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Automatic Solar Tracking Panel

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Abstract - *A Resource which can be used repeatedly and replaced naturally from existing sources that are present around us is known as a renewable resource. Renewable energy almost never runs out, for example solar energy. Solar energy can be harnessed from the sun and converted into thermal or electrical energy. And since it is the most abundant and cleanest form of energy, if we make effective use of it, we could limit the use of Fossil fuels. Therefore, increasing the efficiency and maximizing output from the solar panels in essential. This can be achieved by aligning the panels with the sun, but in order to do this we need a device that tracks the position of the sun. Using a stationary solar panel may not be the most effective method to harvest solar energy, consequently using a solar panel that can rotate with respect to the position of the sun, the efficiency of the panel can be improved by about 35%. In order to accomplish this task this paper talks about the design of a solar tracking device constructed using motor driver, stepper motor, solar panel and a microcontroller. The integral component of this tracking device is an MSP430 Microcontroller which tracks the position of the sun and repositions the solar panel such that it receives the highest possible solar energy at any given time, thereby considerably increasing the amount of power generated.*

Key Words: **Solar energy, solar panel, stepper motor, MSP430, renewable resource**

1. INTRODUCTION

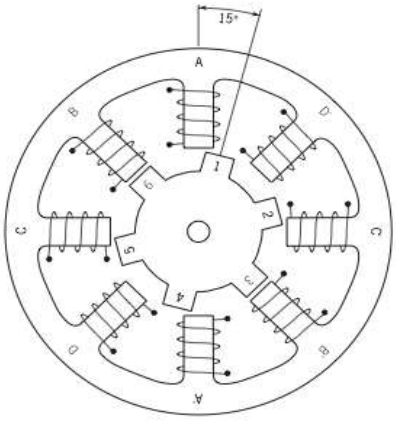
Solar energy is the largest untapped energy source from the sun which can be harnessed using a wide range of technologies such as photovoltaic cells, solar power plants, solar heaters and artificial photosynthesis. It is an extraordinary source of renewable energy which has been gaining a lot of traction in recent years for its potential as a viable source of energy. Solar panels are the most widely used devices to extract the solar energy and to convert into usable solar power. Even though solar panels are widely used, they are not used to their maximum potential due to their immobility. Therefore, utilizing a solar tracker would further boost the yield of the solar panels. Hence, designing such trackers should enable the solar panels to align themselves perpendicular to the solar rays at any given time thereby, increasing the amount of solar energy produced. But there exists a huge challenge in designing a mobile solar panel that can receive the solar energy and convert it into solar energy efficiently. Hence, many considerations have to be taken into account while designing such as the inclination of the sun with respect to the earth, changes in the length of day and knights and the angle at which the panel must be at any given point of time. In this paper we talk about a solar tracking device constructed using a stepper motor, motor driver (ULN2003 A) and an MSP430 microcontroller. Instead of tracking the intensity of sunlight using a Light dependent Resistor (LDR), we use the time of the day and direction of the sunrise to track the sunlight. In unfavorable conditions such as cloudy or rainy weather where LDR ceases to be useful, this time-based solar tracking device can be used. The working of our device is based on the rotation of a stepper motor which in turn changes the position of the solar panel such that it is always perpendicular to sun ray at any given time during the day. The motor is driven by a motor driver which in turn is controlled by the microcontroller. The geographical location and angle of the panel have to be taken into consideration when the solar panel is being installed.

2. HARDWARE IMPLEMENTATION

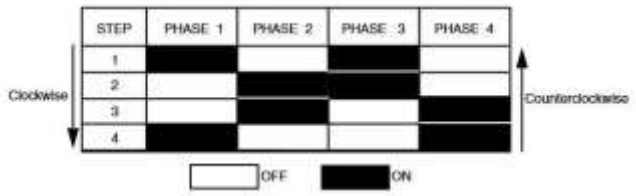
2.1 STEPPER MOTOR

Stepper motor is a brushless, synchronous electric motor that can divide a full rotation into an expansive number of steps. The position of the motor can be accurately controlled without the need for any kind of feedback mechanism when is sized carefully based on the application. These motors run of pulses of electric current where each pulse rotates the motor by a certain degree. Therefore, there exists a lot of control over the degree of rotation of the motor. Stepper motor with computer-controlled stepping can achieve very precise positioning and speed control.

