Dual Axis Solar Tracking System

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***Abstract*: Solar energy is expected to become a major source of renewable energy in the future. The operational idea is to keep photovoltaic modules aligned with sunbeams at all times, maximizing solar panel exposure to the sun radiation. As a result, solar panel may provide more output power. The performance of solar cells varies with temperature. Change Power is affected by temperature changes. As a result, it's vital to enhance solar PV cell efficiency It's possible to be efficient, either by altering the PV material or by concentrating solar energy rays or with the help of a solar tracking system. We utilize for two purposes in this research, electromechanical gadgets in axis solar tracking systems. The apparent location of the Sun is detected by a controller, and regulates the panel-supporting structure's position the direction of the sun. The solution of a two-axis solar system is the subject of this research. Photo sensor outputs are used to create a tracking system. An ATmega328P microcontroller was used to control the movement of two geared motors. To do this, a low-power microcontroller that has been properly programmed is utilized to drive two electric motors that ensure the panel's supporting framework is always oriented towards the sun.**

***Keywords*: PV Panel, Light Dependent Resister, Motor Driver, DC Geared motor, Arduino UNO, Battery.**

I. INTRODUCTION

A large amount of energy is available within the core of sun. The energy that is received from sun in an hour is more than that is consumed by us in a working year. If humans are able to harvest even a fraction of the energy which we receive through solar radiation, then one can cater the need of our race for a long time. Efforts are continuously being made to harvest optimal amount of energy in order to store most of the energy which we are getting. The increasing interests in using renewable energies for detached houses come from solar thermal energy systems for local hot water and solar systems to the micro production of electricity.

In order to maximize power output from the solar panels, one needs to keep the panels aligned with the sun. A two axes solar tracking system, according to several studies, increases the energy production by approximately 40%. The primary source of energy is the sun. The sun provides the earth with 16 quintillion unites of energy every year which is 20,000 times the amount by energy required by mankind on the planet. Some solar energy causes water to evaporate, resulting in rainfall and the formation of rivers, among other things. Some of it is used in photosynthesis, which is necessary for life on Earth to exist. Man has attempted to harness this limitless supply of energy. However, unite now, only a tiny percentage of this energy has been taped. The heating and cooling of residential and commercial building are two main areas of possible large-scale solar power use.

There are two types of solar tracking: single axis tracking, in which the solar panel travels horizontally with one motor, and dual axes tracking, in which the solar panel moves horizontally and vertically with two motors. When the sun's path is stationary, a single axis tracker is highly beneficial; but, when the sun's path changes with the seasons, a dual axes solar tracker, which follows the sun regardless of its path, is quite effective.

II. OBJECTIVES

A. The main purpose of this system is to obtain maximum output from solar panel.
B. The proposed system changes its direction in two axis to trace the coordinate of sunlight.

III. LITERATURE REVIEW

In 2017, Abhishek Surti, Hanan Mansoori, Sameer Salunke and Sangeeta Jain proposed a system of dual axis solar tracker. The purpose of this system is to efficiently harvest solar energy and convert it into a useful form for energy appliances and devices [1].
In 2017, a Muhamad Dwisnanto Putro, Meita Rumbayan from Indonesia proposed a single axis tracking system to improve panel efficiency. There were eight light dependent resistors as sensors used. A servo motor as actuator and an Arduino as the controller. The system results consist of system design, hardware design and algorithm design [2].
In 2019, P. Suresh, S. Manojkumar, E. Rakesh and N. Saranraj from india proposed a two-axis Arduino based solar tracking system. This system used only two LDR's. According to the experimental results. The proposed automatic solar tracking system has an overall energy increase of 17% ~ 25% more than the fix angle PV system in sunny days and about 8% ~ 11% in cloudy days [3].
In 2020, Ashish Patil, Mangesh Dhavalikar, Sunil Dingare and Virendra Bhojwani from Pune (India) designed and prototyped a dual axis solar tracking system to improve performance enhancement of solar photo-voltaic power plant. In this system, the tetrahedron geometry is used to mount the three LDR's on the three sides of tetrahedron and the connecting wires are taken from the base side of the same. This system will increase the energy efficiency. Due to increase in efficiency, the size of solar panel and cost of power generation will reduce for the same power generation capacity in comparison with the fixed solar panel [4].
In 2020, Kiran S. Jadhav, Himali D. Suryawanshi, Bhushnali D. Dhangar, Ajinkya P. Vadnere and Ravindra B. Patil proposed a dual axis solar tracking system with monitoring for improving efficiency. In this system four LDR's are used. The experimental results clearly show that dual axis tracking is superior to single axis tracking and fixed module system. Power captured by dual axis

