FAULT DETECTION AND MONITORING OF PV SOLAR PANELS USING IOT

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Abstract— Solar energy is becoming increasingly attractive as we grapple with global climate changes. However, while solar energy is free, non-polluting, and inexhaustible, solar panels are fixed. As such, they cannot take advantage of maximum sunlight as weather conditions and seasons change. A solar panel receives the most sunlight when it is perpendicular to the sun's rays, but the sunlight direction changes regularly with changing seasons and weather. Currently, most solar panels are fixed, i.e., the solar array has a fixed orientation to the sky and does not turn to follow the sun. To increase the unit area illumination of sunlight on solar panels, we designed a solar tracking electricity generation system. The design mechanism holds the solar panel and allows the panel to perform an approximate3-dimensional (3-D) hemispheroidal rotation to track the sun's movement during the day and improve the overall electricity generation. This system can achieve the maximum illumination and energy concentration and cut the cost of electricity by requiring fewer solar panels, therefore, it has great significance for research and development. The main use of this report is to utilize the maximum power from the sun. Now a day we are in heavy need to use the solar power as in the coming days everything we use might depend on this kind of systems.

***Keywords*—Solar Tracking, Solar Panel, Microcontroller, Motor, Analog-to-Digital Converter, Liquid Crystal Display.**

1. INTRODUCTION

Solar energy refers to the utilization of the radiant energy from the sun. Solar power is used interchangeably with solar energy, but refers more specifically to the conversion of sunlight into electricity by photovoltaic, concentrating solar thermal devices, or by an experimental technology such as a solar chimney or solar pond.

Solar panels are Photovoltaic cells which gives voltage directly if you place them in sun light. Here if you change the position of panels the power output will vary. Means, direct sunrays on solar panel can give good output otherwise there might be decrease in the value of their outputs. So we have to track the path where the maximum power will attain.

Solar panel devices are of two types that collect energy from the sun. One is solar photovoltaic modules which use solar cells to convert light from the sun into electricity and the other is solar thermal collector which converts the sun's energy to heat water or another fluid such as oil or antifreeze. In this project we are using the photovoltaic type.

The main aim of the project is to design one system for automated solar tracking system. For this we are using AVR family microcontroller and two LDR for finding the light intensity and stepper motor for rotation of the solar panel. We are implementing one application program using embedded C and loading the program into microcontroller through ISP (in system programmer) and it will read data from the sensors through ADC MCP3208 and according to the data stepper motor is rotating. Stepper motor is directly connected to microcontroller.

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2. SYSTEM ANALYSIS

2.1 Circuit Operation:

The main aim of the project is to design one system for automated solar tracking system. For this we are using 8051 family microcontroller and two LDR for finding the light intensity and stepper motor for rotation of the solar panel. We are implementing one application program using embedded C and loading the program into microcontroller through ISP.

In the following block diagram, when sun rays fall on the LDR then according to intensity of light, it generates variable analog output. ATMEGA328P microcontroller will read data from the LDR through MCP3208 which is serial ADC used for converting analog signal to digital one. Oscillator gives the clock to microcontroller which is necessary for program execution. In program, ATMEGA328P microcontroller compares the output of LDR which is already fetched. Program generates control signals which are given to servo motor. Servo motor is rotating via Arduino chip.

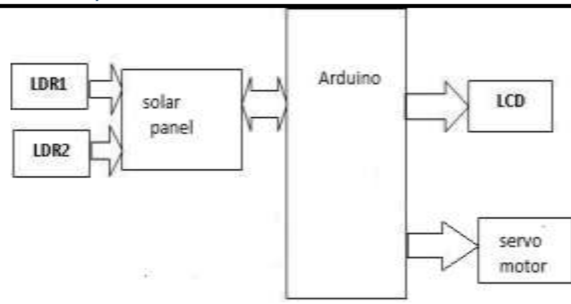

Fig. 1 Schematic representation of Solar Tracking System

A. Hardware:

- ✓ ATMEGA328P (Microcontroller)
- ✓ LDR (Light Dependent Resistor)
- ✓ LCD (Liquid Crystal Display)
- ✓ Servo Motor

B. Software:

Arduino ide programming

3. SELECTION OF HARDWARE

3.1 .Selection of Microcontroller:

As we know that there so many types of micro controller families that are available in the market.

