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Increasing the efficiency of solar panel by solar tracking system

A Imthiyas¹, S.Prakash¹, N Vijay², A Alwin Abraham² and B Ganesh Kumar²

¹Assistant Professor, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation, Deemed to be University, Tamilnadu, India.

²UG Scholars, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation, Deemed to be University, Tamilnadu, India.

E-mail: imthiyas@avit.ac.in

Abstract. Solar energy is a promising sustainable power source asset. If the solar panels have an opposite profile to the beams of the sun it will create more vitality. The objective of the work is to track the sun, so that the rays of sun will always be in perpendicular with panel. As the cost of manufacturing the solar tracking setup is high, there are alternative less expensive choices that have been proposed. This work aims to design and develop a model of solar tracking system. ATmega328P micro controller is utilized for the manufacture of control circuit. Light Dependent Resistors (LDR) is utilized to recognize daylight which impels the servo motor to turn the solar panel. The solar panel is kept in a region of most extreme exposure to daylight. Greatest torque and speed are achieved by a servo motor. Servo motor is most efficient with the scope of 80-90%. Servo motors are free from vibration issues. Execution and attributes of solar panel are examined tentatively. solar cells made of Silicon produced an maximum efficiency of 20%. Most of the solar panels still operate at level less than 40%. Because of their reduced performance. The initial cost increases due to the purchase of large sized panels, else the number of panels has to be increased. The efficiency and cost of the panel is inversely proportional to each other solar tracking finds a better way of improving the performance without increasing the rate of the panel. The area of exposure to sunlight is increased. Classification is based on the number of trackers single axis trackers are less efficient than Dual trackers A single tracking system is used. It is cheaper, less complex to install and still achieves the required efficiency. The increase in the initial setup cost is negligible when compared to the increase of power output. Maintenance costs are not high.

Keywords: Solar Panel, Light Dependent Resistor, Microcontroller, Voltage regulation

1. Introduction

Sun radiation vitality is pollution free and accessible in enormous amount. Even though the conversion of sun heat energy is from long use, the conservation of sun light energy into electrical energy is emerging. The earth receives 84 Terawatts of power and our world consumes about 12 terawatts of power per day. We are trying to consume more energy from the sun using solar panel [1]. In the past, solar cells have been hooked with fixed elevating angles. They do not track the sun and therefore, the efficiency of power generation is low [2]. These are for industrial and household applications, with the increased pace of exhausted consumption of major traditional energy sources like oil, coal and gaseous petrol, combined with ecological effects and for harnessing these conventional resources. So the unavoidable demand of electric



energy to be produced by renewable energy is the future demand. These features are extremely useful in autonomous PV power systems installed in remote areas for system control and monitoring [3]. Hence the area of investment in the field of renewable sources is of highlighted. The industrial range solar cells have a higher efficiency in a range of 10 and 20 percent. This indicates there is still a zone of progress to be engaged. Maximizing power output from a solar system is desirable to increase efficiency. In order to maximize power output from the solar panels, one needs to keep the panels aligned with the sun [4]. By tracking the sun, such that the sun's rays always strike normal to the array's surface, more energy can be received [5]. This undertaking intends to build the productivity of solar cell. Sun tracking systems are, in general, timer controller-based (15° per hour rotation) and require manual intervention for starting and stopping the system because solar time changes throughout the year [6]. The following instrument activates the servo motor to align the sun panel for the greatest sun beams to fall in it. Different ways focus on identifying losses and discovering approaches to relieve them. The efficiency of solar panel is improved by either increasing the solar cell productivity or by amplifying the yield of power by the utilization of solar tracking system. Maximum power point Time (MPPT) aims at increasing the efficiency of solar panel by holding its activity on the knee purpose of P-V qualities. MPPT offers increased performance which can't be achieved in solar panels of stationary types at random time. Light dependent resistor is used in solar tracking system to track sun which precisely controls the mechanism [7]. This system can't increase the proficiency if the board isn't adjusted. Improvement of yield by 30% and 60% than the stationary framework is conceivable by the following framework. Double pivot trackers are most productive, however this accompanies multifaceted in nature. Double trackers track daylight from box axis. . Single pivot trackers are a superior choice on equator region. The climate and the performance of the solar tracking system decide the increase of productivity of solar panel. The efficiency of the tracking unit decides the performance increase of solar cells. According to the use of single-axis tracking can increase the electricity yield by as much as 27 to 32 percent. On the other hand, a dual-axis solar tracker follows the angular height position of the sun in the sky in addition to following the sun's east-west movement reports that dual-axis tracking increases the electricity output as much as 35 to 40 percent. [8]. Hence there is a huge scope in increasing the efficiency of the solar panel by attaching the solar tracker so that huge radiation will fall on the surface of the solar panel [9-10].

