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Time operated solar tracking for optimum power generation

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ABSTRACT

The growth or energy demand in response to industrialization, urbanization and social affluence has led to an extremely un even global distribution of primary energy consumption. The Sun, Wind, Waves and geothermal heat are renewable energy sources that will never run out. They are perpetual or self renewing. The rate of consumption does not exceed rate of renewability. The cost of generating electricity from wind and solar power has decreased by 90% over the past 20 years. Maximizing power output from a solar system is desirable to increase the efficiency of a solar tracing system. To maximize the power output from solar panels, we need to keep the panels aligned with the sun. In this paper, the design of an efficient solar tracking system based on Real Time Clock (RTC) using microcontroller is described. The proposed tracking system is a low cost, high accurate, more efficient with low power consumption.

INDEX TERMS: Micro controller, Real time clock, Renewable energy, Solar tracking.

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1. INTRODUCTION

The regeneration energy also called the green energy, has gained much importance nowadays. Green energy can be recycled, much like solar energy, water power, wind power, biomass energy, terrestrial heat, temperature difference of sea, sea waves, morning and evening tides, etc. [1,2]. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. The conversion principle of solar light into Electricity, called Photo-Voltaic (PV) conversion, is not very new, but the efficiency improvement of the PV conversion equipment is still one of top priorities for many academic and/or industrial research groups all over the world. Among the proposed solutions for improving the efficiency of PV conversion, we can mention solar tracking [3]-[4], the optimization of solar cell configuration and geometry [5]-[6], new materials and technologies [7]-[8], etc.

The topic proposed in this paper refers to the solar tracking system that automatically adjusts the PV panel position based on the given tilt times with respect to the natural position of the Sun at different times of the day by means of a DC motor controlled by a intelligent microcontroller(AT89S52) that equipped with an algorithm to provide the tracking position using RTC(DS1307).From the experimental results, the proposed tracking system generates efficient energy compared to that of fixed system.

2. SENSING AND TRACKING PRINCIPLE

Various methods have been implemented and used to track the position of the sun. The principle of operation of a PV cell is shown in Fig.1.

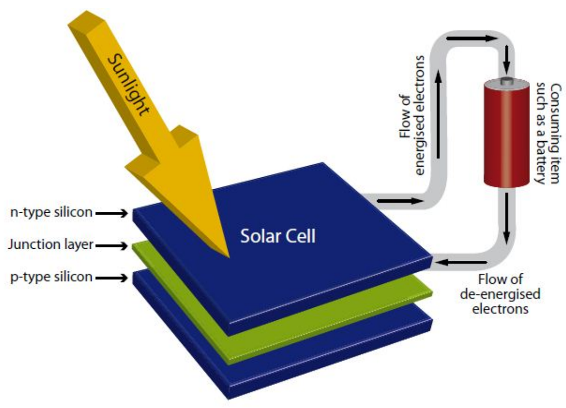

Fig.1:Principle of operation of a PV Cell.

The simplest of all uses an LDR – a Light Dependent Resistor to detect light intensity changes on the surface of the resistor. Other methods, such as that published by Jeff Dam in "Home Power" [10], use two phototransistors covered with a small plate to act as a shield to sunlight, as shown in Fig. 2.

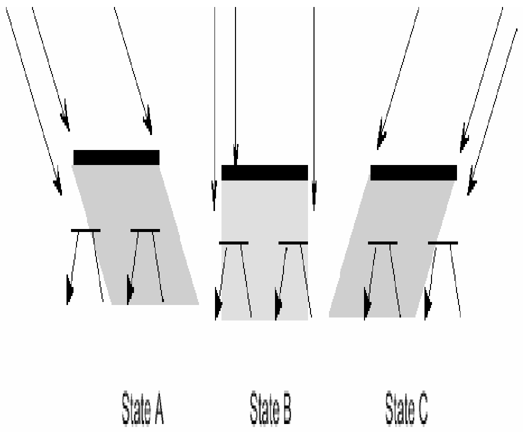

Fig.2: Principle of operation of an LDR

When morning arrives, the tracker is in state A from the previous day. The left phototransistor is turned on, causing a signal to turn the motor continuously until the shadow from the plate returns the tracker to state B. As the day slowly progresses, state C is reached shortly, turning on the right phototransistor. The motor turns until state B is reached again, and the cycle continues until the end of the day or until the minimum detectable light level is reached. The problem with a design like this is that phototransistors have a narrow range of sensitivity, once they have been set up in a circuit under set bias conditions [9]. It was because of this fact that solar cells themselves were chosen to be the sensing devices. They provide an excellent mechanism in light intensity detection because they are sensitive to varying light and provide a near-linear voltage range that can be used to an advantage in determining the present declination or angle to the sun.

