NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF RESEARCH PUBLICATIONS IN ENGINEERING AND TECHNOLOGY [IJRPET]
VOLUME 1, ISSUE 1, 2015 WWW.IJRPET.ORG

DESIGN AND FABRICATION OF DUAL AXIS SOLAR TRACKER FOR MAXIMUM ENERGY HARVESTING

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Abstract: **Now-a-days we are using static solar panels but this system does not give maximum harvesting of solar energy. In this project, we are presenting the hardware design and implementation of Dual Axis Solar Tracking System that ensures a perpendicular profile of the solar panel with the sun in order to extract maximum energy falling on it. The LDRs do the job of sensing the change in the position of the sun which is dealt by the respective change in the solar panel's position by switching on and off the DC geared motor. With the implementation of the proposed system the additional energy generated is greater than conventional system with very less consumption by the system itself.**

Keywords: Photovoltaic (PV), Light Dependent Resistor (LDR), Dual Axis Solar Tracking System (DAST system).

I.INTRODUCTION

The solar panels are usually tilted at a fixed angle corresponding to the latitude of the location. Solar tracking can be further classified as - a) Single axis solar tracking (passive or active) and b) Dual axis solar tracking (only active).

A single-axis solar tracker follows the movement of the sun from east to west by rotating the structure along the vertical axis. Use of single-axis tracking can increase the percentage of sun rays incident by as much as 7 to 10 percent.

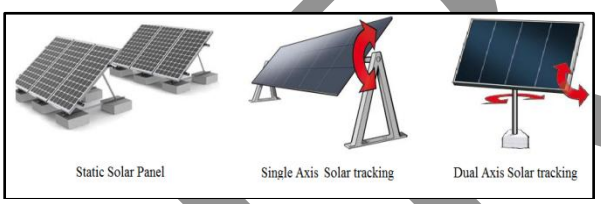


Fig. 1: Different types of solar systems

On the other hand, a dual-axis solar tracker follows the angular position (north-south) of the sun in the sky in addition to following the sun's east-west movement reports that, dual-axis tracking increases the percentage of sun rays incident by 15 to 20 percent.

Objective of Project: Objective of this project is - maximum harvesting of solar energy throughout the year for improving the efficiency of solar power plant. This is achieved by keeping the solar panel always perpendicular to the sun rays incident on it.Dual axis tracking system uses the solar panel to track the sun from east to west and north to south using two pivot points to rotate. The dual axis tracking system uses two LDR's, two motors and a controller.

Scope of Project: 1) By using solar energy as much as possible, use of fossil fuels can be reduced, which are exhausting rapidly.2) With the help of Dual axis solar tracking system, solar panel remains perpendicular to sun rays. So that maximum harvesting of solar energy is possible.

II. PROBLEM IDENTIFICATION

Drawbacks of Static Solar Panel

- Static solar panel does not remain perpendicular to the solar radiations all over the day. Maximum sun rays can be catched only if solar panel remains perpendicular to the sun rays falling on it. So, maximum harvesting of solar energy is not possible.
- Solar energy available on earth gets wasted due to use of static solar panel.
- As compared to DAST system, for generating same amount of electricity we need more number of solar panels which increases cost as well as area of installation.

Drawback of IR Sensors

- IR sensors are sensitive to inclement weather conditions and ambient light.
- They can be affected by humidity and weather.

III.HARDWARE DESCRIPTION

1) PCB Layout:

PCB Design: PCB is designed in PROTEL E 99 software. The PCB layout is a mirrored positive one black on white. Mirror is viewed from the silkscreen top (component) side. The PCB layout is printed 1:1 on paper by means of a laser printer or copier machine.

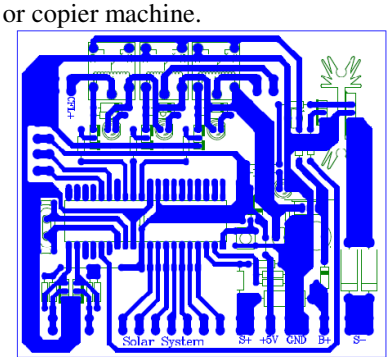


Fig.2: PCB Layout

2) Sensor: The sensors will trigger the motor to move the mounting system so that the solar panels will always face the sun. Some Improvements were made to the design of the sensor holder to make the sensor more sensitive. This was done by increasing the length of the sensor holder. For the front sensor, the sensor holder was redesigned to suit the angular movement of the sun so that shadow can be cast onto the LDR from any angular height of the sun in the sky.

LDR (Light dependent resistor)

- Resistance of LDR is inversely proportional to the intensity of incident light.
- Output voltage is also proportional to intensity of incident light.
- Depending upon the sun position intensity of light changes on both the LDR thus output voltage changes.

- The microcontroller sends signal to the motor to rotate the solar panel in such a manner that sensor will sense maximum sun rays.
- In this way the sun is tracked.

3) Solar Panel: It is a collection of array of semiconductor cell arranged in a specific manner to perform in an efficient manner. The effective collection area of a flat-panel solar collector varies with the cosine of the misalignment of the panel with the Sun.

