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Dual Axis Solar Tracking System by Arduino and LDRs

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DUAL AXIS SOLAR TRACKING SYSTEM BY ARDUINO AND LDRs

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***Abstract*- Due to the rapid decline in the amount of conventional energy resources and their harmful effects on the environment, there has been a substantial growth in the invention and usage of various non-conventional energy resources. The most important of these resources is the solar energy. Solar energy has been used in various ways over a immeasurable period of time.**

PV cells are the electronic devices that are used to convert solar energy into electricity. The most efficient way to increase the energy output from these PV panels is by solar tracking i.e. the arrangement consisting of solar cells should adjust its position in such a way that it always faces the direction of maximum solar irradiance.

Single axis solar trackers have been in use from over a couple of decades now and they are 30-32% more efficient than the fixed solar panels system .These allow the solar panels to move in only one direction i.e. south-north to track the direction of maximum solar radiation. An improvement to these are the Dual axis solar tracking system that allow the bidirectional movement (north-south and east-west) of solar panels and are 79-81% more efficient than the fixed solar panels.

KEY WORDS – PV Cells, Solar energy, Single axis solar trackers, Dual axis solar tracking system.

A. INTRODUCTION

According to the National Centre for Policy Analysis the capacity of electricity generation by solar energy has increased by an impressive amount of 60% from 2009 to 2018, hence making solar energy the fastest growing renewable source of energy.

There are two ways to extract the solar energy: Heat and light.

The heat energy of sun is utilised by solar thermal power plants which heats liquids like water and Freon by solar radiations and these liquids are used to generate steam which then turns the turbines to generate electricity.

The other method of solar energy harvesting is its light energy: photovoltaic energy. This energy is utilised by the help of PV solar cells. These cells convert light energy of sun into electrical energy.

Commercially PV cells are combined together in series in the form of panels and then arrays to increase the energy output. Earlier in the beginning of this technology these panels were kept stationary on a plane. Later it was realised that the power output and efficiency of PV panels is dependent on the amount of

solar radiations are input on the surface of the panel. But due to the movement of sun with respect to the earth's surface these incident rays are not always normal to the surface hence their intensity is not always maximum and thus we get poor efficiency of produced electricity. To improve the efficiency of the solar panels a new technology of single axis solar tracker was invented that was employed to move the direction of the solar panel in the direction of the maximum solar radiation (ideally the one where solar radiation fall normally on the surface of the panel). These tracker move the panels in one direction to track the sun's movement and use hardware components like LDR sensors, motor drivers, microcontroller (like ATMEGA, Arduino uno etc.), servo motors along with the ever constant PV cells.

There were many other inventions similar to this technology but the most latest and efficient one is the Dual Axis solar tracking system. This tracking system enables the arrangement of solar panels to move in both directions (north-south & east-west).

This paper discusses in detail the construction, design and implementation of dual axis solar tracking system.

B. COMPONENTS REQUIRED

The main hardware components used in dual axis solar tracking system are:

A. Solar panel
B. Arduino
C. LDRs
D. Motor driver
E. Servo motor

I. Solar panels

Charles Fritts invented the first ever genuine solar cell formed by coating sheets of selenium with layers of gold. Solar panels are electronic devices used to collect clean renewable energy of sun and convert it into electrical energy. They are composed of layers of silicon, phosphorous and boron. They work by absorbing photons from the sun light and the energy from the photons is used to remove electrons from their atomic orbits and move freely producing an electric current. This process is called the Photovoltaic effect (hence the solar panels are also called PV panels). The electricity produced is the DC type, it is converted into AC current by the use of inverters. The battery banks are used to store the surplus amount of electricity for later use.

Fig. 1 Solar Panel

II. Arduino Uno

It is a microcontroller board and is based on ATmega328P microcontroller. It has a number of digital/analog I/O pins. It has 14 digital I/O pins, 6 analog I/O pins, an external 9-volt battery. It contains everything that is needed to support a microcontroller. In this project this board is used to take input from LDR sensors and control the movement of solar panels by controlling the motor.

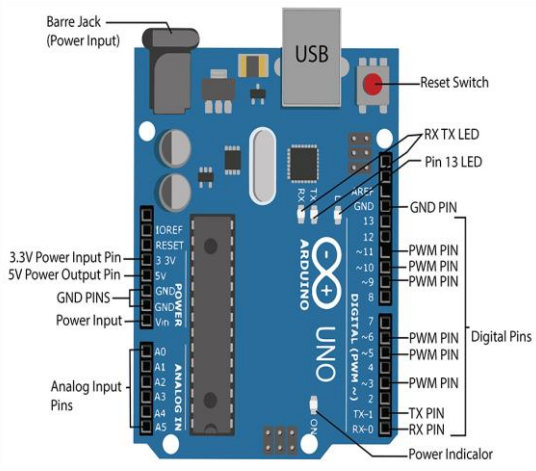


Fig. 2 Arduino Uno

III. LDRs

Light detecting resistors are the electronic components that are used to detect the presence of light or in this case the intensity of light. These are used in place of photodiode or photo transistor because of the large change in resistance for small change in the light level.

