1909610 - DESIGN & FABRICATION PROJECT

DUAL AXIS SOLAR TRACKING SYSTEM WITH INTEGRATED CONTROLS

MINI PROJECT REPORT

Submitted By

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BONAFIDE CERTIFICATE

This is to certify that the project entitled "**DUAL AXIS SOLAR TRACKING SYSTEM WITH INTERGATED CONTROLS"** is a bonafide work of

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Submitted for the university examination held on………………

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ABSTRACT

The main objective of this project is to implement the sun tracking dual-axis solar panel in the market which is more efficient compared to the existing solar panels, and increasing the productivity. The solar panels is one of the most important source in producing electricity in renewable energy.

It is primarily designed to produce electricity from sunlight. Each individual panel is constructed of a layer of silicon cells, a metal frame, a glass casing surrounded by a special film, and wiring. For maximum effect, the panels are grouped together into array and placed on rooftops or in large outdoor spaces. The solar cells, which are also referred to as *photovoltaic cells*, absorb sunlight during daylight hours.

Within each solar cell is a thin semiconductor wafer made from two layers of silicon. One layer is positively charged, and the other negatively charged, forming an electric field. When light energy from the sun strikes a photovoltaic solar cell, it energizes the cell and causes electrons to ‘come loose’ from atoms within the semiconductor wafer. Those loose electrons are set into motion by the electric field surrounding the wafer, and this motion creates an electrical current.

Other advantage is it will give 40% more electricity than a nonmoving solar panel.it has a higher degree of flexibility, allowing for a higher energy output on sunny days, higher degree of accuracy in directional pointing.

Force is achieved with the help of dual-axis motion. Now in this world the electricity generation will be increased. Now we are using the most basic type of solar panels.

The aim of the project is to design and construct a dual-axis rotating solar panels that will tilt in the direction of sun automatically. The machine is portable.

Solar power represents **9.8%** of the total installed power capacity in India as of Q1 2020. Small hydro installations contributed a lower share than the same time last year at 1.26%, down from 1.28% last year, Installed capacity, if we implemented dual-axis panel then the contribution of solar energy.

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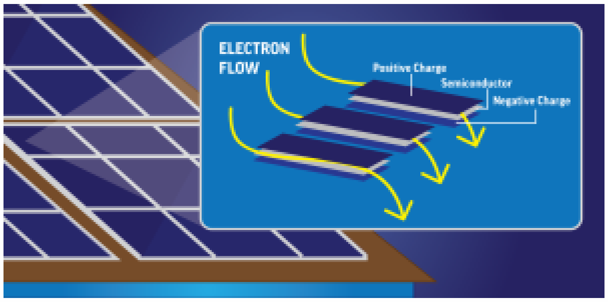
CHAPTER 1

INTRODUCTION

The energy from the sun can be used to overcome the energy crisis generated by the scarcity of Fossil fuel resources, Solar energy is free and everywhere. Due to the decreasing of solar photovoltaic energy cost, it's superior in the renewable energy sources and widely utilized in many countries. Solar power is one of the most widely used alternative pathway in the renewable energy domains or sources. The global demand/installation and production of PV modules are parallel increasing exponentially for the past 10 years with the largest share/development located in Europe followed by Asia Pacific region . Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the earth is approximately (1.8×1011) MW, which is many thousands of times larger than the present consumption rate on the earth of all commercial energy sources. Problem associated with the use of solar energy is that its availability varies widely with time. The variation in availability occurs daily because of the day night cycle and also seasonally because of the earth's orbit around the sun. To rectify the problems the solar panel should be such that it always receives maximum intensity of light. It has been seen since past that the efficiency of the solar panel is around 10-15% which is not meeting the desired load requirements. So there is a need of improving the panel efficiency through an economical way.

1.1 **PANEL MECHANISM**

Solar PV panels are comprised of many small photovoltaic cells – photovoltaic meaning they can convert sunlight into electricity. These cells are made of semi-conductive materials, most often silicon, a material that can conduct electricity while maintaining the electrical imbalance needed to create an electric field.



When sunlight hits the semiconductor in the solar PV cell the energy from the light, in the form of photons, is absorbed, knocking loose a number of electrons, which then drift freely in the cell. The solar cell is specifically designed with positively and negatively charged semiconductors sandwiched together to create an electric field (see the image to the left. This electric field forces the drifting electrons to flow in a certain direction- towards the conductive metal plates that line the cell. This flow is known as an energy current, and the strength of the current determines how much electricity each cell can produce. Once the loose electrons hit metal plates, the current is then directed into wires, allowing the electrons to flow like they would in any other source of electric generation .

As the solar panel generates an electric current, the energy flows through a series of wires to an inverter . While solar panels generate direct current (DC) electricity, most electricity consumers need alternating current (AC) electricity to power their buildings. The inverter's function is to turn the electricity from DC to AC, making it accessible for everyday.

1.2 TYPES OF TRACKING SYSTEM

1. **STATIC SYSTEM**
2. **SINGLE AXIS SOLAR TRACKING SYSTEM**
3. **DUAL-AXIS SOLAR TRACKING SYSTEM**

SINGLE AXIS SOLAR TRACKING SYSTEM

Solar trackers can increase energy production by up to a third or more versus a fixed system. This means that more energy can be produced without needing to increase the size of the system, making for smarter use of land. While the energy generation benefits are clear, there are some things to consider when deciding if a single axis tracking system is suited to your site's needs. Installation costs are generally higher, as there is often more work to be done in prepping the site. The need for periodic upkeep and repairs must be considered too, as trackers utilize moving machinery. Single-axis tracking systems also tend to weigh more than fixed systems, so use in ground-mounted solar is preferred over roof-mounted solar. When deployed under the right conditions, solar trackers can add significant value to the system by boosting energy production that quickly makes up for these initial costs.

BENEFITS OF SINGLE AXIS SOLAR TRACKING SYSTEM

The three main benefits of single axis solar trackers being increased energy production, cost-effectiveness and sustainability are outlined below.

1. **INCREASED ENERGY PRODUCTION**

   Single axis tracker technology increase energy production by up to a third compared to a fixed solar system. This allows for more efficient use of the land the project inhabits, as the project can produce more power in a more confined space.

2.COST-EFFICTIVENESS

Implementing single axis trackers with your next solar project can have some financial benefits that offset the added cost of the trackers. If the trackers are installed in an environment with ideal conditions, they will add value to the solar system, boosting energy production and making up for these initial costs. Additionally the boost in system production allows project owners to put energy back into the local grid, which can lead to dividends known as srec's **.**

3.SUSTAINABILITY

As with any renewable energy project, installing single axis trackers with your next solar project will increase your company's sustainability and decrease its carbon footprint. With the addition of single axis trackers to your solar project, the system will be able to maximize power generation. This will decrease your company's reliance on the local grid therefore increasing reliance on renewable energy as an alternative source for electricity generation. Demonstrating a commitment to renewable energy will attract likeminded individuals to your company whether in the form of potential employees or customers.

DUAL AXIS SOLAR TRACKING SYSTEM

Dual axis trackers have two degrees of rotation i.e. azimuth rotation (which allows the panel to move in a circular path parallel to the surface) and horizontal rotation, also called elevation angle rotation (which allows the panel to move up and down). The dual axis trackers can orient themselves towards the sun so that the panel can be in direct contact of the sun for maximum power generation.