Those are:

- ✓ 8051 Family
- ✓ AVR microcontroller Family
- ✓ PIC microcontroller Family
- ✓ ARM Family

Basic 8051 family is enough for our application; hence we are not concentrating on higher end controller families.

A. In order to fulfil our application basic that is AT89C51 controller is enough. But still we selected ATMEGA328P controller because of inbuilt ISP (in system programmer) option.

There are minimum six requirements for proper operation of microcontroller.

Those are:

- ✓ Power supply section
- ✓ pull-ups for ports (it is must for PORT0)
- ✓ Reset circuit
- ✓ Crystal circuit
- ✓ ISP circuit (for program dumping)
- ✓ EA/VPP pin is connected to Vcc.

PORT0 is open collector that's why we are using pull-up resistor which makes PORT0 as an I/O port. Reset circuit is used to reset the microcontroller. Crystal circuit is used for the microcontroller for timing pluses. In this project we are not using external memory that's why EA/VPP pin in the microcontroller is connected to Vcc that indicates internal memory is used for this application.

B. Selection of ADC:

Here in this project we selected MCP3208 ADC. In this project ADC is used to convert analog voltage sent by the LDR to digital voltage. We can use parallel ADC (ADC 0804) but we need more pins to interface that, so to reduce port pins we can use MCP3208.

C. Selection of LCD:

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images, and moving pictures. Its uses include monitors for computers, televisions, instrument panels, and other devices ranging from aircraft cockpit displays, to every-day consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. Among its major features are its lightweight construction, its portability, and its ability to be produced in much larger screen sizes than are practical for the construction of cathode ray tube (CRT) display technology. Its low electrical power consumption enables it to be used in battery powered electronic equipment. It is an electronically modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in colour or monochrome.

D. Connections to Microcontroller:

Microcontroller has 4 ports and every port has 8 pins we are connecting all external components to this ports only. LCD is connected to the PORT0 and ULN2003 is connected to PORT2 and MCP 3208 which is acting as ADC is connected to the P1.

