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Modification and Analysis of a Two-Axis Solar Tracking System

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Introduction

Solar tracking is related to moving the solar panels in such a way that its solar panel always points toward the sun which results into maximum output. The goal of this research is to modify and improve a two-axis solar tracking system that was designed earlier [2], by a Union College ME graduate. The rotation of the module is controlled by a rotational motor and the tilt is controlled by a linear actuator. The motion and direction of these two motors is controlled by an Arduino code which compares the electrical current going through four mini solar collectors (used as sensors) mounted in orthogonal pairs at the top of the PV panel. If a solar collector has a higher current reading, then it is exposed to more sunlight, so the panel is adjusted until all of the mini solar collectors have nearly the same current output, and thus are receiving the same amount of sunlight. Testing of the designed system was performed alongside an identical, stationary solar panel, which allows for a direct comparison between the electrical outputs of the two solar panels. The two modules are shown in Figure 1.

Figure 1 . Stationary panel alongside tracking panel.

Tracking Modification

Previously, outputs from the stationary and tracking systems were too similar to make a definitive conclusion as to whether the solar tracking system was able to provide a significant increase in power output. This was because the original design and code were tracking the sun by comparing open circuit voltage outputs, which do not vary greatly with sunlight and therefore not giving a precise response to changing amounts of sunlight. Therefore, the original design was modified to get much more accurate readings by adding resistors across the four mini solar collectors and modifications of the code. By doing that, it was possible to measure and compare current outputs instead of open circuit voltage and get much more accurate readings and better tracking. This is because current is more sensative than voltage with varying amounts of sunlight. The four mini collectors are shown in Figure 2.

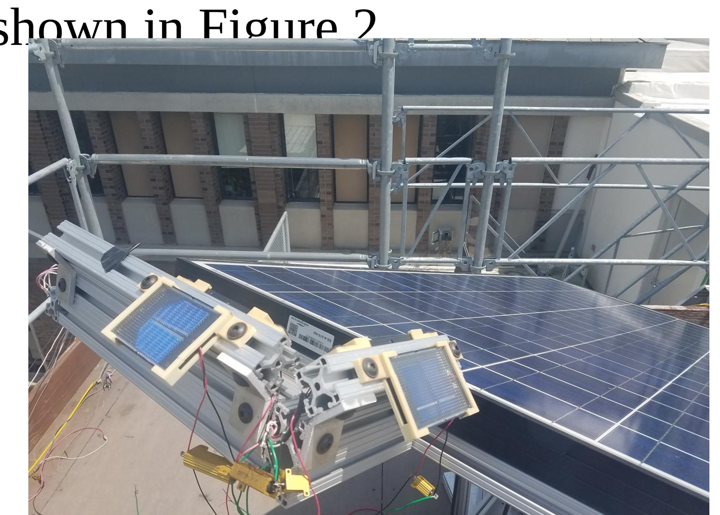

Figure 2. Four mini solar collectors mounted in orthogonal pairs on top of the PV panel.

Base Modification

One feature that was added to the tracker was a sliding base for the rotational motor. The motor's shaft is connected to a sprocket. The sprocket drives a chain that rotates the base of the tracking system. The old base was rusty and was not strong enough to hold the rotational motor firmly in place and was causing the motor's shaft to bend. The new base was built out of 1.5 inch T-slot extrusions; the T-slot feature allowed for a sliding base that provides easier adjustability of the chain and much easier maintenance. The new base is shown in the Figure 3.

