Implementation of dual axis solar tracker model by using microcontroller

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Abstract— As we are in increasing demand of power these days, power sector has been playing a vital role in our day today life. Heading towards the damp increasing power, solar energy comes to the picture or in our mind why because it is one of the most important renewable energy sources on the earth which must be collected and should be utilized to its maximum efficiency. Considering the utilization of solar power we have tried to develop a dual axis model of a solar panel which can provide or utilize the maximum solar power headed by the practical efficiency. Experimental designs proved that solar energy utilization can easily solve the problem of power in the world if used to its maximum. The single axis model have reached up to 50% efficiency and we have tried to increase the efficiency again by 20-30%.This paper describes the design of a dual axis model of solar panel which tracks the maximum solar energy with the help of microcontroller. No doubt our system encircled by solar panel, microcontroller, gears, sensors and stepper motor.

Keywords— Solar cell, solar panel, solar tracker, photocell, microcontroller, sensor, stepper motor.

INTRODUCTION

In recent years there has been increasing interest in the solar cell as an alternative source of energy. When we consider that the power density received from the sun at sea level is about 100 mw/cm^2, it is certainly an energy source that requires further research and development to maximise the conversion efficiency from solar to electrical energy. This document explicitly describes the controlling of solar panel with the help of microcontroller to track maximum solar energy. The precise control of solar panel is done by stepper motor. Having said that microcontroller is the heart of the design for controlling action. Microcontroller is going to sense the photon energy with the help of sensor which will provide the interrupt to turn on the controlling action. Photon energy is captured at right angles to the solar panel by stepper motor.Solar panel consist of series of solar cells whose output power in terms of electrical voltage is provided to the battery for the storage purpose. The efficiency calculations are provided at the end to have an exact idea of dual axis model. This dual axis model is totally interactive in nature due to the microcontroller action. The ports of microcontroller define the specific functions of the design, such as port1 defines the input signal from the sensor, port2 handles the stepper motor, port3 defines the excited solar cells and the converted power is defined by port4.Envirnmental conditions are also sensed by the microcontroller such as cloudy conditions, etc.

I. SOLAR CELL

The basic construction of solar cell is as shown in figure. As shown in the top view, every effort is made to ensure that the surface are perpendicular to the sun is maximum. Also note that the metallic conductor connected to the p-type material and the thickness of the p-type material are such that they ensure a maximum number of photons of light energy will reach the junction.

A photon of light energy in this region, may collide with valence electron and impart to it sufficient energy to leave the parent atom. The result is a generation of free electrons and holes. This phenomenon will occur on each side of the junction. In the p-type material the newly generated electrons are minority carriers and will move rather freely across the junction. A similar discussion is true for the holes created in the n-type material. The result is the minority carrier flow which is opposite in direction to the conventional forward current of the p-n junction. This increase in forward current is as shown in figure.

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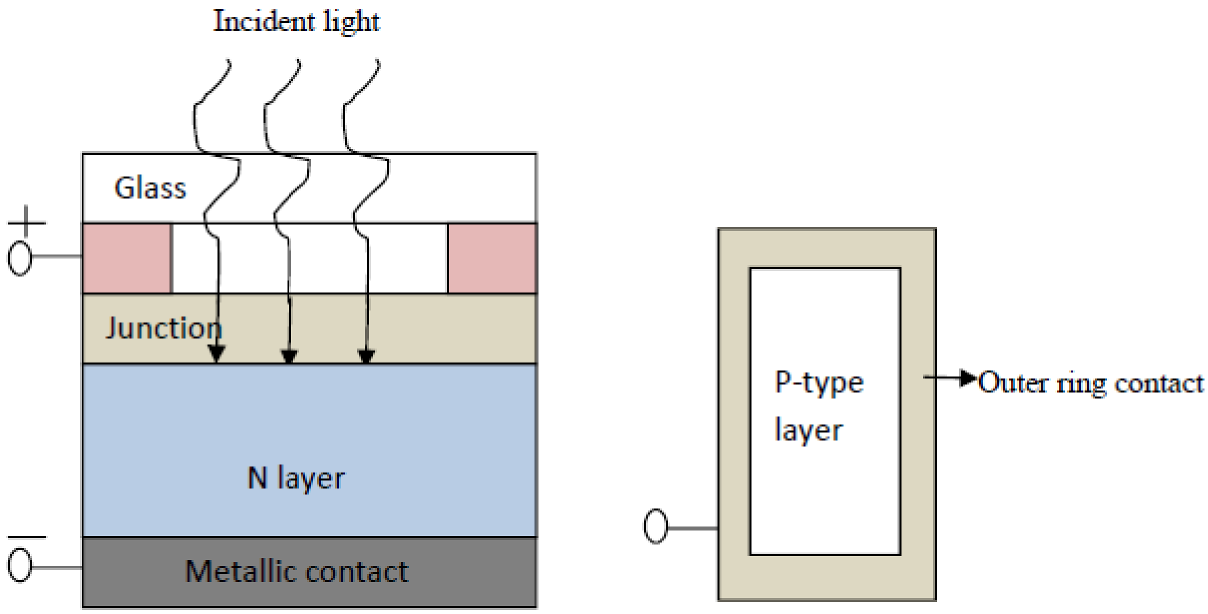

