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A Microcontroller-Based Multi-Function Solar Tracking System

D. Baskar

Electrical and Electronics Engineering,
Bharath University, India

Abstract: Microcontroller based multi-function solar tracking system are used to drive the load using the power from the solar panel in the morning time, when during the night time it will be operated using the battery. In this study has been worked on new method to increase the power output of solar cell by moving it in during a day and seasons with detecting degree of sunlight. And one fixable mechanism with three degrees of freedom has been designed and constructed for movement the panel of solar cell by very low power hydraulic arm and electric motor. In this way a microcontroller form PIC family has been applied for sampling of solar cell output, controlling the hydraulic arm and finding the best position of panel under the sunlight. This system follows the sun like sunflower and with this way in all hours of day uses of maximum power of solar energy.

Key words: Solarpanel · Lcd · Pic microcontroller · Stepper motor · Battery

INTRODUCTION

In this study has been worked on new method to increase the power output of solar cell by moving it in during a day and seasons with detecting degree of sunlight. And one fixable mechanism with three degrees of freedom has been designed and constructed for movement the panel of solar cell by very low power hydraulic arm and electric motor. In this system has not been used of any external sensor for detecting the best location of panel under the sunlight and just with measuring the output voltage of solar cell the controller finds the best position. In this way a micro controller form AVR family has been applied for sampling of solar cell output, controlling the hydraulic arm and finding the best position of panel under the sunlight [1]. This system follows the sun like sunflower and with this way in all hours of day uses of maximum power of solar energy. The aim of this study is making a system for using in industry. And all of the equipments are cheap and installation of them is so easy.

Power supply Unit: The supply of 5V DC given to the system, which is converted from 230V AC supply. Firstly, the step down transformer used here is for converting the 230V AC into 12V AC. The microcontroller will support only the DC supply, so the AC supply is converted to DC using the bridge rectifier. The output of the rectifier will have ripples so we are using the 2200uf capacitor for filtering those ripples. The output from the filter is given to the 7805 voltage regulator, which will convert the 12V DC into 5V DC. The output from the regulator will be filtered using the 1000uf capacitor, so the pure 5V DC is getting as the output from the power supply unit [2].

PIC16F877A Microcontroller: The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/ PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART and a Parallel Slave Port. The PIC microcontroller has inbuilt ADC which is used to convert the analog voltage from the solar panel in to digital and is fed for further processing.

Program Memory: A memory that contains the program (which we had written), after we've burned it. As a reminder, Program Counter executes commands stored in the program memory, one after the other.

Corresponding Author: D. Baskar, Electrical and Electronics Engineering, Bharath University, India.

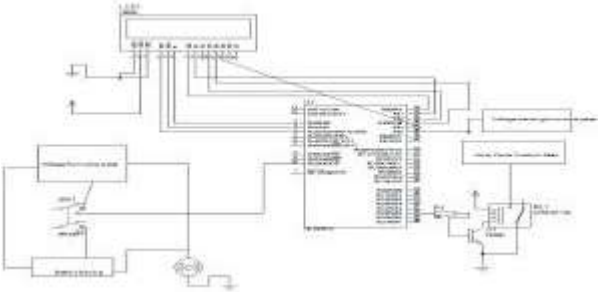


Fig. 1:

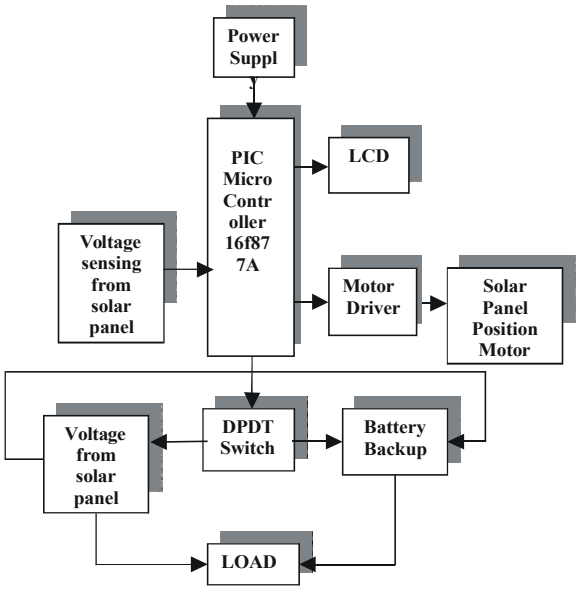
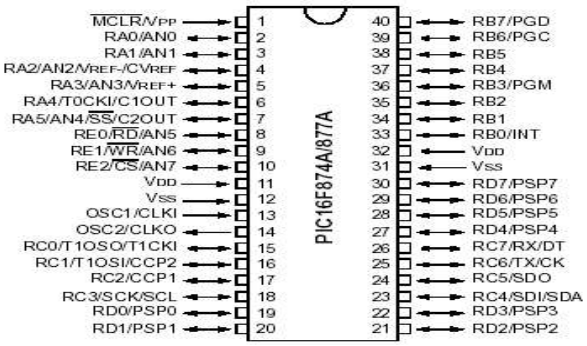


Fig. 2:

Data Memory: This is RAM memory type, which contains a special registers like SFR (Special Faction Register) and GPR (General Purpose Register). The variables that we store in the Data Memory during the program are deleted after we turn of the micro. These two memories have separated data buses, which makes the access to each one of them very easy.

Data EEPROM (Electrically Erasable Programmable Read-Only Memory)-A memory that allows storing the variables as a result of burning the written program. Each one of them has a different role. Program Memory and Data Memory two memories that are needed to build a program and Data EEPROM is used to save data after the microcontroller is turn off. Program Memory and Data EEPROM they are non-volatile memories, which store the information even after the power is turn off. These memories called Flash Or EEPROM. In contrast, Data Memory does not save the information because it needs power in order to maintain the information stored in the chip.



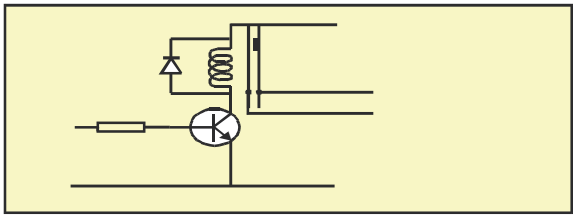


Fig. 3.1:

Motor Driver (Relay Driver): A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply. The diagram below shows a typical relay (with "normally-open" contacts). The current needed to operate the relay coil is more than can be supplied by most chips (op. amps etc), so a transistor is usually needed, as shown in the diagram below.

Relay Driver with Flip-Flop: In many situations in which you use a relay, you will also need a bi-stable flip-flop. One useful integrated circuit flip-flop is the 4013. (This is actually contains two flip-flops.) With the connections as shown in the circuit below, when the voltage on pin 3 changes (rapidly) from 0v to the positive supply voltage, the flip-flop changes state (it "flips"). The next time the same thing happens, the flip-flop changes back to its original state again (it "flops") [3].

Liquid Crystal Display: In the early 1970's, digital watches started showing up in the marketplace with a new and different type of display-the liquid crystal display or LCD. The LCD displays used in these early digital watches were very different from the LEDs they replaced. While even a tiny LED display consumes a few milli-watts of power, the LCD consumes just microwatts of power. Hence, the LCDs are over 1000 times more efficient at their job than the LEDs. Since their commercialization in the '70s, LCDs are the most popular electronic display device,