Fig. 3: Solar Panel

4) Power Supply: In this project power supplies with 12V, normally +6V is enough for total circuit. Another supply is used in case of OP amp circuit. Voltage is rectified using two full wave rectifiers .The rectified output is given to a filter circuit to filter the unwanted ac in the signal. After that the output is again applied to a regulator LM7805 (to provide +5v) regulator. Whereas LM7805 (regulator IC) is for providing 5V regulation. Voltage regulator is used to convert 12 V into 5V. The AC voltage is converted to pulsated dc using a center tapped full wave rectifier. Any ripples if present are eliminated using a capacitive filter at the output of the full wave rectifier. The capacitive filter output is input to LM 7805(voltage regulator), which produces a dc equivalent of ac 5V. This 5V dc acts as VCC to the micro controller.

5) Inverter: A solar inverter or PV inverter, converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a frequency alternating (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary commercial appliances. Solar inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking.

6) Microcontroller PIC16F877A: Since the project's focus is on embedded software control, the microcontroller is the heart of the system. The microcontroller selected for this project had to be able to convert the analog photocell voltage into digital values and also provide four output channels to control motor rotation. The PIC16F877 was selected as it satisfies these requirements in addition to already being provided with the class lab kit. Specifically, it possesses the following three features to satisfy the specific project goals.

- 10 bit multi-channel analog-to-digital converter
- 5 input/output ports
- 256 x 8 bytes of data EEPROM memory

A 4 MHz crystal oscillator is also used in conjunction with the PIC16F877 to provide the necessary clock input. This speed is sufficient for the application.

7) LCD Display: The term liquid crystal is used to describe a substance in a state between liquid and solid but which exhibits the properties of both. Molecules in liquid crystals tend to arrange themselves until they all point in the same specific direction. This arrangement of molecules enables the medium to flow as a liquid. Depending on the temperature and particular nature of a substance, liquid crystals can exist in one of several distinct phases. Liquid crystals in a nematic phase, in which there is no spatial ordering of the molecules, for example, are used in LCD technology. One important feature of liquid crystals is the fact that an electrical current affects them. A particular sort of nematic liquid crystal, called twisted nematics (TN), is naturally twisted. Applying an electric current to these liquid crystals will untwist them to varying degrees, depending on the current's voltage.

Fig.4: LCD Display

8) DC Motor: The tracking systems would need to consist of two motors, which control the position of the array, and a control circuit (either analog or digital) to direct these motors. Geared DC motor can be defined as an extension of DC motor. A geared DC motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotation of shaft per minute and is as rpm. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. The concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This insight will explore all the minor and major details that make the gear head and hence the working of geared DC motor.

9) Battery: The battery is an essential component of almost all aircraft electrical systems. Batteries are used to start motors and auxiliary power units, to provide emergency backup power for essential equipment. Many of these functions are mission critical, so the performance and reliability of a battery is of considerable importance.

Circuit Description: The logic flow design of the system is implemented with an embedded processor control circuit. When the tracking control circuit is activated, the system performs tracking, energy conservation, and system protection, as well as system control and external anti-interference measures. The main goal of this project is to develop and implement a prototype of two-axis solar tracking system based on a microcontroller. This two axis auto tracking system has also been constructed using microcontroller.

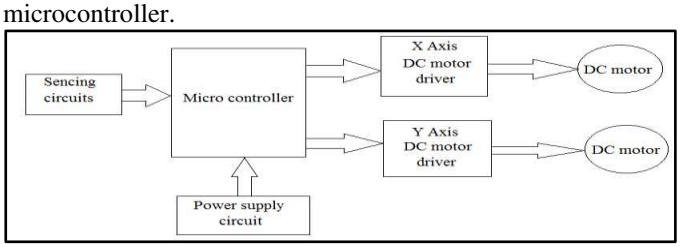


Fig.5: Block diagram of DAST system

This auto tracking system is controlled with two motors. The two light sensors are used to track the sun and to start the operation (Day/Night operation). The two-axis solar tracking

system is constructed with both hardware and software implementations.

Table 1: Main components of DAST system

Sr. No.	Name of Material	Quantity	Voltage Rating	Current Rating
1	Solar plate	1	12 V DC	0.34 Amp
2	DC Gear motor (60rpm)	2	12 V DC	0.30 Amp
3	Battery (6V)	2	12V DC	2.7Amp
4	Microcontroller IC-PIC16F877A	1	5V	1 Amp
5	LDR	2	-	-
6	LCD Display	1	-	-

Program Used

In this project, we developed a program in embedded C language with the help of KEIL software.

