Design and Improvement of Efficiency for Sun Tracking Solar Panel

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Abstract

Solar energy is fast becoming the most important means of renewable energy. In the perspective of Bangladesh it is more important to be considered. Since the Solar we are using in Bangladesh can't track the sun light, the consumers aren't usually having energy from the Solar panel as it is expected. The position of the sun is not stationary so the angle of incidence also change with time, thereby performance of the solar panel. If the panel is made to align itself perpendicularly to sun rays, maximum efficiency can be achieved. This procedure is called solar tracking. Depending on the number of axes the panel is moving, trackers are4 differentiated as dual axes and single axis trackers, a single axis tracker can show good performance when the sun's path is stationary, but as the sun's path always changes with season. Dual axes tracker, which tracks the Sun irrespective of the sun's path, is preferable than single axes tracker. The tracking mechanism mainly uses LDR sensors to detect the Sun's position. This paper elucidates the construction of a Dual axes Solar tracker using LDR sensors, microcontroller and servo motors it's uses over conventional trackers.

Keywords: Solar cell, solar panel, solar tracker, microcontroller, sensor, servo motor.

1. INTRODUCTION

Solar panels are devices that convert light into electricity. Solar panels are also termed as photovoltaic which means basically "light-electricity". A solar panel is a collection of solar cells spread over a large area can work together to provide enough power to be useful. The more light that hits a cell, the more electricity it produces. These solar cells cells function similarly to large semiconductor and utilize a large area p-n junction diode. When the solar cells are exposed to sunlight the p-n junction diodes convert the energy from sunlight into usable electrical energy.

A solar tracker is a device that orients a payload toward the sun. The use of solar tracker can increase the electricity production. The purpose of solar panel is to meet the growing demand for renewable energy resources. In the modern world the demand for electricity has grown at an alarming rate to meet the needs of today's society. To find an alternative way in order to meet the growing need of energy numerous funds are being allocated and many concerned scientists are working tirelessly. A solar tracker can increase the electricity through rotating the solar panel towards the sun. There are various categories of sun tracking technologies : Active tracker, Passive tracker, Chronological tracker, Single axis tracker, Dual axes tracker, Horizontal axle tracker, Vertical axle tracker.

2. LITERATURE RIVIEW

R. Banerjeepresented model for sun tracking solar panel using stepper motor and 555 timer[1]. T. Tudorache, L. Kreindlerintroduced a design of tracker system using DC electric motor[2]. Again G. Ozuna, C. Anaya introduced a solar system using fuzzy logic[3]. V. Bhote, Prof. J. Singh introduced dual axis tracker using microcontroller. This paper is completely different from other works. Servo motor and microcontroller has been used in this paper to illustrate the function of a solar tracker and also this paper discusses about the design of solar tracker and the efficiency gain by the solar tracker.

3. SYSTEM DESIGN

3.1 System architecture

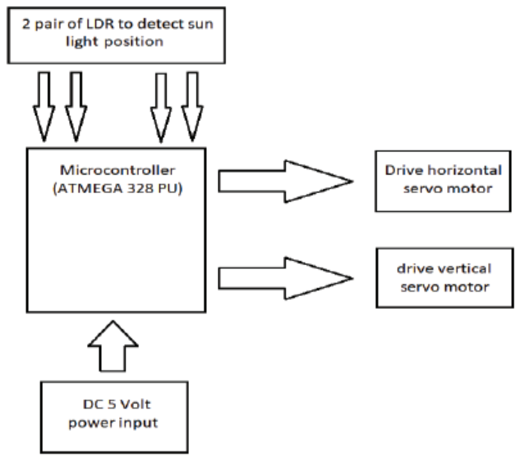

Figure 1. Block diagram of whole system.

The sensors are the main feedback of the system which sends signals to the control system. The backbone of the control system is a microcontroller decides which motor should move in which direction to adjust the system in such a way that the sun light falls orthogonally on the panel.

There are three major parts of the control system:

a. Sensors(2 pair of LDR)
b. Atmega 32 Microcontroller.
c. Servomotor.