I. SCHEMATIC DIAGRAM

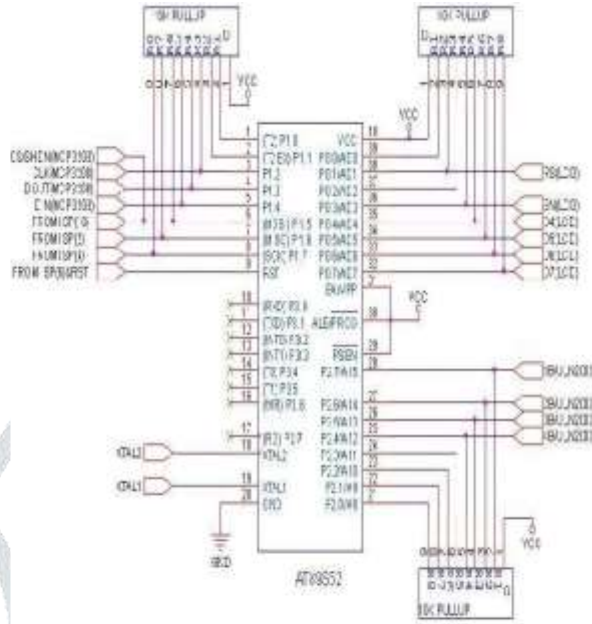

Fig. 2 Input output pins of microcontroller

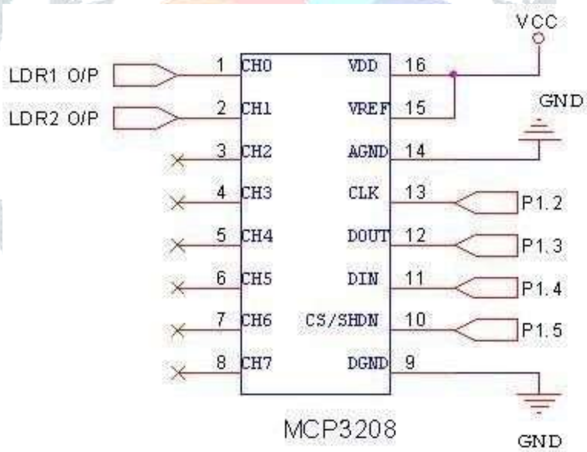

Fig .3 ADC Converter 7

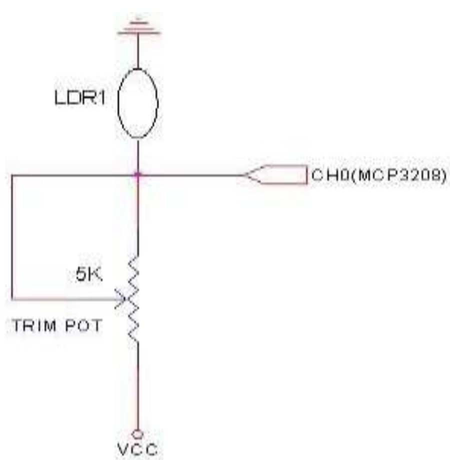

Fig.4 Light Dependent Resistor

II. POWER SUPPLY SECTION

In-order to work with any components basic requirement is power supply. In this section there is a requirement of one voltage level i.e. 5V DC power supply.

Now the aim is to design the power supply section which converts 230V AC in to 5V DC. Since 230V AC is too high to reduce it to directly 5V DC, therefore we need a step-down transformer that reduces the line voltage to certain voltage that will help us to convert it in to a 5V DC. Considering the efficiency factor of the bridge rectifier, we came to a conclusion to choose a transformer, whose secondary voltage is 3 to 4 V higher than the required voltage i.e. 5V. For this application 0-9V transformers is used, since it is easily available in the market.

The output of the transformer is 9V AC; it feed to rectifier that converts AC to pulsating DC. As we all know that there are 3 kinds of rectifiers that are:

- Half wave rectifier
- Bridge rectifier

Here we short listed to use Bridge rectifier, because half wave rectifier has we less in efficiency. Even though the efficiency of full wave and bridge rectifier are the same, since there is no requirement for any negative voltage for our application, we gone with bridge rectifier.

Since the output voltage of the rectifier is pulsating DC, in order to convert it into pure DC we use a high value (1000UF/1500UF) of capacitor in parallel that acts as a filter. The most easy way to regulate this voltage is by using a 7805 voltage regulator, whose output voltage is constant 5V DC irrespective of any fluctuation in line voltage.

