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ENERGY UP GRADATION USING SOLAR PV TRACKER TECHNIQUES

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ABSTRACT

In this paper, different techniques of solar PV tracker implementation are analyzed, like, dual axis tracker design techniques &electrical energy extraction techniques. Implementation techniques reviewed include designs based on position sensitive diodes (PSD), microcontroller & PLC. It was noted in the review that dual axis tracker has around 40% increases in efficiency than the fixed position panel in the recent times. Also, the grid feed inverter integrated with tracker position control unit is more reliable & efficient in concentrated PV applications.
Keywords: dual axis tracker, energy extraction, position sensitive diode, grid feed inverter.

INTRODUCTION

Solar Energy is rapidly advancing as a renewable energy in the high time of the need for some energy sources in order to overcome the depletion of non-renewable energy resources. These systems use collectors in the form of PV panels, pumping systems, optical reflectors to collect energy. Due to static placement of the panel, the energy obtained is less than the maximum attainable. As a measure to tackle this, the tracking system is developed that tracks the sun movement throughout so as to get the maximum output. Experiments have been carried out on such tracking systems that vary in many aspects like, design, simulation, mathematical models, etc.

This paper proposes to review some such papers that are based on:

- Dual Axis Design Technique
- Energy Extraction Technique

DUAL AXIS TRACKER DESIGN TECHNIQUES

The utilization of solar energy efficiency depends on perpendicularity between sun light and solar panels. Aim to Omnidirectional tracking the sun position, a location detector consists of an Omnidirectional photoelectric sensor and a PSD is designed. According to the luminous intensity two tracking mode is designed. Position Sensitive Diode (PSD) is based on the principle of horizontal photoelectric effect. Fixed solar photovoltaic power generation system is inefficient, but the tracking solar photovoltaic power generation systems can improve the efficiency up to more than 30%, the light intensities contrast of sampling light between the follow-up mode and non-tracking mode light.

In order to achieve the automatic tracking of the sun, the following design is adopted: the whole tracking system including the photoelectric detection and tracking machinery, the sun position measurement devices including PSD, shield, lens, light-road hole, shading a barrel, light intensity condition device, pitch and azimuth adjustment devices, stepper motor, and support shelf, driving is by using gear. The combination of methods of the light-electric tracking and tracking movement to enhance the stability of the system.The hardware design for the tracking system is shown in Fig 1.

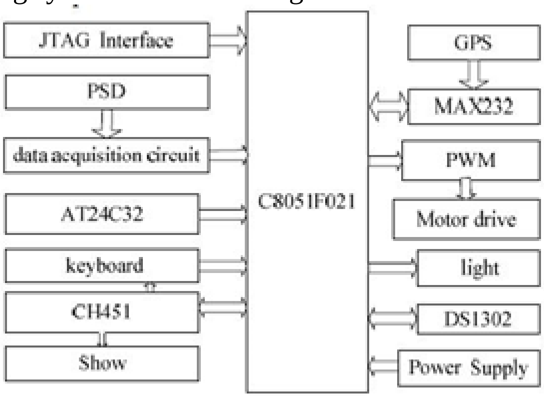

Fig.1.Hardware Design of Sun Tracking System

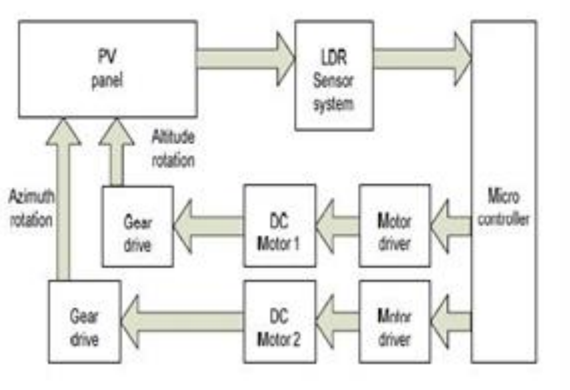

Fig.2. Schematic diagram of the system

The system is set to run the start and end time, when the starting time, the system began to run, if reset to the initial position, which calculate the sun's elevation and azimuth angle, So the sun measuring device can run the field of electro-optical tracking range, once the completion of the track light, system will determine whether the scope of the light- electric tracking The electro-optical tracking real-time tracking, depending on the day , the system time is set to move every 10min. DS1302 calculate the current solar azimuth and a high degree of angle, and the result has a subtraction operation with the results of previous calculations. If the result is positive, stepping motor will rotating positive direction, and vice-versa. So the combination of the two track approach, can work whether it is sunshine or rain day.