3.2 Sensor (LDR)

LDR stands for light dependent resistors. These are special kind of resistors whose resistance decreases with increasing incident light intensity. LDR is also sometimes known as photo resistors. A photo resistor is made of a high resistance semiconductor. If light falling on the device has high frequency, photons absorbed by the semiconductor give electrons enough energy to jump into the conduction band [4]. The resulting free electron conduct electricity, thereby lowering resistance with the increase in light intensity.

3.3 Microcontroller (Atmega32)

For our automatic solar tracker to work, we needed a device that can make decision which way to rotate the whole system in order to track the sun. This was achieved by using a microcontroller which is ATmega 32. This microcontroller is from the AVR ATMEL family with built in 32 kilobytes of memory. Feeds from the sensors are taken and microcontroller does the rest of the job of assigning which motor should the pulses Microcontroller is the backbone of our whole system. To activate the microcontroller we had to program it with embedded C. The diagramof the ATmega 32 microcontroller is shown in the following figure.

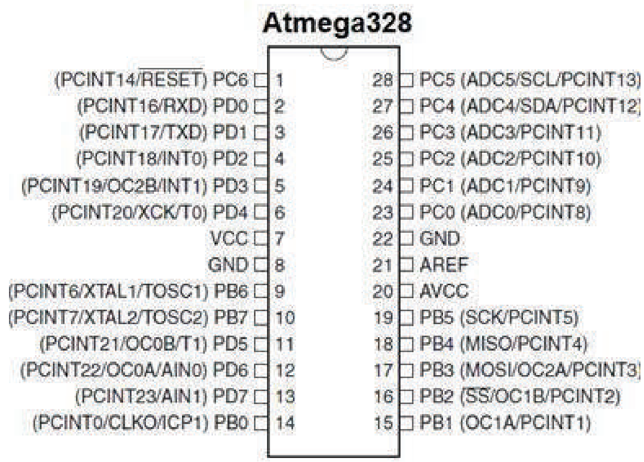

Figure 2.ATmega 32[5]

3.4 Servo motor

To build the two axis automatic solar tracker, we have used two servo motors so that we can control the movement of the system more precisely. According to the requirement of the project, both the motors are different in ratings from each other [6]. One of the motors which have a rating of 1.8v and 3.0A is responsible for the rotation of the solar panel. The solar panel will have a freedom of rotation from zero to 180 degrees in order to track the sun throughout the whole day. This servo motor has a lower rating compared to the other one. Both the servo motors used for this thesis project has a resolution of 1.8 degree/step. This means that when a pulse is applied to the servo motor, the shaft will rotate by 1.8 degrees. The other servo motor used has slightly higher ratings because it will have to rotate a circular base as well as the panel, the smaller servo motor and the associated structure [7]. This servo motor has a rating of 2.6v and 3.1A. This servo motor will also rotate the base from zero degree to 180 degrees. As we know, that the sun does not always follow the same path throughout the year, so the mechanism that we are going to develop will allow the system to automatically track the sun no matter which ever path it follows [8].

3.5 Final circuit

In order to make the automatic solar tracker, we had to link together all the components so that they work in unison to track the sun. It is very important to design the system carefully so that slightest movement of the sun can be tracked and this was achieved through the circuit we designed.

