AISSMS
INSTITUTE OF INFORMATION TECHNOLOGY
ADDING VALUE TO ENGINEERING

A

PROJECT REPORT ON

# "SINGLE AXIS SOLAR TRACKING SYSTEM BY USING ARDUINO"

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE

OF

## BACHELOR OF ELECTRICAL ENGINEERING

BY


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UNDER THE GUIDANCE OF

**PROF. VIJAYKUMAR S. KAMBLE**

DEPARTMENT OF ELECTRICAL ENGINEERING

**AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, PUNE**


**ACADEMIC YEAR 2020-21**

# CERTIFICATE

This is to certify that the project report entitled

**"Single Axis Solar Tracking System by Using Arduino"**

Submitted by


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Is a bonafide work carried out by them under the supervision of Prof. Vijaykumar S. Kamble and it is approved fir the partial fulfilment of the requirement of Savitribai Phule Pune University for the award of the Degree of Electrical Engineering.

This project report has not been earlier submitted to any other Institute or University for the award of any degree or diploma.

| **MR. VIJAYKUMAR S. KAMBLE** | **MRS. A. D. SHIRALKAR** |
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Date:

Place:

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**PIYUSH GAIKWAD** **ADVAIT KULKARNI**

**SUSHANT LONDHE** **NISHIKANT KHANGAR**

# 1. ABSTRACT

The energy demand of whole World is increases with respect to the growth and development. Many countries adapt new technologies and move towards the automation for more efficient and more production in less time. For this electrical energy requirement is increase. There are basically two sources for energy generation renewable energy sources and non-renewable energy sources. Renewable energy sources have advantages like pollution free power generation and non-ending source and this is beneficial for us. Sun is the largest source of energy. To convert solar energy into electrical energy mostly fixed solar panel use. To increase the efficiency of solar power generation we need to improve interfacing between solar panel and sunrays. There are different methods of tracking system single axis solar tracker, dual axis solar tracker, active and passive solar tracker. In this project single axis solar tracker is explained and developed by which solar panel tracks the position of sun with the help of LDR, servo motor and program are run by Arduino Uno software. By improving interfacing between sun rays and panel increases and power output is also more as compared to fixed solar panel, therefore efficiency also increases.

**Keywords:** LDR (Light Dependent Resistor), Arduino, Servo motor, solar panel, solar tracker.

# INDEX

# LIST OF FIGURES

# 1. INTRODUCTION

We all know that how electricity is playing vital role in our day-to-day life. Everyone is dependent on electricity. All the production houses, industries, research centre, hospitals, hotels etc. requires electricity to fulfil our needs and for development purpose. We all move towards the technology and to become a more efficient, more productive and to do operations safely. Without electricity almost all the works become stop. If we see in the past, in September 1882 Thomas Edison generates electricity using hydro plant. After that many revolutions occurs in electricity. There are different sources found by which electricity can be generated and along with that demand of electricity also increases. Further along with the water, wind, coal, nuclear also used as energy sources. Due to which thermal power plant, hydro power plant, steam power plant, nuclear power plant, gas power plant developed but some energy sources like coal produce pollution and its bad effect result in environment. The storage of this sources is reducing day by day hence whole world is looking for new technologies for power generation which is environment friendly and source is renewable. Then most of the countries focus on the hydro, wind and solar power generation. In 1839, a young France physicist Edmond Becquerel gives the photovoltaic effect using this after 30-40 years solar cell developed.

