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Single Axis Automatic Solar Tracking System Using Microcontroller

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Abstract

Solar power generation had been employed as a renewable energy for years ago. Residents that use solar power as their alternative power supply will bring benefits to them. The main objective of this paper is to develop a microcontroller-based solar panel tracking system which will keep the solar panels aligned with the Sun in order to maximize in harvesting solar power. When the intensity of light is decreasing, this system automatically changes its direction to get maximum intensity of light.Light dependent photo resistors are used as the sensors of the solar tracker. For rotating the appropriate position of the panel, a steper motor is used. This design is covered for a single axis and is designed for residential use. Finally, the project is able to track and follow the Sun intensity in order to get maximum power at the output regardless motor speed.

Keywords*: photovoltaic cell, solar tracking, microcontroller, stepper motor, photo resistor*

1. Introduction

The solar energy is known to be one of the preferred renewable green energies, which is much cleaner and free from harmful production to the environment compared with the conventional counterparts [1, 2]. Maximizing power output from a solar system is desirable to increase efficiency. In order to maximize power output from the solar panels, one need is to keep the panels aligned with the sun, means that the tracking of the sun is required [3]. Solar trackers are the most appropriate and proven technology to increase the efficiency of solar panels through keeping the panels aligned with the sun's position. Solar trackers get popularized around the world in recent days to harness solar energy in most efficient way [4, 5]. The main objective of this paper is to design the sun tracking solar system model which is a device that follow the movement of the Sun regardless of motor speed. Beside that, it is to improve the overall electricity generation using single axis sun tracking system and also to provide the design for residential use.

2. The Proposed Method

The Automatic Solar Tracking System (ASTS) is completely automatic and keeps the panel in front of sun until that is visible. The unique feature of this system is that instead of taking the earth as its reference, it takes the sun as a guiding source. Its active sensors constantly monitor the sunlight and rotate the panel towards the direction where the intensity of sunlight is maximum controlled by the microcontroller based control panel. In case the sun becomes invisible e.g. in cloudy weather, the panel sensor can't detect the sun. After a while when the cloud vanishes, it will scan the sky and again aligned to face the sun vertically, by this process maximum efficiency can get throughout the whole day [6-12]. Schematic diagram of An ASTS is shown in Figure 1. Moreover the system can handle the errors and also supplies the error messages on the LCD display.

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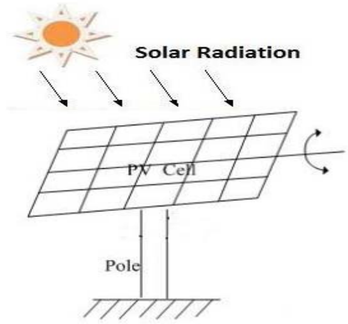

Figure 1. Automatic Sun Tracking System—Dishes and PV

3. Research Method

This design is divided into two parts, hardware development and programming development. Block diagram of microcontroller and associated circuitry is shown in Figure 2.

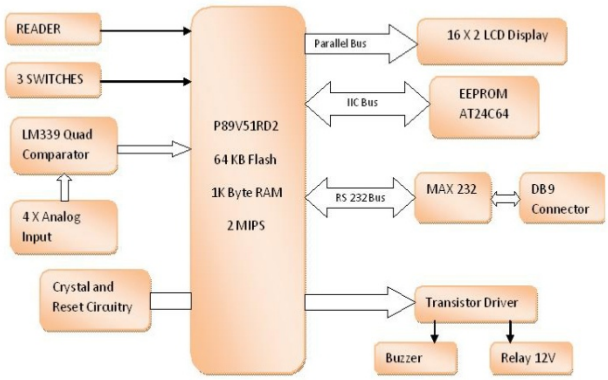

Figure 2. Block Diagram of Microcontroller and Associated Circuitry

3.1. Hardware Operation

Since the project focus is on embedded software control the microcontroller is the core of the organization. The entire system depends upon a program in embedded c burned in the microcontroller. The microcontroller selected for this task had to be able to change the analog photocell voltage in the digital values and offer four output channels to control the stepper motor rotation. A 4 MHz crystal oscillator was also used in conjunction with the P89V51RD2 to provide the necessary clock input. This speed is sufficient for the applications.

The 12V DC input voltage is injected to the PCB after necessary stepping down from the adapter. This 12V DC supply goes to 7805 Voltage Regulator from where the output 5V DC spread to all logic circuitry. The 12V DC supply is only for Relay and THE Motor Driver. There are three switches and a reset switch are connected to the microcontroller for controlling necessary condition.LM339 Quad Comparator is also connected to the microcontroller for comparing the solar panel sensor voltage. The analog input from the light sensor during operation first goes to the ADC0804 from where after converting it to digital signal it is displayed in the LCD display. This ADC0804 is also linked up to the microcontroller by parallel bus to get the output.The EEPROM AT24c64 is connected to the microcontroller by IIC bus to keep the accumulated memory of microcontroller after the power runs away.

The microcontroller P89V51RD2 is compiled with the assistance of software named Keil µ-Vision software. The microcontroller is connected to the PC by a DB9 Connector. MAX232 protocol connects the microcontroller with DB9 Connector by an RS232 BUS.

The L293D motor driver controls the driving performance of the stepper motor which is likewise linked with the microcontroller.

A BUZZER and a 12V Relay are there for output operation and sensing the voltage respectively.

3.2. Software Operation

As was fundamental to the course, the assembly language was utilized for the project. It was more than adequate to satisfy design objectives while enhancing level of understanding of the programming language.

The software operation can be split into various sections. The first part is initial positioning. Prior to powering up the system, the photocell must be manually set to a starting point (East).

