Solar Tracking System: Effective Use of Solar Panels

Vrij Mohan Vidyarthi [1] Neelam Rawat [2], Sonia Arora[3]
Department of Electrical Engineering
JBIT, Dehradun, Uttarakhand

Abstract:
This paper shows the potential system benefits of simple tracking solar system using a servo motor and light sensor. This method is increasing power collection efficiency by developing a device that tracks the sun to keep the panel at a right angle to its rays. A solar tracking system is designed, implemented and experimentally tested. The design details and the experimental results are shown.

Keyword: Solar Tracker, H-Bridge, LDR, Solar panel

I. INTRODUCTION:

Extracting useable electricity from the sun was made possible by the discovery of the photoelectric mechanism and subsequent development of the solar cell – a semi conductive material that converts visible light into a direct current. By using solar arrays, a series of solar cells electrically connected, a DC voltage is generated which can be physically used on a load. Solar arrays or panels[3] are being used increasingly as efficiencies reach higher levels, and are especially popular in remote areas where placement of electricity lines is not economically viable. This alternative power source is continuously achieving greater popularity especially since the realization of fossil fuels shortcomings. Renewable energy in the form of electricity has been in use to some degree as long as 75 or 100 years ago. Sources such as Solar[3], Wind, Hydro and Geothermal have all been utilised with varying levels of success. The most widely used are hydro and wind power, with solar power being moderately used worldwide. This can be attributed to the relatively high cost of solar cells and their low conversion efficiency. Solar power is being heavily researched, and solar energy costs have now reached within a few cents per kW/h of other forms of electricity generation, and will drop further with new technologies such as titanium oxide cells. With a peak laboratory efficiency of 32% and average efficiency of 15-20%, it is necessary to recover as much energy as possible from a solar power system[1-5]. This includes reducing inverter losses, storage losses, and light gathering losses. Light gathering is dependent on the angle of incidence of the light source providing power (i.e. the sun) to the solar cell's surface, and the closer to perpendicular, the greater the power. If a flat solar panel is mounted on level ground, it is obvious that over the course of the day the sunlight will have an angle of incidence close to 90°in the morning and the evening. At such an angle, the light gathering ability of the cell is essentially zero, resulting in no output. As the day progresses to midday, the angle of incidence approaches 0°, causing a steady increase in power until at the point where the light incident on the panel is completely perpendicular, and maximum power is achieved. As the day continues toward dusk, the reverse happens, and the increasing angle causes the power to decrease again toward minimum again. From this background, we see the need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible. By tilting the solar panel to continuously face the sun, this can be achieved. This process of sensing and following the position of the sun is known as Solar Tracking. It was resolved that real-time tracking would be necessary to follow the sun effectively, so that no external data would be required in operation.

II. TECHNIQUES USES IN SOLAR TRACKER:

i) Ball and Beam system:

The purpose of the design is to the position of ball along the track by manipulating the angular position of servo. The beam consists of a steel rod in parallel with a nickel-chromium wire-wound forming a track upon which a metal ball is to free to roll. One end of the beams is coupled to the servomotor through a lever arm and gears and the other end is fixed. The wire-wound resistor is biased and when the rolls along the track it acts as wiper similar to a potentiometer. The position of the ball along the track is obtained by measuring the voltage at the steel rod.

An optional remote sensor is also available for operation in master/salve tracking mode. This sensor is used, as the input the Ball &Beam desired position, making the Ball on the beam follow the ball on the remote sensor.

ii) H-bridge:

An H-Bridge [1] is an electronic power circuit that allows motor speed and direction to be controlled. Often motors are controlled from some kind of"brain" or micro controller to accomplish a mechanical goal. The micro controller provides the instructions to the motors, but it cannot provide the power required to drive the motors. An H-bridge circuit inputs the micro controller instructions and amplifies them to drive a mechanical motor. This process is similar to how the human body generates mechanical movement; the brain can provide electrical impulses that are instructions, but it requires the muscles to perform mechanical force. The muscle represents both the H-bridge and the motor combined. The H-bridge takes in the small electrical signal and translates it into high power output for the mechanical motor. This document will cover the electronic principles in creating the H-Bridge portion of the"muscle".

