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Design and Implementation of Microcontroller Based Time Operated Solar Tracking System

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Abstract:

Solar energy is rapidly advancing as an important means of renewable energy resource. Solarpanel has been used increasingly in recent years to convert solar energy to electrical energy. In order to maximize the conversion from solar to electrical energy, the solar panels have to be positioned perpendicular to the sun.Thus tracking of the sun's location and positioning of the solar panel are important. A microcontroller based design methodology of an automatic solar tracker is presented in this paper. Light dependent resistors are used as the sensors of the solar tracker.The control circuit for the solar tracker is based on an AT89C51 microcontroller. The tracking system will move the solar panel so that it is positioned perpendicular to the sun for maximum energy conversion at all time. This is programmed to detect the sunlight through the LDRs and then actuate the stepper motor to position the solar panel where it can receive maximum sunlight. The results have been shown in this paper to advocate that the designed system realized precise automatic tracking of the sun and can greatly improve the utilization of solar energy.

Key words: AT89C51, tracking, LDR, Stepper Motor.

1. INTRODUCTION:

A solar tracker is a device for orienting a Photovoltaic array solar photovoltaic panel or concentrating solar reflector or lens toward the sun. The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky. Solar powered equipment works best when pointed at or near the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position, at the cost of additional system complexity. There are many types of solar trackers, of varying costs, sophistication, and performance.

One well-known type of solar tracker is the heliostat, a movable mirror that reflects the moving sun to a fixed location, but many other approaches are used as well. Non-concentrating applications require less accuracy, and many work without any tracking at all. However, tracking can substantially improve both the amount of total power produced by a system and that produced during critical system demand periods (typically late afternoon in hot climates). The use of trackers in non-concentrating applications is usually an engineering decision based on economics. Compared to photo voltaic, trackers can be inexpensive. This makes theme especially effective for photovoltaic systems using high-efficiency (and thus expensive) panels[1,2]. Extracting usable electricity from the sun was made possible by the discovery of the photoelectric mechanism and subsequent development of the solar cell – a semi conductive material that converts visible light into a direct current. By using solar arrays, a series of solar cells electrically connected, a DC voltage is generated which can be physically used on a load. Solar arrays or panels are being used increasingly as efficiencies reach higher levels, and are especially popular in remote areas where placement of electricity lines is not economically viable. The process of sensing and following the position of the sun is known as Solar Tracking. It was resolved that real-time tracking would be necessary to follow the sun effectively, so that no external data would be required in operation.The tracking system will move the solar panel so that it is positioned perpendicular to the sun for maximum energy conversion at all time. Our system will output up to 40% more energy than solar panels without tracking systems.

2. PROTOTYPE OF AUTOMATIC SOLAR TRACKER:

Development of solar panel tracking system has been ongoing for several years. As the sun moves across the skyduring the day,

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it is advantageous to have the solar panels track the location of the sun, such that the panels are always perpendicular with the position of the sun. Available solar trackers in the market are much costly to integrate with solar panel system [3&4]. In the developing countries where cost is one of the major issues to integrate technologies, solar tracking prototype presented at this paper can provide an effective solution. Fig.1 shows the block diagram of the solar tracking system.

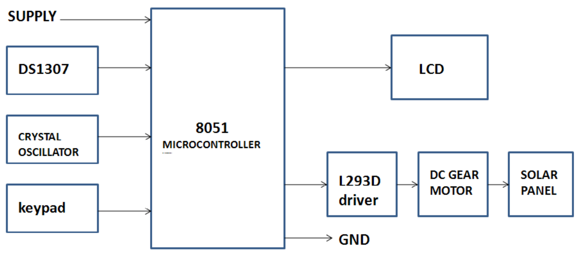

Fig.1 Block diagram of sun tracking solar panel

The major components those are used in the prototype are:
•Photo resistor
•Stepper motor
•Microcontroller

2.a. Photo Resistor/LDRs:

Cadmium sulphide (CDS) photo resistor is used in the designed prototype. 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.

2.b. Stepper motor:

A stepper motor (or step motor) is a brushless synchronous electric motor that can divide a full rotation into a large number of steps. Stepper motors operate differently from DC brush motors, on the other hand, effectively have multiple “toothed” electromagnets arranged around a central gear-shaped piece of iron. To make the motor shaft turn, first one electromagnet is given power, which makes the gear’s teeth magnetically attracted to the electromagnet’s teeth.

So when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one, and from there the process is repeated.The stepper motor that has been used in the prototype has the specifications of 24 volts, 130 Ω resistance,7.5°per step, 4 phase, unipolar. Half stepping rotation is considered for the tracker to control position accurately with sun’s rotation which results in 3.75°per step[5].

