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Research Article

Automatic Dual Axis Sun Tracking System using LDR Sensor

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Abstract

The aim of this paper is to present a solar energy collection technology by a photovoltaic cell. To present this efficient solar distributed generation system, a dual-axis solar tracker is designed. The tracker actively tracks the sun and changes its position accordingly to maximize the power output. The designed tracking system consists of sensors, microcontroller operated control circuits to drive DC motors and gear- bearing arrangements with supports and mountings. Two geared dc motors are used to move the solar panel so that sun's beam is able to remain aligned with the solar panel.

Keywords: *Solar tracker, LDR, Microcontroller, Geared DC motor, Power gain.*

Introduction

With the rapid increase in population and economic development, the problems of the energy crisis and global warming effects are today a cause for increasing concern. The utilization of renewable energy resources is the key solution to these problems. Solar energy is one of the primary sources of clean, abundant and inexhaustible energy that not only provides alternative energy resources, but also improves environmental pollution.

Solar tracking is the most appropriate technology to enhance the electricity production of a PV system. To achieve a high degree of tracking accuracy, several approaches have been widely investigated. Generally, they can be classified as either open-loop tracking types based on solar movement mathematical models or closed-loop tracking types using sensor-based feedback controllers. In the open-loop tracking approach, a tracking formula or control algorithm is used. Referring to the literature, the azimuth and the elevation angles of the Sun were determined by solar movement models or algorithms at the given date, time and geographical information.

The control algorithms were executed in a microprocessor controller. In the closed-loop tracking approach, various active sensor devices, such as charge couple devices (CCDs) or light dependent resistors (LDRs)were utilized to sense the Sun's position and a feedback error signal was then generated to the control system to continuously receive the maximum solar radiation on the PV panel. This paper proposes an empirical research approach on this issue.

Solar tracking approaches can be implemented by using single-axis schemes, and Dual-axis structures for higher accuracy systems. In general, the single-axis tracker with one degree of freedom follows the Sun's movement from the east to west during a day while a dual-axis tracker also follows the elevation angle of the Sun. In recent years, there has been a growing Volume of research concerned with dual-axis solar tracking systems. However, in the existing research, most of them used two stepper motors to perform dual-axis solar tracking. With two tracking motors designs, two motors were mounted on perpendicular axes, and even aligned them in certain directions. In some cases, both motors could not move at the same time.

Furthermore, such systems always involve complex tracking strategies using microprocessor chips as a control platform. In this work, employing a dual-axis with only single tracking motor, an attempt has been made to develop and implement a simple and efficient control scheme. The two axes of the Sun tracker were allowed to move simultaneously within their respective ranges. Utilizing conventional electronic circuits, no programming or computer interface was needed. Moreover, the proposed system used a stand-alone PV inverter to drive motor and provide power supply. The system was self-contained and autonomous. Experiment results have demonstrated the feasibility of the tracking PV system and verified the advantages of the proposed control implementation.

Man has needed and used energy at an increasing rate for his sustenance and well-being ever since he came on to the earth a few million years ago. Solar energy promises of becoming a dependable energy source without any polluting effects.

Solar energy can be used both directly and indirectly. It can be used directly in a variety of thermal applications like heating water or air, drying, distillation and cooking. The heated fluids can in turn be used for applications like power generation or refrigeration. A second way in which

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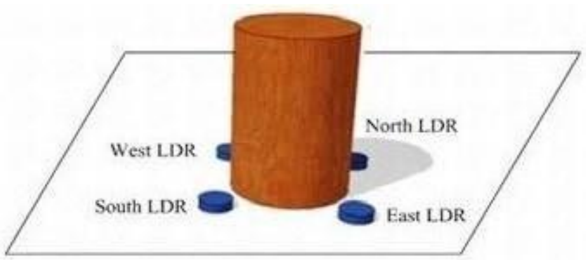
it is converted to electric energy is by indirectly causing the winds to blow, plants to grow, rain to fall and temperature differences to occur from the surface to the bottom of oceans. Useful energy can be obtained for commercial and non-commercial purposes through all these renewable sources.

Methodology

To develop this dual axis tracking system light dependent resistor (LDR) is used as sensor. The resistance of LDR decreases with increasing light intensity. Two 12 volt full geared stepper motors are used here for rotating the solar panel in two different axes. In this dual axis we are using four LDR s for detecting the light intensity. To track the sun movement accurately dual axis tracking system is necessary. With the sun always facing the panel, the maximum energy can be absorbed as the panel operates at its greatest efficiency. The main objective of this paper is to improve the power gain by accurate tracking of the sun. The daily motion causes the sun to appear in east to west direction over the earth whereas the annual motion causes the sun to tilt at an angle of 23.5 degrees while moving along east-west direction. So the maximum efficiency of the solar panel is not being used by single axis tracking system. In this project L293D is used for binary data into mechanical data.