III. IMPLEMENTED TECHNIQUE:

Many different methods have been proposed and used to track the position of the sun. The simplest of all uses an LDR [5] – a Light Dependent Resistor to detect light intensity changes on the surface of the resistor. Other methods, such as that use two phototransistors covered with a small plate to act as a shield to sunlight, as shown Fig1.

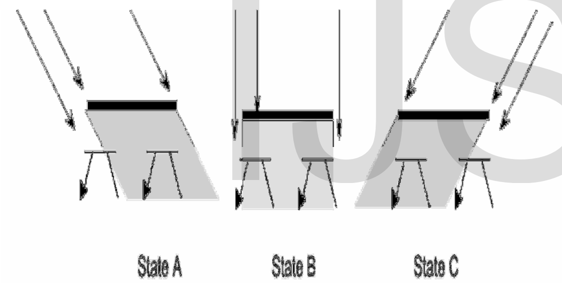


Fig. 1 Alternative solar tracking method

When morning arrives, the tracker is in state A from the previous day. The left phototransistor is turned on, causing a signal to turn the motor continuously until the shadow from the plate returns the tracker to state B. As the day slowly progresses, state C is reached shortly, turning on the right phototransistor. The motor turns until state B is reached again, and the cycle continues until the end of the day or until the minimum detectable light level is reached. The problem with a design like this is that phototransistors have a narrow range of sensitivity, once they have been set up in a circuit under set bias conditions. It was because of this fact that solar cells themselves were chosen to be the sensing devices. They provide an excellent mechanism in light intensity detection – because they are sensitive to varying light and provide a near-linear voltage range that can be used to an advantage in determining the present declination or angle to the sun. As a result, a simple triangular set-up was proposed, with the two solar cells facing opposite directions, as shown in Fig. 2.

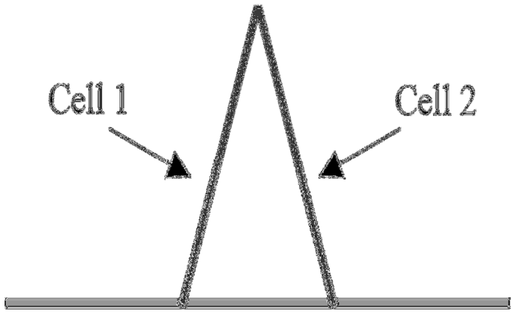


Fig. 2 Set-up of solar reference cells

In its rest position, the solar cells both receive an equal amount of sunlight, as the angle of incidence, although not 90° is equal in both cases. It can be seen in Fig. 3

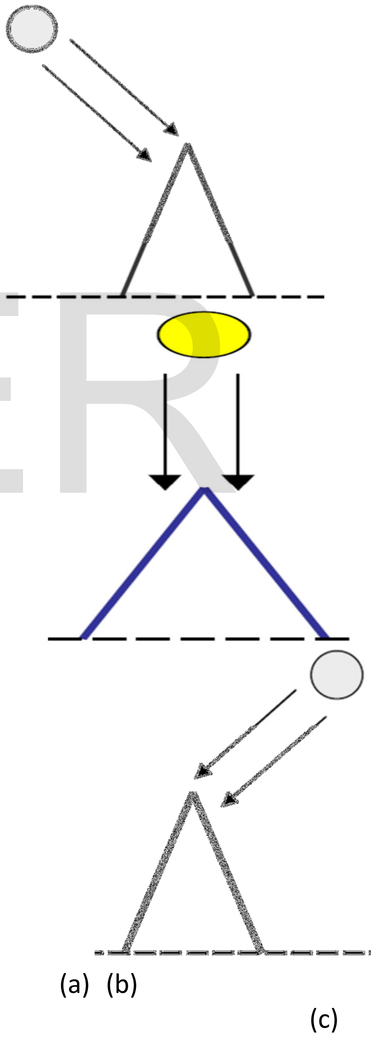


Fig 3 *Solar reference cells at a significant angle to the sun, solar reference cells at rest position*

that as the sun moves in the sky, assuming that the solar tracker has not yet moved, the angle of incidence of light to the reference panels will cause more light to fall on one cell than the other.

