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Design and Implementation of High Efficiency Solar Tracking System

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Abstract –*Now a day the scarcity of power plays a vital role, so for this we depend on renewable energy resources especially solar energy. Capturing the solar power at optimal efficiency is the top most criteria in present day's scenarios. The design of Solar (photovoltaic) systems is becoming popular day by day. To maximize the power output of a solar (photovoltaic) system, we have to align the solar panel with the direction of the sun. This is the main drawback of the system till now.*

The proposed method is used to overcome the manual solar panels alignment by using a solar tracking system. This tracking system tracks the maximum intensity levels of the sun. The system monitors the position of the sun using light dependent resistors (LDR's), and makes the decision to move the solar panel rotate towards the sun. This is a microcontroller based solar tracking system. This is a cost effective solution rather than purchasing additional solar panels. The estimation tells that the yield from a solar panel can be increased by 30 to 40 percent by using a tracking system compared to a fixed solar panel. This type of solar tracking system will be helpful to people who reside in remote areas. Our system is designed for small sized applications which will meet the minimum requirements of people who reside in remote areas where power is a major problem.

Keywords- solar energy, Photovoltaic,

Solar tracking, Microcontroller, LDR, Power.

I. INTRODUCTION

Solar energy is energy derived from the heat and light of the sun. There are many ways to do this. Photovoltaic (solar cells) convert sunlight directly into electricity. Solar energy is the energy received by the earth from the sun. This energy is in the form of solar radiation, which makes the production of solar electricity possible. Wind power comes from uneven heating of the earth's atmosphere by the sun. Solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources. It is vital for engineering fields to understand the technologies associated with this area. Our paper includes design and implementation of high efficiency solar tracking system, where the system is based on a microcontroller. This solar tracking system allows more energy to be produced because the solar array is able to remain aligned with the sun.

In remote areas the sun is the cheap source of electricity because instead of hydraulic generators it uses solar cells to produce electricity. While the output of the solar cell directly depends on the intensity of sunlight and the angle of incidence. It means to get the maximum efficiency; the solar panel must remain in front of sun during the whole day.

The proposed system mainly concentrates on the remote areas, where the power was not available in a proper way; one can install this tracking system and can produce electricity for their uses. This is pollution free, clean process of producing electricity compared to other resources and energy. Section II provides a related study of solar tracker; section III explains the hardware resources of the system. Section IV describes the hardware implementations of the proposed system, section V describes firmware implementation finally the conclusion is given in section VI.

II. RELATED STUDY

1. Solar tracker

A solar tracker is a device that orients a payload toward the sun. Payloads can be photovoltaic panels, reflectors, lenses or other optical devices. It is used in many applications such as transport signaling, emergency phones. The main objective of this system is to track the maximum radiation of the sun in order to get maximum charge of battery.

In flat-panel photovoltaic (PV) applications, trackers are used to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity. Trackers are expensive for photovoltaic, for this we use high efficiency panels. Inspection and lubrication is needed for tracking system on regular basis.

The optics in concentrated solar applications accepts the direct component of sunlight light and therefore must be oriented appropriately to collect energy. Tracking systems are found in all concentrator applications because such systems do not produce energy unless pointed at the sun. Tracking is a cost effective solution rather than purchasing additional solar panels.

Here in this paper we use photovoltaic panel, mainly intended for small and medium sized applications. Mainly we concentrate on small sized applications which will be helpful to people live in remote areas. The system was designed mainly to satisfy the people of remote areas with power requirements. Some PV cells produce electricity from infrared (IR) or ultraviolet radiation.

1.1. Applications of solar tracker

Here in this paper the system is used to track the maximum power point of the sun. Tracking enables us to gather more energy with a single panel. Tracking can also be used for solar heaters which track the sun the whole day, where fewer panels are required at the initial cost.

This system can also be used in home automation systems, generally for automatic lighting systems and other remote controlled applications. This system designed for small sized applications will meet the minimum requirements of a family.

III. HARDWARE RESOURCES

1. Power supply circuit

The main building block of any electronic system is the power supply to provide required power for their operation. For the microcontroller keyboard, LCD, RTC, and loads like MP3/FM player, LED lights +5V are required & for driving buzzer and a DC fan (load) +12V is required. The power supply provides regulated output of +5V & non-regulated output of +12V. The hardware part consists of the components and the sensors used in the system. This part mainly collects the status of the sensors and stores it into the micro controller‘s EEPROM.

2. Servo motor

Servos contain a small DC motor, a gearbox and some control circuitry, and feed on 5 volts at about 100mA maximum, and about 10-20mA when idle. They have a three-wire connector, one common wire (0 volt, usually black), one +5v wire (usually red), and one signal wire.

