SUN TRACKING SOLAR PANEL

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Abstract : Solar energy is fast becoming a very important means of renewable energy resource. With solar tracking, it will become possible to generate more energy since the solar panel can maintain a perpendicular profile to the rays of the sun. Even though the initial cost of setting up the tracking system is considerably high, there are cheaper options that have been proposed over time. This project discusses the design and construction of a prototype for solar tracking system that has a single axis of freedom. Light Dependent Resistors (LDRs) are used for sunlight detection. The control circuit is based on an Arduino (ATMega328P microcontroller). It was programmed to detect sunlight via the LDRs before actuating the servo to position the solar panel. The solar panel is positioned where it is able to receive maximum light. As compared to other motors, the servo motors are able to maintain their torque at high speed. They are also more efficient with efficiencies in the range of 80-90%. Servos can supply roughly twice their rated torque for short periods. They are also quiet and do not vibrate or suffer resonance issues. Whereas there has been a steady increase in the efficiency of solar panels, the level is still not at its best. Most panels still operate at less than 40%. As a result, most people are forced to either purchase a number of panels to meet their energy demands or purchase single systems with large outputs. There are types of solar cells with relatively higher efficiencies but they tend to be very costly. One of the ways to increase the efficiency of solar panels while reducing costs is to use tracking. Through tracking, there will be increased exposure of the panel to the sun, making it have increased power output. It is cheaper, less complex and still achieves the required efficiency. The increase in power is considerable and therefore worth the small increase in cost. Maintenance costs are not likely to be high.

I. INTRODUCTION

Solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications. With the alarming rate of depletion of depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells.

The best efficiency of the majority of commercially available solar cells ranges between 10 and 20 percent. This shows that there is still room for improvement. This project seeks to identify a way of improving efficiency of solar panels. Solar tracking is used. The tracking mechanism moves and positions the solar array such that it is positioned for maximum power output. Other ways include identifying sources of losses and finding ways to mitigate them. When it comes to the development of any nation, energy is the main driving factor. There is an enormous quantity of energy that gets extracted, distributed, converted and consumed every single day in the global society. Fossil fuels account for around 85 percent of energy that is produced. Fossil fuel resources are limited and using them is known to cause global warming because of emission of greenhouse gases. There is a growing need for energy from such sources as solar, wind, ocean tidal waves and geothermal for the provision of sustainable and power.

Maximum power point tracking (MPPT) is the process of maximizing the power output from the solar panel by keeping its operation on the knee point of P-V characteristics. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at any given time. The technology cannot however increase generation of power when the sun is not aligned with the system. Solar tracking is a system that is mechanized to track the position of the sun to increase power output by between 20% and 40% than systems that are stationary. It is a more cost-effective solution than the purchase of solar panels.
There are various types of trackers that can be used for increase in the amount of energy that can be obtained by solar panels. Dual axis trackers are among the most efficient, though this comes with increased complexity. Dual trackers track sunlight from both axes. They are the best option for places where the position of the sun keeps changing during the year at different seasons. Single axis trackers are a better option for places around the equator where there is no significant change in the apparent position of the sun.

The level to which the efficiency is improved will depend on the efficiency of the tracking system and the weather. Very efficient trackers will offer more efficiency because they are able to track the sun with more precision. There will be bigger increase in efficiency in cases where the weather is sunny and thus favorable for the tracking system. Solar panels directly convert radiation from the sun into electrical energy. The panels are mainly manufactured from semiconductor materials, notably silicon. Their efficiency is 24.5% on the higher side. Three ways of increasing the efficiency of the solar panels are through increase of cell efficiency, maximizing the power output and the use of a tracking system.

II. PROBLEM STATEMENT

Wherever A solar tracker is used in various systems for the improvement of harnessing of solar radiation. The problem that is posed is the implementation of a system which is capable of enhancing production of power by 20-40%. The control circuit is implemented by the microcontroller. The control circuit then positions the motor that is used to orient the solar panel optimally.

