International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 02 – Issue 07 || July 2017 || PP. 236-241

Solar Panel Control and Power Optimization Using 2 Axis Stepper Motors

[1]Darshan S, [2]Manjuprasad, [3]Kruthi Jayaram
[1]B.E student, 8th sem,
[2]B.E student, 8th sem, Dept of EEE, BNMIT, Bangalore
[3]Assistant Professor, Dept of EEE, BNMIT, Bangalore

Abstract: Sustainable energy systems are necessary for the economic growth and a healthy environment. The world is using up all the resources to meet the daily demands of energy and it is quite expectable that in the near future we will run of any naturally occurring fossil fuels. As a result, renewable energy solution has achieved a great demand today to save the natural resources. Solar energy is rapidly gaining its popularity as an important source of renewable energy. The traditional design of solar system gives the efficiency to a minimum value to overcome this disadvantage dual axis solar tracker is implemented to keep the solar panel oriented always to the sun throughout a day. Dual axis solar trackers can be used to increase the efficiency of the solar system in a day. This paper proposes a solar tracking system, which helps the solar panel to be kept oriented to the sun at optimum possible angle. Solar panel changes its direction in two-axis to trace the coordinate of sunlight by detecting change in light intensity through light sensors. Light Dependent Resistors (LDRs) are used for sunlight detection. The control circuit is based on 8051 microcontroller. The solar panel is positioned where it is able to receive maximum sunlight.

A working system will ultimately be demonstrated to validate the design. Hardware Implementation is the contribution in the project work.

Keywords: Solar panel, Types of tracking system, LDR, LCD, ADC, Gear motor, 8051 microcontroller, Hardware implementation.

I. Introduction

Electricity is the modern societies most convenient and useful form of energy without it, the present social infrastructure would not be feasible. The energy in the form of electricity is most desirable as it is easy to transport, and can be easily converted to any other form or work as per the requirement power is generated in various methods from various resources. Out of all Solar, Thermal, Hydro and nuclear power generation have gained importance for their availability in abundance and east existence of their resources.

Solar Energy is an inexhaustible. Extracting usable part of it was a challenge until the discovery of Photovoltaic Effect and Photovoltaic Cells. Solar Panel converts the solar energy into electrical DC voltage.

The main objective of the paper is to propose a solar tracking method, which helps the solar panel to be kept oriented to the sun at optimum possible angle. The Solar panel rotates according to the sensor output. The required mechanical moment is achieved by controlled stepper motors. This optimization technique enhances the efficiency of panels.

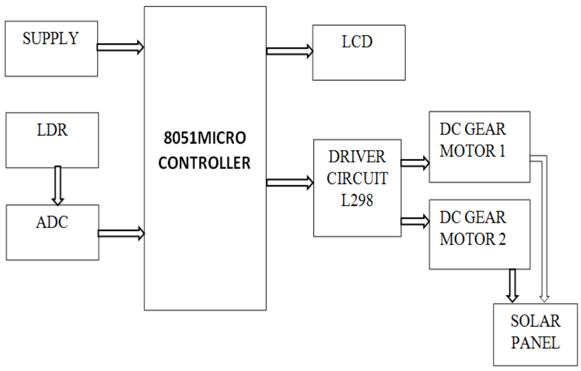

Fig1: Block diagram of solar panel control

The supply is given to the microcontroller; the LDR senses the light intensity and gives analog signals to ADC. The analog signals are converted to digital signals by ADC. Then these signals are given as input to the microcontroller and the same is displayed on the LCD. Microcontroller is so programmed that, depending on the value of ADC output it gives the input to the motor driver circuit (L298) and driver circuit provides the required voltage to the motors. These motors are mechanized to rotate the panel depending on the angle of rotation of the motor, the solar panel rotates.

II. Solar Panel and Types of Rotation

A solar tracker is a device used for orienting a photovoltaic array solar panel or for concentrating Solar reflector or lens toward the sun. The position of the sun in the sky is varied both with seasons and time of day as the sun moves across the sky. Solar powered equipment work best when they are pointed at the sun. Therefore, a solar tracker increases how efficient such equipment is over any fixed position at the cost of additional complexity to the system. There are different types of trackers.

Extraction of usable electricity from the sun became possible with the discovery of the photoelectric mechanism and subsequent development of the solar cell. The solar cell is a semiconductor material which converts visible light into direct current. Through the use of solar arrays, a series of solar cells electrically connected; there is generation of a DC voltage that can be used on a load. There is an increased use of solar arrays as their efficiencies become higher. They are especially popular in remote areas where there is no connection to the grid. Photovoltaic energy is that which is obtained from the sun. A photovoltaic cell, commonly known as a solar cell, is the technology used for conversion of solar directly into electrical power. The photovoltaic cell is a non mechanical device made of silicon alloy.

The photovoltaic cell is the basic building block of a photovoltaic system. The individual cells can vary from 0.5 inches to 4 inches across. One cell can however produce only 1 or 2 watts that is not enough for most appliances. Performance of a photovoltaic array depends on sunlight. Climatic conditions like clouds and fog significantly affect the amount of solar energy that is received by the array and therefore its performance. Most of the PV modules are between 10 and 20 percent efficient.

