

Dual-Axis Solar Tracker, A Case Study

Shailesh Bhojar¹, Pradip Bodke¹, Shubham Ramteke¹, Aarti Bodkhe¹, Avinash Gadpayle¹, Swati dewase¹, Mahadeo Gaidhane²

Dept. of EE, WCEM Nagpur-441108, India.

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HOD Dept. of EE, WCEM Nagpur-441108,India

Abstract: Renewable energy resources become very popular and commonly used now a days. The main purpose of this project is to overcome the issues of energy crisis in today's World. To overcome this we used renewable energy resources manifold. This project deals with Techno-Economical study of solar static and dual axis tracker. The contest in converting sunlight to electricity via photovoltaic (PV) solar cell. Solar tracker superiority over stand still or single axis tracker to improve the quality of efficiency of the solar cell. Energy generation basically required huge starting investment. The outcome of the solar tracking system has analysed and compared with fixed solar panel and found better performance in terms of power and economically beneficial.

Hence according to case study tracking system the Photovoltaic (PV) Panel are able to receive maximum sunlight that generate more energy.

Keywords: Solar panel, Solar tracking, Microcontroller, Renewable energy.

I. Introduction

Solar power is the fastest growing means of renewable energy production with grid connected solar capacity increasing on average by 60 % annually from 2009 to 2018 according to the National Center for Policy Analysis [A]. Yet solar energy contributes to only ... The current situation of the more mature segment of solar energy production, the Photovoltaic (PV) solar cell technology, is one in which energy production is improving from....Seyad Samsamod N Chaleshtori author of the new working paper "Econometric analysis of solar tracker system in India, a case study" believe the future of PV solar technologies look promising considering favorable location and continued federal tax subsidies, as well as state renewable standard protocol. The energy produced by any solar conversion system depends mainly on efficient collection of solar radiation. However, to be able to collect the maximum of the solar energy. In this paper two axis solar tracking system was proposed to keep solar panel perpendicular to sunlight by using two DC motor. What is the need of solar power? Because the world population increase day by day and demand for energy is increase accordingly. Coal and Oil as the main source of energy nowadays, but energy crisis is most important issue in today's world. Because non-renewable sources are become decreasing. The need of the hour is renewable energy resources with cheap running cost. In general, India has a relatively long sunny day for more than ten months and cloudy sky rest of two months as we know that angle of the inclination ranges between -90° after sun rise and $+90^{\circ}$ before sun set. The dual axis solar tracker uses an elevation actuator and an azimuth actuator to alter the azimuth of an attached solar panel fig. 1. Microcontroller actually control the actuator controller circuit which control the actuators. The microcontroller utilizes information about latitude, longitude as well as time of date and day to control the actuator and track the movement of sun without sensors.

However, these systems can be economically profitable only if the extra cost of the additional panels which will lead to the same power production with a system having a fixed structure.

