MINI PROJECT REPORT

SOLAR TRACKING SYSTEM WITH 12V TO 220V INVERTER

A PROJECT REPORT

submitted by

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to

the APJ Abdul Kalam Technological University

in partial fulfillment of the requirements for the award of the Degree

of

Bachelor of Technology

In

Electronics and Communication Engineering

Department of Electronics and Communication Engineering

College of Engineering Chengannur

Chengannur

JUNE 2023

DEPARTMENT OF ELECTRONICS ENGINEERING

COLLEGE OF ENGINEERING CHENGANNUR, ALAPUZHA

CERTIFICATE

This is to certify that the report entitled **"SOLAR TRACKING SYSTEM WITH 12V TO 220V INVERTER**" submitted by **AMAL KUMAR A , ASHWIN S NAIR , GOVIND M NAIR , NITHIN MATHEW JOJI** to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in (B-tech in Electronics and Communication Engineering) is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose**.**

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	Project Coordinator	Head of the Department

ACKNOWLEDGEMENT

We take this opportunity to express our sincere gratitude to the people who have been instrumental in the successful completion of our project.

We would like to place on record our deep sense of gratitude to our Principal**, Dr. Smitha Dharan**, and the Head, Department of Electronics Engineering **Dr. Laila D** for providing more than adequate facilities.

We are thankful to our project coordinator **Dr. Deepa VS** for her timely help and advice. We are also indebted to **Dr. Deepa J** for his guidance and support throughout the project.

Support from our family has helped us move forward, and is always our strength. We would like to thank our dear friends and family for extending their cooperation and encouragement throughout the project preparation, without which we would never have completed the project this well.

ABSTRACT

The proposed project presents the design and implementation of a solar tracking system integrated with a 12V to 220V inverter circuit By dynamically aligning solar panels with the sun's position throughout the day and converting the generated DC power into AC power at 220V for household applications, the project aims to increase the efficiency of solar panels.

The solar tracking system includes light sensors that are carefully positioned to measure the intensity of sunlight coming from various directions. The control system uses the data from these sensors to determine the best tilt and azimuth angles for the solar panels. Two servomotors are controlled by the control system to move the solar panels precisely into alignment with the sun. The project also entails designing and putting a 12V to 220V power inverter circuit into operation. This circuit transforms the DC power generated by the solar panels into AC power that can run electrical devices and appliances in a home. To ensure dependable and secure operation, the power inverter circuit incorporates effective conversion strategies, voltage regulation, and protection mechanisms.

The project places a strong emphasis on documentation, which includes thorough design specifications, construction methods, and testing outcomes. The solar tracking system and power inverter circuit are put through rigorous testing to assess their performance, effectiveness, and dependability in a variety of environmental conditions. The proposed project aims to maximise the use of solar energy, improve the effectiveness of energy production, and encourage the use of renewable energy sources. The project contributes to a sustainable and environmentally friendly energy landscape by implementing an automated solar tracking system coupled with a power inverter circuit, enabling the effective utilisation of solar power for residential and commercial applications.

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ABBREVIATIONS

No .	Abbreviation	Expansions
1	LDR	Light Dependent Resistor
2	Li- ion battery	Lithium Ion battery
3	BMS	Battery Management System
4	CSP	Concentrated solar power
5	DC	Direct Current

NOTATIONS

No	Notation Used	Remarks	Units(if any)
1	R1,R2,R3,R4,R5	Restitance is denoted	KΩ
2	C1,C2	Capacitance is denoted	nF
3	Q1,Q2,Q3	BJT	
4	TR1	Transformer 1	

CHAPTER I
INTRODUCTION

1.1 GENERAL BACKGROUND

Solar power is one of the planet's most abundant and promising renewable energy sources, and solar panels are growing popular for both domestic and commercial use.Growing interest in solar power generation is a result of the rising demand for sustainable energy sources. To capture solar energy and turn it into power, solar panels are frequently employed. Solar tracking devices, however, can greatly improve the effectiveness of solar panels.The use of a solar tracking system, which automatically changes the position of the panels to guarantee that they are constantly facing the sun, can significantly increase the efficiency of solar panels.

A solar tracking system is made up of a number of sensors and motors that cooperate to position the solar panels so that they receive the most sunlight possible throughout the day.Solar tracking systems are a cost-effective approach to increase the effectiveness of a solar energy system since they may significantly increase the energy production of solar panels, sometimes by as much as 40%. In order to make sure that solar panels are constantly receiving as much sunlight as possible, solar tracking devices can be especially helpful in regions with a lot of cloud cover or where the sun's position in the sky changes quickly throughout the day.Solar tracking devices are anticipated to become even more popular as solar energy gains in acceptance and price, particularly in locations where increasing energy output is a major goal.

1.2 OBJECTIVE

This project's goal is to create and put into operation a solar tracking system with a 12V to 220V inverter circuit. In order to optimise solar panels' alignment with the sun, the system will be able to move them automatically, boosting the efficiency of energy production overall. Additionally, the system will have an inverter circuit that will convert the DC power produced by the solar panels into AC power at 220V, making it possible to power a variety of electrical devices and appliances in the home.

1.3 SCOPE

The following essential elements and features are included in the project's scope:

- Designing and constructing a mechanical system that can precisely track the sun's movement and modify the position of the solar panels as necessary is known as a "solar tracking mechanism." To choose the best tilt and azimuth angles for the panels, this may require the use of sensors, motors, and control algorithms.
- Control System: Constructing a control system that uses data from the sun tracking mechanism to direct the movement of the solar panels. The panels will always be in line with the sun's position thanks to the control system.Designing and implementing a 12V to 220V power inverter circuit is necessary to convert the DC power generated by the solar panels into AC power that can be used to run home appliances. The inverter circuit needs to be effective, dependable, and able to supply a steady power supply.
- Features for monitoring and safety: Monitoring systems that keep tabs on the efficiency and energy output of the solar panels. Adding safety features like temperature monitoring, short circuit protection, and overvoltage protection to protect the system and connected devices.
- Testing and documentation: The inverter circuit and the solar tracking system's design, construction, and testing processes were all documented. rigorous testing to confirm the system's reliability, effectiveness, and functionality.
- Cost and Feasibility Analysis: Analysing the project's costs will help you decide whether it's feasible and will show you where you might be able to cut costs. assessing the system's overall economic viability and payback period.