Two pair of light dependent resistors (LDR) is used as sensors to track the sun's exact position One pair senses the position o the sun in vertical axis i.e. east and west side and other pair in the horizontal axis i.e. north and south side. This information is then passed to the light comparison unit. The rest LDR senses the night mode and the signal is sent to the light comparison unit. A light dependent resistor (LDR) is a resistor whose resistance ecreases with increasing incident light intensity. Microcontroller is the main control unit of this whole system. The output from the light comparison unit comes to the input of the microcontroller which determines the direction of the movement of the motors both in the horizontal and vertical axes. For this project 89v51RD2 microcontroller is use. The design of the light sensor is based on the use of the shadow. If the PV panel is not perpendicular to the sunlight, the shadow of the cylinder will cover one or two LDRs and this causes different light intensity to be received by the sensing device.

Why we go for Solar Energy

Generally we can generate power in two ways

- Convention al Fuels.
- Non Convention al Fuels.

Due to the excessive usage of conventional fuels there has been depletion in our natural resources. According to the scales, fuels like coal will last approximately for about 100years and petrol and diesel for about 15 years. Therefore the future power depends entirely on Non-Conventional Fuels.

Under the category of Non-Conventional Fuels we have are Solar, Wind, Ocean, Tidal, and Geothermal energy sources. The reason as to why we are choosing only solar energy in our project is because of its merits when compared to the other energy sources.

1) In India, the speed of the wind is only 15 to 20km/hr. and also this is possible only at hilly and vast areas (remote areas) but still the conversion of wind energy to useful energy is economical.
2) For Tidal energy we require full moon and half-moon days. Also we can extract more amount of energy at full moon days because there are more tides on this day. This is because the Sun, the Moon, and the Earth come in a straight line on full moon day, while they are perpendicular on half-moon days. Moreover, we have 702 tides per year according to the scales.
3) For the Geothermal energy hot temperatures and rocky areas are needed. Even though it extracts huge amount of energy of about 88% compared to the other energy sources but the conversion efficiency is low of about 15%.
4) Keeping in view all these factors we consider solar energy to be the best option for power generation.

Merits of Solar Energy

- It is a Non-Conventional Fuel energy source.
- The Sun is a universal source and it cannot diminish.
- Free from Pollution.
- Cost of fuel is free.
- It is a reliable one

Block Diagram

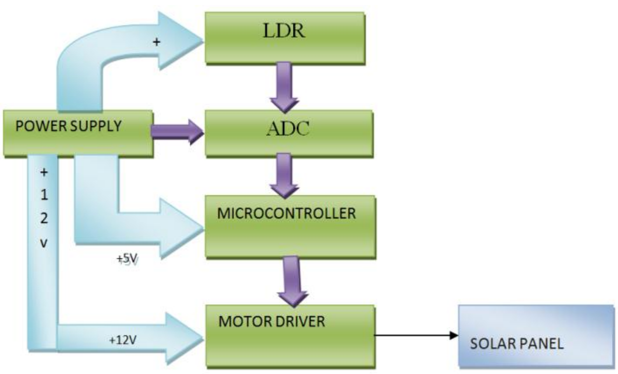


Fig: Automatic dual axis solar tracking system

Result

Efficient energy from the sun is gained by the solar panels. And track the position of the sun by using the LDRs. Two geared stepper motors are used to move the solar panel so that sun's beam is able to remain aligned with the solar panel.

Experimental Setup

Table.1 shows the current and voltage values received from both the static and tracking panel for different times in a day. From the table it is seen that at 8:00 am there is much improvement in current by tracking panel compared to the static panel. But as time goes on this difference in current between this two technology decreases up to around 1:00 pm. After that when the sun rotates more towards west this difference increases again. The highest current of static panel and tracking panel is 0.31amp and 0.34amp respectively at 12:00 pm. But in case of voltage the variation is lesser compare with current as the voltage has no direct relation with the sun light intensity. Fig. 7 shows the comparison of current curves for both the static and tracking panel

Table 1: Current and voltage values of static and tracking panel at different times in a day

Time	Static panel		Tracking panel	
	Current (amperes)	Voltage (volts)	Current (amperes)	Voltage (volts)
8:00 am	0.113	11.1	0.23	11.7
9.00 am	0.22	10.9	0.29	11.2
10.00 am	0.23	11	0.29	11.8
11.00 am	0.25	11.2	0.31	11.6
12.00 pm	0.28	11.4	0.34	11.9
1.00 pm	0.27	11.6	0.32	11.7
2.00 pm	0.25	11.6	0.29	11.8
3.00 pm	0.18	10.6	0.25	10.6
4.00 pm	0.15	8.5	0.16	8.8
5.00 pm	0.10	6.4	0.12	6.6

