DUAL AXIS SOLAR TRACKING FOR EFFICIENT SOLAR POWER CONVERSION

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ABSTRACT

The project will include the design and construction of Arduino based dual axis solar tracking system. The system builds upon topics learned in the course. A working system will be ultimately be demonstrated to validate the design. PROTEUS Simulation is used for the initial validation of the proposed scheme and for the selection of circuit parameters. And lastly, a comparison of efficiency is done between the traditional solar tracking system and a dual axis solar tracking system.

Keywords—solar panel, dual axis tracking, Arduino

I. INTRODUCTION

Renewable energy is that from of energy whose utilization rate is lower than its rate of renewal. The source can be terrestrial (thermal energy), gravitational (tidal power) and solar (energy stored in solar radiation, the kinetics of winds and waves), Moreover, the sources of agricultural waste, municipal and industrial renewable energy are considered. The renewable energy sources are appropriate to the strategy of sustainable development, contribute to improving the global comprehensiveness of industries, have positive effects on regional development and employment and ultimately, end users are more conscious to consume and preserve the environment . Out of all the renewable energy sources, solar energy is the most abundant and easily available energy. Solar cell (Also called photo voltaic cell) is an electrical device that converts energy of light directly into electricity by photovoltaic effect. Solar cells are building blocks of photovoltaic modules, otherwise known as solar panels. Solar panel is a set of photo voltaic modules which is electrically connected and mounted on supporting structure to absorb sun rays as a source of energy for generating electricity or heating. A dual axis tracking system was used. It is cheaper, less complex and still achieves the required efficiency. In terms of costs and whether or not the system is supposed to be implemented by those that use solar panels, the system is viable. The increase in power is considerable and therefore worth the small increase in cost. Maintenance costs are not likely to be high.
A comparison of efficiency is done between the traditional solar tracking system and a dual axis solar tracking system.[1]

This design consists a working experimental model which focuses on the use of solar panel which would follow sun's motion viz. Azimuth altitude, automatically adjusting itself every time without human intervention. To serve this purpose, we are using Light Dependent Resistors (L.D.Rs -4 Nos.) which will trace the sunlight every time and would give signal to main circuit for the motion of the panel. The motion of the panel would be done by means of gears and servo motor. All the electrical components would be controlled by Arduino which would be programmed accordingly. Dual axis tracking makes sure that panel is always in the most accurate position for better output. The photo voltaic cell (PV) cell of solar panel will convert this solar energy to electrical energy which we can store in batteries for further use Small prototype model can be installed in schools, home use, offices, etc. as standard power source and this would help reduce the energy cost substantially.

The Main components of our system are;

A. Solar Panel

A miniature solar panel is selected for incorporating it in the project as the main aim of the project is to design a charging model for mobile phones. Smaller size gives more flexibility for the design though it lowers the efficiency of power generation by the panel.[]3

B. Sensors

The main aim of LDR is to sense the higher density range of sunlight give command to relay circuit which will direct the direction of our solar panel.

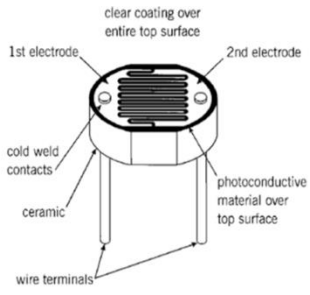


Figure1. LDR

C. Controller

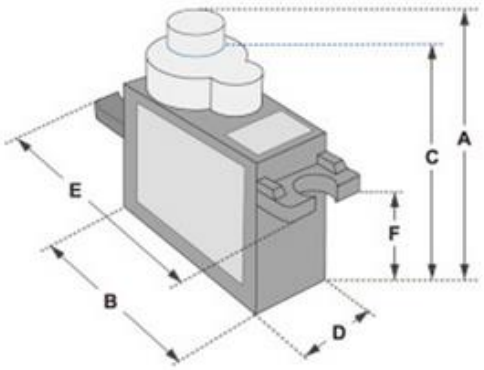
Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students

and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices.It is also capable of receiving and sending information over the internet with the help of various Arduino shields.[12]