2. Objective of the study

The main objective of the study is to increase the efficiency of the solar panel by converting the fixed panel structure into a tilting structure that can track the sun. A simple setup is designed with two LDRs to align the solar panel for maximum exposure to sun, a stepper motor to make angular rotation, a micro controller and voltage regulator to keep the output voltage at a constant level. In this study the increase in output voltage of solar panel by solar tracker is analyzed for various climatic conditions.

3. Methodology

The solar panel is designed to track the sun for maximum light rays to fall. So two LDR are used to position the solar panel. One axis is azimuth which allows the solar panel to move left and right. The other axis is elevation and allows the panel to turn up and down. The result of this new development provides the solar panels with extensive freedom of movement. There are three different sections of circuit of solar tracking system. There sensors, potentiometer, programmed micro controller along with the control circuit which drives the servo unit. The two LDR along with a voltage regulator forms the input unit. The embedded system composed of at mega 382 micro controller fed with C program. These three phases are designed separately before coupled into the frame work. In this methodology, the programming is done in stepwise with refinement. It has been effectively used as it conforms an accurate and very sensible methodology which is of direct and easy to understand. . It also ensures that if any errors occur, it is considered separately and corrected.

4. Design and Fabrication

4.1 Light Dependent Resistor

The very simple design of optical sensor is a photon resistor or photocell which is a light sensitive resistor. It is made up of cadmium sulfide (CdS) and gallium arsenide (GaAs). Cadmium sulfide (CdS) photocells are utilized for detecting the strong light. The change in the

photograph cell is relative to the measure of light force falls on it which is associated in arrangement with capacitor. Dull opposition and light immersion obstruction are the standards roughly 30,000 lux, where the force of light is estimated in utilized in photocells. The enlightenment of daylight is the unit Lux.

4.2 The concept of using two LDRs

If the two sensors are in same intensity of light then solar panel will be stable position. No change of voltage occurs if the two sensors are exposed to same light source. A change of voltage occurs if the two LDR senses a different intensity of light. The sensors will trigger the motor to move the mounting system so that the solar panels will always face the sun. Figure 1 shows the schematic view of LDR sensor

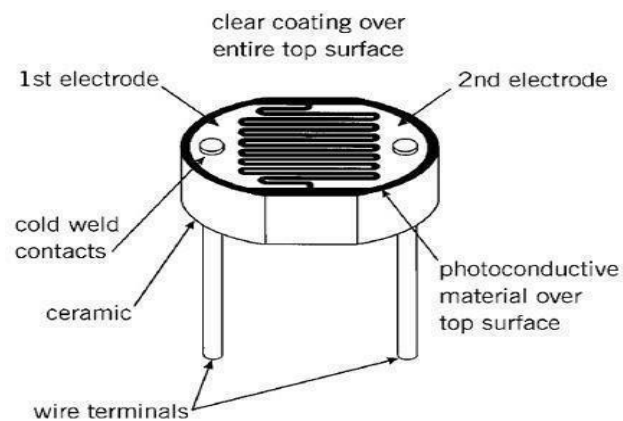


Figure: 1 LDR sensor

4.3 Servo motor

The application of servomotor is versatile. They are typically cheap and have greater efficiency. The servo hardware actuates the motor unit and accompanies shaft in position that is coupled with gear assembly. The electrical pulse controls the motor that decides the angular rotation of shaft. The three major parts of servo motor is a small DC motor, a potentiometer unit and a circuit for control. Gears are attached to the motor which is coupled to the control wheel. As the motor rotates, the change of voltage in the potentiometer actuates the control circuit which manages the measure of movement of rotation. Figure 2 shows the servomotor coupled with micro controller.



Figure 2 Servo motor coupled with micro controller

4.4 Voltage regulation

Voltage controllers are used to maintain the voltage at a prescribed level. In this present work the LM7805 voltage controller is used. It is a unique from of 78xx arrangement voltage controller of fixed type ICs. In general the circuit is having varying voltage along the transmission lines and doesn't have the option to fix the voltage to constant level. The voltage controller IC maintains the voltage at a constant level. The LM7805 voltage regulator maintains +5V control supply. Capacitors are incorporated in the system to maintain the voltage.

4.5 Microcontroller

Microcontroller is a simple chip which is in tiny scale PC made through VLSI. A microcontroller is also called as implanted controller on the ground and its help circuits are regularly made as an integral part of gadgets that they control. A microcontroller is manufactured in varying length like chip (4bit,8bit,16bit,32bit,64bit and 128 piece microcontrollers are accessible today). Figure 3 shows the solar panel coupled with solar tracker system .



