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Development of an Automated Solar Tracking System with Integrated Inverter Module for Enhanced Power Generation

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Abstract: Renewable energy sources are becoming one of the most important resources in today's world because of their many benefits. In particular, solar energy continues to be a source of non-combustible and non-polluting energy to meet our ever-growing energy needs. However, solar panels, which are important components of solar energy conversion, are not able to track the direction of sunlight through daily and seasonal changes. This reduces the area of exposure to sunlight to solar panels and the efficiency of the solar tracking system involving solar panels. We have developed a solar tracking system using a combination of micro-controller, stepper motor and light dependent resistors (LDR's) for the primary purpose of improving solar energy efficiency. A key part of this tracker is an Arduino controller designed to detect sunlight with the help of LDRs and then set up a ladder to position the solar panel in such a way that it receives maximum sunlight. So this system can achieve greater light and can reduce the cost of generating electricity by requiring a small number of solar panels with the right shape and sunlight.
Keywords: Solar tracker mechanism, LDR, DC motor, controller, solar panel, Inverter, AC load etc.

I. INTRODUCTION

It has been found that the efficiency of solar panels improves by 30-60 percent when using a portable solar tracking system instead of a fixed solar panel system. Therefore, designing and using an energy-efficient solar tracker is challenging due to the immobility of solar panels.

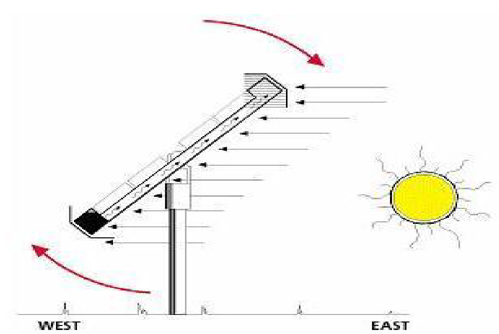
The angle of inclination of the sun's rays and solar panels continues to change due to the movement of the sun from east to west due to the rotation of the earth without weather conditions. In addition, during cloudy days the situation becomes extremely tense. Adding to the earth's axis changes the distance between the earth and the sun which introduces a change in the pattern of incoming solar radiation.

All of these factors must be taken into account in designing a solar tracking system to achieve maximum efficiency.

To develop a solar tracking system using a combination of micro-controller, stepper motor and light dependent resistors (LDR's) with the primary objective of improving the efficiency of solar panels. Nowadays Many street lights soalr have a fixed location, pointing to this problem statement we want to add a dual solar tracking system.

A key part of this tracker is an Arduino controller designed to detect sunlight with the help of LDRs and then set up a ladder to position the solar panel in such a way that it receives maximum sunlight.

So this system can achieve great light and can reduce the cost of generating electricity by requiring a minimumthe number of solar panels in the correct position and sunlight.



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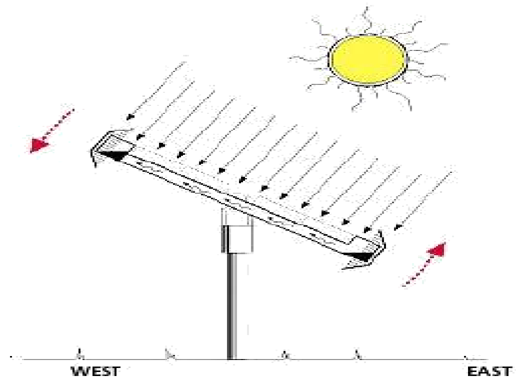

Fig.1. Passive tracking system

In this project, we have discussed a solar tracking system designed using some LDR (light-based light), Arduino control, OPAMP's contrast, crystal oscillator, stepper motor and stepper motor driver, tracker Mechanism . The basic idea behind this work is that the intensity of the light will be felt by the LDR separated by a certain angular distance, the comparators will compare the intensity of the incident light with the intensity of the perpendicular incident. The controller will rotate the stepper motor at the angle you want depending on the output of the comparators with the stepper driver circuit to increase efficiency. Due to changes in the position of the device and the weather conditions, the intensity of the sunlight changes, which we have done to change the value of the threshold by changing the resistance.

