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Optimal Localization of Solar Panel for Better Energy Utilization

Priyanjan Sharma*, Nitesh Malhotra

Department of Electronics and Communication Engineering, Amity University, Noida-201301, India

*Corresponding author email: priyanjansharma@gmail.com, Tel.: +91-9560440019

ABSTRACT

In this advancing era of technology we are more concerned about the advancements made in technology rather than thinking upon the alternative sources of energy. Decreasing in the amount of non-renewable sources of energy and increasing in the consumption of the energy as per growth in technology we are trying to find newer ways to extract more amount of energy on renewable sources. Since, as solar energy which is also considered a renewable form of energy can be used to offset some of the power coming from the main grid that is generated by let us say non-renewable sources of energy, and creating these renewable sources in such a way that these provide us with the maximum efficiency is our main goal. This paper proposes a solar tracking system designed with microcontroller and light detecting sensors say LDR's that will actively track the position of sun and change the position of solar panel's position accordingly to maximize the energy output. The other LDR incorporated on solar panel helps to detect day or night.

Keywords - Microcontroller, solar tracking, LDR (light detecting resistor).

1. INTRODUCTION

Solar Energy, radiant light and heat has been harnessed by the humans since ancient times using a range of revolving technologies. Extracting energy from sun includes solar cells, solar photovoltaics, solar trackers or seekers. This way we can convert sun's energy to electrical form and consume it and decrease the load on renewable sources of energy.

The total solar energy absorbed by Earth's surface atmosphere, oceans and land masses is approx. 3,850,000 exajoules (EJ) per year. In 2002, this was more energy in one hour than the world used in one year. Photosynthesis captures approximately 3,000 EJ per year in biomass. The technical potential available from biomass is about 100-300 EJ per year. The amount of solar energy reaching the surface of the earth is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of energy i.e. coal, oil, natural gas, and mined uranium combined.

Now if we talk about extracting solar energy, sunlight has two components, the "direct beam" that carries about 90% of the solar energy, and the "diffused sunlight" that carries the other 10%. As majority of the light is in the direct beam of light, maximizing collection requires the sun to be visible to the panels as long as possible.

Many researches have been going on how to extract solar energy and improve on converting it to other forms. Improvements are done on lowering the costs of solar panels and advancements are made on thin film solar cell technology. This journal deals with the micro-controller based solar panel tracking system. Solar seekers help to increase the efficiency of the solar panel as it makes the rotation of the solar panel with the sun's movement. This makes the panel perpendicular to the rays of the sun always and hence increases the efficiency of the solar panel. As the sun rotate from east to west in a day's time, solar seeker with help of photo-detector decodes the position of the sun and follows its movement like a shadow but always perpendicular to the sun. This will lead to more amount of absorption of solar energy and increases the output of the whole system. Installing solar seekers over a fixed system can increase the power output by 30% - 60%. This much amount of increase in the output is enough to replace fixed systems with the tracking ones despite the cost. It is possible easily possible to track the sun using micro-controller which is considered heart of this system.

2. NEED OF SOLAR TRACKER

The sun travels through 360 degrees east-west a day, but from the perspective of any fixed location the visible portion is 180 degrees during a ½ day period. Local horizon effects reduce this somewhat, making the effective motion about 150 degrees. A solar panel in a fixed orientation between the dawn and sunset extremes

will see a motion of 75 degrees on either side, and thus, according to the table below, will lose 75% of the energy in the morning and evening. Rotating the solar panels from east to west can help recapture the losses produced when the panels are kept fixed. A tracker rotating only in the east-west direction is known as a single-axis tracker with no side-ways movement.

The sun moves through 46 degrees north-south over the period of a year. The same set of panels set at the midpoint between the two local extremes will thus see the sun move 23 degrees on either side, causing losses of 8.3%. A tracker that accounts for both the daily and seasonal motions is known as a dual axis tracker.

The energy contributed by the direct beam drops off with the cosine of the angle between the incoming light and the panel WHICH IS SHOWN IN Table 1.

Table 1 Direct power lost (%) due to misalignment (angle i)

Misalignment (angle i)	***Direct power lost (%)=1-cos(i)***
0	0
1	.015
3	.14
8	1
23.4	8.3
30	13.4
45	30
60	>50
75	>75

3. SYSTEM BLOCK DIAGRAM

Block diagram consists of a Microcontroller, LDR's, Solar Panel, Stepper motor, Crystal Oscillator.

First of all voltage coming from the main switch is step down to 9V using transformer after which the bridge rectifier circuit is used to convert ac to dc voltage. Filter circuit is used to filter the ripples because of rectifier. And this voltage is converted into 5V by voltage regulator and supplied to the circuit.

Light Dependent Resistors are connected to the op-amp (LM 358). One LDR which detects day/night is connected to one op-amp and the other op-amp is connected to the second LDR (tracks the movement of the sun) which is mounted on the solar panel. Microcontroller (AT89S52) is programmed to rotate the solar panel as per the requirements. It instructs the stepper motor to produce required tracking of solar panel.