The light sensitive properties of the LDR are due to its fabrication by semiconductor material (InSb, PbS, Cd). When light falls on the LDR surface the electrons gets excited and get free hence decreasing the resistance of the material, as more light is incident (the intensity increases) more electrons gets free and more is the decrease in the resistance .

In this project the intensity of solar radiation affects the resistance level of LDR. The LDR is the connected to the Arduino board which takes the input of solar radiation and generates an output according to the program stored in it to run the motor accordingly.

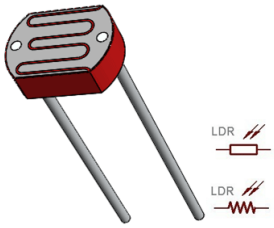


Fig. 3 LDR (Photoresistor)

IV. Motor Driver

Unlike servo motors other DC motors do not have a direct interface present to get connected to the microcontroller (like in this case Arduino). In order to interface these motors to Arduino we need a motor driver (e.g., L298N). Motor requires a relatively large amount of current to operate whereas microcontrollers require low current signals. So the function of motor driver is to take low current signals from microcontrollers and then convert them to high current signals for the motors.

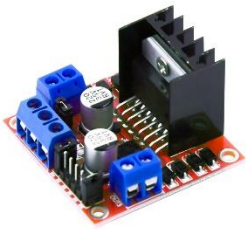


Fig. 4 Motor Driver- L298N

V. Servo motor

It is a special type of motor based on the servomechanism. It offers precise control of position (both linear and angular), velocity and acceleration. It is a motor that contains an additional sensor to provide feedback control (in case of position sensor a potentiometer is used). Unlike other motors which wait for the stop instruction to stop servomotors stop after every input signal and wait for another thus providing precise movement.

Fig. 5 Servo Motor

C. PROPOSED SYSTEM

The proposed project is designed to change the vertical and horizontal alignment of the solar panels.

The block diagram of the proposed system is given below:

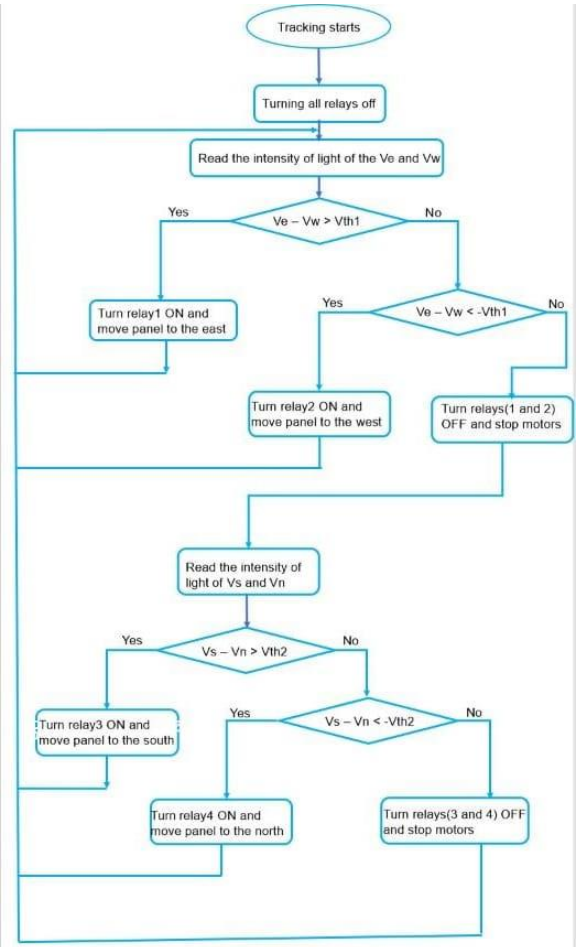


Fig : Flow chart

The 4 LDRs act as the sensing device of this system and senses the intensity of the light radiations of the sun. Usually, the LDRs are arranged in a module that generates digital output for the incoming anolog signal (light radiations). The digital output then acts as the input for Arduino board. The Arduino processes these signals through the prewritten program and generates an output for motor driver. The motor driver converts the low level signals from Arduino to high level signals for motor.

In this project there are 2 motors present, one to move the panels horizontally and the other vertically. These motors on getting the signals from the microcontroller move the panels in the direction of maximum solar radiation.