CHAPTER II

LITERATURE SURVEY

1.J. -N. Juang and R. Radharamanan, "Design of a solar tracking system for renewable energy," Proceedings of the 2014 Zone 1 Conference of the American Society for Engineering Education, Bridgeport, CT, USA, 2014, pp. 1-8, doi: 10.1109/ASEEZone1.2014.6820643.

In this paper, a solar tracking system for renewable energy is designed and built to collect free energy from the sun, store it in the battery, and convert this energy to alternating current (AC). This makes the energy usable in standard-sized homes as a supplemental source of power or as an independent power source. The system is designed to respond to its environment in the shortest amount of time. Any source of error at both the software and the hardware level is eliminated, or at least controlled. The system is tested for real-time responsiveness, reliability, stability, and safety. The system is designed to be stable while it is operating. It is also designed to be resistant to weather, temperature and minor mechanical stresses. Furthermore, the system is fail-safe; it can recover from failures or at least indicate that it is in that condition.

2. A. Lokesh, A. Surahonne, A. N. Simha and A. C. Reddy, "Solar Tracking System Using Microcontroller," ***2018 International Conference on Inventive Research in Computing Applications (ICIRCA)*****, Coimbatore, India, 2018, pp. 1094-1098, doi: 10.1109/ICIRCA.2018.8597267.**

A renewable resource is a resource that can be repeatedly used and yet be recovered from natural sources that are present in our solar system, some of the renewable resources are oxygen, sunlight, fresh water, etc. Solar energy is one of the main renewable sources of energy which has a greater importance than before. Since the solar energy is available in abundance, if we make proper and efficient use of it, we will be able to solve the crisis of the reduction in fossil fuels. Maximizing power output from a solar system is to increase the efficiency. In order to maximize power output from solar panels, the panels must be aligned with the sun. To do so a system that tracks the sun is required. But having a stationary solar panel, might not be the most efficient way for conversion of solar energy into electrical energy. By using panels that can be rotated along an axis, with respect to the position of the sun, we can improve the efficiency of conversion by at least 30-40%. This paper deals with the design and construction of solar tracking system by using a microcontroller, stepper motor, motor driver and solar panel. The main component of this tracker is MSP430 micro-controller which is programmed to track the sunlight and to make sure that the solar panel is made to receive a great volume of sunlight and help in generating a considerably large amount of power. This work was basically a development that was done as a college project.

3. K. Charafeddine and S. Tsyruk, "Automatic Sun-Tracking System," ***2020 International Russian Automation Conference (RusAutoCon)*****, Sochi, Russia, 2020, pp. 191-195, doi: 10.1109/RusAutoCon49822.2020.9208086.**

The traditional sources of energy in the world are beginning to fade and the issue of finding alternative sources has become an urgent and fundamental. Hence, alternative sources of energy have become the desired solution for a prosperous future and a clean environment. Thus, solar energy is considered one of the most important renewable sources of energy. This paper describes an automatic sun tracking system, based on two stepper motors, and moving solar panel. To gain more energy from the sun, the active surface of the solar cells should be perpendicular to solar radiation, which means that the panel must follow the path of the sun all the time. The orientation of the solar panel towards the sun is achieved by using a C++ program. An experimental comparison between a fixed panel and a moving one is presented.

4. N. Verma, M. Kumar and S. Sharma, "Real-Time Solar Tracking System with GPS," ***2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS)*****, Coimbatore, India, 2021, pp. 783-788, doi: 10.1109/ICAIS50930.2021.9396052.**

In the present world, people are shifting towards renewable sources of energy and solar energy is a widely explored area. Due to the less efficiency and small duration of peak power, it cannot be a reliable source. Here, the power output can be maximized from a solar power system. A solar tracking technique is used based on GPS to achieve maximum power output. This system is especially proposed for the moving platforms that keep on changing their location with time. In this article, various subsystems and the maximum power output in an effective way and its advantages over the existing techniques were discussed.

5. R. Mallwitz and B. Engel, "Solar power inverters," ***2010 6th International Conference on Integrated Power Electronics Systems*****, Nuremberg, Germany, 2010, pp. 1-7.**

This paper reviews the history of solar power inverters and highlights aspects of power electronic packaging concerning functional and packaging integration in solar inverter technology. The most important indicators to characterize the advances in inverter technology are efficiency and losses respectively, mean time between failure and inverter costs. A high integration level is bounded up with high reliability and life time and less costs. The paper presents the state of the art and trends in the inverter design towards higher functional and packaging integration. Several generations of medium power inverter are analyzed concerning integration level which will be described by different indicators.

6. Dip Narayan Sarkar, Aranya Bagchi, Soham Mohanti, Mrinmoy Patra , Shaon Paul," Solar Inverter with Microcontroller Based Tracking System", International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016

Sunlight is the basic source for the generation of solar energy for producing electricity. Here sunlight is being harnessed to produce solar energy along with the use of inverter circuit. Sunlight, falling on solar array made up of silicon material, is basically a semiconductor. The solar array is being rotated with the help of a stepper motor according to certain delay of time using microcontroller. The microcontroller which is used belongs to AVR family of microcontroller. Light having photon, energize the semiconductor which breaks the forbidden energy gap of semiconductor and electron are made to excite from valance band to conduction band, causing the current to flow. This D.C power is directly fed to a rechargeable battery without the use of a charge controller because of low power applications. Then this power is supplied to the inverter (dc to ac converter) which is connected to load.

CHAPTER III
METHODOLOGY

The methodology used for implementing the device has been explained in the following section. The design, construction, and testing processes for the solar tracking system with a 12V to 220V inverter circuit involve a systematic approach.. The creation of the solar tracking mechanism, control system, and 12V to 220V inverter circuit will then be part of the design phase. This will involve choosing the proper components while taking efficiency, reliability, and cost-effectiveness into account.

