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Review of Dual Axis Solar Tracker and Development of Prototype

SP Trikal[1], Ritik Barwad[2], Atharva Wakodikar[3], Deepak Nagar[4], Dhawal Raja[5], Sagar Bhagwat[6], Kamran Ozair[7]
HOD, Mechanical Engineering, Shri Sant Gajanan Maharaj College of Engineering , Shegaon, India [1]
Student, Mechanical Engineering, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, India[2,3,4,5,6,7]

Abstract: *In this growing era Renewable energy are the popular solution to meet the requirement of energy in the world. Solar energy is going to be one of the most reliable sources of energy. Fixed solar panel use to provide efficiency about 15% to 17%. Dual axis tracking system increase the efficiency up to 8% to 10%. The solar panel in this system can trace the maximum light intensity region and thus increase the efficiency*

Keywords: Solar Tracking; Dual Axis; Efficiency; Maximum Light Intensity; Renewable Energy

I. INTRODUCTION

The non-renewable source of energy such as coal, crude oil, natural gases are getting depleted. In near future the renewable source of energy will be an important part to deal with energy crisis. Solar system is a crucial part for the renewable energy generation. Dual axis solar tracking system is used to position the photovoltaic system in X-Y coordinates. The system will detect the maximum intensity region and move the system in that particular direction.

All the efficient solar system uses the tracker to produce more solar energy by direct incident of light rays on solar panels. There are two type of solar tracker technology single axis solar tracker and dual axis solar tracker, this system combines with the photovoltaic module and create a cost-efficient system. Rural areas have very limited resources of energy. Thus, this system can be ideal for rural areas. One of key component is photovoltaic module which convert solar energy into electric energy. Semiconductor material with doping is used to make this type of solar panels. When we use fixed solar panel, it doesn't give maximum output power due to change in climate.

So, to overcome this problem and to get the maximum output power we use solar tracking system which maintain the positioning of the solar panels.

II. LITERATURE REVIEW

2.1 "In 2017, Rashmi Biswas, Shreyasi Chakraborty, Nilanjana Mukherjee. Renewable power sources are getting one of the pinnacle priorities for modern-day internationally due to their many advantages, specifically, to fulfill our ever-growing power needs, energy of sun is appearing as a capacity origin of limited and uncontaminated electricity. However, PV panels, which can be essential elements of the transformation of Solar strength, are set up at a sure attitude and with active during the day and seasonal shifts, are powerless to tune the course of sunlight. Working with a Arduino, a sun intensity tracking gadget is made that can track the sun efficiently."

2.2 "In August 2019, the thin Hiwe mentioned to satisfy the needs of energy in this growing world, solar will be uncontaminated and unlimited source of energy. Microcontroller instance pushed computerized sun following machine with the help of LDRs, Microcontroller, and motors. The programming based on Algorithms use to provide the accurate horizontal and vertical movement. The prototype is designed to reduce the cost of power manufacturing through accurate positioning of tracker and it is capable of lighting fixtures."

III. METHODOLOGY AND WORKING

Dual axis solar tracker uses to collect the light intensity of different region with the help of sensor. With the help of the light intensity readings of different region calculate the maximum light intensity region based on the Algorithm. Dual axis solar tracker prototype has following main components:

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1. A microcontroller (Arduino UNO R3)
2. LDR (Light Dependent Resistor) Sensors
3. D.C Motors
4. Motor Drivers and Analog to Digital convertor
5. Cylindrical Shaft and Cylindrical Gear Wheel