The accuracy of large range of tracking is verified ,which make up the shortcomings of the equatorial plane-solar tracker, and the device have the advantage such as suit to all-weather, fully automated, tracking precision, operational reliability, easy to install, high- precision tracking, low-cost. Single axis tracking follows the E-W movement of the sun, while the two axis tracking system follows the azimuth angle that the seasonal movement of the sun also. A closed loop tracking system is employed for this system. In this system, the tracker senses the sunlight falling upon it and gives appropriate command signal to the motor to alter its position. However this system is not reliable during foggy and cloudy weather conditions.

The proposed system uses 3 LDR's and 2 DC motors for the tracking. The control loop algorithm is implemented using ATMEGA 32(L) microcontroller. The schematic system of the proposed model is shown in the Fig 2. The LDR's are placed in such a way they are at 120 degree with each other. The difference in voltage between 2 LDRs is given as input to the microcontroller which compares it with the set value. If the difference in voltage is higher than the set value the microcontroller gives specific signal to the MOSFET drive which amplifies it and gives the input to the DC motor. The DC motor uses a gear drive to change the position of the collector. The motor is on until the 3 LDRs are equally illuminated which means the solar collector is normally incident to the sunlight.

The operation code used is Code-visionAVR which is fed to the microcontroller. The control is developed in C-code and converted to hex code using Code-visionAVR. The operation code is tested using PROTEUS 7. The difference of analog signal given to the ADC channel is compared to the set value and the DC motor moves the panel is clockwise or anti-clockwise direction only for values higher than the set value. For comparative performance analysis the proposed two axis tracking system is compared with a fixed tilt solar collector with tilt at 37 degree facing south. The following factors are analysed.

Comparison of solar radiation received on the collector: The solar radiation of two axes tracking and fixed with the resultant gain is evaluated. At 8:00 AM maximum irradiation gain of 221.19 W/m2 and at 1:00 PM minimum gain of 2.33 W/m2 has been recorded.

Comparison of maximum hourly electrical power and efficiency gain: The maximum hourly electric output is calculated and analysed by its V-I characteristics. The hourly gain of maximum power is calculated at the maximum power point value.The gain in efficiency is calculated between fixed and two axis tracking system. The maximum gain is obtained between 7:00 AM to 4:00 PM for two axis tracking system when compared to fixed tilt.

Comparison of short circuit (Isc) and open circuit voltage (Voc): The cell temperature of a PV module increases for temperature change. The short circuit current and open circuit voltage changes are analyzed in the course of the day.

Comparison of Fill Factor: Fill factor represents the ratio of area of two rectangles formed with VI characteristics as calculated below.

The fill factor is calculated on hourly basis as shown in Fig 3 and it is seen that there is rapid variation for fixed tilt than for a two axis tilt which shows that the proposed PV system is more efficient with less temperature changes.However in the proposed system due to increase in solar irradiation, there are significant losses in the PV module which declines the performance of the system. This behavior is noted throughout the day, however fill factor remains low.

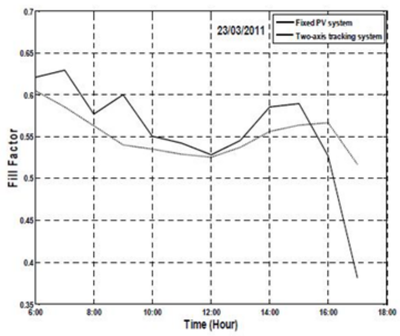

Fig.3.Fill factor of two axis and fixed tilt tracking system

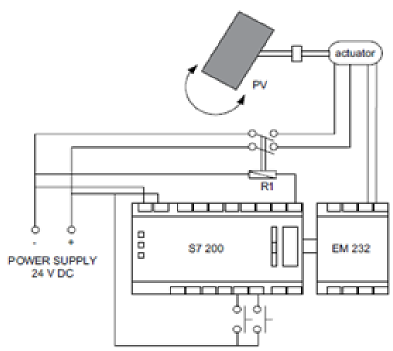

Fig.4. Electromechanical connection of the system

Two axis tracking system of PV panels controlled using PLC has been designed & implemented. The timely slope angles of the sun were calculated & the PLC was programmed according to those angles. The actuator motors were controlled as per the analog signal form the PLC and as such the movement of the panel occurs so as to obtain maximum efficiency at right angles to the sun. For the movement of the panel on both the axes, panel & gear pins were attached to the actuator motor pins as per the electromechanical design shown in Fig 4. Control unit with two analog inputs & outputs is used, wherein the analog outputs give the control signal to actuator motor. PLC has built in adjustable real time clock & the program written in PC is loaded to the PLC.