Selection of sensor

In this project, choosing the right sensors is essential for precisely tracking the sun's position for the best alignment of the solar panels. Five light-dependent resistors (LDRs) were selected in this instance to serve as the sensors for measuring the strength of the sun's rays coming from various directions.LDRs are chosen for a number of reasons.

First of all, LDRs are a cost-effective option for this project because they are accessible and reasonably priced. Second, the quick response time of LDRs enables real-time positioning adjustments of the solar panels as the sun moves across the sky. Accurate tracking and alignment are made possible by their sensitivity to variations in light intensity. Additionally, LDRs have a broad dynamic range, allowing them to precisely measure light intensity at all levels, from low levels at dawn and dusk to high levels during the height of the day. LDRs are a good choice for tracking the sun's position throughout the day because of their adaptability. LDRs can also be connected to microcontrollers or other control systems in a fairly straightforward manner. This multi-sensor strategy improves the sun tracking mechanism's precision and dependability, enabling exact adjustments to the orientation of the solar panels.

Selection of MCU

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. The audrino is programmed using audrino ide.

3D modelling

Fusion 360 and Ultimaker Cura have been used for the 3D modeling and slicing of custom parts.

3D printing

3D printing technology has been used to fabricate the horizontal and vertical servo mounts, latch, and the enclosure. The custom fabricated parts were printed in Ender-3 3D printer using PLA filament in the following specifications- 2mm layer height and 50g of filamen.

CHAPTER IV

DETAILED OVERVIEW

4.1 PROPOSED PROJECT

The proposed project aims to develop and put into use a solar tracking system with a 12V to 220V inverter circuit. Solar tracking systems are created to maximise the efficiency of solar panels by dynamically adjusting their position to line up with the path of the sun throughout the day. The solar panels can receive the most exposure to sunlight and produce more energy by continuously tracking the sun's position.The goal of the project is to create a solar tracking device that tracks the sun's position using light sensors. These sensors will be placed carefully to measure the strength of the sun's rays coming from various angles. A control system will analyse the sensor data and choose the best tilt and azimuth angles for the solar panels.The goal of the project is to create a solar tracking device that can locate the sun using light sensors. These sensors will be carefully positioned to measure the strength of the sun's rays coming from various angles. A control system will process the sensor data and choose the best tilt and azimuth angles for the solar panels.The control system will direct the motion of two servomotors that are in charge of adjusting the position of the solar panels in order to achieve precise alignment. The solar panels will be able to precisely track the movement of the sun because the servomotors will react to the control signals produced by the control system.

The project will also include a circuit for a power inverter that converts 12V to 220V. This circuit can power a variety of home appliances and electrical devices by converting the DC power produced by the solar panels into AC power at 220V. The power inverter circuit will be built with built-in protection mechanisms to safeguard the system and connected devices, ensuring efficient and dependable power conversion.For the duration of the project, complete documentation will be kept to document the design decisions, construction techniques, and testing outcomes. The system's functionality, effectiveness, and dependability will be thoroughly tested in a variety of settings. The significance of the proposed project lies in its potential to use an automated solar tracking system to significantly increase the energy generation effectiveness of solar panels. The addition of a 12V to 220V inverter circuit increases the system's usability by supplying AC power for a variety of domestic applications. The project's ultimate goal is to encourage the use of renewable energy sources and support the transition to an energy system that is more environmentally friendly and sustainable.

4.2 BLOCK DIAGRAM

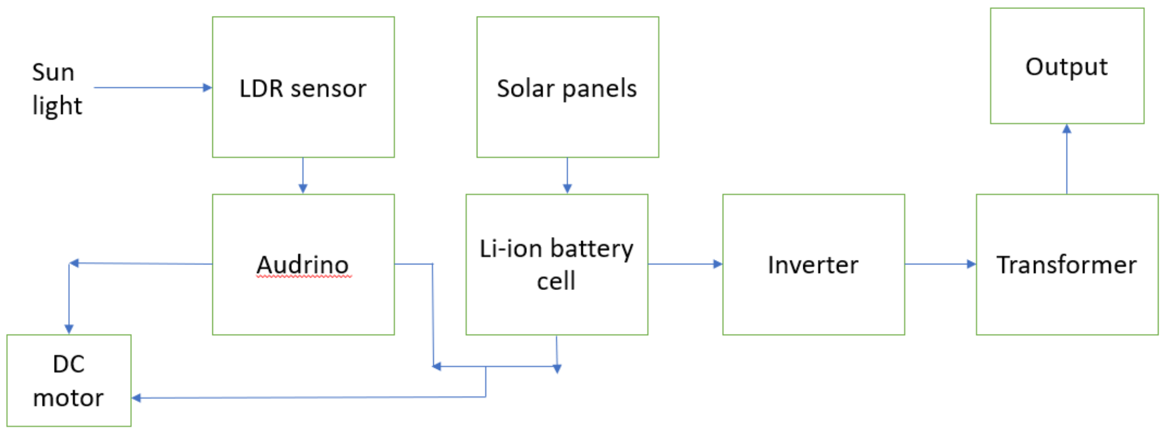

Fig 1.1 Block Diagram

As per the block diagram shown in Fig 1.1 the main components are:

- Arduino
- LDR sensors
- Servo motors
- Centre tapped Transformer
- Li ion battery
- Solar panel

A Light Dependent Resistor (LDR) solar tracker is a device that adjusts the position of a solar panel to maximize the amount of sunlight it receives. The tracker uses an LDR, which varies its resistance based on the intensity of light it receives.

Here's how an LDR solar tracker typically works:

- Light depending resistor is a photo-resistor, which decrease the resistance when the light increases.An LDR or photo-resistor is made any semiconductor material with a high resistance. It has a high resistance because there are very few electrons that are free and able to move – the vast majority of the electrons are locked into the crystal lattice and unable to move. Therefore in this state there is a high LDR resistance.
- As light falls on the semiconductor, the light photons are absorbed by the semiconductor lattice and some of their energy is transferred to the electrons. This gives some of them

sufficient energy to break free from the crystal lattice so that they can then conduct electricity. This results in a lowering of the resistance of the semiconductor and hence the overall LDR resistance.

