INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.5 Issue.5,
May 2017
Pg: -64-72

AUTOMATIC SUN TRACKING SOLAR PANEL SYSTEM

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ABSTRACT

Solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources. As such, it is vital that those in engineering fields understand the technologies associated with this area. This project includes the design and construction of a microcontroller-based solar panel tracking system. Solar tracking allows more energy to be produced because the solar array is able to remain aligned to the sun. This system builds upon topics learned in this course. To make solar energy more viable, the efficiency of solar array systems must be maximized. A feasible approach for maximizing the efficiency of solar array systems is sun tracking. This is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. Solar modules are devices that cleanly convert sunlight into electricity and offer a practical solution to the problem of power generation in remote areas. The solar tracker designed and constructed in this project offers a reliable and affordable method of aligning a solar module with the sun in order to maximize its energy output. Automatic Sun Tracking System is a hybrid hardware/software prototype, which automatically provides best alignment of solar panel with the sun, to get maximum output.

1. INTRODUCTION

In remote areas the sun is a cheap source of electricity because instead of hydraulic generators it uses solar cells to produce electricity. While the output of solar cells depends on the intensity of sunlight and the angle of incidence. It means to get maximum efficiency; the solar panels1 must remain in front of sun during the whole day. But due to rotation of earth those panels can't maintain their position always in front of sun. This problem results in decrease of their efficiency. Thus to get a constant output, an automated system is required which should be capable to constantly rotate the solar panel. In last ten years, many of residential around the world used electric solar system as a sub power at their houses. This is because solar to become increasingly important in the longer term, for providing electricity and longer term, for providing electricity and has the potential to be the major energy supply in the future. Solar tracker is an automated solar panel that actually follows position in the sky varies both with equipment over any fixed position.

1.1 SOLAR ENERGY

One of the most important problems facing the world today is the energy problem. This problem is resulted from the increase of demand for electrical energy and high cost of fuel. The solution was in finding another renewable energy sources such as solar energy, wind energy, potential energy...etc. Nowadays, solar energy has been widely used in our life, and it's expected to grow up in the next years.
Solar energy has many advantages:

1. Need no fuel
2. Has no moving parts to wear out
3. Non-polluting & quick responding
4. Adaptable for on-site installation
5. Easy maintenance
6. Can be integrated with other renewable energy sources
7. Simple & efficient

1.2 SOLAR PANNEL

One well-known type of solar tracker is the heliostat, a movable mirror that reflects the moving sun to a fixed location many of the solar panels had been positioned on a fixed surface such as a roof. As sun is a moving object, this approach is not the best method. One of the solutions is to actively track the sun using a sun tracking device to move the solar panel to follow the Sun. With the Sun always facing the panel, the maximum energy can be absorbed, as the panel is operating at their greatest efficiency.

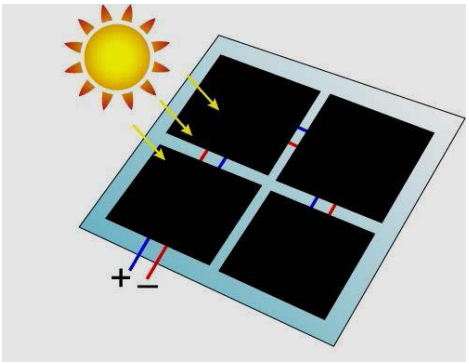

Figure.1.1 Solar Panel

1.3 NEED OF SUN TRACKING

Each day, the sun rises in the east, moves across the sky, and sets in the west. Whenever the sun is shining on us, it is sending energy in our direction. If there is a solar cell to turn and look at the sun all day, then it would be receiving the maximum amount of sunlight possible and converting it into the more useful energy form electricity. It is seen that the sun appears to follow a path that is nearly directly overhead. However, for locations north or south of the tropics (e.g., latitudes greater than 23.5 degrees), the sun never reaches a position that is directly overhead. Instead, it follows a path across the southern or the northern part of the sky.

1.4 TRACKING TECHNIQUES

There are several forms of tracking currently available; these vary mainly in the method of implementing the designs. The two general forms of tracking used are fixed control algorithms and dynamic tracking. The inherent difference between the two methods is the manner in which the path of the sun is determined. In the fixed control algorithm systems, the path of the sun is determined by referencing an algorithm that calculates the position of the sun for each time period. That is, the control system does not actively find the sun's position but works it out given the current time, day, month, and year.

