SINGLE AXIS SOLAR TRACKER SYSTEM USING ARDUINO

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ABSTRACT
The energy demand of country is increases with respect to the growth and development. Along with this energy generation should be eco-friendly and from the renewable energy sources. Solar energy plays an important role as a primary source of energy, especially for rural area. This project aims at the development and explain the process of track the sun and attain maximum efficiency using Arduino Uno for real time monitoring. There are different methods for tracking system but this paper focuses on single axis solar tracker as it has advantages of simple design, easy to operate, less cost, less maintenance and good efficiency. This system consists of three subsystem 1) mechanical system-platform for tracking system 2) electrical system- PV system, stepper motor 3) control system-Arduino, LDR, motor drive. The performance of the system has been tested and compared with static solar panel. This project describes the design of a low cost, solar tracking system.

KEYWORDS: LDR, Arduino, DC motor, Gearbox mechanism, Photovoltaic (PV) panel, Solar tracker.

INTRODUCTION

We all knows that how electricity is playing vital role in our day-to-day life. Everyone is dependent on electricity. All the production houses, industries, research centre, etc. requires electricity to fulfil our needs and for development purpose. But in today's life the use of electricity is one of the essential. There are many sources to produce electricity but it is very important that the sources we are using are environmentally clean and doesn't cause any pollution. So, we have an abundant and inexhaustible source of energy which is most useful for generation of electricity and we call it as Solar Energy. Solar energy is free of cost and almost available in every part of the world. We have solar energy then why we are using fossil fuels. This fuel tends to very harsh impact on not only the environment but on human being also regarding respiratory diseases. Therefore, many researchers are working on photovoltaic system and how the efficiency can be improved. By using fix solar panels electricity can be produced but as we know the that the position of earth is not fix at every time hence fix panels cannot grasp the solar rays at every point in day time. In most of things we are using in day-to-day life there is existence of sun. the water we drink, the food we eat all are obtained from sun only. Plant uses sunlight to produce oxygen as well as food also for themselves and for us. Solar tracker is also already in nature in the form of flower named as Sunflower. As sunflower moves according to the direction of sun. Therefore, to overcome this problem solar tracking system is required to move the panel according to the position of rays facing to panels. As sun rises at east and sets at west so solar panels will move themselves accordingly and gives maximum output for day than fix solar panels.

MATERIALS AND METHODS

Materials

1. Arduino Uno + USB Cable
2. Arduino Sensor Shield
3. 2 x 9g Metal Gear Servos
4. 1 x 5 Port Terminal Block
5. 1 x 4 Port Terminal Block (or 3 port will do)
6. 4 x 10K Ohm Resistors
7. 4 x Light Detecting Resistors
8. 4 x JST Socket Connector Cables
9. Jumper Wires
10. 5.5V Solar Cell
11. LED Volt Mete

LITERATURE SURVEY

Photovoltaic Education Network [1] focuses in this paper that getting the maximum power from solar panel is the main goal of increasing the efficiency. The project is nothing but the implementation and simple design with affordable price for single axis solar tracker. There is a comparison of solar tracker with fixed solar panel so we can get a proper table

showing the difference, how solar trackers are giving more output than fixed one. The whole project is mainly composed of light dependent resistor, solar panel, DC motor, dish and ball joint, sensor module and electronic circuit. Hardware and Electronics are the two parts of the project. In hardware there is presence of solar panel, DC motor with gearbox mechanism and LDR sensor module. In electronic part there is presence of one commanding device like Arduino, raspberry-pie, microcontroller, etc. Solar irradiance is the most important part for proper extraction of solar energy from solar collector or photovoltaic (PV). Solar collector should always place normal with respect to incident radiation for maximum extraction of energy from sun. To follow the sun path, solar collector moves accordingly with the help of solar tracker. Due to this the solar collector keeps the orientation at an optimal tilt angle. In this project position of the sun has sensed in two phases in first phase the LDR sense the solar light and moves accordingly. In second phase if there is presence of dusty or cloudy whether then tracking system stops the movement and stays in the position. The energy efficiency of photovoltaic panel is improved by solar tracking system. Solar tracking system is more efficient and reliable than fixed solar panel.