The PV panel is mounted in a fixed position facing the south in first position and in second position, the panel was mounted in a such a way that it tracks the sun at every hour between the sunrise and the sunset.It was observed that the analog output signals of the PLC analog module changed at every hour and the PV panel tracked the sun on both axes, these signals were given to the actuator motor. Program models for azimuth & elevation angles are developed for the tracking.In analysis, power, voltage & current readings were obtained every hour and compared with fixed tilt solar panel as shown in Fig 5.

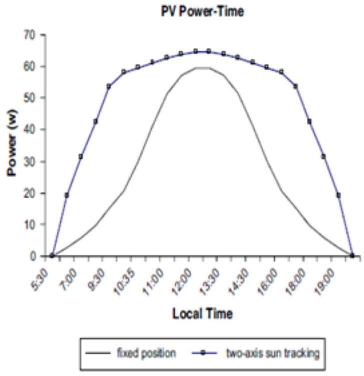

Fig.5. Power Vs Time Results

The system is advantageous over the photosensor based system because of the overcast & the partly cloudy weather conditions and also additional hardware & command signals are required in sensor system. The study conducted in Turkey, has proved the system to be 42.6% more efficient than fixed position system. Decrease in investment costs, energy saving & increase in efficiency are the merits of the system.

ENERGY EXTRACTION TECHNIQUE

Combining mechanical & electrical control of solar trackers in power plants involves the integration of power electronics that supplies the drives as well as sun tracking algorithms into a specially designed grid feeding inverter called as Tracking Inverter.

A local decentralized grid feeding inverter is more advantageous than a centralized inverter. Drawbacks of a centralized inverter include maintenance of DC lines, redundant converter required to improve reliability, inverter failure leading to plant shut down and mismatch in string connections. Hence distributed architecture is more preferred for (C)PV tracker fields. Solar trackers are driven by electrical motors powered by electronic circuits in general. High data flow between actuators, sensors & control unit along with the restricted angle acceptance of (C)PV systems calls for the use of decentralized control units attached on tracker towers.Hence, all the decentralized units communicate with a central control unit for supervision & data monitoring. Integrating the tracker position control unit into the grid feeding inverter, thesystem as shown in Fig 6, inverter's processor controls the overall PV system. The combination acts as an autonomous multi - tasking device called the Tracking Inverter.

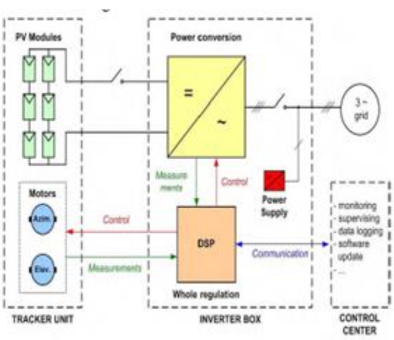

Fig.6. Tracking Inverter System

The CPV system's power balance is analyzed where daily power generation of a 6 kWp CPV two-axis tracker equivalent, realized on a sunny summer day. If integrating the DC power curve (blue) during the whole day we obtain quite good amount of energy.

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The generated vs consumed power balance favors the two-axis sun tracking. The tracking inverter has many advantages over dual unit solutions or central control on the field, making it perfectly suited for both conventional tracked PV and CPV power plants.

CONCLUSION

The dual axis design techniques &electrical energy extraction techniques of solar PV panels is extensivelystudied. The microcontroller based as well as PLC based tracking system is advantageous over the photosensor based system because of the overcast & the partly cloudy weather conditions and requirement of additional hardware & command signals for the sensor based system. The study can be extended based on other techniques of tracking, mathematical modeling involved& performance analysis.

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