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DESIGN AND FABRICATION OF TILTING SOLAR PANEL

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Abstract:

Solar energy is rapidly advancing as an important means of renewable energy resource. Solar tracking enables more solar energy to be generated because the solar panel is able to maintain a perpendicular profile to the sun's rays. Though initial cost of setting up a solar tracking system is high, this project report proposes a cheaper solution. Design and construction of a prototype for solar tracking system with single degree of freedom, which detects the sunlight using Light Dependent Resistors (LDR) is shown in report. Tilting solar panel is done for improving the efficiency of the PV panel output power using stepper motor-controlled tracking system. Solar energy is rapidly becoming an alternative means of electricity source. This is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. The prototype is designed using Arduino microcontroller which controls the tracking system by communicating with the LDR's and stepper motor driver based on the movement of the solar radiation. The performance and characteristics of solar tracker system is monitored and compared with the conventional method.

Key Words: Solar energy, solar radiation, Light Dependent Resistors.

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1. Introduction

In solar thermal technology, solar energy is harnessed into thermal energy for domestic and/or commercial applications such as drying, heating, cooling, cooking, etc. However, on the industrial scale, concentrated solar thermal (CST) technologies are being used to fulfil such heating requirements while concentrated solar power (CSP) technologies are being employed to generate electricity. Maximum power point tracking (MPPT) controllers play an important role in photovoltaic systems. They maximize the output power of a PV array for a given set of conditions. Saleh et al. [1] presents an overview of the different MPPT techniques. Each technique is evaluated on its ability to detect multiple maxima, convergence speed, ease of implementation, efficiency over a wide output power range, and cost of implementation. Programmable Logic Controller (PLC) solar panel tilting system is designed and proposed by Krishnamoorthi et al. [2]. By using this system, we can obtain uniform and higher power generation when compared to solar panels placed in fixed position. Solar panel frame is majorly affected by the various factors such as wind force, rain, fog etc., among them the major factor affecting the solar panel frame is the high wind force. Generally various frame structures are designed and analyzed by subjecting it against various wind force to select the suitable frame structure which withstands for maximum wind force with less deflection. Design and construction of a prototype for solar tracking system with single degree of freedom, which detects the sunlight using Light Dependent Resistors (LDR), is discussed by Ankit et al. [3]. The control circuit for the solar tracker is based on an ATMega16 microcontroller. This is programmed to detect the sunlight through the LDRs and then actuate the stepper motor to position the solar panel where it can receive maximum sunlight. Compared with any other type of motor, the stepper motor is more controllable, more energy efficient, steadier and has high tracking accuracy and suffers little environmental effect. Theoretical analysis and research results have been shown in this paper to advocate that the designed system realized precise automatic tracking of the sun and can greatly improve the utilization of solar energy.

2. Experimental Procedure

Tilting solar system: The working of the system is illustrated through the above block diagram. The block diagram (Fig. 1) is divided into two parts. The first part is the tracking section. The

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second part is the converter and inverter section. In the block diagram of the tracking section, the first block is Light Dependent Resistor. It is connected to the Arduino microcontroller board.

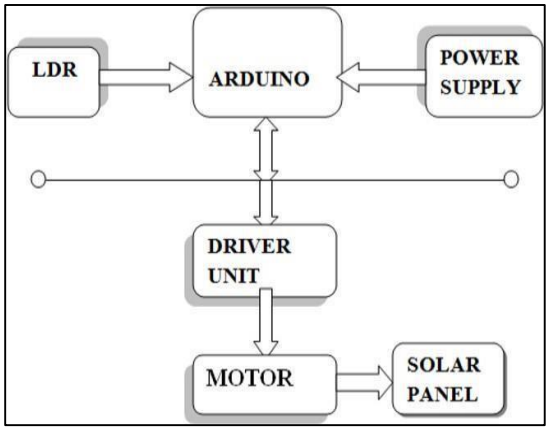

Fig. 1: Block diagram of tracking section

The controller is interfaced with driver unit for driving the stepper motor. Depending on the signals from the LDR the motor rotates either in clockwise or anti-clockwise direction. Three LDR's are used in which one LDR is permanently mounted in east direction. The other one LDR's are fixed in a straight line or at the center and another one is mounted in the west direction such that depending on the intensity of each LDR the stepper motor rotates the panel in counterclockwise direction. When the sun is in east direction the first LDR senses the light that will have high intensity compared to other two LDR's. At that time the panel is rotated in clockwise direction and braking operation is performed when second LDR intensity goes high compared to first and third LDR. The panel is rotated from west to east during sunrise depending on the intensity of first LDR. The data from the LDR are collected and according to that data the stepper motor is made to rotate all this is done by the microcontroller called arduino. The arduino is programmed in such a way that it has to compare the LDR's and the motor is to be rotated accordingly. The flowchart of the programme is given below.