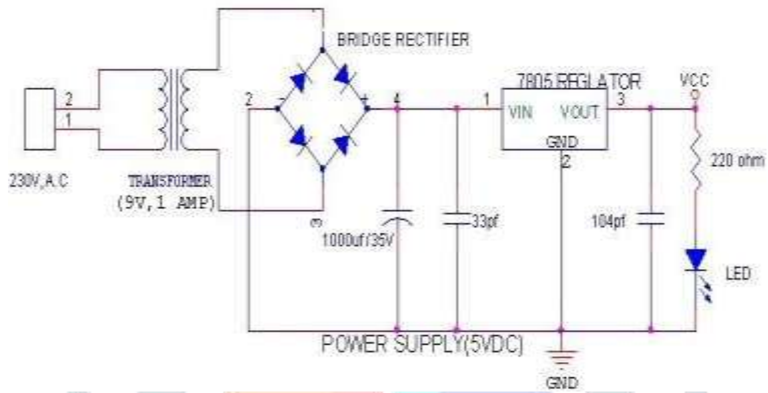

Fig. 5 Power Supply

III. FLOW CHART

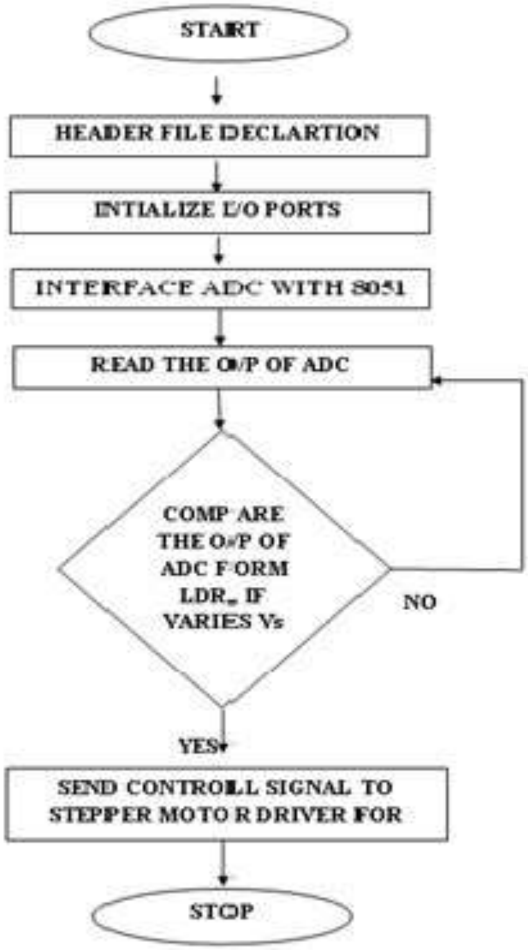

Fig 6. Flow chart of solar tracking system

IV. CODE IMPLEMENTATION

A. Arduino ide programming

Many companies provide the arduino assembler, some of them provide shareware version of their product on the Web, arduino is one of them. We can download them from their Websites. However, the size of code for these shareware versions is limited and we have to consider which assembler is suitable for our application.

Fig. 7 IDE Window

4. Results and Discussion

A simple auto solar tracking system was tested; the tracking route followed the motion trail of COSMOS Motion simulation analysis. The results indicated that direction of sunlight was always kept fixed with respect to the solar panel. Thus, we obtained the maximum solar flux. If the system deviated from the direction of sunlight, there was a decrease in the rate at which the system received solar radiation.With an increase in the angle of deviation, there was a decrease in the rate at which the sunlight passed through the system.the power produced by the solar tracking system was 10.94 Wh, while that produced by the fixed panel was only 9.11 Wh. Thus, the solar tracking system produced 20% more power than that produced by the fixed panel (Figures 1 and 2). the power generated by the solar tracking system was 17.08 Wh, while that produced by the fixed panel was only 14.13 Wh. Thus, the solar tracking system generated 21% more power than that produced by the fixed panel., the power produced by the solar tracking system was 20.93 Wh, while the power generated by the fixed panel was only 17.03 Wh. Compared to the power generated by the fixed panel, the solar tracking system generated about 23% more power. the solar tracking system produced 21.87 Wh, while the fixed panel produced only 17.65 Wh. Thus, compared to the power generated by the fixed panel, the solar tracking system generated about 24% more power. Overall, the results indicate that the solar tracking system generated approximately 20% to 25% more power than the fixed panel. In the solar tracking system, power production was rapid. Moreover, the solar radiant intensity of the solar tracking system was higher than that of the fixed panel.