- The process is progressive, and as more light shines on the LDR semiconductor, so more electrons are released to conduct electricity and the resistance falls further.
- The fifth resistor is placed on the middle position of the solar top,when the light is minimum, the micro controller Arduino read the resistance value and the the threshold value is sated in the coding section, when the light is available and the threshold level breaks, the Arduino rotate the stepper motor.
- now the main work is going to progress, according the sun rotation other 4 LDRs sense the light and send data to the Arduino, and Arduino process the data then rotate the servo motors according the sun rotation, the rotation position of the servo is max 170 degrees
- when the sun goes down the fifth LDR sense data again and this time the process is reverse condition, the LDR data goes down blow the threshold level and Arduino Rotate the stepper motor according to the limit set within the audrino.
- We are going to use 6 pieces of solar panel and each has 6V 70mAh power output, We will wire the one pair of panels in series and 3 pairs in parallel, then the voltage output will be 6+6=12v, So basically when the panels are fully opened the voltage output is 12V and when the panel goes on in home position the voltage output will be 1-3 volts.
- More over 12v dc as it is not that useful so we will be using a basic inverter system to convert 12v dc to 220 v ac
- More over we will be generating power from solar panels and will be storing them in a battery pack (li ion or polymer battery via battery management system)
- An Inverter system is used so that we can use the power to run larger devices.

Here 555 timer ic is configures in an astable mode to generate around 50-60hz square wave at the output and this signal is fed into the base of the 2 mosfet to alternate 12v on to the secondary of the 12-0-12 transformer , hence we achieve 220v ac at the transformer output (max load 5amps)

4.3HARDWARE COMPONENTS

4.3.1 SENSORS

LDR Sensor

Light depending resistor (LDR) : is a photo-resistor, which decrease the resistance when the light increases.An LDR or photo-resistor is made any semiconductor material with a high resistance. It has a high resistance because there are very few electrons that are free and able to move – the vast majority of the electrons are locked into the crystal lattice and unable to move. Therefore in this state there is a high LDR resistance.

Electrical characteristics

TA = 25°C. 2854°K tungsten light source

Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	1000 lux 10 lux	- -	400 9	- -	Ω kΩ
Dark resistance	-	1.0	-	-	MΩ
Dark capacitance	-	-	3.5	-	pF
Rise time 1	1000 lux 10 lux	- -	2.8 18	- -	ms ms
Fall time 2	1000 lux 10 lux	- -	48 120	- -	ms ms

Table 1.1 electrical characteristics of LDR

1. Dark to 110% RL

2. To 10 3 RL RL = photocell resistance under given illumination

Fig 1.2 LDR Sensor

4.3.2 Audrino uno

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller board, programming environment, and community support. It is commonly used for prototyping and DIY projects.

Here **Arduino uno** is used ,it is a small microcontroller board based on the **ATmega328P** microcontroller. It is often used for prototyping and DIY projects, and can be programmed using the **Arduino IDE**.

Fig 1.3 Audrino uno

Microcontroller	ATmega 328P
Rated operating voltage	5v
Recommended input voltage	7V to 12V
Input voltage limits	6V to 20V
I/O digital pins	14
Analogue Input pins	8
DC current per the I/O pin	40 mA
DC current of 3.3v pin	50 mA
Flash memory	32 KB of which 0.5KB used for boot loader
SRAM	2 KB
EEPROM	1 KB
Clock speed	16 MHZ

Table 1.2 Audrino uno specifications

4.3.3 Servo Motor / Actuator

A servo motor is a type of motor that can rotate to a precise angle based on the input it receives. They are commonly used in robotics and remote control systems.we use two MG 995 acurator.This high-speed servo actuator is not code dependant;You can use any servo code, hardwareor library to control them.The MG995 Actuator include arms and hardware to get started

Fig 1.4 MG995 Servo Motor

Specifications

- Weight: 55 g
- Dimension: 40.7 x 19.7 x 42.9 mm approx.
- Stall torque: 8.5 kgf·cm (4.8 V), 10 kgf·cm (6 V)
- Rotation Angle: 120deg. (+- 60 from center)
- Operating speed: 0.2 s/60º (4.8 V), 0.16 s/60º (6 V)
- Operating voltage: 4.8 V to 7.2 V
- Dead band width: 5 µs
- Stable and shock proof double ball bearing design
- Metal Gears for longer life
- Temperature range: 0 ºC – 55 ºC

4.3.4 Transformer

A transformer is an electrical device that transfers electrical energy from one circuit to another through electromagnetic induction. They are commonly used to step-up or step-down voltage levels.Here we use **a 1A 12V centre tapped transformer**.

Fig 1.4 Transformer

4.3.5 Solar panels

A solar panel is a device that converts sunlight into electrical energy by using photovoltaic cells. The energy produced can be used to power various electronic devices or stored in a battery for later use. They are commonly used in renewable energy applications.Here a **6V-60mAh 80mm x 40 mm** is used.

Fig 1.5 solar panels

4.3.6 Li ion battery

Li-Ion Battery with 2.6v Battery pack Rechargeable Li-ion battery,Input Voltage: 12.6 V Output voltage: 11.1 - 12.6v DC Output Current: About 1-3A kis used.A Lithium-Ion battery is a type of rechargeable battery commonly used in portable electronics. They have a high energy density, are lightweight, and have a long lifespan.

Fig 1.6 Li ion battery

4.3.7 Battery Management System and rechargeable batteries

To control the charging and discharging of batteries and to prevent damage to the battery when it is overcharged and deeply discharged.

Fig 1.7 Battery Management System Module

4.3.8 MOSFET driver IRFZ44N

The **IRFZ44N** N-Channel MOSFET is available in 3-pin just like a general **MOSFET**. It is used as a general-purpose power MOSFET for various applications.

