Sun Tracking Solar Panel

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What is a sun tracking solar panel?

A sun tracking solar panel is a solar panel that is mounted on an apparatus that will move the solar panel in such a way that it always points towards the sun which results into maximum output. A single-axis tracker will move the panels on one axis of movement so that the panel will follow the sun from sun rise to sunset (east to west). A dual-axis tracker moves the panel on two axis (north to south, and east to west). The dual axis tracker allows for tracking changes in the height of the sun throughout the year as well as from east to west from sunrise to sunset. There are also active or passive solar tracking systems. Active systems use motors or gears to move the panel so that the face of the panel is at the optimum angle. Our system is an active system since we use servo motors and 3D printed gears to control the position of the panel. Passive systems contain a fluid and use the heat from the sun to create a swishing motion to move the panel to the optimum angle. [1]

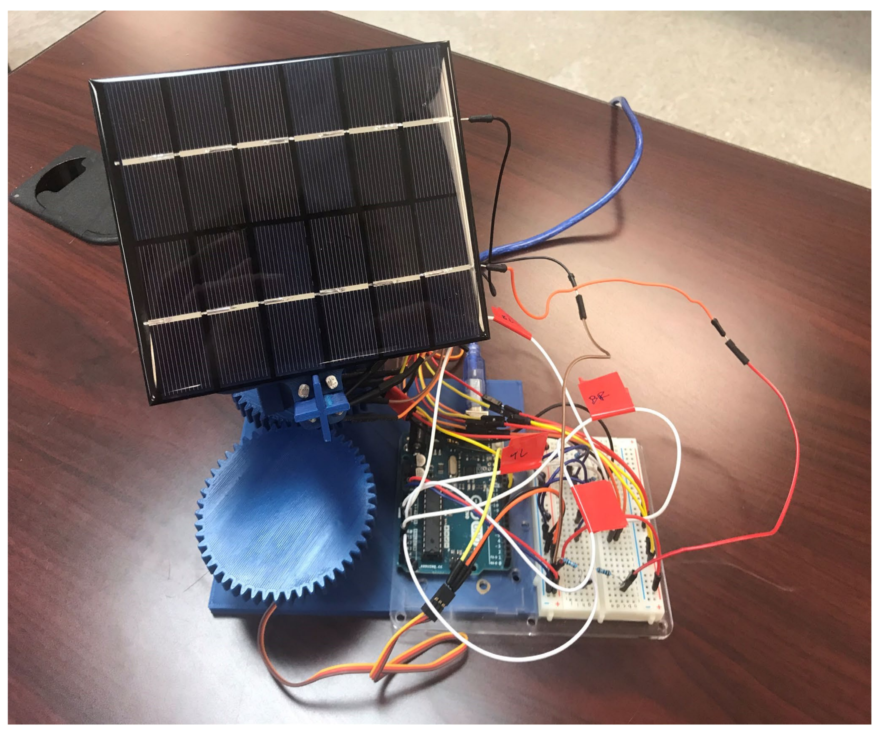

Figure1. Dual-Axis Solar Tracking Panel.

Benefits of a dual-axis sun tracking system

In photovoltaic systems, trackers help to minimize the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface at the point of incidence, called the normal) between the incoming light from the sun and the panel, which results in an increase of the amount of energy the system produces. Tracking the sun also allows for the solar panel to be at the optimal angle to receive the most energy possible from the sun throughout the day resulting in maximum output. The dual axis is better than the single axis since the dual axis can also adjust to the change in the altitude of the sun, where the single axis can only accommodate tracking east to west. Based on our research tracking the sun can account for a 15% - 40% increase in power production from a solar panel depending on the geographic location of the panel.

Our Design

Our design consists of a dual-axis 3D printed mount that allows for east-west and north-south movement. This design is divided into hardware and software development. The hardware consists of four light dependent resistors (LDR) to capture the maximum light source from the sun. Two servo motors also were utilized to move the solar panel to the optimal location sensed by the LDRs. The open-source Arduino Programming Software (IDE) was used to write the code. The code was written in C programming language in order to target the Arduino Uno controller.