Figure 3 solar panel with solar tracker device

5. Results and Discussion

The output of the solar panel is recorded from LDRs integrated solar tracking system which is at fixed position. The experiment was carried out for four days and the output was recorded. The output of the LDRs is dependent on the power of the light source falling on their surfaces. The sequence of Arduino has to convey with computerized pins namely 0 (RX) and 1 (TX) like a USB to connect with PC. Arduino which is worked in sequential mode can be utilized to transfer data with the arduino board. For each and every 60 minutes the output data from the tracking system is made to record by programming with specific code.

Table 1 Readings of bright sunny day

Time	LDR readings for fixed panel		LDR readings for tracking panel	
	LDR1	LDR 2	LDR1	LDR 2
0630Hrs	0.679	0.489	1.477	1.487
0730Hrs	0.792	1.061	2.804	2.839
0830Hrs	1.779	1.672	3.203	3.990
0930Hrs	3.167	1.119	3.990	3.990
1030 Hrs	3.421	3.226	4.130	4.149
1130 Hrs	4.604	3.208	4.500	4.590
1230 Hrs	4.990	4.980	4.990	4.990
1330 Hrs	4.980	4.990	4.888	4.990
1430 Hrs	4.888	4.941	4.976	4.985
1530 Hrs	4.413	3.878	4.941	4.892
1630 Hrs	3.935	3.824	4.873	4.790
1730 Hrs	2.639	2.639	3.964	3.940
1830 Hrs	1.569	1.031	2.708	2.815

The reading of bright sunny day is recorded and shown in the Table 1. From the table it is evident that the LDR readings of the fixed panel is always less than that of the solar tracking system as the tracker makes a huge intensity of light rays to fall on the surface of solar panel.

Table: 2 Readings of cloudy Morning and Sunny Afternoon

Time	LDR readings for fixed panel		LDR readings for tracking panel	
	LDR1	LDR 2	LDR1	LDR 2
0630Hrs	0.196	0.176	1.477	1.487
0730Hrs	0.249	0.210	1.804	1.839
0830Hrs	0.225	0.196	2.757	2.933
0930Hrs	0.723	0.567	3.631	3.783
1030 Hrs	0.733	0.816	3.900	3.798
1130 Hrs	3.211	2.297	3.910	3.969
1230 Hrs	4.888	4.941	4.990	4.990
1330 Hrs	3.803	3.910	4.985	4.990
1430 Hrs	3.456	4.057	4.976	4.985
1530 Hrs	3.930	3.846	4.941	4.892
1630 Hrs	1.999	1.544	4.824	4.594
1730 Hrs	1.090	1.144	3.128	2.981
1830 Hrs	0.718	0.787	0.982	0.968

Table: 3 Results for a cloudy day

Time	LDR readings for fixed panel		LDR readings for tracking panel	
	LDR1	LDR 2	LDR1	LDR 2
0630Hrs	0.147	0.117	0.274	0.244
0730Hrs	0.161	0.156	0.547	0.601
0830Hrs	0.274	0.205	1.090	1.075
0930Hrs	0.435	0.279	1.227	1.276
1030 Hrs	0.572	0.547	1.271	1.305
1130 Hrs	1.041	0.816	1.618	1.569
1230 Hrs	2.175	1.965	2.165	2.151
1330 Hrs	1.975	1.794	1.848	1.794
1430 Hrs	1.119	1.623	1.090	1.075
1530 Hrs	1.022	1.510	0.982	0.943
1630 Hrs	0.543	1.017	0.762	0.728
1730 Hrs	0.264	0.367	0.547	0.538
1830 Hrs	0.064	0.103	0.327	0.220

The readings of cloudy morning sunny day and cloudy day are recorded and shown in the table 2, 3 respectively. The output data in terms of voltage qualities from the two LDRs are monitored and recorded at the given intervals. The LDRs measure the intensity of light falls into it and in this method the amount of electric energy obtained is proportional to the efficiency of the solar panel. By estimating the light rays falls at a periodic time for the fixed panel and the panel equipped with solar tracker the increase in performance is calculated by comparing the power output. From the experimental data it is clear that the performance of the solar panel equipped with solar tracking system depends on the intensity of light rays falls in it.