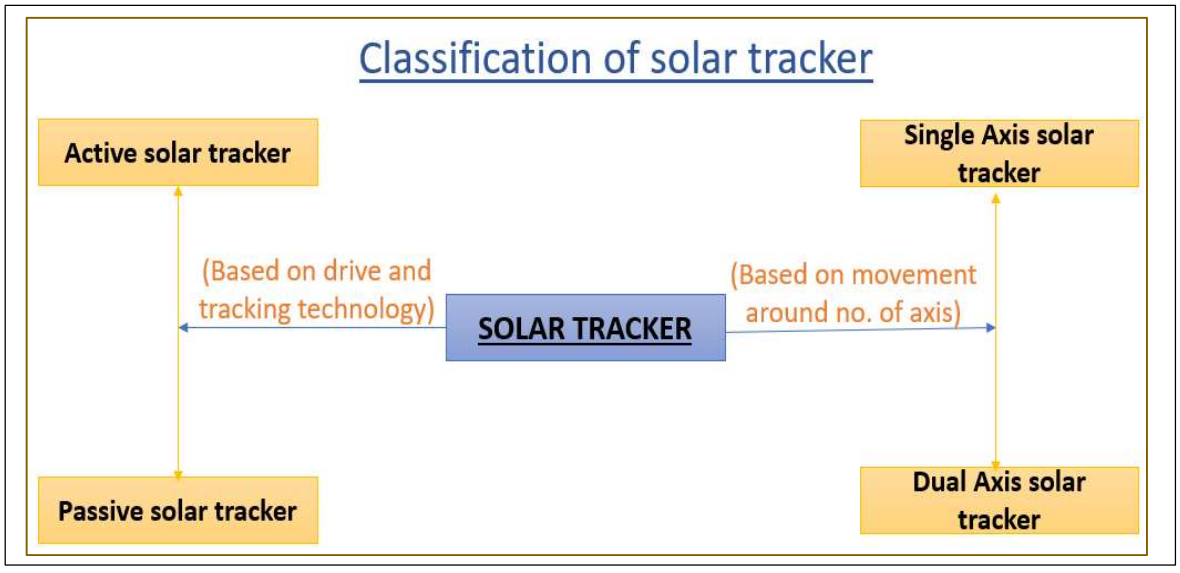


**Fig:1**

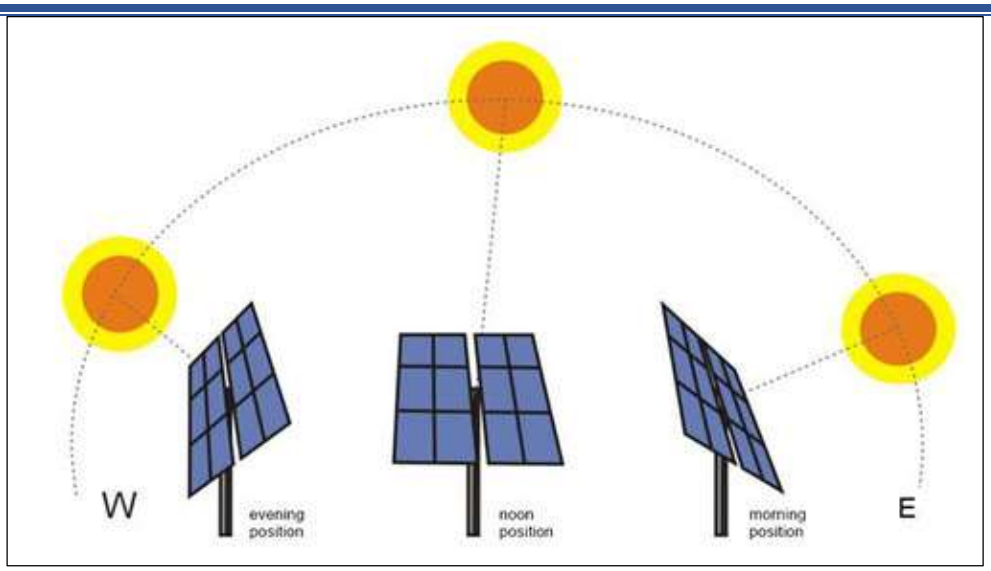


**Fig:2**

Solar panel generates electricity but efficiency is less. We all know sun is the large source of energy and now we have challenged to utilize this energy as much as we can. In many solar power plants, fixed solar panels are used. They can collect only sunrays that interface with panel. We have challenge to improve this interfacing. When sun rays are interfacing with solar panel at 90° then its power generation capacity is high. There are many things in our environment which gives us idea about innovation for example sunflower which faces the sun as sun move from east to west. So, we can adapt this technique. Fixed solar panel generates power but, in less amount, so we have challenge to improve this efficiency. It is interesting because it can track sun position and for which we have to learn some new aspects and this project is needed because only finding of new source is not important, whatever source we have and how we utilize and renewed it also important aspect.

## 1.1 AIM OF THE PROJECT

to learn Arduino Uno board and its software, to study different components required to develop tracking system and selection of tracking system. Also, our goal is to develop program for solar tracking and proper hardware alignment which can gives us more efficiency. For this we first interface the separate component like LDR, servomotor, Arduino etc. And finally try to merge it accordingly our project.

# 2. LITERATURE SURVEY

Photovoltaic Education Network [1] focuses in this paper that getting the maximum power from solar panel is the main goal of increasing the efficiency. The project is nothing but the implementation and simple design with affordable price for single axis solar tracker. There is a comparison of solar tracker with fixed solar panel so we can get a proper table showing the difference, how solar trackers are giving more output than fixed one. The whole project is mainly composed of light dependent resistor, solar panel, DC motor, dish and ball joint, sensor module and electronic circuit. Hardware and Electronics are the two parts of the project. In hardware there is presence of solar panel, DC motor with gearbox mechanism and LDR sensor module. In electronic part there is presence of one commanding device like Arduino, raspberry-pie, microcontroller, etc. Solar irradiance is the most important part for proper extraction of solar energy from solar collector or photovoltaic (PV). Solar collector should always place normal with respect to incident radiation for maximum extraction of energy from sun. To follow the sun path, solar collector moves accordingly with the help of solar tracker. Due to this the solar collector keeps the orientation at an optimal tilt angle. In this project position of the sun has sensed in two phases in first phase the LDR sense the solar light and moves accordingly. In second phase if there is presence of dusty or cloudy whether then tracking system stops the movement and stays in the position. The energy efficiency of photovoltaic panel is improved by solar tracking system. Solar tracking system is more efficient and reliable than fixed solar panel.

O.V. Singh et.al [2] in their research paper elucidates that due to improved performance of solar panels the design requirement of tracking system is increasing day by day. In the period of morning and evening solar collector extract the solar rays at an acute angle. In case of fixed solar panel, the energy output is less as sun rays will move continuously. Hence, to improve the work of solar collector there is need to enhance the mean radiation intensity and solar tracking system is most commonly used for it. This paper is having two parts first one is pseudo code development and second one is hardware. In this proposed work two signals from two sensors are matched. LDR (Light dependent resistor) has been utilized as a light sensor. The sensors are divided by separator. If solar collector is not normal to sun, then there will be shadow on single side of LDR. For supervising the rotation of motor through relay Arduino works as a great operator. Arduino handles the data received by LDR. Arduino works as a

sending and operating device which sends the data input from LDR to DC motor through relay for the confirmation of the solar panel is normal to side of sun.

Ashok Kumar Saxena et. al. [3] in their research paper explained about the solar tracking controller design and parameter monitoring. Paper is focusing on the solar tracking design and controller capacity to receive photovoltaic and meteorological data. To control tracking system and data monitoring microcontroller is used as an electronic controller. In Design section, their focused on the fully automatic and simple to operate system. For this, they provide 4 pwm signal to stepper motor and program required to operate system is stored in EPROM. For tracking they had implemented both open and close loop strategies and system also monitor parameter Isc, Voc, Pm etc for load and batter management. Close loop strategy is used to tracking solar panel from home position to maximum position and again back to home position and open loop strategy is used to monitoring data.