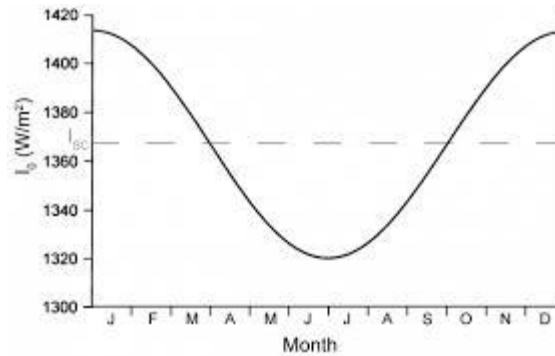


Fig1. Solar angle of incidence

II. Solar Energy

A. Solar Energy Circumstances of India

Solar power in India is a fast developing industry. The country's solar installed capacity reached 25.21 GW as of 31 December 2018. The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US\$100 billion. India expanded its solar-generation capacity 8 times from 2,650 MW on 26 May 2014 to over 20 GW as on 31 January 2018. The country added 3 GW of solar capacity in 2015-2016, 5 GW in 2016-2017 and over 10 GW in 2017-2018, with the average current price of solar electricity dropping to 18% below the average price of its coal-fired counterpart. Rooftop solar power accounts for 3.4 GW, of which 70% is industrial or commercial. In addition to its large-scale grid-connected solar PV initiative, India is developing off-grid solar power for local energy needs. Solar products have increasingly helped to meet rural needs; by the end of 2015 just under one million solar lanterns were sold in the country, reducing the need for kerosene. That year, 118,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national program, just over 1.4 million solar cookers were distributed in India. In January 2019, Indian Railways announced the plan to install 4 GW capacity along its tracks. The International Solar Alliance (ISA), proposed by India as a founder member, is headquartered in India.

B. Solar Energy Perception in India

India has a hopeful radical prospective in solar energy. To fulfill this demand India government has premeditated to increase countrywide power production competence up to 16000 MW of that 800 MW is expected to be generate from renewable sources. The necessities of electricity are often met by using the solar tracker. Within the coastal region of India, the bright sunshine varies from 3 to 11 hours daily. This information reveals that encompasses a sensible expectation in using solar panel and PV function. Vacate all the tax on raw materials of the solar system by the government of India. So it is often on the market to any citizen of India. Daily basis solar emission $4.65\text{kWh}=\text{m}^2=\text{day}$ for Dhaka city just the once a year collected from NASA Surface meteorology and Solar energy.

III. Brief Description Of Dual Axis Solar Tracker

The rectangular frame make suitable for receiving a solar panel and the central made of amorphous or crystalline silicon are well known for generating electricity directly from sunlight. Solar trackers are grouped under two basic categories: the single axis trackers and the dual axis trackers. The single tracker rotates east to west following the sun's movement, and the dual trackers include vertical and horizontal movements i.e. they can incline or tilt to account for winter and summer sun angles. Single Axis Trackers are trackers with only one degree through which they rotate or use as axis of rotation. This axis is usually aligned following the North meridian. They rotate azimuthally from east to west following the path of a sun. Double or Dual Axis Tracker have two different degrees through which they use as axis of rotation. The dual axis are usually at a normal of each rotate both east to west (zenithal) and north to south (azimuthally)

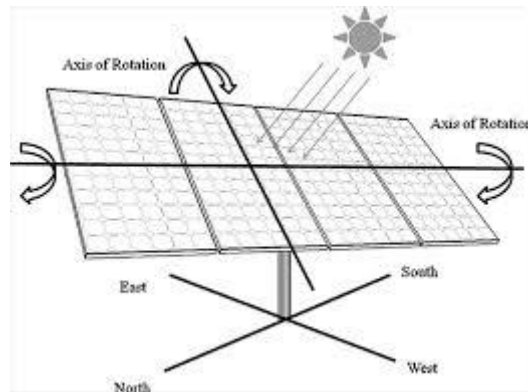


Fig2. Solar panel

IV. Motion Of The Sun Throughout The Year

4.1 Importance of Sun position

Fig 3 show the diagrammatic view where it shows the sun's motion in summer, winter & in spring. In a year sun takes different path in the sky. latitude only says the exact path of sun.

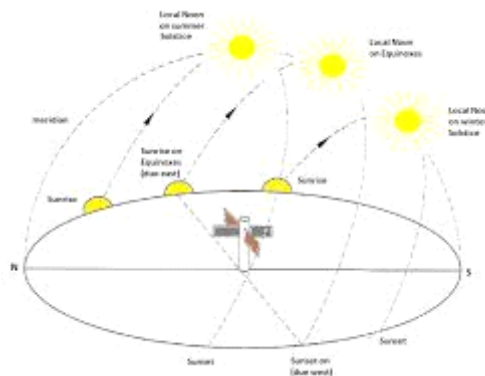


Fig 3. Diagrammatic view of motion of the sun throughout the year

4.2 Solar power in India

Solar power in India is a fast developing industry. The country's solar installed capacity reached 25.21 GW as of 31 December 2018. The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US\$100 billion. India expanded its solar-generation capacity 8 times from 2,650 MW on 26 May 2014 to over 20 GW as on 31 January 2018.[3][4] The country added 3 GW of solar capacity in 2015-2016, 5 GW in 2016-2017 and over 10 GW in 2017-2018, with the average current price of solar electricity dropping to 18% below the average price of its coal-fired counterpart.

