Sunflower Imitator Solar Panel

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Abstract—This paper is based on understanding the working of solar tracker and to design the same. Solar panel has been used increasingly in recent years to convert solar energy to electrical energy. The panels can be utilized either as a large solar system that is connected to the electricity grids or as a stand-alone system. The 84 Terawatts of power is collected by the earth and our world munches somewhere about 12 Terawatts of power each day. We are trying to munch additional energy from the sun via solar panel. In order to maximize the conversion from solar to electrical energy, the solar panels needs to be placed at right angle to the sun. Thus the tracing of the sun’s position and positioning of the solar panels is a significant task. The goal of this project is to make an automatic tracing system, which can trace location of the sun. The tracing device will move the solar panel so that it is positioned perpendicular to the sun for maximum energy conversion at all time. LDR’s are used as sensors in this system. The system will consist of light sensing system, microcontroller, gear motor system, and a solar panel. Our system will output up to 30% more energy than solar panels without tracking systems.

Keywords—Solar Tracker, Stepper Motor, Sensors, LDR (Light Dependent Resistors), ATMEGA16, Microcontroller (AVR)

I. INTRODUCTION

Solar panels are devices that convert light into electricity [1]. Solar cells or PV cells depends completely on the photo voltaic effect to absorb the energy through the sun and causes the flow of the current in midst two oppositely charged layers. A solar panel is a collection of solar cells. Although each solar cell provides a relatively minor quantity of power, many solar cells ranged over a huge space can deliver sufficient power to be useful. According to Encyclopedia Britannica the first genuine for solar panel was built around 1883 by Charles Fritts.

A Solar Tracker is a device onto which solar panels are fitted which follows the movement of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. The Solar Tracker will maintain the perpendicular angle of exposure of light throughout the whole movement sun. One of the most efficient and widely used renewable energy sources having a huge potential of conversion into electrical power is the energy from the sun. The conversion of solar radiation into electrical energy by Photo-Voltaic (PV) effect is a very favorable technology, being clean, silent and dependable, with very small maintenance costs and small ecological impact. Among PV efficiency improving solutions we can mention: solar tracking, optimization of solar cells geometry, enrichment of light trapping capability, use of new materials, etc. The output power generated by the PV panels depends strongly on the incident light radiation. This project is based on the solar tracing method. The main components of the system are:-

- Light Dependent Resistor.
- Microcontroller.
- Stepper Motor.

II. TECHNOLOGIES APPLIED

A. Light Dependent Resistor

Light Dependent Resistor is made of a high-resistance semiconductor. It can also be referred to as a photoconductor. If light falling on the device is of the high enough frequency, the absorbed photons by the semiconductor gives bound electrons sufficient energy to jump into the conduction band. The resulting free electron conducts electricity, thereby lowering resistance [2]. Hence, Light Dependent Resistors is very useful in light sensor circuits. LDR is very high-resistance, sometimes as high as 10M, when they are illuminated with dramatically fall in light resistance. A LDR is a resistor that changes in value according to the light falling on it. A commonly used device, the ORP-12, has a huge resistance in the dark, and a small resistance in the light. Connecting the LDR to the microcontroller is very straightforward, but some software calibrating is required. As we know, the LDR response is non-linear, and so the readings will not fluctuate in precisely the same way as with a potentiometer. In general there is a larger resistance change at brighter light levels. This can...
be compensated for in the software by utilizing a lower range at darker light levels.

B. Mechanism of LDR Pair working to attain maximum sunlight

Here movement of the solar panel is made using the pair of LDR module and a stepper motor. In this model solar panel is directly connected to the stepper motor for the movement and with two LDR modules connected on both the sides of the solar panel separated by a little elevated hindrance provided near the sensor on the module. Movement is seen in solar panel with the help of motor and LDR sensor with respect to that of sun to maintain the fixed angle with the sun.

C. AVR MICROCONTROLLER

A microcontroller acts as the brain of the complete system. It is a compact computer on a single integrated circuit consists of a processor core, memory, and programmable input/output peripherals. The microcontroller used is Atmega16 for the working of the model.

<table>
<thead>
<tr>
<th>Step</th>
<th>Coil1</th>
<th>Coil2</th>
<th>Coil3</th>
<th>Coil4</th>
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<td>1</td>
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III. HARDWARE COMPONENTS

A. LDR Module

Photosensitive resistor module is most sensitive to environment light intensity and is generally used to detect the ambient brightness and light intensity [3-4]. When module light conditions or light intensity reach the set threshold, DO (digital output) port output is high, and when the external ambient light intensity exceeds a set threshold, the module DO (digital output) output is low. DO (digital output) connected directly to the MCU (micro controller unit), and sense low or high TTL (transistor–transistor logic), thus sensing ambient light intensity changes. DO (digital output) module can directly drive relay module, which can be made of a photoelectric switches. AO (analog output) module and AD (analog to digital) module can be linked through the AD (analog to digital) converter, which can provide a more accurate light intensity value.