III. PROPOSED METHOD OF SOLAR TRACKER

Light detecting sensor that maybe used to build solar tracker include; phototransistors, photodiodes, LDR and LLS05. A suitable, inexpensive, simple and easy to interface photo sensor is analog LDR which is the most common in electronics. It is usually in form of a photo resistor made of cadmium sulphide (CdS) or gallium arsenide (GaAs). Next in complexity is the photodiode followed by the phototransistor.

IV. LIGHT DEPENDENT RESISTOR THEORY

The simplest optical sensor is a photon resistor or photocell which is a light sensitive resistor these are made of two types, cadmium sulphide (CdS) and gallium arsenide (GaAs). The sun tracker system designed here uses two cadmium sulphide (CdS) photocells for sensing the light. The photocell is a passive component whose resistance is inversely proportional to the amount of light intensity directed towards it. It is connected in series with capacitor. The photocell to be used for the tracker is based on its dark resistance and light saturation resistance. The term light saturation means that further increasing the light intensity to the CdS cells will not decrease its resistance any further. Light intensity is measured in Lux, the illumination of sunlight is approximately 30,000 lux.

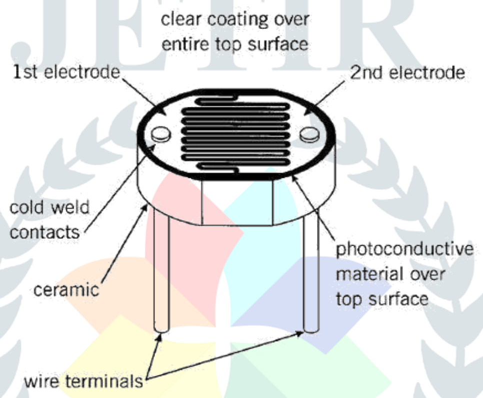

Figure 4.1 LDR construction

V. CONCEPT OF TWO LDR

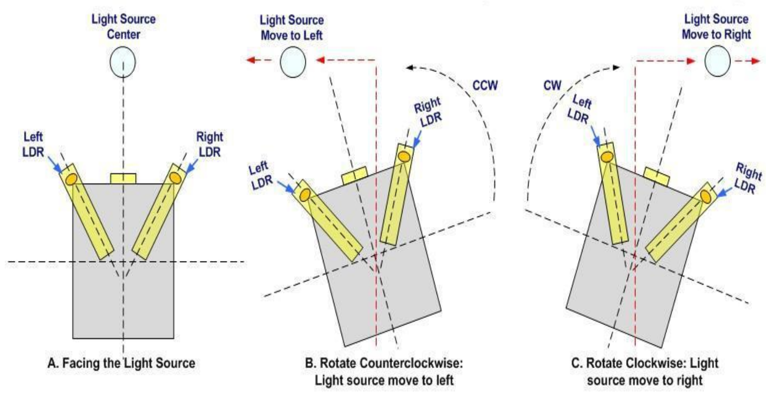

Figure 3.2 Use of Two LDRs

Concept of using two LDRs for sensing is explained in the figure above. The stable position is when the two LDRs having the same light intensity. When the light source moves, i.e. the sun moves from west to east, the level of intensity falling on both the LDRs changes and this change is calibrated into voltage using voltage dividers. The changes in voltage are compared using built-in comparator of microcontroller and motor is used to rotate the solar panel in a way so as to track the light source.

VI. RESULTS AND DISCUSSION

The results for the project were gotten from solar panel of the solar tracking system and of the solar panel that has a fixed position. The results were recorded for two days, recorded and tabulated. The output voltage of the solar panel was dependent on the light intensity falling on their surfaces. Arduino has analog pins A0 and A1, these pins are connected to the two LDRs and an analog input is obtained from these is converted in to digital signals by the Arduino, these signals are compared and then an error signal is generated. The control signal generated to rotate the servo motor depends on this error signal.The direction of rotation of the servo motor depends up on the control signal sent from the Arduino. The control signal produced by the Arduino depends on the error signal produced by the program that is already dumped in the Arduino.