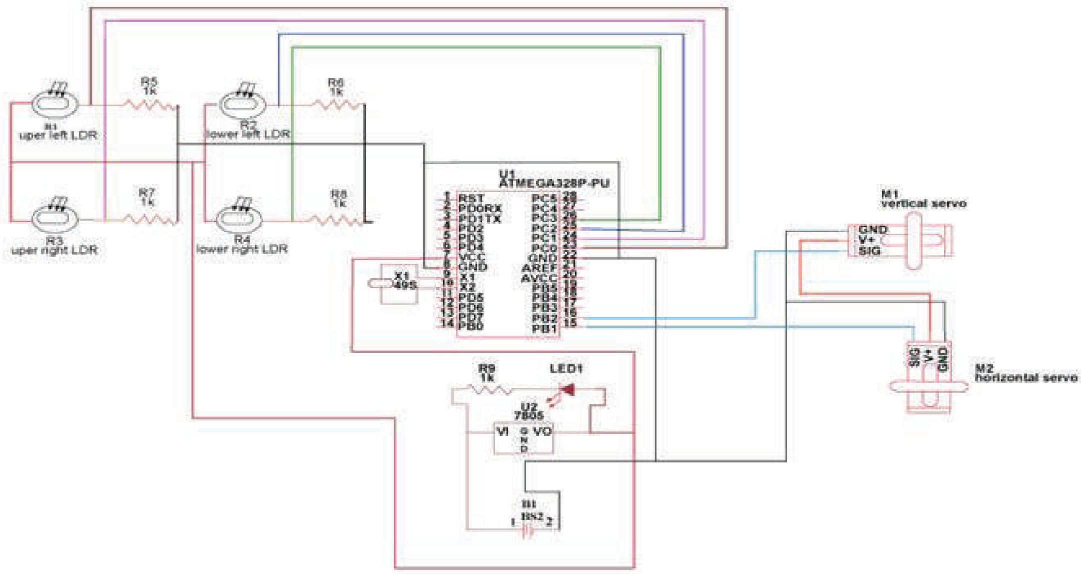

Figure 3.Circuit diagram of the whole system.

As the circuit shows we used 4 LDRs in order to track the sun on two axis. Each pair of LDRs are responsible for tracking the sun on each of the two axis. At first the light intensity on two adjacent LDRs are measured. The circuit diagram has been given below.

4. RESULT AND DISCUSSION

4.1 Result from the thesis

The sole purpose of this thesis was to improve the efficiency of the solar photovoltaic cell applications. And for that purpose we adopted the automatic solar tracking system. During our thesis, we conducted various experiments to find out the feasibility of improving efficiency through automatic sun tracking system and with the results, we progressed to finalize the system.

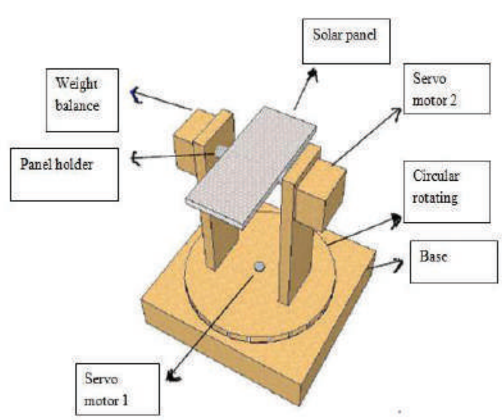

Figure 4.Final model of Solar Tracker.

Alongside, we also conducted experiments to find out the characteristic curves of the solar panel.volt .25 amp 2 solar panels connected parallel and put the solar panel in north west direction in 70degree rotated with vertical full day voltage chart of date July 8, 2018.

Figure 5: Solar Tracker

Average temperature 35-28 degree centigrade, Sun rise in 05:11 and sun set time is 18:48. There are two tables below that show the efficiency gain either in normal solar panel as well as in the solar tracker.

Table 1
Voltage gain by the normal solar panel

Time	Voltage gain by
07:00 am	2.6
08:25 am	2.7
09:15 am	2.8
11:20 am	3.1
13:00 pm	2.6
14:18 pm	2.8
15:28 pm	3.1
16:56 pm	2.7

The total gain by the normal solar panel is: 22.4v.

The average gain is: 22.4/8= 2.8v
The table given below shows the efficiency gained by our tracking system:
3 volt .25 amp 2 solar panels connected parallel and put the solar panel in our solar sun tracker device Date of July 8, 2018, Average temperature 35-28 degree centigrade, Sun rise in 05:11 and sun set time is 18:48.

