Dual-Axis Solar Panel Tracker

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Introduction

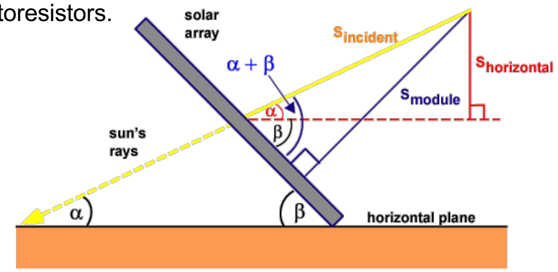
With the increase in popularity of solar power, large commercial and utility scale solar plants are being developed to further transition the world to using solar power. Even though these plants house a large quantity of solar panels, they are not optimized to generate the maximum amount of energy from the sun because all of the panels are at a fixed tilt. One method to more efficiently harvest the sun's energy is to use a dual-axis solar panel tracker. This tracker will keep the solar panel incident upon the sun by changing the direction that the panel is facing and tilting with respect to the sun's position in the sky.

Specifications

1. Solar panel size greater than or equal to 6" x 6"
2. Ratio of electrical output of dual-axis panel relative to fixed-tilt panel is shown to be greater than 1
3. Energy consumption of tracker over the course of a day to be less than 1% of solar energy generated
4. Powered by solar panels
5. Battery Storage
6. *Multiple Methods of tracking
7. *USB Charging capabilities

Methods

We chose to implement 2 methods of tracking the sun; one passive (using a GPS module) and one active (using photoresistors). While both of these methods work, we were able to determine the more effective method that generated more and consumed less energy to be the photoresistors.



Results

We were successfully able to meet every design specification. Our system operated at such a low power, that even with a fixed tilt, the ratio of energy consumed to energy generated was still under 1%[3]. From the months of December to June, the ratio of electrical output relative to fixed output was shown to be greater than 1 for every month calculated. Data for this is shown in Table 1, but the actual ratios are present in Table 2. We were successfully able to charge a phone with the USB charger at a rate of 5V at 400mA and we decided to use a 4.2v 6Ah lithium ion battery to store excess charge.

Date	Fixed (Wh/day)	Dual-Axis (Wh/day)
Dec 21st	40.3469	44.3359
Jan 21st	41.3223	45.8462
Feb 20th	45.6425	55.6828
Mar 20th	46.0327	65.7827
April 20th	44.330	69.8538
May 21st	41.6701	78.9554
June 21st	40.5409	80.1834

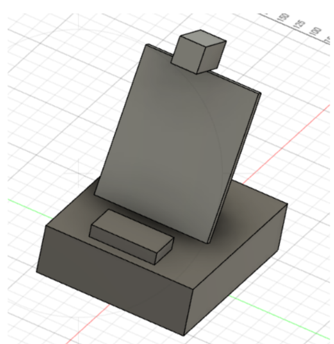
Table 1: Net Energy Generated

Date	Dual-Axis/Fixed
Dec 21st	1.0989
Jan 21st	1.1095
Feb 20th	1.2200
Mar 20th	1.4290
April 20th	1.5758
May 21st	1.8948
June 21st	1.9778

Table 2: Ratio of Fixed/Tracking Energy Gen.

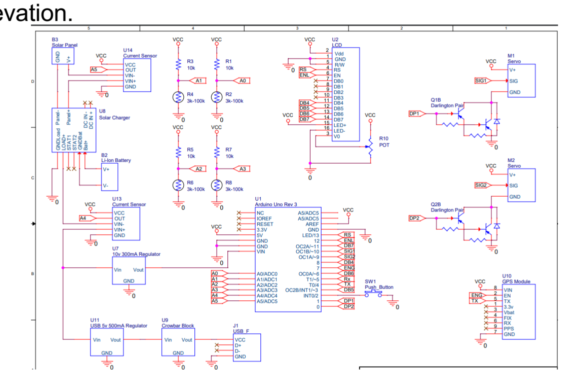
Date	Dual-Axis (Wh/day)
Dec 21st	0.50%
Jan 21st	0.49%
Feb 20th	0.40%
Mar 20th	0.34%
April 20th	0.32%
May 21st	0.28%
June 21st	0.28%

Table 3: Ratio of Power Used/Generated



Design

Overall, we ended up using every available pin on the Arduino. We have our solar panel connected to a solar charge controller module which is also connected to our battery and our entire circuit as the load. There are current sensors at the input and output of the charger to measure the current generated by the panel and consumed by the circuit. The Arduino and USB charger required separate power supplies because they operate at a different voltage than the solar panel generates. The photoresistor values and current sensor values are read by the Arduino's onboard ADC and the servos are adjusted according to the photoresistor voltage divider output values. On a cloudy day, the GPS values of latitude and time of day are used to adjust the servos based on equations for sun azimuth and elevation.



Glossary:

Fixed Tilt – a solar panel at a static position equal to the latitude of where it is located

Dual-Axis – a solar panel which rotates and tilts to match the azimuthal angle and elevation of the sun at any position

Azimuth Angle – The compass direction from which the sunlight is coming, where North = 0° and South = 180°

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