DESIGN AND DEVELOPMENT OF ARM PROCESSOR BASED SOLAR TRACKING SYSTEM USING DC MOTOR

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Abstract

Renewable Energy (RE) is making a noticeable impact especially in the lives of rural masses. Simultaneously though, its use for urban and semi-urban applications is also growing day to day. Maximizing power output from a solar system is desirable to increase efficiency. In order to maximize power output from solar panels, we need to keep the panels aligned with the sun. As such, a means of tracking the sun is required. This is more cost effective solution than purchasing additional solar panels to produce maximum power. In this paper, a prototype for a RTC (Real Time Clock) based solar tracking system is described, which will keep the solar panels aligned with the sun in order to maximize efficiency.

Index Terms: *ARM processor, DC Motor, Ethernet, PID Controller, PWM.*

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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 or 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 design of a single axis solar tracker system that automatically adjusts the optimum PV panel position with respect to the sun by means of a DC motor controlled by an intelligent controller unit that is equipped with a positioning algorithm to mathematically solve the optimum tracker position for any time of the day using Real Time Clock (RTC).

A practical measurement of the sun position with respect to the natural time relational table is implemented as an algorithm to track the sun position to achieve maximum energy. Finally, a comparison between the tracking system and the fixed system is made. From the experimental results, the proposed tracking system is verified more efficiently in generating energy than the fixed system.

2. THE SENSING AND TRACKING METOD

Various methods have been implemented and used to track the position of the sun. 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 Damm in ‘Home Power’ [10], use two phototransistors covered with a small plate to act as a shield to sunlight, as shown in Fig. 1.

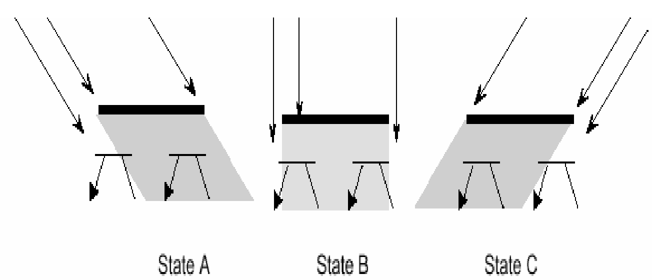

Fig 1: Solar plate shield

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 RTC based control system is proposed, with the natural positioning of the sun with respect to time has been implemented as an algorithm to control the solar PV by controlling the DC Motor.

3.ARCHITECTURE OF SYSTEM HARDWARE

The system architecture of the proposed solar tracking control system using ARM Processor LPC2148 is shown in Fig. 2. The positional direction of the sun with respect to time has been measured and implemented as an algorithm in the controller. Then, the controller in the chip delivers an output, the corresponding PWM signals, to drive the stepping motors. Thus, the directions of the single dimensional solar platform can be tuned to achieve optimal energy, respectively. There are two modes in the controller as follows:

(1) Balancing mode: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.

(2) Automatic mode: In this mode the controller will continuously reads the Real Time Clock (RTC) and compares with the tabular values stored, if it matches with those values the corresponding positional values will be send to the PWM generator which will make the motor to operate to rotate solar panel to words sun shine, By tuning the two-dimensional solar platform, the optimal efficiency of generating power will be achieved.

3.1 System functionality

The final stage involved coupling the circuitry to the motor and mounting it as single unit. The final product model is seen complete in Fig. 2.

It has LPC2148 development board with in built ADC and RS232 features and a 6V 300mA solar panel fixed to the DC motor rotor. Communication between controller and the PC is established using RS232 serial communication to record the O/P voltage obtained from the panel in to the data base for analyses. The DC motor control input signals are connected to the controller and the output of the panel was connected to a load that would dissipate 9W that would match the panel's rating. 9W at 12V corresponds to a current of 0.75A, so by Ohm's law; a load resistance was calculated as being 16Ω. A 15Ω 50W resistor was the closest value found and was connected to the panel. The tracking device still requires power, but a 12V battery that is connected in a charging arrangement with the solar panel supplies it. The voltage across and current through the load was monitored using ADC channels of the controller, and was recorded every half hour on a clear day into a data base. The readings were taken on a span of days that possessed similar conditions including no cloud cover. The readings are shown below in a graph generated in Fig. 6.

3.2Software

To provide the flexibility and to reduce complexity modularization programming method has been implemented; with modularizing the whole software, the work of designing, testing, debugging, maintenance and so on become flexible [11]. For the writing of application program, Keil cross compiler and Embedded C language are combined. The developed application program is burnt in to the controller ROM. The GUI application is developed in the VB6 at system end to visualize the received data values (voltage) of the solar panel and temperature and to store the same in to the database.