Table 2
Data for voltage gain

Time	Voltage gain by
07:00 am	2.7
08:25 am	2.8
09:15 am	2.9
11:20 am	3.2
13:00 pm	3.3
14:18 pm	3.3
15:28 pm	3.3
16:56 pm	3.1

The total efficiency gained by the tracking sytem is: 24.6v
The average voltage gain by the tracking system is: 24.6/8= 3.075v
With the normal solar panel we found the average voltage gain 2.8v.On the other hand using the device "sun tracking solar panel" we found the average voltage gain 3.075v.The difference between voltage gain is (3.075-2.8=0.275v) .
Thus we found the calculation of efficiency:
Efficiency = (100*0.275)/2.8
=9.821%

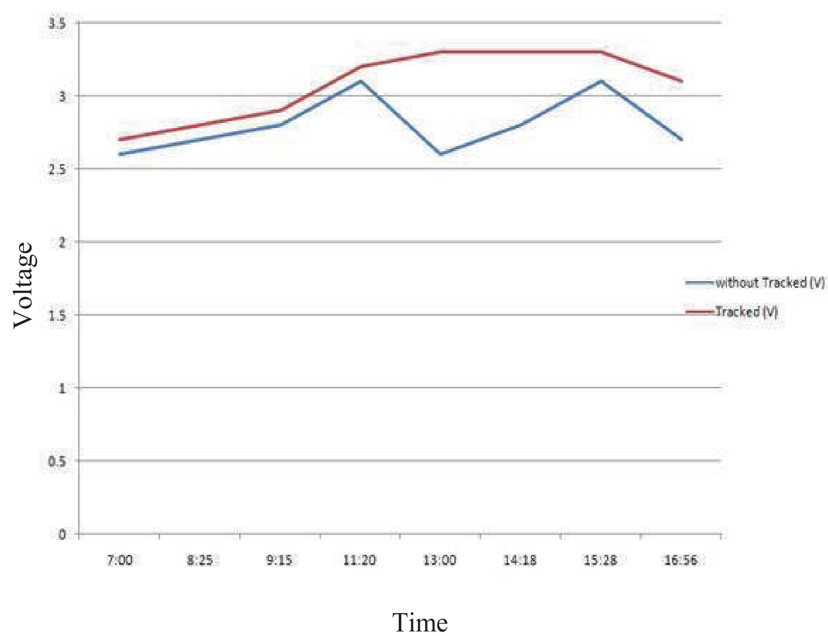

Figure 6: Characteristic Curve.

4.2 Analysis of the curve

The graphs which we obtained are the expected ones. As mentioned in the curve we can see that our solar tracker can achieve the maximum voltage throughout a day where a simple solar panel without tracking equipment can not achieve the maximum voltage. Through our system we can achieve voltage 9.821%.

5.CONCLUSION

Firstly, we chose to work on solar project because of the enormous scope of development and implementation in our country. Because of this marvelous form of harvesting energy, many houses in rural areas can now enjoy the blessing of electricity. But solar energy utilization in rural area is not the answer to the question throw by solar energy. We have to harvest it efficiently and use it to our full benefit. And through our thesis, we effectively tried to propose the solar panels to have sun tracking mechanism. Although this technology is nothing new to this world but it is something new for our country.

Commercially, two axis sun tracking is still rare even in countries where a significant part of electricity is being generated by solar energy as they claim that single axis tracking is doing the job. But dual axis tracking can significantly increase the efficiency – the prime objective of our thesis.

Through our experiments, we have found that dual axis tracking can increase energy by about 40% of the fixed arrays. With more works and better systems, we believe that this figure can raise more. And since the world will face energy crisis because of the limited amount of resources in the future, it is always wise to start early. Even 1% improvement in efficiency would save tons of fuels and ores in a year and that is not a small amount.

Solar energy is unlimited, solar panels are easy to maintain and has a very long lifetime. All these favor the use of it in our country. With a system that can track the sun – this renewable energy can be harvested even more efficiently and maybe two houses can be supplied with electricity using the panel that could only support one house without any tracking mechanism. We hope that there will be more research on this and our country will move forward to implement sun tracking system to minimize the electricity crisis that is hitting us at the very moment.

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