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Dual axis solar tracking system using Arduino UNO

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ABSTRACT

Solar photovoltaic cells generate the energy by approximately following the intensity of light and using the light energy to create an electric current. There are many PV cells within solar panels and the current created by all of the cells together adds up to enough electricity. A dual axis solar energy system using "Arduino UNO" works as an automatic tracking system and controls the elevation and orientation angles of solar panels such that the panel always maintained perpendicular to sunlight. The measured variable of our automatic dual axis solar tracking system is low cost, reliable and efficient. As a result of experiment, by using monocrystalline solar panel and following the intensity of sunlight, the energy generated by dual axis solar tracking system increases consumption of energy up to 8%-25% more than fixed PV system.

Keywords— *Photovoltaic cells, Arduino UNO, monocrystalline solar panel, PV system*

1. INTRODUCTION

Our earth intercepts around 173 thousand terabytes of solar energy, which is enormous amount of energy. But from that we can only consumed about 46% of solar energy and from that we can use 15% to 20% of energy for commercial use. And the reason behind this cloudy weather, rainy season, sometime dust takes place on solar panel, and as we all know that our sun rotates around earth so, there is day-night situation.

We already have solar technology but from that we can use only about 15% to 20% of energy. So, to boost the energy consumption, to increase the amount of energy. We came up with "Dual Axis Solar Tracking System." In this we are using monocrystalline solar panel and we used servo motors to rotates our panel as sun changes its direction to keep the panel parallel with sun, and to increase consumption around 30% to 35% of energy.

2. METHODOLOGY

The solar tracking system with an intelligent method contains an Arduino uno microcontroller board. Four LDR sensors, two servo motors, a motor driver board and an MPPT charger module. An FLC is applied within the system through Arduino programming. The aim of this project is consumption and maximize the solar power generation. The Arduino uno microcontroller board which controls the general performance of the system and feedback operation. The MPPT charger modify this and voltage output of solar PV panel, then the FLC supplies conclude and decision to an Arduino uno board concerning the position to which the solar PV panel should rotate and therefore the direction of rotation. Four LDR's sensors are placed on the solar array.

One on all sides. These sensors are used for the sensing the positional changes of the sun, thus the tracking the movement of the sun. the LDR sensor are inputted into Arduino and Eventually used because the input variable to FLC. Then FLC makes decision encouraged outputs imprecise reasoning and sends the output to motor drivers. Two power window motor pivot the solar PV panels horizontally and vertically to the position during which the panel is perpendicular to the sun and intensity of solar irradiance is maximized. The sensor continuously monitors the radiation and this data are transferred to power window motor via the Arduino uno microcontroller.

3. TYPES OF SOLAR PANELS

Solar panels interact with the photons coming from sun. when these photons appear on solar panel then the electron starts conducting and electrons which are laced in solar cell gets

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activated and start to flow through panel. And while flowing through they convert photons into electrical energy.

Table 1: Types of Solar Panel

Parameter	Dual axis solar tracking system	Medium size dual axis solar tracking system	Dual axis solar tracking system using Arduino
Type of solar panel	Polycrystallin e	Monocrystalli ne	Monocrystalli ne
Type of supply	External	External	Internal battery
Power efficiency	Low	High	High
Convertor	Invertor circuit	MPPT	Invertor circuit

3.1 Polycrystalline Solar Panel

Polycrystalline solar panel is also known as multi-crystalline solar panel. Because of those panels consist several crystals of silicon in single photovoltaic cell. Some silicon fragments are melted to form a wafer for the panel. This panel surface look like mosaic. When photons from sunlight bombarded on panel, it imparts energy to electron so they can flow as electric current.

Here, p-type material is inferior of electron and n-type material are abundance of electron. As there are numerous silicon crystal in each silicon cell, so polycrystalline solar panel allows minuscule movement of electron inside the cell. And that's the reason behind their low efficiency and the range is in between 15% to 20%.

3.2 Monocrystalline Solar Panel

Monocrystalline solar panel is made by single crystal of pure silicon. In this, silicon is formed into bars and then cut it into wafers. Monocrystalline solar panel is in black color. Because of bars when photon interact with solar cells are flow in serial form. To maximize the utility of the cells the circular wafers are wire cut to octagonal shaped wafer. These cells look unique because of octagonal shape. These cells are in pyramid pattern which offers a largest surface area to collect more energy from sun's rays. To reduce reflection the cells are coated with silicon nitrate. This panels are made out of highest grade of silicon which are pure form of silicon and therefore the efficiency of monocrystalline solar cell is high and the range is in between 20%-25% this panels have longevity and they exhibit greater heat resistance.