O.V. Singh et.al [2] in their research paper elucidates that due to improved performance of solar panels the design requirement of tracking system is increasing day by day. In the period of morning and evening solar collector extract the solar rays at an acute angle. In case of fixed solar panel, the energy output is less as sun rays will move continuously. Hence, to improve the work of solar collector there is need to enhance the mean radiation intensity and solar tracking system is most commonly used for it. This paper is having two parts first one is pseudo code development and second one is hardware. In this proposed work two signals from two sensors are matched. LDR (Light dependent resistor) has been utilized as a light sensor. The sensors are divided by separator. If solar collector is not normal to sun, then there will be shadow on single side of LDR. For supervising the rotation of motor through relay Arduino works as a great operator. Arduino handles the data received by LDR. Arduino works as a sending and operating device which sends the data input from LDR to DC motor through relay for the confirmation of the solar panel is normal to side of sun.

Ashok Kumar Saxena et. al. [3] in their research paper explained about the solar tracking controller design and parameter monitoring. Paper is focusing on the solar tracking design and controller capacity to receive photovoltaic and meteorological data. To control tracking system and data monitoring microcontroller is used as an electronic controller. In Design section, their focused on the fully automatic and simple to operate system. For this, they provide 4 pwm signal to stepper motor and program required to operate system is stored in EPROM. For tracking they had implemented both open and close loop strategies and system also monitor parameter Isc, Voc, Pm etc for load and batter management. Close loop strategy is used to tracking solar panel from home position to maximum position and again back to home position and open loop strategy is used to monitoring data.

Yasser M. Safan et. al. [4] in their research paper explained about the different types of solar tracking system and mainly focused on the maximum output power of the panel during the day with the minimum required driving energy. It uses PID controller to track the Sun rays. This design or system also focus on the maintaining a maximum possible solar radiation incident normal to the solar panel due to which output power generation increases. There are different types of tracking system mentioned according to number of axis or based on degrees of freedom and movement capability for example: single axis solar tracker, dual axis solar tracker another classification is active solar tracker, passive solar tracker and hybrid solar tracker. In this paper, design of hybrid solar tracker is explained. For which both open loop and close loop strategies are used. Sun sensor tracking errors are comes in open loop strategy. To feedback sun position and proper alignment data of axis close loop strategy is used. There are three main subsystems explain for construction 1) mechanical system- Aluminium solar tracker structure. 2) Electrical system- PV system, two stepper motor 3) control system- microcontroller, motor drive and sensor.

Mohamed I. Abu El-Sebah [5] in their paper explains about photovoltaic (PV) systems and how to improve their efficiency has been discussed. The main input to photovoltaic systems is the solar radiation, which cannot be manipulated and has a variable intensity based on daily and seasonal variations. To manipulate these perturbations, a solar tracking system could be used. The solar tracking system improves the photovoltaic system output power by maintaining a maximum possible incident solar radiation normal to the PV panels. The main problem in sun tracking process is that it may lead to less efficient system due to the high-power consumption in driving the tracking system. There are mainly two types of solar trackers based on degrees of freedom and movement capability; single-axis solar tracker and dual-axis solar tracker. Another classification as an active solar tracker and passive solar tracker based on the tracking technology and drive type also exists. Active solar trackers may be classified according to their control type into open-loop controlled, closed loop-controlled, and hybrid controlled solar trackers.

S. Gupta et.al. [6] in their paper elucidates that as shortage of energy resources aims the scientists to utilize the solar energy generating the electric power, they found that photovoltaic cell is the generating unit of electricity that would be studied to maximize the output power and its system can be developed. Performance of solar photovoltaic cell is

associated with its material, size, ray's intensity and atmospheric conditions. The voltage-current curve at various incident radiation (measures along the day time) when a resistive load is connected to the solar cell. They recorded the readings of curve at mid-day time when the incident radiation energy consumption around the world. They conclude that the current amount generated by a solar cell depends on its efficiency, its size (surface area) and the intensity of sunlight striking the surface. Literature review includes several methods and techniques reported for maximum power point tracking (MPPT) until 2007 replaced by fixed solar systems. All researches aim to maximize the gain output power from solar system to keep sun rays perpendicular on the solar panel along the day time. Comparison between them is investigated which interested system costing, fasting technique and most efficient techniques connected dc converters.

