

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 6, June 2018

SOLAR TRACKING INSTRUMENTATION SYSTEM

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ABSTRACT:Energy is the prime factor for the development of a nation. An enormous amount of energy is extracted, distributed, converted and consumed in the global society daily. 85% of energy production is dependent on fossil fuels. The resources of the fossil fuels are limited and their use results in global warming due to emission of greenhouse gases. To provide a sustainable power production and safe world to the future generation, there is a growing demand for energy from renewable sources like solar, wind, geothermal and ocean tidal wave. The sun is the prime source of energy, directly or indirectly, which is also the fuel for most renewable systems. Among all renewable systems, photovoltaic system is the one which has a great chance to replace the conventional energy resources. Solar panel directly converts solar radiation into electrical energy. Solar panel is mainly made from semiconductor materials. Si used as the major component of solar panels, which is maximum 24.5% efficient. Unless high efficient solar panels are invented, the only way to enhance the performance of a solar panel is to increase the intensity of light falling on it. Solar trackers are the most appropriate and proven technology to increase the efficiency of solar panels through keeping the panels aligned with the sun's position. Solar trackers get popularized around the world in recent days to harness solar energy in most efficient way. This is far more cost effective solution than purchasing additional solar panels.

KEYWORDS:Solar energy, Renewable energy, Instrumentation, Safety, Control, Solar panel

I.INTRODUCTION

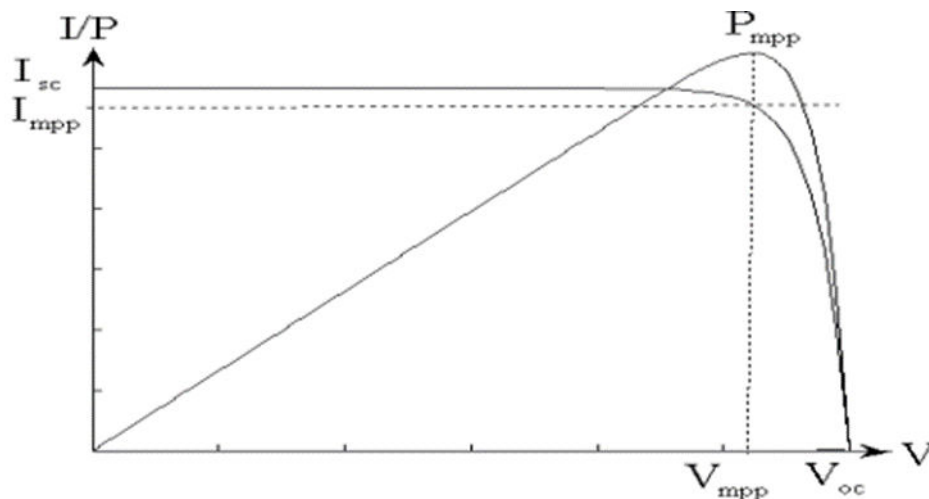
The most abundant and convenient source of renewable energy is solar energy, which can be harnessed by photovoltaic cells. Photovoltaic cells are the basic of the solar system. The word photovoltaic comes from "photo" means light and "voltaic" means producing electricity. Therefore, the photovoltaic process is "producing electricity directly from sunlight". The output power of a photovoltaic cell depends on the amount of light projected on the cell. Time of the day, season, panel position and orientation are also the factors behind the output power. The current-voltage and power-voltage characteristics of a photovoltaic cell are shown in Fig. 1.

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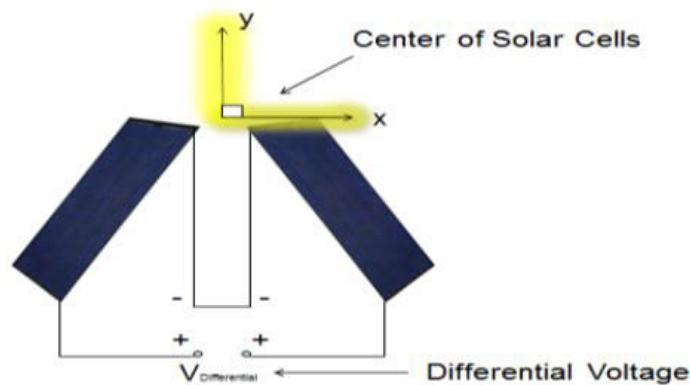
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II. PHOTOVOLTAIC CELLS

Photovoltaic cells are the smallest part of a solar panel. Solar panel gives maximum power output at the time when sun is directly aligned with the panel. Development of solar panel tracking system has been ongoing for several years. As the sun moves across the sky during the day, it is advantageous to have the solar panels track the location of the sun, such that the panels are always perpendicular with the position of the sun. Available solar trackers in the market are much costly to integrate with solar panel system. In the developing countries where cost is one of the major issues to integrate technologies, solar tracking prototype implemented in this mini project can provide an effective solution. The idea behind using solar cells would be to place them at equal and opposite angles to receive signals from each based on the strength of the sun in either direction. Using the differential voltage between the two, the direction of the motor changes until the two opposing light detecting components produce roughly a zero volt differential voltage.