D. Servomotor

In the project two identical servo motors (SG90) are used. One connected horizontally and the other vertically along with the model. Servo implies an error sensing feedback control which is utilized to correct the performance of a system. It also requires a generally sophisticated controller; often a dedicated module designed particularly for use the servomotors. Servo motors are DC motors that allows for precise control of angular position. They are actually DC motors whose speed is slowly lowered by the gears. The servo motors usually have a revolution cutoff from 90° to 180°. A few servo motors also have a revolution cutoff of 360° or more. But servo motor does not rotate constantly. Their rotation is limited in between the fixed angles.[15]

Figure 2. Servomotor



II. SOLAR TRACKER

The Solar Trackers are used to continuously direct the solar panel towards the sun rays, thus assisting in maximizing the expectation towards this system. This system efficiently tracks sun's position in the sky and generate more electricity than their counterparts because of increased direct exposure to the sun light. There are two kinds of solar tracker single axis and dual axis trackers. Solar tracker generates more electricity in roughly the same amount of space needed for fixed tilt systems, making them
ideal optimizing land usage [11]. Also very necessarily, it emphasizes on not only on increasing the production of energy, but also ameliorates the way power output is delivered.

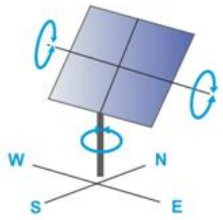
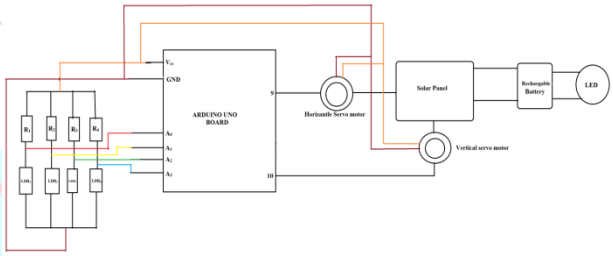


Figure 3. Dual axis tracking

Sunlight has two components, the direct beam that causes about 90% of the solar energy, and the diffused sunlight that carries the remainder. The diffused portion is the sky on a clear day which increases proportionately on a cloudy day. As the majority of the energy is in the direct beam ,maximum collection requires the sun to be visible to the panels as long as possible. A typical solar panel converts only 30 to 40 percent of this incident solar radiation into electrical energy [1], [5].

Figure 4. Block Diagram



III. METHODOLOGY

The sun is tracked with the help of Arduino programming. In which we track the sun as early as possible since from the sunrise to the sunset without using LDR. As per the survey the sun rotate about in 108 degree angle since sunrise to sunset at our place or this place. So we programmed the servo motor in a such manner that the solar panel will track the sun completely from sunrise to sunset. To track that solar panel 108 degree angle we rotated the solar panel horizontally 12 degree/hour since from 8 AM to 5 PM i.e. East to West. Now the second axis of tracking i.e. North to South. As per sources sun rotate about 47 degree angle in 183 days from North to south and vice versa. So we programmed our second stepper motor in that manner. For the days between 21st march -22nd June the sun will move towards north by the 23.5 degree and it takes 91 days to reach there. After 22nd June sun moves again towards it's first position on 21st of march after that that will reaches on 21st of September and after that it moves toward south till 22nd December and it moves back till 21st of march. So the second axis rotates by 5 degree/20 days.
In the conventional design of dual axis solar tracking
system, motion is conveyed to the panel with the help of two linear actuators. But the use of linear actuator results in various problems:

- Motion range is limited
- Noisy operation.
- Very slow operation.

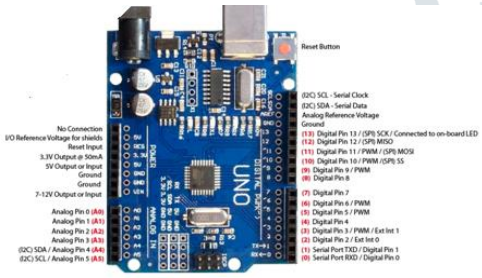
Thus, in this design we opted for the use of gear arrangement for the motion of panel along both the axes.
The use of gear instead of linear actuator we get:

- Increase in step motion accuracy.
- Smooth operation.
- Increase in the motion range.