DESING OF PROPOSED DUAL AXIS SOLAR TRACKER

The proposed plan must satisfy certain requirements which are as follows

1. It should be reliable under harsh conditions like change in temperature, wind, dust, and humidity.
2. It should consume minimum electricity so that there can be optimum

performance to cost ratio.

3. . Since solar panels are costly affair, the tracker should give good results with small investment.
4. Considering all the parameters the proposed plan to drive the solar panel is based on below mentioned components
5. A servo electric motor, light dependent diodes, potentiometers for speed control and tolerance, ATmega328P microprocessor-based Arduino uno
6. A measurement system for light intensity applied to the PV panel, representing the sensor that commands the solar panel movement.

WORKING OF TRACKING SYSTEM

Solar tracking system is a device that orients a solar panel according to the movement of sun for maximizing the intensity of sunlight. It automatically changes its position when the intensity of sunlight decreases. Solar tracker is designed in such a way that the angle between the sunlight and solar panel is maintained around 90 degrees at all the times. Using solar trackers electricity production can be increased by around 40% when compared with fixed modules. This tracking system can move a 180 degree of rotation. Therefore, solar tracker is much superior then a stationary module.

1.3 USES OF RENEWABLE ENERGY

Renewable energy offers a range of benefits including offering a freely available source of energy generation. As the sector grows there has also been a surge in job creation to develop and install the renewable energy solutions of tomorrow. Renewable sources also offer greater energy access in developing nations and can reduce energy bills too. Of course, one of the largest benefits of renewable energy is that much of it also counts as green and clean energy. This has created a growth in renewable energy, with wind and solar being particularly prevalent. However, these green benefits are not the sole preserve of renewable energy sources. Nuclear power is also a zero-carbon energy source, since it generates or emits very low levels of CO_2. Some favour nuclear energy over resources such as solar and wind, since nuclear power is a stable source that is not reliant on weather conditions. Which brings us onto some of the disadvantages of renewable energy.

1.4 TYPES OF SOLAR PANELS

Monocrystalline and polycrystalline solar panels

Both monocrystalline and polycrystalline solar panels have cells made of silicon wafers. To build a monocrystalline or polycrystalline panel, wafers are assembled into rows and columns to form a rectangle, covered with a glass sheet, and framed together. While both types of solar panels have cells made from silicon, monocrystalline and polycrystalline panels vary in the composition of the silicon itself. Monocrystalline solar cells are cut from a single, pure crystal of silicon. Alternatively, polycrystalline solar cells are composed of fragments of silicon crystals that are melted together in a mold before being cut into wafers.

Thin-film solar panels

Unlike monocrystalline and polycrystalline solar panels, thin-film panels are made from a variety of materials. The most prevalent type of thin-film solar panel is made from cadmium telluride (CdTe). To make this type of thin-film panel, manufacturers place a layer of CdTe between transparent conducting layers that help capture sunlight. This type of thin-film technology also has a glass layer on the top for protection. Thin-film solar panels can also be made from amorphous silicon (a-Si), which is similar to the composition of monocrystalline and polycrystalline panels. Though these thin-film panels use silicon in their composition, they are not made up of solid silicon wafers. Rather, they're composed of non-crystalline silicon placed on top of glass, plastic, or metal. Lastly, Copper Indium Gallium Selenide

(CIGS) panels are another popular type of thin-film technology. CIGS panels have all four elements placed between two conductive layers (i.e. glass, plastic, aluminum, or steel), and electrodes are placed on the front and the back of the material to capture electrical currents.

1.5 ANALYSIS

This project show maximum power has been generated from the sunlight automatically. This system is tracking for maximum intensity of light. When there is decrease in intensity of light this system automatically changes its direction to get maximum intensity of light. Development dual axis tracking system used light dependent resistor (LDR) as sensor. The resistance of LDR decreases with increasing light intensity. Two motors are used here for rotating the solar panel in two different axes. In this dual axis we are using four LDR s for detecting the light intensity. To track the sun movement accurately dual axis tracking system is necessary. With the sun always facing the panel, the maximum energy can be absorbed as the panel operates at its greatest efficiency. The main objective of this paper to get the maximum energy from the sun by accurate tracking of the sun.

Two pair of light dependent resistors (LDR) is used as sensors to track the sun’s exact position One pair senses the position of the sun in vertical axis i.e. east and west side and other pair in the horizontal axis i.e. north and south side. This information is then passed to the light comparison unit. The rest LDR senses the night mode, and the signal are sent to the light comparison unit. A light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity. A photoresistor is made of a semiconductor which has high resistance that absorbs photons and based on the quantity and frequency of the absorbed photons the semiconductor material give bound electrons enough energy to jump into the conduction band. The resulting free electrons conduct electricity resulting in lowering resistance of the photoresistor. The number of electrons is dependent of the photons frequency Arduino controller is the main control unit of this whole system. The output from the light comparison unit comes to the input of the Arduino controller which determines the direction of the movement of the motors both in the horizontal and vertical axes. shows the practical design of mechanism of dual-axis solar tracking system.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SUMMARY

The following are the review paper on two different tracking systems based on their mode of rotation. Review on single axis solar tracker and dual axis solar tracker.

1.Mayank Kumar Lokhande presented an automatic solar tracking system. He designed a solar panel tracking system based on microcontroller and observed that single axis tracker increases efficiency by 30% compared to the fixed module.

2.Guha Li, run sheng Tang, Hao Zhong investigated horizontal single-axis tracked solar panels. They obtained result as east west axis tracking was poor to improve the energy while tracking the sun about south-north was best. The efficiency increased for east-west axis was less than 8% whereas for south-north axis increased by 10-24%.

3.Chaiko and Rizk developed a tracking system using solar panels efficiently. They designed a simple single axis tracking system using stepper motor and light sensor. They observed that this system stretches the efficiency of power collection by keeping a solar panel perpendicular to the sun rays. And they also found that the power gain was increased by 30% over static PV system.

4.Imam Abadi, Adi Soeprijanto and Ali Mustafa designed fuzzy logic based single axis solar tracker. They implement a fuzzy logic controller on ATMEGA 8353 microcontroller to improve the power energy of PV panel. They found that the PV panel has maximized and it exceeded up to 47% compared to the stationary system.

5.Ashwin R, Varun A.K et al. presented a sensor based single axis solar tracker to achieve highest degree of energy through solar panel. It keeps tracking continuously for the maximum strength of light. This system spontaneously changes its direction when the sun moves from its position to get maximum light energy. Therefore, the experimental result shows the robustness and productiveness of the proposed method.

6.Gamal M DOSOUKY, Abou-Hashemi et al. presented an enhanced orientation design for energy-productivity in PV panels. For maximum incident radiation, the panels are pitched with monthly-based angle. They investigate the proposed strategy in two cities i.e. Japan (Fukuoka) and Egypt (AI-Kharijah). The results showed that the proposed design attained a growth of energy building in both the cities.

7.In 2013, Anusha, Chandra, and Reddy designed solar tracking system based on real time clock. They compared a static photovoltaic (PV) panel and single axis tracker based on real time clock using ARM processor. The experiment demonstrated that the tracking system build up the efficiency about 40% and the energy achieved from the sun is enhanced from 9:00 am to 6:00 pm.

8.Tiberiu Tudorache and Liviu Kreindler presented a tracking system devoted to the PV conversion panels. The proposed design certifies the perfection of converting solar energy into electricity by genuinely aligning the solar panel according to the actual posture of sun. The result concluded as output energy is maximized by the PV panel through desirably locating implemented only for adequate amount of light intensity.

