Nigeria Presented a paper in Title called Test of a Solar Tracking System Using Photo Sensor The Technology used For the tracking system to be able to detect and respond quickly to the movement of the sun away from the Light Dependent Resistor The conclusion Derived is We use the technology of effective automatic solar tracking. Apurv Deshmukh Department of Mechanical Engineering Lokmanya Tilak College of Engineering Navi Mumbai, India Presented a paper in Title called Design and Analysis of Automated Dual Axis Solar Tracker Based on Light Sensors The Technology used is solar energy can be collected more effectively at unfavourable locations and weather conditions, as well as, compare data with single axis solar system The conclusion Derived is We use this technology for effective placement of LDR sensor. Prachi Rani Electrical Engineering Department Gautam Buddha University Greater Noida, Uttar Pradesh, India Presented a paper in Title called An Analysis on Arduino based Single Axis Solar Tracker The Technology used is Alignment of solar panel with the Sunlight for getting maximum solar radiation is experiment The conclusion Derived is Implementing an automatic single axis solar tracking system.

2.3 CONCLUSION

Thus, research was done regarding this project on various sources of literature. The many methodologies were studied and this information has helped to complete the project successfully.

CHAPTER- 3

SYSTEM DESIGN

3.1 INTRODUCTION:

Knowing about the existing system is more important to model a automated version of the same system. This chapter gives outlook of the existing model and proposed model with drawings.

3.2 EXISTING SYSTEM:

The typical home needs around 14-36 PV solar panels to cover their electricity bill.Although solar panels are much smaller nowadays, the average residential solar panel dimensions are about 5.4ft by 3.25ft, which is approximately 17.5 ft^2.So for 20 solar panels, hence we will need about 351 ft^2 of roof space, which is quite alot.

Fig 3.2 Existing system

3.3 PROPOSED SYSTEM

The disadvantages of the existing systems can be reduced by converting it into Automatic sun position tracking system

3.3.1 BATTERY

Batteries convert chemical energy directly to electrical energy. A battery consists of some number of voltaic cells. These voltaic cells consist of certain chemical compositions where the chemical reactions takes places. Each cell consists of two half cells connected by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the negative electrode, the electrode to which anions (negatively charged ions) migrate; the other half-cell includes electrolyte and the positive electrode to which cations (positively charged ions) migrate. Redox reactions power the battery. Cations are reduced (electrons are added) at the cathode during charging, while anions are oxidized (electrons are removed) at the anode during charging. During discharge, the process is reversed. The electrodes do not touch each other, but are electrically connected by the electrolyte

Fig 3.3.1 Battery

3.3.2 SOLAR PANEL

The term solar panel is used colloquially for a PV module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photo voltaic system supply electrical energy to electrical equipment.Each module is rated by its DC output power under standard test conditions (STC) and hence the on field output power might vary. Power typically ranges from 100 to 365 Watts (W). The effeciency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. Some commercially available solar modules exceed 24% efficiency. Currently, the best achieved sunlight conversion rate (solar module efficiency) is around 21.5% in new commercial products typically lower than the efficiencies of their cells in isolation. The most efficient mass-produced solar modules have power density values of up to 175 W/m^2 .

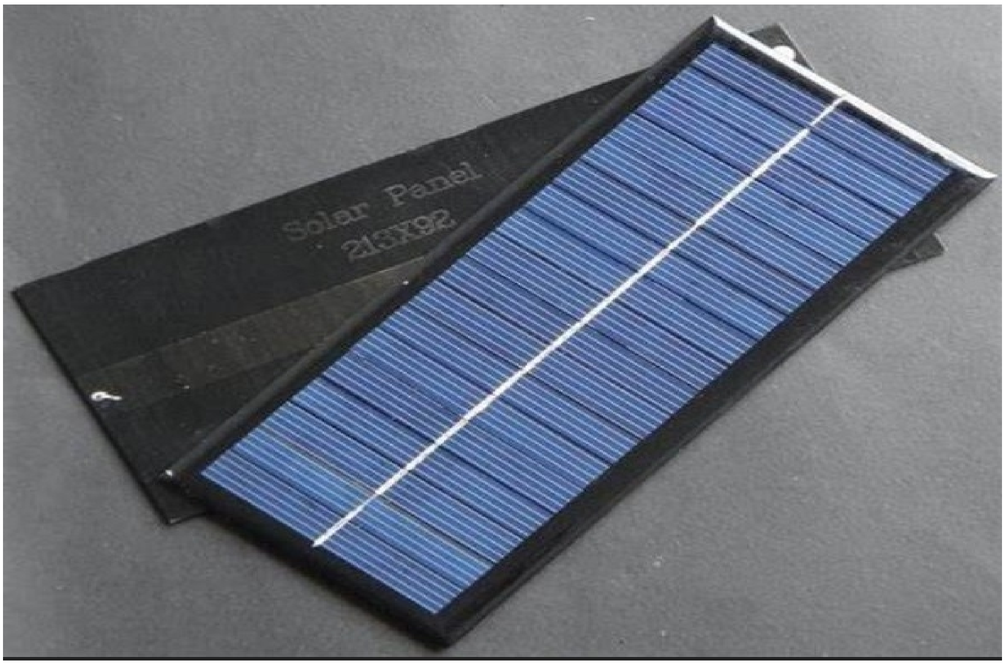

Fig 3.3.2 Solar panel

3.3.3 ARDUINO UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328Pmicrocontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output(I/O)pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE(Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery,though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0

