

Solar tracking system essay sample



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Abstract- Energy development is the ongoing effort to provide abundant and accessible energy, through knowledge, skills and constructions. Solar energy is rapidly advancing as an important means of renewable energy resource. More energy is produced by tracking the solar panel to remain aligned to the sun at a right angle to the rays of light. This paper attempts to describe in detail the design and prototype for solar tracking system. The solar tracking system is designed and built using a simple mechanical structure using with a stepper motor, light sensor and a control method. The control circuit for the solar tracker is based on a PIC16F877A microcontroller (MCU). This is programmed to detect the sunlight through the Light sensor and then actuate the motor to position the solar panel where it can receive maximum sunlight.

Keywords: PIC, MCU, Solar energy, Light sensor, Renewable energy.

I. INTRODUCTION

The world trend nowadays is to find a non-depletable and clean source of energy. Non-renewable energy, obtained from exhaustible fossil fuels, is no more satisfactory to many nations. Not only the resources (coal, oil & natural gas) are subject to be severely reduced, but also they are considered to be non-secure; wars and politics afflict its availability and cost. Moreover many environmental organizations address this energy production scheme as the main contributor to pollution and global warming. For a long time, it has been thought that atomic energy would be a solution for the growing energy problem, but in recent times solar energy has proved to be an efficient, more

secure and safe way of providing energy. Concepts related to the solar energy have constantly been under heavy research and development.

The basic objective is to optimize the energy produced from photovoltaic cells, by making the overall systems more efficient and cost effective. Most solar panels are statically aligned. They have a fixed position at a certain angle towards the sky. Therefore, the time and intensity of direct sunlight falling upon the solar panel is greatly reduced, resulting in low power output from the photovoltaic (PV) cells. From this background, we see the need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible. By tilting the solar panel to continuously face the sun, this can be achieved. This process of sensing and following the position of the sun is known as Solar Tracking system.

II. SYSTEM OVERVIEW

The design of Solar Tracker is to develop and implement a simplified diagram of a horizontal-axis and active tracker method type of solar tracker fitted to a solar panel. A solar panel along with the direction of sunlight; it uses a gear motor to control the position of the solar panel, which obtains its data from a PIC16F877A microcontroller. Two light dependent resistors (LDR) are used for each degree of freedom. LDRs are basically photocells that are sensitive to light. Software will be developed which would allow the PIC to detect and obtain its data from the two LDRs and then compare their resistance. The two LDRs will be positioned in such a way, so that if one of the two comes under a shadow, the MCU will detect the difference in resistance and thus actuate the stepper motor to move the solar panel at a position where the

light upon both LDRs are equal. A simple mechanical structure has been constructed for this by using aluminium channel. Power MOSFET has been to design the driver circuit of stepper motor. A 12V lead Acid battery has been used to power up the motor and store the energy from solar panel. Charge controller control the charging of batter. Figure 1 shows the block diagram representation of the tracking system under design.

Figure 1: Overview of the Complete System

III. MECHANICAL STRUCTURE

Before designing the mechanical structure for solar tracking system it is important to select an appropriate method of alignment. There are two possible methods of aligning the solar panel. The mechanical structure of a solar tracking system lot more depend on proper alignment of solar panel. The first method involves, tilting the solar panel in two axes to maintain the desired position and the second method involves rotating and tilting. Since it is single axis tracking system so the first method implemented. A CAD drawing of this structure has been done using AUTOCAD 2010 software. Figure 1 shows the design of the mechanical structure.

Figure 2: Mechanical Structure Design.

The hardware structure of this solar tracking system designed used solar panel, five Aluminium Bars, stepper motor, metal L shape plate for fixing the Aluminium bars with one another, bracket and gear for holding the solar panel by motor shaft and screws.

IV. STEPPER MOTOR

A stepper motor is an electromechanical device which converts electrical pulses into mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motor's rotation has several direct relationships to these applied input pulses. A 12V 6 lead wires 1.8° unipolar hybrid stepper motor has been used for this solar tracking system project. The motor has been mainly chosen depending on the weight of the solar panel and holding torque.

Figure 3: Stepper Motor.