II. PROBLEM STATEMENT

Too many areas prefer to use mineral oil as their main source of electricity. This means that people are subject to the limits and the filth that comes with it. With traditional power, broad and expensive infrastructure must be installed which means that in developing countries, electricity is limited to one lamp or brand new buildings. This project proposes to implement a system that can improve solar energy production by 30-40% using a tracking system to use a control circle that sets the two stepping motors used to orbit the solar panel properly.

III. OBJECTIVES OF STUDY

The main objectives of the research are set out below:

- Design a system that can control the location of the solar panel in line with the solar environment.
- Establish a more affordable solar tracker for commercial solar trackers.
- To apply this power to AC loads using MPPT and inverter module.

The aim of our projects is to utilize the highest solar energy through a solar panel. This is a digital digital day tracking system.
The solar panel automatically tracks the sun from east to west for maximum light intensity.

IV. SCOPE OF PROJECT

The project tested the use of a solar panel to tracker stepper motors due to its high speed and low power consumption, tracking the sun in a horizontal position so that there is more light on the panel at any time of the day. Two light sensors mounted on a solar panel were able to detect the sun's rays, that is, a pair of motion on each axis. The voltage at the two opposite ends of the solar panel was compared and the microcontroller used their difference as an error that stepper motors had to rotate at a corresponding angle to adjust the position of the solar panel until the two LDR inputs were equal. Since LDRs produce analog output voltage and the controller can read only digital output, an external Analog-to-Digital converter is used in the system. The stepper motor was driven by the IC motor driver as the microcontroller could handle the power requirements of the stepper motor. In this way the solar tracker does its job.

V. BLOCK DIAGRAM

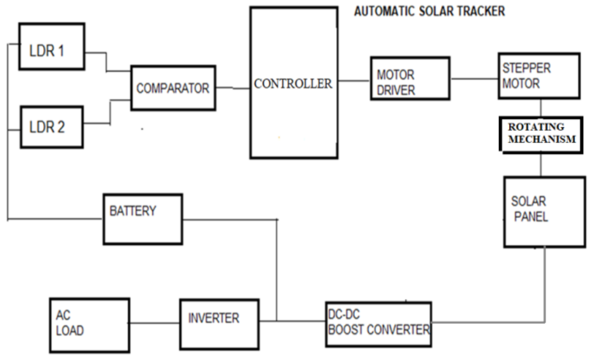

Fig.2. Block Diagram of system

VI. WORKING

- In hardware setup to make the most of this project, LDRs should be on top of the maximum curvature. And the machine must be made so that any two adjacent LDRs can be operated on time. And the DC engine will follow a small pattern of, and the solar panel connected to the shaft of the DC motor will remain in direct sunlight. The LDR combination plays an important role. In fact these signal combinations are provided by the Arduino control and this directs the engine associated with it.
- The solar panel is connected to the DC motor and its rotation system. So the function of tracking the sun is happening. It also helps to increase the efficiency of the solar panel. The solar panel generates energy and is stored in the battery. It is then used for active AC loading with Inverter module.

VII. COMPONENTS

The main operating components of this system are:

- Photovoltaic Solar Panel
- Arduino controller
- Comparator LM324
- Gears Mechanism
- LDRs
- Motor driver IC L293D
- DC motor
- Frame
- Inverter
- Battery
- AC Load
- Others

VIII. ADVANTAGES

1) Solar trackers are the most effective machines. Operating costs are much lower when the initial investment is made to build a solar power plant.
2) Since the solar tracker is directly exposed to the sun's rays, it can produce more electricity compared to its immovable counterparts.
3) Solar trackers continuously direct photovoltaic panels to the sun, increasing investment in photovoltaic systems.
4) Most likely, in the same space required for fixed tilt systems when installed with solar trackers, solar trackers can generate additional electricity which makes the space more efficient.
5) Solar trackers can best be used in low-lying and shady areas from dawn to dusk.

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IX. RESULT & DISCUSSION

The designed prototype was tested with the help of a flashlight portable lamp in the laboratory. When the flash light was introduced from the east side where the LDR1 was placed the contrast difference was found to be correct and greater than the boundary value. As we moved from east to west, there was a constant flow of contrast that continued to drop until the point where the comparison was zero, this time a torch was common on the solar panel. As we moved further west we noticed that the comparative output began to increase exponentially. In prototype 8051 it was used as a microcontroller, OPAMP was used as a comparison, the l293d was used as a dc car driver and a dc 12v motor.