1) UNIPOLAR STEPPER MOTOR: A unipolar stepper motor rotates when 4 electric pulses are given to all its windings in a sequence. These windings (coils) are organized in groups called phases. By energizing each phase in sequence, the motor rotates one step at a time. Most common is the 4-phase stepper motor. In general, greater the number of phases higher the control of degree of rotation of the motor.



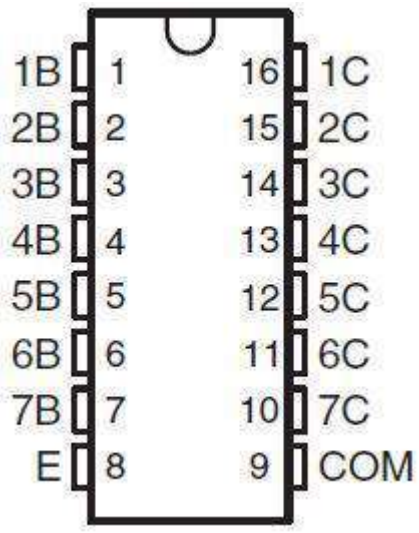
2) STEP ANGLE: The step angle of a stepper motor refers to the degree of rotation for each electrical pulse. It can vary from as small as 0.9° to 90°. A motor with step angle of 0.9° requires 400 pulses to complete one rotation.



2.2 ULN2003A MOTOR DRIVER

The ULx200xA motor driver is a high-current, high-voltage Darlington transistor array. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. A single Darlington pair has a collector-current rating of 500 mA. Higher current capability can be achieved by paralleling the Darlington pairs. The ULN2003A devices can operate directly with TTL or 5-V CMOS devices as they have a 2.7-kΩ series resistor for each pair of Darlington transistors. The ULN2003A requires less voltage when compared to other similar devices.

1) FEATURES: High -Voltage Output: 50V, Output clamp diodes, 500-mA Rated, Inputs compatible with various types of logic, Relay-Driver Applications.
2) APPLICATIONS: Stepper and DC Brushed motor drivers, Lamp Drivers, Line drivers, Logic buffers, Relay drivers



2.3 MSP430 MICRO CONTROLLER

MSP430 is a mixed -signal microcontroller family from Texas instruments, which is built around a 16-bit CPU. It is designed for low cost and specifically, low power consumption applications and has a wide range of features. This allows us to choose the best microcontroller for the application. MSP430 is a versatile and powerful microcontroller that can be used to create low power embedded devices. The prominent features of the MSP430 are outlined below:

