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An Efficient Low Cost Solar Tracker Using Microcontroller

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Abstract: *Solar energy is gaining importance day by day as an energy resource. Efficiency of solar panel systems must be maximized to make solar energy more usable. By sun tracking we can increase the efficiency of solar panel. When the solar panel is perpendicular to the sun's rays it receives more sunlight. This paper is about follow the sunlight direction across the sky by using a DC gear motor, the AT89S52 microcontroller control the movement of gear motor by this the solar panel will change their position, solar panel detects the sunlight using photocells. The objective is to design and implement an automatic solar-tracking mechanism using embedded system design with minimum cost and reliable structure.*
Keywords: *AT89S52 microcontroller, photocell, solar panel, solar energy, dc motor.*

I. Introduction

This is a new solar age. Humans have been using up fossil fuels for last few hundred years. To use the sun energy more directly we must put more effort technological. The sun light or solar energy is easily and economically available in the space, so by this solar tracker we can use most of the part of it. We have photovoltaic technologies that help us towards a solar future. The PV panels are usually mounted on the roof of the house or at a near open area to face the sun. The PV panels fix in a way that they follow country latitude angle.

These trackers automatically change its position with respect to sun rays to collect as much solar energy. It is more convenient and efficient to use a sun tracking system. In this tracking system, the surface of the panel tracks the sun throughout the day. To achieve maximum power output from PV cells, the sunlight angle needs to be constantly perpendicular to the solar panel. This requires constant tracking of the sun during daytime, and hence develops an automated sun tracking system which carries the solar panel and positions it in such a way that direct sunlight is always focused on the solar cells. Moving to automatic tracking, this can be around either one or two axes. One - axis tracking is generally adequate for non concentrating systems and for systems using low - to - medium concentrations. Many systems, including large power plants, are based on flat plate PV modules and use tracking without any concentration·

II. The Light Dependent Resistors

To work in closed loop form, the controller needs to sense the light through a light sensor to track the sun, so LDR are used for this purpose .The LDR consists of a disc of semiconductor material with two electrodes on its surface. In the dark or in dim light, the material of the disc has a relatively small number of free electrons in it. There are few electrons to carry electric charge. This means that it is a poor conductor of electric current; Its resistance is high. In the light, more electrons escape from the atoms of the semiconductor. There are more electrons to carry electric charge. It becomes a good conductor; Its resistance is low. The more light, the more electrons, the lower the resistance. The LDR used in this paper is the CdS photo resistor shown in Fig 1. The LDR used has a dark resistance of about 100 kΩ and light resistance of 10 kΩ . From the graph shown in Fig. 2, it can be clearly seen that the resistance of the LDR is inversely proportional to (the light intensity that as the light intensity increases the resistance of the LDR decreases).

Figure 1 LDR

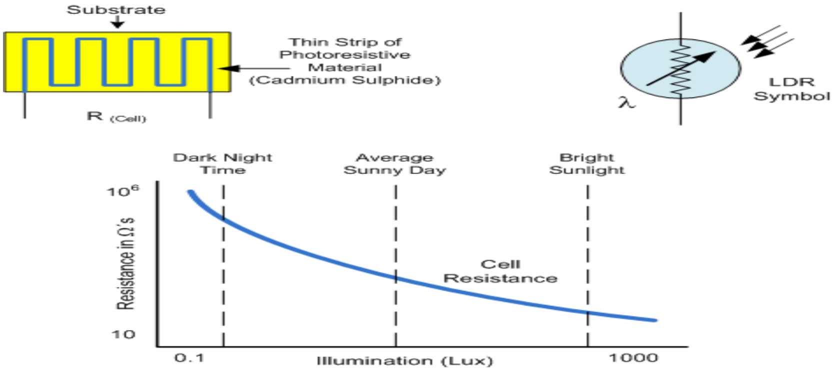

Figure 2 Characteristics of LDR

III. The At89s52 Microcontroller Architecture

The device which we used in our model is the 'AT89S52' which is a typical 8051 microcontroller manufactured by Atmel™. The block diagram provided by Atmel™ in their data sheet that shown in fig 3 the architecture of 89S52 device seemed a bit complicated. A simpler architecture can be represented below.

The 89S52 has 4 different ports, each one having 8 Input/output lines providing a total of 32 I/O lines. Those ports can be used to output DATA and orders do other devices, or to read the state of a sensor, or a switch. Most of the ports of the 89S52 have 'dual function' meaning that they can be used for two different functions.

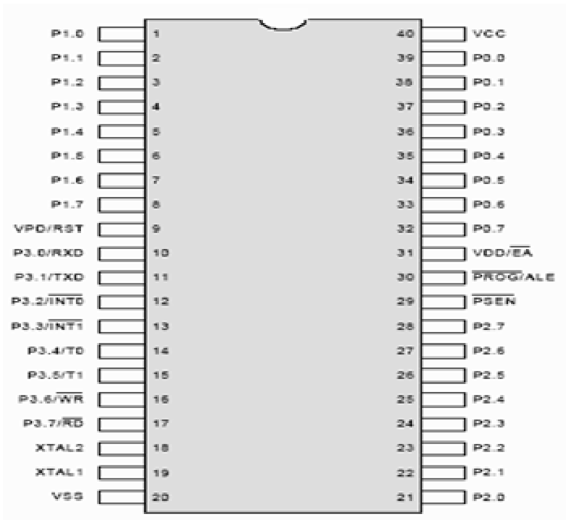

Figure 3 89S52 Architecture

The controller board consists of three parts: the AT89S52 microcontroller which represents the brain of the system, the sensing part which represents the 'eyes', and the motor part or the actuator. Fig.4 shows the controller board, and the complete circuit diagram.