Yasser M. Safan et. al. [4] in their research paper explained about the different types of solar tracking system and mainly focused on the maximum output power of the panel during the day with the minimum required driving energy. It uses PID controller to track the Sun rays. This design or system also focus on the maintaining a maximum possible solar radiation incident normal to the solar panel due to which output power generation increases. There are different types of tracking system mentioned according to number of axis or based on degrees of freedom and movement capability for example: single axis solar tracker, dual axis solar tracker another classification is active solar tracker, passive solar tracker and hybrid solar tracker. In this paper, design of hybrid solar tracker is explained. For which both open loop and close loop strategies are used. Sun sensor tracking errors are comes in open loop strategy. To feedback sun position and proper alignment data of axis close loop strategy is used. There are three main subsystems explain for construction 1) mechanical system- Aluminium solar tracker structure. 2) Electrical system- PV system, two stepper motor 3) control system-microcontroller, motor drive and sensor.

Mohamed I. Abu El-Sebah [5] in their paper explains about photovoltaic (PV) systems and how to improve their efficiency has been discussed. The main input to photovoltaic systems is the solar radiation, which cannot be manipulated and has a variable intensity based on daily and seasonal variations. To manipulate these perturbations, a solar tracking system could be used. The solar tracking system improves the photovoltaic system output power by maintaining a maximum possible incident solar radiation normal to the PV panels. The main problem in

sun tracking process is that it may lead to less efficient system due to the high-power consumption in driving the tracking system. There are mainly two types of solar trackers based on degrees of freedom and movement capability; single-axis solar tracker and dual-axis solar tracker. Another classification as an active solar tracker and passive solar tracker based on the tracking technology and drive type also exists. Active solar trackers may be classified according to their control type into open-loop controlled, closed loop-controlled, and hybrid controlled solar trackers.

S. Gupta et.al. [6] in their paper elucidates that as shortage of energy resources aims the scientists to utilize the solar energy generating the electric power, they found that photovoltaic cell is the generating unit of electricity that would be studied to maximize the output power and its system can be developed. Performance of solar photovoltaic cell is associated with its material, size, ray's intensity and atmospheric conditions. The voltage-current curve at various incident radiation (measures along the day time) when a resistive load is connected to the solar cell. They recorded the readings of curve at mid-day time when the incident radiation energy consumption around the world. They conclude that the current amount generated by a solar cell depends on its efficiency, its size (surface area) and the intensity of sunlight striking the surface. Literature review includes several methods and techniques reported for maximum power point tracking (MPPT) until 2007 replaced by fixed solar systems. All researches aim to maximize the gain output power from solar system to keep sun rays perpendicular on the solar panel along the day time. Comparison between them is investigated which interested system costing, fasting technique and most efficient techniques connected dc converters.

Ayushi Nitin Ingole et.al. [7] in their research paper focuses the importance of using solar energy. The demand of electrical energy is increasing year by year due to globalization. The increase in demand of electricity gives an impact on the loss of main resources available to produce electrical energy. Human beings have explored more ways and technologies for the production of electrical energy using the renewable energy resources. The energy which is generated using natural resources which are freely available in nature is called as renewable energy. Solar energy is the most suitable among all. Because it is available abundant in nature free of cost. So, it makes sense to use solar energy for generating electricity. Also, solar energy is environment friendly since it does not create any pollution like fossil fuels. Solar energy is available in the form of solar radiations. Solar radiations from the sun are absorbed by the solar panels and converted into DC electric energy. Solar energy has a great potential for conversion into electrical energy in Malaysia because it has very high solar radiation levels.

Deepthi S. et. al. [8]in their research paper mentioned about the types of single axis tracking systems. A Single axis tracking system is an ideology of continuously rotating the solar panel towards the sun's direction from east to west, by continuously tracking the sun's position throughout the day. There are three types of single axis tracking system: Horizontal single axis tracking system, Vertical single axis tracking system and Tilted single axis tracking system. In the Horizontal system the axis of rotation is kept horizontal with respect to the ground, and the face of the module is kept parallel to the axis of rotation. In the Vertical system the axis of rotation is kept vertical with respect to the ground and the face of the module is kept at an angle with respect to the axis of rotation. In the Tilted tracking system, the axes of rotation are kept between horizontal and vertical axes and the face of the module is kept parallel to the axis of rotation, similar to the Horizontal tracking system. The single axis tracking system consist of two LDR's. One LDR is placed on the east side of the solar panel and the other one is placed on the west side of the solar panel. Depending on the intensity variation of the sun rays falling on both the LDRs, the panel is rotated. As the day progresses, the intensity falling on the west side LDR increases and the controller rotates the solar panel towards west direction.

# 3.REQUIREMENT AND ANALYSIS

## 3.1 PROBLEM STATEMENT

We know sun is the largest source of renewable energy and we have to consume maximum solar radiation for maximum solar power generation. To generate power from solar energy, fixed solar panels are used in maximum power plant. What is problem with fixed solar panel or why we need to move towards tracking system? Our planet earth is continuously revolved around the sun there for the direct exposure of sun rays with the panel for power generation is less due to which absorption of sun rays reduces power generation also reduces and it results decrease in efficiency. To overcome this drawback our project addresses to develop or install tracking system. It works as the direction of sun changes position of panel also change and direct contact between sun rays and panel can be possible. Due to which power generation and efficiency increases.

## 3.2 OBJECTIVE

1) To increase the efficiency of solar power generation.
2) To design a proper tracking system for movement of solar panel
3) To develop tracking system with moderate cost.

