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Dual Degree of Freedom Solar Tracking System

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ABSTRACT—Photovoltaic cells are designed to receive incident sun rays and convert it into equivalent electrical energy. But these photovoltaic panels are not that efficient as they are freezed only at a particular angle. This inefficiency can be reduced by designing a solar tracking system which automates its position as per the sun's movement. The goal of this proposed design is to get maximum power output, a dual-degree of freedom solar tracker is designed. The tracker actively traces the sun motion and automatically changes its position accordingly to increase and maximize the power output.

Index Terms—Solar Cell, Panel, Dual Axis, Two DoF, LDR, Maximum Power, Servo Motor.

I. INTRODUCTION

The incident sun rays can be used to overcome the electrical energy crisis generated by the scarcity of Fossil fuel resources. Solar energy is free and everywhere. Due to the decreasing of solar photovoltaic energy cost, it's superior in the renewable energy sources and widely utilized in many countries. One of the most widely used alternative route in the frame of renewable energy domains or sources is Solar Energy. Solar power is a very exorbitant, unlimited source of energy. The energy from the sun received by the earth is estimated to (1.9×1011) Mega Watts, which corresponds to many thousands of times more than the current usage rate on the earth from all of all energy sources available commercially. Issues concerned with the utilization of solar power is that its accessibility varies broadly with space and time. To solve these issues, the solar panel should be installed such that it always intercepts maximal intensity of light it can. It has been observed since many years of experimentation that the efficiency of the solar panel is around 15-20% which is not meeting the desired load requirement. This problem can be rectified by means of efficient solar trackers. Solar tracking approaches can be enforced by using single degree of freedom or dual degree of freedom for better accuracy and high efficiency. In general, the Single-Degree of Freedom tracker with one degree of freedom follows the Sun's motion from the geographical east to geographical west during daytime. If Dual-Degree of Freedom tracker is considered, then it will follow the elevation angle of the Sun [1].

II. METHODOLOGY

As mentioned before, this project is to visualize and analyse the benchmark and performance of dual- Degree of Freedom solar tracking system. There are three prime components: inputs from the LDRs, the controller to control the entire assembly and the output to carry out actuation. The inputs are taken from LDRs to detect the intensity of sun-rays, the Arduino is acting as the controller to take necessary action in setting angles and, the servo motor as the actuator to set the desired angles fed by controller output. The overall system is presented in Figure 2. In this project, the prime controller, Arduino accepts analogue input from LDRs and digitized the input signal data using analogue-to-digital (A-D) converter. Then the controller feeds the desired angles to servo motor in order to carry out the actual actuation determining the motion of the solar panel [3].

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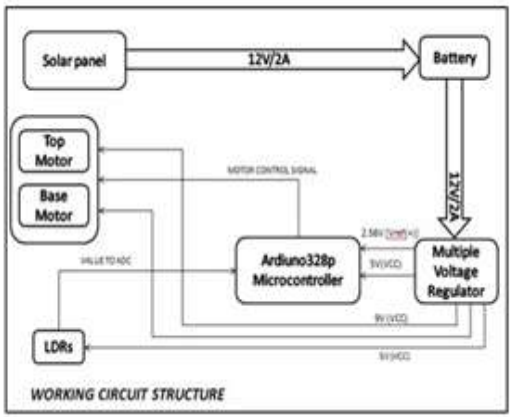

Fig. 1. Block Diagram of Proposed Design

A. Light Dependant Resistor (LDR):

Photo-resistor or light dependant resistor (LDR) is a resistor whose value of resistance bears an inverse relation with intensity of light or it can be stated that the LDR considers photo-conductive property. For this proposed project, the intensity of light sensed by the LDRs acts as an input transducers to the prime controller Arduino.

B. Solar Panel:

Photo-voltaic cell or Solar panel is a device that converts sun- light directly into equivalent electric power. For this proposed project, we select the mono-crystalline type of solar panel as it exhibits higher efficiency and outcome in comparison to other type. The specifications of solar panels were source current of 500mA and source voltage as 6V. To get 1A current approximate and voltage as 12V, designer has connected four panels as shown in Fig.2

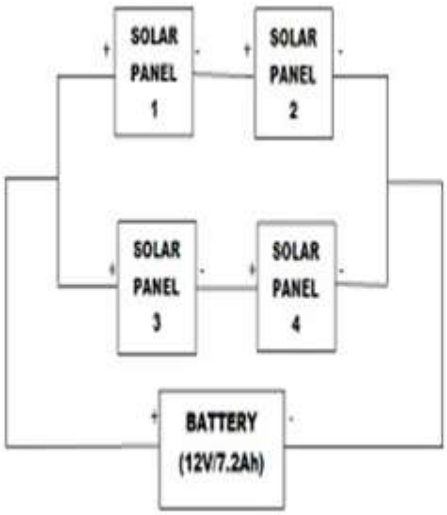

Fig. 2. Solar Panels Connections.