solar tracker is high during the whole observation time period and it maximizes the conversion of solar irradiance into electrical energy output [5].

In 2018, Sunil R. Bangale, Aniket A. Pujare, Shivnath S. Shirsat and Amit D. Tikhe proposed a system of 'dual axis solar tracking using light sensors. Main purpose of this system is to obtain more energy from solar energy [6].

IV. Problem Identification

The common problem in solar Tracking is the complex movement of sun. For a specific longitude, the sun moves from east to west along a fixed solar path every day. But the sun moves through 46° north and south during 21st June to 21st December which is as shown in below figure [4].

1. A dual axis solar tracker can account for both the daily and seasonal motion of the sun.
2.

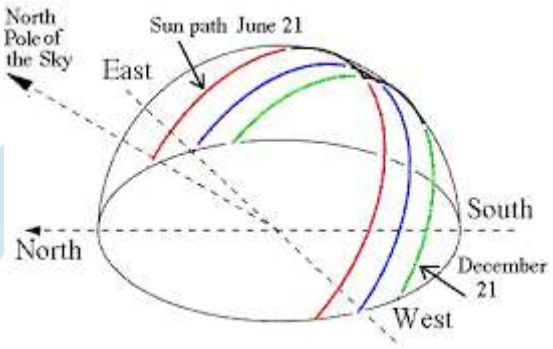


Fig.1. Path of sun during different seasons [4].

V. Principle of Solar Tracking

The sun goes from east to west every day, and it also moves north and south periodically. However, the PV panel system absorbs the most amount of energy. When the sun beams are perpendicular to the panel So there you have it. having the solar panels track the position is useful to obtain the highest power output from the sun

Solar tracking systems are divided into two categories: active and passive & inactive. Electronics are used in the active solar tracking system. Sensors and actuators to track the sun's current location. The liquid is used in the passive solar tracking system has a low boiling point, so that it evaporates when exposed to the sun. The solar tracking is done as a result of the heat.

VI. Methodology

As we see in the block diagram, there are Four Light Dependent Resistors (LDRs) which are placed on a common plate with solar panel. Light from a source strike on them by different amounts. Due to their inherent property of decreasing resistance with increasing light intensity i.e. photoconductivity, the value of resistances of all the LDRs is not always same.

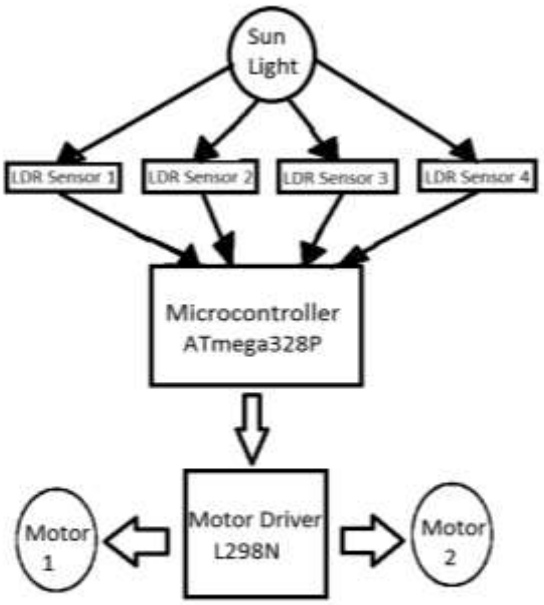
Each LDR sends equivalent signal of their respective resistance value to the Microcontroller

which is configured by required programming logic. The values are compared with each other by considering a particular LDR value as reference.