This will obviously cause a voltage difference, where the cell that is facing the sun will have higher potential than the other. This phenomenon will result in a detectable signal at each cell, which can be processed by a suitable circuit.

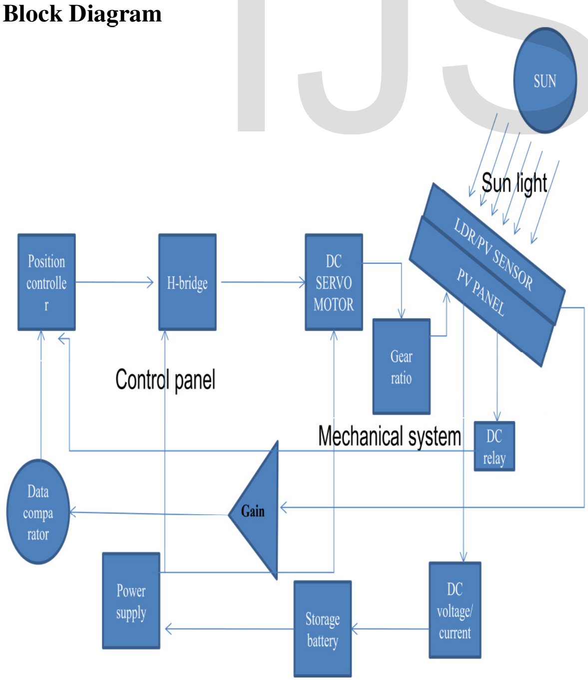
Advantage:

- An overall power collection efficiency increase from only 39% for a fixed panel to over 70% for the same panel on the tracking device.
- By utilizing this simple design, it is possible for an individual to construct the device themselves.
- A solar tracker is designed employing to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output.
- Solar tracking is by far the easiest method to increase overall efficiency of a solar power system for use by domestic or commercial users.

Disadvantage:

- Problems arise during rainy season towards the cloudy nature of the day in which sun light not comes properly towards panel.

Block Diagram

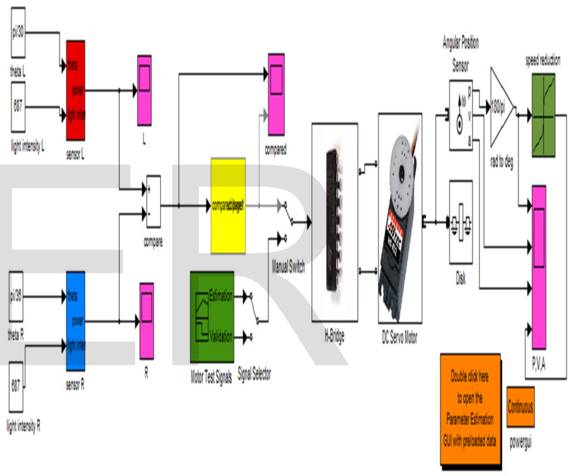


IV SIMULATION OF SOLAR TRACKER:

Our Solar tracker system is design on Mat lab Simulation program in which we make different type of circuit which perform the task to tracks the sunlight. In the simulation part shown in simulation in which a light sensor which detected the light intensity of right and left sensor. Then after that both the data of light sensor goes to the comparator which compared the data and send a voltage signal to the H-bridge which command the servo motor/dc motor to rotate in forward or reverse direction if command is positive than motor rotate in forward direction and if negative than it rotate in reverse direction and if bother sensor are same intensity than motor get stop.