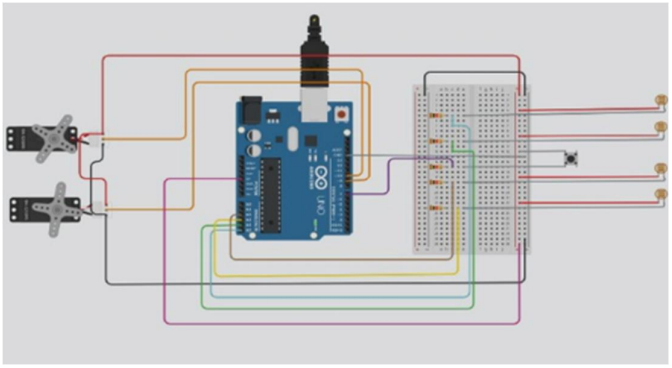

Fig. 1 Basic Circuit diagram of Dual Axis Solar Tracker

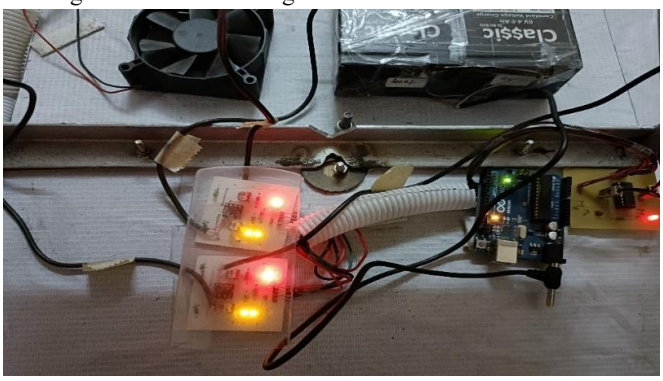

Fig.2 Actual Circuit of Prototype of Dual Axis Solar Tracker

This system is being broken down into different component for better explanation of the sub functions. The system has 4 LDR sensors placed at the four different directions of the solar panel. Resistance of LDR sensor use to reduce whenever there is high light intensity, this result in variation in voltage reading and thus determine the light intensity of the region. This LDR sensor are connected to the Microcontroller (Arduino Uno) through ADC (Analog to Digital Convertor). The LDR are connected to ADC and ADC is connected to the digital pins of the microcontroller.

Further the Microcontroller is connected to the Motor Driver. The digital pins of the Arduino are connected to the Motor driver. The Motor driver is further connected to the D.C Motors. The Power supply to the Motor is directly provided from the 12 V power input port of the Arduino UNO. The Arduino operates at 5 V approximately and if we provide power to Motor through 5 V supply port of Arduino there will be overheating issues in Arduino Uno and sufficient power can't be transmitted to the motor.

Thus, direct power supply to motor from 12 V power input port of the Arduino is made to provide sufficient amount of power to motor. The motors are connected to the shaft and cylindrical gear wheel. The Shaft and the cylindrical gear wheel use to provide the rotational motion to the solar panel.

The LDR reads light intensity at four different directions as input values. The input readings are analog value, for the calculation of maximum light intensity region our algorithm requires the input as digital value. To convert the analog value of input reading to digital value, we use the ADC (Analog to Digital Convertor). After converting input reading into binary values, the Microcontroller use to compare the binary input readings (High or Low) of the opposite pair of the LDR and then instruct the motor drive to rotate Motor in direction of the High value of input. Thus, the Arduino instruct the motor drive till the binary input value of opposite pair of LDRs becomes same as High.

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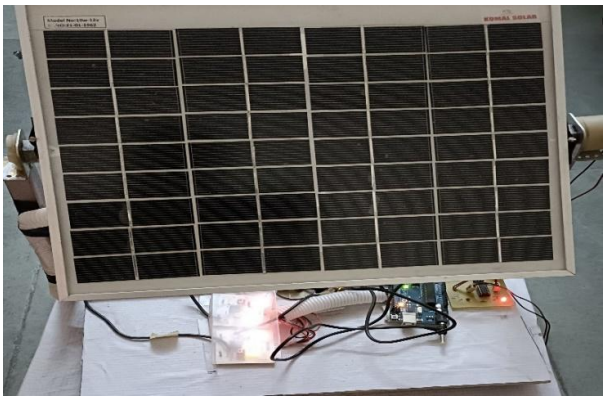

Fig.3 Complete Prototype of Dual Axis Solar Tracker

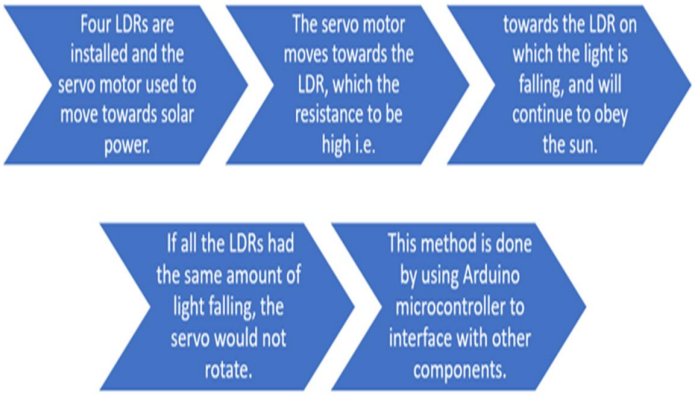

Fig.4 Flow Control of Working of Dual Axis Solar Tracker

IV. DESIGN AND CAD

The Design of the structure of the tracker consist of cylindrical gear wheel, C Shape frame, cylindrical shaft. The motor is mounted at the base plate and the shaft of the motor is connected to the gear wheel. Another rectangular plate is mounted on the gear wheel. As the gear wheel use to rotate, this causes rotation of the rectangular plate which gives our solar panel horizontal movement of 180 degree. The C shape frame is mounted on the rectangular plate. The C shape frame holds the solar panel with the help of a shaft and bearings.