The dynamic tracking system, on the other hand, actively searches for the sun's position at any time of day (or night). Common to both forms of tracking is the control system. This system consists of some method of direction control, such as DC motors, stepper motors, and servo motors, which are directed by a control circuit, either digital or analog.

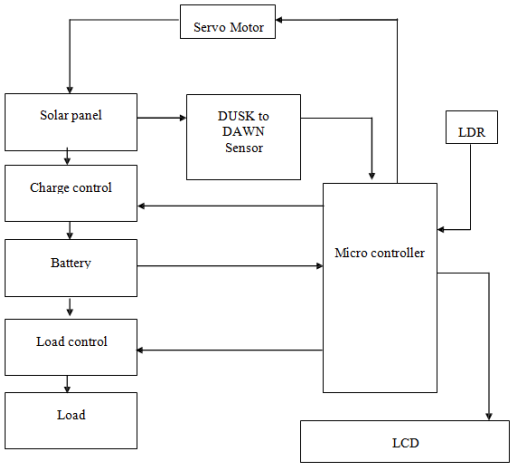

Figure.1.2 Block diagram

1.5 BLOCK DIAGRAM DESCRIPTION

Microcontroller

It is the major part of the system. The microcontroller controls all the operations. The solar panel is aligned according to the intensity of sunlight under the control of the microcontroller.

Sensor

The system consists of two sensors, each composed of LDR. One unit is made up of four LDRs. These are placed at the four corners of the solar panel. The intensity of sunlight is sensed by the LDR and the output is sent to the controller. The control unit analyzes it and decides the direction in which the panel has to be rotated, so that it gets maximum intensity of light.

Servo Motor

Servo motor is used to rotate the panel in desired direction. It is controlled by the controller.

Solar Panel

Solar panel is used for the conversion of solar energy directly into electricity. It is composed of photo voltaic cells, which convert solar energy into electrical energy.

Charge Control

It is meant to control the charging of battery. It sends the status of battery to the microcontroller unit.

Battery

It is for the storage of energy received from the panel. A rechargeable battery is normally employed for this purpose.

Load Control

Load control is meant for the control of the load. It receives control signals from the controller and controls the load.

Load

Different types of load can be controlled as per the requirements. Here a load for lighting purpose is controlled.

LCD Display

LCD display unit displays the status of the battery. An inbuilt voltmeter is set up in the controller and it reads out the voltage level of the battery. The read out voltage is displayed on the LCD display.

1.6 COMPONENTS DESCRIPTION

Passive Device

A Passive Device is one that contributes no power gain (amplification) to a circuit or system. It has not control action and does not require any input other than a signal to perform its function. In other words, "the components with no brains" Examples are Resistors, Capacitors and Inductors

Active Devices

Active Devices are components that are capable of controlling voltages or currents and can create a switching action in the circuit. In other words, "Devices with smarts" Examples are Diodes, Transistors and integrated circuits. Most active components are semiconductors.

Resistor

A resistor is a component of a circuit that resists the flow of electrical current. It has two terminals across which electricity must pass, and it is designed to drop the voltage of the current as it flows from one terminal to the other. Resistors are primarily used to create and maintain known safe currents within electrical components. Resistance is measured in ohms, after Ohm's law. This law states that electrical resistance is equal to the drop in voltage across the

terminals of the resistor divided by the current being applied. A high ohm rating indicates a high resistance to current.

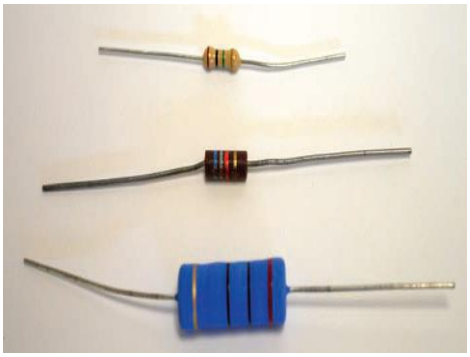

Figure 1.3: From top to bottom: $\frac{1}{4}$ W, $\frac{1}{2}$ W, And 1-W Resistors

Sensors

A Sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

Light dependent resistors (LDR):

LDRs have cadmium sulfide zigzag tack whose resistance decreases as the light intensity incident on it increases. In the absence of light, its resistance is in mega ohms but on the application of light, the resistance falls drastically. These resistors are used in many consumer items such as camera light meters, street lights, clock radios, alarms, and outdoor clocks.