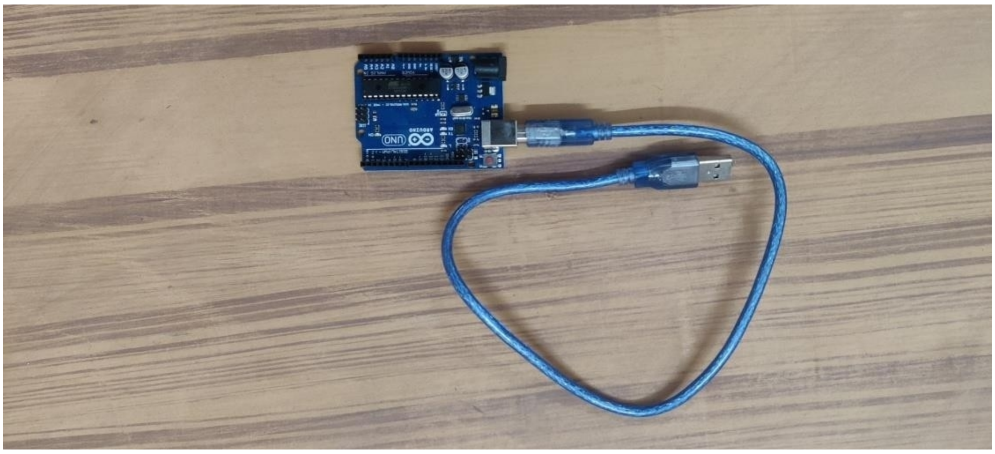

Fig 3.3.3 Arduino

3.3.4 LDR SENSOR

A photoresistor or LDR (Light Dependent Resistor), as the name suggests will change it resistance based on the light around it. That is when the resistor is placed in a dark room it will have a resistance of few Mega ohms and as we gradually impose light over the sensor its resistance will start to decrease from Mega Ohms to few Ohms.This system works by sensing the intensity of light in its environment. The sensor that can be used to detect light is an LDR. It's inexpensive, and you can buy it from any local electronics store or online.

The LDR gives out an analog voltage when connected to VCC (5V), which varies in magnitude in direct proportion to the input light intensity on it. That is, the greater the intensity of light, the greater the corresponding voltage from the LDR will be. Since the LDR gives out an analog voltage, it is connected to the analog input pin on the Arduino. The Arduino, with its built-in ADC (analog-to-digital converter), then converts the analog voltage (from 0-5V) into a digital value in the range of (0-1023). When there is sufficient light in its environment or on its surface, the converted digital values read from the LDR through the Arduino will be in the range of 800-1023.

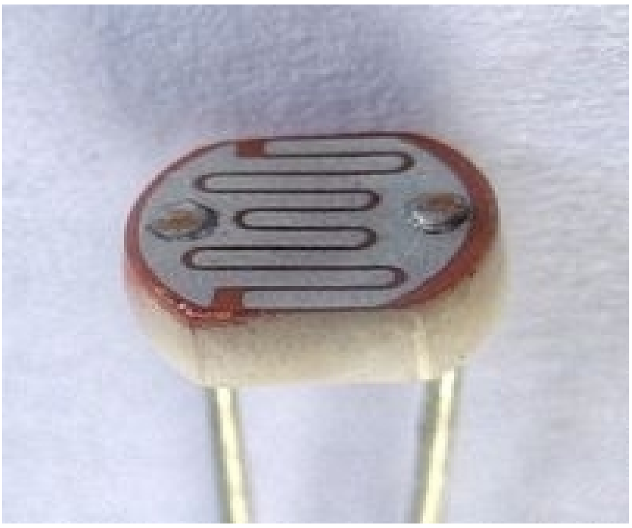

Fig 3.3.4 LDR sensor

3.3.4 JUMPER WIRES

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.Though jumper wires come in a variety of colors, the colors don't actually mean anything. This means that a red jumper wire is technically the same as a black one. But the colors can be used to your advantage in order to differentiate between types of connections, such as ground or power.Jumper wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

Fig 3.3.5 Jumper wires

3.3.5 LCD DISPLAY WITH I2C/IIC INTERFACE

Whenever we work with embedded system we need a reliable output device with the help of which we get the required information, now this problem is solved with the introduction of 16 character by 2 i.e. 16X2 LCD Display with IIC/I2C interface. 16×2 LCD is an alphanumeric display that can show up to 32 characters on a single screen. You can display more characters by scrolling the texts one by one. We already know that to connect LCD Display directly with the Arduino using 4bit and 8bit modes will utilize many numbers of GPIO Pins of our Arduino or other boards and we would have to end up with less number of pins for other sensors and actuators.To overcome this problem we use LCD I2C backpack with our LCD. This I2C Backpack uses PCF8574 Remote 8 bit I/O Expander. It translates the data received from the I2C Bus into Parallel data that is needed for the LCD Display.Inter-integrated Circuit (in short I2C) is a two-wire short distance communication protocol. You can use multiple slave devices in the same two wires with one or more master controllers. . By using the address the data is sent to the specific device connected on the same I2C Bus.

Fig 3.3.6 Lcd display with I2C\IIC display

3.3.6 DHT11 SENSOR

The DHT-11 Digital Temperature And Humidity Sensor is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any micro controller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability.DHT11 senor consists of a capacitive humidity sensing element and a thermistor for sensing temperature.The humidity sensing capacitor has two electrodes witha moisture holding substrate as a dielectric between them.Change in the capacitance value occurs with a change in humidity levels.The IC measure,process this changed resistence values and change them into digital form..