V. LIGHT SENSOR THEORY

A light sensor is the most common electronic component which can be easily found. The simplest one is LDR. There are two LDR used for this tracking system project. If light falling on the device is of the high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons conduct electricity, thereby lowering resistance. Hence, Light Dependent Resistors (LDR) is very useful in light sensor circuits. LDR is very high-resistance, sometimes as high as 1000 000Ω, when they are illuminated with light resistance drops dramatically. Two voltage divider circuits have been developed and the output of these two circuits has given the signal two microcontrollers. The microcontroller will detect and obtain data from two LDR by comparing their resistance.

VI. TRACKING CONTROLLER ALGORITHM

A tracking controller programming has been developed by using C language. The MPLAB IDE has been used to write the code for the tracking controller circuit. The analog to digital conversion (ADC) feature has been used to embedded the code. The light sensor will provide the analog signal to the PIC and the PIC will convert the analog signal to digital signal to provide pulse in stepper motor. A PIC16F877A MCU has been embedded for this project. It has five input/output PORTS with 40 pins. It has 256 byte memory.

Figure 4: PIC Pin Configurations.

The flowchart of the tracking controller algorithm has shown below figure 5.

Figure 5: Flowchart of PIC Program Code.

VII. TRACKING CONTROLLER CIRCUIT

A microcontroller based tracking controller circuit has been designed and implemented in this project. The main components of this tracking controller circuit are PIC16F877A, PC817, N channel power Mosfet IRF830, diode 1N4148, oscillator. A voltage supply of 12V is applied to the circuit which is then passed through a 5V voltage regulator. The regulated voltage is then supplied to the PIC. The output which drives the motor is obtained from port RB0 to RB3. MCLR reset input port is also connected to 5V supply. The external clock determines MCU fundamental operating characteristics; therefore it needs to be selected wisely. A 20Mhz oscillator clock was selected.

Figure 6: Schematic of Tracking Controller Circuit.

To drive the stepper motor four power MOSFET has been used with 1N4148 diodes. This MOSFET has chosen because it is capable to handle high current and the diodes used to remove the spikes during the switchin of transistor.

VIII. CHARGE CONTROLLER CIRCUIT.

The charge controller is designed to control charging storage battery. Its function is to regulate the power flowing from a photovoltaic panel into a rechargeable battery. It features easy setup with one potentiometer for the float voltage adjustment, an equalize function for periodic overcharging, and automatic temperature compensation for better battery charging over a wide range of temperatures. The control is basically to protect the battery from over charge or voltage.

Figure 7: Schematic of Battery Charge Controller.

IX. PROTOPTYPE

Figure 8: Complete Structure of Tracking System.

The light sensor has been positioned top of the PV panel. The sensors are mounted inside a plastic box and a divider has given in between two sensors. This has been done because the LDR is too light sensitive. In given figure shows the sensor position .

Figure 9: Sensor Position.

X. RESULTS AND DISCUSSION

Time| PV Output Power|

9. 00 am| 5. 01W|

10. 00am| 6. 46W|
11. 00am| 7. 47W|
12. 00pm| 8. 67W|
01. 00pm| 9. 53W|
02. 00pm| 9. 57W|
03. 00pm| 8. 11W|
04. 00pm| 7. 00W|
05. 00pm| 4. 01W|
06. 00pm| 3. 32W|

Figure 10: Fixed System Data .

Time| PV Output Power|

9. 00 am| 6. 03W|
10. 00am| 7. 11W|
11. 00am| 8. 13. W|
12. 00pm| 9. 47W|
01. 00pm| 9. 53W|
02. 00pm| 9. 57W|
03. 00pm| 9. 01W|
04. 00pm| 7. 00W|
05. 00pm| 3. 88W|
06. 00pm| 3. 14W|

Figure 11: Tracking System Data .

Figure 12: A compareable graph between tracking and fixed system. If we observed the fixed system value and tracking system value the tracking system generated more power than the fixed system until 3pm. Normally

after 2 pm the sun light becomes low down. As a result power also becomes low. But after 3pm the tracking system generated power became less than fixed system values. This is happened because weather change. The sky covered by cloud that is why the generated power became low for those particular hours. The power distribution graph is plotted against the 9am-5pm period as shown in below figure.

XI. CONCLUSION

A solar tracker was proposed, designed and constructed. The system has been tested under the sun and overall efficiency also observed comparing with fixed PV system. The system is quite efficient and the results are repeatable. The system has some limitations with the mechanical structure and tilting of PV panel. By utilizing the dual axis tracking system and improved mechanical structure will be able to provide more efficient result in future.

XII. REFERENCES

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