C. Servo Motor:

Servo motor is one of the major variants from family of DC motor available in electronics and electric control application. This type of motor sinks power supply minimum of 6V to maximum of 7.2V. This motor encompasses three pin-outs in its terminal: data wire, +Vcc power supply wire and Neutral wire. Servo motor can perform utmost rotation of capital value of 360 degrees. PW signals in servos is used to establish and control the position and direction of the motor. For this proposed project, we need two servo motors for vertical and horizontal axis respectively.

Fig. 3. Servo Motor (MG995).

D. Arduino:

Programming code is composed using insights from C language for the targeted controller. The codes were burned to Arduino UNO board. This proposed design uses total of five number of LDRs interfaced with Arduino Analogue pins A0 to A4. Five LDRs were connected to act as the input sensors for proposed system. As Arduino UNO comprises of built-in Analog-Digital Converter, it suffices in conversion of analog inputs from LDR to its digital equivalent. The capital value of light intensity recorded by one of the LDR was analysed and its address corresponding to its geographical direction is traced and then from the look-up table the solar panel is made to move as per the angles fed by the controller. This follows a Round-robin approach or polling method to check out, which LDR provides maximum intensity and thus its geolocation is tagged. Eight directional corners are taken into consideration[2].

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Fig. 4. Arduino328p.

E. Voltage Regulator:
The voltage regulator is specifically designed to maintain a constant and sustained voltage level. Servo Motor requires 6Volt Power Supply for operation. Hence, voltage regulator is required to do the needful.

Fig. 5. Voltage Regulator.

III. MECHANICAL STRUCTURE DESIGN

The structure of the solar tracker system is a dual-Degree of Freedom. The system contains an upper axis aids the panel move from geographical east to geographical west direction. But during the winter solstice and summer solstice, the sun Is at an angle with the prime meridian. There was also a need of lower circular disk to enable the movement from north to south. The structure is made up of acrylic and PVC plastic making it light and durable. A PVC pipe is cut and connected using a T-shaped joint and L-shaped joints. this creates a Y-shaped structure that stands on a circular disk that rests on the motor. The disk is supported by four wheels like movable pillars so that the weight of the structure does not break the disk. Now, there are two servo motors, one as a vertical movement and second as horizontal movement, both capable of 360-degree motion. The upper vertical motor is connected to an axial and the other end is supported by a ball bearing. The ball bearing is connected to a screw with an upper wedge of diameter greater than the inner part of the bearing but lesser than the outer part and is attached to it by a metal washer and a nut bolt so it works as an axial. A plank rests on this axial further on which the solar panel and the LDR and fixed [4].

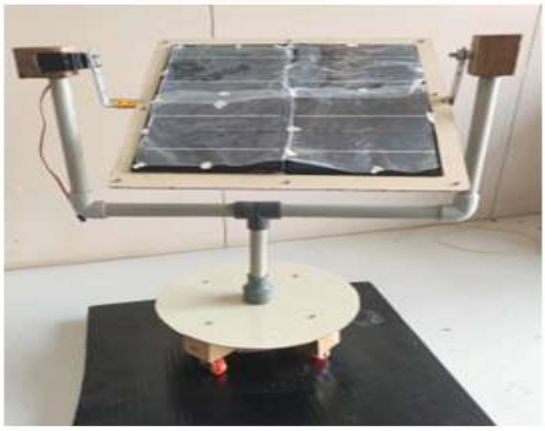

Fig. 6. Mechanical Structure.

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IV. OBSERVATION TABULAR READINGS

Time interval	Reading of whole day		
	Voltage (V)	Current (mA)	Power (W)
9am	9.8	205	2.009
10am	10.76	348	3.744
11am	11.35	466	5.289
12pm	11.69	524	6.125
1pm	11.72	586	6.867
2pm	12.26	595	7.294
3pm	11.82	498	5.886
4pm	11.39	427	4.863
5pm	10.64	364	3.872
6pm	9.56	190	1.816

Table 1. Observation Table of whole day.

V. CONCLUSION

This proposed project paper has described an improved and a bettered way to improve the efficiency of the power generation by making the solar panel rotate in dual degree of freedom. It can be found that this proposed design is much better to generate power as it possesses the dual degree compared to other conventional mechanisms. Moreover, it can also help in solving the day to day problem of electrical power supply crisis in rural areas. This design aids a better way to manage and generate electric supply as on demand.

REFERENCES

[1] Jeng-Nan Juang and R. Radharamanan, " Design of a Solar Tracking System for Renewable Energy", Proceedings of 2014 Zone 1 Conference of the American Society for Engineering Education (ASEE Zone 1), 2014

[2] Nashaat Othman, M.I.A. Manan, Zulbasri Othman, Syed Abdul Mutalib Al Junid, "Performance analysis of dual-axis solar tracking system", 2013 IEEE International Conference on Control System, Computing and Engineering (ICCSCE),November 2013

[3] Priyanjan Sharma and Nitesh Malhotra, Solar Tracking System using Microcontroller, Proc. in 1st IEEE Conf. ICONCE, Kalyani, West Bengal, India, 2014, 99-100.

[4] Muserk Rights Management, Dual-Axis solar tracking system project B-tech final year student 9848060761, Availabe [Online] https:/youtu.be/D6EmuDBrZy8.