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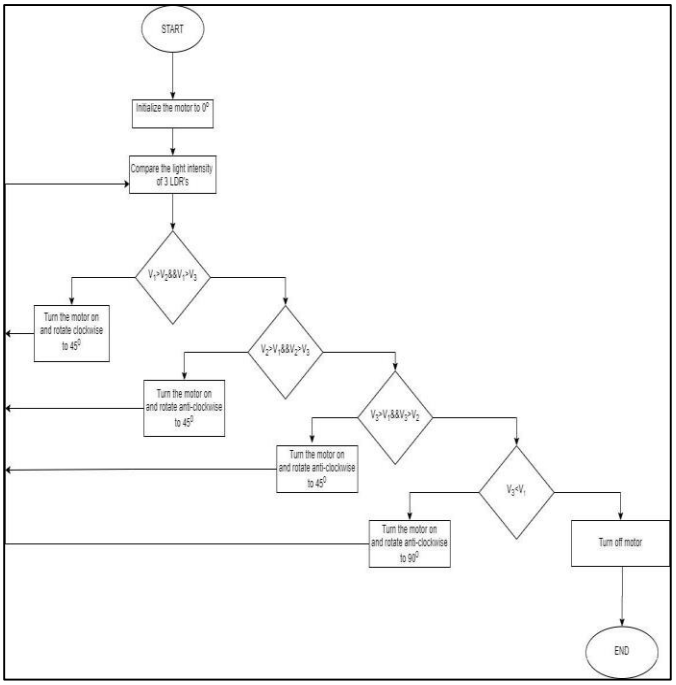

Fig 2 polycrystalline PV panel

The polycrystalline PV panel will efficiently collect the solar radiation and convert into electric current. This electric power is collected and stored in a lead acid battery with the help of solar charge controller. The solar charge controller has a small inbuilt inverter which will also help to convert the DC current which is produced by the solar panel and stored in battery into AC current for the load or for other external use.

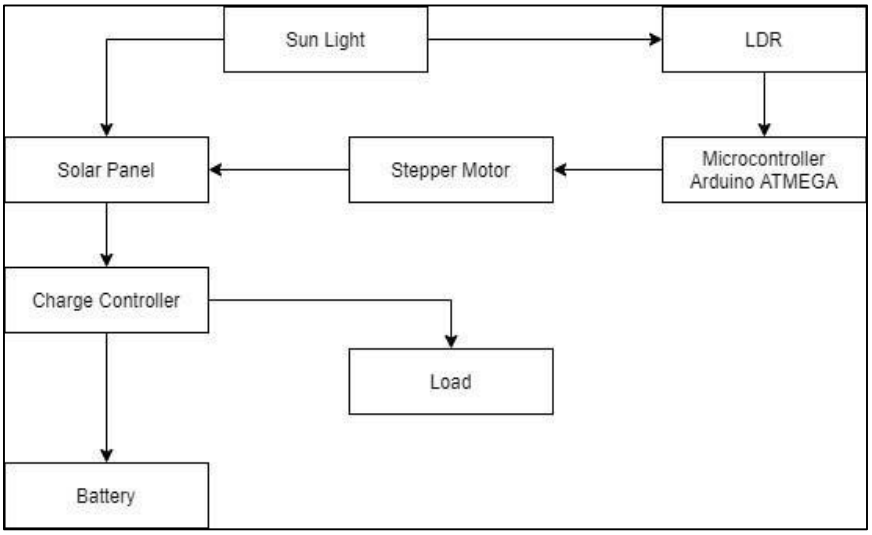

Fig. 3: Overall block diagram of tilting solar panel

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Results and Discussion

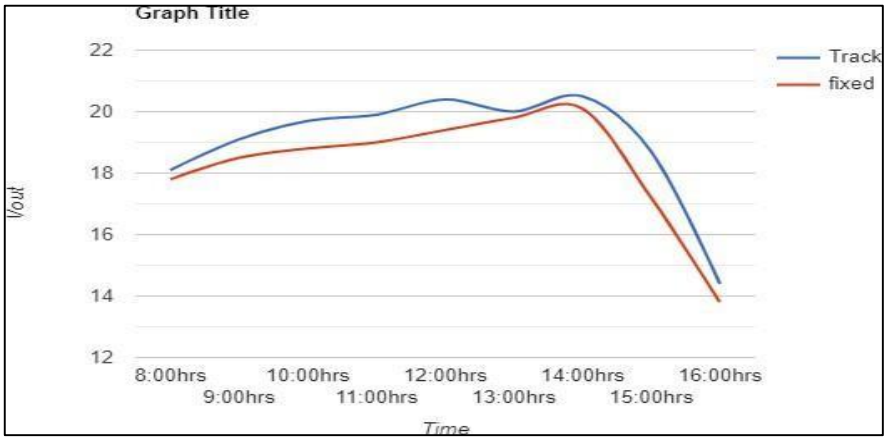

Fig. 17: Comparison of Voltage O/P between fixed solar panel and tilting solar panel

The above line graph representation in Fig 17shows comparison between output voltage of a fixed solar panel and a tracking solar panel at every 1hrs interval shown on X-axis and Vout in volts on the Y-Axis

