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DUAL AXIS SOLAR TRACKING SYSTEM

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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. Our project 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. A working system will ultimately be demonstrated to validate the design. Problems and possible improvements will also be presented .Sustainable energy systems are necessary for the economic growth and a healthy environment. To overcome the issues about lack of energy sources the use of renewable energy resources needs to be enhanced manifold. The main purpose of this paper is to present a control system which will cause better alignment of Photo voltaic (PV) array with sun light and to harvest solar power. The proposed system changes its direction in two axis to trace the coordinate of sunlight by detecting change in light intensity through light sensors. Hardware testing of the proposed system is done for checking the system ability to track and follow the sunlight in an efficient way. Dual axis solar tracking system superiority over single axis solar tracking and fixed PV system is also presented.

INTRODUCTION

Solar power is one of the most popular energy sources that available and can be converted into electricity by using solar panels. For solar panels to produce maximum output power, the incidence angle of the sunlight needs to be constantly perpendicular to the solar panel. However, most of the solar panels that used by the users in nowadays are in static direction. As the sun's position changes, low output power will be generated. In this paper, a two axis solar tracking system was proposed to keeps the solar panel perpendicular to sunlight by using two DC motors.

Why we need to harvest the solar power? Because, 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.

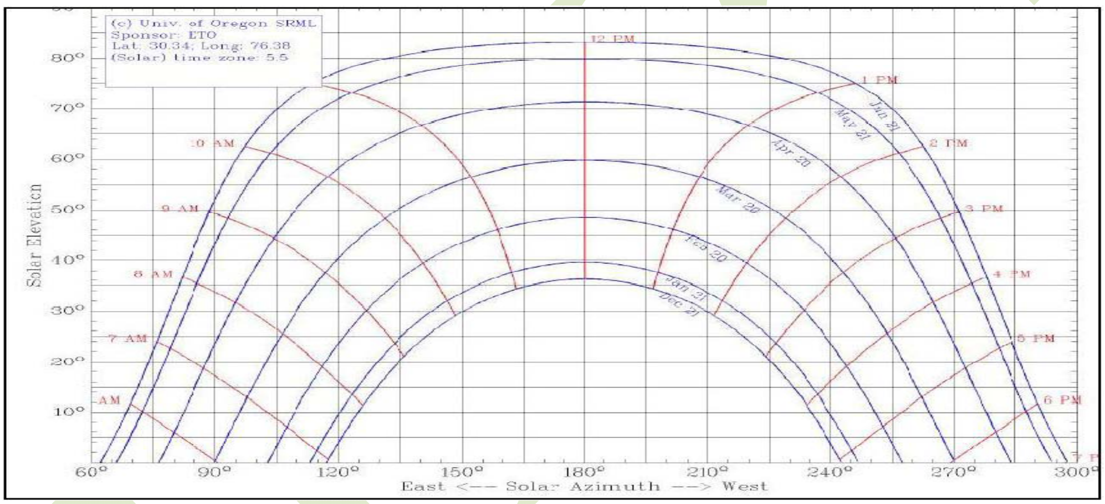

Figure 1: Sun path at latitude of 31^0

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 -90o after sun rise and +90o before sun set passing with 0o 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. 1.1 shows the yearly sun path at the latitude of30o. From the figure 1.1, one can estimate the exact position of sun in every month and at any time during the day.

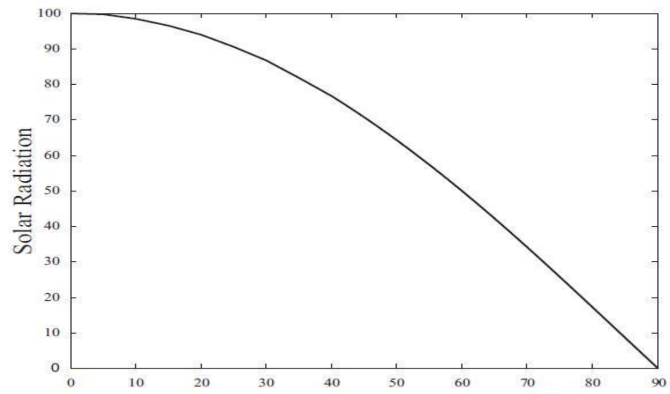

Figure 2: Solar angle of incidence

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 00 which means that the panel is perpendicular to the sun.