Fig2: Solar panel

Types of solar trackers:

Solar Tracker is a device which follows the movement of the sun as it rotates from the east to the west every day. **Solar Trackers** are used to keep solar collectors/solar panels oriented directly towards the sun, as it moves through the sky every day. Using Solar Trackers increases the amount of solar energy which is received by the solar energy collector and improves the energy output of the heat/electricity which is generated. Solar Trackers can increase the output of solar panels by 20-30%, which improves the economics of the solar panel project.

1. Passive trackers use a low boiling point compressed gas fluid that is driven to one side or the other (by solar heat creating gas pressure) to cause the tracker to move in response to an imbalance. As this is a non-precision orientation it is unsuitable for certain types of concentrating photovoltaic collectors, but works fine for common PV panel types.

2. Active trackers use motors and gear trains to direct the tracker as commanded by a controller, responding to the solar direction. Since the motors consume energy, one wants to use them only as necessary.

3. Single axis trackers have one degree of freedom that acts as an axis of rotation. The axis of rotation of single axis trackers is typically aligned along a true North meridian. It is possible to align them in any cardinal direction with advanced tracking algorithms. There are several common implementations of single axis trackers. These include horizontal single axis trackers (HSAT), vertical single axis trackers (VSAT), tilted single axis trackers (TSAT) and polar aligned single axis trackers (PSAT).

4. Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. The axis that is fixed with respect to the ground can be considered a primary axis. The axis that is referenced to the primary axis can be considered a secondary axis. There are several common implementations of dual axis trackers. They are classified by the orientation of their primary axes with respect to the ground. Two common implementations are tip-tilt dual axis trackers (TTDAT) and azimuth-altitude dual axis trackers (AADAT). Dual axis trackers are typically used in smaller residential installations and locations with very high government.

III. Hardware Implementation:

Light dependent resistor (LDR):

An LDR is a light-controlled variable resistor. The resistance of an LDR decreases with increasing incident light intensity, i.e., it exhibits photoconductivity.

It is made of a high resistance semiconductor. In the dark, it can have a resistance as high as several mega ohms (MΩ), while in the light, as low as a few hundred ohms. If incident light on the LDR exceeds a certain 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. The resistance range and sensitivity of an LDR can substantially differ among dissimilar devices.

Fig3: LDR

Liquid crystal display (LCD):

The Liquid Crystal Display (LCD) is a low power device (microwatts). Now a day most Applications LCDs are using rather using of LED displays because of its specifications like low power consumption, ability to display numbers and special characters which are difficult to display with other displaying circuits and easy to program.

Analog to digital converter (ADC):

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog to digital convertor, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation registers. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments. Easy interfacing to microprocessor is provided by the latched and decoded multiplexer address inputs and latched TTL TRI-STATE® outputs. The design of the ADC0808 been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808 offers high speed, high accuracy minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power; these features make this device ideally suited to applications from process and machine control to consumer and automotive applications.

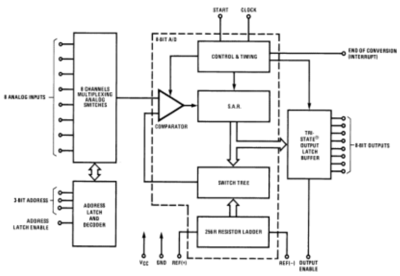

Fig4: Circuit diagram of ADC

8051microcontroller:

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. In modern terminology, it is a system on a chip or SOC. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

H-Bridge Motor driver:

The H-Bridge motor driver acts as a current amplifier and provides higher current output signal. This higher current signal is used to drive the motors. The IC chip contains of two H-bridge circuit in common mode of operation. Two dc motors can be driven simultaneously, both in forward and reverse direction.

DC gear motor:

A DC gear motor is an upgraded version of a DC stepper motor. In a stepper motor the rotation of the shaft is divided into number of equal steps. Whereas in the case of gear motors the shaft is connected with gears, which facilitates reduction in speeds and improves the torque output of motor.

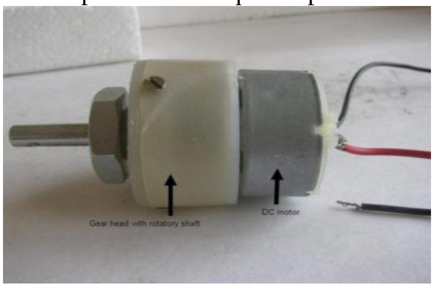

Fig5: DC Gear motor

INTERFACING LCD WITH 8051:

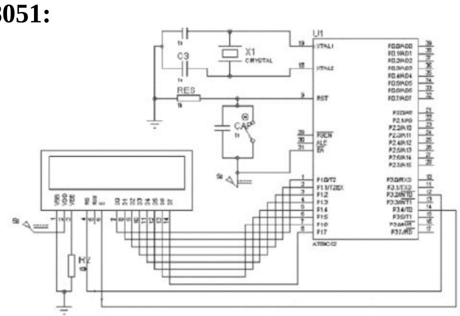

Fig6: LCD Interfacing with 8051

The above circuit shows the interfacing of LCD with the 8051 micro controller. The LCD is connected to the I/O port-1 of the micro controller. And a supply of 5v is provided to the LCD pin-1. Also enable and serial bit pins are connected to port pins 3.4 and 3.2 respectively.