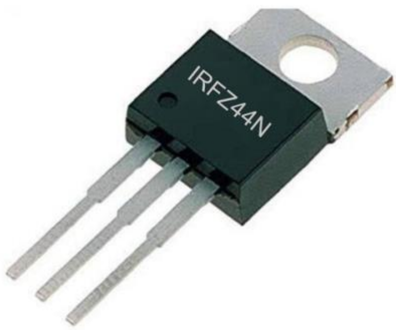

Fig 1.8 MOSFET driver IRFZ44N

4.4 SOFTWARE COMPONENTS

4.4.1 ARDUINO IDE

Arduino IDE is an open-source software used to write the code, burn them and upload it to the board. Arduino IDE is a beginner-friendly designing platform that supports all Arduino boards. It helps to connect the microcontroller hardware to a pc and upload firmware to the Arduino Board. Arduino IDE has been chosen for its simplicity and ease of use

4.4.2 FUSION 360

Fusion 360 is a cloud-based CAD/CAM tool for collaborative product development. Fusion 360 enables exploration and iteration on product ideas and collaboration within a distributed product development team. Fusion 360 combines organic shapes modeling, mechanical design and manufacturing in one comprehensive package. The F3D format is the default file format in Autodesk Fusion 360. The 3D modelling done in Fusion 360 is shown in the fig .

4.4.3 ULTIMAKER CURA

Cura is an open-source slicing application for 3D printers. Ultimaker Cura is free-to-use, open-source software compatible with a wide range of 3D printers. Ultimaker Cura works by slicing the user's model file into layers and generating a printer-specific gcode. The cura receives the.obj files that Fusion 360 has rendered. It is then converted into gcode. Slicing of the 3D printed model is shown in the fig .

4.5 CIRCUIT DIAGRAM

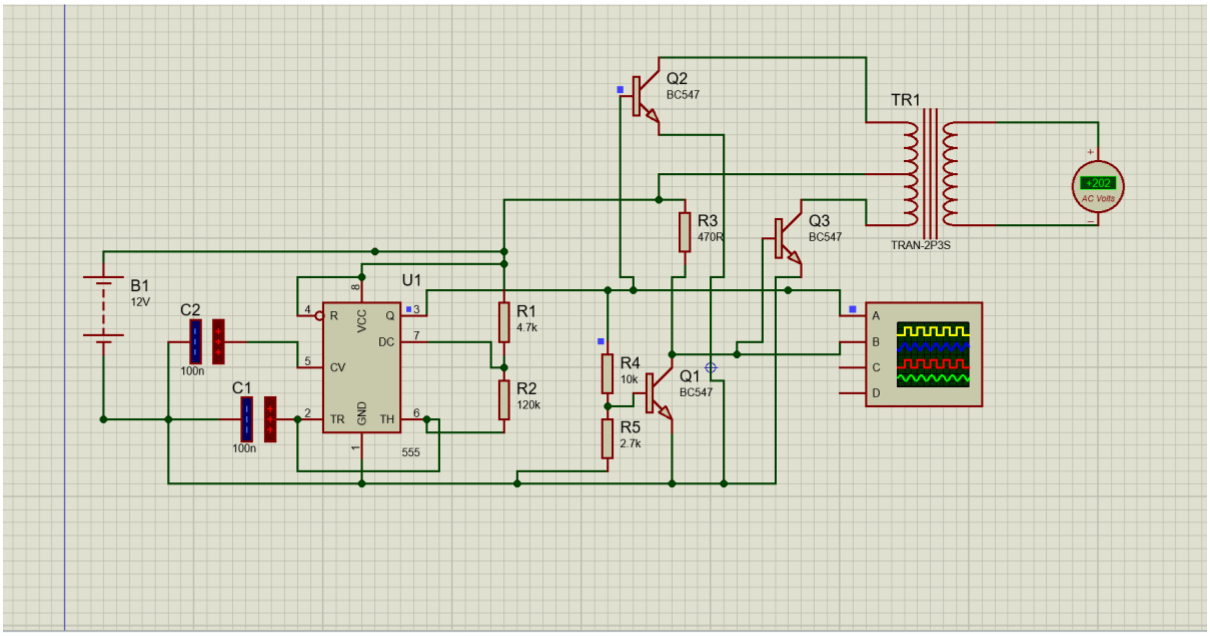

Fig 1.9 Inverter circuit simulation in proteus

The proposed project's inverter circuit is built to convert solar panels DC power output into AC power at 220V, making it work with common electrical and household appliances. The inverter circuit makes use of a number of essential elements and procedures to guarantee dependable and effective power conversion.

Section for Input: DC Input: The input portion of the inverter circuit is wired to receive the DC power output from the solar panels. Depending on how the solar panels are set up, this voltage typically ranges from 12V to 48V.

Transition Stage: Converter: A DC-DC converter receives the DC input and stabilises and regulates the input voltage. The converter optimises the functionality of the inverter circuit by ensuring that the voltage stays within a predetermined range.

Transitional Stage: Oscillator(Astable multivibrator): An oscillator, typically a high-frequency oscillator, is a component of the inverter circuit that produces square wave signals. The AC waveform is created using this signal as a reference.

Power Transistors: A group of power transistors, typically MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) or IGBTs (Insulated Gate Bipolar Transistors), are then fed the square wave signal from the oscillator. As switches, these transistors quickly turn on and off to create the desired AC waveform.

Output Transformer: An output transformer is connected to the power transistors output. By stepping up the voltage to the desired 220V AC output level, the transformer helps to ensure compatibility with common electrical appliances.

Results Section: Filtering: Harmonic distortion and noise may be present in the transformer's AC output. Filtering elements like capacitors and inductors are used to smooth the waveform and lower unwanted harmonics in order to address these problems.

Voltage regulation: To keep the output voltage at a constant 220V even under varying load conditions, the inverter circuit incorporates voltage regulation mechanisms. This guarantees that the connected appliances get a steady and dependable power supply.

Defending techniques:

Protection Against Overvoltage: The inverter circuit has safeguards against overvoltage situations. This may involve the application of voltage clamping hardware or circuitry that tracks the output voltage and initiates safety features when it rises above a set limit.

Fuse or circuit breakers are used as short circuit protection to guard against damage to the circuit in the event of a short circuit. In order to safeguard the inverter and connected devices, these devices look for excessive current flow and interrupt the circuit.

