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Smart Solar Tracking System

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Abstract : **A solar tracking device is a machine which contains a motor equipped with relevant sensors which orients the payload towards the sun.**
Payloads can be photovoltaic panels, reflectors, lenses or optical devices. In flat-panel photovoltaic applications, trackers are used to minimize the angle of incidence between the incoming sunlight and photovoltaic panel.

Key words : Solar tracker, Sensor, Photovoltaic (PV) Panel, Arduino Uno, Servo motor

1. INTRODUCTION

Solar energy is rapidly advancing as an important means of renewable energy resource. Solar tracking enables more solar energy to be generated because the solar panel is able to maintain a perpendicular profile to the sun's rays.
Design and construction of the proposed solar tracker prototype with single-axis rotation, which detects the sunlight intensity via the Light Dependent Resistors (LDR) is discussed in this paper
The solar tracker circuit is based on the platform of Arduino Uno micro-controller. It is programmed such that servo motor is activated in the direction of maximum sunlight intensity detected via the LDR pair.
This kind of solar tracking system can be used for efficient generation of electricity in remote homes, livestock, plantation irrigation, pool filtration, solar heating. The proposed solar tracking system can increase the efficiency from anywhere between 35% to 60% based on the location and various other parameters relative to the mounted solar tracking system.

Organization: The paper is organized in the following sections. Section 2 describes about the sensors, Section 3 describes about the servo motor, Section 4 describes about the Arduino Uno micro-controller, Section 5 describes about movement of solar panel.

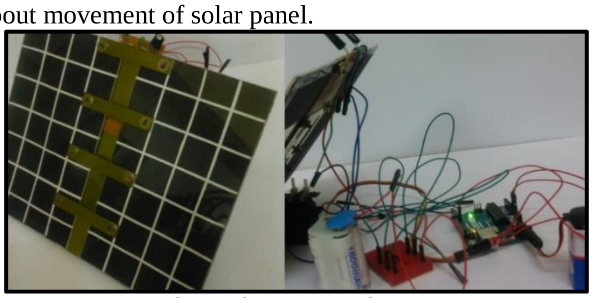

Fig.1 Solar Tracker – Front and Circuit View

The solar tracker prototype can be divided into several blocks, as shown in Fig.2:

- Sensor
- Servo Motor
- DC Power Supply (9V and 4.8V)
- Resistor And LDR pair
- Arduino Uno micro-controller

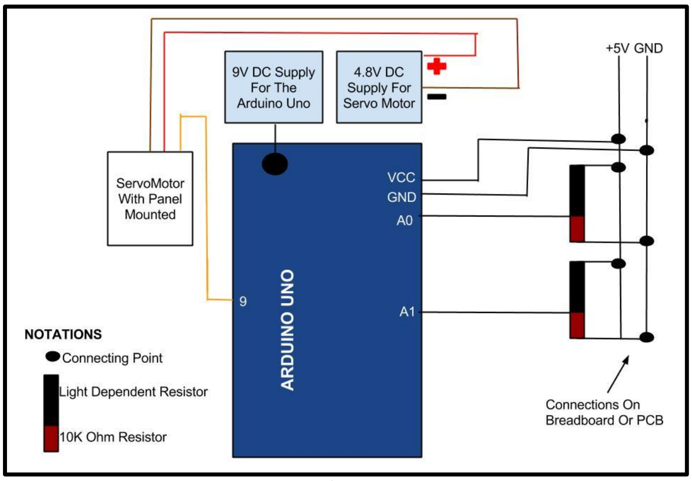

Fig.2 Block Diagram for Solar Tracking System

2. SENSORS

The senor part consists of a set of LDR pair placed, as shown in Fig.3:

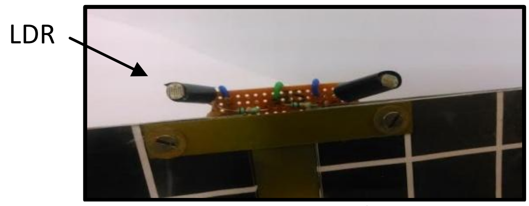

Fig.3 LDR – Top Center of Solar Panel

A photo resistor or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. The minimum intensity which the LDR can sense is 20 candela. The sensor track is made up of Cadmium Sulphide.
The LDR pair is placed such that they point to the east and west direction accordingly in order to track the complete movement from Sunrise to Sunset for maximum tapping of the energy.