9.Hussain S. Akbar designed a single axis tracker using AVR microcontroller. The sun was tracked in Azimuth axis. The result showed that the designed sun tracker improved the output power gain by 18-25% compared to static panel in Kirkuk city, Iraq. In order to get more efficiency, they modified the tracker system using another solar panel which is placed parallel (Infront side) and opposite to the first panel (in front side).

Therefore, after the modification, result showed that output power in opposite solar panel gives about 56.49% higher than single axis panel tracker and 64.60% compared with the fixed panel.

10.Asmarashid Ponniran et al. developed an automatic solar tracking system which tracks the intensity of light by keeping the solar panel perpendicular to the sun in order to maximized power energy. Besides, they also used DC geared motor with low speed for omitting parameter of motor speed so that the panel focus only in following the sun's intensity. Therefore, the result showed successful that maximum output power was tracked regardless motor speed.

11. Solar panels are a cumulative orientation of photovoltaic cells. The PV cells are arranged in a solar panel or a PV array such that is serves the purpose of exciting the electron of the material consisting inside the solar cells using photons. The average amount of sunlight received by solar panels depends on the position of the sun.

12. The paucity of available resources has forced contemporary society to look for measures to consummate the demands of the latter. With the nurturing civilization, the depletion of conventional fuels, due to human practices has been an alarm to sustainable development issues. The scarcity of energy and its source guided us towards the optimistic approach of using the alternative resources.

CHAPTER 3

CONSTRUCTION

3. COMPONENTS REQUIRED

- ▶ Arduino uno v.3 board
- ▶ SG 90 servo motor
- ▶ LDR light sensor
- ▶ 1 ohm resistor
- ▶ 3d printed parts
- ▶ solar panel
- ▶ soldering kit

3.1. **ARDUINO UNO V.3 BOARD**

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. 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 I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is like 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.

Technical specs of UNO board

Microcontroller: Microchip ATmega328P

Operating Voltage: 5 Volts

Input Voltage: 7 to 20 Volts

Digital I/O Pins: 14 (of which 6 can provide PWM output)

PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)

UART: 1

I2C: 1

SPI: 1

Analog Input Pins: 6

DC Current per I/O Pin: 20 mA

DC Current for 3.3V Pin: 50 mA

Flash Memory: 32 KB of which 0.5 KB used by bootloader

SRAM: 2 KB

EEPROM: 1 KB

Clock Speed: 16 MHz

Length: 68.6 mm

Width: 53.4 mm

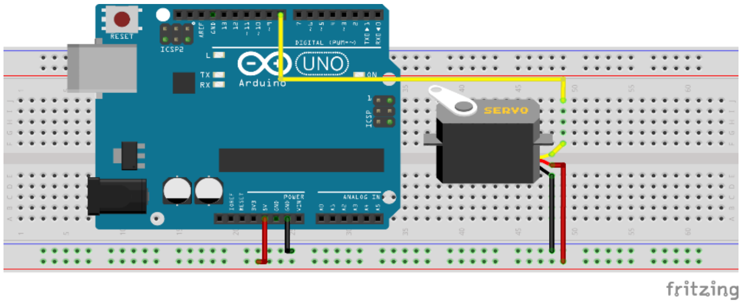
Weight: 25 g

Power Sources: DC Power Jack & USB Port

3.2 SG 90 SERVO MOTOR

Servo motors are high torque motors which are commonly used in robotics and several other applications since it’s easy to control their rotation.

Servo motors have a geared output shaft which can be electrically controlled to turn one (1) degree at a time. For the sake of control, unlike normal DC motors, servo motors usually have an additional pin aside the two power pins (Vcc and GND) which is the signal pin. The signal pin is used to control the servo motor, turning its shaft to any desired angle**.**



Specifications:

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm 21pprox..
- Stall torque: 1.8 kgf,cm.
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

3.3 LDR LIGHT SENSOR

Photoresistors, also known as light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity

3.4 **OHM RESISTOR**

An ohm is the resistance that occurs when a current of one ampere (A) passes through a resistor with a one volt (V) drop across its terminals. The current is proportional to the voltage across the terminal ends.

3.5 3D PRINTED PARTS

To print a model through 3D printing needs to go through the following four steps: modeling, slicing, printing, and post-processing

3.6 **SOLAR PANEL**

A solar panel is a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels. Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells. When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow. In a year, their effectiveness decreases only about one to two per cent (at times, even lesser).Most solar panels are made up using crystalline silicon solar cells. Installation of solar panels in homes helps in combating the harmful emissions of greenhouse gases and thus helps reduce global warming. Solar panels do not lead to any form of pollution and are clean. They also decrease our reliance on fossil fuels (which are limited) and traditional power sources These days, solar panels are used in wide-ranging electronic equipment like calculators, which work if sunlight is available. However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged.

3.7 **SOLDERING KIT**

A soldering iron supplies the heat that melts the solder. It consists of a tip, which you apply to the metal parts you want to solder together, and an insulated handle so that you can hold the iron. There are several variations of soldering irons.