Monitoring of Temperature: Critical components' temperatures can be kept track of using temperature sensors. The inverter circuit can activate cooling mechanisms or start a shutdown to stop overheating if the temperature rises above safe thresholds.

So,the power generated through solar panels will be stored in a battery pack (li ion or polymer battery via battery management system) An Inverter system is used so that we can use the power to run larger devices.Here 555 timer ic is configures in an astable mode to generate around 50-60hz square wave at the output and this signal is fed into the base of the 2 mosfet to alternate 12v on to the secondary of the 12-0-12 transformer , hence we achieve 220v ac at the transformer output (max load 5amps)

5.6 AUDRINO IDE-PROGRAM

```
#include <Servo.h>
Servo horizontal; // horizontal servo
int servoh = 180;
int servohLimitHigh = 175;
int servohLimitLow = 5;
// 65 degrees MAX

Servo vertical; // vertical servo
int servov = 45;
int servovLimitHigh = 60;
int servovLimitLow = 1;

// LDR pin connections
// name = analogpin;
int ldrlt = A0; //LDR top left - BOTTOM LEFT <--- BDG
int ldrrt = A3; //LDR top rigt - BOTTOM RIGHT
int ldrld = A1; //LDR down left - TOP LEFT
int ldrrd = A3; //ldr down rigt - TOP RIGHT

void setup(){
horizontal.attach(9);
vertical.attach(10);
horizontal.write(180);
vertical.write(45);
delay(2500);
}
void loop() {
int lt = analogRead(ldrlt); // top left
int rt = analogRead(ldrrt); // top right
int ld = analogRead(ldrld); // down left
int rd = analogRead(ldrrd); // down right
int dtime = 10; int tol = 90; // dtime=diffirence time, tol=toleransi
int avt = (lt + rt) / 2; // average value top
int avd = (ld + rd) / 2; // average value down
int avl = (lt + ld) / 2; // average value left
int avr = (rt + rd) / 2; // average value right
int dvert = avt - avd; // check the diffirence of up and down
int dhoriz = avl - avr;// check the diffirence og left and rigt

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) // check if the diffirence is in the
tolerance else change horizontal angle
 {
 if (avl > avr)
 {
 servoh = --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);

}
```

5.7 IMPLEMENTATION

Importing the necessary libraries:

Importing the "Stepper" library to control the stepper motor.

Step1: Initialize the servo objects for horizontal and vertical movement and set initial positions.

Step 2: Read analog values from the four LDR sensors connected to specific pins.

Step 3: Calculate the average values for the top, bottom, left, and right LDR sensors.

Step 4: Calculate the difference in values between the top and bottom sensors (dvert) and the **left and right sensors (dhoriz).**

Step 5: Check if the difference in the top and bottom values (dvert) is within the tolerance range (-tol to +tol).

a. If the average value of the top sensors (avt) is greater than the average value of the bottom sensors (avd):

Increment the vertical servo angle (servov) by 1.

Limit the maximum angle to servovLimitHigh.

b. If the average value of the top sensors (avt) is less than the average value of the bottom sensors (avd):

Decrement the vertical servo angle (servov) by 1.

Limit the minimum angle to servovLimitLow.

c. Write the updated servov value to the vertical servo.

Step 6: Check if the difference in the left and right values (dhoriz) is within the tolerance range (-tol to +tol).

a. If the average value of the left sensors (avl) is greater than the average value of the right sensors (avr):

Decrement the horizontal servo angle (servoh) by 1.

Limit the minimum angle to servohLimitLow.

b. If the average value of the left sensors (avl) is less than the average value of the right sensors (avr):

Increment the horizontal servo angle (servoh) by 1.

Limit the maximum angle to servohLimitHigh.

c. If the average value of the left sensors (avl) is equal to the average value of the right sensors (avr):

Delay for 5 seconds.

d. Write the updated servoh value to the horizontal servo.

Step 7: Delay for dtime milliseconds before repeating the loop.

Step 8: Continue looping to continuously track and adjust the solar panel position based on the LDR sensor readings

Detailed Working

Initialize the servo objects for horizontal and vertical movement and set initial positions.Read analog values from the four LDR sensors connected to specific pins.Calculate the average values for the top, bottom, left, and right LDR sensors.Calculate the difference in values between the top and bottom sensors (dvert) and the left and right sensors (dhoriz).Check if the difference in the top and bottom values (dvert) is within the tolerance range (-tol to +tol).

a. If the average value of the top sensors (avt) is greater than the average value of the bottom sensors (avd):

Increment the vertical servo angle (servov) by 1.

Limit the maximum angle to servovLimitHigh.

b. If the average value of the top sensors (avt) is less than the average value of the bottom sensors (avd):

Decrement the vertical servo angle (servov) by 1.

Limit the minimum angle to servovLimitLow.

c. Write the updated servov value to the vertical servo.

Check if the difference in the left and right values (dhoriz) is within the tolerance range (-tol to +tol).

a. If the average value of the left sensors (avl) is greater than the average value of the right sensors (avr):

Decrement the horizontal servo angle (servoh) by 1.

Limit the minimum angle to servohLimitLow.

b. If the average value of the left sensors (avl) is less than the average value of the right sensors (avr):

Increment the horizontal servo angle (servoh) by 1.

Limit the maximum angle to servohLimitHigh.

c. If the average value of the left sensors (avl) is equal to the average value of the right sensors (avr):

Delay for 5 seconds.

d. Write the updated servoh value to the horizontal servo.

Delay for dtime milliseconds before repeating the loop.

Continue looping to continuously track and adjust the solar panel position based on the LDR sensor readings.

LDR Connections: The LDR sensors are connected to specific analog input pins (ldrlt, ldrrt, ldrld, and ldrrd) on the Arduino board.The Arduino program uses the analogRead() function to read the analog values from the LDR pins. This function returns a value between 0 and 1023, representing the voltage level at the respective pin.The program calculates the average values of the LDR sensors for different orientations (top, bottom, left, and right) by adding the readings from the corresponding LDRs and dividing them by 2.Then the program calculates the difference in average values between the top and bottom LDRs (dvert) and between the left and right LDRs (dhoriz).