## 3.3 SOFTWARE AND HARDWARE REQUIREMENT

- **Software Requirement**

1. Arduino UNO software (IDE)

- **Hardware Requirement**

1) Arduino Uno
2) LDR
3) Servo motor
4) Solar panel
5) LCD display
6) Resistor

## 3.4 METHODOLOGY

The main aim is to design a high-quality solar tracking system. The single axis solar tracking system rotates from east to west keeping the face of the solar panel towards the sun throughout the day. This is achieved using two LDRs and a servo motor interfaced with Arduino.

This system is divided into two different parts; hardware and software. It consists of three main constituents which are the inputs (LDRs), controller (Arduino) and the output (Servo motor). Normally, an LDR has very high resistance, sometimes in megaohms, but when they are illuminated with light, the resistance drops. LDR's have low cost and simple structure. The Servo motor can turn either clockwise or anticlockwise direction depending upon the sequence of the input logic signals. The principle of the solar tracking system is done by Light Dependant Resistors (LDRs). Two LDR's are connected to Arduino analog pins AO to A1, acting as an input for the system. The sequence of the input logic signals depends on the difference of light intensity falling on the LDR sensors. The built-in Analog-to-Digital Converter which is inside the Arduino will convert the analog value of LDR into digital. The input to the system is analog values of LDR. Arduino will act as a controller and the servo motor will be the output of the system. In this system, Arduino is powered by the 9V battery and all the other parts are powered by the Arduino. The positive wire of the battery is connected to the Vin pin of the Arduino and the negative wire of the battery to the ground pin of the Arduino. LDR1 and LDR2 are taken as pair. If light intensity falling on the one LDR is more than the other, a difference will occur on node voltages, this information is sent to the respective Arduino channel to take necessary action. The Servo motor will move the solar panel towards the direction of the high intensity LDR.

The two LDR's are placed at the two opposite sides of the solar panel, one is placed at east side and the other one is placed at the west side of the panel and the servo motor is used for rotating the solar panel. LDR is an active sensor which senses light intensity and its resistance decreases with increase in the intensity of light. LDRs acts as input, sensing the intensity of the sun. Servo motor is coupled to the panel through an axle. The servo will move the solar panel towards the direction of the LDR, whose resistance will be low, means towards the LDR on which light intensity is falling more as compared to the other LDR, that way it will keep following the light intensity. And if there is same amount of light intensity is falling on both the LDRs, then the servo motor will not rotate and will remain stable. As long as the light

intensity falling on both the LDRs remains same, the servo motor will not rotate the panel and if the resistance of one of the LDR changes then it rotates towards lower resistance LDR. As the intensity falling on the west side LDR increases than the east side LDR (as the day progresses, the sun will be rotating towards west), the servomotor will rotate the panel towards west direction.

An assembly language program is utilized and saved into Arduino to achieve the rotation as stated earlier. The software part of the system can be split into two parts. The first part is initial positioning. Prior to powering up the system, the panel must be set towards the east, after the sunset and before the sunrise of the next day. The second part deals with the actual movement of the panel, this is the heart of the program. Once the initial position of the panel is set, it is ready to align itself more preciously by continuously tracking the sunlight intensity. The compiled program controls the whole hardware operation.

# 3.5 SPECIFICATION OF SYSTEM

## 3.5.1 Specification of Software

**1) Arduino Uno software:**

Arduino Uno (IDE) is a software can install on computer which is used to give command or to programmed Arduino. User writes program on IDE software and upload on Arduino hardware through USB cable. Arduino IDE is open-source software which is simple and many projects can be done using this. It is also easy for beginners and it is available freely. It works on Mac, windows and Linux. The language used for programming is similar to c language. Basic steps to use Arduino is 1) connect Arduino board to computer 2) Install IDE software and open it. 3) configure the setting 4) write code and upload 5) compile and recheck if any error occurs 6) Run the program.

### 3.5.2 Specification of Hardware

**1) Arduino Uno:**

Arduino Uno is a modified version of micro controller. Arduino board consist of microcontroller ATmega328p, 14 digital input output pins out of which 6 pins are used as PWM output. It has 16 MHz crystal quartz. Arduino has reset and header button. It is connected to computer through USB cable. Power supply is given by adapter (ADC) or by battery. Arduino microcontroller runs the program which is uploaded by software. There is small LED on board to display operation status.

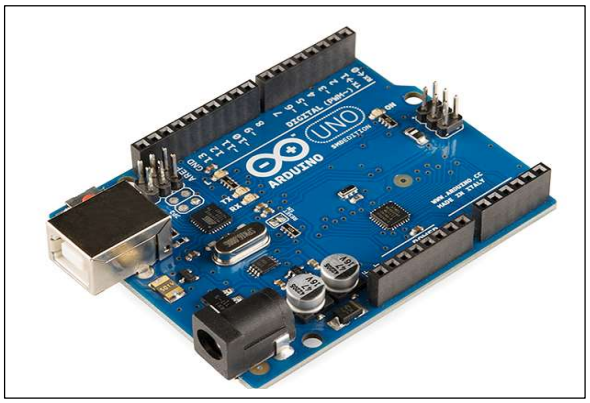


**Fig:3**

**Specification:**

Microcontroller: ATmega328p-8bit AVR family microcontroller

Operating voltage: 5v

I/P Voltage: 7-12v

Analog I/P: 6(A0-A1)

Digital I/O pin:14

RAM: 2 kB

EEPROM: 11kb.

clock speed: 16 MHz

**2) LDR (Light dependent resistor):**

There are many sensors used in electronics system to sense the different parameter for example piezoelectric sensor, flow control sensor, proximity sensor etc. LDR is also one of the sensors which operates according to light intensity. As light fall on LDR sensor it's resistance value changes. That is as light intensity fall on LDR increases its resistance value decreases. In LDR light sensing material like ceramic is used in random structure and it is work on photoconductivity principle.