The LDRs measure the intensity of light and therefore they are a valid indication of the power that gets to the surface of the solar panel. As a result, by measuring the light intensity at a given time, it will be possible to get the difference in efficiency between the tracking panel and the fixed one. The light intensity is directly proportional to the power output of the solar panel. A code is written that made it possible to obtain readings from the two LDRs. The EEPROM came in handy in this. It is the memory whose values are kept when the board is turned off. The ATmega 328P has 1024 bytes of EEPROM.The results were obtained for different days. Getting results from different days was helpful in that it made it possible to compare the various values gotten from different weather conditions. The values obtained were recorded and used to draw graphs to show the relations.

Time of the Day	Voltage with fixed Panel	Voltage with tracking Panel
6:30 AM	6.23	9.5
7:30 AM	6.5	9.8
8:30 AM	10.01	10.62
9:30 AM	9.59	9.91
10:30 AM	10.4	11.2
11:30 AM	10.35	10.59
12:30 PM	10.84	10.84
1:30 PM	10.7	10.73
2:30 PM	10.05	10.58
3:30 PM	9.81	10.02
4:30 PM	9.76	10.35
5:30 PM	6.34	9.52
6:30 PM	4.32	9.01

Table 6.1: Results for cloudy Morning and Sunny Afternoon for 7th April 2018

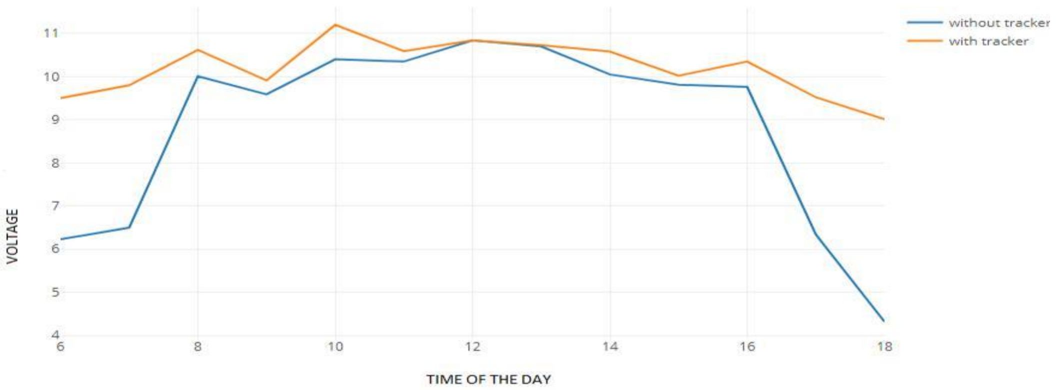

Figure 6.1: Graph of results obtained on 7th April 2018

Table 6.2: voltage outputs for bright sunny day on 7th April 2018

Time of the day	Voltage with Fixed panel	Voltage with Tracking panel
6:30 AM	6.23	9.4
7:30 AM	7.69	9.8
8:30 AM	9.23	10.5
9:30 AM	9.43	10.46
10:30 AM	10.8	11.2
11:30 AM	11.35	11.42
12:30 PM	11.2	11.2
1:30 PM	10.92	10.98
2:30 PM	11.06	11.18
3:30 PM	10.86	11.34
4:30 PM	9.46	10.48
5:30 PM	7.64	9.68
6:30 PM	6.56	9.43

