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Fabrication and Performance Analysis of Solar Tracking System by Using By-Pass Diodes and Super-Capacitor Technology

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----------ABSTRACT----------
Energy is a burning issue that almost every person experience now a days. Energy demand increases exponentially since a decade. Due to the global warming and it's threatening impacts on human life. Therefore, to overcome such disastrous impacts on the planet, renewable energy resources play vital role now a days. Solar energy is one of the vastest available renewable energy resources around the globe, but the main issue is its poor efficiency. Pakistan is facing energy shortage that can be compensated through solar power and the need is to design a project that maximizes its efficiency. So, the research is mainly focused on improving efficiency of solar panels against shading loss by using different techniques. In this research, different results will be obtained and compared with different techniques which are LDR based solar tracking system, by-pass diodes technology and super capacitors. Fabrication of solar tracker is based on Microcontroller that drives L298N driver to operate stepper motor.

INDEX TERMS: Solar Tracker, L298N Driver, Solar Energy

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I. INTRODUCTION

Since last many years, most of domestic and commercials consumers of electricity round the world used solar energy. This is mainly because the solar energy is an infinite energy resource currently available and in future to meet the electricity demand and heat energy requirements [1]. Sun shines almost all the year in Pakistan which gives Pakistan enough potential to tackle her energy needs through sun only. However, some areas in Pakistan are sunnier than other. Solar potential in Pakistan is far more than her energy needs in all respect [2]. Solar PV Module is one of major component for producing electricity from solar radiations; however, improving efficiency is one the key factor in generation from solar. Solar tracker is an automated system that is available which follow Sun light throughout the day to increase the power output [3]. The position of the solar panel changes according to sun's direction over any fixed position [4]. This sun tracker framework helps the PV panel to face the sun all the time so that angle of incidence remains unaffected most of the time. Sun tracker is a device that takes after the change of the sun as it turns for from east to west consistently [5]. Heliostat is one of the famous type of solar tracker, which have a free movable mirror that reflects sun light over a fixed point, but there are many other techniques available as well [6]. Trackers that contain mechanical gear trains and motors such type of trackers are controller based that respond to the solar light [7]. Several applications contain solar tracker such as solar thermal arrays, solar day lighting system and solar cells. Tracker is very beneficial device for higher efficiency [8]. Majority of the solar panel are roof mounted. As the sun is a moving object, this one is not a useful method. The best method is to track the sun path by using sun-tracking system. Such that the maximum energy can be absorbed when the panel facing is exactly in front of sun light. This could be a panel's highest efficient position [9]. The capital cast of implementing PV arrays to harvest the solar energy is quite high for under developing countries like Pakistan. Thus locating solar PV arrays at right place and making them capable of harvesting maximum solar energy is real challenge that researchers are facing [10]. The moto of this research project is to obtain enhanced efficiency from the PV cells. However, many solar trackers are available in the market, which are highly priced because solar panel technology is not that much old, only few countries have such resources to produces PV panels. For residential purpose, large-scale solar tracker is not suitable [11]. In this regard, sun-tracking system is supposed to be developed which will be cost effective.

II. SYSTEM DESCRIPTION

Proposed research work consists of a solar tracker that supports the photo-voltaic panel and tracks the sun route in day time to maximize the efficiency of solar panels. PIC Arduino board gets the signal from LDR sensor and through its programming, Arduino gives signal to L289N driver circuit that rotates the tray through 12v DC motor.