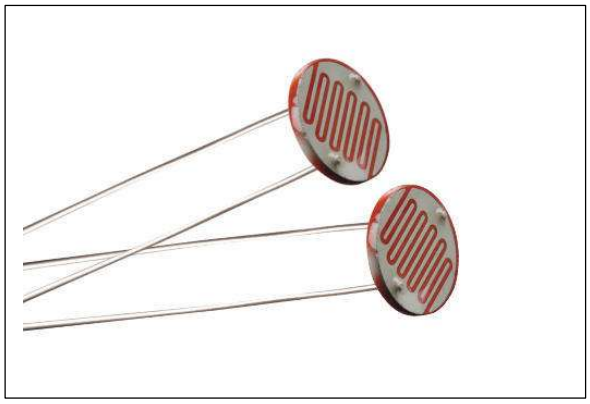

**Fig:4**

**Specification:**

Maximum power dissipation: 200 MW

Maximum voltage at 0 lux: 200v

Peak wavelength: 600 mm

Minimum resistance @10 lux 1.8kohm

Maximum resistance@10 lux 4.5 John

**3) Servo motor:**

Servo motor is a motor operating on DC supply which is rotate by angular position. Servo gear are used to angular rotation. It is properly controllable with small angle rotation. Hence this motor runs by servo mechanism.

Servo motor consists of 3 wire:

a) Orange wire- to drive motor (PWM signal D3 pin of Arduino)

b) Red wire- +5 v (powers the motor)

c) Brown wire- ground


**Fig:5**

**Specification**

Operating voltage 5V

Torque 2.5kg/cm

Operating speed 0.1 s/60°

Gear type – plastic

Rotation: 0-180°

Weight: 9gm

**4) Solar panel:**

Many solar cells combined to form solar panel. Solar cell is formed by semiconductor material and element like silicon which has valance band, conduction band. As sun rays falls on the panel it starts conducting or generate power from solar energy. There are different rating panels are available in market. For our project we use following specification solar panel:

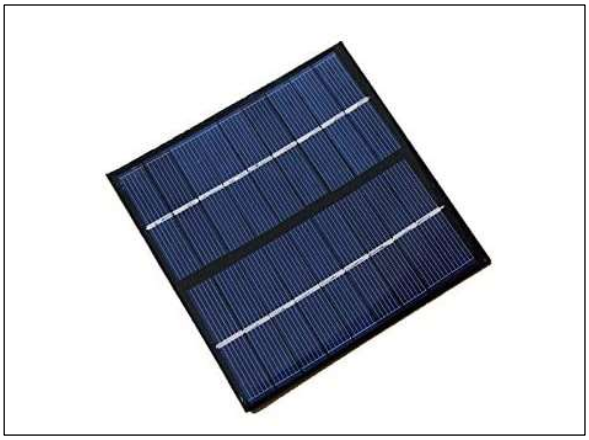

**Fig:6**

**Specification:**

Dimension: 130*165*3 mm

Voltage- 9v

Current: 250 mA.