The shaft in C frame is connected to second motor, second motor use to rotate the shaft which provides the solar panel vertical movement of 180 degree. One pair of LDR connected to motor 1 is responsible of the horizontal movement. Another pair of LDR connected to motor 2 is responsible for the vertical movement.

Lead Acid battery of 12 Volt is used for supplying power to the system. The solar panel of 12 Volt, 10 Watt is used in prototype.

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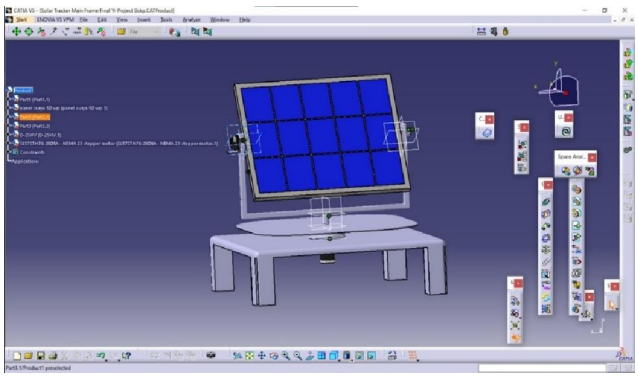

Fig.5 CAD Model Dual Axis Solar Tracker

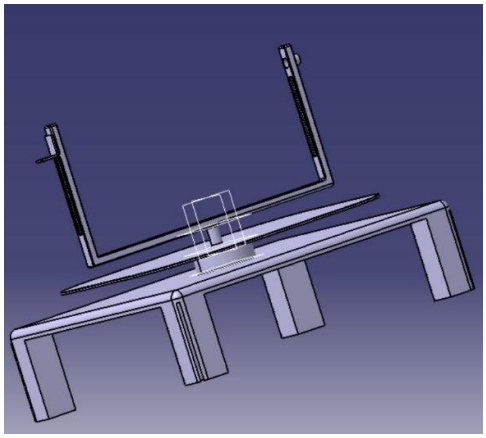

Fig 6: Main Frame

OBSERVATION AND CALCULATION

The following readings are taken from morning 8 am to evening 6 pm for every one hour on 20 April 2022 at SSGMCE, Shegaon (20.7930° N, 76.6910° E).

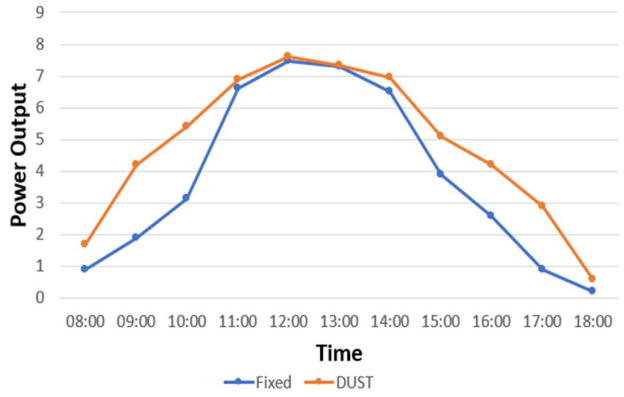

Fig 7. Comparison of Fixed Mount and Dual Axis Tracker System

HOURS	POWER OF FIXED MOUNT (W)	POWER OF DUAL-AXIS (W)
8 am	0.9	1.7
9 am	1.9	4.2
10 am	3.12	5.4
11 am	6.6	6.89
12 pm	7.46	7.62
1 pm	7.31	7.33
2 pm	6.5	6.94
3 pm	3.9	5.1
4 pm	2.6	4.2
5 pm	0.9	2.9
6 pm	0.2	0.6

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To find the increase in efficiency we have done the following calculations,

$$\eta = \frac{\text{Power generated by dual axis system} - \text{Power generated by fixed solar system} - \text{Power consumed by electronics}}{\text{Power generated by fixed solar system}} \times 100$$

$$\eta = \frac{48.68 - 41.39 - 3}{41.39} \times 100$$

$$\boxed{\eta = 10.36\ \%}$$

Therefore, the efficiency of Dual axis solar tracking system is 10.36 % greater than the Fixed solar system. Electronics Components consume 1.46% from total power generated.

V. CONCLUSION

Through this study it can be concluded that dual axis solar tracking system are vital for Photo Voltaic panels and other solar operations. The proposed model of the binary axis solar tracker can track the sun's position throughout the time. But for larger solar panels mechanical actuators can be used. The binary axis solar tracker system provides the advanced affair power when compared with fixed panel. According to the measured readings the efficiency of the dual axis solar tracker is 10.36% more than that of a fixed panel.

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