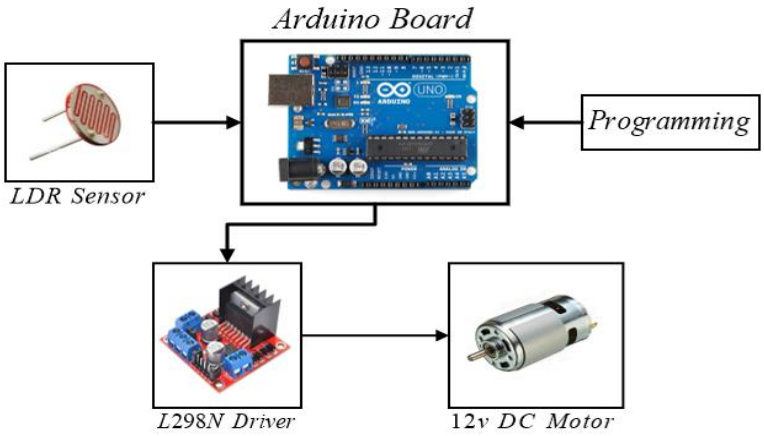

Fig 1: Block diagram of Solar Tracker System

III. RESEARCH METHODOLOGY

There are multiple components are used in tracker i.e. microcontroller over Arduino board, LDRs as sensor, L298N motor driver relay and many more. Arduino/Genuino Uno board contain microcontroller, which is based on the principle of ATmega328P. Arduino UNO board contain 6 analog input pins, 14 digital pins out of which six can be used as a PWM output. Arduino board has a USB port to interface with computer and power jack to energize Arduino board without using computer. Project utilizes four light dependent resistor as a sensor. They sense the higher thickness territory of daylight. The sunlight based board moves to the high light thickness region through servo engines. Each L.D.R is associated with power supply shaping a potential divider, consequently any adjustment in light thickness is corresponding to the adjustment in voltage over the L.D.R. L298N is an IC that that comes in a circuit driver. The driver circuit can run two DC motors at a time with voltage ranging from 5v to 35v. It is dual H-bridge circuit that is commonly used in trackers to set the position precisely.

IV. HARDWARE MODEL OF TRACKER

Solar photovoltaic panel is placed on module with thread shaft support to move it with proper angle in means of horizontal and vertical to get the maximum sun light reflectivity and maximum amount of output electric power. LDR as sensor give input to the controller in Arduino board that keep changing the angle of the tracker called hour angle. When an observer is observing sun from any point on the Earth, Sun keeps changing its angle from its solar noon position, which is just vertically above the observer.

Fig 2: Hardware Model of Solar Tracker

Hardware model of the tracker is capable of changing its plane angle corresponding to the solar hour angle.

V. RESULTS AND DISCUSSION

After design of the hardware and its fabrication of the hardware, results are taken to validate the results of the prototype. The results for the performance indication of the tracker is taken in Mehran University of Engineering and Technology, Jamshoro. The results are taken for 6 days i.e. from 27th June 2018 to 2nd July 2018. Data for current and voltage is taken from 09:00am to 04:00pm in prescribed dates and the average of short circuit current, open circuit voltage and power of the static photovoltaic panel and the prototype is given in table 1.

	Voc Static PV	**Voc Prototype**	**Isc Static PV**	**Isc Prototype**	**Pav Static PV**	**Pav Solar PV**
Day 1	20.12V	19.66V	0.286A	0.47A	5.78W	9.25W
Day 2	20.12V	19.78V	0.31A	0.52A	6.67W	10.13W
Day 3	19.87V	19.75V	0.28A	0.51A	5.70W	10.21W
Day 4	19.85V	19.77V	0.29A	0.51A	5.74W	9.73W
Day 5	19.88V	19.76V	0.27A	0.50A	5.53W	10.09W
Day 6	19.86V	19.75V	0.28A	0.50A	5.67W	10.82W

Table 1: Average values of Voc, Isc and power of PV panel

Results taken from the prototype are compared with the static solar PV model and the results are analyzed for efficiency of these two and difference in their output power which are given in table 2.

Serial No.	**Test Setups**	**Efficiency (%)**
1	**Static Solar Photovoltaic penal**	**11.99**
2	**Prototype**	**24**

Table 2: Efficiency Comparison of Static PV Panel and Prototype

Though the setup is giving results for six days but from the data of six days it becomes clear that the solar panel with tracker is more efficient. Particularly the efficiency of solar PV panel placed on tracker is 12.01% more as compare to the solar PV panel without changing its position corresponding to the position of the sun though out the day time.

VI. CONCLUSION

Through the research given in fore chapters following points came worth mentioning as given below one by one.

- The prototype made is proved to be efficient than the static solar photovoltaic panel without tracker.
- Super capacitor attached in system for high current and small-time disturbance is proved to increase the current and voltage of the panel which is laid on the frame with tracker mechanism.
- Efficiency of the Static solar PV panel is 11.99% whereas the efficiency of the prototype is 24%, that shows the prototype of the tracker mechanism is having 12.01% more efficiency.

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