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Sun Tracking Solar Panel Car

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Abstract

This paper is based on a solar panel powered car which has sun tracking solar panels. The solar panel is the primary source of energy for the car and is supplemented by the battery provided. When the car is idle, the solar panel charges the battery and when adequate sunlight is available to the solar panel, it drives the car and also provides the electrical power to run the micro-controller which controls the movement of the solar panel.

1. INTRODUCTION

With the rising obligation to harvest renewable source of energy to make technology environment friendly, we have adopted several alternative sources of clean energy like the sun, the wind, energy from flowing water and geothermal energy. Solar energy is the most abundant and richest source of energy that is available. With solar radiation varying from 1000 kWh/m2 to 3000 kWh/m2, solar energy is the most practical source of energy besides hydro-energy. However, effective tapping of solar energy has stood out to be the greatest concern of the past decade. With solar plants having efficiency in the range of 10%-35%, gaining suitable power from solar has been a topic of concern. With advances in technology several kinds of photovoltaic cells like the silicon photovoltaic cell, Nano-carbon based photovoltaic cell has been developed with efficiency increasing rapidly at each stage of innovation. However, it is at this point where we must take a step back and contemplate the problem intensely. One of the key factors that affect the efficiency of the photovoltaic cells is the angle of inclination of the sun. Thus, we must address the fact that the sun moves from east to the west throughout the day. As a result of this the inclination of the solar rays' changes and so does the efficiency. Tracking the sun's movement is a solution of this problem, which is what forms the basis of this project. This tracking is so effective that with suitable calibration and efficiency of the photovoltaic cells this can be used to drive cars, data-collection rovers, and in many other sophisticated applications. However, further research is necessary to fine tune the technology and sharpen its rough edges so that it can give us better results. In this paper the fine details of both the Solar panel control system and the power distribution system is discussed thoroughly.

2. SOLAR PANEL CONTROL SYSTEM

A. Basic Concept

[1] [4] The basic concept behind our solar panel control system is voltage division. Two pairs of LDRs (Light Dependent Resistors) are connected in series (with a common point say 'A') to a 5V Arduino supply. From the point 'A' an input is fed to one of the pins of the analog pins of the Arduino. These two pairs of LDRs are fixed on the opposite sides of the solar panel and when the light falling on any one pair charges, the reading of the analog pin changes due to the effect of voltage division and hence the input to the analog pin changes predictably. Then it is processed and according to that servo motor(s) are used to move the solar panel accordingly.

An LDR is a primary transducer that changes it resistance with a change in illumination. The resistance of a Light Dependent Resistor is a function of the incident electromagnetic energy. They are made up of semiconductor materials having high resistance. When light is incident upon them, their resistance decreases. This particular feature of an LDR has been employed in our application.

The second particular device is a solar panel which is used to drive the car. This panel is used in running the motor as well as charging a storage device, a battery.

A battery charging circuit housing a variable potential IC, LM317 has been employed to charge the chargeable battery.

The auxiliary power source in the form of a battery has been introduced to ensure working of the car in the absence of usable solar energy.

B. Components and Speifications

The primary components employed are:

1. Solar Panel

   2 solar panels of dimensions 6 X 6 cm was used each with power specifications

2. Light Dependent Resistor (LDRs)

   A Cadmium Sulfide (CdS) LDR was used.

   Light Resistance measured at 10lux is 2854Kohm. (Pre illumination at 400-600lux prior testing).

   As obtained from the gamma characteristics the tolerance is of +-0.1.

   Also the tolerance of the spectral peak is +-50nm.

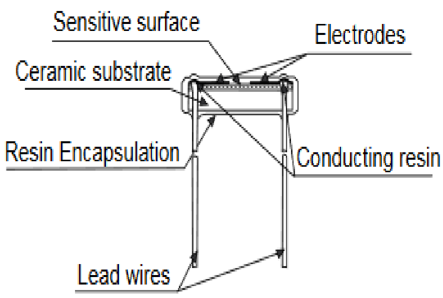

Fig 1: Diagram of a LDR.

Taken from specification sheet of LDR.

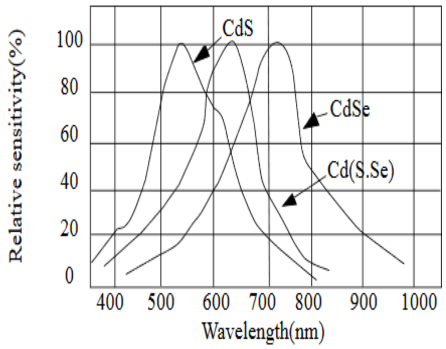

Fig 2: Relative sensitivity of a LDR wrt to wavelength of incident light in nm

Taken from specification sheet of LDR.