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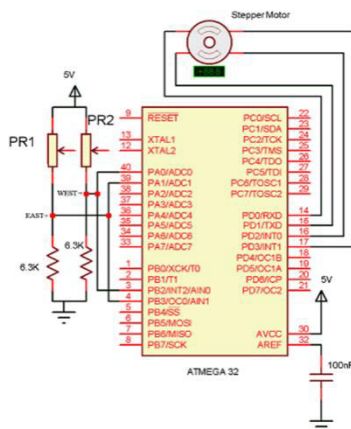
III.MAJOR COMPONENTS

The major components those are used in the prototype are given below:-

- Photo resistor
- Microcontroller
- Stepper motor

A. Photo resistor

Cadmium sulphide (CdS) photo resistor is used in the designed prototype. The CdS photo resistor is a passive element that has a resistance inversely proportional to the amount of light incident on it. To utilize the photo resistor, it is placed in series with another resistor. A voltage divider is thus formed at the junction between photo resistor and another resistor; the output is taken at the junction point to pass the measured voltage as input to microcontroller.



Microcontroller requires a 5 In the solar tracker prototype, it is desired that output voltage at junction point will increase as the light intensity increases and so the photo resistor is placed at the top position in series connection with resistor.

A. Stepper motor

Stepper motors are commonly used in precision positioning control applications. Five characteristics of the stepper motor have been considered while choosing stepper motor for the solar tracker prototype. Stepper motor is brushless, load independent, has open loop positioning capability, good holding torque and excellent response characteristics. The stepper motor that has been used in the prototype has the specifications of 24 volts, 130 Ω resistance, 7.5° per step, 4 phase, unipolar. Half stepping rotation is considered for the tracker to control position accurately with sun's rotation which results in 3.75° per step.

B. Microcontroller

PIC microcontroller has been used in the prototype. Microcontroller is the heart of overall system. ATMEGA32 volt regulated voltage supply. '7805' voltage regulator is used to provide fixed 5 volts supply to the microcontroller.

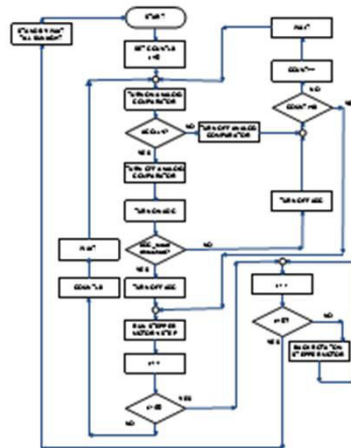
Operational flow chart of the solar tracker is given in Figure below.

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IV. PIC MICROCONTROLLER

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller" now it is "PIC" only.

PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

Advantages of PIC are:

- Small instruction set to learn
- RISC architecture
- Built in oscillator with selectable speeds
- Easy entry level, in circuit programming plus in circuit debugging PICKit units available for less than \$50
- Inexpensive microcontrollers
- Wide range of interfaces including I²C, SPI, USB, USART, A/D, programmable comparators, PWM, LIN, CAN, PSP, and Ethernet.
- Availability of processors in DIL package make them easy to handle for hobby use.

V. CONCLUSION AND FUTURE ENHANCEMENT

While developing the overall system, hardware and software portions of the project are separated into stages consisting of light detection, microcontroller input, software enhancements, motor driving and finally dummy panel rotation.

The attractive feature of the constructed prototype is the software solution of many challenges regarding solar tracking system. The designed prototype requires only two photo resistors to sense the light, which lessens the cost of the system. Power consumption of the system is negligible as 'wait' states are calculated perfectly with the sun's position.

Another major problem of system initialization at the start of the day is solved through a simple programming application. All these software based solution reduce the system cost far more than all other systems proposed to date. As the prototype is a miniature of main system, it has some limitations which can be mitigated through future developments. Instead of solar panel, a small plastic board is rotated in the system. As a miniature system, it works out well. Solar panel must be integrated with the system to prepare result and cost analysis.

CdS photo resistors which have been used in the prototype have a better response on 500nm to 700nm of wave length.

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The mini project has presented a means of tracking the sun's position with the help of microcontroller. Specially, it demonstrates a working software solution for maximizing solar cell output by positioning a solar panel at the point of maximum light intensity. The prototype represents a method for tracking the sun both in normal and bad weather condition.

Moreover, the tracker can initialize the starting position itself which reduce the need of any more photo resistors. The attractive feature of the designed solar tracker is simple mechanism to control the system. The solar tracker also provides lucrative solution for third world countries to integrate it into their solar system with a comparatively low cost through software based solution. Though the prototype has limitations in hardware areas as an initial set up, still it provides an opportunity for improvement of the design methodology in future.

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