One of the two dc geared motors is mechanically attached with the driving axel of the other one so that the former will move with rotation of the axel of latter one. The axel of the former DC Geared motor is used to drive a solar panel. These two-DC Geared motors are arranged in such a way that the solar panel can move along X-axis as well as Y-axis.

The microcontroller sends appropriate signals to the DC Geared motors through Motor driver based on the input signals received from the LDRs. One DC Geared motor is used for tracking along x-axis and the other is for y-axis tracking

In this way the solar tracking system is designed [1].



Fig,1. Block Diagram

VII. EXPERIMENTAL SET-UP

A. Construction

The sun tracking solar panel consists of four LDRs, solar panel and a two DC Geared motor and ATmega328P Micro controller. Four light dependent resistors are arranged on the corner of the solar panel. Light dependent resistors produce low resistance when light falls on them. DC Geared motor rotates the panel at certain angle. The four LDR's output connected to as a input to the microcontroller at digital pin number 2,3,4,5. The output of microcontroller from pin number 6,7,8,9 is connected as input to the motor drive. According to signals provided by microcontroller, motor drive rotates the motors at different speed and direction. Power supply given to microcontroller by 9-12v battery source and also supply provide to motor drive. Solar panel mounted on horizontal steel rod and vertical axis mounted on wooden strip. This way the full setup of our project mounted on wooden board [7].

B. Circuit Diagram

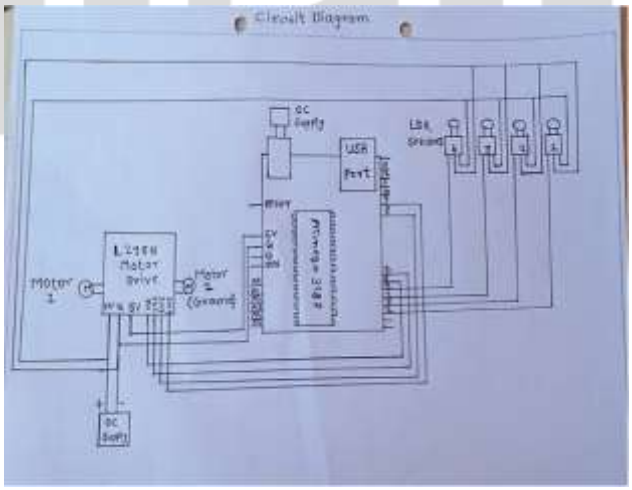


Fig.2. Circuit Diagram

a) Circuit Diagram Explanation

1. Arduino UNO:

Fig.3. Arduino UNO

It is a heart of out project & supply microcontroller supported a semiconductor unit ATmega328P microcontroller. Main perform of Arduino is that the offer input and offer management signal to the motor. It is an AVR family microcontroller. It is based on advance RISC architecture. It is an 8-bit controller. It has 32k bytes of programmable flash memory and 1k bytes EEPROM. It has 2k bytes SRAM [8].

2. Sensor:

This is really a cool little device that not only allows you to measure current, but voltage as well with a little multiplication, you can even measure power

Fig.4. Sensor

3. LDR:

The all LDR's are mounted. Once the one LDR value is changes then the Arduino provides command to activated the direction of the motor. So that the motor is rotates clockwise or anticlockwise. LDR works on the principle of photo conductivity [9].

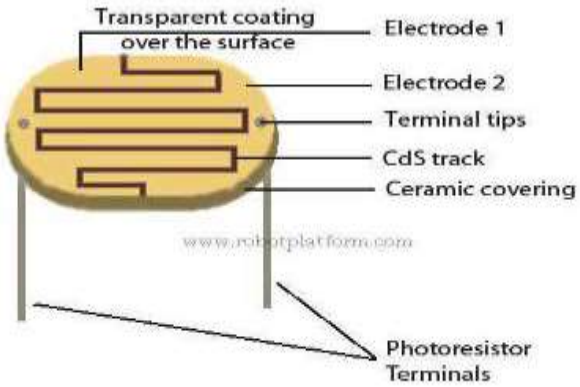


Fig. 5. Light Dependent Resister

A high resistance semiconductor whose resistance decreases with increasing incident light intensity.
When light falls on such a semiconductor, the valence electrons receive the light energy incident and jump to the conduction band. The conductivity of the device increases, decreasing its resistivity. Photo conductivity is an optical phenomenon in which the material's conductivity is increased when light is absorbed by the material. The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image above). The resistance of an LDR may typically have the following resistances: Daylight = 5000Ω.
Dark = 20000000Ω