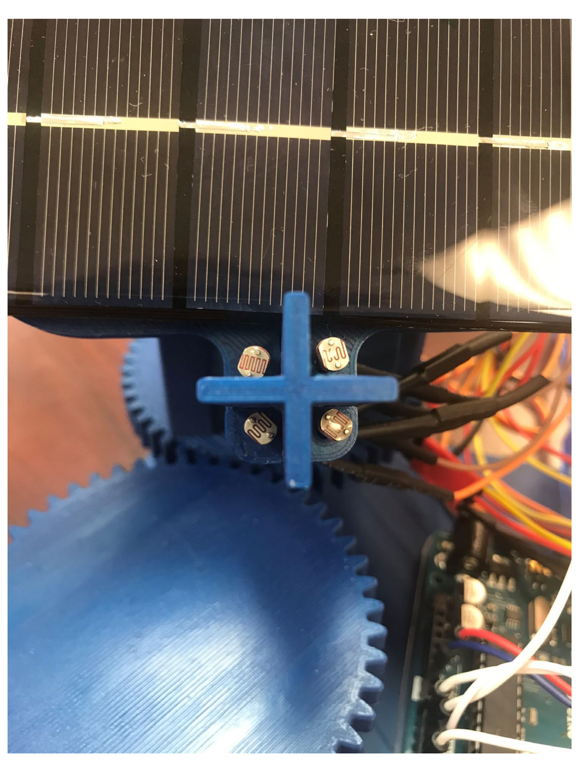

Figure 2. Light dependent resistors

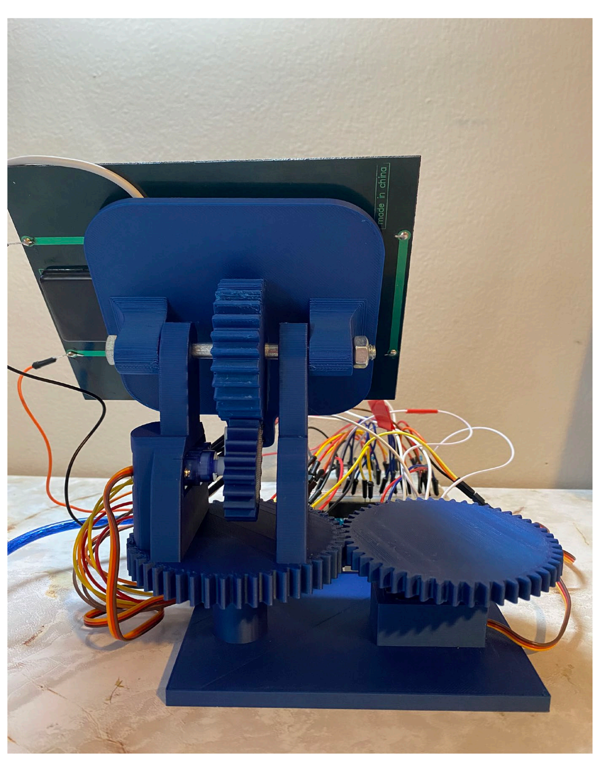

Figure 3. Vertical and Horizontal gears with servo motors housing

How does it work?

The solar panel is connected to an Arduino Uno board which has been wired and coded so that the solar panel will move to the position in which the sun is directly hitting the panel. LDR's are placed on each corner of a square and separated by an extruded cross that isolates each LDR so that the receive different amounts of light based on the angle of the incoming light rays. As an LDR is exposed to more light it's resistance rises. This means by comparing the average resistance values of the top, bottom, left and right portions of the cross we can provide a direction for the solar panel to move to collect the most amount of light. Once these values have been obtained the Arduino sends the input to the servo motors to adjust their position based on the average LDR values.

The Code

The code for this project consists of three main portions:

1. Reading voltage values from the analog inputs on the Arduino and calculating the current and power coming from the solar panel. The solar panel outputs more voltage than the Arduino is capable of reading so we had to use a voltage divider to step the voltage down so that it can be read by the Arduino.

```
float volt = analogRead(A5)*5.0/1023;
   float voltage = 2*volt;           //  Volt=(R1/R1+R2)*Voltage / R1=R2=10Ohms  => voltage=2*volt)
   float current = voltage/(22);        //  I=voltage/(R1+R2) R1 & R2 = 10 ohm
   float power = voltage*current;
```

2. Writing these voltage, current, and power values onto the serial monitor.

```
Serial.print(voltage);  //send the voltage to serial port
   Serial.print("\t");
   Serial.print(current);   //send the current to serial port
   Serial.print("\t");
   Serial.print(power);  //send the power to serial port
   Serial.print("\t");
   Serial.println(" ");
```