Fixed and solar tracking systems produced the same amount of power on cloudy days . When the solar irradiance declined to 0.014 kW/m2, the power generated by the two methods reached zero simultaneously, indicating that the performance of both the systems was poor on cloudy days. Thus, although the solar tracking system efficiently collects incident solar radiation on sunny days, its system is ineffective on cloudy days. Therefore, the tracking mode did not produce measurable increases in power output on cloudy days. Therefore, on cloudy days, the tracking mode should be suspended to save the energy required to drive the system.

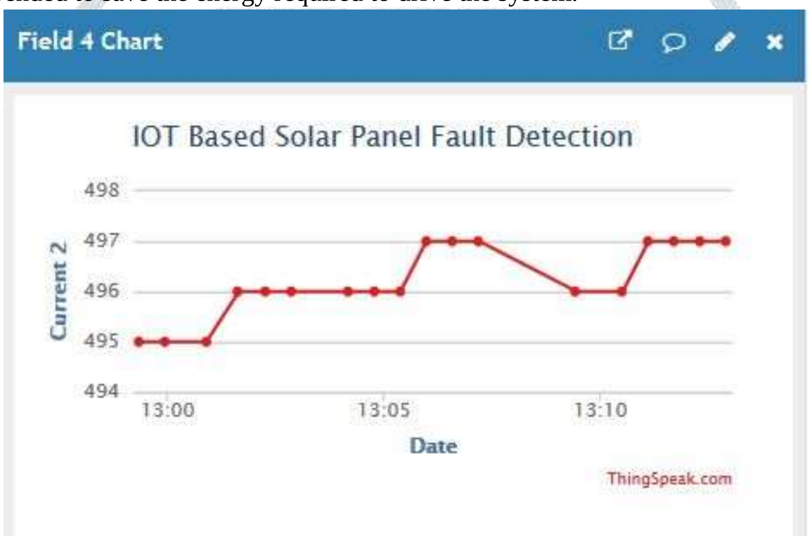

Fig. 8 Fault detection of solar panel using IOT

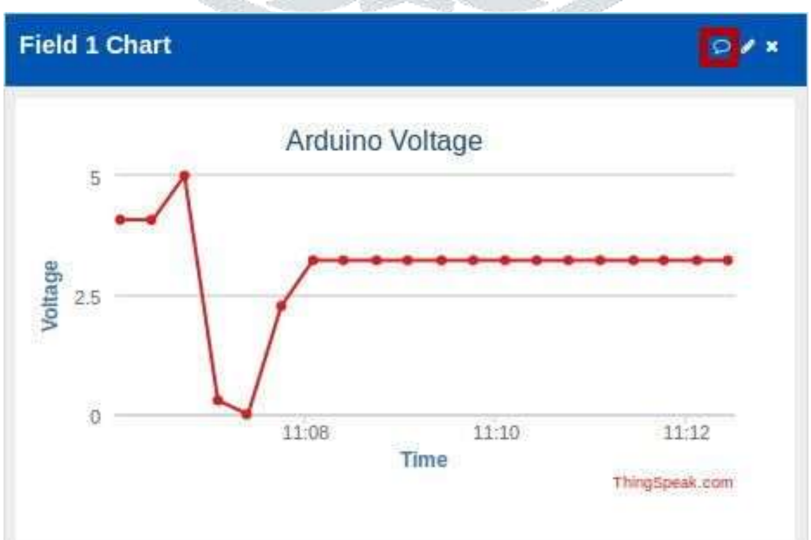

Fig 9. Arduino voltage waveform

5. CONCLUSION

In this design, we used ATMEGA328P microcontroller. This design represents a new system design technology, and Arduino based Compiler helped us see the powerful design technologies of software and hardware systems. Most traditional circuit designs are composed of hardware components building on a printed circuit board (PCB), we used same. If errors are found or the system needs to be improved or upgraded, the PCB must be redesigned. Adjusting and modifying the PCB is very inconvenient and increased the design cost and development period. This implementation has great future scope because the Sun is important source of energy which available in free of cost. As today's world need greater amount of energy it can be satisfy by our project use.

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