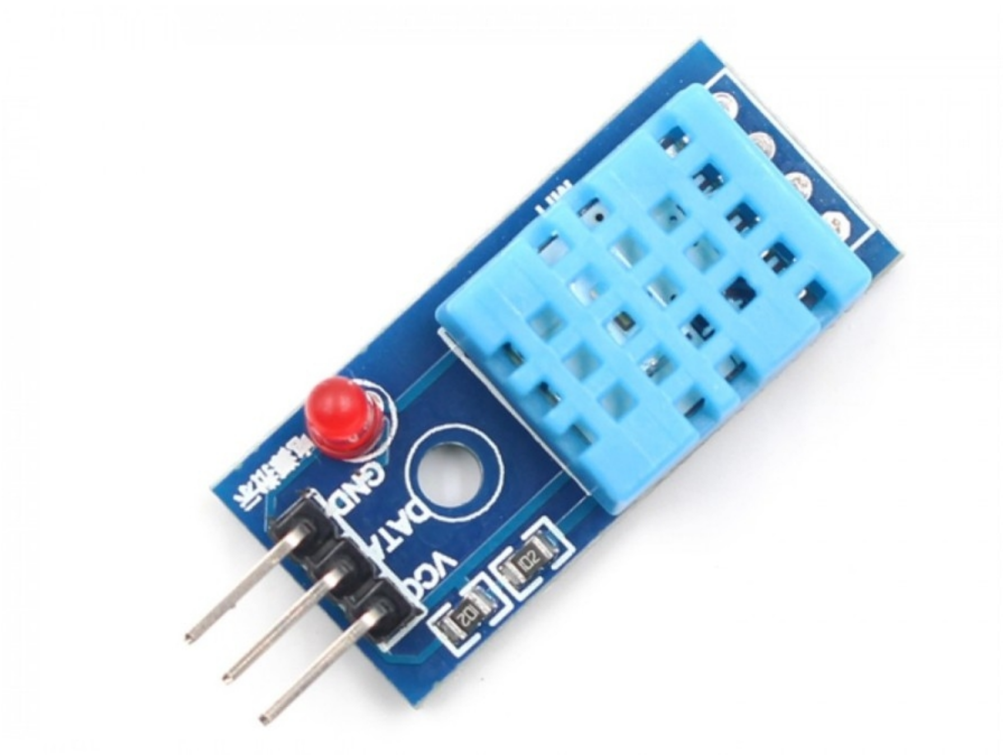

Fig 3.3.7 DHT11 sensor

3.3.7 SERVO MOTOR

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism.

If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics.

A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Fig 3.3.8 Servo motor

3.3.8 POTENTIOMETER

A potentiometer is a three-resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electrical voltage (voltage); the component is an implementation of the same principle, hence its name.Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducer, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.Potentiometers consist of a resistive element, a sliding contact (wiper) that moves along the element, making good electrical contact with one part of it, electrical terminals at each end of the element, a mechanism that moves the wiper from one end to the other, and a housing containing the element and wiper.

Fig 3.3.9 Potentiometer

3.3.9 RAINDROP SENSOR MODULE

A **rain sensor** or *rain switch* is a switching device activated by rainfall.The rain drop sensor module is a smart and low-cost rain sensing device. It has two parts i.e. a rain sensing pad and a control board. The sensitive sensing pad detects any water present on it while the control board reads these signals and can also binarize them. The rain drop module has a major application in the automobile industry. It can be used to monitor the rain and send closure requests to shutters or windows whenever the rain is detected. The post is a guide to help make your own smart project.It consists of two parts one is a blackboard with nickel layers on it and the other is an integrated chip provided with some output pins. Board has 2 output pin and the chip has 6 pins.A rain drop sensor is basically a board on which nickel is coated in the form of lines. It works on the principle of resistance. When there is no rain drop on board. Resistance is high so we get high voltage according to V=IR. When rain drop present it reduces the resistance because water is a conductor of electricity and the presence of water connects nickel lines in parallel so reduced resistance and the reduced voltage drop across it.

