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# Design of a Sun Tracker with Position Display

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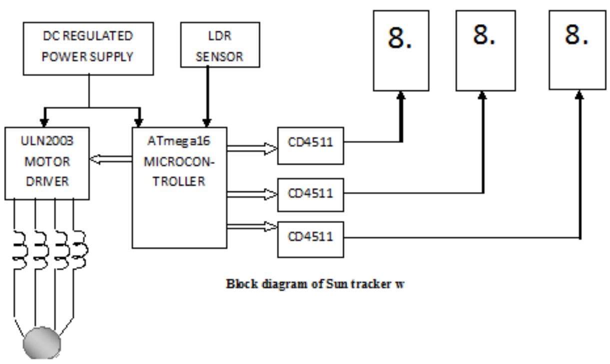
## ABSTRACT

The power generated from solar panels cannot be directly used in many applications. One of the key reasons is that the sun is not stationary as it keeps moving from east to west. The solar panels are able to receive peak sun light only for a short time period of day when the sun is directly facing the solar panels. During rest of the day, they get only partial sun light. For this purpose "SUN TRACKER WITH POSITION DISPLAY" is one of the optimal way that allows the solar panel to track the sun's position, ensuring maximum power generation. Such systems are based on a solar collector, designed to collect the sun's energy and to convert it into either electrical power or thermal energy. The literature contains many studies regarding the use of solar collectors to implement such applications as light fixtures, window covering systems.

## INTRODUCTION

"SUN TRACKING SYSTEM" used to control and set the moment of solar panels and tracks the maximum intensity position and rests in that position. The solar panel is made to rotate in all the directions facing the sunlight. The basic idea of the project is to increase the efficiency of the solar systems. Rotation of DC motor through the desired angle is achieved by using Topwin6 compiler. This system uses DC motor to control the angle of rotation of the panels. Solar energy is rapidly advancing and more energy is produced by tracking the solar panel to remain aligned to the sun at a right angle to the rays of light. This paper describes in detail the design and construction of a prototype for solar tracking system with two degrees of freedom, which detects the sunlight using photo censors. The control circuit for the solar tracker is based on an Atmega16 microcontroller (MCU). This is programmed to detect the sunlight through the photo sensors and then actuate the motor to position the solar panel where it can receive maximum sunlight. The hardware part comprises of microcontroller Atmega16A, ULN2003 Motor Driver, LDR Sensor, Stepper Motor etc.Microcontroller Atmegaa16A is a heart of the circuit. It is a low power, high performance, and 8bit microcontroller with 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The software part consists of a program for the microcontroller is written using assembly language and microcontroller burner software.




**Block diagram of Sun tracker with position display**

## CIRCUIT DESCRIPTION

The circuit is built around ATmega16A microcontroller, common-cathode 7-segment display to indicate the position of the panel, ULN2803 high-voltage and high-current

Darlington array IC, bipolar stepper motor and CD4511 display driver. A sensor, LDR is used to receive the sun rays and the signal is processed through a microcontroller to rotate the solar panel towards the maximum sunlight using a stepper motor. The resistance of the LDR varies from zero to few mega-ohms depending upon the sunlight intensity falling on it. Using this feature, the microcontroller has been programmed to control the stepper motor such that the solar panel rotates towards the maximum availability of the sun rays. The main controlling device is the ATmega16A microcontroller. It is used to process the signal received from the sensor. The conversion starts by writing a logical '1' to the ADC starts conversion bit. This bit stays high as long as the conversion is in progress and will be cleared by the hardware when completes. The digital values can be anywhere between 0 and 1023 depending upon the analogue input received from the sensor. A threshold values is set by the user using hit-and-trial method such that the stepper motor is stationary when the sun is directly facing towards the panel. This is the point where the solar panel gets maximum energy from the sun. The analogue input is detected from the sun. Whenever it reaches below a threshold level, the program instructs the stepper motor to advance by one step so that the panel gets a much broader view of the sun. As the sun moves from east to west, so does the panel. But after nine hours, on the next day, the panel will return to the same position facing towards east, waiting for the sun.

**Tracker Components**

The main elements of a tracking system are as follows:

• Sun tracking algorithm: This algorithm calculates the solar azimuth and zenith angles of the sun. These angles are then used to position the solar panel or reflector to point toward the sun. Some algorithms are purely mathematical based on astronomical references while others utilize real-limelight-intensity readings.

• Control unit: The control unit executes the sun tracking algorithm and coordinates the movement of the positioning system.

• Positioning system: The positioning system moves the panel or reflector to face the sun at the Optimum angles. Some positioning systems are electrical and some are hydraulic.

• Drive mechanism/transmission: The drive mechanisms include linear actuators, linear drives, hydraulic cylinders, swivel drives, worm gears, planetary gears, and threaded spindles.

• Sensing devices: For trackers that use light intensity in the tracking algorithm, pyranometers are needed to read the light intensity. Ambient condition monitoring for pressure, temperature and humidity may also be needed to optimize efficiency and power output.

## PROCESS

Tracker control algorithms typically incorporate a control strategy that is a hybrid between open-loop and closed loop control.

1.The open-loop component is needed because the sun can be obscured by clouds, distorting the feedback signals.

2. The closed-loop component is needed to eliminate errors that result from variability in installation, assembly, calibration, and encoder mounting.

3.Closed loop systems track the sun by relying on a set of lenses or sensors with a limited field of view, directed at the sun, and are fully illuminated by sunlight at all times.

4.As the sun moves, it begins to shade one or more sensors, which the system detects and activates motors to move the device back into a position where all sensors are once again equally illuminated.

