DUAL AXIS SOLAR PANEL AND PANEL CLEANING SYSTEM

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ABSTRACT

Sun is a low cost source of electricity and instead of using the generators; solar panel can convert direct sun rays to electricity. Conventional solar panel, fixed with a certain angle, limits there area of exposure from sun due to rotation of Earth. In pursuing to get the maximum energy converted from the sun, an automatic system is required which should be capable to constantly rotate the solar panel. The automatic solar tracking system solves this problem. There are single axis trackers and dual axis trackers. In this paper we will discuss PLC based dual axis tracker. Dual axis trackers have two degrees of freedom that act as axes of rotation. PLC based I/O configuration is used as the hardware along with the comparison unit of photosensitive resistance for detecting the ray strength and shift the panel towards the maximum output from the sun. Stepper motor arrangement is used to rotate the panel to the desired position. The system tracks by comparing the intensity of light falling on the sensors. Based on the sensors output the motor can rotate the solar panel to meet the sun's maximum position. Thus, solar panel can be driven by the motor which in turn gets the input signals from the PLC. Precise control of the stepper motors is possible by using the PLC. By giving a suitable delay between each step, the time for rotation of the solar panel to a particular position can also be controlled. This system also connected with cleaning arm, which cleans the panel in suitable rotation with the help of the DC motor. The control of this cleaning system is depends on the PLC controller with is timer mode of function. This cleaning feature which helps to increase the efficiency of the solar power.

I INTRODUCTION

As the range of applications for solar energy increases, so does the need for improved materials and methods used to harness this power source. There are several factors that affect the efficiency of the collection process. Major influences on overall efficiency include solar cell efficiency, intensity of source radiation and storage techniques. The materials used in solar cell manufacturing limit the efficiency of a solar cell. This makes it particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process. Therefore, the most attainable method of improving the performance of solar power collection is to increase the mean intensity of radiation received from the source. There are three major approaches for maximizing power extraction in medium and large scale systems. They are sun tracking, maximum power point tracking or both. The solar tracker, a device that keeps photo voltaic or photo thermal panel in an optimum position perpendicularly to the solar radiation during daylight hours, can increase the collected energy from the sun by up to 40%.

Usually the fixed PV panels cannot follow the sun movement. The single-axis tracker follows the sun's East-West movement, while the two-axis tracker follows the sun's changing altitude angle too. Sun tracking systems have been studied with different applications to improve the efficiency of solar systems by adding the tracking equipment to these systems through various methods. A tracking system must be able to follow the sun with a certain degree of accuracy, returns the panel to its original position at the end of the day, and also tracks during cloudy periods. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

The potential solar energy that could be used by humans differs from the amount of solar energy present near the surface of the planet because factors such as geography, time variation, cloud cover, and the land available to humans limits the amount of solar energy that we can acquire

II LITERATURE SURVEY

Nader Barsoum describes to maximize the capture of the rays from the sun for conversion into electricity. This paper presents fabrication and installation of a solar panel mount with a dual-axis solar tracking controller. This is done so that rays from the sun fall perpendicularly unto the solar panels to maximize the capture of the rays by pointing the solar panels towards the sun and following its path across the sky.

Sneha.V.M presents low cost source of electricity and instead of using the generators; solar panel can convert direct sun rays to electricity. Conventional solar panel, fixed with a certain angle, limits there area of exposure from sun due to rotation of Earth. In pursuing to get the maximum energy converted from the sun, an automatic system is required which should be capable to constantly rotate the solar panel

MohdZainalAbidinAbKadir presents the design, programming and results of a device that achieved low power consumption. The system has dual-axes tracking controlled by a Programmable Logic Controller using a formula which were pre calculated using the altitude and azimuth of the sun. P.Shunmugakani, SudhaRajayogan explains different techniques of solar PV tracker implementation are analyzed, like, dual axis trackerdesign techniques and electrical energy extraction techniques. Implementation techniques reviewed include designsbased on position sensitive diodes (PSD), microcontroller & PLC.

III SYSTEM DEVELOPMENT

Renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. The systemwill tend to maximize the amount of power absorbed byPhoto Voltaic systems. It has been estimated that the use ofa tracking system, over a fixed system, can increase thepower output by 20% - 25%. The increase is significantenough to make tracking a viable preposition despite of theenhancement in system cost. It is possible to align thetracking heliostat normal to sun using electronic control bya micro controller. Design requirements are during thetime that the sun is up, the system must follow the sun'sposition in the sky. And it should be totally automatic and simple to operate and clean the solar panel. The operator interference should beminimal and restricted to only when it is actually required.