Actual Model of DAST System

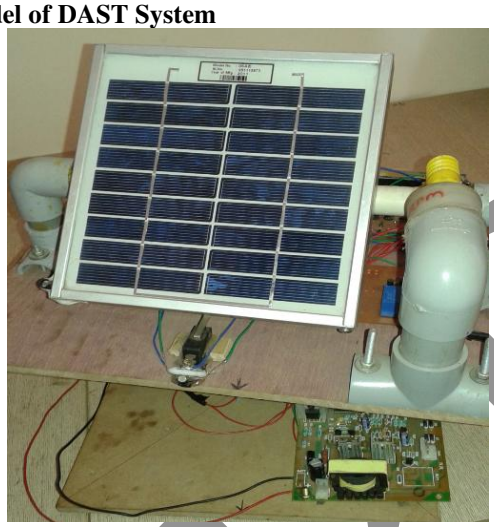


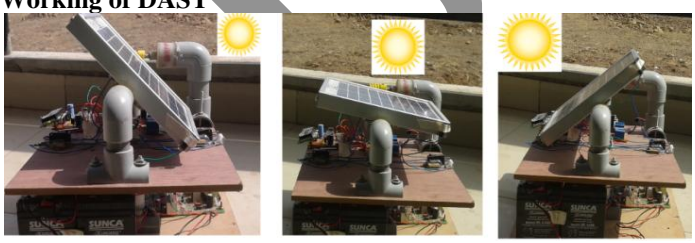
Fig.6: Hardware Implementation of DAST system

Working of Static Solar Panel

Morning Noon Evening

Fig.7: Working of Static Solar Panel

Working of DAST



Morning Noon Evening

Fig.8: Actual working of DAST

IV. RESULT & DISCUSSIONS

Using static solar panel system, we found that as the sun moves away from the solar panel, the output decreases and it is maximum when sun rays are perpendicular to the solar panel. In order to remove this drawback, we built a dual axis solar panel which changes its position along with the movement of the sun. Thereafter we experimented with the dual axis solar panel by moving the light source and we got a constant value at each and every point because same intensity falls on the solar panel as it moves along with the position of sun. Hence we shown that dual axis solar panel is better than the traditional one, as we able to utilize solar energy more efficiently. With the implementation of the proposed system the additional energy generated is greater than conventional system with very less consumption by the system itself.

V.COMPARISON BETWEEN STATIC AND DAST SYSTEM

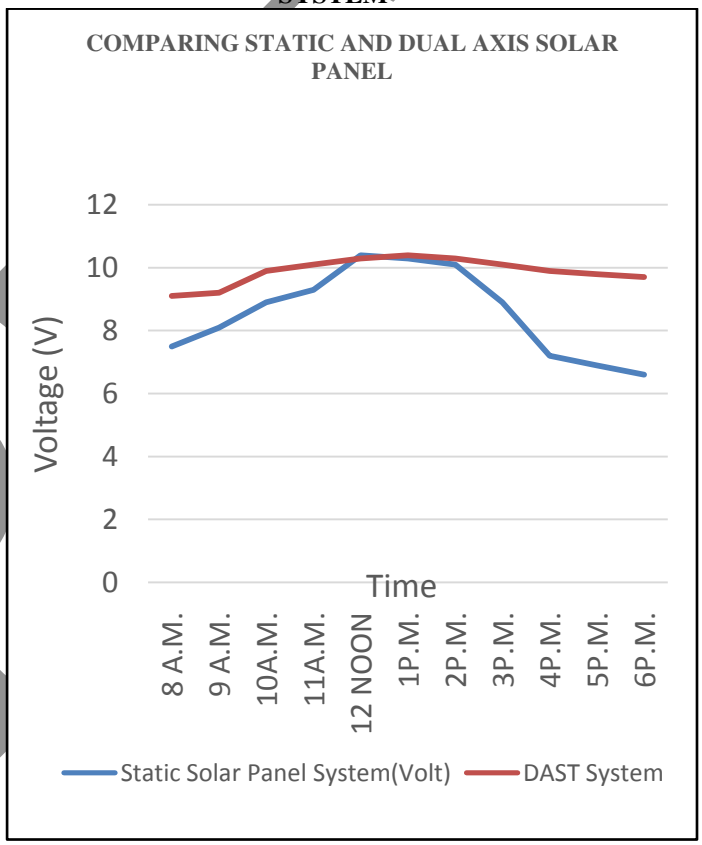


Fig.9: comparison between static solar panel and DAST system

VI.ADVANTAGES & DISADVANTAGES

Advantages

1. Solar power is pollution free during use. Production end wastes and emissions are manageable using existing pollution controls. End-of-use recycling technologies are under development.
2. Grid-connected solar electricity can be used locally thus reducing transmission/ distribution losses.
3. Once the initial capital cost of building a solar power plant has been spent, operating costs are extremely low compared to existing power technologies.
4. The power obtained by solar tracking is almost constant over a period of time when compared with the output obtained by a panel without tracking.

Disadvantages

1. Periodic maintenance is required.
2. Due to electronic circuits system becomes complicated.

VI. CONCLUSION

- The dual axis solar tracking system has been designed successfully and tested.
- Using highly advanced ICs and with the help of growing technology the project has been successfully implemented.
- Use of DAST system increases the efficiency of solar panel up to 15.54% (according to the readings taken in summer season in India).
- The DAST system is powered by battery which is charged by the system itself, so it is independent of external power supply.
- It is an emerging field and there is a huge scope for research and development.
- For Multistage parking
- In Hospital for different purposes like for carrying biological waste.
- In Malls
- Domestic lift
- To lift delicate parts in industry

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