DUAL AXIS SOLAR TRACKING SYSTEM

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ABSTRACT

The goal of this project work is to develop a laboratory prototype of a solar tracking system, which is able to enhance the performance of the photovoltaic modules in a solar energy system. The operating principle of the device is to keep the photovoltaic modules constantly aligned with the sun beams, which maximizes the exposure of solar panel to the Sun's radiation. As a result, more output power can be produced by the solar panel. The work of the project included hardware design and implementation, together with software programming for the microcontroller unit of the solar tracker.

The system utilized an ATmega328P microcontroller to control motion of two servo motors, which rotate solar panel in dual axis. The amount of rotation was determined by the microcontroller, based on inputs retrieved from LDR sensors located next to solar panel. At the end of the project, a functional solar tracking system was designed and implemented. It was able to keep the solar panel aligned with the sun, or any light source repetitively. Design of the solar tracker from this project is also are reference and a starting point for the development of more advanced systems in the future.

Keywords: solar tracking, dual axis, solar panel, microcontroller, LDR sensor

INTRODUCTION

In this project a dual axis solar tracking system has been developed by which more energy from the sun can be harnessed. In this project, an Arduino Uno, which is an Atmel microcontroller based board, has been used as the main controlling unit. To detect the position of the sun on the sky, two LDRs have been used and to rotate the orientation of the Solar PV panel a servo motor has been used. The sensors and servo motor have properly been interfaced with the Arduino board. The servo motor has been mechanically coupled with the PV panel. The driving program has been written using the Arduino IDE. The whole system has been assembled together and its performance has been tested. This tracker changes the direction of the solar panel based on the direction of the sun facing to the panel successfully. Single axis solar tracker tracks the sun on daily basis and makes the solar panel more efficient. Solar energy is an unlimited source of energy which if harnessed properly will get the mankind devoid of using the conventional sources of energy he has been long using. This project has been designed keeping this in view to make the harnessing of solar energy more efficient. The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent and reliable, with very low maintenance costs and minimal ecological impact. A photovoltaic panel is a device used to capture the suns radiation. These panels consist of an array of solar cells. The solar cells are made up of silicon (sand). They are then connected to complete a photovoltaic (solar) panel. When the sun rays are incident on the solar cells, due to the photovoltaic effect, light energy from the sun is used to convert it to electrical energy. We know that most of the energy gets absorbed, when the panels surface is perpendicular to the sun. Stationary mounted PV (photo voltaic) panels are only perpendicular to sun once a day but the challenge for is to get maximum energy from the source, so for it we use trackers on which the whole system is mounted. In tracking system, solar panels move according to the movement of sun throughout the day.

Tracker systems follow the sun throughout the day to maximize energy output. The Solar Tracker is a proven single-axis tracking technology that has been custom designed to integrate with solar modules and reduce system costs. The Solar Tracker generates up to 25% more energy than fixed mounting systems and provides a bankable energy production profile preferred by utilities.

To track the sun in two directions that is elevation and azimuth, a dual-axis tracking prototype is developed to capture the maximum sun rays by tracking the movement of the sun in four different directions. One axis is azimuth which allows the solar panel to move left and right. Our tracker is a dual axis tracker, meaning it tracks in both X and Y. To put it into even more simple terms, it goes left, right, up, and down. This means once you have your tracker set up you will never need to change or adjust anything, since anywhere the sun moves your tracker will follow. This also impresses people at parties because you can have it track a flashlight around. This method gives the best results for power generation. A Solar tracker is an automated solar panel which actually follows the sun to get maximum power. The primary benefit of a tracking system is to collect solar energy for the longest period of the day, and with the most accurate alignment as the Sun's position shifts with the seasons. Dual Axis Tracker has two different degrees through which they use as axis of rotation. The dual axis is usually at a normal of each rotate both east to west and north to south. Solar tracking is the most appropriate technology to enhance the electricity production of a PV system. To achieve a high degree of tracking accuracy, several approaches have been widely investigated. Generally, they can be classified as either open-loop tracking types based on solar movement mathematical models or closed-loop tracking types using sensor-based feedback controllers. In the open-loop tracking approach, a tracking formula or control algorithm is used. the azimuth and the elevation angles of the Sun were determined by solar movement models or algorithms at the given date, time and geographical information. The control algorithms were executed in a microprocessor controller. In the closed-loop tracking approach, various active sensor devices, such as charge couple devices (CCDs) or light dependent resistors (LDRs) were utilized to sense the Sun's position a feedback error signal has the generated to the control system to continuously receive the maximum solar radiation on the PV panel. This paper proposes an empirical research approach on this issue. Solar tracking approaches can be implemented by using single-axis schemes, and dual-axis structures for higher accuracy systems. In general, the single-axis tracker with one degree of freedom follows the Sun follows the movement from the east to west during a day while a dual-axis tracker also follows the elevation angle of the Sun. In recent years, there has been a growing volume of research concerned with dual-axis solar tracking systems. However, in the existing research, most of them used two stepper motors or two DC motors to perform dual-axis solar tracking. With two tracking motors designs, two motors were mounted on perpendicular axes, and even aligned them in certain directions. In some cases, both motors could not move at the same time. Furthermore, such systems always involve complex tracking strategies using microprocessor chips as a control platform. In this work, employing a dual-axis with only single tracking motor, an attempt has been made to develop and implement a simple and efficient control scheme. The two axes of the Sun tracker were allowed to move simultaneously within their respective ranges. Utilizing conventional electronic circuits, no programming or computer interface was needed. Moreover, the proposed system used a stand-alone PV inverter to drive motor and provide power supply. The system was self-contained and autonomous. Experiment results have demonstrated the feasibility of the tracking PV system and verified the advantages of the proposed control implementation.