b) Specification and implementation of Hardware

1. Solaer Panel

It's made up of a number of solar cells connected in series internally convert solar energy to electricity based on photo voltaic effect. Photo voltaic effect produces a change in electrical characteristics when light is incident upon it. Solar panel is placed at the top and connected to a load directly. The load may a led or a voltmeter which could be connected to get the exact voltage which depends on the intensity of light falling on the panel and the position of the tracker. Concentrated solar photovoltaic and have optics that directly accept sunlight, so solar trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun.

Fig. 6. Solar Panel

2. Motor Drive

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.IN3 & IN4 are direction control pins for Motor A and Motor B.

1) Driver Model: L298N 2A
2) Driver Chip: Double H Bridge L298N
3) Motor Supply Voltage (Maximum): 46V
4) Motor Supply Current (Maximum): 2A
5) Logic Voltage: 5V
6) Driver Voltage: 5-35V
7) Driver Current:2A
8) Logical Current:0-36mA
9) Maximum Power (W): 25W
10) Current Sense for each motor
11) Heatsink for better performance

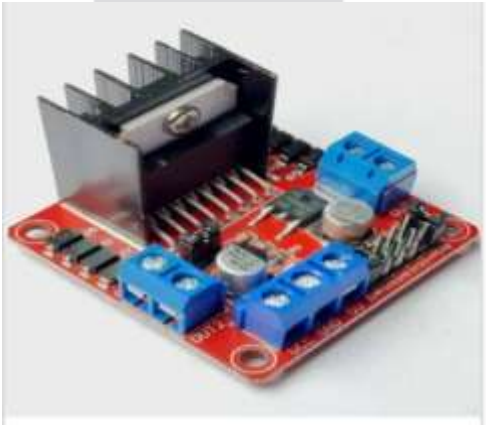


Fig. 7. Motor Drive

3. DC Geared Motor

A DC Geared motor consists of a small DC motor, feedback potentiometer, gearbox, motor drive electronic circuit and electronic feedback control loop. It is more or less similar to the normal DC motor. The stator of the motor consists of a cylindrical frame and the magnet is attached to the inside of the frame. A brush is built with an armature coil that supplies the current to the commutator. At the back of the shaft, a detector is built into the rotor in order to detect the rotation speed. With this construction, it is simple to design a controller using simple circuitry because the torque is proportional to the amount of current flow through the armature.
DC Motor – 10RPM – 12Volts geared motors are generally a simple DC motor with a gearbox attached to it. This can be used in all-terrain robots and variety of robotic applications.The most popular L298N H-bridge module
with onboard voltage regulator motor driver can be used with this motor that has a voltage of between 5 and 35V DC.