**5) LCD Display**

**Fig:7**

**6) Resistor**

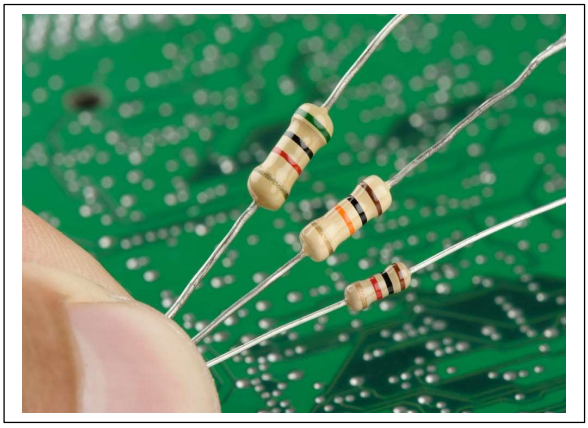

**Fig:8**

# 4. BLOCK DIAGRAM OF THE SYSTEM AND ITS EXPLANATION

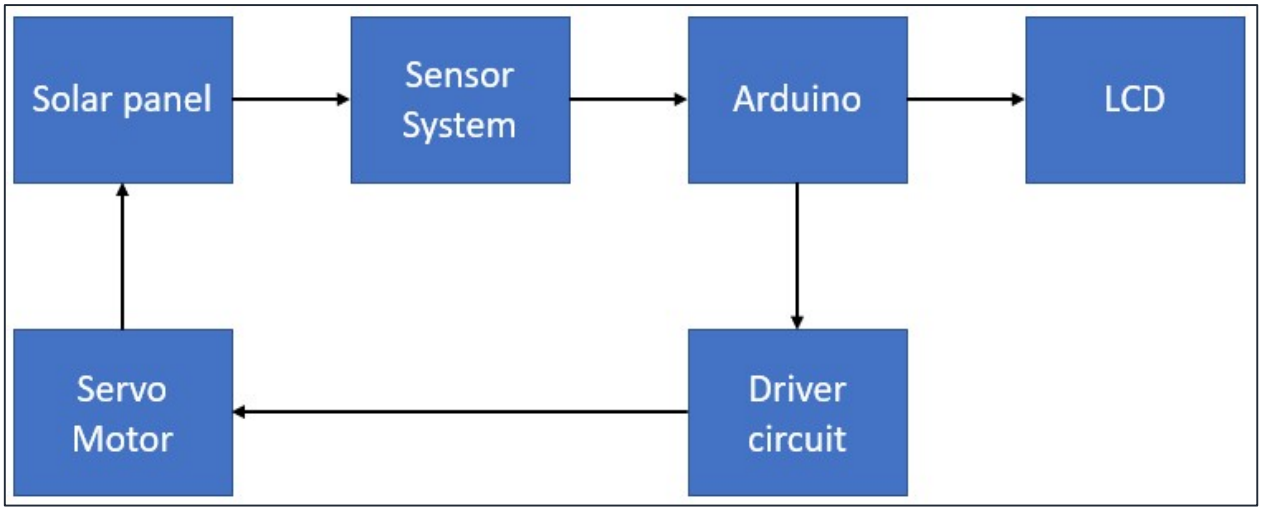


**Fig:9**

- Figure shows the block diagram for the single axis solar tracking system.
- The first component is solar panel on which sunlight falls.
- Sensor system consisting of LDRs are placed on the panel. LDRs senses light intensity. The output of the sensor system is given as input to the Arduino.
- Arduino takes input from the sensor system, converts it into digital form and according to this input, sends data to the driver circuit.
- Driver circuit is used for controlling the rotation of the servo motor. It receives the data from Arduino and rotates servo motor accordingly.
- Servo motor which is mechanically coupled with solar panel, is used to achieve the actual rotation of the solar panel. Servo motor allows small rotation and precise control of angular rotation. This is the reason behind using servo motor in this system.
- LCD is also interfaced to the Arduino which displays the output of the solar panel.

# 5. HARDWARE DESIGN

While designing this project the most important factor is to calculate the moment of inertia of the solar panel. This is to be done for the purpose of finding the rotary axis. So, while designing, rotating axis can either fix in middle of horizontal side or middle of vertical side of solar panel. As compared to horizontal sided one if the axis is fix in the middle of vertical side, then it will have less moment of inertia and having less moment of inertia helps to easier movement of solar panel. In the whole prototype we had used a hard board as a basement or foundation of our project. On that we had used a zero PCB for designing the circuit of the Project. The circuit is consisting of LDRs, Servo Motor, Arduino, LCD Display, Battery. After designing the circuit, PCB was placed on a box and that box was fixed on the foundation. With the help of triangular shaped axis arrangement solar panel was mounted on that.

Basically, Arduino is a device which reads the input data and turn it to output data. Arduino is the brain of our project. All commands are given by arduino to different components. LDR sense the light intensity and actuates the signal to servo motor through arduino for that LDR mounting is important. LCD interfacing uses for displaying purpose of voltage, current and power.

**LDR:** LDR has two terminals out of which one terminal is connected to 10k resistor and another terminal is connected to 5v supply. Terminal which is short with 10k resistor is given to the A0 pin of Arduino and another terminal of 10k resistor is connected to ground.

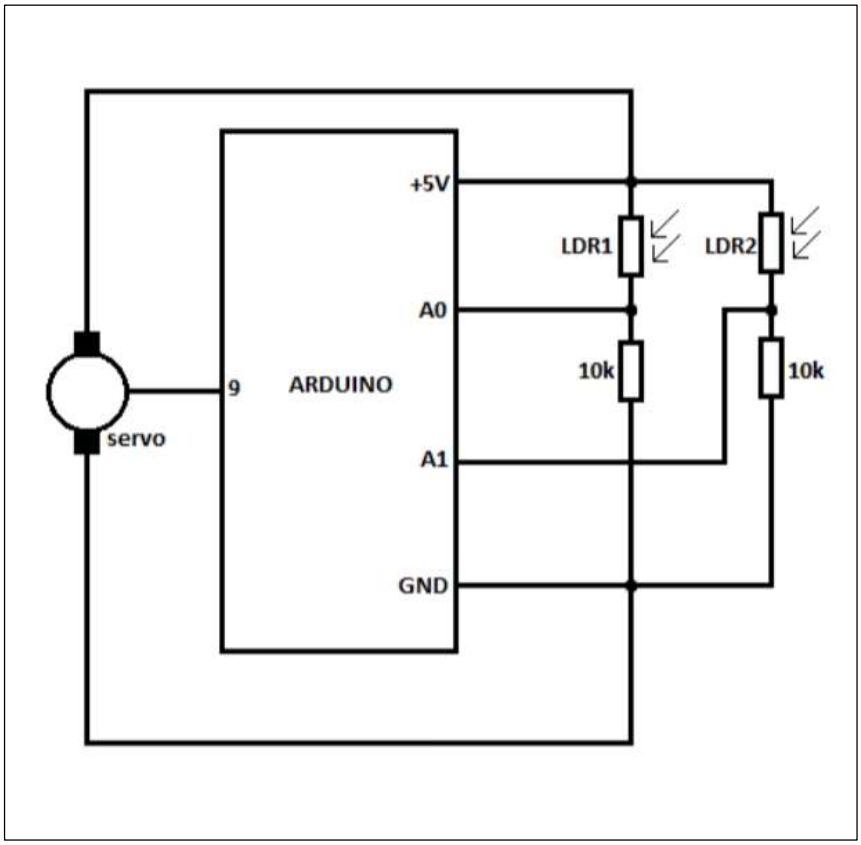


**Fig: 10 (Basic Circuit Diagram)**

**SOLAR PANEL CONNECTION:** Solar panel consists of 2 wires positive one and negative one which can connect to battery for storage purpose but here we take voltage and current reading and display it on LCD.

**SERVO MOTOR CONNECTION:** Servo motor has 3 wires Orange, Red, Brown. Orange one is connected to pin D3 which is digital I/O pin (PWM Signal). Red wire is for supply which is connected to positive 5v pin on arduino. Brown wire is connected to ground. Thus, servo motor takes signal form LDR through arduino and rotates accordingly and try to rotate the panel towards the sun. Battery is used for external supply only.