There are three methods of tracking:

1. Active tracking system: - The position of the sun is determined by the sensors. These sensors will trigger the motor to move the mounting system so that the panels will always face the sun rays perpendicular to it

throughout the day. But in this system, it is very difficult for sensors to determine the position of sun in cloudy days. So, it is not a very accurate.

2. Passive tracking systems: - The position of the sun by moving the panels in response to an imbalance pressure between the two points at both ends of the trackers. The imbalance pressure caused by solar heat creates a gas pressure on a low boiling point compressed gas fluid that is driven to one side or the other accordingly, which then moves the system. This method is also not accurate as the shade /reflectors that are used to reflect early morning sunlight to "wake up" the panel and tilt it towards the sun can take nearly an hour to do so.

3. Chronological system: - A chronological tracker is a timer-based tracking system whereby the structure is moved at a fixed rate throughout the day. The theory behind this is that the sun moves across the sky at a fixed rate. Thus, the motor or actuator is programmed to continuously rotate at a slow average rate of one revolution per day (15 degrees per hour). This method of sun-tracking is very accurate. However, the continuous rotation of the motor or actuator means more power consumption and tracking the sun. In manual tracking system, drives are replaced by operators who adjust the trackers. This has the benefits of robustness having staff available for maintenance and creating employment for the population in the vicinity of the site.

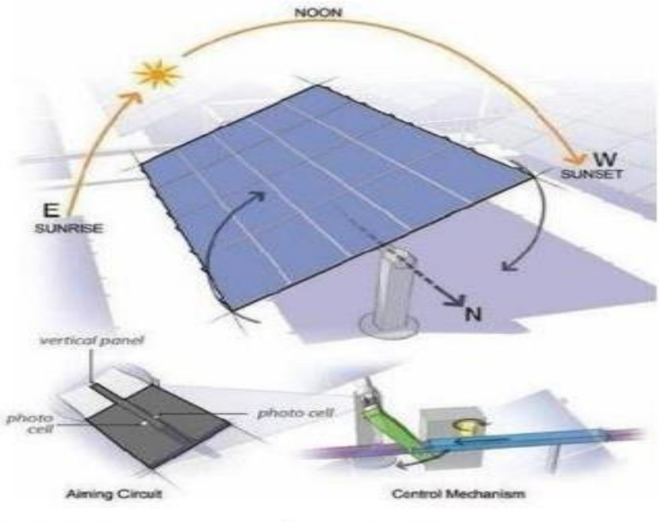
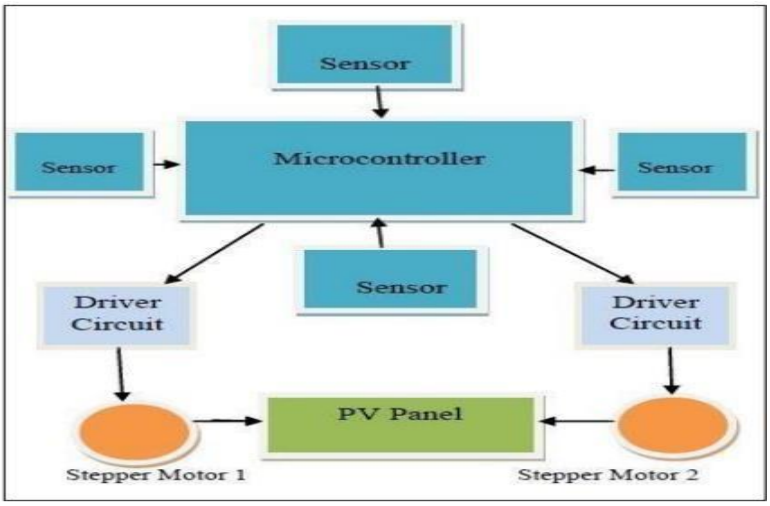


Fig1: Movement of panel with respect to sun.