4.3 India's largest photovoltaic (PV) Power plants

1. Pavagada Solar Park of Karnataka state is installed at Pavagada taluk of Tumkur district and generate 600 MW by January 2018
2. Kurnool Ultra Mega Solar Park is the world's largest solar park, spread over a total area of 5,932.32 acres in Kurnool district of Andhra Pradesh
3. Kamuthi Solar Power Project is the largest single location solar power plant in the world, located at Kamuthi in Tamil Nadu. The Kamuthi solar plant is the world's second largest solar park with a capacity of 648 MW commissioned by Adani Power.
4. Bhadla Solar Park near Jodhpur district of Rajasthan is the third largest solar park in India, spread over a total area of 10,000 acres. The park has total capacity of 2,255 MW and NTPC announced that it had commissioned 115 MW on 22 February 2017
5. Charanka village solar park is one of the Asia's biggest solar park, located at northern Gujarat. The site is the world's second largest photovoltaic power station and spread across 5,384 acres of unused land.

V. Experiment Setup

The proposed tracking system can track a lot of radiation actual fact by PV panel rotation in different axis . In dual axis system we can track the sun path in four directions .we can achieve more energy from the solar panel . Movement in two axes is explained with the assist of Fig. 4 That's explaining basic plan in the rear dual axis tracking

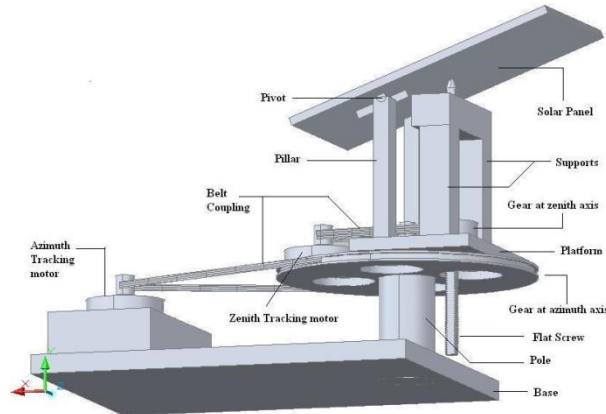


Fig:4 Solar tracker panel

The DC motor is performing operate to following the path of the sun. This two DC motor and four LDR sensors are interfaced with a microcontroller that's scheming DC motor on the base of sensor's input . Sun light sense by LDR sensors and send a signal to Arduino microcontroller . The microcontroller received signals from LDR sensors and its deciding rotation direction of DC MOTORS . Dual Axis tracker solar tracking system explained with the help of block diagram shown in Fig. 5.