CHAPTER 4

OPERARTION INVOLDES

▶ angle setup

▶design and 3d printing using auto cad

▶ writing codes in Arduino ide

▶calculation to be involved using hour angle

▶schematic diagram for Arduino soldering

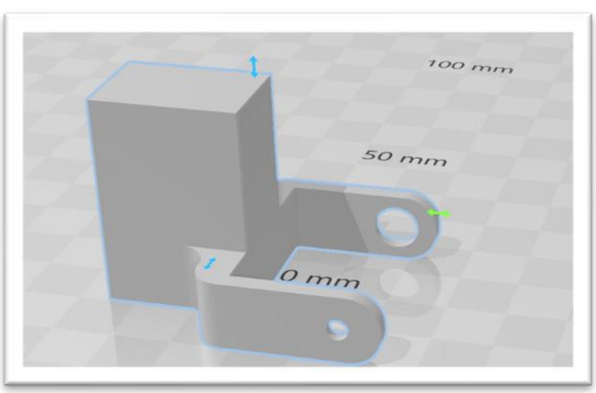
▶methods involved in soldering

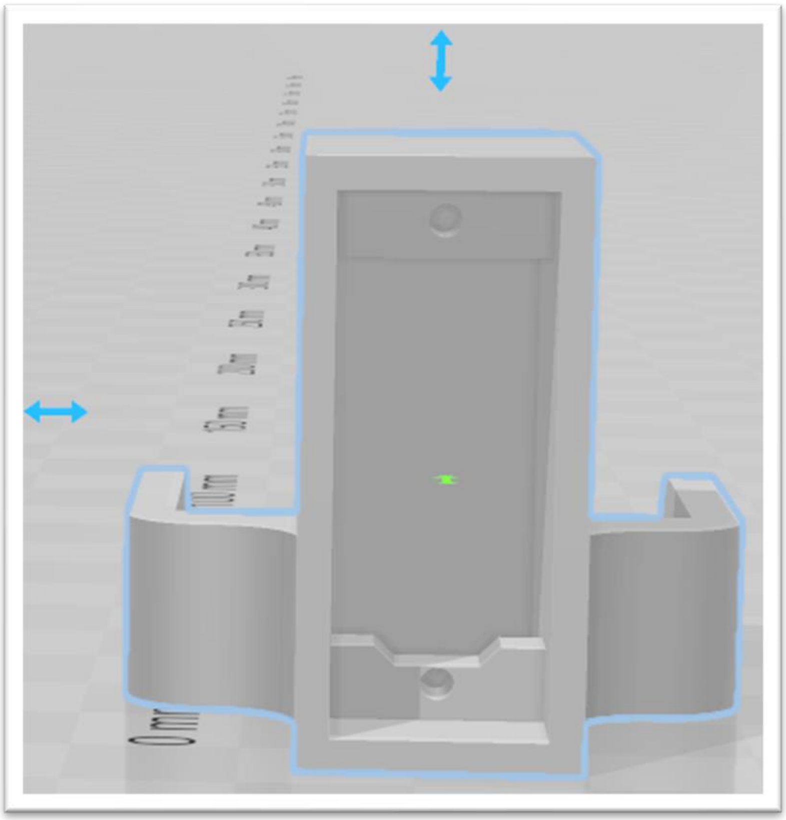
4.1 ANGLE SETUP

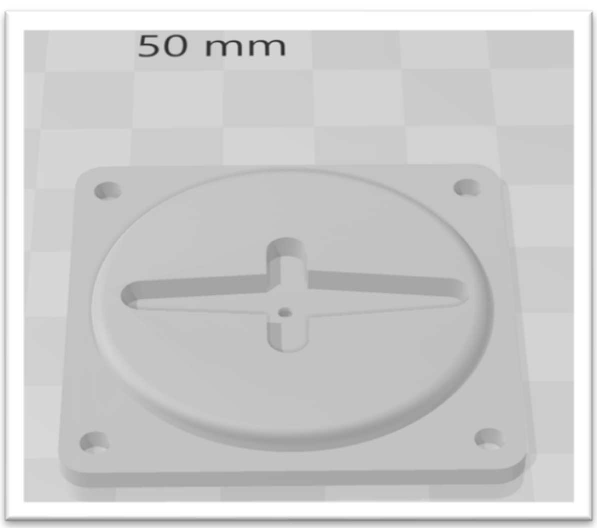
The aim is to produce more heat in the winter and less heat in the summer. Example: In Marseille, for conventional thermal energy, $4m^2$ of panels are necessary for a typical home's hot water needs (200 L at 45 ° C) and the best inclination of the panels is between 50° and 55°. This inclination does not correspond to maximum sunshine, but because there is a surplus of production in the summer, it is better to optimize the angle for the winter.

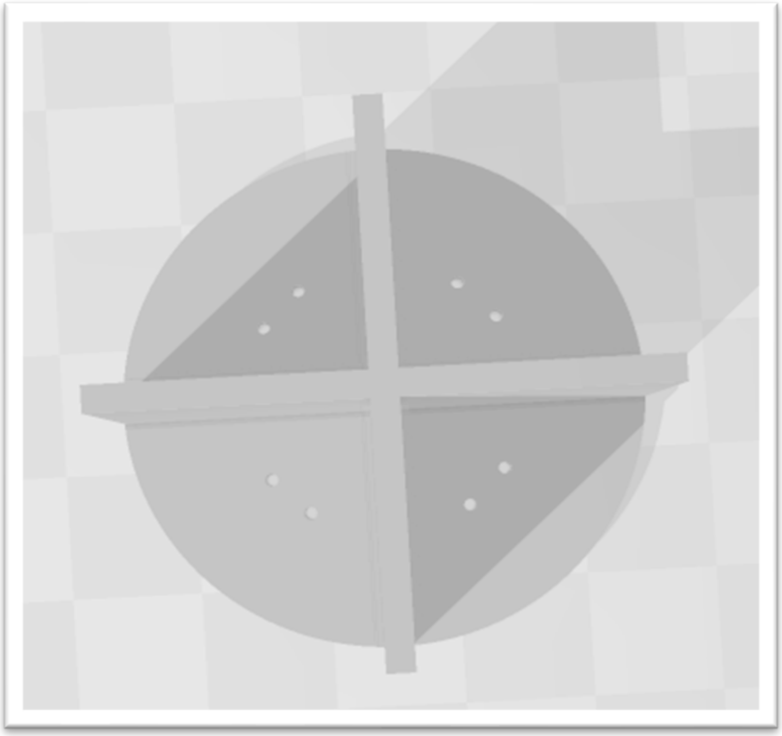
4.2 DESIGN AND 3D PRINTING USING AUTO CAD

Using AUTOCAD and gcodes the 3d components are been designed and printer using 3d printer.






50 mm



G-CODES FOR 3D PRITRING PARTS:

;FLAVOR:Marlin

;TIME:2130

;Filament used: 1.48791m

;Layer height: 0.2

;MINX:83.5

;MINY:83.5

;MINZ:0.3

;MAXX:136.5

;MAXY:136.5

;MAXZ:5.1

;Generated with Cura_SteamEngine 4.13.0

M140 S60

```
M105
M190 S60
M104 S200
M105
M109 S200
M82 ;absolute extrusion mode
G28 ;Home
G1 Z15.0 F2000 ;Move the platform
G92 E0
G92 E0
G1 F1500 E-6.5
;LAYER_COUNT:25
;LAYER:0
M107
M204 S1000
G0 F7500 X85.606 Y85.513 Z0.3
;TYPE:SKIRT
G1 F1500 E0
G1 X85.887 Y85.268 E0.0186
G1 X86.298 Y84.942 E0.04477
G1 X86.593 Y84.72 E0.06319
G1 X87.068 Y84.415 E0.09135
G1 X87.388 Y84.259 E0.10911
```