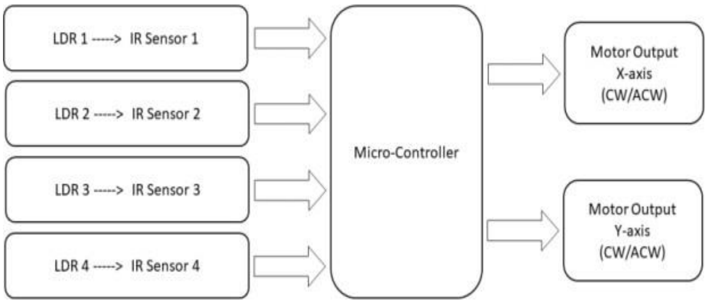
BLOCK DIAGRAM



WORKING PRINCIPLE

The project is built using a balanced concept which is four signals from the different sensors are compared. Light Dependent Resistor (LDR) as a light sensor has been used. The four light sensors are separated by divider which will create shadow on one side of the light sensor if the solar panel is not perpendicular to the sun. The Arduino microcontroller will take continuous readings of LDR and control the motors accordingly by sending signals to motor driver. Motor driver IC(L298n) controls the rotation of the motor either to rotate clockwise or anticlockwise depending on the signal from Arduino microcontroller. The solar panel that attached to the motors will be reacted according to the direction of the motors.

The basic working of the system is shown below in the diagram:



ARDUINO PROGRAM WORKING

- If all four LDRs are HIGH: Do not send any signal to motors, system is receiving maximum sunlight.
- If both LDRs of RIGHT are HIGH: Rotate the system to the right to receive maximum sunlight.
- If both LDRs of LEFT are HIGH: Rotate the system to the left to receive maximum sunlight.
- If both LDRs of TOP are HIGH: Rotate the system so that the solar panel rotates upwards to receive maximum sunlight.
- If both LDRs of BOTTOM are HIGH: Rotate the system so that the solar panel rotates downwards to receive maximum sunlight.
- If TOP-LEFT LDR is HIGH: Rotate the system to the left and upwards using both motors simultaneously to receive maximum sunlight.
- If BOTTOM-LEFT LDR is HIGH: Rotate the system to the left and downwards using both motors simultaneously to receive maximum sunlight.
- If TOP-RIGHT LDR is HIGH: Rotate the system to the right and upwards using both motors simultaneously to receive maximum sunlight.
- If BOTTOM-RIGHT LDR is HIGH: Rotate the system to the right and downwards using both motors simultaneously to receive maximum sunlight.
- Else do not send any signal to the motor driver.

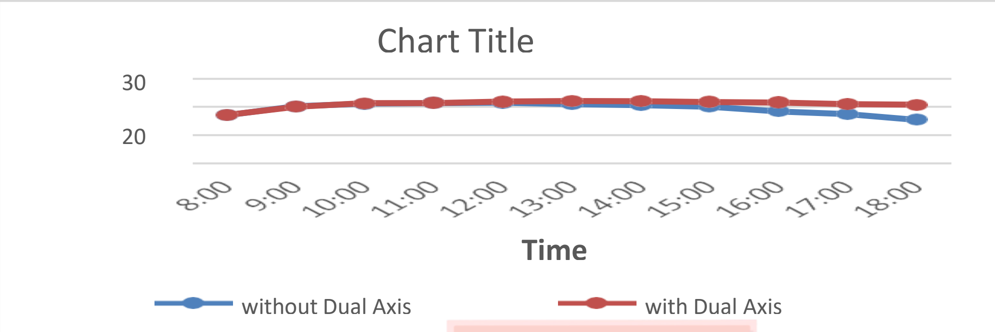
The system will receive maximum sunlight based on the above conditions. This will make solar power generation most efficient throughout the year.

RESULT

HOUR	VOLTAGE FORFIXED MOUNT	VOLTAGE FOR DUAL AXIS
00:08	17.14 V	17.20 V
00:09	20.22 V	20.15 V
00:10	21.14 V	21.35 V

00:11	21.40 V	21.48 V
00:12	21.54 V	21.90 V
00:13	21.11 V	22.05 V
00:14	20.65 V	22.08 V
00:15	20.15 V	21.85 V
00:16	18.46 V	21.58 V
00:17	17.54 V	21.05 V

GRAPHICAL REPRESENTATION



APPLICATIONS

- Solar Photovoltaic plants require continuous orientation towards sun for consistent efficiency output. This product will prove a great boon for them.
- Solar water heating applications can also implement the same technique to heat water throughout the day.
- Concentrated applications like concentrated photovoltaic panels require a high degree of accuracy to ensure the sunlight is directed precisely at the focal point of the reflector or lens.
- Non concentrating applications do not require tracking but using a tracker can improve the total power produced by the system. Photovoltaic systems using high efficiency panels with trackers can be very effective.

FUTURE SCOPES

- In future this Tilting mechanism with collector can be implemented on large solar plants and also can be operated automatically.
- We can make the work very easy with the help of electric tilting mechanism. We are working on the same to implementing automation for same mechanism with electric or mechanical actuators or components.
- This mechanism can be implemented on the Solar Cookers, Ovens, and Driers and on thermal solar heater.

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