Table 2: Output Voltage and Current for a Fixed and a Tracking Solar Panel.

Time	Fixed Solar Panel		Tracking Solar Panel	
	Output Voltage (Volts)	Output Current (Ampere)	Output Voltage (Volts)	Output Current (Ampere)
8.00 hrs	10.8	0.21	11.9	0.37
9.00 hrs	10.9	0.45	11.8	0.47
10.00 hrs	11	0.48	12.2	0.51
11.00 hrs	11.4	0.50	.12.3	0.53
12.00 hrs	11.8	0.52	12.8	0.56
13.00hrs	12.3	0.51	12.7	0.55
14.00hrs	12.8	0.50	12.6	0.53
15.00 hrs	11.5	0.43	11.9	0.49
16.00hrs	11.4	0.37	11.5	0.42

We know that Output Power of DC equipment is given as:

$$Pout = Voltage * Current$$

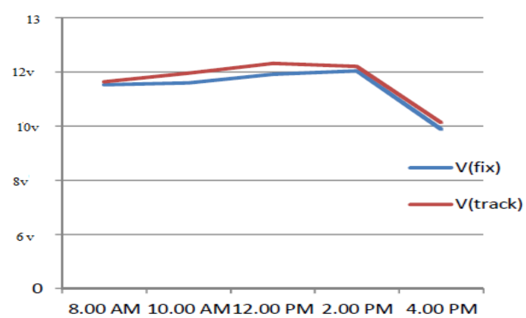

Fig.3. Comparison of Voltage O/P between fixed solar panel and tracking solar panel

The graph representation of the line above in Fig 6 shows the comparison between the power output of a fixed solar panel (Vfix) and a solar tracking panel (Vtrack), every 2-hour intervals shown on X-axis and Vout by voltages at Y-Axis.

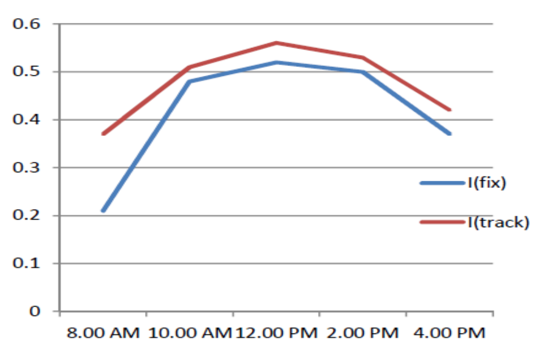

Fig.4. Comparison of Current O/P between fixed solar panel and tracking solar panel

The graph representation of the line above in Fig. 7 shows the comparison between the output of the fixed solar panel, I (fix), and the solar tracking panel, I (track), every 2 hours intervals displayed on the X-axis and Iout e Amperes on the Y-axis.
To calculate the increasing percentage of energy output due to the following solar panels with respect to fixed solar panels we have the following formula:

$$\left(\left(\frac{\text{Power Output of Tracking Solar Panel}}{\text{Power Output of Fixed Solar Panel}}\right) - 1\right) * 100$$

As shown in the table both the single axis and the double axis have their share of advantages and disadvantages, in fact the double axis works very well, but due to the low cost of designing a single axis tracker, they are not very large changes in the output of a single axis . solar panels due to two trackers in the northern parts of the country with bright sun and that depending on the season varies we can personally direct the solar panel facing north during the summer and south in the winter every 6 months without much controversy, we chose design. single-axis tracking system.

X. FUTURE SCOPE

This project presents an interesting and easy attempt to use Solar Tracker using LDR and Microcontroller. The use of gears instead of a line actuator helps to increase the efficiency of the overall tracker. The design helps to generate maximum energy from the sun's rays by tracking using a double axis tracker. This can happen if the solar panel stays in direct contact with the sun's rays. The proposed method identifies the following features:

- Easy implementation and economy.
- Ability to simultaneously adjust the panel on both axes.
- Ability to adjust tracking accuracy.
- Provides effective tracking even under different weather conditions.