G1 X87.999 Y83.994 E0.14234

G1 X88.211 Y83.909 E0.15374

G1 X88.75 Y83.737 E0.18196

G1 X89.107 Y83.666 E0.20012

G1 X89.654 Y83.584 E0.22772

G1 X89.797 Y83.565 E0.23491

G1 X90.071 Y83.534 E0.24867

G1 X90.39 Y83.511 E0.26436

4.3 SOURCE CODE FOR SOLAR TRACKING SYSTEM USING C-PROGRAMMING

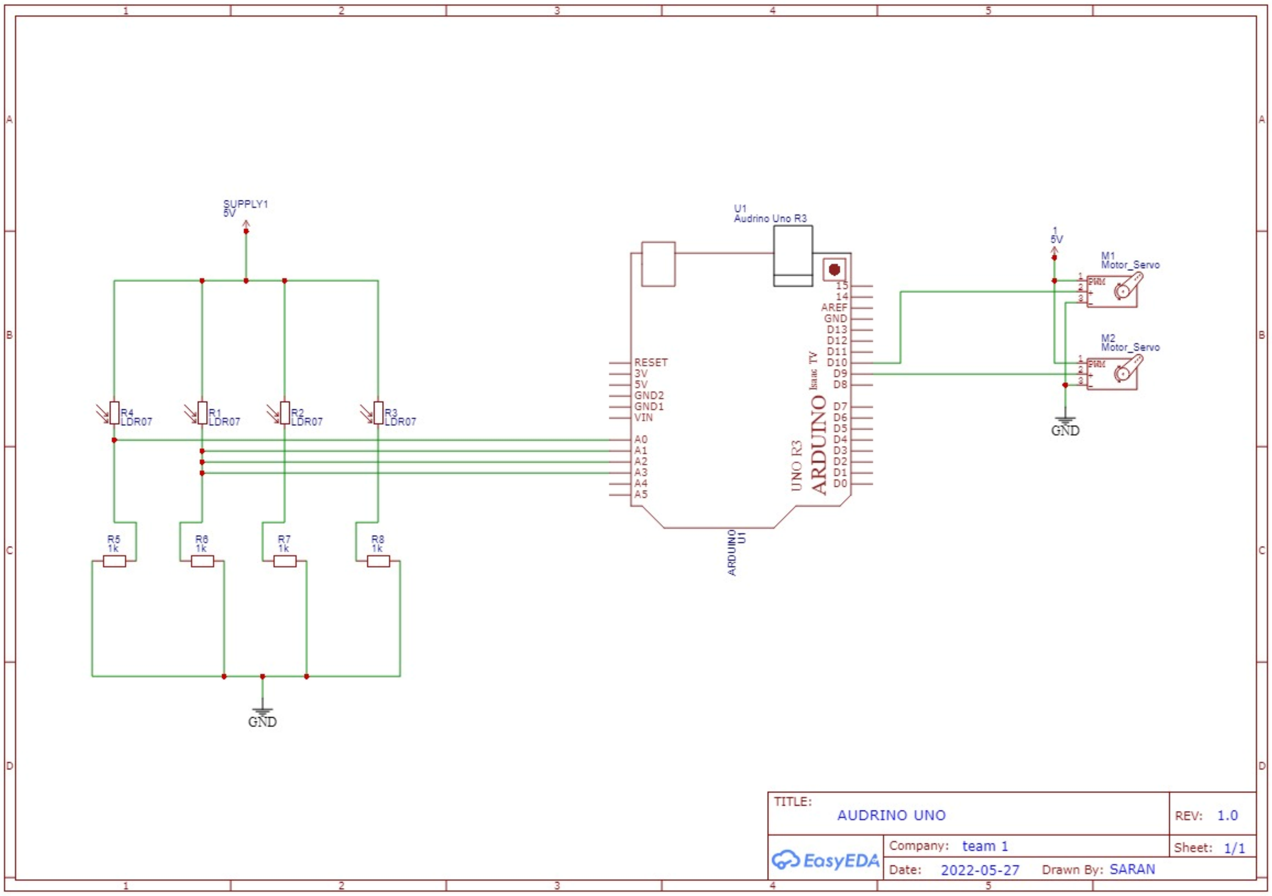
```
#include <Servo.h>

//defining Servos

Servo servohori;

int servoh = 90;

int servohLimitHigh = 160;

int servohLimitLow = 20;


Servo servoverti;

int servov = 90;

int servovLimitHigh = 160;

int servovLimitLow = 20;



//Assigning LDRs

int ldrtopl = A2; //top left LDR green
```

```
int ldrtopr = A3; //top right LDR yellow
int ldrbotl = A1; // bottom left LDR blue
int ldrbotr = A0; // bottom right LDR orange
 void setup ()
 {
  servohori.attach(10);
  servohori.write(90);
  servoverti.attach(9);
  servoverti.write(90);
  delay(500);
 }

void loop()
{
  servoh = servohori.read();
  servov = servoverti.read();
  //capturing analog values of each LDR
  int topl = analogRead(ldrtopl);
  int topr = analogRead(ldrtopr);
  int botl = analogRead(ldrbotl);
  int botr = analogRead(ldrbotr);


// calculating average
  int avgtop = (topl + topr) / 2; //average of top LDRs
  int avgbot = (botl + botr) / 2; //average of bottom LDRs
```

```
int avgleft = (topl + botl) / 2; //average of left LDRs
int avgright = (topr + botr) / 2; //average of right LDRs

if (avgtop < avgbot)
{
  servoverti.write(servov +1);
  if (servov > servovLimitHigh)
   {
    servov = servovLimitHigh;
   }
  delay(10);
}
else if (avgbot < avgtop)
{
servoverti.write(servov -1);
  if (servov < servovLimitLow)
{
  servov = servovLimitLow;
}
  delay(10);
}
else
{
  servoverti.write(servov);
}
```

```
 if (avgleft > avgright)
 {
   servohori.write(servoh +1);
   if (servoh > servohLimitHigh)
   {
   servoh = servohLimitHigh;
   }
   delay(10);
 }
 else if (avgright > avgleft)
 {
   servohori.write(servoh -1);
   if (servoh < servohLimitLow)
    {
    servoh = servohLimitLow;
    }
   delay(10);
 }
 else
 {
   servohori.write(servoh);
 }
 delay(50);
}
```

4.4 CIRCUIT DIAGRAM FOR ARDUINO SOLDERING



4.5 CALCULATION FOR SOLAR TRACKER

We have procedure to calculate the angle of the sun for every hour

1.Angle of Incidence(**δ**)

$$\delta(\text{in degrees}) = 23.45[\frac{360}{365}(284 + n)]$$

where, **δ- Approximate equation of copper (1989)**

n- Is the day of the year (Ex:21 June, 1988 is the 173th (31+29+31+30+31+21)day of 1988 i.e. n=173)

2.Calculate the LST or ST (Local Solar time or Solar time)

$$LST = LT + 4(L\,site - LSTM) + EoT$$

Where, LST-Local Solar time.

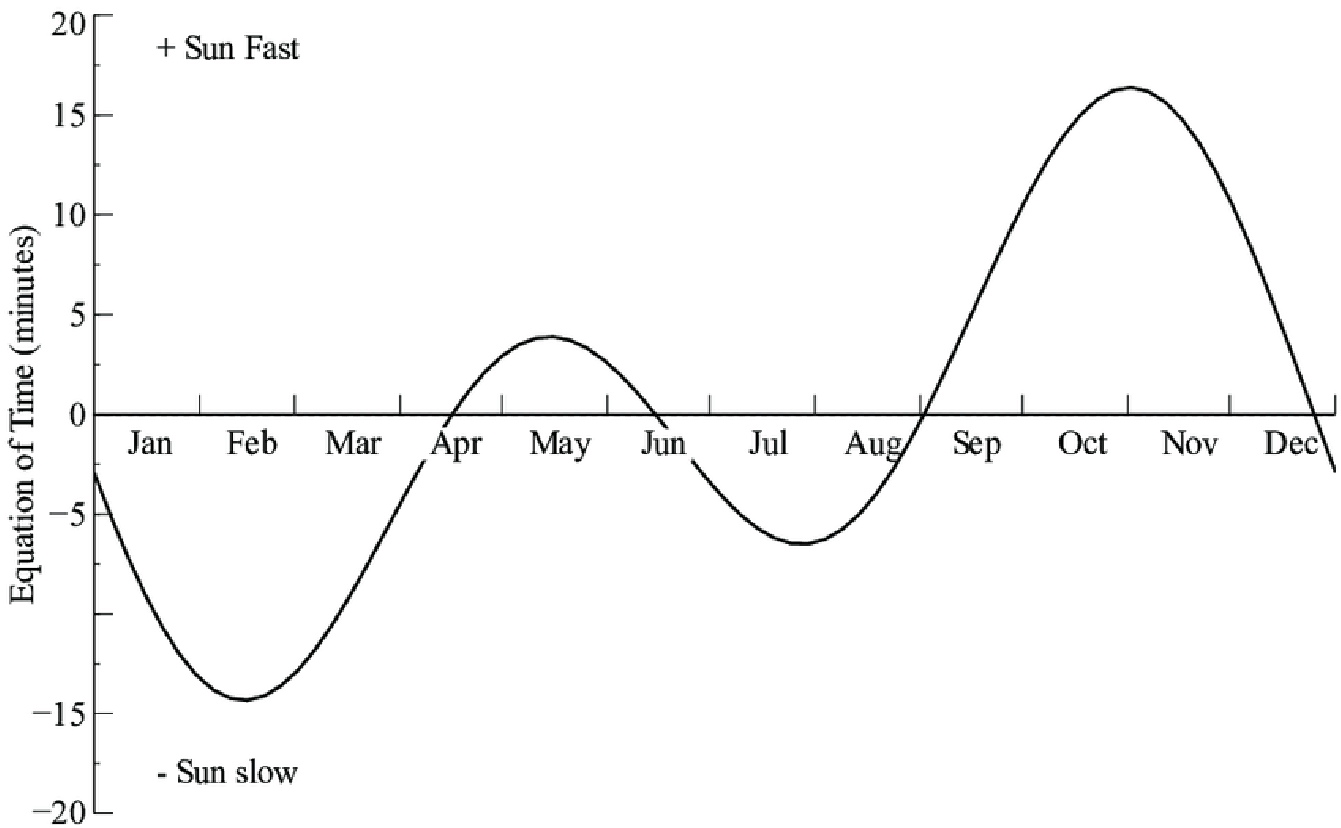
LT-Local time.

