A Review on Different Technologies used for Design and Construction of an Automatic Solar Tracking System

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Abstract

Solar energy is the most important renewable source of energy. The demand of Photovoltaic system is due to the fact that they produce electric power without hampering the environment. Solar PV modules directly convert solar energy into electrical energy. Solar energy is clean and completely natural energy. By using the Solar Tracking System solar module able to maintain the position that sun's rays are always perpendicular to it. Solar Tracking system increases the output from of solar module. This paper reviews the progressive development of the technology used for solar tracking system. This paper also tries to emphasize the various practices and methods to promote the benefits of solar tracker and also discusses other techniques to increases the efficiency of solar module.

Keywords: Photovoltaic Cell, Solar Tracking, Light Dependent Resistors (LDR), Real Time Clock (RTC) Device, Stepper Motor, Controller

I. INTRODUCTION

Energy is the prime factor for the development of a nation. An enormous amount of energy is extracted, distributed, converted and consumed in the global society daily. 85% of energy production is dependent on fossil fuels. The resources of the fossil fuels are limited and their use results in global warming due to emission of greenhouse gases. To provide a sustainable power production and safe world to the future generation, there is a growing demand for energy from renewable sources like solar, wind, geothermal and ocean tidal wave [3].

Solar energy can be used as an alternative source of energy for the world's ever increasing energy requirements. Currently the average output of a normal sized solar photovoltaic module is only adequate enough to power small commercial devices. In order to supply enough power to operate larger devices, larger solar cell arrays are required. These are typically too large, and therefore unfeasible, for the application. Instead of increasing the size of the array, it is more beneficial to increase the performance of the solar cell. The overall performance of solar module can be increased by two ways: 1) By increasing the efficiency of the solar cell and 2) By tracking the sun and maintaining the angle between sun and solar module[2].

II. LIGHT DEPENDENT RESISTORS (LDR)

Light Dependent Resistors (LDR) is most common light sensor. LDR is passive component whose resistance is inversely proportional to the amount of light intensity fall on it. Here LDR is used as the optical sensor which tracks the sun's position.

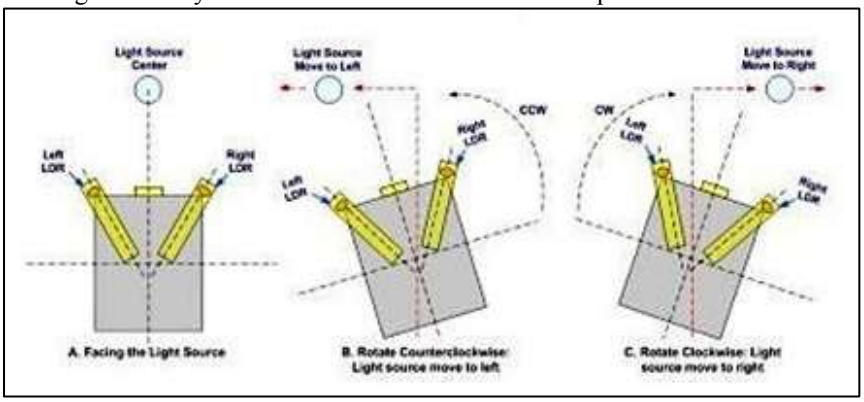

Fig. 1: Position of LDR use for tracking

Concept of using two LDRs for sensing is explained in figure 1.The stable position is when the two LDRs having the same light intensity. When the light source moves, i.e. the sun moves from east to west, the level of intensity falling on both the LDRs

changes and this change is calibrated into voltage using voltage dividers. The changes in voltage are compared and the controller controls the motor is used to rotate the solar panel in a way so as to track the light source [4].

III. STEPPER MOTOR

The movement of solar panel is done by motor. The motor used for positioning the solar module may be DC motor or Stepper motor, but the Stepper motors are preferred.

Stepper motors are commonly used in precision positioning control applications. Five characteristics of the stepper motor have been considered while choosing stepper motor for the solar tracker prototype.

Stepper motor is brushless, load independent, has open loop positioning capability, good holding torque and excellent response characteristics.