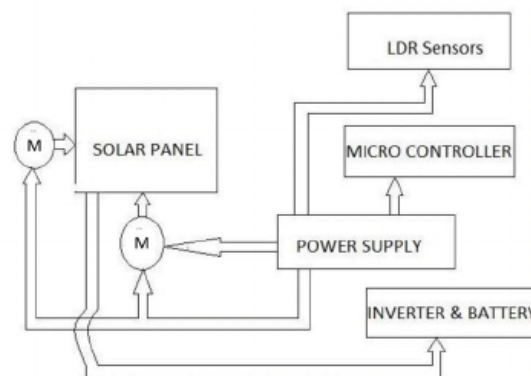


Fig 5: Block diagram of overall system

The block diagram is showing that LDR sensors once sensing the sunshine forward the signal to Microcontroller . Assume if the sun changes its individual locality and go from east to west, it'll cause light absorption to vary on one sensor as related to different one. On the base of light intensity feature on sensors, the controller starts driver circuits and moves DC motor to new positions wherever light falling on sensor pairs is same .The same method can maintain it up with a change in sun's locality surround by the sky. As a result, this proposed model is able to capture supplementary sun rays and system's solar energy conversion capability is greatly superior. When it collects data from LDR sensors then main algorithm is starts. Sensors productivity is analogue that's stimulated to digital signals. This serviceable task is performed using analogue to digital converter (ADC) . Digitized signals are forwarded to Arduino microcontroller. After collecting digital signals, it decides relating to the movement direction and steep angle of DC MOTORS. Control algorithm is viewing that Arduino microcontroller drives DC MOTORS as long as sensor light sensing is not equal to one another and if sensor signals are equal. It goes to start of the algorithm. This methodology is incessant till light falling on detector pairs is equal and PV panel is adjusted in a position for optimum power. The voltage generated by the solar panel is assorted and desires to be synchronized . A regulator is often used when the solar

panel which may regulate the voltage coming back from solar panel . For this principle, supply is provided by generated solar energy . There is not any would like to give exterior power supply that makes our system economical and cost effective . The purposed model can also use as an impartial system by introducing battery storage and proper supervision of storage system . Battery storage is controlled by the thought of generated voltage . Charging and discharging events for generated voltage .

VI. Experimental Result

Experimentations outcomes were performed by placing the proposed system in the rooftop. These annotations were performed on 14, 15 and 16 May 2016 for three cases. The output power data is collected during 8:00 A.M. to 6:00 P.M.

TABLE I. FIXED SOLAR PANEL

Time	Voltage(V)	Current(A)	Power(Watt)
8.00	7.51	0.02	0.15
9.00	8.70	0.10	0.87
10.00	15.08	1.12	16.89
11.00	17.10	1.18	20.18
12.00	17.18	1.12	19.24
13.00	17.76	1.14	20.25
14.00	17.72	0.83	14.71
15.00	17.79	0.92	16.36
16.00	15.08	0.56	8.44
17.00	6.45	0.17	1.09
18.00	6.44	0.11	0.70

TABLE II. DUAL AXIS SOLAR PANEL

Time	Voltage(V)	Current(A)	Power(Watt)
8.00	9.18	0.1	0.92
9.00	16.55	1.16	19.19
10.00	21.16	1.46	30.89
11.00	21.82	1.49	32.51
12.00	22.07	1.53	33.76
13.00	22.12	1.67	36.94
14.00	21.44	1.38	29.58
15.00	20.58	1.34	27.57
16.00	20.47	1.29	26.40
17.00	18.23	1.24	22.60
18.00	14.46	1.18	17.06

In Table 1. shows the assessment of output power is shown in tabular form for Two cases. We are liable to performed comparison for two cases by plotting two power table for two cases with the help of information provided in Table.curve is higher on top of the fixed PV array system, however,dual axis is showing higher influence as compared to the single axis. Dual axis system high power capturing property is obvious from the table comparison.

VII. Conclusions

Dual axis tracker utterly aligns with the sun route and tracks the sun movement in a very a lot of cost-effective loom and includes a marvelous performance upgrading. The investigational outcomes clearly show that dual axis tracking is good enough than single and fixed solar systems. The proposed system is value effective conjointly as a stroke adjustment in single axis tracker provided notable power increase within the system. Through our experiments, we've got found that dual axis tracking will increase energy by about 40% of the fixed arrays. With a lot of works and higher systems, we tend to believe that this figure can raise more.

VIII. Future Work

Commercially, dual axis solar tracking is still rare even in countries wherever a major part of electricity is being produced by solar energy as they claim that single and fixed axis tracking is doing the work. However dual axis tracking will noticeably increase the potency. For our research work we implemented this procedure on a sporadic power PV panel. Cost effectiveness and proposed system potency may be discovered on a business level. crystalline material based PV panel also can be used for this proposed model. We used LDR for this proposed model but LDR is not a good choice as a sensor as it affected by dust. So in future, we can also

use the more efficient sensor. A reliable structure is very expensive compared to solar panel cost; therefore, adding an additional panel to the system of spending on tracking structure is much more cost effective

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