Single-Axis Sun Tracking Solar Panel

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Abstract:—With the steep increase in demand for energy and depleting resources of non-renewable energy, it is imperative to develop new and efficient ways of harnessing energy to meet the demand. Solar energy being an abundant resource is still not as efficient as conventional power plants. While work is being done in order to improve the efficiency of solar panels, it must be noted that their efficiency can also be improved by means of moving it along with change in incidence of light on the panel. This solar tracker aims to increase the efficiency of harnessing solar energy which is cheaply available. The solar tracker is built with the help of Arduino UNO.

Keywords: - Solar tracker, Arduino UNO

I. INTRODUCTION

The solar tracker is simple yet dynamic, inspired from sunflowers which rotate along with the change in direction of incidence of sunrays. Trackers direct solar panels or modules toward the sun. These devices change their orientation throughout the day to follow the sun's path to maximize energy capture.

In photovoltaic systems, trackers help minimise the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface) between the incoming light and the panel, which increases the amount of energy the installation produces. Concentrated solar photovoltaics and concentrated solar thermal have optics that directly accepts sunlight, so solar trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun

II. PRINCIPLE

The movement of the solar panel is dependent upon the direction from which the sunrays are incident on the two LDRs fixed at opposite ends of the panel. The signal is then transmitted to the Ardunio UNO which directs the motor driver to signal the rotation of stepper motor. Light shining on the solar cell produces both a current and a voltage to generate electric power. This process requires a material in which the absorption of light raises an electron to a higher energy state, and secondly, the movement of this higher energy electron from the solar cell into an external circuit. The electron then dissipates its energy in the external circuit and returns to the solar cell. A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials in the form of a p-n junction.

III. WORKING

When light is incident on any one of the LDRs, it senses this and sends a signal to the Arduino UNO. The UNO in turn decides based on which LDR sent the signal, the need to rotate by a maximum of 45degrees. Once decided it sends the signal to the motor driver which in turn drives the rotation of the stepper motor thereby rotating the panel attached to the pencil acting as the arm i.e. electrical energy is converted to mechanical energy. Here the micro-controller draws power from the supply by means of a USB cord whereas the motor driver draws power from the battery.

IV. COMPONENTS REQUIRED

- LDR
- Motor driver L298
- 5V DC Stepper motor
- Battery (12 V)
- Arduino UNO
- Solar panel

B) COMPONENTS DESCRIPTION

4.1) Solar Panel A solar cell is, in principle, a simple semiconductor device that converts light into electric energy. The conversion is accomplished by absorbing light and ionizing crystal atoms, thereby creating free, negatively charged electrons and positively charged ions. If these ions are created from the basic crystal atoms, then their ionized state can be exchanged readily to a neighbour from which it can be exchanged to another neighbour and so forth; that is, this ionized state is mobile; it behaves like an electron, and it is called a hole. It has properties similar to a free electron except that it has the opposite charge

Light-emitting diodes are elements for light signalization in electronics. The basic principle behind the working of LED is electroluminescence. The Light emitting diode should be forward biased to get the light.

Fig1. Solar panel

The main advantage of Light emitting diode over other light sources is its increased efficiency. LEDs are available in red, orange, amber, yellow, green, blue and white. Blue and white LEDs are much more expensive than the other colours.

4.2) Light Dependent resistor

A light dependent resisitor is a resisitor whose resistance changes with the intensity of incident light. The working principle of light dependent resistor is photoelectric effect. A light dependent resisitor is made of a high resistance semiconductor. If the energy of the incident light is greater than the band gap of the semiconductor, electron -hole pairs are generated. The photogenerated electron-hole pair transits the device giving rise to photoconductivity.

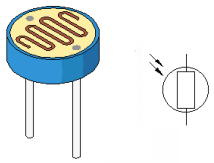

Fig2. Light Dependent Resistor and its circuit symbol

4.3) Arduino UNO

It is a micro-controller board based on ATmega328 having 14 pins for input/output. It is powered by USB connection or external power supply. The program coded in the micro-controller directs the motor driver to rotate the motor.

4.4) Motor driver L298

The L298 is an integrated monolithic circuit in a 15-lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver de- signed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. It contains two enable outputs as well. It drives the motoring action of te motor.

4.5) Stepper Motor

A unipolar stepper motor has one winding with center tap per phase. Each section of windings is switched on for each direction of magnetic field. Since in this arrangement a magnetic pole can be reversed without switching the direction of current, the commutation circuit can be made very simple (e.g., a single transistor) for each winding.

4.6) Battery

A battery is an electrochemical cell (or enclosed and protected material) that can be charged electrically to provide a static potential for power or released electrical charge when needed. It is used to give power supply to the motor driver.

V. HELPFUL DIAGRAMS

A. Circuit Diagram

The circuit diagram given is for reference, it depicts the connections required between the motor, motor driver and micro-controller.

This can be used for construction and learning purposes.

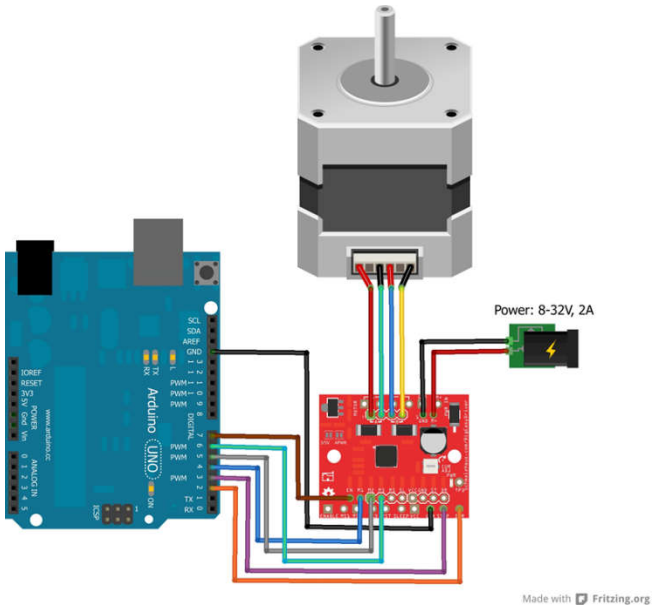

Fig3. Circuit diagram without solar panel

VI. USE OF THE PROJECT

This project is a step in solving the energy demand-supply crisis. It is based on generating cleaner energy and making such systems more efficient. The solar Tracker increases the amount of sun light capyured thereby increasing power generation and at the same time increases profitability of keeping solar panels.

VII. ADVANTAGES

- As compared to stationary panels, they generate more electricity due to increased exposure requiring nearly the same amount of space.
- A Single-axis solar tracker can generate around 20% more electricity than a stationary panel.
- Economically feasible and highly efficient in hilly regions and places where tariffs are high

VIII. LIMITATIONS

It must be noted that even though it is a project to increase efficiency of harnessing energy, the design is ultimately dependent on external power source.

IX. FUTURE SCOPE

The major setback is that due to its single-axis rotation the amount of incident light received is along one dimension. It is possible to move the panel along two different axes so as to improve its efficiency and increase amount of light incident on it

X. CONCLUSION

The Solar Tracker design is effective in increasing the amount of energy generated using the same solar panels placed stationary elsewhere. Also it increases the efficiency of power generated from the solar panel setup.

XI. ACKNOWLEDGMENT

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XII. PROJECT PHOTO