As a result, a simple time operated solar tracking system using RTC based control system is proposed, with the tilt times of a panel position with respect to natural position of the Sun has been implemented as an algorithm to controller.

3. ARCHITECTURE OF THE SYSTEM HARDWARE

The system architecture of the proposed solar tracking control system using AT89S52 is shown in fig.3

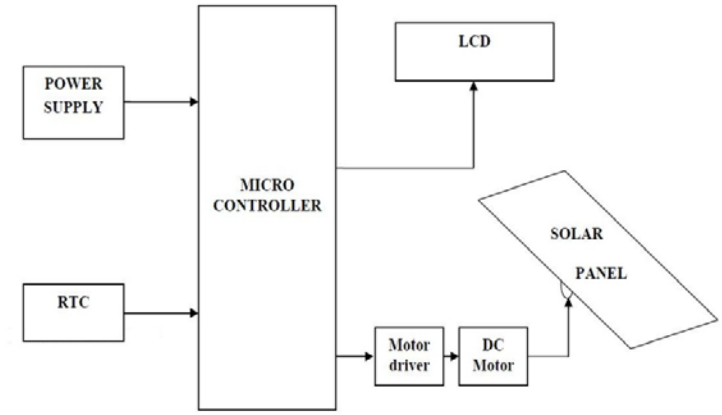

Fig.3: Block diagram of the Time operated solar tracking system using RTC

The time at which panel is tilted to certain angles in a particular direction either in clockwise or anti clockwise is called *tilt time*. The different tilt times of a panel with respect to the natural direction of the Sun is implemented as an algorithm to the controller. Then the controller delivers an output, the corresponding PWM signals to drive the DC motor, so that panel position can be adjusted.

There are two modes in the controller. They are

3.1 Balancing mode

It is used to set the initial position of the solar platform, we use switches for balancing position. The goal is to set boundary problems around for preventing too large elevating angles, which may make the solar panels crash the mechanism platform, and thus damage the motors and the platform.

3.2 Automatic mode

In this mode the controller will continuously reads the RTC and compares with the tabular values of the tilt times stored. If it matches with the values, the corresponding tilt angles will be sent to the micro controller which will make the motor to rotate solar panel using L293D driver.LCD displays the real time, day, month, date, number of the tilt and solar panel voltage at particular position of the panel.

4. PROTYPE OF TIME OPERATED SOLAR TRACKING SYSTEM

The prototype of time operated solar tracking system using RTC is shown in fig.4

Fig 4: Prototype of Time operated solar tracking system using RTC

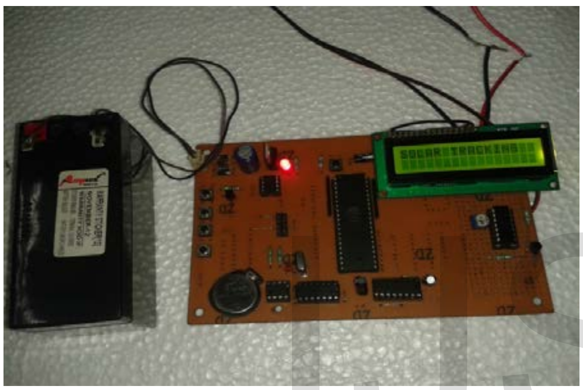

Fig 5: Control equipment of solar tracking system

The main components used are microcontroller (AT89S52), RTC (DS1307), ADC (MCP3201), Op-Amp (LM324N), 16X2 LCD, Voltage controller (7805). The solar panel, Battery, DC motors are connected externally. The solar panel used in our project is made up of poly-crystalline cells. For these cells aiming is not critical as the cells are picking up the light from many different angles.