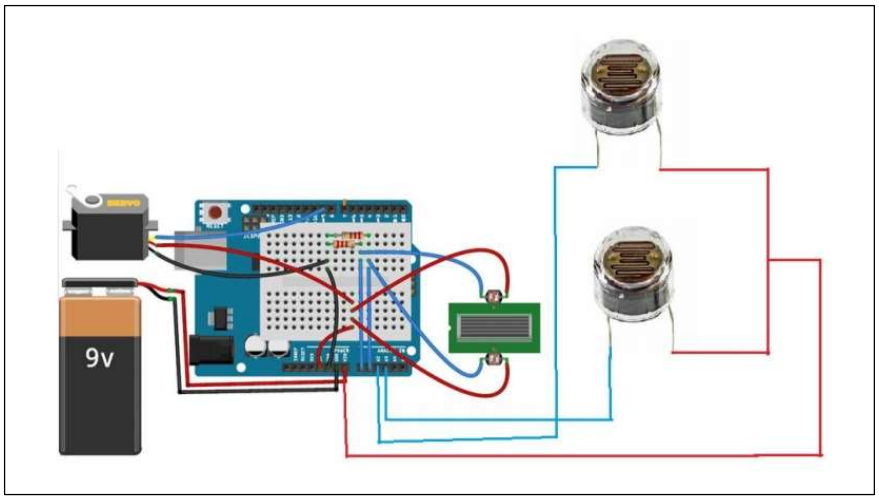


**Fig:11 (Detailed Circuit Diagram)**

**LCD DISPLAY:** LCD is interface with arduino and takes all required data from arduino and displays on screen.

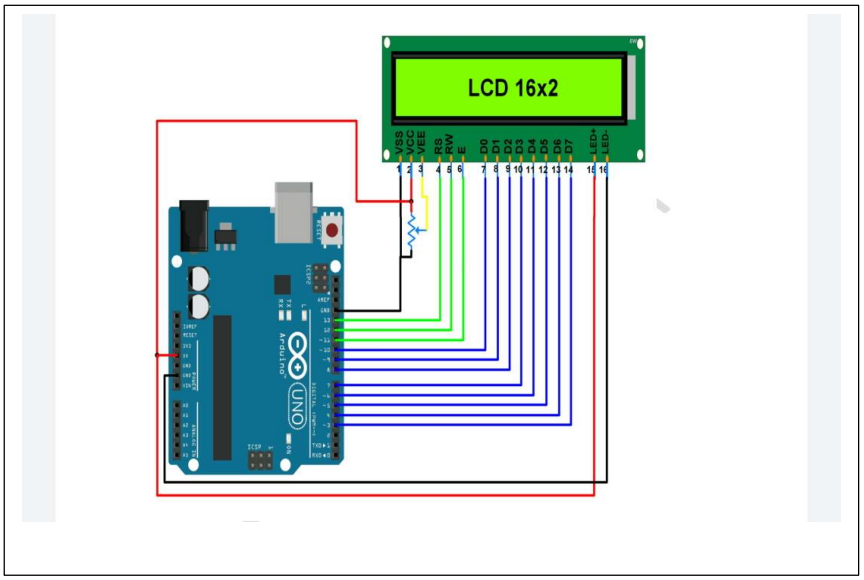


**Fig:12 (Interfacing Diagram)**

# 6. SOFTWARE DESIGN

For servo motor, library is needed to include and for initial position of servo motor initialization of variable should be done. To read the signals of LDR's and servo motor again the initialization of variables should be done. To read servo from the pin 9 of Arduino sg90. attach(servo pin) this command is used. Then the LDR pins are set to input pins for the purpose of reading the values from LDR and for movement of solar panel accordingly. Servo motor is then set to its initial position i.e., at 90 degree. Then the values from LDR will read and save to R1 and R2. For the movement of servo motor, we will make the difference in between the 2 LDRs. Solar panel will not move if the difference between 2 LDRs will be zero as the light falling on each side is same. 'Error' which is a variable name with value 5 is used for if the difference between the sensors will be under 5 then the servo will not move. Servo will keep rotating if we will not do this. Servo motor will move the panel in the direction of LDR on which the light is falling, if the difference is greater than the error value i.e., 5. So, in this way the panel will automatically move towards light like a Sunflower and tracking can be done.