A typical controller for a hybrid stepper motor includes

- Logic Sequence Generator: Generates programmed logic sequence required for operation of stepper motor.
- Power Drivers: These are power switching circuits which ensure a fast rise of current through the phase windings which are to be turned on at a particular step in the logic sequence.
- Current limiting circuits: These are meant to ensure a rapid decay of current in phase winding that is turned off at a particular step in the logic sequence [4].

IV. CONTROLLER

The controller has been required for controlling the solar module. For the controlling purpose the following controllers are used:-

- Microcontroller: ATMEGA32, ATMEGA16, FPGA Microcontroller, AT89C51 microcontroller, ATmega328, PIC 18F452 micro controller, these are the microcontroller used for the controlling purpose.
- Programmable Logic Controllers (PLC): PLC can also used for the controlling of the solar modules. By the suitable programming of Ladder Logic the output signal generated which control the motor and rotates the motor clockwise or anticlock wise for tracking the sun's position.
- LABVIEW: Labview programs are called virtual instruments, or VIs, because their appearance and operation often imitate physical instruments, such as oscilloscopes and multimeters. Labview support graphical/ block diagram programming. Labview contains a comprehensive set of tools for acquiring, analyzing, displaying, and storing data, as well as tools to help we troubleshoot code we write.
- When we create a new VI we will see two windows: the front panel window and the block diagram.
- Front Panel When we open a new or existing VI, the front panel window of the VI appears. The front panel window is the user interface for the VI.
- Block Diagram Block diagram objects include terminals, subVIs, functions, constants, structures, and wires, which transfer data among other block diagram objects.

Labview is also used for controlling purpose of tracker.

V. REAL TIME CLOCK (RTC)

A real-time clock (RTC) is a battery-powered clock that is included in a microchip in a computer motherboard. This microchip is usually separate from the microprocessor and other chips and is often referred to simply as "the CMOS" (complementary metal-oxide semiconductor). A small memory on this microchip stores system description or setup values - including current time values stored by the real-time clock. The time values are for the year, month, date, hours, minutes, and seconds. When the computer is turned on, the Basic Input-Output Operating System (BIOS) that is stored in the computer's read-only memory (ROM) microchip reads the current time from the memory in the chip with the real-time clock. Here Real time clock is suitable for data logging, clock-building, and timer. For dual axis tracking microcontroller takes month and hours value from RTC device to track the sun's annual motion [5].

VI. OPERATION

Trackers direct solar panels or move toward the sun. These devices change their orientation throughout the day to follow the sun's path to maximize energy capture. In photovoltaic systems, trackers help minimize the angle of incidence between the incoming light and the panel, which increases the amount of energy the installation produces [1]. In case of Single-axis solar trackers the solar panel rotate on one axis moving East to West and in maximum cases two optical sensors are used to track the sun's position and the output of sensors go into the controller which actuates the motor and solar panel is moving. In case of Dual-axis solar trackers the solar panel moves in two axes, i.e. East to West for daily motion and north-south movement for seasonal motion. In most of cases for East-West movement two optical sensors are used to track the sun's position as mentioned in single axis tracker, and for north-south movement by using Real Time Clock (RTC) or Fuzzy Logic or Data logger the controller control the solar Panel movement, sometime optical sensors also used for north-south movement.