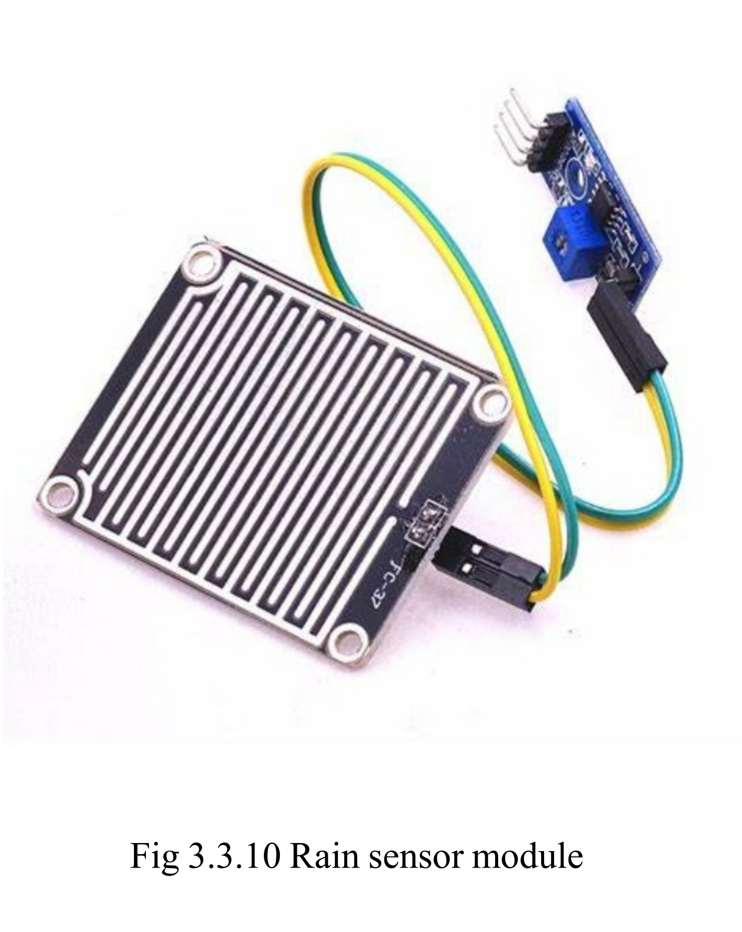

Fig 3.3.10 Rain sensor module

3.4 CONCLUSION

The objective of this project work has been framed into chapters for the design and fabrication of solar panel with sun osition tracking system. The arduino programming and design calculations along with photos have been included in the following chapters.

CHAPTER 4

DESIGN CALCULATION

4.1 INTRODUCTION

The Major requirement for fabrication is the theoretical calculation for achieving the desired result in the first model. The design calculation for the various mechanisms such as servomotor movement in accordance to input is explained in detail. The parameters required for choosing an electronic component suitable for working of those mechanisms also mentioned in this chapter.

4.2 DESIGN CONSIDERATION:

The following are the various attributes required to manipulate with the design calculation.

i. Weight of solar panel.
ii. Servo Motor selection.
iii. Servo Movement calculation.

4.3MECHANICAL DESIGN

CAD MODEL

The CAD model for the Solar Panel with sun position tracker control system is shown infig 4.3.1 and fig 4.3.4 gives the detailed assembly diagram