B. Stepper Motor

Motor is use to drive the Solar Tracker to the best angle of exposure of light. For this section, we are using stepper motor [5]. The stepper motor is an electromagnetic device that is used to transform digital pulses into mechanical shaft rotation. Many benefits are achieved using these kind of motors, such as higher simplicity, since no brushes or contacts are present, cost reduction, greater reliability, greater torque at lesser speeds, and greater accuracy of motion. Many systems with stepper motors need to control the acceleration/deceleration when changing the speed. Dissimilar to those dc motors, which spins round freely when power is supplied, stepper motors needs that the power supplied to them should be continuously pulsed in particular patterns. For each pulse the stepper motor rotates around one step often 15 degrees giving 24 steps in a full revolution. There are two main types of stepper motors - Unipolar and Bipolar. Unipolar motors normally have four coils which are turned on and off in a particular sequence. Bipolar motors have two coils in which the current ow is reversed in a similar sequence. All the four coils in the Unipolar stepper motor must be turned on and off in a certain order for the motor to turn. Many microprocessor systems use four output lines to control the stepper motor, every single output line controlling the power supplied to one of the coils. As the stepper motor operates at 5V, the standard transistor circuit is required to switch each coil. As the coils generate a back EMF when turned off, a suppression diode on every single coil is also needed. The table below shows the four different steps required to make the motor turn.

Table 1. Stepper motor steps [5]

Look carefully at the table 1 and notice that a pattern is visible. Coil 2 is always the reverse or logical NOT of coil 1. For coils 3 and 4 the same pattern applies. It is therefore possible to cut down the number of microcontroller pins required to just two by the utilization of two more NOT gates. Luckily the Darlington driver IC ULN2003 can be utilized to provide both the NOT and Darlington driver circuits. It also contains the back EMF suppression diodes so no external diodes are required.

C. AVR Development Board

AVR development board consist of microcontroller base, ports and other necessary components mounted on zero PCB. Zero PCB is a fiberglass sheet with pores all over it and with copper coating on one side. One of the advantage of zero PCB is that it can be customized according to users need and is also economical. The components
required for the model such as resistors, capacitors, regulator IC, power socket, IC holder base and port pins are soldered onto the PCB. The connections and wiring is done on the other side of PCB using connection wires.

![Fig.3. Self-Developed AVR Board](image)

**D. Microcontroller (ATMEGA16)**

The ATmega16 is a low-power, high-performance advance RISC 8-bit microcontroller with 32K bytes of in-system programmable Flash memory. The on-chip Flash permits the memory of the program to be reprogrammed in-system or by the conventional non-volatile memory programmer [6-7]. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel ATmega16 is a powerful microcontroller, which provides a highly cost-effective and a flexible way for so many embedded control applications. The ATmega16 offers the following standard features: 32K bytes of Flash, 1024 byte of EEPROM and 2KB INTERNAL S RAM, 32 I/O lines. Other than these key features eight other features including: (i) watch dog timer, (ii) two data pointers, (iii) two 16-bit timer/counters, (iv) a six-vector two-level interrupt architecture, (v) a full duplex serial port, (vi) on-chip oscillator, (vii) 8-channel 10 bit ADC, (viii) clock circuitry are also present to enhance its use. In addition to this, the ATmega16 is created with static logic for operation down to 0 frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while permitting the RAM, counters/timer, serial port, and interrupts system to continue working. The Power-down mode saves the RAM con-tents but freezes the oscillator, disabling all other chip functions until the next interrupt.

**IV. SOFTWARE USED**

ATMEL Studio 6.1 is the application used where the user can code in embedded c and in some other languages like assembly language, then can check the code compile it and can execute it by creating a hex file and run it on the simulator like Proteus.

**V. THE PROPOSED SYSTEM**

**A. OVERVIEW**

This Solar tracker is basically single axis tracker. The algorithm of this solar tracking system is very simple and based on ‘scan and go’. At first it will scan the values of light intensity of both the LDR sensors. The resistance of LDR will be changed according to the light intensities. So the voltage drop across the LDR will also be changed. This voltage drop will automatically get converted into digital data form with the help of ADC IC present in the LDR Module and then this digital data is fed to the port connected to ATMEGA16, then a corresponding value is stored in the MCU memory. After scanning it will check all the intensity values and decide which one is maximum and hence the corresponding location is located.

This will stay at the same location till the time there is no noticeable difference is found between both the LDR sensors present in their corresponding modules which results in the further movement of the motor in direction of the sun.

**B. Architecture**

The microcontroller is the central processing unit of the system. The Stepper motor and LDR module are connected with it. The LDR module is connected to the ports of AVR board containing ATMEGA16.

![Diagram](image)
The LDR module is continuously senses the value and sends the data to the microcontroller for the processing of the remaining code. The power is provided through DC Adapter to the board and then to the peripherals connected to it. The system provides nearly optimal results when exposed to sunlight with the right movement of the solar panel in the direction of the sun.

VI. RESULTS & SIMULATIONS

The above system has been simulated in Proteus ISIS v4.

Motor will automatically turns the solar panel in the direction of the sun with readings it get from sensors present in the LDR Module.

CONCLUSION

A solar tracker is designed employing the principles of using solar panel to function as self-adjusting panels using LDR sensors, providing a variable indication of their relative voltage drop. Using this methodology, the solar tracker was effective in upholding a solar array at a sufficiently perpendicular angle to the sun. The power increase gained over a fixed horizontal array was in excess of 30%. The project has offered the means of controlling a sun tracing array with the help of an embedded microprocessor system. Specifically, it demonstrates a working automated solution for maximizing solar cell output by positioning a solar array at the point of maximum light intensity. This project utilizes a single-axis to increase tracking accuracy.

This design represents a functioning miniature scale model which could be replicated to a much larger scale. The connections of LDR sensors to microcontroller are done using wires which may lead to binding problems and current losses. This problem can be removed by using wireless connections between sensors and microcontroller. Larger motors with more torque can be used for more effective results. More sensitive and accurate sensors can also be used to increase the efficiency and the output of the whole system. A digital display can be configured to provide a more user friendly interface and better working.

REFERENCES