4. COMPARATIVE ANALYSIS

4.1 Fixed Mount Solar Panel

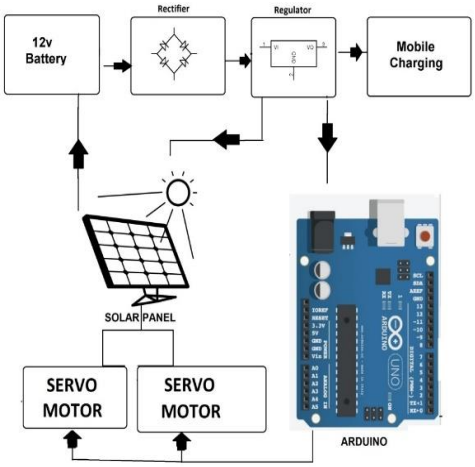
This solar panels will have ideal output when they are superbly perpendicular to then sun. given that, the angle will almost always moment each day when the panels are perpendicular to the sun and utilize all the available energy; the rest of time they are not quit operating at full capacity.

4.2 Single Axis Solar Tracker System

Single axis tracking system tracks sun position as sun moves from east to west. In this it uses one electric motor to rotate the panel estimate trajectory relative to sun's position. The rotation can be horizontal, vertical or oblique. Single axis tracker will generate less energy as compare to dual axis solar tracking system.

5. BLOCK DIAGRAM

As we see in the block diagram, there are three Light Dependent Resistors (LDRs) which are accommodate on a common plate with solar panel. Light from a source afflict on them by different amounts. Due to their intrinsic property of decreasing resistance with enlarging incident light intensity, i.e. photoconductivity, the value of resistances of all the LDRs is not every time same. Each LDR sends identical signal of their respective resistance value to the Microcontroller which is configured by required programming logic. The values are compared with each other by contemplate a particular LDR value as reference. One of the two dc servo motors is mechanically attached with the driving axle of the other one so that the foregoing will move with rotation of the axle of latter one.



6. WORKING

For "Dual Axis Solar Tracking System" we are using monocrystalline solar panel to enhance the consumption of energy, LDR to detect high intensity of sun, servo motor to rotate and keep solar panel parallel with the sun, battery to store the consumption of energy and Arduino uno to controlling all components and take appropriate actions.

In this project our main focus is on sun intensity. Cause sun is the source of light on earth, it is the core of light, that's why as light spread the more intensity we collect from the core. If we may explain it phonetically, as sun rises it spread light, the medium of this source is having more intensity as compared to surrounding area. So, to determine high intensity, we have placed 4 LDR at each corner of the solar panel. Those LDR detect high intensity, locate the sun position and that position status send it to Arduino uno. It collects that data and takes an appropriate action, rotates the panel by servo motor and keep in parallel with sun.

Then monocrystalline solar panel accept the photons, collect those and then solar cell gets excited and activated. After activation those solar cells convert those photons into solar energy and stored in battery.

7. RESULTS

In this Dual Axis Solar Tracker we observed that, when the source light falls on the panel, the panel adjusts its position according to maximum intensity of light falling perpendicular to it. The objective of the project is completed. This was achieved through using light sensors that are able to detect the amount of sunlight that reaches the solar panel. An input stage that was responsible for converting incident light to a voltage. A control stage that was responsible for controlling actuation and decision making. A driver stage with the servo motor. It was responsible for actual movement of the panel. The input stage is

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designed with a voltage divider circuit so that it gives desired range of illumination for bright illumination conditions or when there is dim lighting. The potentiometer was adjusted to cater for such changes.

Table 2. Comparison Between Power for Fixed Mount, Single Axis, And Dual Axis

Hours	Power for fixed mount in W	Power for single axis in W	Power for dual axis in W
07.00	0.09	0.35	0.68
08.00	0.25	0.47	0.87
09.00	0.75	1.02	1.55
10.00	0.98	1.23	1.78
11.00	1.58	2.24	2.86
12.00	2.5	3.1	3.15
13.00	2.22	2.54	2.98
14.00	1.88	2.11	2.44
15.00	1.58	1.86	2.3
16.00	1.56	1.7	2.01
17.00	0.78	0.98	1.56
18.00	0.44	0.65	0.78
Sum = 12 hrs	14.61 W	18.25 W	22.96 W
Solar energy in W/hr. (Day Time)	1.2175 W/hr	1.5208 W/hr	1.9130 W/hr
All day solar energy output	**0.6087 W/hr**	**0.7604 W/hr**	**0.9566 W/hr**

The LDRs were found to be most suitable for this project because their resistance varies with light. They are readily available and are cost effective. Temperature sensors for instance would be costly. The control stage has a microcontroller that receives voltages from the LDRs and determines the action to be performed. The microcontroller is programmed to ensure it sends a signal to the servo motor that moves in accordance with the generated error. The final stage was the driving circuitry that consisted mainly of the servo motor. The servo motor had enough torque to drive the panel. Servo motors are noise free and are affordable, making them the best choice for the project.

8. CONCLUSIONS

Dual axis tracker immaculate aligns with the sun direction and tracks the sun movement in a more efficient way and has a immense performance improvement. The proposed system is cost efficacious also as a little modification in single axis tracker provided eminent power rise in the System.

8. FUTURE SCOPE

Now days people are seeking for electric vehicles, we can plant Some vehicle charging stations. Also, at airport energy used is 19.7kWh so if we use solar energy we don't need to generate energy sources for providing electricity. Even in India some airports work on solar energy, for e.g., Puducherry airport, Cochin airport. Which generates around 12-megawatt power with fixed panel if we used dual axis then the energy would be multiplied.

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