3. Voltage Regulator IC 317

   The following are the salient features of the LM317:

   - Output Voltage Range adjustable from 1.25V to 37V.
   - Output current greater than 1.5A.
   - Internal Short-Circuit Current Limiting.
   - Thermal Overload Protection.
   - Output safe area compensation.

4. Arduino Mega with an ATMEGA32 processor
5. Car chassis, screws and wheels .
6. Motors, resistors, wires and other basic electrical components.

II. Alternate to using Arduino

Instead of using an arduino to run the motor we can use an op-amp along with the potential divider circuit. The output of this differential op-amp is used to drive a servo motor that rotates the solar panel in the direction of the sun. Thus this feature of the tracking system is active throughout the day as the sun moves across the day sky.

A. *Tracking Cricuit*

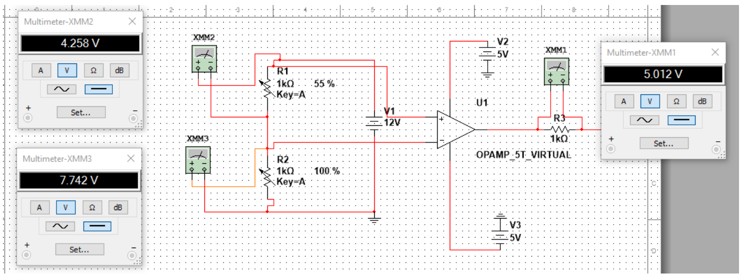

Fig 3: Simulation model of tracking circuit.

[2] As discussed in Section II, the solar tracking system is composed of four LDRs. As the sun moves to one side the other the resistance of the LDR on the side where the sunlight is more decreases this causes a differential output from the op-amp which rotates the servo motor and the solar panel attached to it in the direction of higher illumination.

Some of the triggering signals are

B. *Right trigger*

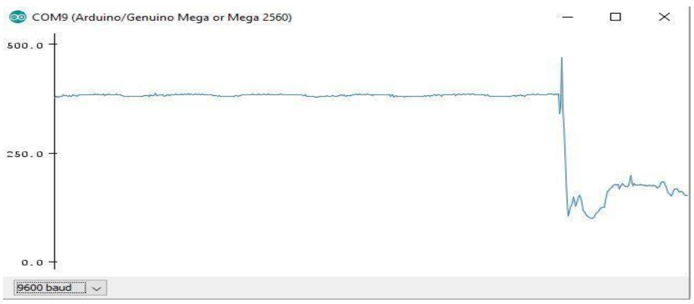

Fig 4: Triggering Value for right trigger.

C. Left trigger

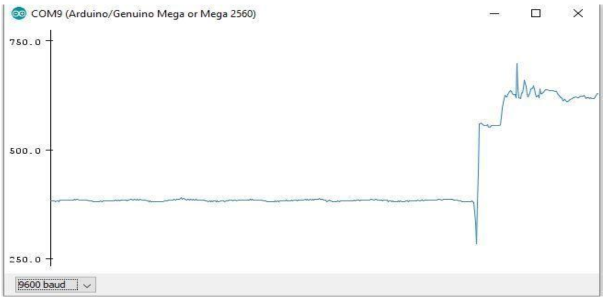

Fig 5: Triggering value for left trigger.

D. Median trigger

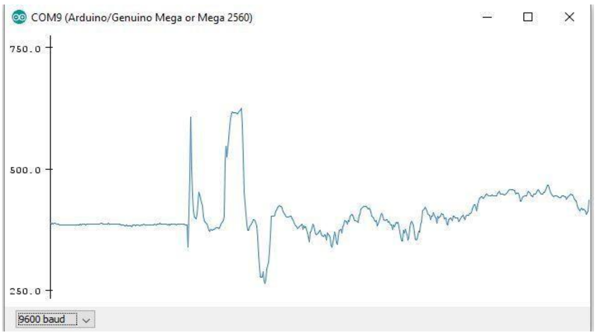

Fig 6: Triggering value for median trigger.

3.IMPLICATIONS OF A SOLAR TRACKING SYSTEM

Solar tracking systems have several implications some of which are advantageous, while some others are disadvantageous.

Solar tracking is an advanced application of technology to improve the productivity of traditional fixed mounted solar panels, which are mounted at an angle. The efficiency is compromised by the movement of the sun and decreases to a great extent once the sun is at a less optimal angle with respect to the solar panel.

This work is ideally tracking the sun and using its power to drive a solar powered electric car which is energy efficient and environment friendly.

