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Horizontal Single Axis Solar Tracker Using Arduino

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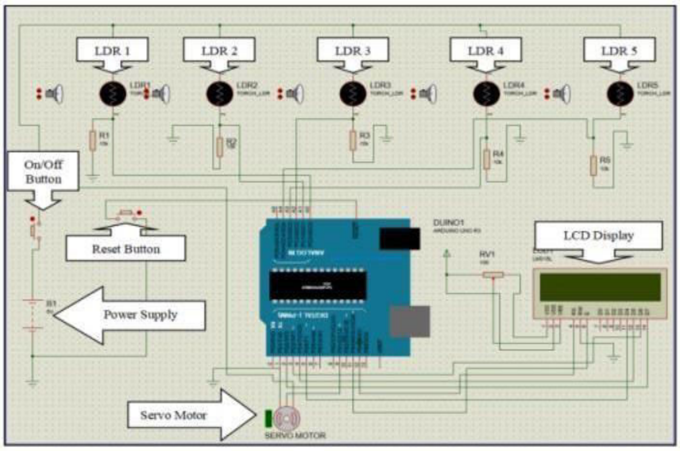
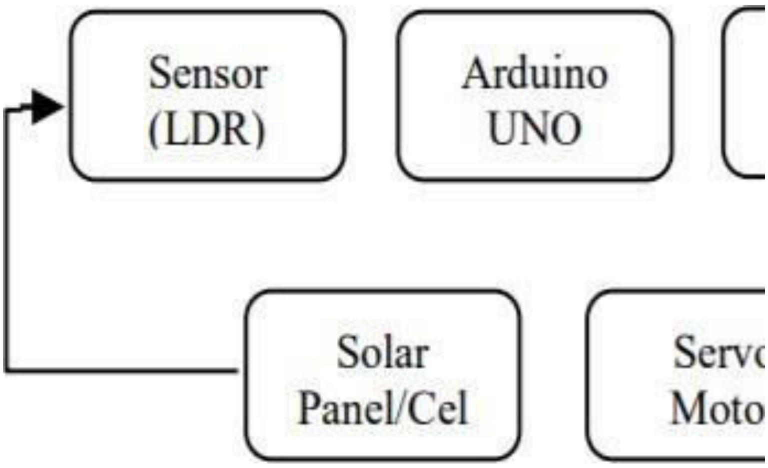
Abstract - This project discusses the development of a Horizontal Single-Axis solar tracker using Arduino UNO which is cheaper, less complex, and can still achieve the required efficiency. For the development of a Horizontal Single-Axis Solar Tracking System, five light-dependent resistors (LDR) have been used for sunlight detection and to capture the maximum light intensity. A servo motor is used to rotate the solar panel to the maximum light source sensing by the light-dependent resistor (LDR) to increase the efficiency of the solar panel and generate the maximum energy. The efficiency of the system has been tested and compared with the static solar panel at several time intervals. A small prototype of a Horizontal Single-Axis Solar Tracking System will be constructed to implement the design methodology presented here. As a result of a solar tracking system, a solar panel will generate more power, voltage, current value, and higher efficiency.

Key Words: Solar cell, Arduino board, Light Dependent Resistor (LDR), Servo Motor, Liquid Crystal Display (LCD)





1) INTRODUCTION

Solar energy is an unlimited source of energy which if harnessed properly will get mankind devoid of using the conventional sources of energy he has been long using. This project has been designed keeping this in view to make the harnessing of solar energy more efficient