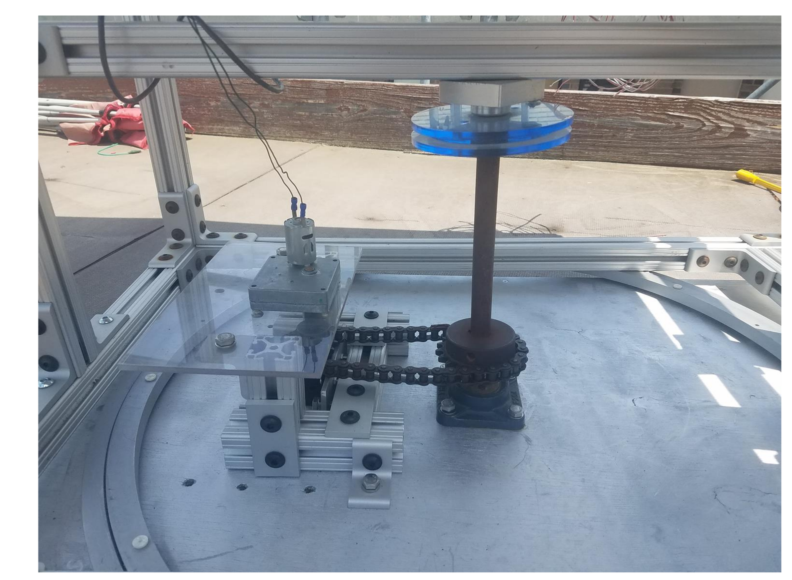

Figure 3. New sliding base built with 1.5 inch T-slot extrusions and a polycarbonate.

Pyranometers

Two pyranometer were also used to measure the solar radiation flux density; one was positioned vertically facing true south and the other was positioned horizontally. The data obtained from the pyranometers shows the amount of power that can be theoretically recovered by the solar panel for each square meter of surface area at different times in the day. Both pyranometers are shown in Figure 4 and the variation of solar radiation flux density with time is shown in Figure 5.

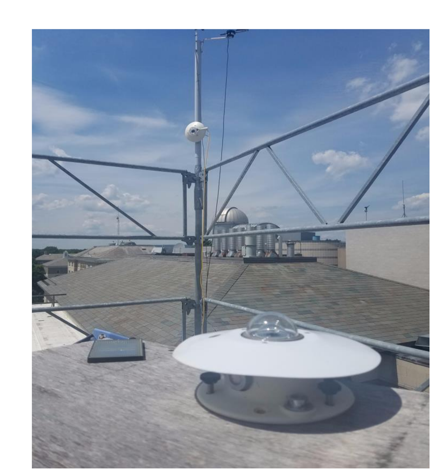

Figure 4. Vertical and horizontal pyranometers.

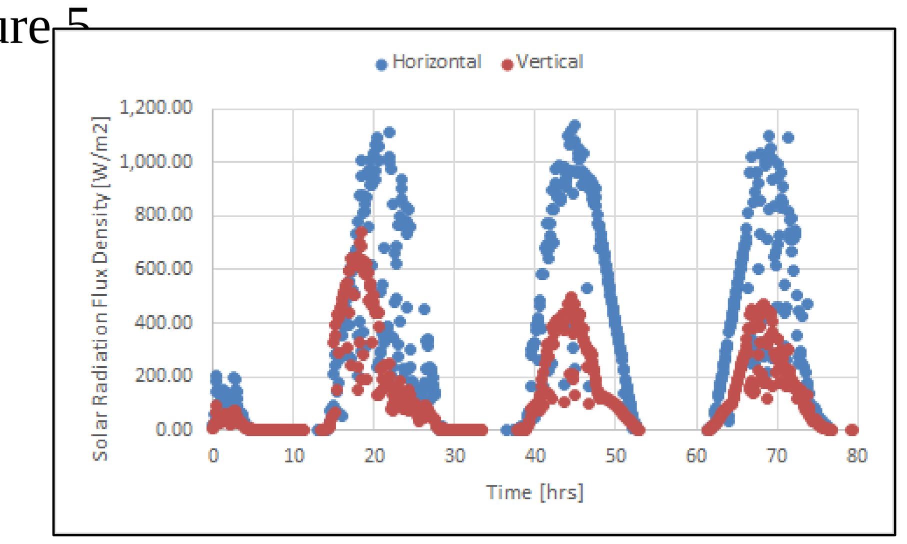

Figure 5. Solar radiation flux density across an 80-hour test period.

Conclusion

A solar tracking system was modified, improved, and tested in this project. The end product was a solar tracker that can move a solar module in two axes, horizontal azimuth and vertical pitch, to successfully track the sun throughout the day.

Acknowledgments

● Professor Richard D. Wilk ● Samuel Rider '16 ● Robert Harlan

References

1. Hasan A Yousaf "Design And Implementation of a Fuzzy Logic Computer- Controlled Sun Tracking System". Proceedings of the IEEE International Symposium on Industrial Electronics. Volume 3. 12-16 July 1999. pp 1030.1034.

2. Rider, Samuel. *Design of a Two-Axis Solar Tracking System*, Senior Thesis, Union College, Department of Mechanical Engineering, (2016).