SENSOR L	SENSOR R	DIRECTION
0	0	STOP
1	0	COUNTERCLOCKWISE
0	1	CLOCKWISE
1	1	STOP

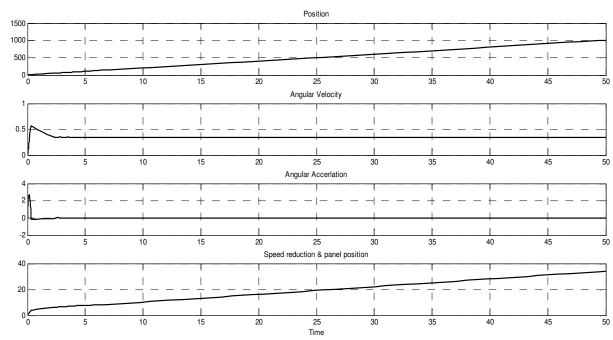
SIMULATION:



V RESULT:

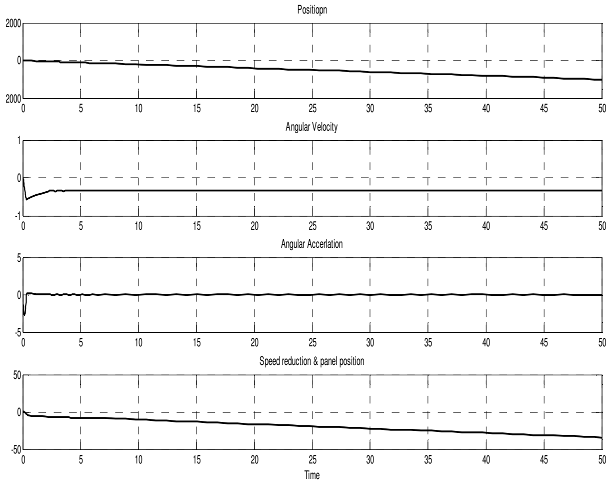
V.I Counter Clockwise Rotation:

Here in which the left sensor intensity is higher than right sensor the motor will rotate in left side i.e., counter clockwise.

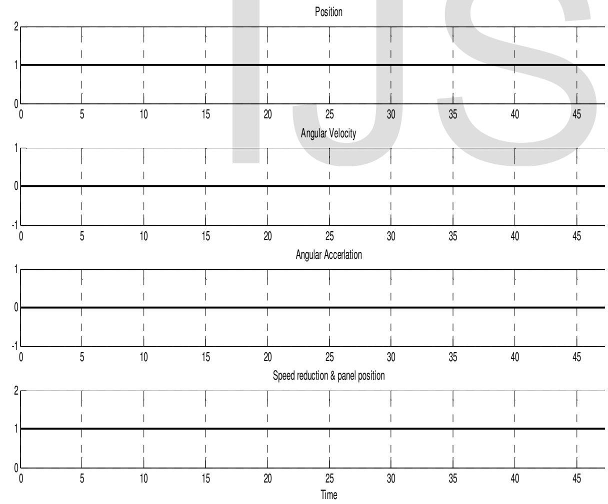


International Journal of Scientific & Engineering Research Volume 8, Issue 10, October-2017
ISSN 2229-5518

V.II Clockwise Rotation:
Here in which the right sensor intensity is higher than left sensor the motor will rotate in right side i.e., clockwise.



V.III No Rotation:
When either sensor will get the equal intensity or when there is no light in panel than motor will not rotate i.e., stop.



VI CONCLUSION:

A solar tracker is designed employing the new principle of using small solar cells to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output. By using this method, the solar tracker was successful in maintaining a solar array at a sufficiently perpendicular angle to the sun. The power increase gained over a fixed horizontal array was in excess of 30%.

VII REFERENCES:

[1] H-bridge-reference-ualberta-arvp Liping Guo received the B. E. degree in Automatic Control from Beijing Institute of Technology,Beijing, China in 1997, the M. S. and Ph. D. degrees in Electrical & Computer Engineering from Auburn University, AL, USA.
[2]Fahrenburch, A. and Bube, R. 1983, Fundamentals of solar cells,
Academic Press, New York.
[3]Solar power in India - Wikipedia, the free encyclopedia
[5]Mousazadeh, H., Keyhani, A., Javadi, A., Mobli, H., Abrinia, K., Sharifi, A.. "A review of principle and sun-tracking methods for maximizing solar systems output". Renewable and Sustainable Energy Reviews
[6]Krauter, Stefan. "Solar Electrical Power Generation: Photovoltaic Energy Systems". Springer
[7] Damm, J. Issue #17, June/July 1990. An active solar tracking system, Home Brew Magazine.