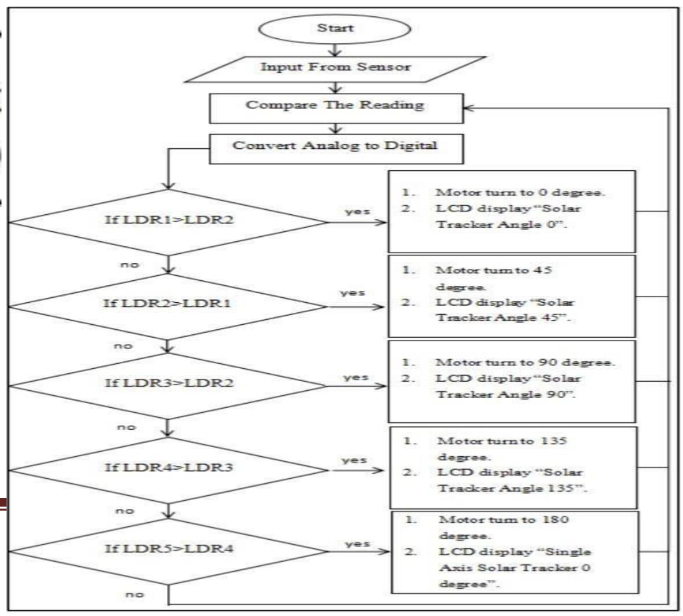


Figure 3. System Flowchart for Horizontal Single Axis Solar Tracker

2) SOFTWARE DESIGN

Software Design This section explained the circuit design of a light-dependent resistor controlling the rotation of the servo motor by using Proteus software. This circuit consists of an Arduino UNO and LCD Display, a servo motor, five units of light-dependent resistor (LDR), five units of 10kΩ resistor, a reset button, an on/off button. The system flowchart, block diagram, and circuit design of horizontal single-axis solar tracking circuit have been shown in Figures 3 and 4 respectively.

3) COMPONENTS

I. Solar cell:-

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.[1] It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels. The common single-junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts.[2]

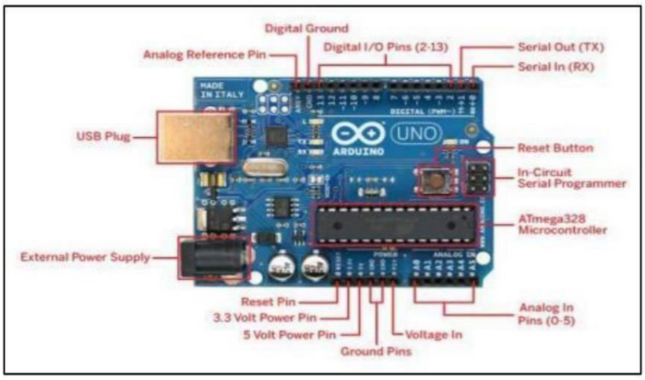


Figure 1. Arduino UNO

Figure 2. Poly-crystalline Solar Cell

Table 3. Specifications of Poly-crystalline

Type	3W 9V solar panel
Solar Cell	Poly-crystalline Solar Cell
No. Of Cells and Connections	18pcs (2x9)
Maximum Power	3W
Voltage at Max Power	9V
Current at Max Power	330mA
Open Circuit Voltage	10.8V
Dimension	195x125x3mm
Weight	90g

II. Arduino:-

The Arduino UNO is a microcontroller board based on the ATmega328 as shown It has fourteen digital input/output pins (of which six of it can be used as PWM outputs), six analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; it can simply connect to a computer with a USB cable or power it with an AC-toDC adapter or battery to get started

III. Servo Motor:-

A servo motor can be operated with a power supply from 4.8V to 6V. Normally voltage of 5V with operating frequency, f0 = 40Hz is used. Servo motor is used to give accurate angle control such as 45 degrees, 90 degrees. The angle can be held continuously. It can rotate from 0 degrees to 180 degrees when the pulse duty ratio changed.

IV. Light Dependent Resistor (LDR):-

A light-dependent resistor is made from semiconductor materials which enable them to have their light-sensitive properties. A Light-dependent resistor is very sensitive towards light. The resistance of a light-dependent resistor may change over many orders when light shines on it. The significance value of the resistance falling as the level of light shine on the light-dependent resistor increases.

V. Liquid Crystal Display (LCD):-

Liquid Crystal Display (LCD) is an electronic display module or screen and has a wide range of applications. It is very basic and very commonly used in many devices and circuits. LCD can display sixteen characters per line and a second line on the screen (16x2). The LCD will be displayed in a matrix of 5x7 pixels.

Table 1. Specifications of Arduino UNO

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14
PWM Digital Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Length	68.6mm
Width	53.4mm
Weight	25g

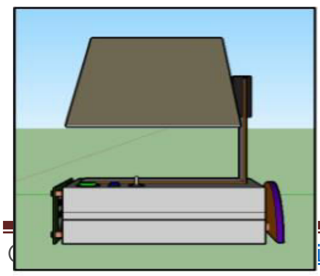


Figure 6. Front View

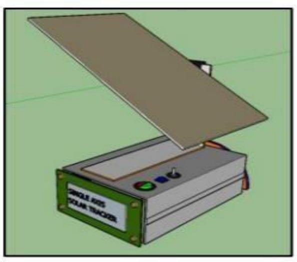


Figure 7. Isometric View

3) GRAPHING

If we observe in the graph, we also made a graphical representation of voltage vs time, current vs time, power vs time graphs and identify the changes that happen in the regular and tracking solar system. Go through figures 11,12,13.