a) Construction Top view

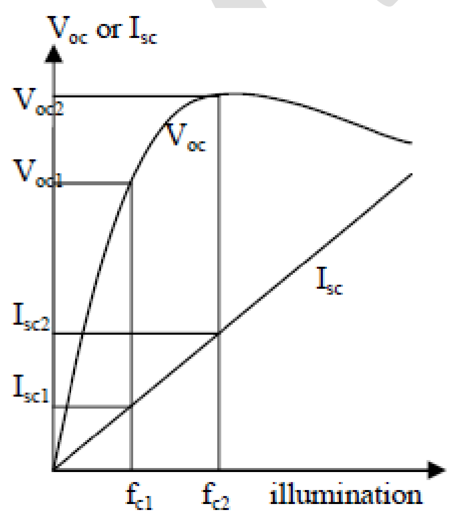

Fig 1-Voc and Isc versus illumination for a solar cell

Since v=0 anywhere on the vertical axis and represents a short circuit condition, current at this intersection is called the short circuit current and is represented by the notation I_{sc}. Under open circuit condition I_d=0 the photovoltaic voltage V_{oc} will result. This is a logarithmic function of illumination as shown in figure below. V_{oc} is the terminal voltage of the battery under no load or open circuit condition. Note however in the same figure that the short circuit current is a linear function of the illumination, while the change in V_{oc} is less for this region. The major increase in V_{oc} occurs for a lower level increase in illumination. Eventually a further increase in illumination will have very little effect on V_{oc}, although I_{sc} will increase causing the power capabilities to increase. Selenium and silicon are the most widely used materials for solar cells, although gallium arsenide, indium arsenide and cadmium sulphide among others are also used.

The wavelength of the incident light will affect the response of the p-n junction to the incident photon. In general silicon has the higher conversion efficiency and greater stability and is less subject to fatigue. Both materials have excellent temperature characteristics. That is they can withstand extreme low and high temperatures without a significant drop-off in efficiency. A very recent innovation in the use of solar cell appears in the following figure. The series arrangement of solar cells permits a voltage beyond that of a single element. The performance of a typical four array solar cell appears in the same figure. At the current of about 2.6mA, the output voltage is about 1.6v, resulting in an output power of 4.16mW

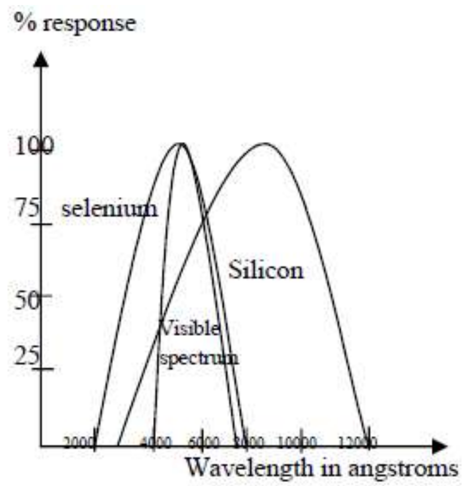

Fig 2: relative spectral response for Si, Ge and selenium as compared to human eye

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The schottky barrier diode is included to prevent battery current drain through the power converter that it will appear as an open circuit to the rechargeable battery and not draw current from it.

The efficiency of operation of a solar cell is determined by the electrical power output divided by the power provided by the light source,

i.e. $n=P_o$(electrical)/P_i(light energy)*100%

Typical levels of efficiency range from 10% to 40%. A level that should improve measurably if the present interest continues on the dual axis model.

II. MICROCONTROLLER INTERFACING

***Automatic solar tracker*:-**We all are familiar with the Newton's corpuscular theory of light, that light is made up of small particles called “corpuscles” which travel in straight line with a finite velocity and energy. Solar energy is the major Eco-friendly & Pollution less method of producing the electricity today. According to - U.S. solar research center: “ If we convert the Total Solar energy reaches to earth in one time into ELECTRICITY, then it will be more enough than whole power used by all the nations per year.