XI. CONCLUSION

In this project a solar tracker has been upgraded to increase the amount of energy generated by the solar panel as the sun passes through the sky. A controller was used to control the movement of the solar panel. The system is designed to be independent; so much so that the energy produced by the solar panel will be used to charge two batteries of lead acid. In this project some difficulties regarding placement or LDR are faced, so that at the same time more than two LDRs can be implemented. All readings are taken very carefully during the project to eliminate as many errors as possible.

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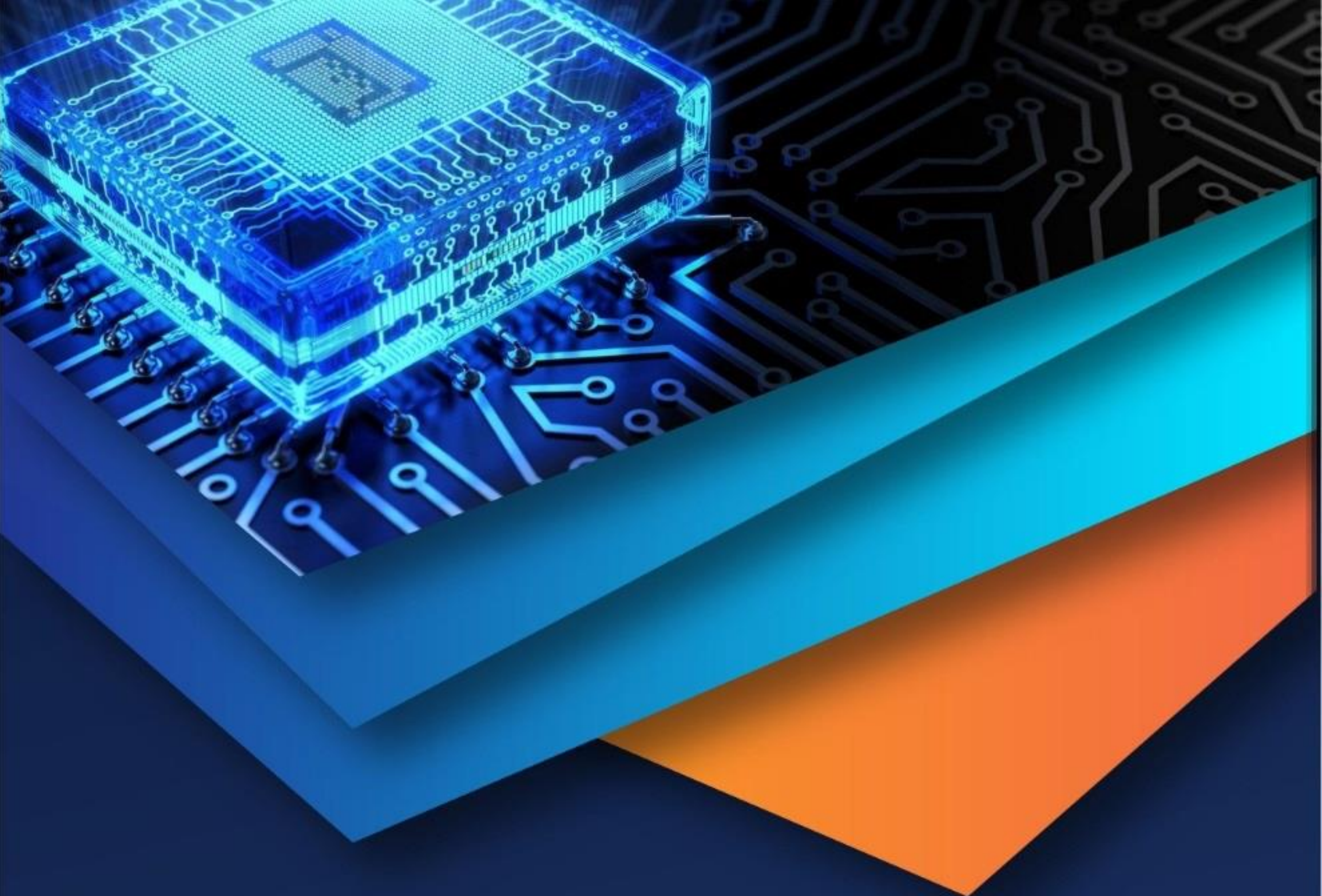

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