The primary focus however is developing a good enough solar tracking system that can be employed in practical life as well.

However, before discussing the advantages of a solar tracking system it is essential to first understand the kind of tracking that can be applied. This type of tracking depends on the requirement of the project as well as the economic impact it can have on the project, the later is of paramount importance as increasing the cost effectiveness of solar system is one of the primary objectives of a tracking system.

Broadly classifying there are two types of solar tracking system, single axis tracking and [3] double axis tracking.

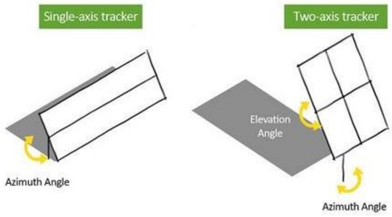

Fig 7: Single Axis and Multi axis solar tracking. Obtained from internet sources.

The tracking system depends on the azimuth angles.

Single axis systems are economical in nature. In a single axis tracking system the tracking is done either horizontally, vertically or obliquely.

Dual axis tracking system on the other hand provide better efficiency in capturing the maximum solar power, however, they are costlier. In this kind of systems the tracking is done by following the suns elevation as well as the movement.

E. Advantages

With increasing endeavors to improve the efficiency of solar system tracking the movement of the sun has become essential. Incorporating tracking technology to a solar system can thus have several advantages.

1) The sun tracking the solar panel maintains the optimum tracking angles at all times.

2) There is no loss of energy with the movement of sun in case of tracking because the tracking system keeps an angle of approximately 90 degrees with the sun rays as long as sun is in the morning sky.

3) Also the energy generated if in surplus can be fed back to the main grid system or stored in a storage unit like a battery for later use when solar light is not available.

4) Solar energy efficiency can be drastically improved when such kind of tracking is employed. Multi-axial solar tracking system is more efficient than single axis as multi-axial solar tracking system tracks the change in sun's path with a change in the season. This maximizes the energy that is obtained.

Data Analysis

F. Figures and Tables

The tracking system was employed in the month of May to July and a comparative study was conducted between tracking solar systems and fixed axis solar systems. The following power values at the same time were recorded at regular intervals of 3 hours starting from 10 a.m. in the morning to 4p.m. in the evening. The kind of solar panel employed was a 24 watt, 12 volt solar panel delivering approximately 1.89 amperes of average current. The fixed angle was kept towards the South East direction as it was installed in the city of Kolkata with an average inclination of approximately 30 degrees.

Table1: Comparison between Tracking Solar System and Fixed Solar System.

Time	***Tracking***	***Fixed***
10:00 a.m.	15.6 W	10 W
1:00 p.m.	16.89 W	11 W
4:00 p.m.	13 W	4 W

As is evident from the data obtained from the experiment tracking can acquire more energy over a given period of time than fixed solar system. An estimate graph is obtained using MATLAB R2016a, which shows us the general trend of the power obtained from the two systems in a continuous time frame.

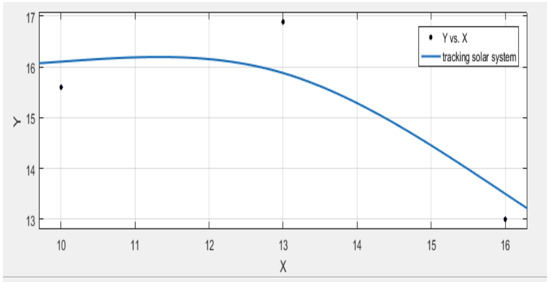

Fig 8: Tracking Solar System.

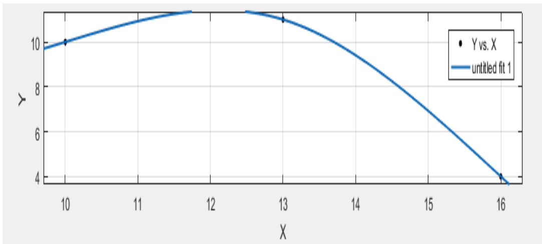

Fig 9: Fixed Solar System.

Thus we can see from the graphical analysis as well that tracking improves the efficiency of the solar system.

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REFERENCES

[1] Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions by K.H. Hussein 1 ; I. Muta ; T. Hoshino ; M. Osakada.

[2] A modified tracking algorithm for maximum power tracking of solar array by Chihchiang Hua and Jongrong Lin.

[3] Multi-axes sun-tracking system with PLC control for photovoltaic panels in Turkey by Cemil Sungur.

[4] Application of one-axis sun tracking system by Ibrahim Sefa, Mehmet Demirtas,IlhamiColak.