5. WORKING OF THE PROPOSED SOLAR TRACKING SYSTEM

The power supply is given to the tracking system from external battery.7805 voltage regulator converts this incoming power supply into 5 volts in order to provide supply to other components in the system. The program to the AT89S52 micro controller is given through ISP pins. Based on RTC ,the number of tilts of the panel will be set manually using four switches that are fed as an inputs to the 74LS21 AND gate and its output as an interrupt to the controller. Real Time, Tilt time settings are displayed on LCD which is connected to Port 1 of the micro controller. In this project, we use 4 tilts for tracking purpose and 5th tilt for bringing the panel back to the initial position. The RTC continuously runs and sends a high output to the microcontroller at our prescribed tilt time. Then microcontroller sends a high output to the L293D driver which drives the DC motors connected to the panel. The panel rotation or tilt angles will be initially fixed in the program that is given to the microcontroller. The output of solar panel is connected to Op-Amp which amplifies the signal and gives it to the ADC which is connected to the port 1 of the microcontroller. Voltage generated by the panel as per the individual tilt time is displayed on LCD. Display of LCD is shown in fig 6.

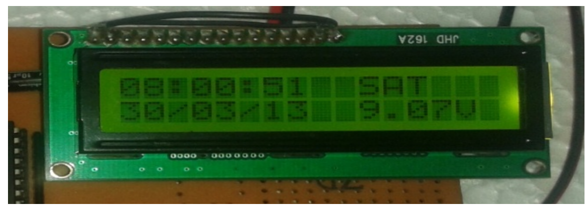

Fig6: LCD display

6. EXPERIMENTAL RESULTS

Captured Panel voltages for with and without proposed tracking system on 30/03/2013 at different times of the day are shown in I and II respectively.

I: Captured Panel voltage with proposed tracking system

S.NO	TIME	PANEL VOLTAGE (IN VOLTS)
1	8.00AM (initial)	9.1
2	9.00 AM	12.9
3	10.00 AM (1st tilt)	15.2
4	11.00 AM	17.1
5	12.00 PM (2nd tilt)	18.9
6	1.00 PM	18.8
7	2.00 PM (3rd tilt)	16.9
8	3.00 PM	16.2
9	4.00 PM (4th tilt)	14.8
10	5.00 PM	11.3
11	6.00 PM (reverse)	5.2

II: Captured panel voltages without proposed tracking system

S.NO	TIME	PANEL VOLTAGE (IN VOLTS)
1	8.00 AM	9.1
2	9.00 AM	12.9
3	10.00 AM	13.4
4	11.00 AM	13.9
5	12.00 PM	14.2
6	1.00 PM	14.1
7	2.00 PM	12.8
8	3.00 PM	11.4
9	4.00 PM	9.3
10	5.00 PM	6.5
11	6.00 PM	1.5

Comparison graph between captured panel voltages of proposed tracking system and fixed system is shown in fig7.

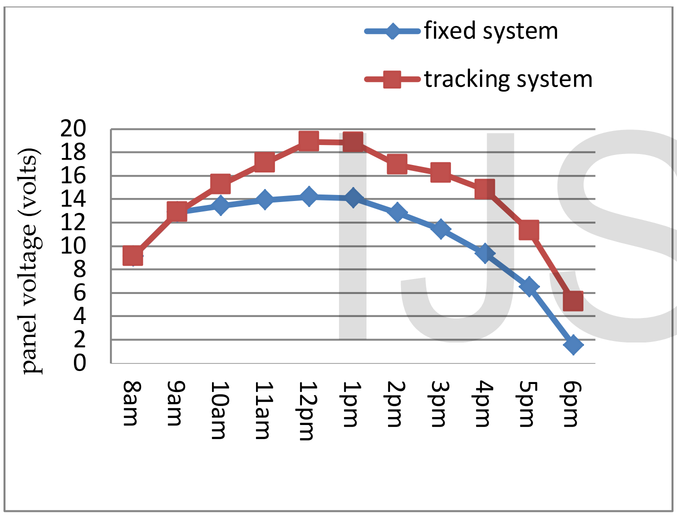

Fig7: Comparision graph between proposed tracking system and fixed system

7. CONCLUSION

The design of microcontroller based an efficient solar tracking system with real time clock is developed and described. The proposed system provides a variable indication of their relative angle to the sun by comparing with pre defined measured readings. By using this method, the solar tracker was successfully maintained a solar array at a sufficiently perpendicular angle to the Sun. The power increase gained over a fixed horizontal array was in excess of 40%. The proposed design is achieved with low power consumption, high accuracy and low cost

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