ISSN: 2250-3676
Volume-3, Issue-3, 106-110

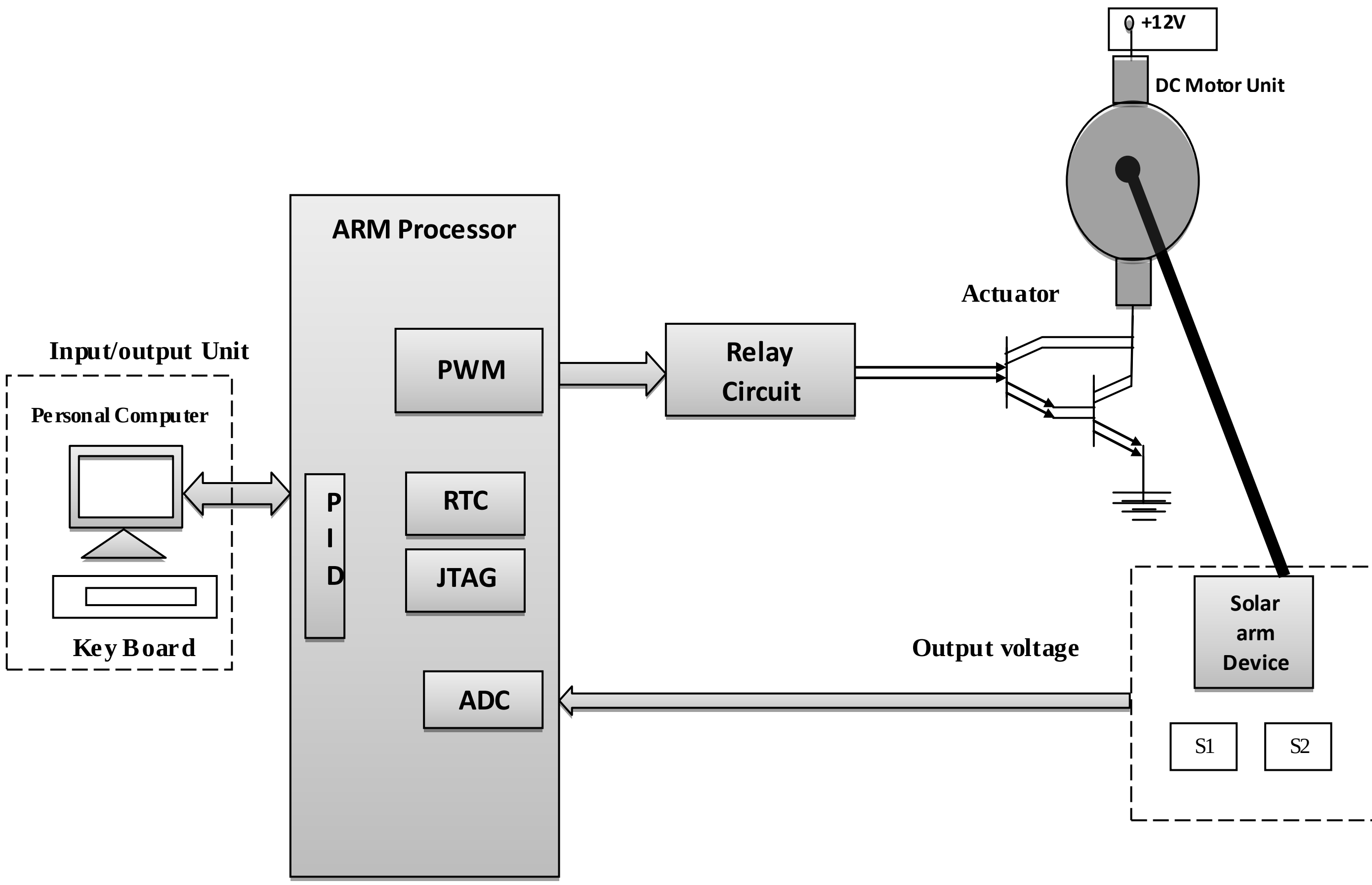

Fig 2: Block Diagram of the ARM Processor based Solar tracking System

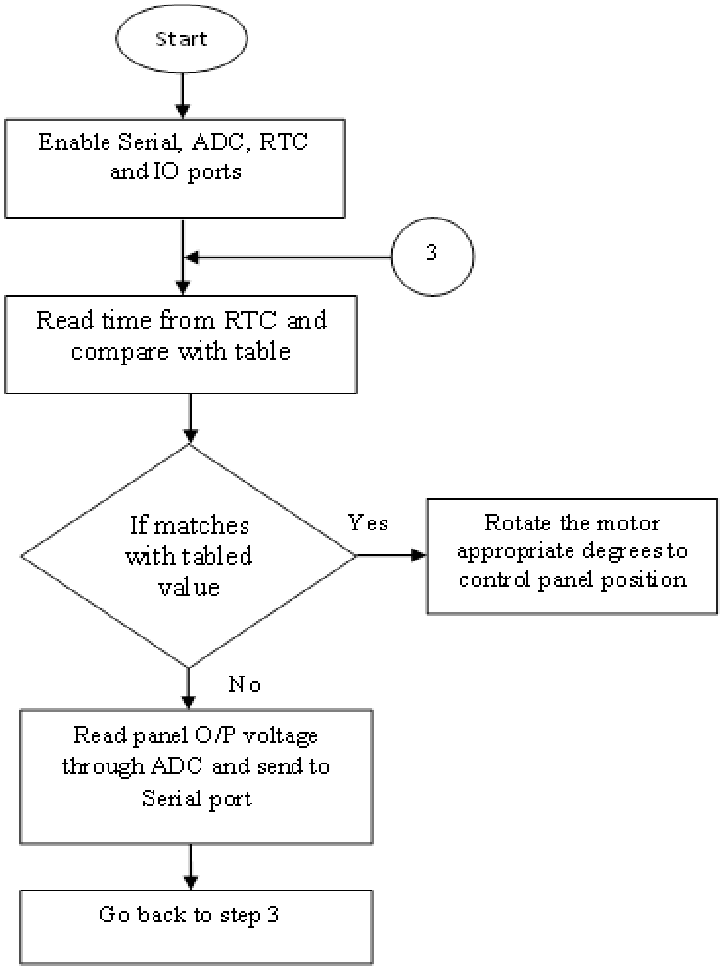

Fig: 3Flow-chart diagram for firmware development.

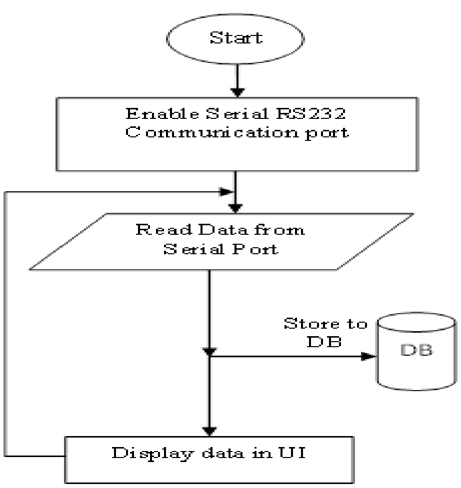

Fig: 4 Flow-chart for system software development.

4. EXPERIMENTAL RESULTS

This experiment applies for solar cell panel. The panel is connected to motor and is controlled through the microcontroller. The output voltage of the panel will be read through the ADC channel of the controller and the converted digital voltage values are sent to the remote device through the RS232 communication channel, at the receiver side the personal computer will receives the signals sent by the controller and stores the readings in the Data Base. Initially the panel output voltage readings have been measured for a day by fixing the panel in a