3. Reading the resistance values from the LDR's and utilizing average resistance values for the bottom, top, right, and left pairs of LDR's to enable the solar panel to move to the position where the light is directly hitting the panel. An example of this portion of the code is as follows:

```
if (avgleft > avgright)
{
  servohori.write(servoh +1);
  if (servoh > servohLimitHigh)
  {
  servoh = servohLimitHigh;
  }
  delay(10);
}
```

Trial Data

This data was taken between 5:50pm and 6:21pm on 4/10/21, during the beginning of this trial there was a large cloud blocking the light from hitting the solar panel. This accounts for the low power output at the beginning of the graph. Once the cloud moved the solar panel moved to face the light and began producing more power as can be seen in the final portion of the graph.

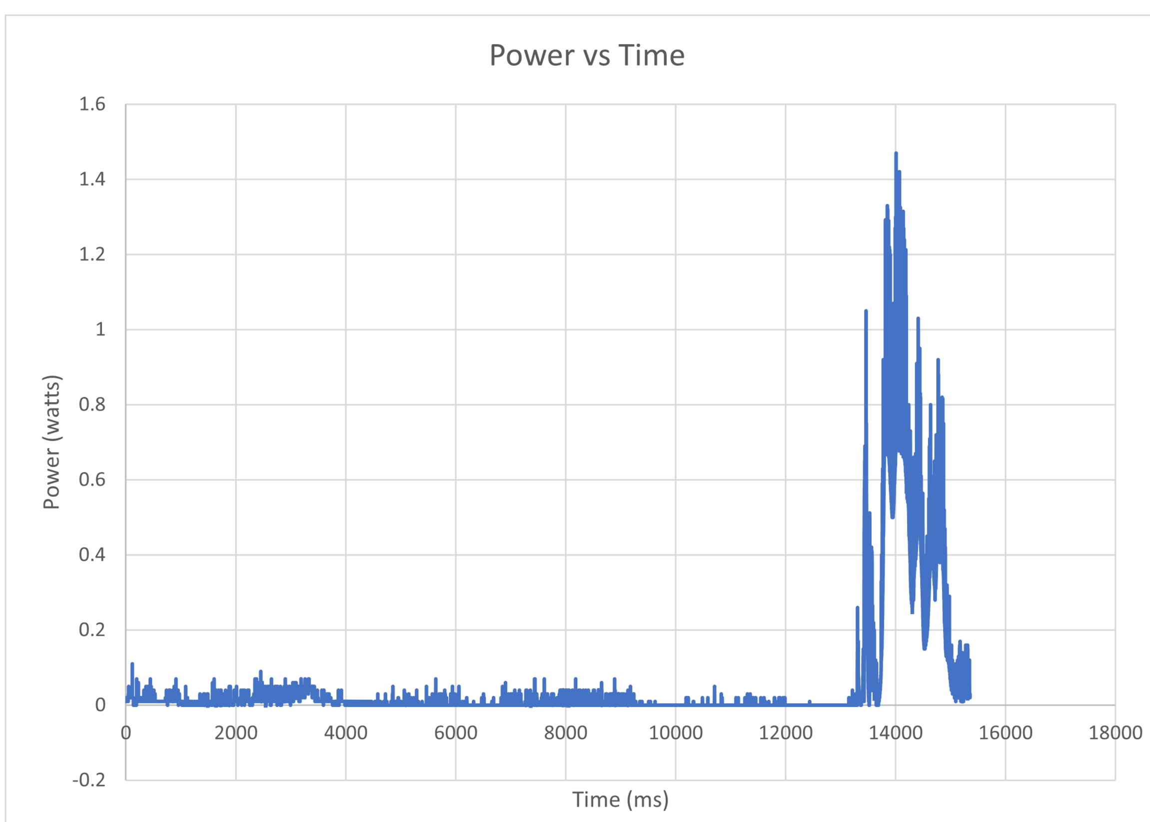

Figure 4. Power vs. Time graph

References

1. https://thesolarstore.com/active-passive-trackers-c-23_28.html
2. https://www.thingiverse.com/thing:53321
3. https://www.e-education.psu.edu/eme812/node/519