VII. LITERATURE SURVEY

Table – 1
Literature Survey

Authors	Subject	Observation
Md. Tanvir Arafat Khan, S.M. Shahrear Tanzil, Rifat Rahman, S M Shafiul Alam	Design and construction of an automatic solar tracking system	ATMEGA32 microcontroller Used as controller, Photo resistors are used as the sensors of the solar tracker, stepper motor rotation control tracker position accurately with sun's position which result in 7.5 degree per step.
Ankit Anuraj, Rahul Gandhi	Solar tracking system using stepper motor.	For the controlling of system ATMEGA16 microcontroller is used, LDR used as sensor to sense the sun's position, Stepper motor rotates the Solar module 3.75 degree to position the solar module.
Rashid Ahammed Ferdaus, Mahiir Asif Mohammed, Sanzidur Rahman, Mohammad Abdul Mannan, Sayedus Salehin.	Energy efficient hybrid dual axis solar tracking system.	Light sensor (LDR) used for measuring light intensity to track the sun's daily motion. Real time clock is suitable for data logging, clock-building, and timer. Microcontroller takes month and hours values from RTC device to track the sun's annual motion.
Rupali Nazar.	Improvement of efficiency of solar panel using different methods.	FPGA Microcontroller control the solar tracking by using two motor for dual axis tracking, Robotic vacuum Cleaner used for Dust cleaning, Hybrid Photovoltaic/Thermal solar system used for cooling the solar cells, reflection is reduced by anti-reflection coating to surface.
Sanjay Sharma	Automatic sun-tracking solar cell array system.	Silicon solar cells used AT89C51 microcontroller use for the control purpose, DC gear motor use for positioning the panel, one photo sensor and two reed sensor uses to control the movement of the platform, reed sensor change the direction and photosensor sense the light.
K.S.Madhu, B.R.Wadekar, Finavivya Chiragkumar.V, Gagan.T.M.	Intelligent two axis solar tracking system with mechanical application.	Observing the efficiency with tracking and without tracking at different time, date and weather. And it is increased by 20% to 60%.
J. Rizk, and Y. Chaiko	Solar tracking system: more efficient use of solar panels.	Two phototransistors having a very narrow range of sensitivity used and its output drive the motor, accuracy of system should be very low.
K. Anusha, S. Chandra Mohan Reddy	Design and development of real time clock based efficient solar tracking system.	ARM processor is used as controller, Real time clock used for positioning the tracker which single axis tracker. solar tracker system that automatically adjusts the optimum PV panel position with respect to the sun by means of a DC motor controlled by an intelligent controller unit that equipped with a positioning algorithm to mathematically solve the optimum tracker position for any time of the day using RTC.
Azwaan Zakariaha, Mahdi Faramarzia, Jasrul Jamani Jamianb, Mohd Amri Md Yunusa.	Medium size dual-axis solar tracking system with sunlight intensity comparison method and fuzzy logic implementation.	Two power motors (one for the horizontal axis and the other for the vertical axis) use to position the system, the LDR sensors detect sun position at five-minute intervals through the intensity measured by them. The fuzzy logic controller helps the microcontroller to give the best inference concerning the direction to which the solar PV module should rotate and position in which it should stay.
Amevi Acakpovi, Nana Yaw Asabere, Daniel Babbo Sunny.	Low cost two-axis automatic solar tracking system.	The system employs Light Dependent Resistors to sense the position of the sun which is directly communicated to a micro-processing board with ATmega328 microcontroller. The micro-processing board therefore commands a set of two stepper motor to re-orient the panel either horizontally or vertically in order to stay perpendicular to the sun rays. Evaluation results show that the new system performs 10.7% better than the static solar system.
Marija chekerovska1, Risto Vasil filkoski	Efficiency of liquid flat-plate solar energy collector with solar tracking system	The presented CFD modeling approach can be used for further investigations of different solar collectors configurations and flow schemes, the efficiency of the system is not good.
Mostefa Ghassoul	Design of an automatic solar tracking system to maximize energy extraction.	PIC 18F452 micro controller used as controller, LDR use as light sensor. The main advantage of the technique is that the rotation only takes place, if the energy obtained in the new position is higher than that consumed by the panels during the transition
Gagari Deb and Arijit Bardhan Roy	Use of solar tracking system for extracting solar energy.	The operation of the experimental model of the device is based on a Stepper motor intelligently controlled by a dedicated drive unit that moves a mini PV module according to the signals received from two light sensors, it is controlled by Labview.

VIII. CONCLUSION

This paper reviewed different technologies used for solar tracking, and has been observed tracker increases the output from a solar module. Both single axis and dual axis trackers are used for tracking the sun to get maximum output from a solar module. Sensors are used to detect the position of sun and controller controls the motor rotation to move the solar module such that it is facing sun most of the time.

The output of the solar modules can be increased by using different trackers as observed but the main challenge is to reduce the complexity in designing a tracker.

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