SOLAR POWER IN INDIA

In July 2009, India unveiled a US$19 billion plan to produce 20 GW (20,000MW) of solar power by 2020. Under the plan, the use of solar-powered equipment and applications would be made compulsory in all government buildings, as well as hospitals and hotels. On November 18, 2009, it was reported that India was ready to launch its National Solar Mission under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013.

INDIA'S LARGEST PHOTOVOLTAIC (PV) POWER PLANTS

1. Reliance Power Pokaran Solar PV Plant, Rajasthan, 40MW 02011-06 June 2011 Commissioning in March 2012

2. AdaniBitta Solar Plant, Gujarat, 40MW 02011-06 June 2011 to be Completed December 2011

3. Moser Baer - Patan, Gujarat,30MW 02011-06 June 2011 Commissioned July 2011

4. Azure Power - Sabarkantha, Gujarat, 10MW 02011-06 June 2011 Commissioned June 2011

5. Green Infra Solar Energy Limited - Rajkot, Gujarat, 10M W 02011-11-29 November 29, 2 011 Commissioned November 2011

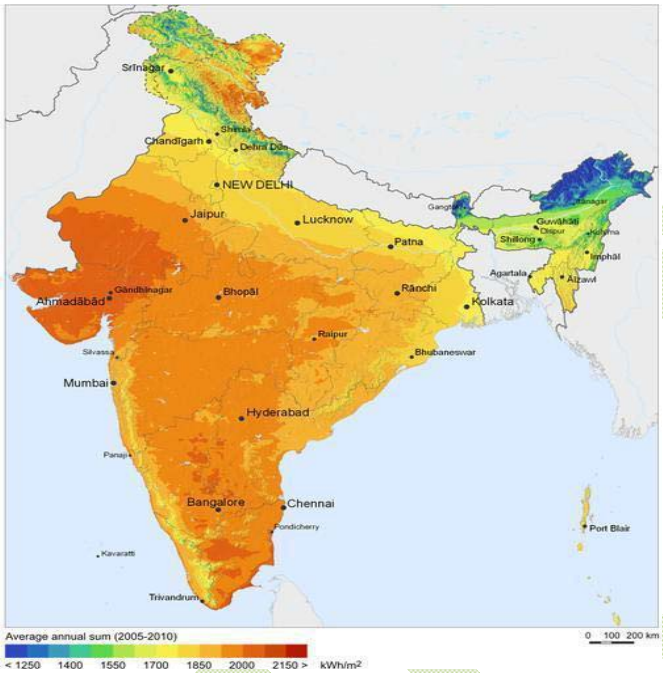

Figure 3: Tthe average solar radiations receiver by different regions in India.

EXPERIMENTAL SETUP

The proposed tracking system does tracking of sunlight more effectively by providing PV panel rotation in two different axis. In dual-axis tracking system optimum power is achieved by tracking the sun in four directions. In this way we can capture more sun rays. Movement in two axis is explained with the help of figure which is explaining basic idea behind dual axis tracking.