The program checks if the calculated differences (dvert and dhoriz) are outside the defined tolerance range (-tol to +tol). If the differences exceed the tolerance, it indicates a need for adjustment.If the difference in average values between the top and bottom LDRs (dvert) is outside the tolerance range, the program adjusts the vertical servo (connected to the Servo object 'vertical').If the average value of the top LDRs (avt) is greater than the average value of the bottom LDRs (avd), the program increments the servo angle (servov) by 1.The program checks and limits the maximum angle to servovLimitHigh.If the average value of the top LDRs (avt) is less than the average value of the bottom LDRs (avd), the program decrements the servo angle (servov) by 1.The program checks and limits the minimum angle to servovLimitLow.The program writes the updated servov value to the vertical servo using the vertical.write() function.

If the difference in average values between the left and right LDRs (dhoriz) is outside the tolerance range, the program adjusts the horizontal servo (connected to the Servo object 'horizontal').If the average value of the left LDRs (avl) is greater than the average value of the right LDRs (avr), the program decrements the servo angle (servoh) by 1.The program checks and limits the minimum angle to servohLimitLow.If the average value of the left LDRs (avl) is less than the average value of the right LDRs (avr), the program increments the servo angle (servoh) by 1.The program checks and limits the maximum angle to servohLimitHigh.

If the average value of the left LDRs (avl) is equal to the average value of the right LDRs (avr), the program delays execution for 5 seconds.The program writes the updated servoh value to the horizontal servo using the horizontal.write() function.

Delay: The program introduces a delay of dtime milliseconds before repeating the loop to control the frequency of adjustments made by the servos.

Repeat: The program continues to loop through these steps, continuously monitoring the light intensity through the LDRs

CHAPTER VI

RESULTS AND DISCUSSION

The Arduino program-driven solar tracking system with servo motors showed effective tracking capabilities. The system was able to move the solar panel into the proper position as a result of the LDR sensors' accurate measurement of the light intensity from various orientations. The solar panel was correctly aligned with the position of the sun throughout the day because the servo motors accurately adjusted in response to the changes that were detected.

Compared to fixed solar panels, the developed solar tracking system has a number of benefits. The system maximises the amount of solar energy harvested by continuously adjusting the position of the solar panel based on the detected light intensity. Through optimisation, solar power systems become more effective and produce more energy.

LDR sensors turned out to be a wise decision for this project. LDRs are readily available, inexpensive parts that are sensitive to changes in light intensity. The system successfully tracked the solar panel by deftly positioning the LDR sensors on the solar panel's various sides. The average values derived from the LDR readings offered a solid foundation for figuring out the necessary orientation adjustments. The solar tracking system relied heavily on the servo motors to convert the data from the LDR sensors into actual movement of the solar panel. The servos performed with precision and ease, reacting quickly to changes in the average LDR values. The servos operated within the desired range of motion thanks to the set limits for servo angles (servohLimitHigh, servohLimitLow, servovLimitHigh, and servovLimitLow).

Based on the measured LDR values, the algorithm used in the Arduino programme successfully controlled the servo motors. The logic of the algorithm, which compared the average LDR values and made the necessary adjustments, worked well to maintain the solar panel's ideal alignment with the sun's position.

In conclusion, the solar tracking system utilising servo motors and LDR sensors offered a dependable approach to maximising the production of solar energy. Solar power systems' efficiency and output are increased by the system's ability to autonomously track the sun's movement throughout the day, making it a promising technology for applications involving renewable energy. Additional improvements might involve adding more sensors or using sophisticated tracking algorithms to take into account things like cloud cover or seasonal variations in the sun's path.