## 6.1 BASIC FLOWCHART OF PROJECT

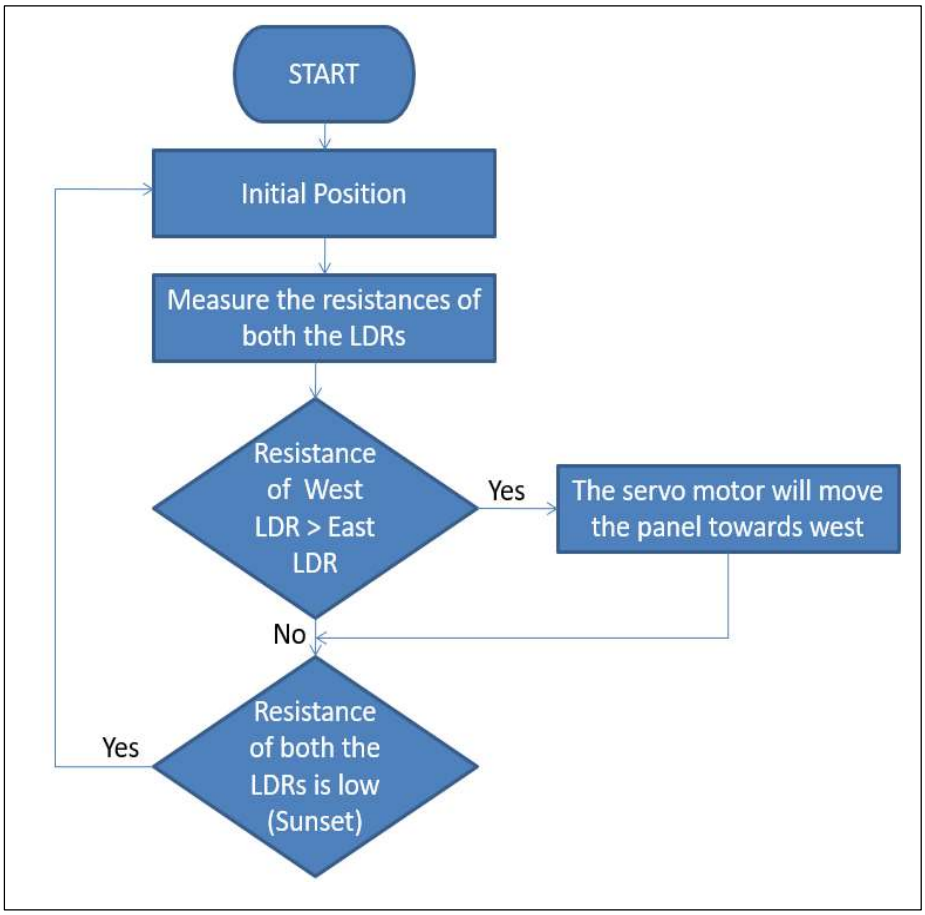


**Fig: 13**

# 7. COSTING

| SR.NO | COMPONENTS | QUANTITY | COST |
|---|---|---|---|
| 1 | Servo Motor (sg90) | 1 | 93 |
| 2 | Solar Panel | 1 | 149 |
| 3 | Arduino UNO | 1 | 499 |
| 4 | LDRs | 2 | 14 |
| 5 | 10 k Resistors | 2 | 4 |
| 6 | Battery (6 to 12 v) | 1 | 30 |
| 7 | Lcd Display | 1 | 399 |
| **TOTAL =** | | | **1188** |

# 8. Results

Output of fixed solar panel and tracking solar panel is monitored on same day with similar weather conditions. This output is monitored using LCD which is interfaced to the Arduino. Readings are taken from 9 am to 6 pm in the interval of 1-2 hours. The comparison between output of fixed solar panel and tracking solar panel is as follows-

| Sr. No. | Time | Fixed panel | | | Tracker | | |
|---|---|---|---|---|---|---|---|
| | | V | I | P | V | I | P |
| 1 | 09:00 | 5.5 | 0.05 | 0.275 | 6.3 | 0.07 | 0.44 |
| 2 | 11:00 | 6.34 | 0.07 | 0.114 | 7.1 | 0.2 | 1.42 |
| 3 | 12:00 | 7.8 | 0.22 | 1.716 | 8.0 | 0.24 | 1.93 |
| 4 | 14:00 | 7.03 | 0.09 | 0.633 | 7.5 | 0.12 | 0.9 |
| 5 | 16:00 | 6.56 | 0.08 | 0.558 | 7.5 | 0.1 | 0.75 |
| 6 | 18:00 | 5.2 | 0.05 | 0.25 | 6.8 | 0.09 | 0.61 |
| Total Power | | | | 3.875 | | | 5.144 |

Total power output is calculated in both cases. The percentage increase in total power output of solar tracker with respect to fixed solar panel is calculated as follows-

$$Percentage\ increase = \frac{5.144 - 3.875}{5.144} \times 100 = 24.67\ \%$$

Hence, percentage increase in output of solar tracker with respect to fixed panel is 24.67 % per day.

# 9. Conclusion

Single Axis Solar Tracker tracks the solar rays more than the fixed solar panel. Generally, up to 20% extra power can be produced per annum using a variable elevation solar tracker investigated the effect of one-axis east-west tracking on solar radiation received by a PV panel compared to fixed installation. To get maximum power at output, system is able to track and follow the sun intensity.

Due to an increased direct exposure to solar rays, solar trackers generate more electricity than their stationary counterparts. There are different types of solar tracker, such as single-axis and dual-axis trackers, which can help us find the perfectly suitable type for the jobsite, according to the requirements. Installation size, local weather, degree of latitude, and electrical requirements are all important considerations that should be considered for selecting the best type of solar tracker. Solar trackers generate more electricity by taking a little more space than amount of land needed for fixed tilt systems. Solar tracker is little costlier than fixed solar system, due to the complex technology used like automation and moving mechanism which is necessary for the operation of the tracking system. This increased cost of installation is easily compensated due to increased efficiency within few months only. So, solar tracker acts as good value for money product for long term usage.

# 10. References


[1] The Sun's Position. (2013, March 28). In Photovoltaic Education Network, from http://pveducation.org/pvcdrom/properties-ofsunlight/suns-position

[2] S. Gupta, O.V. Singh and S. Urooj," A Review on Single and Multijunction Solar Cell with MPPT Techniques," 3rd IEEE International Conference on Nanotechnology for Instrumentation and Measurement, GBU, India, November 16-17, 2017.

[3] A.K. Saxena and V. Dutta, "A versatile microprocessor based controller for solar tracking," in Proc. IEEE, 1990, pp.1105 – 1109.

[4] Yaseer M Safan, Sameh Shaaban, Mohamed I.,"Hybrid Control of a Solar Tracking System Using SUI-PID Controller 978-1-5090-6011-5"2017 IEEE

[5] Mohamed I. Abu El-Sebah, "Simplified intelligent Universal PID Controller." International Journal of

Engineering Research 5, no. 1 (2016): 11-15.

[6 ] S. Gupta and N. Sharma, "A literature review of maximum power point tracking from a PV array with high

efficiency", IJEDR, Volume 4, ISSUE1, 2016.

[7] Ayushi Nitin Ingole (2016, May 24-26). Arduino based

Solar Tracking System. International Conference on Science and Technology for Sustainable Development, KualaLumpur, Malaysia.

[8] Deepthi.S, Ponni.A, Ranjitha.R, 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), Volume 2, Issue 2, March 2018.