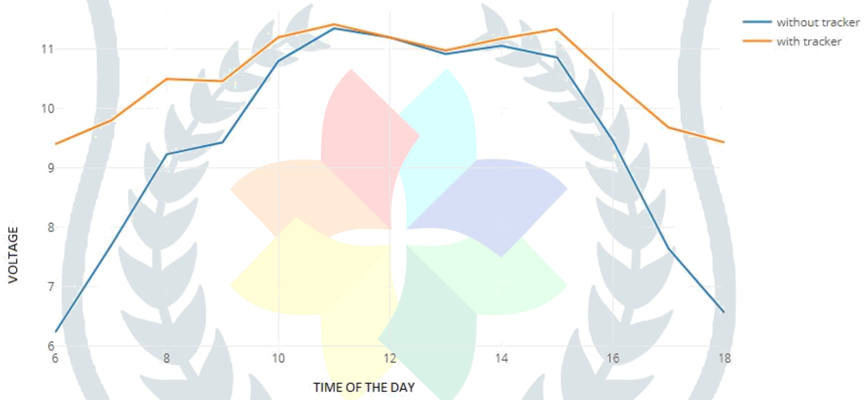

Figure 6.2: Graph for bright sunny day of 7th April 2018

From the curves, it can be seen that the maximum sunlight occurs at around midday, with maximum values obtained between 1100 hours and 1500 hours. In the morning and late evening, intensity of sunlight diminishes and the values obtained are less that those obtained during the day. After sunset, the tracking system is switched off to save energy. It is switched back on in the morning. For the panel fitted with the tracking system, the values of the LDRs are expected to be close. This is because whenever they are in different positions there is an error generated that enables its movement. The motion of the panel is stopped when the values are the same, meaning the LDRs receive the same intensity of sunlight. For the fixed panel, the values vary because the panel is at a fixed position. Therefore, at most times the LDRs are not facing the sun at the same inclination. This is apart from midday when they are both almost perpendicular to the sun.

Days with the least cloud cover are the ones that have the lightest intensity and therefore the outputs of the LDRs will be highest. For cloudy days, the values obtained for the tracking system and the fixed system do not differ too much because the intensity of light is more or less constant. Any differences are minimal. The tracking system is most efficient when it is sunny. It will be able to harness most of the solar power which will be converted into energy. In terms of the power output of the solar panels for tracking and fixed systems, it is evident that the tracking system will have increased power output. This is because the power generated by solar panels is dependent on the intensity of light. The more the light intensity the more the power that will be generated by the solar panel. The increase in efficiency can be calculated. However, it is important to note that there will be moments when the increase in power output for the tracking system in comparison with the fixed system is minimal, notably on cloudy days. This is expected because there will not be much difference in the intensity of sunlight for the two systems. Similarly, on a very hot day at midday, both systems have almost the same output because the sun is perpendicularly above. As such, both systems receive almost the same amount of irradiation. A few values can be used to illustrate the difference in efficiency between the two systems:

For a bright sunny day, we can take the average of the voltages for the entire day of a tracking solar panel. We then use the average voltage value of the fixed solar panel to compare it with the above value. It is calculated as a percentage and the two values compared. While this may not give the clearest indication of the exact increase in efficiency, it shows that the tracking system has better efficiency.

VII. CONCLUSION

A solar panel that tracks the sun was designed and implemented. The required program was written that specified the various actions required for the project to work. As a result, tracking was achieved. The system designed was a single axis tracker. While dual axis trackers are more efficient in tracking the sun, the additional circuitry and complexity was not required in this case. This is because INDIA lies near the equator and therefore there are no significant changes in the apparent position of the sun during the various seasons. Dual trackers are most suitable in regions where there is a change in the position of the sun. This project was implemented with minimum resources. The circuitry was kept simple, while ensuring efficiency is not affected. With the available time and resources, the objective of the project was met. The project is able to be implemented on a much larger scale. For future projects, one may consider the use of more efficient sensors, but which are cost effective and consume little power. This would further enhance efficiency while reducing costs. If there is the possibility of further reducing the cost of this project, it would help a great deal. This is because whether or not such projects are embraced is dependent on how cheap they can be.Shading has adverse effects on the operation of solar panels. Shading of a single cell will have an effect on the entire panel because the cells are usually connected in series. With shading therefore, the tracking system will not be able to improve efficiency as is required.

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