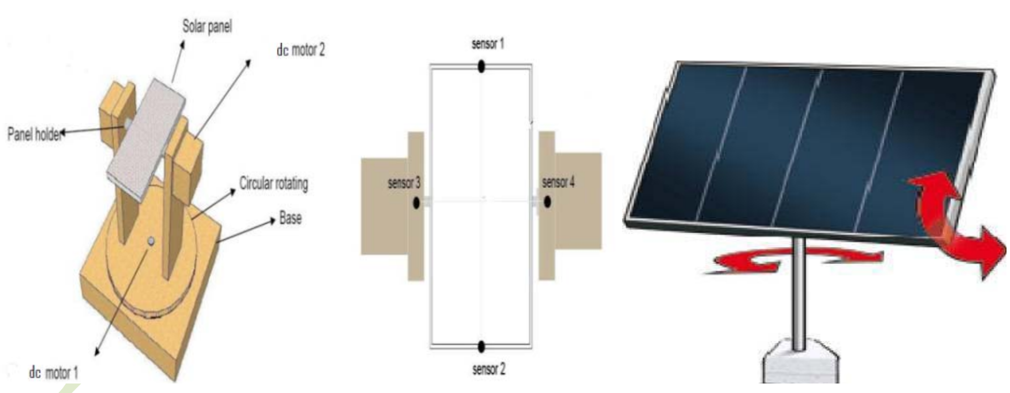

Figure 4: Proposed Model for Dual Axis Tracker

The dual-axis solar tracker follows the angular height Position of the sun in the sky in addition to following the sun's east-west movement [12]. The dual-axis working is similar to single axis but it captures the solar energy more effectively by rotating in the horizontal as well as the vertical axis. The proposed model for dual axis tracker is shown in figure 3. The tracker model is composed of four LDR sensors, two stepper motors and PIC microcontroller. One set of sensors and one motor is used to tilt the tracker in sun's east – west direction and the other set of sensors and the other motor which is fixed at the bottom of the tracker is used to tilt the tracker in the sun's north-south direction.

BLOCK DIAGRAM

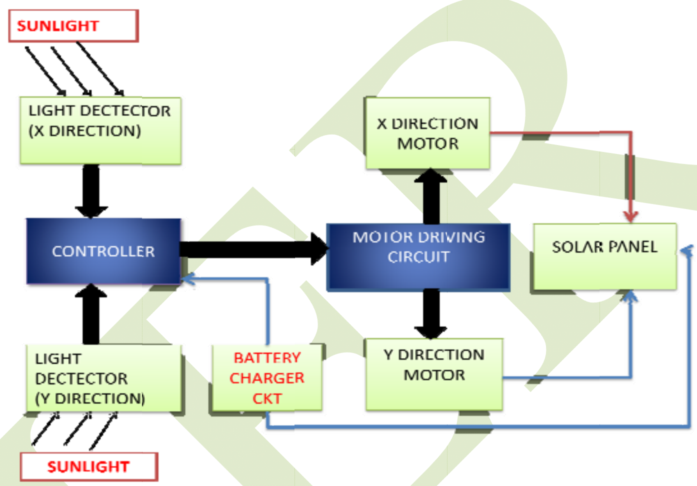

Figure 5: Block diagram

The DC motors are basically performing function of sun tracking. Upper panel holder DC motor tracks the sun linearly and base stepper motor tracks the parabolic displacement of sun. These DC motors and sensors are interfaced with a microcontroller which is controlling DC motors on the basis of sensor's input. LDR sensors sense the light and sends signal to microcontroller. Microcontroller is doing comparison of signals received from LDR sensors and on the basis of stronger signal it is deciding rotation direction of DC motors. Dual Axis tracker control is explained with the help of block diagram shown in figure 4. The bock diagram is showing that LDR sensors after sensing the light forward the signal to Microcontroller. Microcontroller is intelligent device which is taking actions on the basis of sensor input and activating the motor driver's circuit accordingly.

Now suppose if sun changes it location and moves from east to west, it will cause light intensity to be different on one sensor as compared to other one. On the basis of light intensity difference on sensors, controller activates driver circuits and moves DC motors to new positions where light falling on sensor pairs is same. The same process will keep on with change in sun's location in the sky. As a result this proposed model is able to capture more sun rays and system's solar energy conversion capability is greatly enhanced.