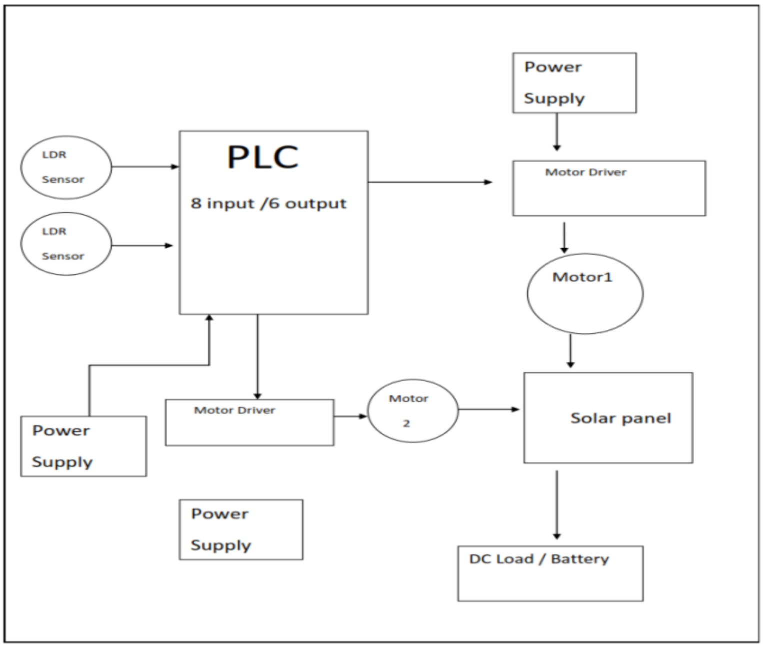

Figure 1 System Overview

3.1 Selection of Sensing Stage

System requires the light sensing system for proper identifying the light. For sensing specification we require proper range of resistance value, sensitivity of the sensor and voltage ratings. All this specifications are provided by the LDR sensors. The table shows the specification of the LDR sensors

Table 1 Specification of LDR

Resistance	400ohm to 400Kohm
sensitivity:	about 3msec
Voltage ratings:	3V,5V and 12V

The System starts from the sensing stage; controller requires the variable values for the working system hardware solar panel. In this system we have to move the panel according to the sun that means the system requires the proper sensing element. The light dependant resistor is provides these requirement which is require for the moment of the panel

3.2 Selection of Relay Driver

In this stage a device is require to drive the relay circuit for more working, this driver circuit requires the following requirement as its current ratings, voltage ratings etc.

- 500 mA rated collector current (single output).
- 50 V output
- Includes output flyback diodes.
- Inputs compatible with TTL.

As the signals from the sensing stage which is require for the input to the controller via relay circuit. The main use of this ULN IC is for driver circuit of the relay. Hence to drive the relay circuitry we used a ULN 2003 IC shows the ULN IC connection in which the output pin is connected to the separate terminal of the relay. In this system four relay for theworking condition. The coil of the each relay is connected to the relay driver IC

. In this system we require to handle high power to control the DC motor or other loads and we also require high input to the PLC, to provide these specification we used relay device. The output from the sensing stage and PLC input requires a proper isolation that means the proper range of the voltage. Hence to provide the isolation between high voltage circuit and low voltage relay is used. There are different voltage range in between sensing stage and PLC signals, relay is device which is use for the switching purpose

Input section of the PLC is connected with the LDR sensors. This connection is complete via relay circuit, that means different output coils of the ULN IC is connected to the coils of the different relays circuit, the use of the relay circuit is to provide proper supply to the PLC, so that the inputs will be configure with the PLC controller

3.3. PLC Connections & Working

The PLC uses for this system which having 8 inputs and 6 outputs. The output from the sensing stage is connected to the that means from LDR sensors is given to the input section of the PLC. And the PLC outputs are connected to the DC motors with 3.5 rpm speed. The DC motors are fitted to the fabrication structure of the system,The actual movement of the system is possible by using the DC motor mechanism. In this system geared DC motors are used. Four 3.5 rpm DC motors are use for the panel rotation. These motors are connected at the four sides of the solar panel. These motors rotate the panel in both axes. That means panel rotates from east to west and again west to east as well as panel rotates when changing the latitude. Hence in this system panel rotates in both X and Y axis.