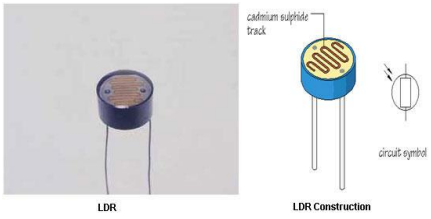

Figure 1.4 Light dependent resistors

Battery

A battery is a device that can create electricity using a chemical reaction. It converts energy stored in molecules inside the battery into electricity. They produce direct current (DC) electricity (electricity that flows in one direction, and does not switch back and forth).

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Figure 1.5 12v battery

Dc Motors

Figure 1.6 DC Motor

Motor is use to drive the Solar Tracker to the best angle of exposure of light. For this section, we are using DC motor. These are very commonly used in robotics. DC motors can rotate in both directions depending upon the polarity of current through the motor. These motors have free running torque and current ideally zero. These motors have high speed which can be reduced with the help of gears and traded off for torque. Speed Control of DC motors is done through Pulse Width Modulation techniques, i.e. sending the current in intermittent bursts. PWM can be generated by 555timer IC with adjusted duty cycle. Varying current through the motor varies the torque.

2. EXPERIMENTAL SETUP

2.1 Circuit Diagram

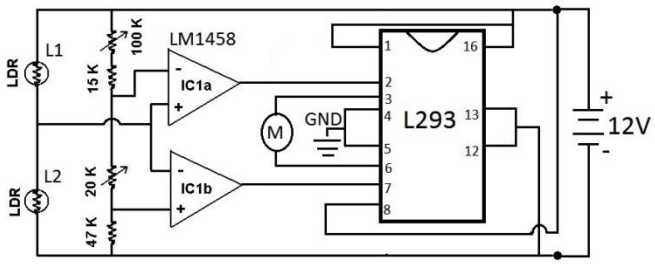

Figure 2.1 single axis solar tracker circuit diagram

2.2 CIRCUIT FUNCTIONS

A careful investigation of the circuit shown in the diagram reveals that the whole configuration is actually very simple and straightforward. Here a single IC1458 is utilized for the required operations.The op amps are primarily wired to form a kind of window comparator, responsible for activating their outputs whenever their inputs waver or drift out of the predetermined window, set by the relevant pots.Two LDRs are connected to the inputs of the op amps for sensing the light levels. As long as the lights over the two LDRs are uniform, the outputs of the op amp remain deactivated.However the moment one of the LDRs senses a different magnitude of light over it (which may happen due to the changing position of the sun) the balance over the input of the op amp shift toward one direction, immediately making the relevant op amps output go high. This high output instantly activates the MOTOR DRIVE (IC293D), which in turn rotates the connected motor in a set direction, such that the panel rotates and adjusts its alignment with the sun rays until uniform amount of light is restored over the relevant set of LDRs. Once the light level over the relevant LDR sets is restored, the op amps again become dormant and switch off their outputs and also the motor.The above sequence keeps on happening for the whole day, in steps, as the sun alters its position and the above mechanism keeps shifting in accordance to the suns position.

3. APPLICATIONS AND ADVANTAGES

3.1 ADVANTAGES:

- This automatic solar tracker is easy to implement since its construction is simple.
- With the implementation the proposed system the additional energy generated is around 25% to 30% with very less consumption by the system itself.
- The solar panel with the sun in order to extract maximum energy falling on it renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate.

3.2 APPLICATIONS

- This system software and hardware can be used to drive a real and very huge solar panel.
- The computer and System Control Unit would have a wireless communication with the mechanical structure of solar panel.
- To make emergency control better more powerful microcontrollers e.g. PIC 16F877A would be used. ‘

4.CONCLUSION

The designed that system which ensures 25 to 30% of more energy conversion than the existing static solar module system. Although ASTS is a prototype towards a real system, but still its software and hardware can be used to drive a real and very huge solar panel. A small portable battery can drive its control circuitry. Therefore by just replacing the sensing instrument, its algorithm and control system can be used in RADAR and moveable dish antennas.

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