Solar Panel:-It is a large component made up of the no of photovoltaic cells connected internally with each other. Used to grab the sunlight and to convert it into the electricity.

***Solar tracker*:-**A Solar tracker is a device used for orienting a solar photovoltaic panel or lens towards the sun by using the solar or light sensors connected with the machine (ex: stepper motor, servo motor, gas filled piston). Hence, the sun tracking systems can collect more energy than what a fixed panel system collects.

***Need of Solar tracker*:-**
- Increase Solar Panel Output
- maximum efficiency of the panel
- Maximize Power per unit Area
- Able to grab the energy throughout the day

***Types of Solar Trackers*:-** The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky. Hence there are also two types of Solar Trackers

1. Single Axis Solar Tracker.
2. Dual Axis Solar Tracker.

***1. Single Axis Solar Tracker*:-**Single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type is used in tropical regions where the sun gets very high at noon, but the days are short. The vertical type is used in high latitudes (such as in UK) where the sun does not get very high, but summer days can be very long.

2. *Dual Axis Trackers*: - Double axis solar trackers have both a horizontal and a vertical axle and so can track the Sun's apparent motion exactly anywhere in the world this type of system is used to control astronomical telescopes, and so there is plenty of software available to automatically predict and track the motion of the sun across the sky. Dual axis trackers track the sun both East to West and North to South for added power output (approx 40% gain) and convenience.

III. BLOCK DIAGRAM DESCRIPTION

***Microcontroller*:-**It is the major part of the system. The microcontroller controls all the operations. The solar panel is aligned according to the intensity of sunlight under the control of the microcontroller

***Sensor*:-**The system consists of two sensors, each composed of LDR. One unit is made up of four LDRs. These are placed at the four corners of the solar panel. The intensity of sunlight is sensed by the LDR and the output is sent to the controller. The control unit analyses it and decides the direction in which the panel has to be rotated, so that it gets maximum intensity of light. The other unit of sensor is also composed of LDRs which is meant for the control of a lighting load.

***Servo motor*:-**Servo motor is used to rotate the panel in desired direction. It is controlled by the controller

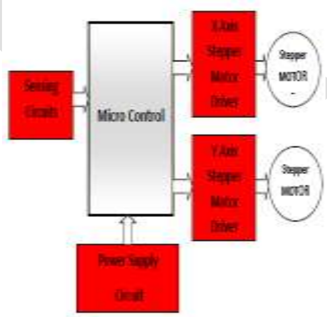

Fig 3: block diagram of dual axis model

D. ***Solar panel*:-**Solar panel is used for the conversion of solar energy directly into electricity. It is composed of photo voltaic cells, which convert solar energy into electrical energy.

E. ***Charge control*:-**It is meant to control the charging of battery. It sends the status of battery to the microcontroller unit.

F. ***Battery*:-**It is for the storage of energy received from the panel. A rechargeable battery is normally employed for this purpose.

IV. PROBLEM IDENTIFICATION & PROPOSED METHODOLOGY

The main goal of this project is to develop and implement a prototype of two-axis solar tracking system based on a microcontroller. The parabolic reflector or parabolic dish is constructed around two feed diameter to capture the sun's energy. The focus of the parabolic reflector is theoretically calculated down to an infinitesimally small point to get extremely high temperature. This two axis auto-tracking system has also been constructed using AT89C51 microcontroller. The assembly programming language is used to interface the AT89C51 with two-axis solar tracking system. The temperature at the focus of the parabolic reflector is measured with temperature probes. This auto-tracking system is controlled with two 12V, 6W DC gear box motors. The five light sensors (LDR) are used to track the sun and to start the operation (Day/Night operation). Time Delays are used for stepping the motor and reaching the original position of the reflector. The two-axis solar tracking system is constructed with both hardware and software implementations. The designs of the gear and the parabolic reflector are carefully considered and precisely calculated and the solar tracker can be still enhanced additional features like rain protection and wind protection which can be done as future also dual axis solar tracker can be constructed using AVR microcontroller such as Atmega 8/16/32 whish has inbuilt 32 KB flash memory and inbuilt Analog to Digital converter

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CONCLUSION

In this paper an attempt has been made to implement dual axis model by using microcontroller operating on a solar panel. The design is going to extract maximum power from the sun by tracking it using a dual axis solar panel. This is possible if solar panel is perpendicular to the intensity of light coming from the sun. The paper puts forward a novel approach in improving the output power as well as protection requirements for the circuit from wind and rain.

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