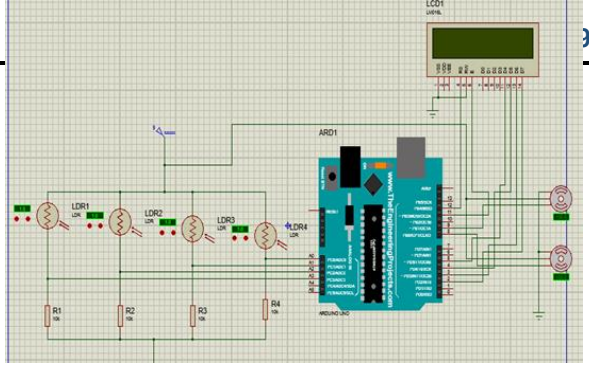
The panel consists of two pairs of LDRs which are used to track the sun's exact position is along the inclined axis and along the azimuth axis. LDR is a resistor whose resistance decreases with increasing incident light. When any of the LDR receives maximum intensity radiation its resistance decreases. This information is sent to the light comparison unit which further transfers this information to the controller.
The controller is the main control unit of the whole system, which determines the direction of movement of the motors in both azimuth and vertical axis. The implementation of the LDR is based on shadow effect. If the solar panel is not perpendicular to the sun's rays the shadow will cover only one or two LDRs, this causes different light intensity to be received by the sensing device.
The output signal from the microcontroller is supplied to the DC motor which gives step motion to the panel accordingly to the incident radiation.

IV. PERFORMANCE ANALYSIS AND RESULTS

The performance carried on our working model showed improvement in the output performance against the static panel and single axis solar panel. The following two graphs show the values of the output obtained on our model. The first graph as shown in Fig.4 gives performance throughout
the day and the second graph as sown in Fig. gives the comparison of output between the various tracking system as mentioned above.



5. (a)



5. (b)

5. (c)

Figure 5. (a) Arduino PIN Diagram
5. (b) Schematic Diagram
5. (c) Hardware Model

LDR Calculation

The calculation is done by adding the two values from two different LDRs and taking there average (summation divided by Two). The panel moves towards the direction of the value greater than the other one. This is one by using 6 different LDR pairs choosing randomly.

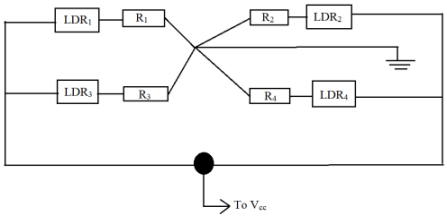


Figure .6 LDR Connection

V. COMPONENTS

Serial Number	Name of the Apparatus	Quantity
1.	LDR	4
2.	Jump Wire	14
3.	Resistance	4(10Ω Each)
4.	Arduino UNO	1
5.	Bread Board	1
6.	Servo motor	2
7.	USB Cable	1

Except these components the connecting wires, circuit board and a universal programmer to turn the clip to load program are used.

VI. FUTURE SCOPE

Alongside a variety of consumer products- electronic watches, calculator, power for leisure equipment- there is an extensive range of applications where solar cells are already viewed as the best option for electricity supply. These applications are usually stand alone, and exploit the following advantages of photovoltaic electricity:

1. The mobile devices will charge independent of any external wire and charger.
2. Solar energy is free and abundant energy.
3. The PV cell to be used is free of any moving parts and noise.
4. It will save customer's electric bills.
5. The energy is also clean and produced no hazardous waste like some of the other power generation resources.
6. As the world's conventional energy resources are diminishing, governments are encouraging for a green movement to help conserve the limited supply.

The current project can also be enhanced to perform in a modified age. We can use motor controller to improve the accuracy of the circuit and detailed study on the location. The irradiation calculation also plays a vital role so there is a need of adding it to the project which can be extended. We can use pilot tracker for tracking the system.

VII. CONCLUSION

The overall aim of this project was to generate 40% more output power than fixed solar panels. It absorbs more sunrays and generating the maximum power during the whole day time. The proposed overall solar tracking system design was tested, based on calculated data of the altitude angle of Tripura. The obtained system response result show the simplicity, accuracy and applicability of design in meeting different operational conditions. It required research into various solar cell technologies and the understanding of the various characteristics of photovoltaic panel to ensure an optimum solution for the project

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