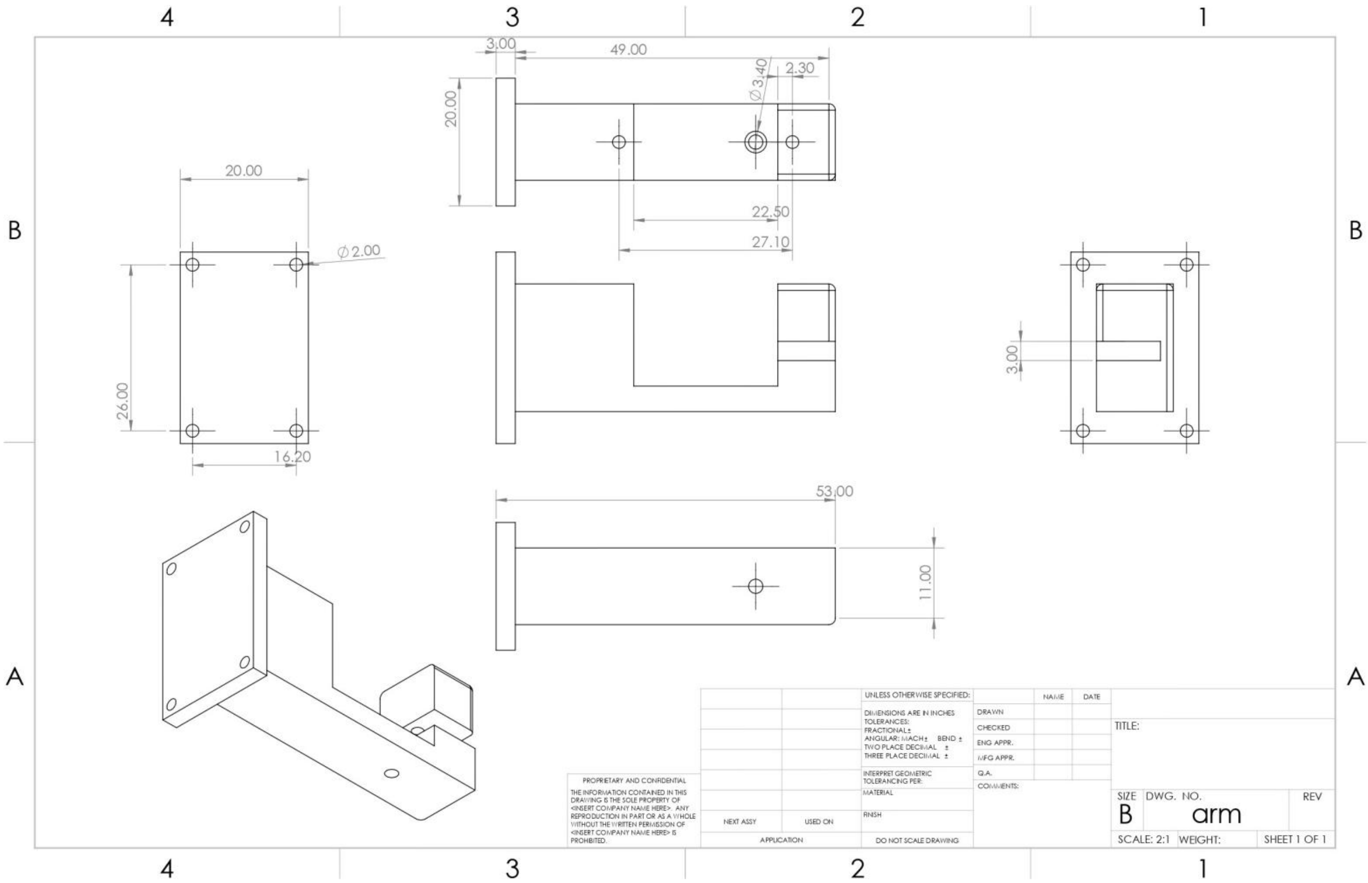

Fig 4.3.1 Arm

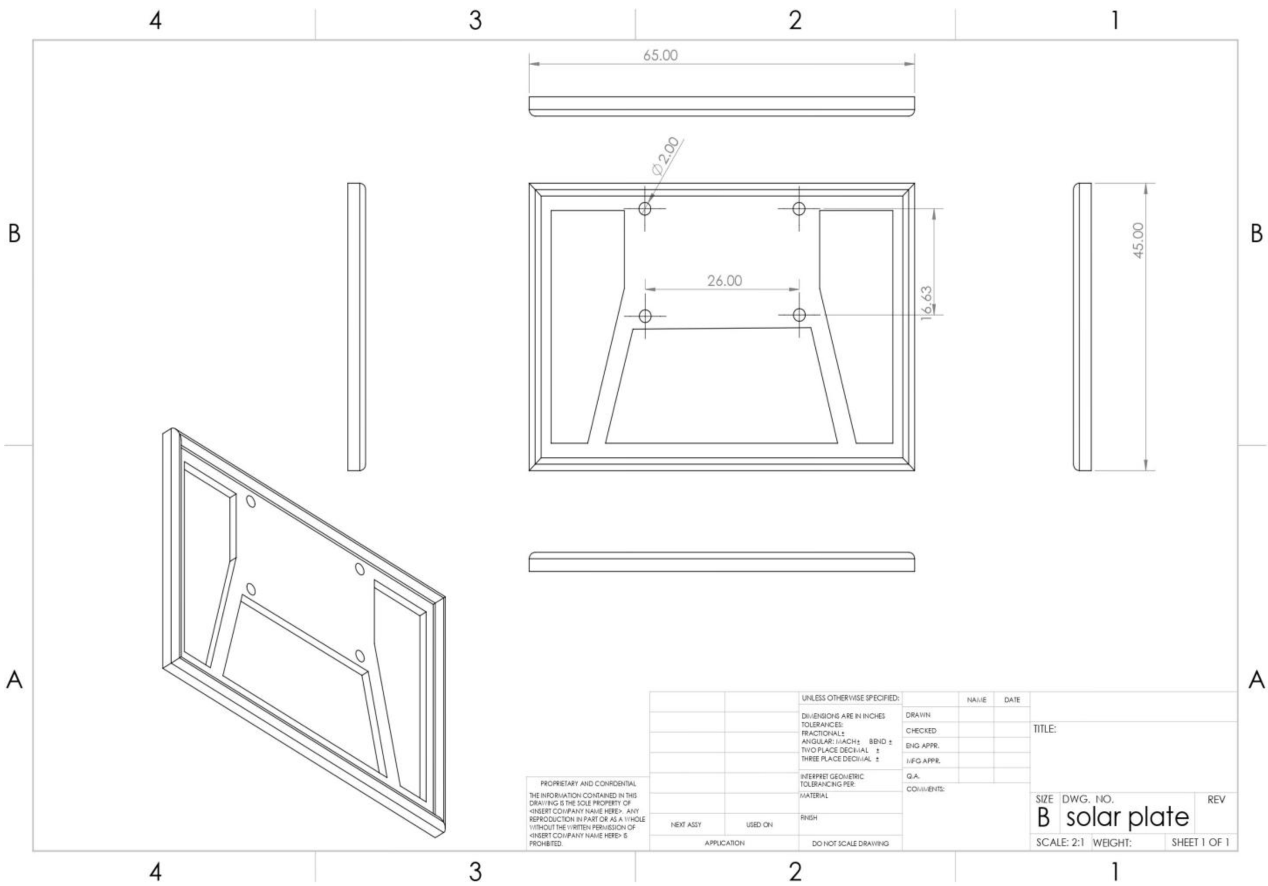

Fig 4.3.2 Solar plate

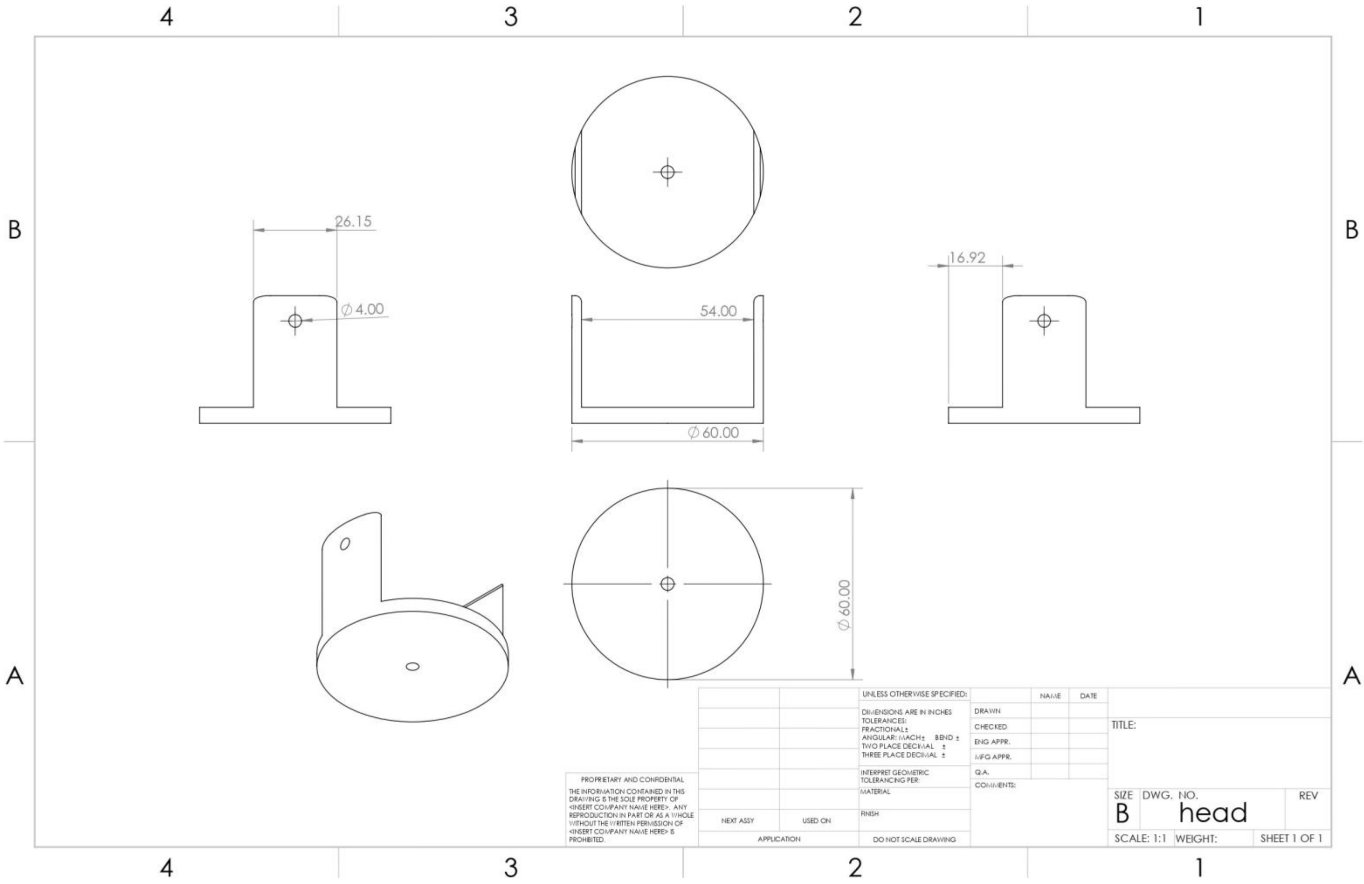

Fig 4.3.3 Head

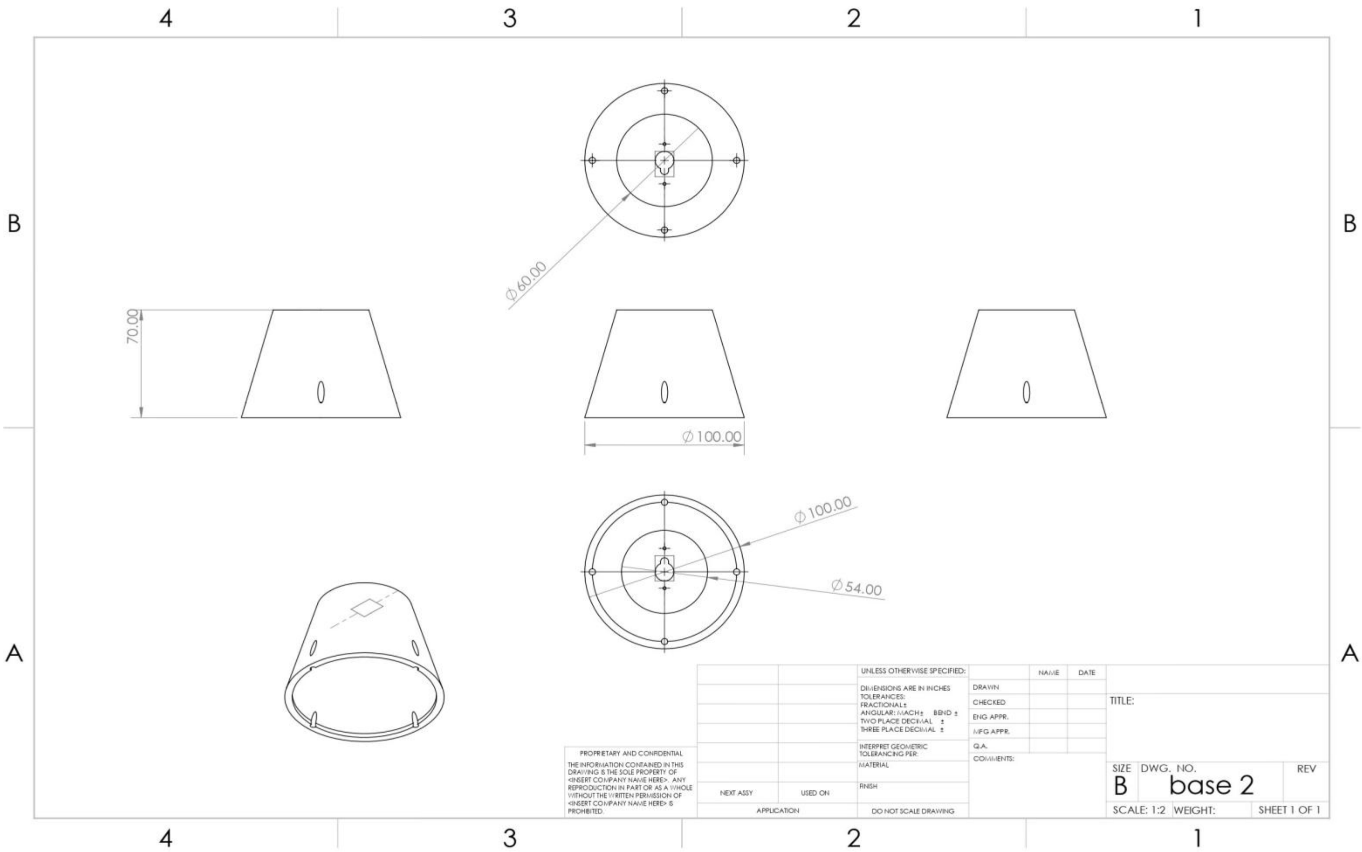

Fig 4.3.4 Base

4.3.5 ASSEMBLY DIAGRAM

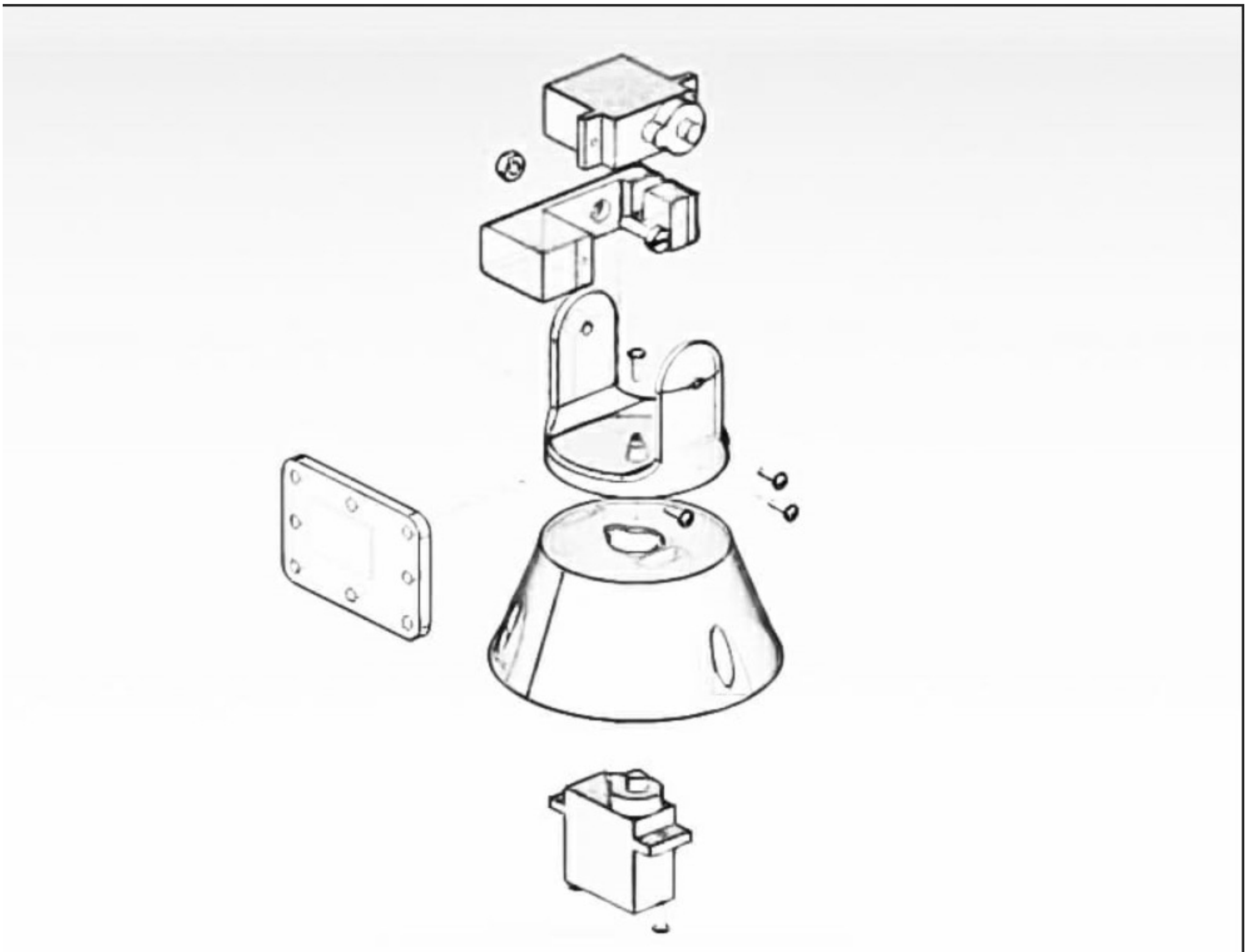

Fig 4.3.5 Assembly diagram

4.4 CALCULATIONS

Horizontal Motor Selection

Mass of frame 1 = 1.0g

Mass of shaft = 0.57g

Length of shaft = 12cm

Moment of inertia of a rectangular body $I=m(a^2+b^2)/12$

where a=10.2cm b=9.7cm

where a is the length of the rectangle, b is the width of the rectangle

$I_{rectangle} = 1.651\times 10\text{-}6\ kgm^2$

$\propto = \nabla\omega / t$, where $\nabla\omega = \omega1 - \omega0$

where $\omega0$ is initial angular velocity

where $\omega1$ is final angular velocity

For a design speed of 500rpm ($52.35rads^{-1}$)

Time (t) = 10sec from potentiometer value 10k ohms (i.e. 1000 is 1 sec)