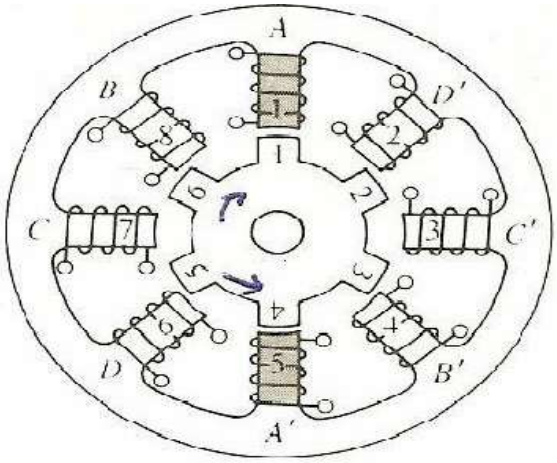


Fig. 5.1:

except one-the CRT. LCD flat full color panels are now challenging the CRT as displays for television and computers. There are also many hybrid systems that use LCD display technology [4].

Liquid crystals-There are 3 states of matter: solid, liquidgas. Solids states can be further categorised into: crystalline which has regular arrangement of molecules; and amorphous where there is no regular structure.

Power Requirements-The LCDs have minimal power requirements. Currently manufactured LCDs consume between 1 and 300 microwatts per square centimeter. This is the lowest power consumption of any display type now available. This very low power consumption allows most LCD products to be battery operated.

Solar Panel Position Motor (Stpper Motor): Stepper motors provide a means for precise positioning and speed control without the use of feedback sensors. The basic operation of a stepper motor allows the shaft to move a precise number of degrees each time a pulse of electricity is sent to the motor. Since the shaft of the motor moves only the number of degrees that it was designed for when each pulse is delivered, you can control the pulses that are sent and control the positioning and speed. The rotor of the motor produces torque from the interaction between the magnetic field in the stator and rotor. The strength of the magnetic fields is proportional to the amount of current sent to the stator and the number of turns in the windings. The stepper motor uses the theory of operation for magnets to make the motor shaft turn a precise distance when a pulse of electricity is provided. You learned previously that like poles of a magnet repel and unlike poles attract. Figure 1 shows a typical cross-sectional view of the rotor and stator of a stepper motor.

Fig. 6.1:

From this diagram you can see that the stator (stationary winding) has eight poles and the rotor has six poles (three complete magnets). The rotor will require 24 pulses of electricity to move the 24 steps to make one complete revolution. Another way to say this is that the rotor will move precisely 15° for each pulse of electricity that the motor receives. The number of degrees the rotor will turn when a pulse of electricity is delivered to the motor can be calculated by dividing the number of degrees in one revolution of the shaft (360°) by the number of poles (north and south) in the rotor. In this stepper motor 360° is divided by 24 to get 15°.

DPDT Switch: In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar for of switch is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can another work-piece. Switches may be operated by process variables such as pressure, temperature, flow, current, voltage and force, acting assessors in a process and used to automatically control a system. For example, a thermostat is a temperature-operated switch used to control a heating process.

An ideal switch would have no voltage drop when closed and would have no limits on voltage or current rating. It would have zero rise time and fall time during state changes and would change state without "bouncing" between on and off positions. Practical switches fall short of this ideal and have resistance, limits on the current and voltage they can handle, finite switching time, etc. The ideal switch is often used in circuit analysis as it greatly simplifies the system of equations to be solved, however this can lead to a less accurate solution. Theoretical treatment of the effects of

Fig. Hardware implementation

non-ideal properties is required in the design of large networks of switches, as for example use in telephone exchanges.

RESULTS AND DISCUSSION

The basic setup behind this project started with the selection of components required to proceed with the experiment. Having decided with the components the next step was to assemble them and test their operation.

Hardware Implementation: The setup of the hardware section is shown below:

The components are soldered and fixed on the board.

CONCLUSION

We concluded that an automatic sunlight adjusting system (ASAS) using solar power for the solar panel control. It can keep solar penal direct to the sun light. On reset the system will continuously scan in which direction the solar power is high. After getting the position, the panel will follow the sun light to get maximum power by switch over to the next quadrant. When the sun sets down the solar panel will come to the reset position [5-9].

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