ALGORITHM

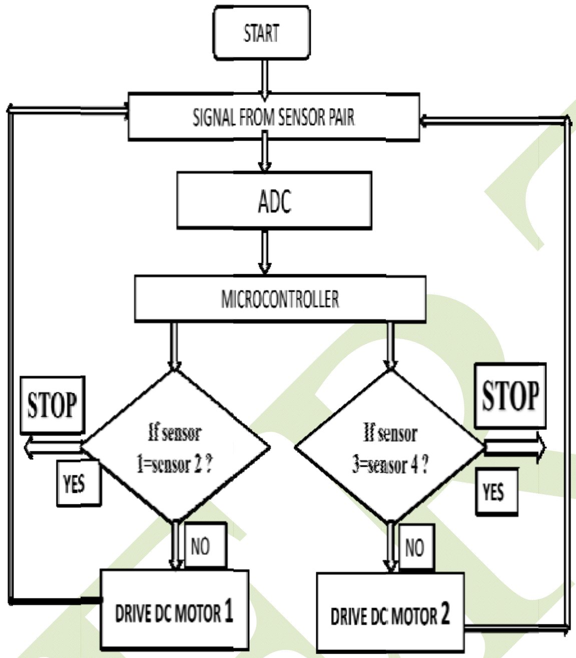

Figure 6: Algorithm

Algorithm starts with taking data from sensors. Sensors output is analogue which is converted to digital signals. This task is performed using analogue to digital converter (ADC). Digitized signals are forwarded to microcontroller. After collecting digitized signals, it decides about the movement direction of DC motors. Controller algorithm is showing that microcontroller drives DC motors only if sensor light sensing is not equal to each other and if sensor signals are equal. It goes to start of algorithm.This process is repeated until light falling on sensor pairs is equal and PV panel is adjusted in a position for optimum power.In addition, to save the generated power the motor is going to be stopped at the time of night when there is no any light intensity fall on the photovoltaic.

HARDWARE IMPLEMENTATION

In previous section details of control algorithm and block diagram of proposed dual axis were described. Now we come to the hardware implementation of the proposed model. We have implemented the proposed system practically and final hardware model is shown in Figure 6. Details of PV Panel ratings, LDR sensors and motor ratings for our hardware design are enlisted in Table I.

Figure 7: Final Hardware Design

For supporting of the hardware we devised a support model which is shown in figure. This support model is of 2 feet height. For better control of tracker elevation of panel can be increased and it must be installed in open air environment. PV panel used for hardware implementation is of 35 watt and it is of mono crystalline type. Two stepper motors of permanent magnet types are used. Stepper motor moves in steps and is best suited for accurate position control. PIC Microcontroller is used for controlling purpose which is easier to use as compared to microcontroller ATMEL family.

Table I: Components Ratings

Component Name	Component Ratings
PV Panel Dimension	16×16 inches square
PV Panel Rating	35 Watts
Motor Rating	6v, O.6 A Permanent Magnet stepper motors
Controller	AT89S52
LDR	GM 9516

TESTING METHOD

After completion of hardware of project there is need to perform test on it to know about his efficienc To check whether the system tracks the sun's position accurately, we had keep the solar tracking system in open space where sunshine available throughout the day easily and taking the readings of power generated hourly. This test is carried out separately on three tracking systems i.e. flat plate, single axis and dual axis per day respectively. After observing the readings we have conclude that the proposed system is more efficient than other.

TESTING RESULT

Time	Flat plate (power in watt)	Single axis (power in watt)	Dual axis (power in watt)
8:00	0.0061	0.00375	0.07
9:00	0.065	0.045	1.58
10:00	1.25	1.61	2.5
11:00	1.64	1.78	2.66
12:00	1.59	1.6	2.76
1:00	1.68	2.22	2.84
2:00	1.31	1.45	2.4
3:00	1.39	1.43	2.22
4:00	0.65	1.55	2.14
5:00	0.06	0.67	1.96
6:00	0.05	0.07	0.58
Total Power(watt)	9.6911	12.2875	21.71

CONCLUSION

Dual axis tracker perfectly aligns with the sun direction and tracks the sun movement in a more efficient way and has a tremendous performance improvement. The experimental results clearly show that dual axis tracking is superior to single axis tracking and fixed module systems. Power Captured by dual axis solar tracker is high during the whole observation time period and it maximizes the conversion of solar irradiance into electrical energy output. The proposed system is cost effective also as a little modification in single axis tracker provided prominent power rise in the system. 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.

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