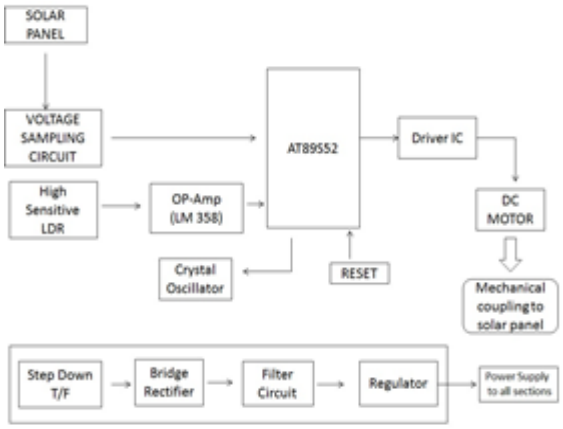

Fig. 1 Block Diagram of Rotating Solar Panel

4. SOFTWARE DESIGN & FINAL ASSEMBLY

As discussed above microcontroller is the heart of our solar tracking device so we have to program it for the functioning of the tracker.

Fig. 2 describes the flow-code of the processing of microcontroller that is required for the functioning of the Photo-Voltaic system.

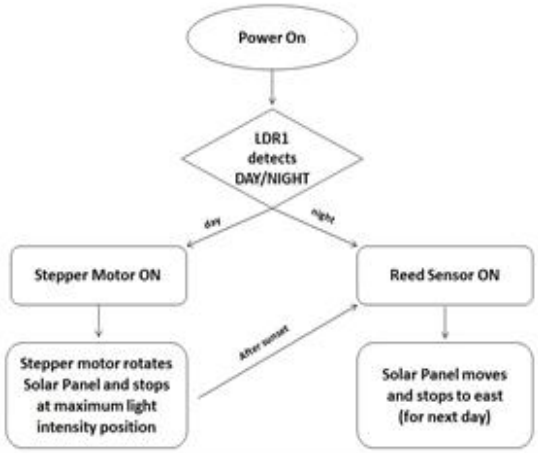

Fig. 2 Flow Chart for Processing of Microcontroller

The final assembly of solar tracking system using Microcontroller is shown in Fig. 3.

6. EXPERIMENTAL RESULTS

As we have discussed above sunlight has two components, the "direct beam" that carries about 90% of the solar energy, and the "diffuse sunlight" that carries the remainder, the diffuse portion is the blue sky on a clear day and increases the proportionately on

cloudy days. Majority of the energy is in the direct beam, and maximizing collection requires the sun to be visible to the panels as long as possible.

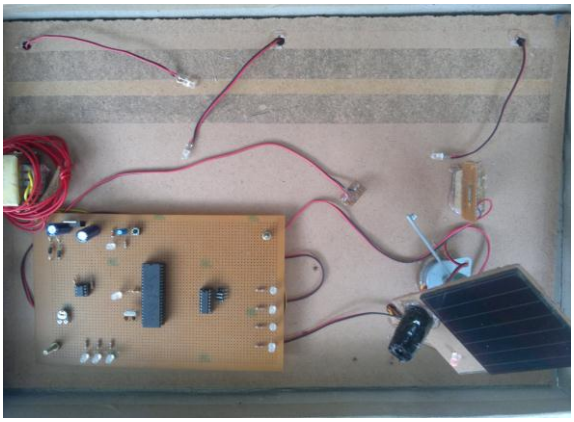

Fig. 3 Final Assembly of the Solar Tracker

The energy contributed by the direct beam drops off with the cosine of the angle between the light of the sun and the panel. In addition, the reflectance (averaged across all polarizations) is approximately constant for angles of incidence up to around 50°, beyond which reflectance degrades rapidly.

Below is the comparison of the single axis rotating solar panel with fixed solar panel.

Table 2 Comparison of powers of fixed mount and rotating solar panel

Hour	***Power for Fixed Mount (Mw)***	***Power for Single-Axis (Mw)***
0800	20.664	62.403
0900	39.780	67.473
1000	44.176	77.212
1100	70.616	93.772
1200	88.110	110.430
1300	104.960	137.160
1400	125.334	130.754
1500	105.342	120.335
1600	86.172	103.096
1700	70.620	89.910
1800	46.494	65.625

The average power values prove that the single-axis panel produces more power than that of the fixed mount. The power efficiency calculated for the singe-axis solar tracker is said to be 13% more than that of the fixed mount.

7. CONCLUSION

Above we have described a more improved way to maximize the power consumption by solar panel using the rotating solar panels that position themselves according to sun. By comparing the results we discovered that direct beam of sun helps in generating more energy than it is produced when the solar panel is kept fixed and the sunlight is directed perpendicular on it just for some period of time.

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