DUAL AXIS SOLAR TRACKING SYSTEM WITH WEATHER SENSOR

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Abstract

Solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources. As such, it is vital that those in engineering fields understand the technologies associated with this area. So, the use of renewable sources for energy generation is increasing rapidly with the help of Indian government policies. Indian government has announced that it will generate 175 GW from renewable sources of energy by 2022, out of which 100 GW will be from solar energy. Solar energy is abundantly available throughout the country all around the year for generating electricity at the roofs of residential and commercial buildings. Indian government policies are also favouring generation from rooftop power plants, as a target of 40 GW has been set to be achieved by 2022. Our research will include the design and construction of a microcontroller-based solar panel tracking system. Solar tracking allows more energy to be produced because the solar array is able to remain aligned to the sun. This system builds upon topics learned in this course to validate the design.

Keywords: renewable sources, tracking system, aligned, design

Introduction

The world population is increasing day by day and the demand for energy is increasing accordingly. Oil and coal as the main source of energy nowadays, is expected to end up from the world during the recent century which explores a serious problem in providing the humanity with an affordable and reliable source of energy. The need of the hour is renewable energy resources with cheap running costs. Solar energy is considered as one of the main energy resources in warm countries.

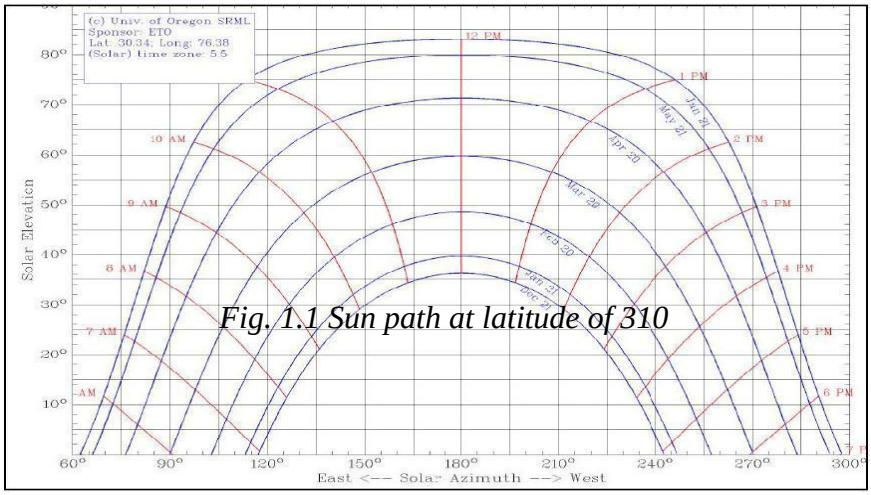


Fig. 1.1 Sun path at latitude of 310

Statement of the Problem

In today's date the electric energy from the conventional sources will going to be end soon. Solar power is the fastest growing means of renewable energy. Thus if it can be designed and implemented a system using simple dual axis solar tracker system, can resolve the problem. In order to maximize energy generation from sun, it is necessary to introduce solar tracking systems into solar power systems. A dual-axis tracker can increase energy by tracking sun rays from switching solar panel in various directions. This solar panel can rotate in all directions. This dual axis solar tracker project can also be used to sense weather, and it will be displayed on LCD. This system is powered by Arduino, consists of servo motor, stepper motor, rain drop sensor, temperature and humidity sensor and LCD.

Objectives of the study

In general, India has a relatively long sunny day for more than ten months and partly cloudy sky for most of the days of the rest two months. This makes our country, especially the desert sides in the west, which include Rajasthan, Gujarat, Madhya Pradesh etc. very rich is solar energy. Many projects have been done on using photovoltaic cells in collecting solar radiation and converting it into electrical energy but most of these projects did not take into account the difference of the sun angle of incidence by installing the panels in a fixed orientation which influences very highly the solar energy collected by the panel.

As we know that the angle of inclination ranges between -90^o after sun rise and +90^o before sun set passing with 0^o at noon. This makes the collected solar radiation to be 0% at sun rise and sun set and 100% at noon. This variation of solar radiations collection leads the photovoltaic panel to lose more than 40% of the collected energy.

