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Development of Variable Reluctance Stepper Motor Controller for PV System

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Abstract: ***A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. VR Stepper motor requires sequencers and driver to operate. Sequencer generates sequence for switching which determines the direction of rotation and mode of operation. We have developed a solar tracking system using a combination of micro-controller, VR stepper motor and light dependent resistors (LDR's) with the primary aim of improving the power efficiency of the solar panels [2]. Thus this system can achieve maximum illumination and can reduce the cost of electricity generation by requiring minimum number of solar panels with proper orientation with the sunlight.***

Keywords: Solar tracker, LDRs, Variable reluctance Stepper motor, Solar panel

1. Introduction

VR stepper Motor is used mostly because it is highly reliable and it require little and no maintenance. It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft. The controlling of VR stepper motor is must. There are various method to control the speed of VR stepper motor. But the method we used is very cheap and convenient. Microcontroller based control system takes care of sensing sunlight and controlling the motorized mechanism [Tsung-Yu Tsai, 2006]. This system works continuously without any interruption. The main controlling device of the project is Microcontroller to which LDR's and stepper motor with panel setup to its shaft are interfaced. The Microcontroller gets input from LDR sensors regarding the direction of sun and controller process this information and controls the movement of solar panel attached to Stepper motor[4][5].

The main objectives of the project are:
1) Tracking sun direction.
2) Automatic starting the system in the morning from start point.
3) Stepper motor controlled movement of solar panel.

2. Light Dependent Resistor (LDR)

A light sensor is the most common electronic component which can be easily found. The simplest optical sensor is a photon resistor or photocell which is a light sensitive resistor these are made of two types, cadmium sulfide (CdS) and gallium arsenide (GaAs). The sun tracker system designed here uses two cadmium sulfide (CdS) photocells for sensing the light. The photocell is a passive component whose resistance is inversely proportional to the amount of light intensity directed towards it. It is connected in series with capacitor.

3. Prototype of Designed Tracker

The major components those are used in the prototype are given below:-

Photo resistor
- Microcontroller
- VR Stepper motor
- Photo resistor
- Cadmium sulphide (CDS) photo resistor

The CdS photo resistor is a passive element that has a resistance inversely proportional to the amount of light incident on it. To utilize the photo resistor, it is placed in series with another resistor. A voltage divider is thus formed at the junction between photo resistor and another resistor; the output is taken at the junction point to pass the measured voltage as input to microcontroller as shown in figure1 and 2.

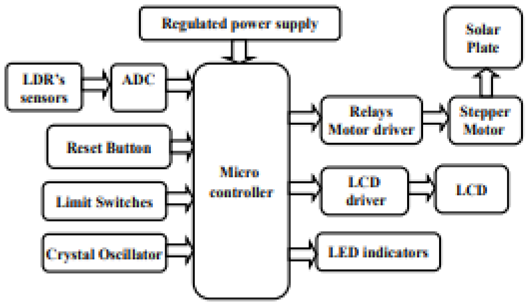

Figure 1: Block diagram of Solar Tracker with Stepper motor control

Circuit Diagram

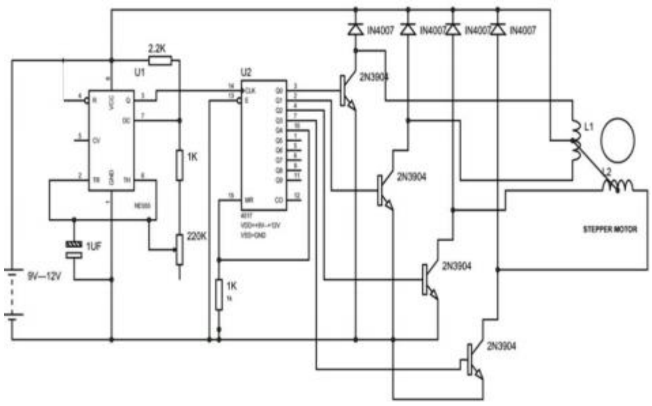

Figure 2: Circuit diagram of VR Stepper motor speed controller

4. Operation of the Solar Tracker

Solar tracker provides three ways of operation and control mechanism

Normal day light condition: - Two photo resistors are used in the solar tracker to compare the output voltages from two junctions. As the sun rotates from east to west in the day time, AIN0 needs to provide higher voltage than AIN1 to sense the rotation of the sun. This condition is considered as normal day light condition and tracker rotates the panel 3.75° after every 15 minutes.

Bad weather condition: - When the sky gets cloudy, there will be less striking of light on both the photo resistors and so sufficient voltages might not be available at junction point. The difference of voltage at junction point will not be greater than the threshold value to rotate the tracker. At the meantime, sun continues rotating in the western direction. To solve this problem, a short delay is provided which will check for voltage input from junction point in every 1.5 minutes. Microcontroller will use the variable Count to check for consecutively 10 times to make the ‘wait’ state equal to 15 minutes (moderate delay) to rotate the stepper motor one step.

Bidirectional rotation: - At day time, the solar tracker will rotate in only one direction from east to west. Variable I will count the total rotation in day time and that is approximately calculated as 40 rotations considering 150° rotation. When the sun sets, no more rotation is needed in western direction. For the next day, the solar panel needs to go to the initial position in the morning to track the sun’s position again. To do so, the variable I that counts the number of rotation in the day time will work out.

5. Hardware Implementation

The attractive feature of the constructed prototype is the software solution of many challenges regarding solar tracking system. The designed prototype in figure 3 requires only two photo resistors to sense the light, which lessens the cost of the system. Power consumption of the system is negligible.

Figure 3: Hardware constructed of VR stepper motor controller for PV System

The solar PV modules are generally employed in dusty environments which is the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. To reduce this loss, a brush along with rollers was fixed with the panel.

6. Conclusion

As the proposed prototype is a miniature of main system, it has some limitations which can be mitigated through future developments. A small cardboard is rotated in the system and 12v solar panel is used for analysis. As a miniature system, it works out well. Larger Solar panel must be integrated with the system to prepare better result and cost analysis.

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