Ayushi Nitin Ingole et.al. [7] in their research paper focuses the importance of using solar energy. The demand of electrical energy is increasing year by year due to globalization. The increase in demand of electricity gives an impact on the loss of main resources available to produce electrical energy. Human beings have explored more ways and technologies for the production of electrical energy using the renewable energy resources. The energy which is generated using natural resources which are freely available in nature is called as renewable energy. Solar energy is the most suitable among all. Because it is available abundant in nature free of cost. So, it makes sense to use solar energy for generating electricity. Also, solar energy is environment friendly since it does not create any pollution like fossil fuels. Solar energy is available in the form of solar radiations. Solar radiations from the sun is absorbed by the solar panels and converted into DC electric energy. Solar energy has a great potential for conversion into electrical energy in Malaysia because it has very high solar radiation levels.

Deepthi S. et. al. [8]in their research paper mentioned about the types of single axis tracking systems. A Single axis tracking system is an ideology of continuously rotating the solar panel towards the sun's direction from east to west, by continuously tracking the sun's position throughout the day. There are three types of single axis tracking system: Horizontal single axis tracking system, Vertical single axis tracking system and Tilted single axis tracking system. In the Horizontal system the axis of rotation is kept horizontal with respect to the ground, and the face of the module is kept parallel to the axis of rotation. In the Vertical system the axis of rotation is kept vertical with respect to the ground and the face of the module is kept at an angle with respect to the axis of rotation. In the Tilted tracking system, the axes of rotation are kept between horizontal and vertical axes and the face of the module is kept parallel to the axis of rotation, similar to the Horizontal tracking system. The single axis tracking system consist of two LDR's. One LDR is placed on the east side of the solar panel and the other one is placed on the west side of the solar panel. Depending on the intensity variation of the sun rays falling on both the LDRs, the panel is rotated. As the day progresses, the intensity falling on the west side LDR increases and the controller rotates the solar panel towards west direction.

METHODOLOGY

The single axis solar tracking system rotates from east to west keeping the face of the solar panel towards the sun throughout the day. This is achieved using two LDRs and a servo motor interfaced with Arduino. Servo motor is coupled to the panel through an axle. One LDR is placed at the east side of the panel and the other one is placed at west side. LDR is an active sensor which senses light intensity and its resistance increases with increase in the intensity of light. LDRs acts as input, sensing the intensity of the sun. As the intensity falling on the west side LDR increases than the east side LDR (as the day progresses, the sun will be rotating towards west), the servomotor will rotate the panel towards west direction. An assembly language is utilized and saved into Arduino to achieve the rotation as stated earlier. The software part of the system can be split into two parts. The first part is initial positioning. Prior to powering up the system, the panel must be set towards the east, after the sunset and before the next sunrise. The second part deals with the actual movement of the panel, this is the heart of the program. Once the initial position of the panel is set, it is ready to align itself more preciously by continuously tracking the sunlight intensity. The compiled program controls the whole hardware operation.

RESULTS AND DISCUSSION

Sr. No	Time	Fixed Panel			Tacker		
		V	I	P	V	I	P
1	9.00	5.5	0.05	0.275	6.3	0.07	0.44
2	11.00	6.34	0.07	0.114	7.1	0.2	1.42
3	12.00	7.8	0.22	1.716	8.0	0.24	1.93
4	14.00	7.03	0.09	0.633	7.5	0.12	0.9
5	16.00	6.56	0.08	0.558	7.5	0.1	0.75
6	18.00	5.2	0.05	0.25	6.8	0.09	0.61
Total Power				3.875			5.144

FORMULAE

$$\text{Percentage increase} = \frac{5.144-3.875}{5.144} \times 100$$

$$=24.67\%$$

Hence, percentage increase in output of solar tracker with respect to fixed panel is 24.67 % per day.

CONCLUSION

Single Axis Solar Tracker tracks the solar rays more than the fixed solar panel. Generally, up to 20% extra power can be produced per annum using a variable elevation solar tracker investigated the effect of one-axis east-west tracking on solar radiation received by a PV panel compared to fixed installation. To get maximum power at output system is able to track and follow the sun intensity. Besides this, low speed DC geared motor has been used for neglecting motor speed parameter hence the system focuses only tracking of sun intensity.

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The authors wish to acknowledge the use of references of different papers which are included in reference column.

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