In normal use they are controlled by pulses of about 1 to 2 milli-seconds at a repetition rate of about 50 per second. A short pulse makes the servo drive to one end of the travel, a long pulse makes it drive to the other end, and a medium one puts it somewhere proportionally between. Some servos have gear components that allow them to rotate continuously. This method needs the servo to have a feedback potentiometer used by internal circuits to measure the position of the output shaft.

It is used to drive the Solar Tracker according to the direction of the sun. The pulses are at normal TTL levels. The speed though, is not greatly affected by the pulse repetition rate, as long as it is above about 30 per second.

3. Light dependant resistor (LDR)

A photo resistor or Light Dependent Resistor or CDS Cell is an electronic component whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor.

A photo resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

So in the proposed system the light falling on the LDR sensors are calculated by the microcontroller and it will take a decision to rotate the panel towards higher intensity levels.

4. Solar panel

A solar cell, sometimes called a photovoltaic cell, is a device that converts light energy into electrical energy. A single solar cell creates a very small amount of energy (about 6 volts DC) so they are usually grouped together in an integrated electrical panel called a solar panel.

When the sun rays fall on the solar cell in some particular direction then only we get maximum output .The output of solar cells depends on the intensity of sunlight and the angle of incidence. To get the maximum output the solar panels must remain in front of sun during the whole day. Hence the solar cells are rotated in the direction of sun's position where we get maximum efficiency.

The sensors are placed on the solar panel, where light falls on them and it is used to detect the maximum sun light. Two sensors are placed making an arrangement each of them facing east and west.

5. LCD (Liquid Crystal Display)

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly.

Features

- 5 ×8 and 5 ×10 dot matrix possible
- Low power operation support: 2.7 to 5.5V
- 64 ×8-bit character generator RAM
- Pin function compatibility with HD44780S
- Internal oscillator with external resistor

6. DS1307 Real Time Clock

The DS1307 Real Time Clock developed by Waiman. The module comes fully assembled and pre-programmed with the current time (ok, so it's our current time - MST). The included Lithium coin cell battery (CR1225 41mAh) will run the module for a minimum of 9 years (17 years typical)

without external 5V power. The DS1307 is accessed via the I2C protocol.

7. MIC 29302 Voltage regulator

The MIC 29302 is a high current, low cost, low drop out voltage regulator designed for high current loads. It is typical battery powered equipment. The MIC 29302 is fully protected against over current faults, reversed input polarity, over temperature operation, and positive and negative spikes.

The MIC 29302 voltage regulator feds the regulated voltage powered from the battery to loads . The battery drives the loads connected and it is the power source for the systems operation.

8. Voltage Regulator 7805

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

These voltage regulators are used in the system where +5v regulation are needed. Typically the microcontroller needs the 5v regulation. The loads also need the 5v regulation in our system.

IV. HARDWARE IMPLEMENTATION OF THE PROPOSED SYSTEM

The system does not need any power supply externally but only the sun light. All the components depend up on each other in the operation. The produced energy is supplied for the system operation and as well as to drive the load. The solar energy collected by the panel is converted into electrical energy; the collected energy is charged into a DC Battery. The motor, sensors, tracker and other components of the system is supplied by the battery to operate.

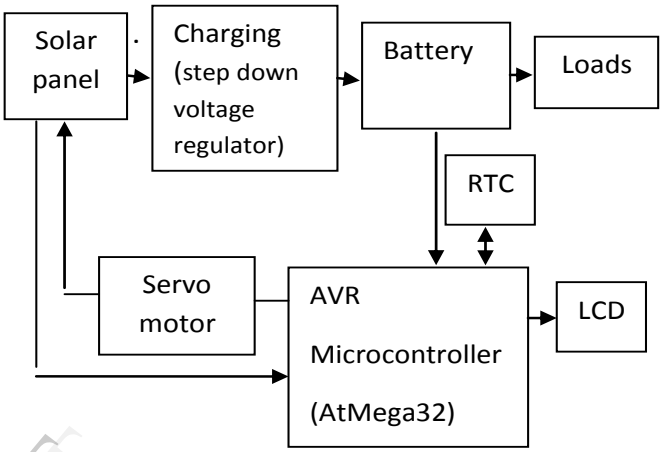

Figure 1 Block diagram of the proposed system

The tracking of the sun undergoes many steps. A microcontroller is used to calculate the maximum radiation of the sun. It is connected to a servo motor and LDR's to redirect the panel to the sun. The system sends the received data to the servo motor to rotate the panel towards to the sun. The position tangles are saved in registers of the microcontroller and can be displayed on the LCD. All the hardware resources like servo motor, LCD, RTC, LDR sensors are interfaced to the microcontroller.