Fig.8. DC Geared Motor

c) Software Program Model

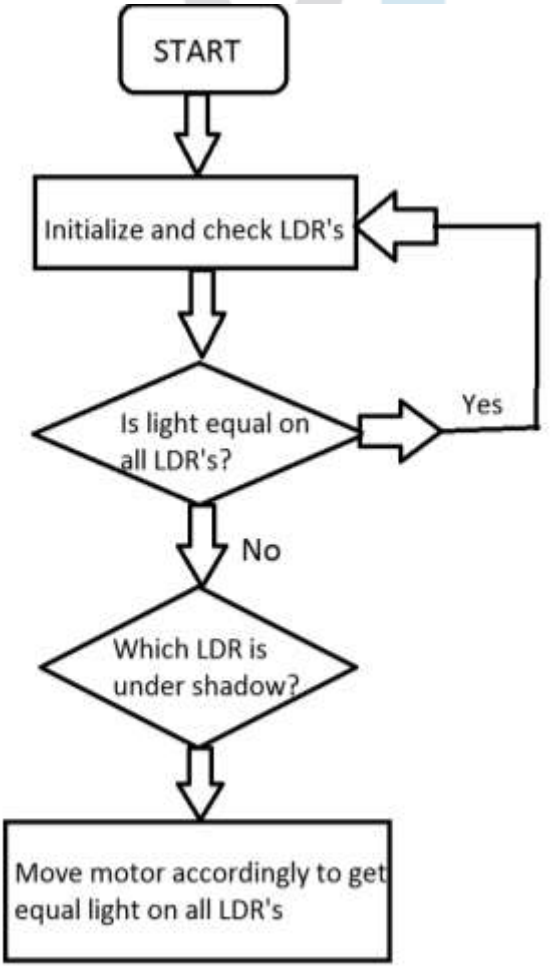


Fig.9. Flowchart

VIII. Experimental Result

Experiments results were observed by placing the designed system in open air. Table I and II show the output power for PV system (stationary tracking and dual axis tracking). The output power data is collected during 8:00 A.M. to 6:00 P.M.

Table.1. Stationary Tracking

Time	Without Solar Tracker		
	Voltage	Current	Power
8 AM	9.259	0.54	5.01
10 AM	11.21	0.55	6.17
12 PM	13.78	0.55	7.58
1 PM	14.99	0.55	8.2467
2 PM	14.72	0.54	7.95
4 PM	11.4	0.55	6.27
6 PM	10.25	0.54	5.54

Table.2.Dual Axis Tracking

Time	With Solar Tracker		
	Voltage	Current	Power
8 AM	13.69	0.54	7.39
10 AM	14.42	0.55	7.93
12 PM	14.58	0.54	8.089
1 PM	15.57	0.56	8.719
2 PM	15.002	0.55	8.2511
4 PM	14.63	0.55	8.046
6 PM	13.68	0.54	7.55

According to above tables, the dual axis solar tracker system produced more energy than stable and single axis tracker system.

IX. HARDWARE EXPERIMENTAL MODEL

Fig.10. Hardware Model

X. CONCLUSION

Dual axis tracker perfectly aligns with the sun direction and tracks the sun movement in a more efficient way and has a tremendous performance improvement. The proposed system is cost effective also as a little modification in single axis tracker provided prominent power rise in the system. In this project, Dual Axis Solar Tracker, we've developed a demo model of solar tracker to track the maximum intensity point of light source so that the voltage given at that point by the solar panel is maximum. After a lot of trial and errors we've successfully completed our project and we are proud to invest some effort for our society.

XI. FUTURE SCOPE AND ADVANTAGES

- With advancements in technology and more awareness from the government and international agencies, solar energy output has increased significantly during the previous decade. Many towns are being created solely with the intention of incorporating solar technology, and this renewable resource is already being used in a variety of areas. During the daytime hours, a solar system may attain the maximum efficiency. Solar tracking systems are one of the best solutions for maximizing the efficiency of renewable solar energy systems throughout the day. The project's major goal is to provide an alternate power source for isolated regions like tiny settlements. The device can also be used as a makeshift power source in disaster-stricken areas. The product must be low-cost and simple to create in order to meet these goals.
- In daylight hours, solar system can achieve the highest efficiency during the sunny day. In order to achieve highest efficiency for renewable solar energy systems in whole day, solar tracking system is one of the optimum solution.
- The main objective to reach these objectives, the product must be low cost and easy to manufacture.
- For satellite stations and for electric vehicle charging stations.
- Once solar cells have been installed and running, minimal maintenance is required. Some solar panels have no moving parts, making them to last even longer with no maintenance The solar energy can be reused as it is non-renewable resource. These can be used in industries as more energy can be saved by rotating the panel.
- of this project is to provide an alternative power solution for remote locations such as research areas and small villages also the system can be used as a temporary power solution for locations affected by natural disasters. In order

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