3.3 Panel Cleaning System

For panel cleaning system a mechanical structure is developed which is shown in the figure 2 The arm is fitted on the solar panel connected with the DC motor. This arm rotates in both direction. The rotation of the arm is depends on the timer mode function which rotates in specific duration of the time. For proper cleaning system a small piece of the cushion is attached to the cleaning arm which covers the entire area of the panel.

In this system the effects of accumulated dust on the performance of the solar panels are investigated by referring the results obtained by experimentation in dusty atmosphere of different levels. Also, an auto cleaning robot to work as the auto cleaner which is equipped on the flat solar panel is proposed. The design of the auto cleaning robot will have flexibility in order fix on different sizes of flat solar panels. In accordance with the dimensions of the flat plate panel, the robot consists of brushes driven by DC-motors. The movement of the brushes is controlled by signal generated by a PLC controller.

Photovoltaic front panel glass is getting dirty from dust, seeds, chemical rain etc. This dirty is expressed in percentage of the surface covered by spots. A negative processed photo of a panel proves this coverage. Current technology disadvantage is photovoltaic panel electricity generation efficiency decreases with dust, chemical or other spot on the cover panel glass. We convert it into an advantage with our invention Cleaning while water spraying with a windshield pantograph type cleaner or roll brush.

The panel cleaning arm which cleans the panel by rotating the cleaning arm which is mounted on the top of the panel and total control of the cleaning arm which depends on the signals from the output section of the PLC controller. The DC motor is connected to the cleaning arm.

Figure 2 . Panel Cleaning System

IV SYSTEM WORKING

As stated before, the aim of this project is to analyze the performance of dual-axis solar tracking system. It consists of three structures which main are the inputs, the controller and the output.

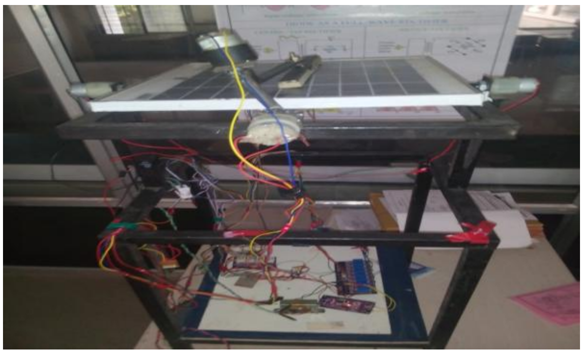

Figure 3.Complete System

The inputs are from the LDRs, the PLC as the controller and, the DC motor as the output. The overall system is presented in this project, the main controller which is the PLC receives analog input from LDRs and it then the controller sends the signal to the motor in order to determine the movement of the solar panel as show figure 3.

V PERFORMANCE ANALYSIS

Tracking systems, that continually orient photovoltaic (PV) panels towards the Sun, are expected to increase the power output from the PV panels. Tremendous amount of research is being done and funds are being spent in order to increase the efficiency of PV cells to generate more power. We report the performance of two almost identical PV systems; one at a fixed latitude tilt and the other on a two-axis tracker. We observed that the tracked panels generated 21.2% more electricity than the optimum tilt angle fixed-axis panels. The cost payback calculations indicate that the additional cost of the tracker can be recovered in 450 days as shown in figure 4.

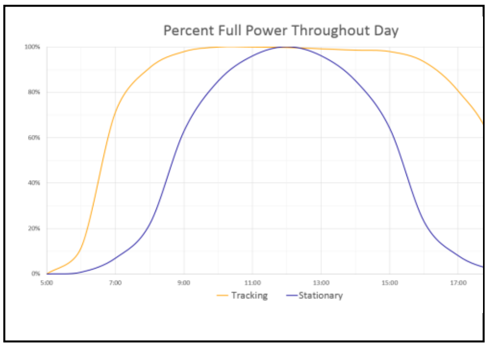

Figure 4. Power Throughout Day

VI EXPERIMENTAL ANALYSIS

By analysing the system we get different values of the power by dual axis solar panel system and the fixed axis system, the table 4.2 shows different values of the power in a day. Which represents power output is high as compared to fixed axis solar tracker in the in the morning and evening period

Table. Result Analysis

Table Result Analysis

Time	Power(W) For Fixed Axis	Power(W) For Dual Axis
7 AM	14.57	38
8 AM	23.9	49.72
9 AM	43.87	52
10 AM	47.94	54.95
11 AM	52	52.94
12 NOON	57.6	59.61
13 PM	57.9	58.04
14 PM	56.4	56.56
15 PM	54.6	55.31
16 PM	48.2	54.85
17 PM	36.72	52.36
18 PM	27.72	52.66