5.Open loop systems track the sun without physically following the sun via sensors (although sensors may be used for calibration).

## OPERATIONS

- Initially the solar panel is at 30degree of elevation (programmable set).
- When the light falls on light dependent resistor i.e., when LDR sense solar intensity, control unit is programmed in such a way that it direct the motor driver IC to rotate motor in that direction to where light detecting resistor has sensed light.
- Correspondingly solar panel faces the sun and absorbs maximum intensity of solar.
- With respect to time when sun changes its position, light detecting resistor detects the light and again the control unit performs the same function.

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- Sun rotates or changes its position; with respect to it solar panel faces the Sun. The circuit performs the function till it reaches its maximum elevation i.e., 150degree.
- When the solar panel reaches its maximum elevation (i.e., at evening), movement of solar panel is stopped and motor stops rotating. After 9hour the solar panel come back to its original place.

## RESULT

A supply of 12V is applied at the input terminal of IC7805.The output of IC 7805 i.e., 5V is served as an input for the whole working circuit. The ULN2003, a motor driver IC, has +12V voltage as an input. This IC drives the motor in the direction sensed by the light dependent resistor. A microcontroller ATMEGA16A act as a control unit. A program in such a way has been installed that it controls all the element of the circuit and hence act as a control unit. +5V is served as an input voltage. Pin no. 2, 3, 4, 5 are connected with pin no. 1, 2, 3, 4 respectively of ULN2003.The control signals are send to motor driver IC through these lines. When the LDR senses the light or intensity of light, the control signals sent to the ULN2003.The motor driver IC drives the motor in the directed direction. Simultaneously the solar panel faces the sun in the respective direction. The microcontroller simultaneously sends signals to the CD4511BC i.e., BCD-to-seven segment is connected with 7segment display. The angle of direction, from where maximum intensity of light is available, to which solar panel is elevated is shown in the 7 segment display.The solar panel facing the sun is not fixed. It changes simultaneously with the change of position of sun. That is the motto of our project. It can be more perfect by using a 7.5 degree bipolar stepper motor. Although by using a stepper motor, this project has been running successfully.

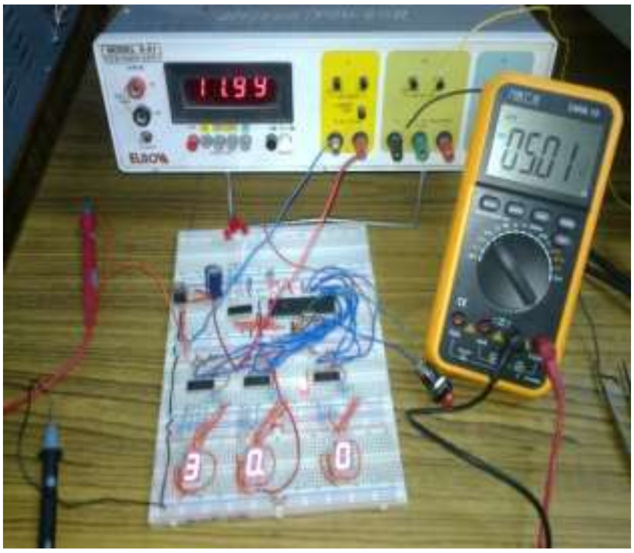
## DISCUSSION

The main motto of this project was to make a device which stores the maximum intensity of sun.Thus the primary benefit of a tracking system is to collect solar energy for the longest period of the day, and with the most accurate alignment as the Sun's position shifts with the seasons. With the help of this device we can use the solar energy in various applications like street lights,calculators,some home appliance like solar water heater etc.The whole circuit is designed successfully.

## APPLICATIONS

- The Sun Tracking system can be utilized for tracking the sun and thus pointing the solar panel at the point of maximum solar intensity.
- It can also be utilized for automatic switching ON/OFF the street lights by mounting it over a street lights and switch ON whenever the sun intensity goes below a threshold value as dictated by the program.
- It can also be employed with Stirling engine.
- We can use this in some home appliance like solar water heater or something like that.

## SNAPS OF PROJECT HARDWARE



HARDWARE-CIRCUIT

Angle (30 degree)

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**(Angle 103 degree)**

## CONCLUSION

A Sun tracker is designed employing the new principle of using small solar cells to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output. By using this method, the solar tracker was successful in maintaining a sun array at a sufficiently perpendicular angle to the sun. The power increase gained over a fixed horizontal array was in excess of 30%.This paper has presented a means of controlling a sun tracking array with an embedded microprocessor system. Specifically, it demonstrates a working software solution for maximizing sun cell output by positioning a solar array at the point of maximum light intensity. This project utilizes a dual-axis design versus a single-axis to increase tracking accuracy.

**Limitation of project-**It can be more perfect by using a 7.5 degree bipolar stepper motor. Although by using a stepper motor, this project has been running successfully.

## FUTURE SCOPE

1.Remedy the motor binding problems due to the photo sensor leads. This could be donewith some sort of slip ring mechanism, smaller gauge wire, a larger motor with moretorque, or a combination of some or all of these ideas.

2.Increase the sensitivity and accuracy of tracking by using a different light sensor. Aphotodiode with an amplification circuit would provide improved resolution and bettertracking accuracy/precision.

3.Different algorithm can be followed for more efficient tracking. This device can be givenmore intelligence, such as after tracking once, it will able to predict the line of movement ofthe sun across the sky.

4.User-handling can be more sophisticated, i.e. user can select the waiting time.

5.A digital display can be configured along with this.

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