1)High performance

2)16bit RISC architecture

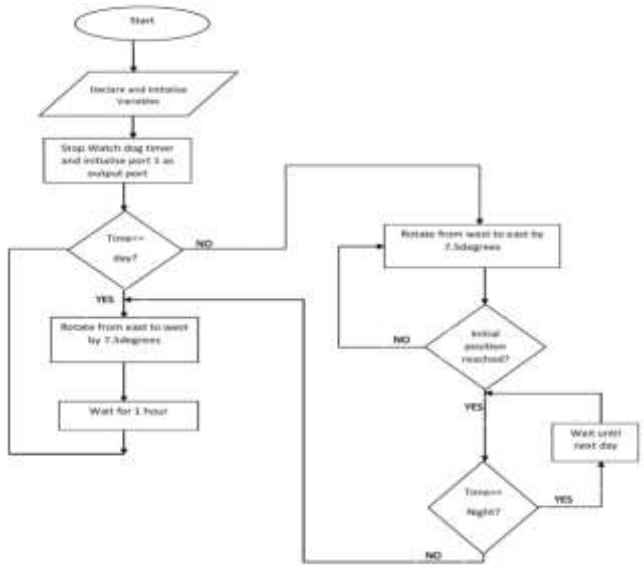
3) Ultra low power

2.4 SOLAR PANEL

Solar panel is used to convert solar energy to electrical energy, which is an arrangement of several photovoltaic cells clubbed together. The electrical energy generated can be stored into batteries since instantaneous energy generated is small. To generate huge amounts of electricity, many such panels are put together to form a module which is then installed. Each panel are made up of large number of photovoltaic cells made up of silicon, which absorbs sunlight(photons) and converts into electric energy by the process of photovoltaic effect. All solar panel module used generates power of 150W to 350 W.

3. PROGRAMMING METHODOLOGY AND WORKING

Code Composer was used to download the program onto the MSP430 microcontroller. The source code was written in Embedded C language, which was downloaded onto the microcontroller for its working. Embedded C is best supported for integrated development environment and debugging tools for embedded system applications. ULN2003 motor driver is used to overcome insufficient power output to drive the motor, the driver steps up the output voltage and current and in turn helps us power the motor. The flowchart and circuit diagram are as shown in the figure. Vcc is made as the power input to power the device and the port pins 1.1, 1.2, 1.3 and 1.4 as output pins. These outputs are given as input to the 4-input pins of the motor driver, used to excite the 4 winding of the stepper motor. OUT1-OUT4 output pins of the motor diver are connected to A-D windings. The program written rotates 15° once every hour. After each rotation the motor waits an hour before the next rotation, to achieve this appropriate delay is generated and reset to initial position after 10 hours, back to east facing and cycle repeats itself. The panels follow the position of the sun during the day time. Geographic location also plays a vital role at the time of installation as initial setup requires proper angled installation with panel facing east. Once this is properly installed, the Solar panel rotates with respect to the rotations of the stepper motor in such a way that it perfectly follows the path of the sun from morning till night, and further gets back to its initial position and waits for the sun again. This helps increase efficiency to the most even though the motor requires only 5 % of total power generated.



4. CONCLUSION

In this paper, universal solar tracker system was designed. This is a software solution to improvise the output of the solar cells depending on the position of the sun, by pointing the panel in the direction of maximum light intensity, which is demonstrated using a working model. The designed solar tracking system could track the movement of the sun with the help of microcontroller and stepper motor. This system works effectively irrespective of the weather condition or the geographical location. One of the advantages of this system is that even if the weather is cloudy or even if it is raining the position of the sun does not change and hence the sunlight that is available is still received by the solar panel. The proposed system is a miniature model of the main system so there are a number of limitations. A bigger stepper motor with gear box has to be used for practical use. Here, we have considered only one-dimensional rotation of the panel. Microcontroller was used to reduce the complexity of the circuit. Though there are a few hardware limitations in the initial set up, there is room for more improvement of design methodology in the future.

REFERENCES

[1] "Solar Energy Perspectives: Executive Summary"(PDF). International Energy Agency. 2011. Archived from the original (PDF) on 3 December 2011.

[2] "Energy". rsc.org.

[3]http://energyinformative.org/solar-panel-tracking-systems

[4] Texas, Instruments. "ULN2003A Datasheet" (PDF).

[5] Microcontroller Programming and Interfacing: Texas Instruments MSP430 (Synthesis Lectures on Digital Circuits and Systems) 1st Edition- Steven F. Barrett and Daniel J. Pack

[6] Reduced Instruction Set Computers – Prof.VojinG.Oklobdzija

[7] Working with stepper motors-Robot Builder's Bonanza, 2nd Edition

[8] Stepper Motor and Its Driver -Reference of EAS 5407 Mechatronics Design Project- http://pegasus.cc.ucf.edu/~cham/eas5407/project/Introstepper.pf