2.c. AT89C51 MICROCONTROLLER:

A microcontroller is a general purpose device, but that is meant to read data, perform limited calculations on that data and control its environment based on those calculations. The prime use of a microcontroller is to control the operation of a machine using a fixed program that is stored in ROM and that does not change over the lifetime of the system. The microcontroller design uses a much more limited set of single and double byte instructions that are used to move data and code from internal memory to the ALU. The microcontroller is concerned with getting data from and to its own pins; the architecture and instruction set are optimized to handle data in bit and byte size. The AT89C51 is a low-power, high-performance 40 pins CMOS 8-bit microcontroller with 4k bytes of Flash Programmable and erasable read only memory (EROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is functionally compatible with the industry-standard 80C51 microcontroller instruction set and pin out.

3.ALGORITHM OF PROGRAM CHIP:

1. Connect the PRO51 to COM port and USB port on your PC. USB is used for +5V power supply only. You can use regulated 5V supply and connect it on pin 4 of the 9 Pin connector.
2. Start PROG51 from your program menu.
3. Select appropriate com port on your PC.
4. Insert desired device in the ZIF socket on PRO51. 20 Pin devices like 89C2051 should be aligned with the bottom side, i.e., pin 10 on the 89C2051 should be inserted in Pin 20 of the
socket.
5. Specify the device in the target device text box.
6. Click Identify button to check if the device inserted matches with the one you specified in the Target Device text box.
7. Load Hex or Binary file generated using compiler or assembler in the buffer.

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8. Click on Erase button to erase the contents of the flash memory of the microcontroller. Erase process will automatically be followed by a blank check.
9. Click on Program button to write the buffer contents in to the program memory of the microcontroller. Program action will automatically be followed by a verify cycle.
10. If you wish click on Lock button to secure the device.
11. Remove the device from ZIF socket.

4. SOLAR TRACKING SYSTEM:

The system contains two modules, one is tracking and the other is controlling module as in figure2. Tracking module which will take angular rotation with the help of DC gear motor in synchronous with the starting position of the sun. As sun rises from East, it will also take the angle according to the angle of raising sun. So it will continuously track the sun till the sun sets in the West. Initially when the supply from the power kit was drawn and given to all the components of the control circuit and keyboard. When the power supply is switched ON the panel comes to the original position and by the keypad switches the clock time in the LCD screen can be setted by the keypad switches. K1, K2 and K3 are the switches of keypad. K1 represents Increment switch, K2 represents Decrement switch and K3 represents Enable switch. Initially the panel stands at reference position 8:00AM and according to the setting time the panel rotates with the help of brushless DC Gear Motor. Module is designed with efficient Microcontroller from ATMEL 89C51 which helps to drive the tracking module at different instants. The keypad switches was connected to the microcontroller through latch to the port2 (Pins 2.6, 2.7, 2.8) and microcontroller was connected to the LCD screen through the pins (P1.4 to P1.7) and the LCD displays the preset time. DS1307 is the RTC (Real Time Clock) used to produce clock pulses through microcontroller which connects the LCD display, displays the time. L293D driver was connected to the DC Motor, microcontroller and 9V battery. The pulses that was produced by the microcontroller helps to connect the DC supply to the DC brushless motor. The DC brushless motor was mounted on a separate stand and connected to a shaft which rotates the solar panel given from the microcontroller based upon this gear motor operates. When the supply was given to the dc gear motor, according to the setting from keypad, the solar panel reaches the set state from the initial position with one degree as one second and after reaching the set position it covers every degree by one degree.

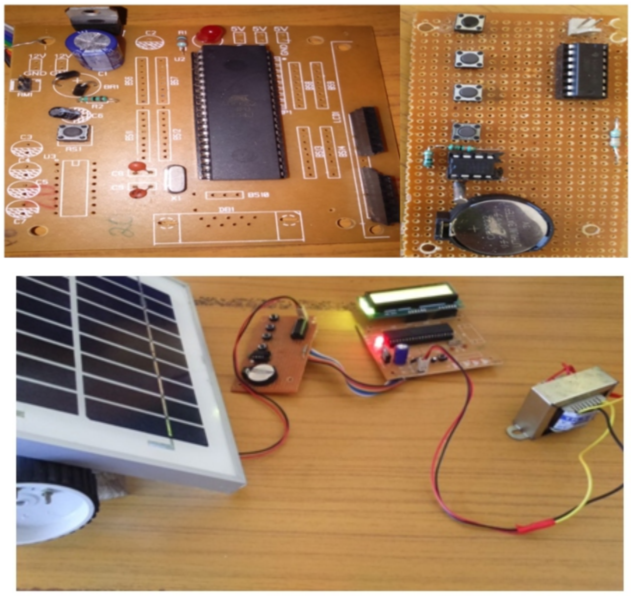

Fig.2 Sun tracking solar panel set up

5. Conclusions:

In recent years, the generation of electricity using solar technology has seen a tremendous growth, in particular because of the economic considerations and smooth operation of the solar panels. Even though the initial costs are high, but operation costs and maintenance costs are low. Solar tracking system today offer an innovative method to track the solar insolation and provide economic compatibility of the generation of electric power where grid connections are difficult to setup and costly. Here the tracking system is based on microcontroller with effective systematic operation and the solar panel is rotated by the dc gear motor effectively. Effective tracking system is achieved when the data considering the rotation of earth with respective to sun is included in the micro controller.

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