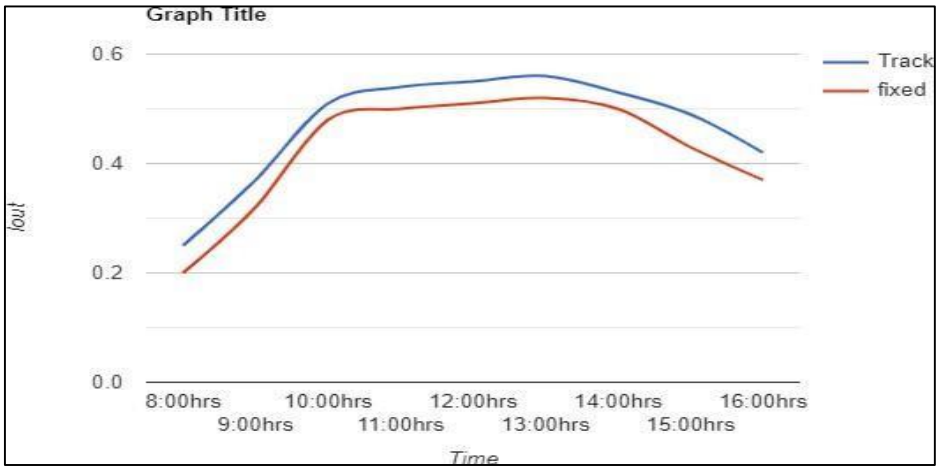

Fig. 3: Comparison of Current O/P between fixed solar panel and tilting solar panel.

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The above line graph representation in Fig 18shows comparison between output current of a fixed solar panel, and a tracking solar panel, at every 1hrs interval shown on X-axis and Iout in Amperes on the Y-Axis.

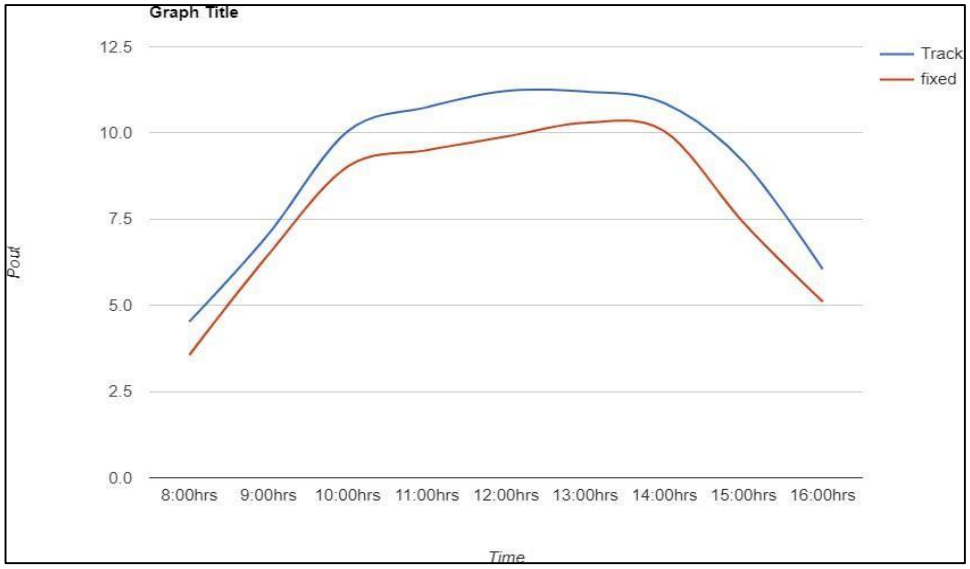

Fig 3 Comparison of Pout between fixed solar panel and tilting solar panel

The average increase in percentage of power output is = 14.78%. So that we are able to obtain almost 30% power output from the tracking solar system. While comparing to the fixed solar system an increase of almost 15% of power out was achieved [4-5].

Conclusion

From our research we were able to come up with many important conclusions and suggestions which will profit the future advancement of solar system. From our results we were able to recommend new design aspects to improve the system and efficiency. Inefficient solar radiation was the huge impact getting the required power output because of the monsoon season.

Implementation of stepper motor-controlled tilting solar panel is an efficient and feasible means of obtaining optimal solar energy from the sun. By constantly aligning the photovoltaic panel with the sun, it directly receives sunlight falling on its surface thereby utilizing maximum energy. The design and construction of Stepper motor controlled solar tracking system implemented is capable of tracking the maximum intensity of light. The power producing ability

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is not restricted to the angle of sun rays on the panel.Also it is easy to maintain and installed in remote or dusty or rainy place to develop electrical energy or to produce heat energy for different applications.

It is clear that the solar tracking system plays an important role to guarantee the maximum solar energy generation from dawn until dusk. As solar power production is used in large scale worldwide so, even an increment in efficiency by 1% than stationery plane will increases the net power production by large amount. Hence, no matter by how much tracker increases efficiency it is always welcomed.

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