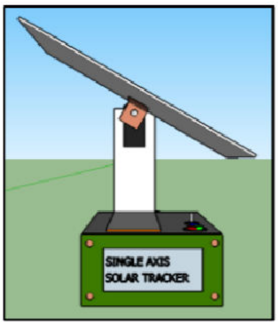


Figure 8. Side View A

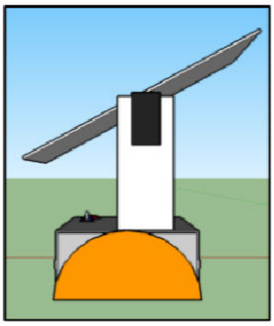


Figure 9. Side View B

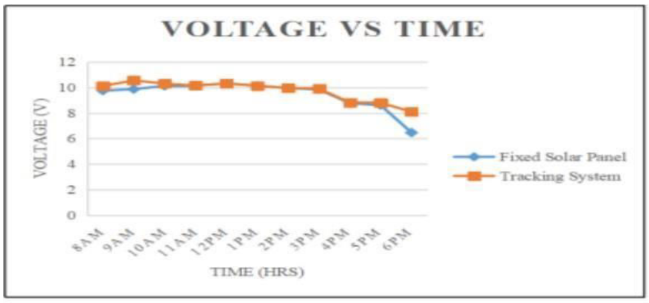


Figure 11. Voltage vs Time Graph

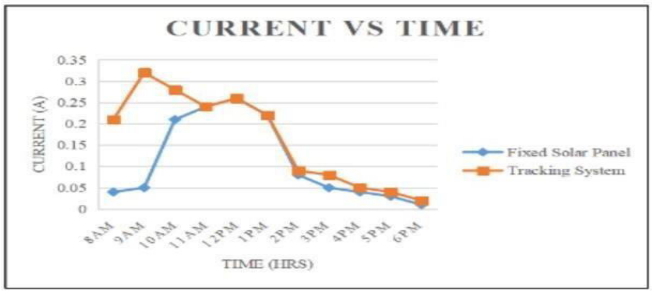


Figure 12. Current vs Time Graph

2) TESTING TABLE

As we made our project, we can see significant changes in some parameters like current, voltage, power, etc. we if we compare regular solar panel/cell system and variable angle axis solar cell system you will find that variable angle axis solar cell system stores more energy at the same time. So, we have taken the reading in both solar cell systems to find out how much difference is there, go through table 4.

1) ACTUAL MODEL

Testing of tracking solar cells by our team

Figure 10. Testing with No Load

Table 4. Comparison of Solar Panel Output Values between Fixed Solar Panel and Horizontal Single Axis Solar Tracker System with No Load

Time	Solar Panel Output Values with Fixed Angle (90°)				Solar Tracker Panel Output Values with Variable Angles			
(Hours)	A(°)	V(V)	I(A)	P(W)	A(°)	V(V)	I(A)	P(W)
8.00am	90	9.74	0.04	0.39	180	10.11	0.21	2.12
9.00am	90	9.86	0.05	0.49	135	10.54	0.32	3.37
10.00am	90	10.11	0.21	2.12	135	10.29	0.28	2.88
11.00am	90	10.14	0.24	2.43	90	10.14	0.24	2.43
12.00pm	90	10.30	0.26	2.67	90	10.30	0.26	2.67
1.00pm	90	10.13	0.22	2.23	90	10.13	0.22	2.23
2.00pm	90	9.94	0.08	0.80	90	9.94	0.09	0.89
3.00pm	90	9.84	0.05	0.49	45	9.90	0.08	0.79
4.00pm	90	8.76	0.04	0.35	45	8.82	0.05	0.44
5.00pm	90	8.61	0.03	0.26	45	8.79	0.04	0.35
6.00pm	90	6.47	0.01	0.06	0	8.10	0.02	0.16
	Total Power			12.29	Total Power			18.33
	Average Power			1.12	Average Power			1.67

Figure 13. Power vs Time Graph

4) CONCLUSION

An application of solar tracker using the Arduino approach has been presented in this study. In a conclusion, firstly the development of a tracking system to control and monitor the movement of solar panels based on the intensity of the light is achieved. The solar panel will face the sun perpendicularly to absorb more solar energy. Secondly, solar tracking systems generate more output during the hours while fixed solar panel installation generates the least power. However, the shading effect gives a slight impact on the solar panel to produce the output value. Thirdly, the percentage efficiency of the system in energy conversion increase when implemented the tracking system. The efficiency gain varies significantly with altitude and the orientation of a fixed solar panel installation in the same location.

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