We use two light dependent resistors in the system for the detection of maximum sun light. These LDR's were placed on the solar panel, arranged each one facing east and west directions respectively. The tracker will measure the values of the LDR's and according to the light intensity levels gathered by the sensors; it will start rotating towards the higher intensity levels of the sun. A servo motor is used to rotate the

panel in the system. Servo motor consists of a DC motor, gear box and a control circuitry. The servo motor works according to the pulses generated by the microcontroller.

V.FIRM WARE IMPLEMENTATION

In order to demonstrate the efficiency of the system an algorithm is generated as shown in below table.

Step	Action
1	Install a small PV(Solar panel)
2	Put the PV in initial position
3	Find the maximum sun light using LDR's
4	Covert the LDR's values using ADC to digital values.
5	Process the ADC data
6	If E>W, then turn servo motor towards east.
7	If E<W, then turn servo motor towards west.
8	If E=W ,then go to step 1

Table 1 Algorithm

Figure 2 shows the flow chart of the sun tracking system. The output values of the sensors are converted into digital values with the help of ADC and it is processed.

The both sensor values are calculated and the panel was rotated towards the higher intensity levels of the sun. If the east sensor value is greater than west sensor then the panel is rotated towards the east panel, and if the west sensor values are more than the east sensor values then automatically the panel will rotate towards the west. The accurate position tangles are tracked in a particular direction whether east or west and then the panel orientation takes place. If both the east and west sensor values are equal then the process goes to the initial stage, again starting the tracking process as indicated in the flowchart.

So the proposed tracking system gathers more solar energy using a single panel by using efficient solar tracking system. The battery charged with solar energy drives the loads of the system. The battery also supplies the power for the system operation.

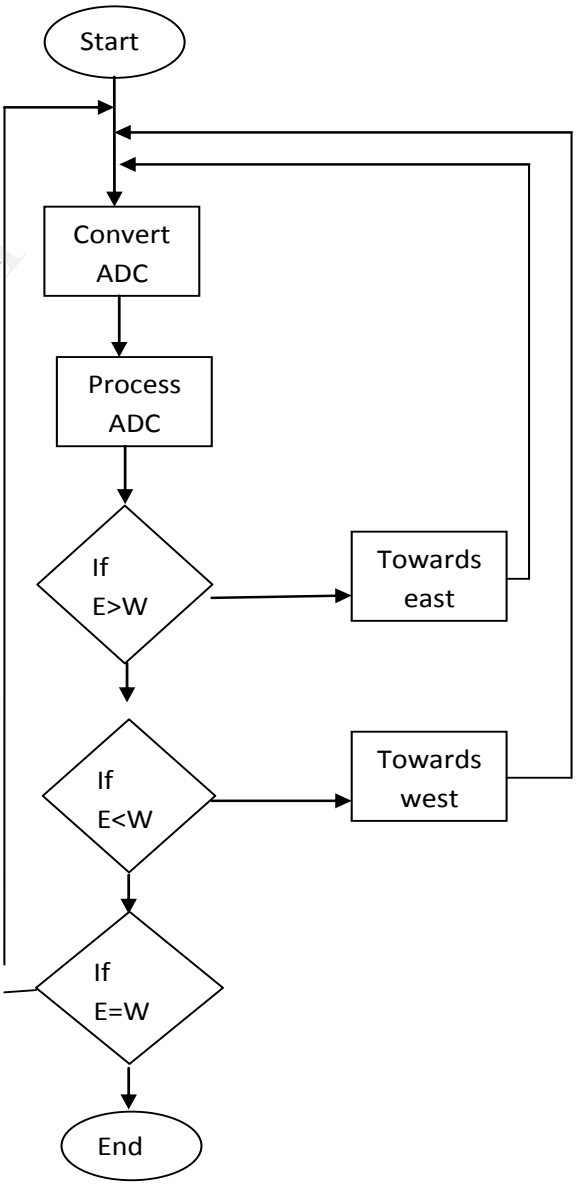

Fig. 2 flowchart for sun tracking system

Experimental set up of the proposed system

The below shown picture represents the experimental setup of the proposed tracking system. This proposed tracking system tracks the maximum solar energy and stores in a battery. the stored energy is used to drive the loads(MP3/FM player, mobile charger, LED lights,DC fan).these tracking system is mainly intended and designed for the usage of people who reside in remote areas.

Figure3: Proposed tracking system

VI. CONCLUSION

As we know that the popularity of solar energy was increasing, because the non conventional energy sources are declining day by day. As sun was the cheapest source of energy in the rural areas, a solar tracking system designed will be helpful to people who reside in remote areas to meet their power requirements.

This paper demonstrates the design and implementation of high efficiency solar tracking system of single axis, mainly intended for small sized applications in remote areas. System was implemented in reduced complexity architecture such as a microcontroller.

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