Therefore Angular acceleration $\propto = 5.235rads^{-1}$

$T = I\times\propto = 8.64\times 10\ {-6}$ Nm or 0.0881g-cm

For shaft I = mL2/12, where L is the length of the shaft and m is its mass

$I_{shaft\ 1} = 6.84\times 10^{-7}\ kgm^2$

Torque = $I\times\propto = 3.581\times 10\ {-6}$ Nm or 0.0365g-cm for shaft 1

Hence total torque = 0.0881 +0.0365 =0.1246g-cm

Vertical Motor

Mass of frame 1 plus frame 2 = 2.2g or 0.0022kg

Mass of shaft 2 = 0.57g or 0.00057kg

Mass of Horizontal Motor = 9g

Radius of shaft (r) = 0.1cm

Torque (T) = I $\times \propto$, I = $mL^2/12$

Taking a total mass of frame plus shaft 1 to be the mass of shaft to be rotated ms = 2.77×10^{-3} kg

I shaft = 3.324×10^{-6} kgm2

Torque T = 1.740×10^{-5} Nm or 0.177g-cm

Torque to rotate the horizontal servo motor on frame 2 = mass × torque arm

Torque arm = 9cm

T = 55× 9 = 495 g-cm

Total torque required to rotate both horizontal motor plus frame and shaft = 0.177 + 495 = 495.18g-cm

4.5 CONCLUSION

Thus, the design calculation for the Solar panel with sun position tracking system has been done. These calculations were keeping in mind the dimensional restrictions for this project, along with economic views. The values are well within the limitand the design is safe and accurate.

Table: 5.2

Bill of materials for Solar panel with sun position tracker:

ITEM NO.	PART NUMBER	QTY.
1	LDR-8mm	1
2	DHT11 Sensor	1
3	Rain Drop sensor module	1
4	Solar panel	1
5	10K Ohm Linear Potentiometer	1
6	1602 LCD Display with I2C/IIC	1
7	GL12 840 Points Solderless Bread Board	1
8	Jumper wire-Male to Female connector	12
9	Jumper wire-Male connector	12
10	Servo motor MG90S	2

5.2 CONCLUSION

Thus the bill of materials has been listed for the Product and the drawings are provided in the upcoming pages.

CHAPTER 6

SIMULATION AND INTERFACING

6.1. INTRODUCTION

For the control of forward and reverse movement of the solar panel, arduino isused for programming.

6.2. ARDUINO PROGRAM

The arduino programming is done using arduino 1.8.12

```
#include <Servo.h>
Servo horizontal;
int servoh = 180;
int servohLimitHigh = 175;
int servohLimitLow = 5;

Servo vertical;
int servov = 45;
int servovLimitHigh = 60;
int servovLimitLow = 1;
int ldrlt = A0;
int ldrrt = A3;
int ldrld = A1;
int ldrrd = A3;
void setup(){
horizontal.attach(9);
vertical.attach(10);
horizontal.write(180);
vertical.write(45);
delay(2500);
}
void loop() {
int lt = analogRead(ldrlt);
int rt = analogRead(ldrrt);
int ld = analogRead(ldrld);
int rd = analogRead(ldrrd);
int dtime = 10;
int tol = 90;
int avt = (lt + rt) / 2;
int avd = (ld + rd) / 2;
int avl = (lt + ld) / 2;
int avr = (rt + rd) / 2;
```

```
int dvert = avt - avd;
int dhoriz = avl - avr;
if (-1*tol > dvert || dvert > tol)
{
if (avt > avd)
{
servov = ++servov;
if (servov > servovLimitHigh)
{
servov = servovLimitHigh;
}
}
else if (avt < avd)
{
servov= --servov;
if (servov < servovLimitLow)
{
servov = servovLimitLow;
}
}
vertical.write(servov);
}
if (-1*tol > dhoriz || dhoriz > tol)
{
if (avl > avr)
{
ervoh = --servoh;
if (servoh < servohLimitLow)
{
servoh = servohLimitLow;
}
}
else if (avl < avr)
{
servoh = ++servoh;
if (servoh > servohLimitHigh)
{
 servoh = servohLimitHigh;
}
}
else if (avl = avr)
 {
delay(5000);
}
 horizontal.write(servoh);
}
delay(dtime);
}
```

6.3 CONCLUSION

Thus the control of forward and reverse movement of the solar panel with sun position tracking using Arduino is used for programming.

CHAPTER- 7

COST ESTIMATION

7.1 INTRODUCTION

This chapter lists the approximate cost of various components used in the project.

7.2 COST TABLE

COMPONENTS	QUANTITY	COST
LDR-8mm	2	74
DHT11 Sensor	1	73
Rain Drop sensor module	1	120
Solar panel	1	1100
Servo motor	2	74
10K Ohm Linear Potentiometer	2	19.50

1602 LCD Display with I2C/IIC	1	159
GL12 840 Points Solderless Bread Board	1	65
Battery	1	5600
Jumper wires	3	5
3d printing parts	9	1500
Arduino UNO	1	700
TOTAL COST		**INR 9,590**

TABLE 7.2 COST TABLE

7.3 CONCLUSION

The components were chosen with cost as a parameter to optimize the development of the system.

CHAPTER – 8

CONCLUSION

8.1 INTRODUCTION

The main mechanism of the solar tracking system consists of the tracking device, the tracking algorithm, the control unit, the positioning system, the driving mechanism, and the sensing devices. The tracking algorithm determines the angles which are used to determine the position of solar tracker. There are two types of algorithms-astronomical algorithms and real time light intensity algorithms. The astronomical algorithm is a purely mathematical algorithm based on astronomical references. The real-time light intensity algorithm is based on real-time light intensity readings. The control unit performs the tracking algorithm and manages the positioning system and the driving mechanism. The positioning system operatesthe tracking device to face the sun at the calculated angles.

Fig 8.2.1 Final output.

8.2 CONCLUSION

The project is successfully completed and tested. All the specified requirements were fulfilled upon completion of the project.

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