D. ARDUINO IDE CODE

The code for Arduino board is as follows:

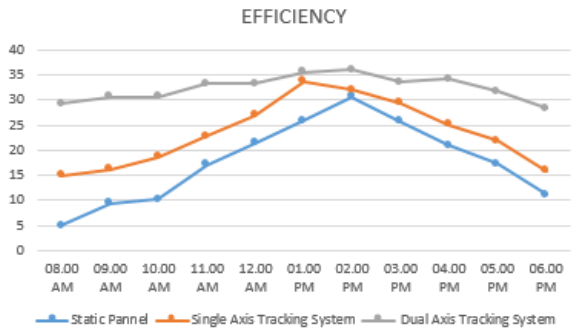
```
void setup () {
// initialize digital pin 13 as an output.

pinMode(2, INPUT);
pinMode(3, INPUT);
pinMode(4, INPUT);
pinMode(5, INPUT);
pinMode(6,OUTPUT );
pinMode(7,OUTPUT );
pinMode(8,OUTPUT );
pinMode(9,OUTPUT );
}

// the loop function runs over and over again forever
void loop()
{
if( digitalRead(2)&amp;&amp;
    digitalRead(3)&amp;&amp;
    digitalRead(4)&amp;&amp;
    digitalRead(5)==HIGH)
{
digitalWrite(6,LOW);
digitalWrite(7,LOW);
digitalWrite(8,LOW);
digitalWrite(9,LOW);
}
else if( digitalRead(2)&amp;&amp;digitalRead(4)==HIGH)
{

digitalWrite(6,HIGH);


digitalWrite(7,LOW);
digitalWrite(8,HIGH);
digitalWrite(9,LOW);
}

else if( digitalRead(3)&amp;&amp;digitalRead(5)==HIGH)
{
digitalWrite(6,LOW);
digitalWrite(7,HIGH);
digitalWrite(8,LOW);
digitalWrite(9,HIGH);
}
else if( digitalRead(2)&amp;&amp;digitalRead(5)==HIGH)
{
digitalWrite(6,HIGH);
digitalWrite(7,LOW);
digitalWrite(8,LOW);
digitalWrite(9,HIGH);
}

else if( digitalRead(3)&amp;&amp;digitalRead(4)==HIGH)
{
digitalWrite(6,LOW);
digitalWrite(7,HIGH);

digitalWrite(8,HIGH);
digitalWrite(9,LOW);
}
else if( digitalRead(2)==HIGH)
{
```

```
digitalWrite(6,HIGH);
digitalWrite(7,LOW);
digitalWrite(8,LOW);
digitalWrite(9,LOW);
}
else if( digitalRead(3)==HIGH)
{
digitalWrite(6,LOW);
digitalWrite(7,HIGH);
digitalWrite(8,LOW);
digitalWrite(9,LOW);
}
else if( digitalRead(4)==HIGH)
{
digitalWrite(6,LOW);
digitalWrite(7,LOW);
digitalWrite(8,HIGH);
digitalWrite(9,LOW);
}
else if( digitalRead(5)==HIGH)

{
digitalWrite(6,LOW);
digitalWrite(7,LOW);
digitalWrite(8,LOW);
digitalWrite(9,HIGH);
}
else
{

digitalWrite(6, LOW);
digitalWrite(7,LOW);
digitalWrite(8,LOW);
digitalWrite(9,LOW);
}
}
```

E. RESULT

The efficiency of single and dual axis solar tracking system has been compared in the following table:

Hours	Static Pannel (mW)	Single Axis Tracking System (mW)	Dual Axis Tracking System (mW)
8:00 AM	4.90	15.00	29.28
9:00 AM	9.44	16.26	30.65
10:00 AM	10.25	18.70	30.66
11:00 AM	17.15	22.84	33.34
12:00 PM	21.47	26.94	33.32
1:00 PM	25.86	33.69	35.58
2:00 PM	30.68	32.08	35.98
3:00 PM	25.78	29.48	33.61
4:00 PM	21.00	25.17	34.21
5:00 PM	17.26	21.87	31.72
6:00 PM	11.08	15.80	28.41



Single axis tracking system is 30-32% is more efficient than fixed plate solar system but Dual axis solar tracking system has an efficiency that is 79-81% more than the fixed plate system.

F. CONCLUSION

The main objective of this paper was to design and implement Dual axis solar tracker and compare it's efficiency from single axis solar tracker system and fixed plate system. This was done by using 4 LDRs as a sensing element, Arduino as microcontroller (controller) and motors as actuators. One motor is used to move the panel in horizontal direction and other in vertical direction hence, maximum possible efficiency was achieved.

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