The second part of the system code deals with the light tracking. This is the heart of the program. Once the tracker has set its initial position to a bright source of light (sun), it is ready to align itself more preciously and continue tracking the light.

The total software operation is compiled in Embedded C and Keil µ-Vision software. This compiled program control the total hardware operation that is the Tracker and the Motor will rotate according to this program.

3.3. System Program Flow Chart

The microcontroller used in this solar tracker system is P89V51RD2. Flowchart of P89V51RD2 program is shown in Figure 3.

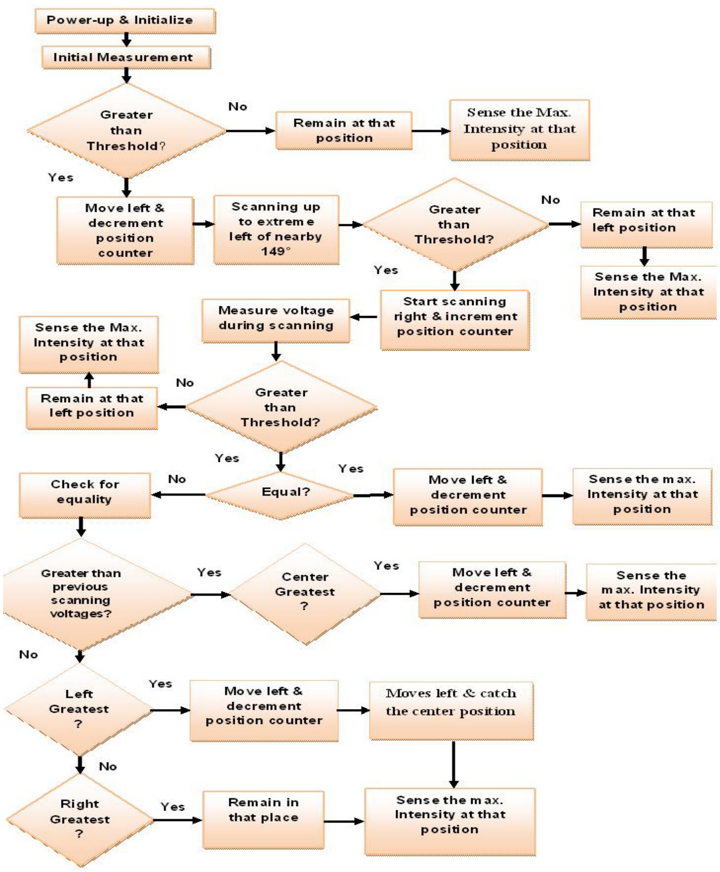

Figure 3. System progam flow chart of P89V51RD2

4. Results and Discussion

For preparing the experimental setup of ASTS, 1.2 volt solar panel is used here and it is shown in Figure 4.

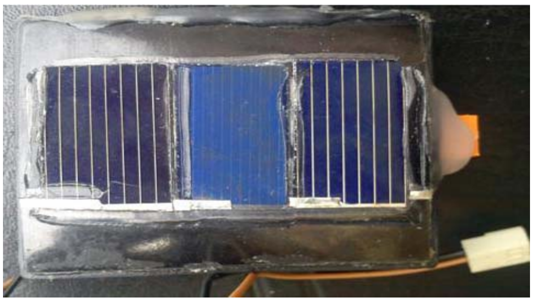

Figure 4. Experimental model of Solar Panel

Low speed stepper motor has been used and the stepper motor used here to prepare the model is shown in Figure 5. As the motor speed is very low, motor speed parameter can be neglected and the system only focuses in tracking of Sun intensity.

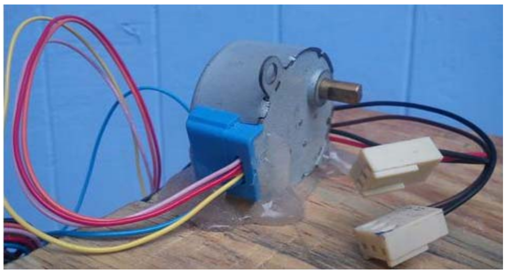

Figure 5. Experimental model of Stepper motor

A practical display during the experiment is shown in Figure 6. As stated earlier that an LCD display is used here to show the result.

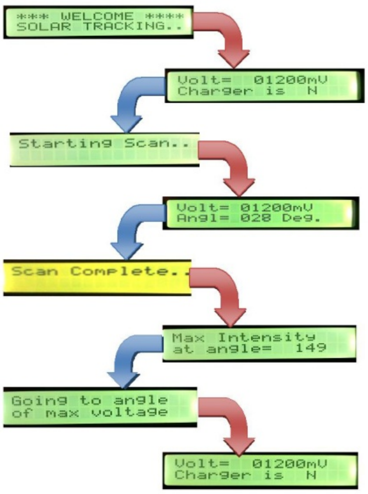

Figure 6. Practical display view

In this display it is clearly shown that the system starts scanning for finding in which angle solar intensity is maximum and align itself in the maximum solar intensity position.

If a fixed solar panel is used in place of ASTS it would not have given 1.2 volt output through out the day due to the varying position of the sun. But in this case it has been clearly shown from the display that the output of the ASTS is maximum.

Though this experimental setup is very small, but if it works for a smaller one, then this principle could be used in bigger panel and grid also.

5. Conclusion

Here Single Axis Solar Tracking System model is developed using microcontroller. The system is able to track and follow the intensity of the Sun in order to get maximum output regardless of motor speed. Besides, low speed stepper motor has been used for neglecting motor speed parameter and therefore the system only focuses in tracking of Sun intensity. The system can be applied in the residential area for alternative electricity generation especially for non-critical and low power appliances.

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