fixed direction, again tested by making panel rotate able according to the sun tracking using RTC these values are recorded for one day the results have been compared with each other, the tracking system will give 40% efficiency than a fixed system.

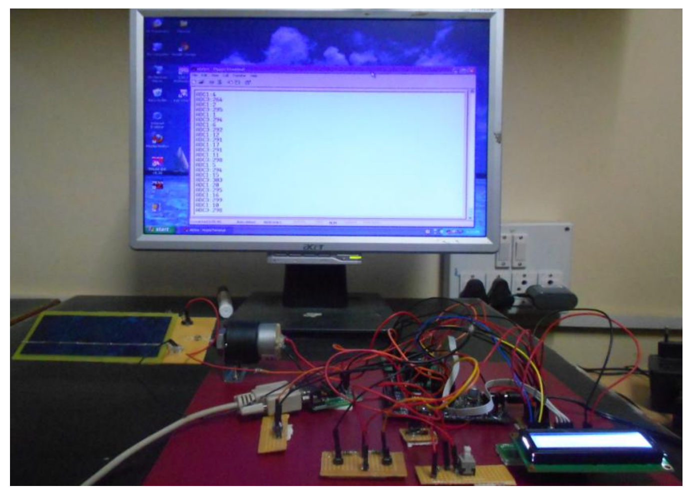

Figure 5: Photograph of the experimental setup with functional units

5. CONCLUSION

A solar tracker is designed employing the new principle of using Real Time Clock (RTC), providing 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 successful in maintaining a solar array at a A solar tracker is designed employing the new principle of using Real Time Clock (RTC), providing 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 successful in maintaining 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%.

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BIOGRAPHIES

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