6.1 TINKERCAD SIMULATION

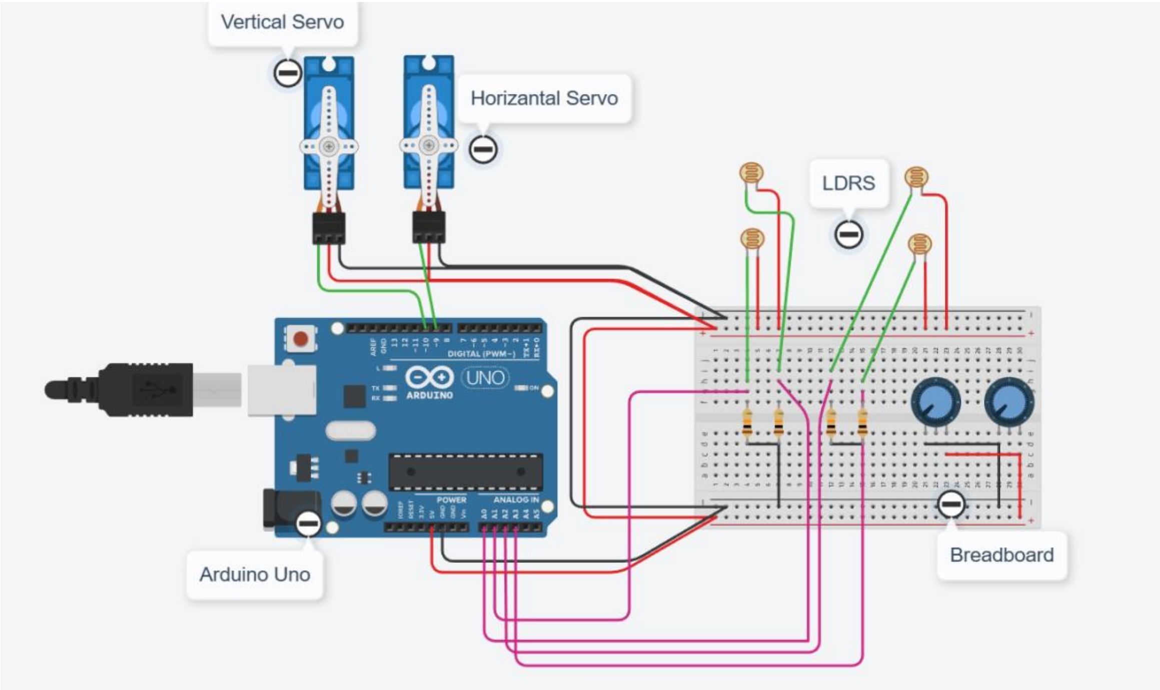

Fig 2.0 solar tracking system

6.2 PCB DESIGN FOR INVERTER CIRCUIT

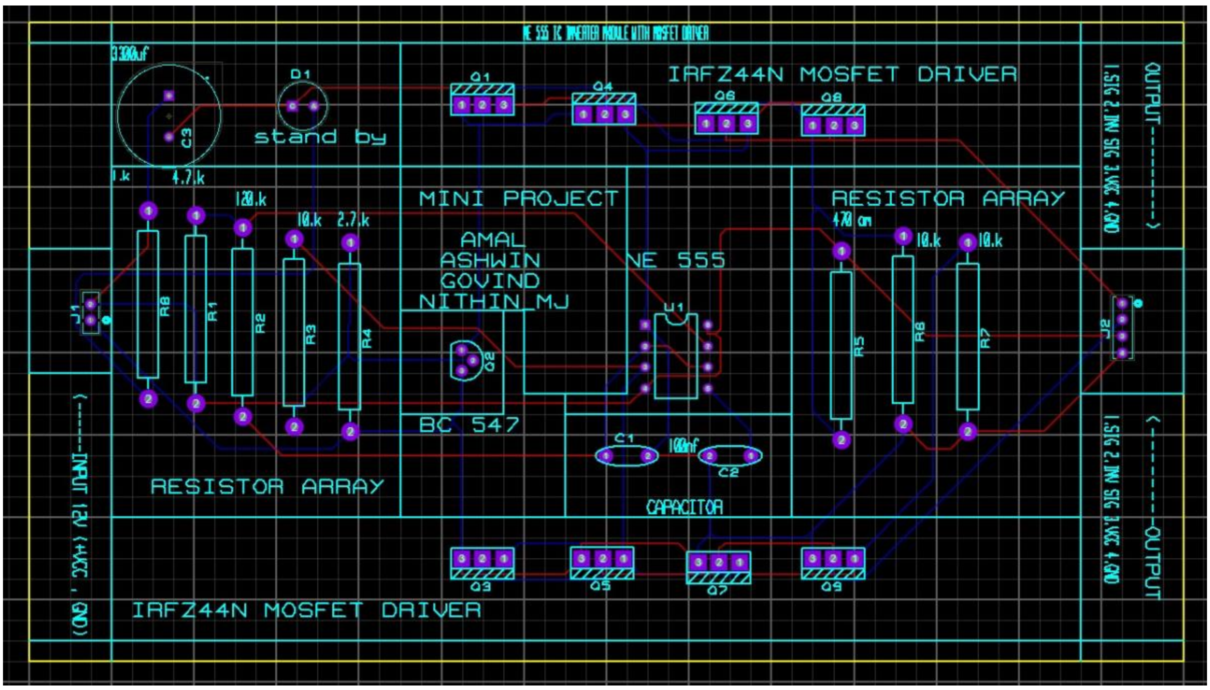

Fig 2.1 PCB design for inverter circuit

6.3 DESIGNED PRODUCT

Fig 2.03 Designed product

CHAPTER VI

CONCLUSION AND FUTURE WORKS

In conclusion, the solar tracking system implemented using LDR sensors and servo motors has successfully showcased its ability to optimize solar energy generation. By continuously adjusting the position of the solar panel to align with the sun's movement, the system maximizes energy output and enhances overall efficiency. The use of LDR sensors proved to be a suitable choice, providing accurate measurements of light intensity from different orientations. The servo motors responded promptly to the LDR readings, ensuring precise movement of the solar panel. The developed algorithm effectively controlled the servos based on the measured values, resulting in reliable solar tracking. The project demonstrates the potential of utilizing affordable and accessible components to create efficient solar tracking systems. The system's adaptability and scalability make it a promising solution for renewable energy applications.

While this project's success is evident, further enhancements could involve

a) Integrating additional sensors and implementing advanced algorithms for improved tracking performance.

b) Also,**different modes or patterns of arrangement of the solar panels** can be done to maximise the efficiency of the solar panels.

Overall, the solar tracking system represents a step towards maximizing solar energy utilization and contributing to a sustainable future.

REFERENCES

[1]J. -N. Juang and R. Radharamanan, "Design of a solar tracking system for renewable energy," Proceedings of the 2014 Zone 1 Conference of the American Society for Engineering Education, Bridgeport, CT, USA, 2014, pp. 1-8, doi: 10.1109/ASEEZone1.2014.6820643.

[2]A. Lokesh, A. Surahonne, A. N. Simha and A. C. Reddy, "Solar Tracking System Using Microcontroller," *2018 International Conference on Inventive Research in Computing Applications (ICIRCA)*, Coimbatore, India, 2018, pp. 1094-1098, doi: 10.1109/ICIRCA.2018.8597267.

[3]K. Charafeddine and S. Tsyruk, "Automatic Sun-Tracking System," *2020 International Russian Automation Conference (RusAutoCon)*, Sochi, Russia, 2020, pp. 191-195, doi: 10.1109/RusAutoCon49822.2020.9208086.

[4]G. Perveen, P. Anand and A. Kumar, "Performance Evaluation of Solar Tracking System," *2020 International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE)*, Bengaluru, India, 2020, pp. 163-168, doi: 10.1109/ICSTCEE49637.2020.9276923.

[5]N. Verma, M. Kumar and S. Sharma, "Real-Time Solar Tracking System with GPS," *2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS)*, Coimbatore, India, 2021, pp. 783-788, doi: 10.1109/ICAIS50930.2021.9396052.

[6]R. Mallwitz and B. Engel, "Solar power inverters," *2010 6th International Conference on Integrated Power Electronics Systems*, Nuremberg, Germany, 2010, pp. 1-7.

[7]Dip Narayan Sarkar, Aranya Bagchi, Soham Mohanti, Mrinmoy Patra , Shaon Paul," Solar Inverter with Microcontroller Based Tracking System", International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016