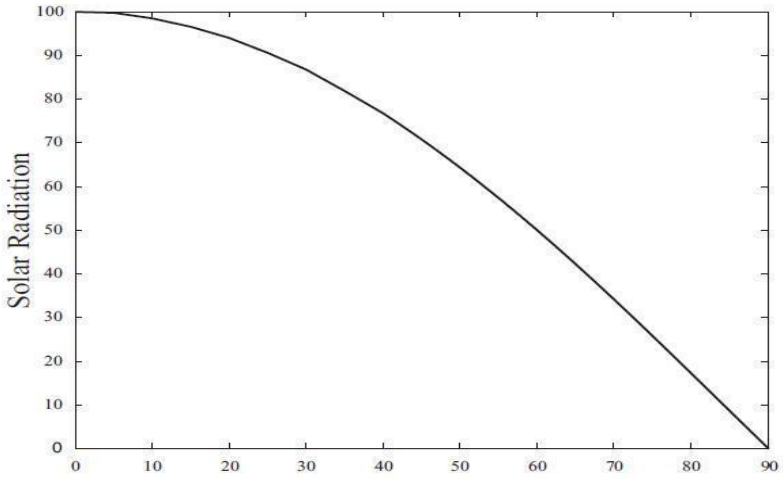


Fig 1.2 Curve for the relationship between the solar radiation and the solar angle of incidence.

The position is decided by two angles in spherical coordinates; the Altitude angle which is the angle of the sun in the vertical plane in which the sun lies, and the Azimuth angle which represents the angle of the projected position of the sun in the horizontal plane. These two angles will be discussed deeply later in this document. Fig. 1.2 shows a curve for the relationship between the solar radiation and the solar angle of incidence. This figure shows that solar radiations falling on the solar array will be maximum when the angle of incidence on the panel is 0^0 which means that the panel is perpendicular to the sun.

Review of Literature

Braun JE & Mitchell JC (2001) found that the sun-synchronous navigation is related to moving the solar powered rover (robot) in such a way that its solar panel always points toward the sun and which results into maximum battery charging and hence the rover can work for long hours. The unique feature of this solar tracking system is that instead of taking the earth as its reference, it takes the sun as a guiding source. Its active sensors constantly monitor the sunlight and rotate the panel towards the direction where the intensity of sunlight is maximum. **Prasad D & Snow M (2005)** investigated the control circuit for the job of fetching the input from the sensor and gives command to the motor to run in order to tackle the change in the position of the sun. By using this system the additional energy generated is around 25% to 30% with very less consumption by the system itself. **Chin CS, Babu A & McBride W (2010)** gives the design and implementation of a fuzzy logic computer controlled sun tracking system to enhance the power output of photo voltaic solar panels. The tracking system was driven by two permanent magnet DC motors to provide motion of the PV panels in two axis. The research describes the use of a microcontroller based design methodology of an automatic solar tracker. Light dependent resistors are used as the sensors of the solar tracker. **El-Moghany MS & Hamed BM (2013**) added the tracking system maximizes

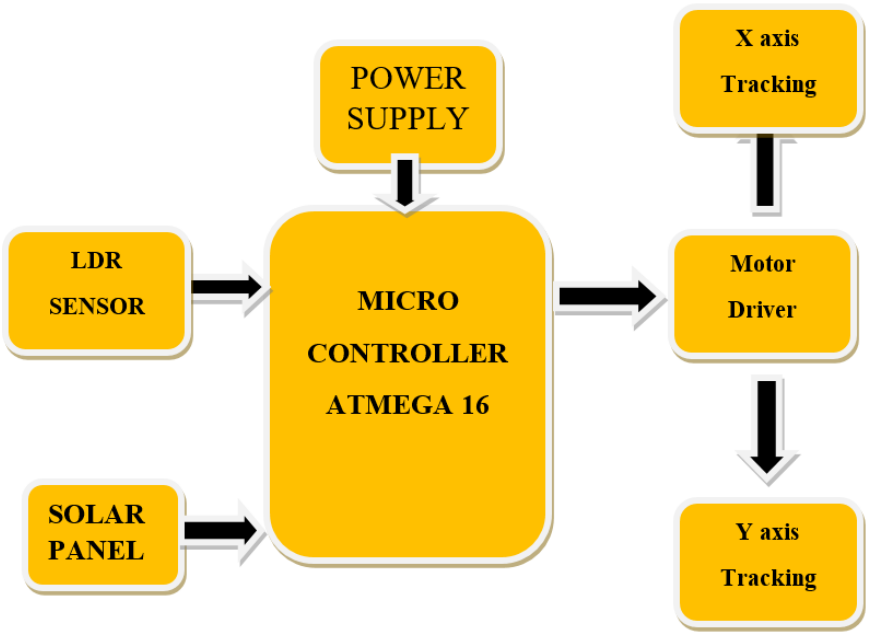
solar cell output by positioning a solar panel at the point of maximum light intensity**.** This paper describe the use of DC motors, special motors like stepper motors, servo motors, real time actuators, to operate moving parts of the solar tracker. The system was designed as the normal line of solar cell always move parallel to the rays of the sun. **Lee, Chia-Yen** (2020) designed the system to control the Altitude angle in the vertical plane as well as the Azimuth angle in the horizontal plane of the photovoltaic panel workspace. And this system is expected to save more than 40% of the total energy of the panels by keeping the panel's face perpendicular to the sun. In the previous solutions, each tracking direction is controlled by using a Sun sensor made by a pair of phototransistors.