4- Earth rotate 1° Longitude every 4 minutes (4 minutes per degree).

L Site- Longitude of site.

LSTM- Local standard time meridian(It is standard to our country 82°5’).

EoT- Equation of time (Adjustment in minutes).



3.Hour angle(ω)

$$\omega = \left(\frac{ST}{3600} - 12\right) * 15 * 0.0175$$

Where, ω- Hour angle(≈15°per hour)

Model calculation

1. Angle of Incidence (Timeline of March 1 to may 25) i.e. n=85days

   δ=23.45 Sin[360/365*(284+85)]

 deflection, **δ=-11.4**

2. Calculate the LST

   LST= 3 +4(80-82)+(-13)

   = 1500-8-13

   = 14.79 (or) 2.39pm

   Where, EoT= -13 using the graph

3. Hour angle(ω)

   ω = (14.79/3600-12)*15*0.0175

   ω = 0.73 radian (41.25° for 3pm)

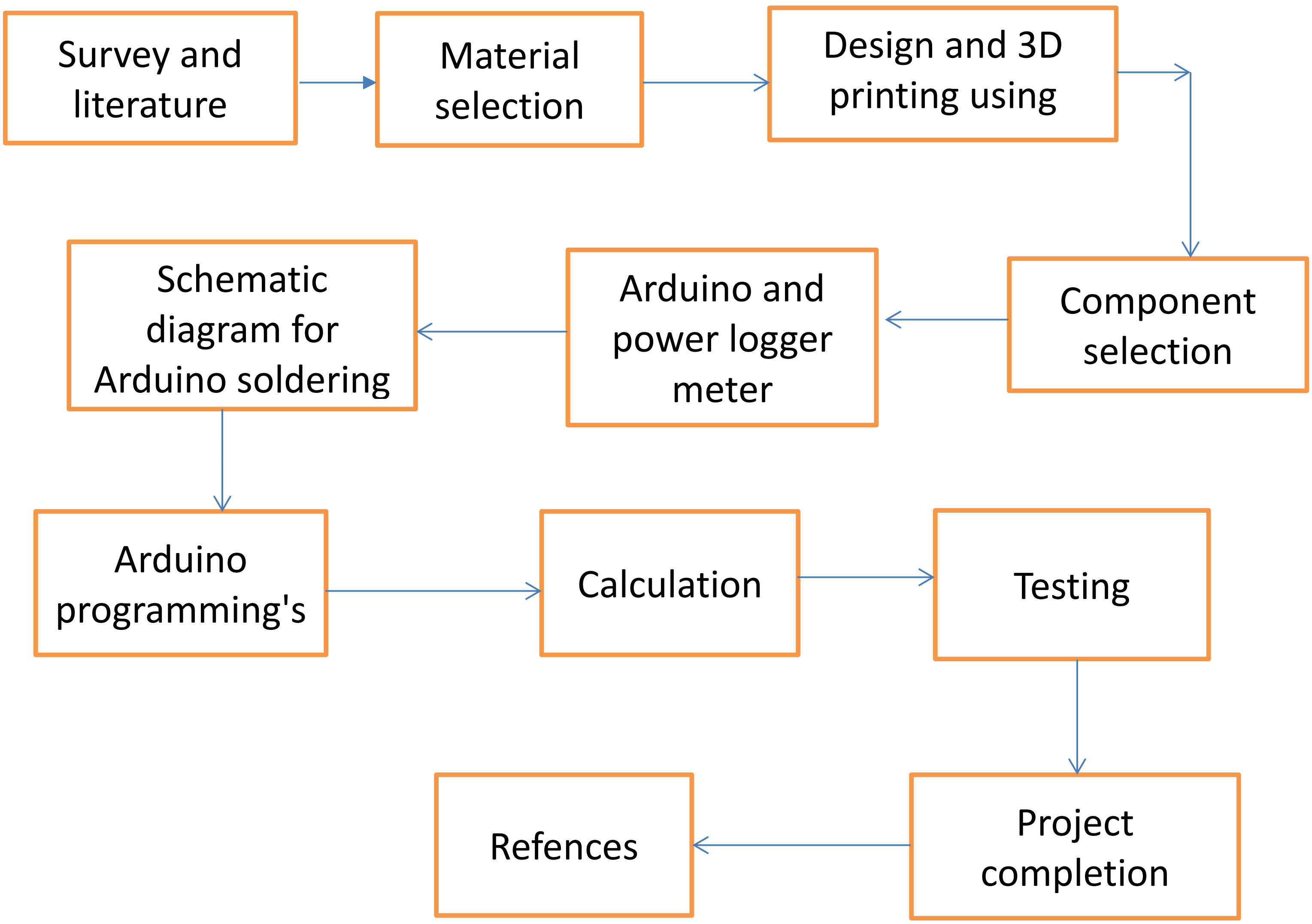
CHAPTER 5

METHODOLOGY

5.1 PROJECT METHODOLOGY

- Taking a complete survey and literature of this project
- Selecting the material to be used in this project
- Designing the motor holding mount and parts using auto cad printing the parts using a 3d printer
- Selection of components to be used in this project
- Preparing a schematic diagram for Arduino soldering
- Generating a program code for Arduino board
- Testing the model and note to readings from it
- Calculating the efficiency and power loss calculation for solar panel
- Completing the project by submitting the report
- Mention the reference journal paper names in report

5.2 Project Methodology Flow chart



5.3WORKING METHODOLOGY

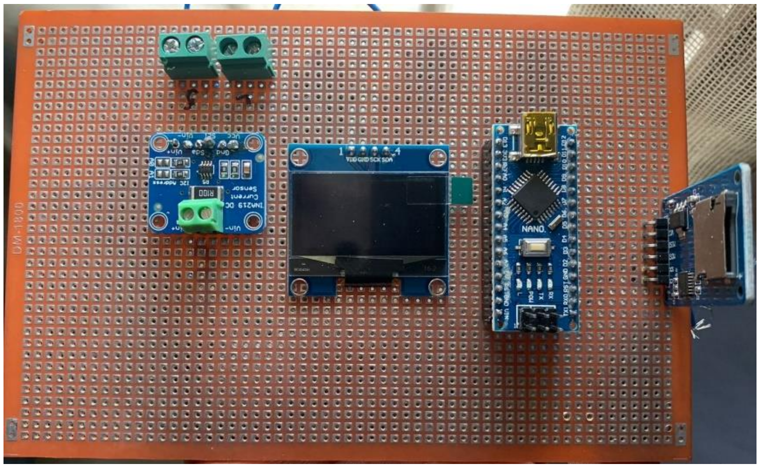
When sunlight hits the semiconductor in the solar PV cell the energy from the light, in the form of photons, is absorbed, knocking loose a number of electrons, which then drift freely in the cell. The solar cell is specifically designed with positively and negatively charged semiconductors sandwiched together to create an electric field This electric field forces the drifting electrons to flow in a certain direction- towards the conductive metal plates that line the cell. This flow is known as an energy current, and the strength of the current determines how much electricity each cell can produce. Once the loose electrons hit metal plates, the current is then directed into wires, allowing the electrons to flow like they would in any other source of electric generation.