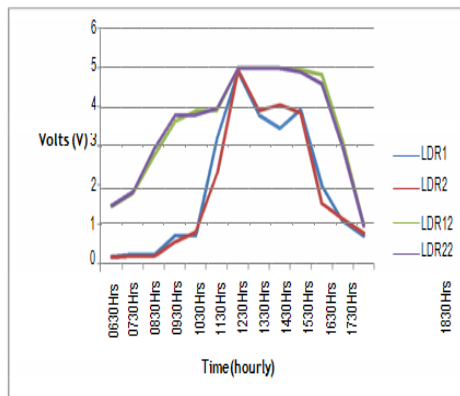


Figure 4 Graph Results for cloudy Morning and Sunny Afternoon

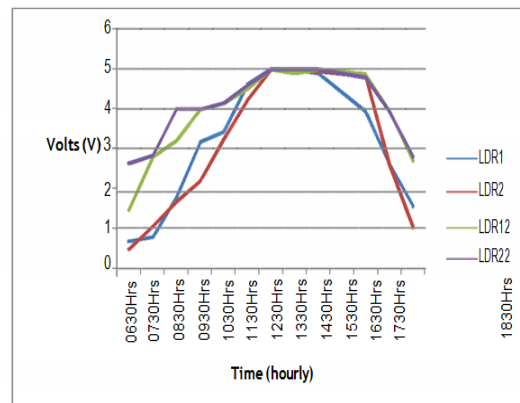


Figure 5 Graph Results for a bright sunny day

From the Figure 4, it tends to be seen that the most extreme daylight happens at around early afternoon, with greatest qualities got between 1200 hours and 1400 hours. The output voltage of the tracking system shows a significance increase with tracker system mainly at the sunny afternoon as the light intensity is high. A gradual decrease in the voltage output is observed but not less than the fixed panel. From Figure 5, it is observed that for a bright sunny day the maximum peak output voltage is obtained than the cloudy day and cloudy morning day. A gradual increase in the LDR output voltage of solar tracker system is achieved than the fixed panel system for the start and end of the day.

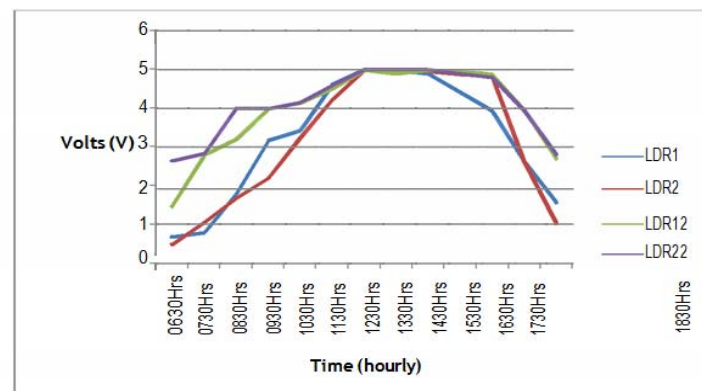


Figure 6 Graph Results for a cloudy day

After nightfall, the following framework is turned off to spare vitality. It is exchanged back on toward the beginning of the day. For the panel fitted with the following framework, the estimations of the LDRs are relied upon to be close. This is on the grounds that at whatever point they are in various situations there is a blunder produced that empowers its development. The movement of the board is halted when the qualities are the equivalent, which means the

LDRs get a similar force of daylight. From Figure 6, it is evident that towards the beginning of the day and late night, power of daylight reduces and the qualities acquired are less than those attained during the day. The maximum peak output voltage of the both the system remains same at peak power from 1230 Hrs. to 1330 Hrs. For the fixed board, the qualities change on the grounds that the board is at a fixed position. Subsequently, in most of the time the LDRs are not possibly tracking the sun at a same tendency. This is been exceptional from start of afternoon when both LDRs are facing them practically opposite to the sun. Days with lower sunlight are noticeable as the working of LDR is altered with the change in the intensity of light. For cloudy days, the efficiency of the normal fixed solar panel and the experimental setup with tracking system doesn't vary a lot as in cloudy days the intensity of solar rays is too low for the LDR to actuate the servo motor. Any other variations are negligible. The following framework is most effective when it is exposed to high beam of sunlight. As far as the power output of the solar panel of fixed frameworks, it is obvious that the tracker system will have an increased power yield. This is on the grounds that the power produced by sunlight based boards is subject to the force of light. If more light falls, then more power will be created by the experimental setup.

6. Conclusion

A solar panel that tracks the sun was designed and tested. The necessary program was made that predefined the different activities required for the servomotor to track the sun. A single tracker system shows a considerable increase of power output. While double trackers are checked it shows an increased performance, with increased complexity in design. Double trackers are generally appropriate in areas where there is an appropriate change of position of sun according to the land scape of different geological surface. This undertaking was actualized with least assets. The hardware was kept simple, with a guaranteed improvement of efficiency of panels.

- A large scope is available for these types of solar tracking system in solar farms as overall efficiency is increased.
- The initial cost for installing the tracker setup is slightly increased that can be compensated by the increase of voltage from the solar panel

A single tracker system can be utilized to control a group of solar panels with mere modification in design

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