Research Methodology

The purpose of a solar tracker is to accurately determine the position of the sun. This enables solar panels to interface to the tracker to obtain the maximum solar radiation. With this particular solar tracker a closed loop system was made.

The electrical system consists of five LDR sensors which provide feedback to a micro controller. This micro controller processes the sensor input and provides two PWM signals for the movement of servo motors.

This servo motor moves the solar panel towards the higher density of solar light. The entire electrical system is powered by a 12volt source power supply.

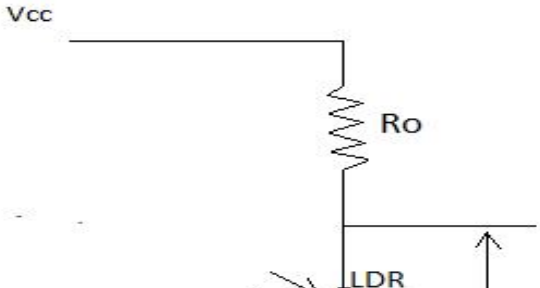


Initially five different analog values are obtained from LDR's, and then they are feed to micro controller. Micro controller gives two different PWM signal for the movement of solar panel through servo motor.

Results and Discussion

Sensors

We are using four Light Dependent Resistor's as a sensor. They sense the higher density area of sun light. The solar panel moves to the high light density area through servo motors. Each LDR is connected to power supply forming a potential divider. Thus any change in light density is proportional to the change in voltage across the LDR's. LDR is a passive transducer hence we will use potential divider circuit to obtain corresponding voltage value from the resistance of LDR. LDRs resistance is inversely proportional to the intensity of light falling on it i.e. Higher the intensity or brightness of light the Lower the resistance and vice versa. Interfaces:



Input (ADC):

Arduino has an inbuilt 10-bit Analog to Digital converter (ADC), hence it can provide Digital values from 0-1023. (Since 2^10=1024). We can also set the ADC reference voltage in Arduino, but here we'll let it use default value. LDR's has two pins, and to get voltage value from it we use potential divider circuit. In potential divider we get Vout corresponding to resistance of LDR which in turn is a function of light falling on LDR. The higher the intensity of light, lower the LDR resistance and hence lower the Output voltage (Vout) And lower the light intensity, higher the LDR resistance and hence higher the Vout.

Output (PWM):

Arduino has an 8-bit PWM generator, so we can get up to 256 distinct PWM signal. To drive a servo we need to get a PWM signal from the board, this is usually accomplished using timer function of the microcontroller but Arduino makes it very easy. Arduino provides a servo library in which we have to only assign servo angle (0-1800) and the servo rotates by that angle, all the PWM calculations are handled by the servo library and we get a neat PWM signal according to the desired angle.

H-Bridge

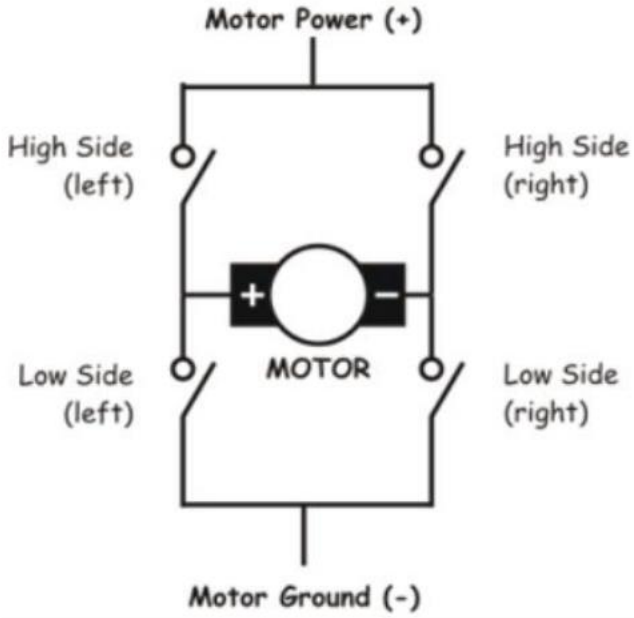
This circuit is known as H-Bridge because it looks like" H" Working principle of H-Bridge. If switch (A1 and A2) are on and switch (B1 and B2) are off then motor rotates in clockwise direction.