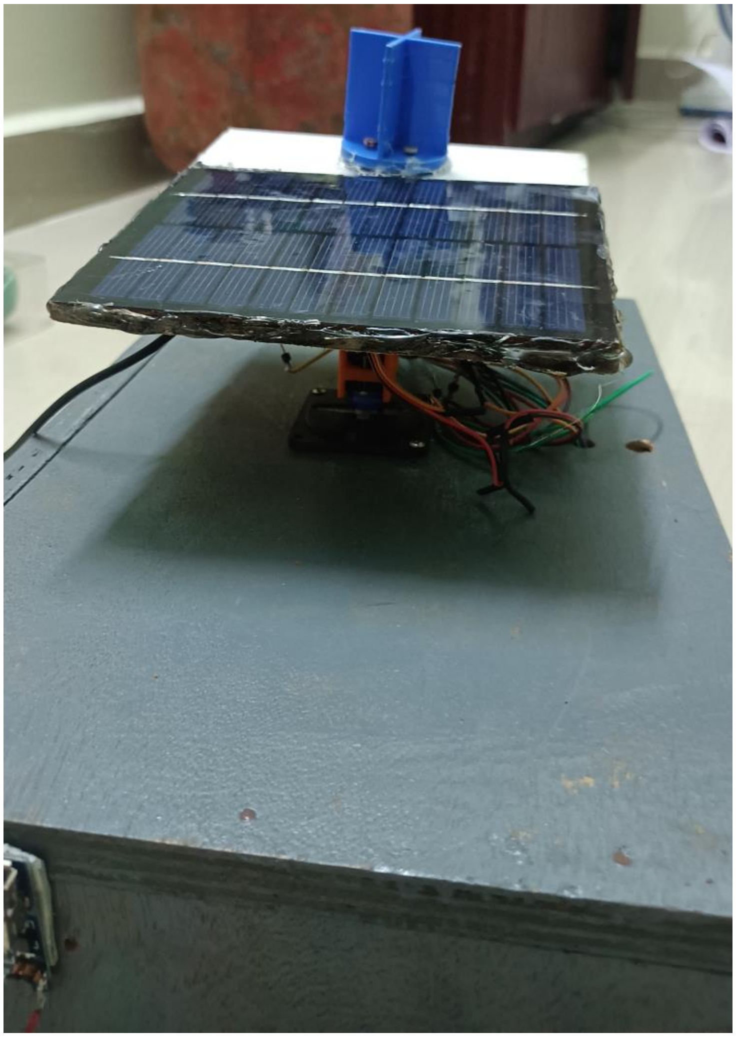
As the solar panel generates an electric current, the energy flows through a series of wires to an inverter, While solar panels generate direct current (DC) electricity, most electricity consumers need alternating current (AC) electricity to power their buildings. The inverter's function is to turn the electricity from DC to AC, making it accessible for everyday use.

After the electricity is transformed into a usable state (AC power), it is sent from the inverter to the electrical panel (also called a breaker box) , and distributed throughout the building as needed. The electricity is now readily available to power lights, appliances, and other electrical devices with solar energy.

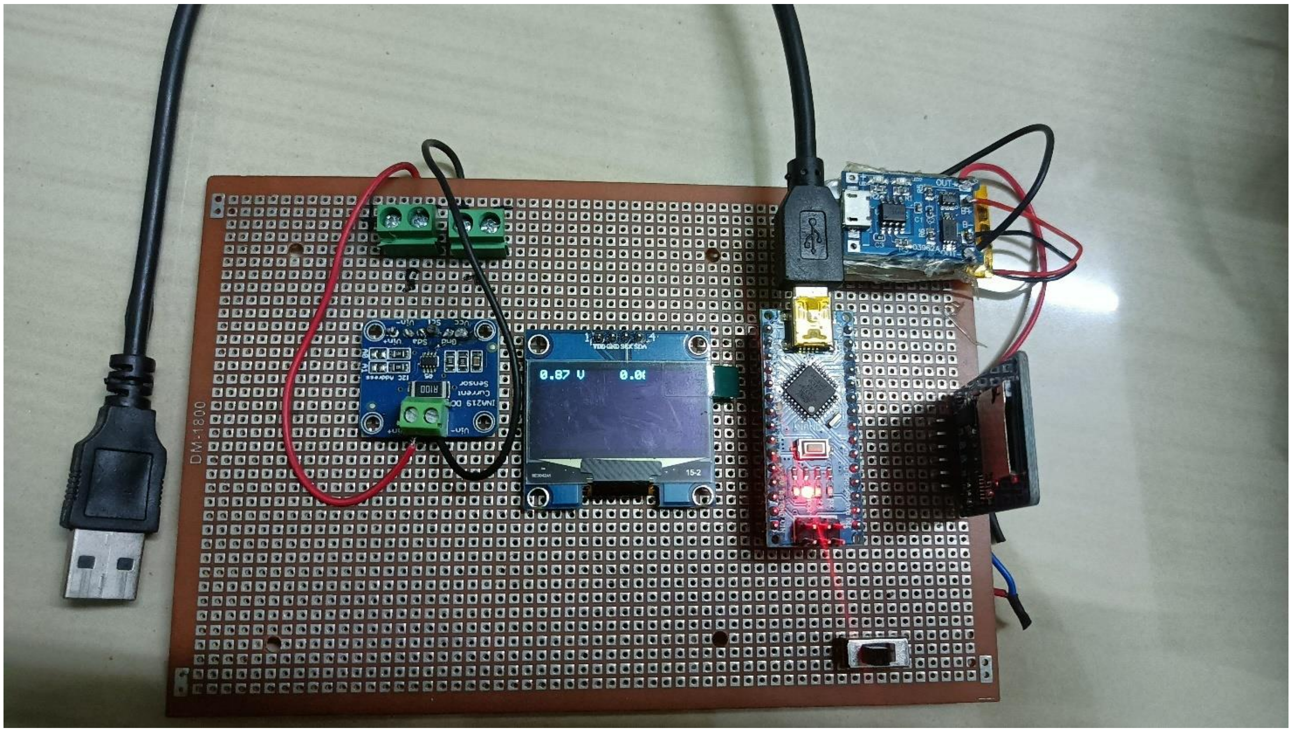
Any electricity that is not consumed via the breaker box is sent to the utility grid through the utility meter. The utility meter measures the flow of electricity from the grid to your property and vice versa. When your solar energy system is producing more electricity than you are using on site, this meter actually runs backwards, and you are credited for the excess electricity generated through the process of net metering. When you are using more electricity than your solar array is generating, you pull supplemental electricity from the grid through this meter, making it run normally. Unless you have gone completely off-grid through a storage solution, you will need to pull some energy from the grid, especially at night, when your solar array is not producing. However, much of this grid energy will be offset from the excess solar energy you generate throughout the day and in periods of lower usage.