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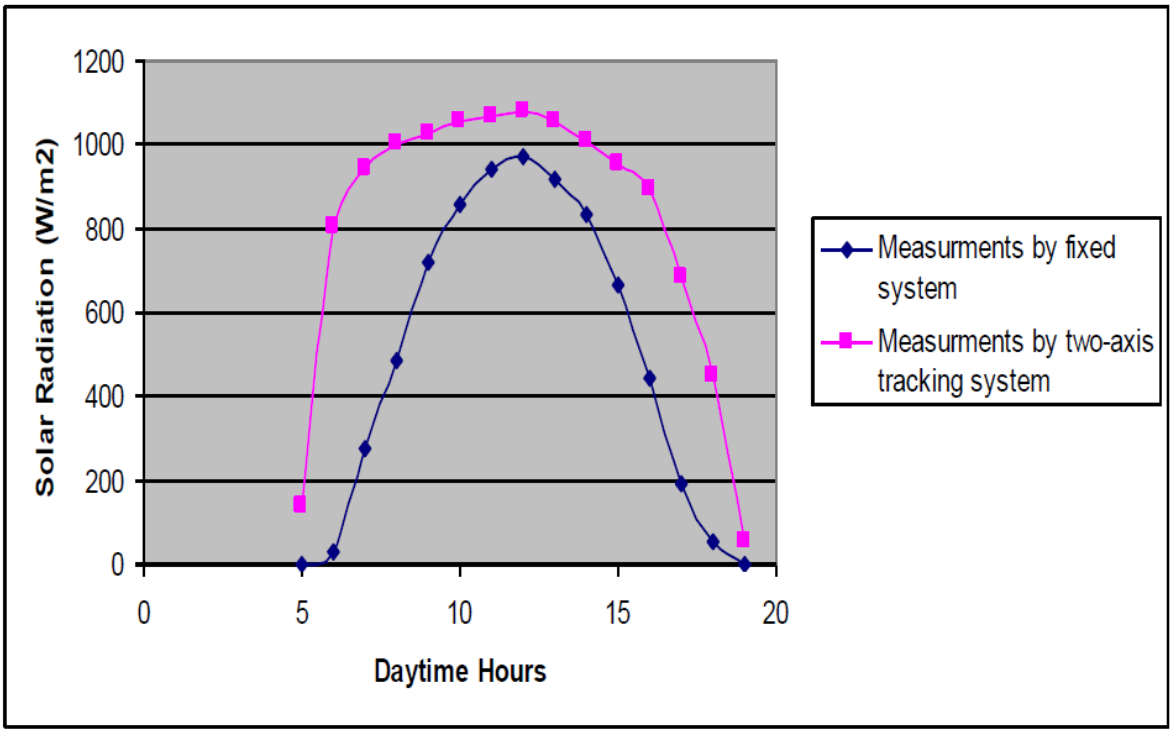

Figure 8: Analysis

VII CONCLUSION

This system has presented a novel and a simple control implementation of a Sun tracker that employed a single dual-axis AC motor to follow the Sun and used a stand-alone PV inverter to power the entire system. The proposed one-motor design was simple and self-contained, and did not require programming and a computer interface. A laboratory prototype has been successfully built and tested to verify the effectiveness of the control implementation. Experiment results indicated that the developed system increased the energy gain up to 24% for a partly cloudy day. The proposed methodology is an innovation so far

VIII FUTURE SCOPE

- Increase the sensitivity and accuracy of tracking by using a different light sensor. A photodiode with an amplification circuit would provide improved resolution and better tracking accuracy/precision.
- Different algorithm can be followed for more efficient tracking. This device can be given more intelligence, such as after tracking once, it will able to predict the line of movement of the sun across the sky.
- User-handling can be more sophisticated, i.e. user can select the waiting time.
- A digital display can be configured along with this

IX APPLICATIONS

The Solar Tracking system can be utilized for tracking the sun and thus pointing the solar panel at the point of maximum solar intensity.

- It can also be utilized for automatic switching ON/OFF the street lights by mounting it over a street lights and switch ON whenever the solar intensity goes below a threshold value as dictated by the program.
- It can also be employed with Stirling engine.
- Solar trackers are devices used to orient photovoltaic panels, reflectors, lenses or other optical devices toward the sun. Since the sun's position in the sky changes with the seasons and the time of day, trackers are used to align the collection system to maximize energy production

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