INTERFACING ADC WITH 8051:

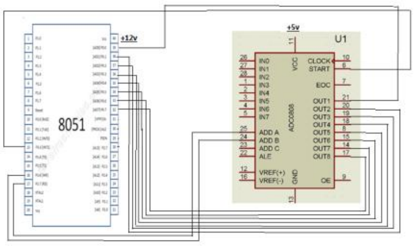

Fig7: ADC Interfacing

The above circuit shows interfacing of ADC-0808 to 8051 micro controller. A supply of 5v is provided to the ADC chip. The voltage levels of LDR are taken as input to ADC. The output from the ADC is being fed to the micro controller through I/O port-0. And the carry bits from the ADC are given to port pins 3.6 and 3.7 of the microcontroller.

INTERFACING 8051 WITH DRIVER CIRCUIT:

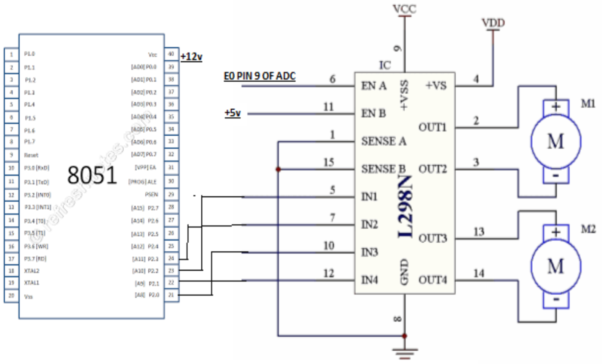

Fig8: Interfacing H-Bridge Driver

The above Fig shows interfacing the H-bridge driver circuit to the micro controller. The micro controller output after processing the program from port pins 2.0 to 2.3 are fed to the input pins of the H-bridge driver circuit. Also the output pins of the driver circuit are connected to the DC gear motors, which acts as a rotating mechanism for the solar panel.

IV. Results & Analysis

The results for the implementation were gotten from LDRs for the solar tracking system and the panel that has a fixed position. The results were recorded for one day, recorded and tabulated. The outputs of the LDRs were dependent on the light intensity falling on their surfaces.

The LDRs measure the intensity of light and therefore they are a valid indication of the power that gets to the surface of the solar panel. As a result, by measuring the light intensity at a given time, it will be possible to get the difference in efficiency between the tracking panel and the fixed one. The light intensity is directly proportional to the power output of the solar panel.

TIME	VOLTAGE (V)
08:00	8.13
09:00	7.94
10:00	8.22
11:00	8.15
12:00	8.23
13:00	8.36
14:00	8.04
15:00	7.93
16:00	8.15
17:00	7.89
18:00	7.67

Table1: Dual Axis Rotation

V. Conclusion

The aim was to build a dual axis solar tracking using stepper motor for solar panel control and power optimization. The paper shows the working of 2 axis solar panel rotation using gear motors which is controlled by 8051 microcontroller. The solar panel rotates according to sensor output. The required mechanical moment is achieved by controlled gear motors.

A solar panel that tracks the sun was designed and implemented. The required program was written that specified the various actions required for the project to work. As a result, tracking was achieved.

VI. References

[1]. "DESIGN AND CONSTRUCTION OF AN AUTOMATIC SOLAR TRACKING SYSTEM" by Md. Tanvir Arafat Khan, S.M. Shahrear Tanzil, and Rifat Rehman published in 6th International Conference on Electrical and Computer Engineering (ICECE) 2010, December, Dhaka, Bangladesh.

[2]. "AUTOMATIC DUAL AXIS SUN TRACKING SYSTEM USING LDR SENSOR" by V Sundara Siva Kumar(Dept. of EIE, RGMCET, Nandyal, A.P India) and S Suryanarayana(Dept.of ECE, Ace Engineering College, Hyderabad, A.P, India) at International Journal of Current Engineering and Technology Sept 2014.

[3]. "SMART DUAL AXES SOLAR TRACKING" by Divya Mereddy, Vijaya Rama Raju.V, Tharun Sadhula-Electrical and Electronics Engineering, GRIET at International Conference on Energy Systems and Applications (ICESA-) 2015.

[4]. "MICRO-CONTROLLER BASED TWO AXIS SOLAR TRACKING SYSYTEM" by Lwin Lwin Oo and Nang Kaythi Hlaing published in Second International Conference on Computer Research and Development.

[5]. "SUN TRACKING BY PEAK POWER POSITIONING FOR PHOTO VOLTAIC CONCENTRATOR ARRAYS" by Pritchard, D. published in IEEE Control Systems Magazine, Volume 3, Issue 3, August 1983.