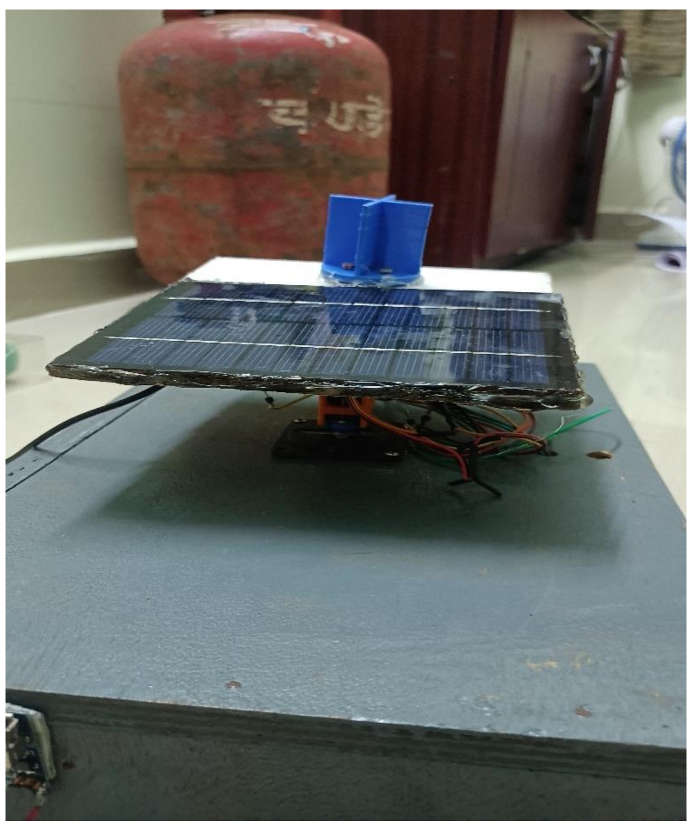
CONSTRUCTION STILLS






UNO


0.87 V
DM-1800



CHAPTER 6

FUTURE AND ASPECTS

- Solar trackers, be it single-axis or dual-axis, can help generate the optimum level of solar power.
- Therefore it is important to decide which type of tracker is suitable considering various factors, including the terrain, climate, and the type of solar panels that are being used.
- If you are a solar installer, depending on the budgetary constraints of your client, the terrain and climate, and the lifespan of the system, you need to consider the key factors to make the right decision.
- Now, when it comes to the future of the solar tracker industry, it seems pretty bright. In 2018, the estimated size of the global solar tracker market was $2.92 billion, according to the Grand View Research.
- The market is expected to expand at a CAGR of 14.1% by 2025 due to the growing demand for solar cells or photovoltaic cells. This growth rate is expected to continue in the coming years.

APPLICATIONS

- As solar tracker is directly exposed to solar rays, they can generate more electricity compared to their stationary counterparts.

- The derived angles can be applied in solutions using
- hydraulic or electrical positioning methods.

- Industrial Hardened component Controllers built to industry standards (UL, IEC, CE, etc.) lowers installation and maintenance costs over “black box” controllers for harsh industrial applications.

- Roughly, in the same amount of space needed for fixed tilt systems if solar trackers are installed, solar trackers can generate more electricity making way for ideal usage of land.

- Components Globally available OTS components are supported worldwide by a network of industry technical specialists, distributors, and systems integrators. OTS components reduce time to market for the OEM and meet end user
- goals for global support.

- Remote monitoring allows OEMs and end users to adjust trackers, diagnose problems and monitor operations reducing operation and maintenance costs.

- Large solar field deployments can utilize open Ethernet/IP networks to achieve high speed, large data transfers (coordinated moves for multiple trackers) from a main control system to the individual trackers.

CHAPTER 7

CONCLUSION

Sun tracking solar system is reliable and mostly used for production of high efficiency in most of the countries. This paper explains solar tracking system through the use of Arduino controller, which also shows the solution software appropriate for increasing the yield of solar systems to the greatest value through the system guide to solar radiation great point, and then return to the status primitive after sunset for a new day. As a result of the lack of efficiency of electricity generation from fixed solar cells, so this paper have resorted to the method of tracking the sun for maximum ability of solar energy through the use of servo motors to control and move the solar panels to track down the sun. After studied this work we have got the maximum energy from the sun and make the system eco-friendly with the environment. The maximum energy from the sun obtained by move the panel in correct direction with correct angle and makes the panel perpendicular to the sun. The effectiveness of the Sun tracker is confirmed experimentally. And the output has been plotted into a graph and has been analysed. The results showed that the dual-axis solar tracking system is highly efficient in terms of electrical energy output when compared with fixed solar system.

CHAPTER 8

REFERENCES

1. Ahmad Mohammed Sinjari and Sarkar Jawhar Mohammed Shareef, "Dual Axis Solar Tracking System Using PLC", 1st International Conference on Engineering and Innovative Technology.

2. T.S.Y. Moh and E.M.S. Ting, "Efficiency Improvement Based on Cooling Effect via Immersion Technique in a PV Solar Panel: Tropical and Cloudy Weather Setting", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering.

3. K. Vijayalakshmi, B. Narendra and K. S. R Anjaneyulu, "DESIGNING A DUAL AXIS SOLAR TRACKING SYSTEM FOR MAXIMUM POWER", INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY.
.

4. Jing-Min Wang and Chia-Liang Lu, "Design and Implementation of a Sun Tracker with a Dual-Axis Single Motor for an Optical Sensor-Based Photovoltaic System", Sensors.

5. A. Salam Al-Ammri, Falah I. Mustafa Al-Attar and Farouk F. Ahmad, "Performance Test of Two-Axis Solar Tracker System with Distinct Tracking Strategies", AASCIT Journal of Energy.

6. Deepthi.S, Ponni.A, Ranjitha.R and 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 (IJESIT).

7. Dhanalakshmi.V, Lakshmi Prasanna.H.N and Priyanka.V, "Dual Axis Solar Tracker Using Arduino Uno", International Journal on Recent and Innovation Trends in Computing and Communication.

8. Nader Barsoum, Rinoe Nizam and Elvin Gerard, "New Approach on Development

a Dual Axis Solar Tracking Prototype", Wireless Engineering and Technology.

9 S. Ozcelik, H. Prakash and R. Challoo, "Two-Axis Solar Tracker Analysis and Control for Maximum Power Generation".

10. PRIYANKA MANE and AKSHAY DHUMAL, "DUAL AXIS SOLAR TRACKING SYSTEM COMPARATIVE STUDY AND MECHANICAL DESIGN IMPLEMENTATION", Proceedings of 54th IRF International Conference, Pune, India.

11. “Design and Implementation of Dual-Axis Solar Tracking System”**Fathy M. Mustafa1** and **Seif** A. Ahmed Electrical Engineering Department, Faculty of Engineering, Beni-Suef University, Beni-Suef, Egypt.