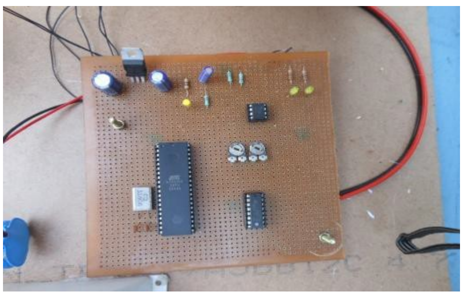

Figure 4 Controller Board

IV (a). The 16f84a Clock Oscillator

The choice of microcontroller clock source determines some of its fundamental Operatingcharacteristics. While "faster is better" in terms of operating speed and Programming execution, faster is definitely worse in terms of power consumption, and also possibly in terms of electromagnetic interference. All timed elements within the microcontroller almost invariably depend on the clock characteristics. If table and accurate timing is required, then the clock oscillator must be stable and accurate. The 16F84A can be configured to operate in four different oscillator modes, allowing implementation of RC, crystal or ceramic oscillators. It can also accept an external clock source. The user selects which mode is to be used by setting the oscillator mode during the PIC programming. 4MHz oscillator is considered an optimum choice when working with applications such as Solar Tracking [10].4MHz crystal and two (22pF) capacitors make up an oscillator that is required by the microcontroller. see Fig. 4.

IV (b). Voltage Regulation

The DC motor does not require voltage regulation; however, the microcontroller does require a steady, regulated 5 volts positive supply with respect to ground. The LM7805 is a +5 V regulator.

IV(c). The H-Bridge Motor Driver

L293D is a dual H-Bridge motor driver. So with one IC, two DC motors can be interfaced which can be controlled in both clockwise and counter clockwise directions and its direction of motion can also be fixed. The four I/O's can be used to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for the protection of the circuit from back EMF, output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver. The name "H-Bridge" is derived from the actual shape of the switching circuit which controls the motion of the motor. It is also known as "Full Bridge".
By using two motors the robot can be moved in any direction. This steering Mechanism of the robot is called differential drive. Fig 5 shows the connection of H- bridge motor driver.

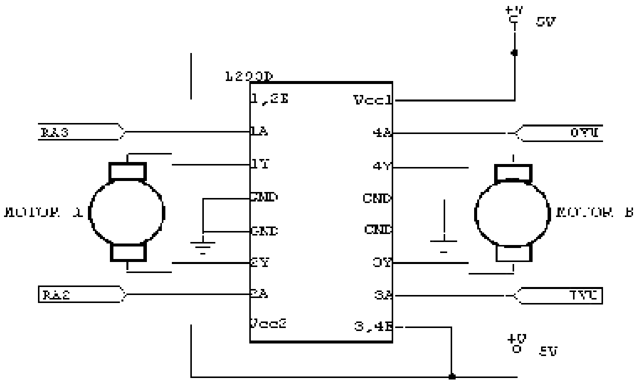

Figure 5 H-bridge Motor Driver

V. System Mechanical Construction

This paper proposed a solar tracking system which is simply a base platform that has a shape of a rectangle. The base platform has 4 solar plates the whole panel is connected with DC gear motor. Reed switch is provided for properly balancing the DC motor.

Figure 6 Product

VI. System Software And Operation

The Sun moves nominally 0.25° angle of the sky every minute. So the speed of rotation is not critical· To achieve high resolution and low power consumption a DC motor with high torque gear transmissions is chosen to perform the rotation.
The solar panel rotates across the sky with the help of microcontroller and motor. The microcontroller reads the light intensity measured by sensor A (LDR1) and sensor B(LDR2). The higher the light intensity the less is the corresponding resistance of the sensor. After reading the resistances of sensors A and B, it calculates the difference between the two readings. If the deference is less than a threshold value, there are two possibilities either the two sensors are under shadow (night time) or both A and B sensors are under the light Perpendicularly (facing the day light). In night time the microcontroller command the motor to rotate the tracker to the reset position.

VII. Cost Considerations

The cost is a very important factor in the system design process. The proposed sun tracking system is a mechatronics system. For the mechanical part the goal was to build a simple but reliable frame that can hold the solar panel and the controller board. The simpler the design, the lower the cost. To make the cost as low as possible the AT89S52 microcontroller has been used, this has a limited set of peripherals, chosen for small and low-cost applications.

VIII. Results and Conclusions

This paper proposed a sun tracking system based on AT89S52 microcontroller. The paper shows how to develop and implement a single axis solar tracking system with minimum cost. The mechanical structure was very simple and reliable, it was designed such that the entire controller board fit within the base platform of the sun tracker system. The controller circuit has been designed with a minimal number of components, to minimize the cost, and has been integrated onto a single board for simple assembly. The software was simple and easy to understand. Suitable components and a geared dc motor were used for the prototype model, which exhibit a clear, stable,and precise movement to face the sun. The efficiency of this system is up to 98%.

Table 1

Time Of Day	Closed Circuit Voltage	Observed Voltage
10 AM	12 V	8 V
12:30 PM	12 V	11.85 V
4:30 PM	12 V	9V

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