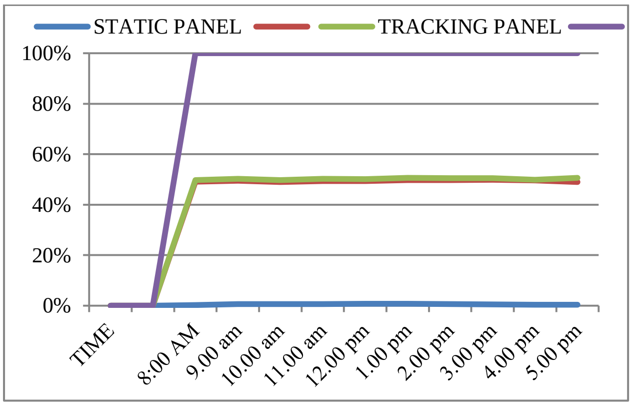


Table 2 shows the power values of both the static and tracking panel. The power gain of tracking panel over static panel for different times is also given in table 3.2. The maximum power output of the static panel and tracking solar panel is 6.417 watt and 7.038 watt respectively is found at 12:00 pm. Much more power gain is achieved in the morning and afternoon because the tracking system can accurately track the sun at these times while the static system not. For both technology power fall were very fast from 3:00 pm to 5:00 pm because of the low duration of day light. Fig. 8 shows the comparison of power collection bar diagrams for both static and tracking panel.

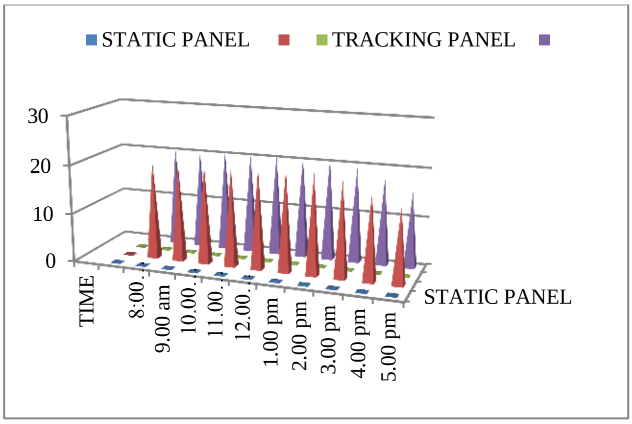
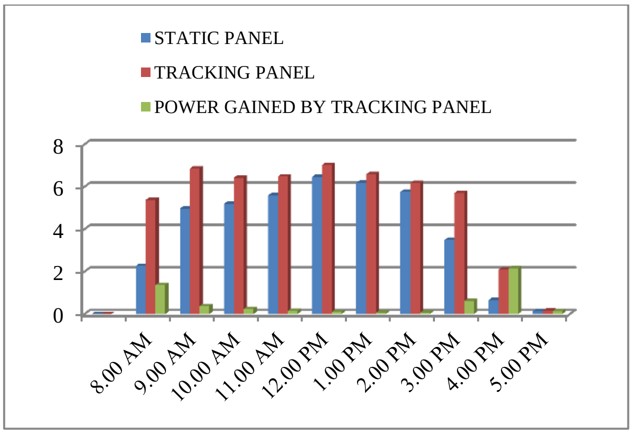


Table 2 Power values of both the static and tracking panel

Time	Static panelPower	Tracking panelPower	Power gained by tracking panel(%)
8.00 AM	1.254	2.69	114.59
9.00 AM	2.398	3.24	35.44
10.00 AM	2.53	3.42	35.25
11.00 AM	2.8	3.59	28.42
12.00 PM	3.192	4.04	26.75
1.00 PM	3.132	3.74	19.54
2.00 PM	2.9	3.42	18
3.00 PM	1.90	2.65	38.88
4.00 PM	1.27	1.40	10.43
5.00 PM	0.64	0.79	23.75



Conclusion

The empirical findings lead us to believe that the research work may provide some contributions to the development of solar energy applications. (1) a simple and cost-effective control implementation, (2) a stand-alone PV inverter to power the entire system, (3) ability to move the two axes simultaneously within their respective ranges, (4) ability to adjust the tracking accuracy, and (5) applicable to moving platforms with the Sun tracker. In this paper a dual axis sun tracking system has been successfully designed, built and tested. It allows the sun's path from morning to evening and then gets back to the initial position facing towards east side. So the system saves lot of energy by keeping the motors off during night period.

This tracking technology is very simple in design, low in cost and accurate in tracking. Several solar technologies are available on the market. But this dual axis tracking technology has higher energy gain comparing with both fixed solar panel and single axis solar tracking technologies.

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