Motor Driver

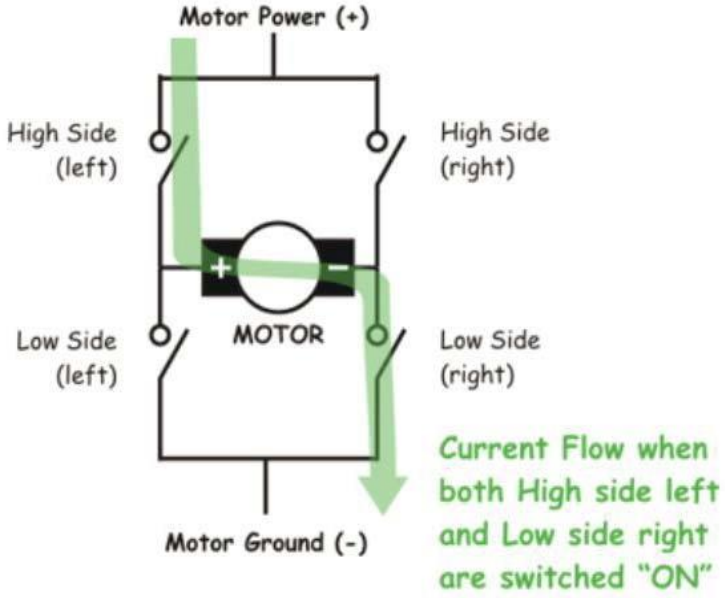
Whenever we are talking about driving a motor through the outputs of our microcontroller, it is not easy to do that work. This is so because our motors specification tells to drive it on 12v dc but our microcontroller can give a max of 5v. So to drive a motor we need some drivers which can amplify the 5v voltage to 12v. . These days many IC manufacturers have H-bridge motor driver available in the market like L293D is most used H-Bridge driver IC. H-bridge can also be made with the help of transistors and MOSFETs etc. rather of being cheap, they only increase the size of the design board, which is sometimes not required so using a small 16 pin IC is preferred for this purpose. The driver which we are using here to drive the motor is an IC L293D.

Working Theory

The name "H-Bridge" is derived from the actual shape of the switching circuit which controls the motion of the motor. It is also known as "Full Bridge". Basically there are four switching elements in the H-Bridge as shown in the figure below.



As you can see in the figure above there are four switching elements named as "High side left", "High side right", "Low side right", "Low side left". When these switches are turned on in pairs motor changes its direction accordingly. Like, if we switch on High side left and Low side right then motor rotate in forward direction, as current flows from P\power supply through the motor coil goes to ground via switch low side right. This is shown in the figure below.



Similarly, when you switch on low side left and high side right, the current flows in opposite direction and motor rotates in backward direction. This is the basic working of H-Bridge. We can also make a small truth table according to the switching of H-Bridge explained above.

Advantages

There are several benefits that solar energy has and which make it favourable for many uses.

- Solar energy is a clean and renewable energy source.
- Once a solar panel is installed, the energy is produced at reduced costs.
- It is pollution free.
- Solar cells are free of any noise. On the other hand, various machines used for pumping oil or for power generation are noisy.
- Once solar cells have been installed and running, minimal maintenance is required.
- On average, it is possible to have a high return on investment because of the free energy solar panels produce.
- Solar energy can be used in very remote areas where extension of the electricity power grid is costly.

Application

Due to the low cost and huge efficiency there are many fields of application

- Refineries
- Domestic use
- Commercial buildings
- Bill boards
- Traffic signals
- Street light
- Space Research

Future Scope

To see in future scope, this project may become useful for all those off-grid areas where the solar panels are the only source to illuminate their homes by generating maximum output in the form of electricity. Because u see, till now in India many areas are rural and undeveloped so that there will be no electricity reach yet. So after develop this project in low cost all category of people in also rural village areas they also use it in their rooftops so that they can get electricity easily.

For further improvements, we may increase the number of panels to be rotated at a time, so that in future we might use more than one panel for tracking by joining several panels together. Moreover, another opportunity in the tracking system is that solar panels use batteries to store the generated power and if, we could use this charged battery for the extra power needed for tracking purpose, there will be reduction in cost of operation of tracking system.

Figure 5.1 Rooftop Solar Panel

In this picture, the project will be invented in all rooftop of the houses so that it will directly absorb the solar energy from the sun and whatever we use, after the energy will save. In the system it will use the weather sensor so that when he weather is in bad condition or the solar energy IS not enough to use then we can use from the storage solar energy.

Conclusions

We know that the dual axis tracking system is more efficient and adds more power to the solar panel than a single axis system. Also we can say and shown with design and experiments that the dual axis solar tracking systems can be developed easily and performs better than fixed mount systems.

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