3. SERVO MOTOR

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. The servo motor consists of a suitable motor coupled to a sensor for position feedback that is it contains a feedback loop which makes it more precise compared to a stepper motor.

In order for the solar panel to rotate horizonatally in accordance with the intensity of sunlight, servo motor is incorporated which actuates the rotation of the panel between 0 degrees and 180 degrees.

The servo motor used here is the Futaba S3003 is used. It's operated between a volatage range of 4.8V to 6.0V. Torque rating of 3.2Kg.cm and 4.1Kg.cm can be achieved at 4.8V and 6.0V respectively.

The movement of servomotor between 0 degrees and 180 degrees is explained in Section 4.

4. ARDUINO UNO MICRO-CONTROLLER

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Initially a tolerance level (Assumed as integer value 2) is defined in the program. The analog inputs from the LDR pair to the Arduino Uno board is converted to digital values by the ATmega328 which are later processed as per the program instruction.

If the difference between the LDR pair readings is lesser than the tolerance level, then the solar panel is rotated towards the 0 degrees (with respect to the servo motor) and when the LDR pair readings difference is greater than the tolerance level, then the solar panel is rotated towards the 180 degrees (with respect to the servo motor) and if the LDR pair readings difference is equal to the tolerance level, there is no movement of the solar panel.

5. MOVEMENT OF THE SOLAR PANEL

Movement of the solar panel that is the depiction of the tracking is as shown below in Fig.4a,b,c.

The top row represents the front view of the solar panel where as the bottom row represents the back view of the solar panel.

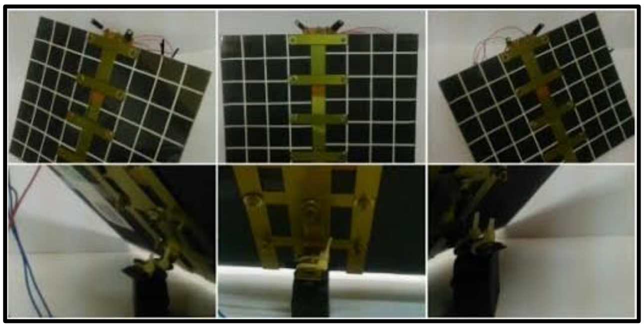

Fig.4a Fig.4b Fig.4c

Fig.4a Solar panel rotates towards the East

Fig.4b Solar panel at stationary position

Fig.4c Solar panel rotates towards the West

Following are the different cases explaining the tracking of solar panel between East and West:

Case1: When the East light intensity is greater than the West light intensity.

In this case, the solar panel is rotated towards East direction, as shown in Fig.4a.

Case2: When the East light intensity is lesser than the West light intensity.

In this case, the solar panel is rotated towards West direction, as shown in Fig.4c.

Case3: When the East light intensity is nearly same as the West light intensity.

In this case, the solar panel is in the stationary position and does not move at that given instant, as shown in Fig.4b

Special Case: During Solar Eclipse, though the sky light becomes dark, its intensity is greater than 20 candela which is greater than the LDR sensor pair being used. Hence, it tracks the sun light as usual after the completion of the Eclipse.

The micro-controller is programmed such that, at the end of the day after Sunset (West), the solar panel is again made to face the Sunrise (East) position for tracking purpose for the next day.

Intensity Of Light		Solar Panel Movement
East	West	
High	Low	East
Low	High	West
Same	Same	Stationary

Table.1: Movement of Solar Panel

RESULT:

The solar panel follows the sun light accurately from sunrise to sunset as shown in Fig.4, for efficient tapping of energy. The result is briefed up as shown in table.1.

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CONCLUSION:

In order to meet the needs of the energy demand especially in the developing countries, this kind of solar tracking should be implemented in large scale. It will also help resolve the problem of depletion of non-renewable resources. It will also help in building a better eco-friendly environment which in turn will reduce the global warming. Application wise it can be used for efficient generation of electricity in remote homes, livestock, plantation irrigation, pool filtration, solar heating. It will also increase the efficiency of the solar panel by 35% to 60% compared to the mounted solar panel systems

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