Maximum Efficiency Solar Tracking Using Image Processing

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Abstract

Solar energy is a great renewable resource that is easily accessible in most parts of the world. However, there are limitations to generating solar power. In order to reduce these limitations, this research project investigates two methods to track the sun's position. Then the system will move the panel to match the movement of the sun across the sky. It is thought that a similar system could be used where allotted space for solar panels is limited.

Theory

Solar panels have one time during each day where there is maximum power generation being produced from the solar panel. This happens when the surface of the solar panel is orthogonal to the incoming electromagnetic waves from the sun [1]. To keep the panel orthogonal to the sun the radiation can be tracked using different methods such as image processing or simply with a method using photoresistors. The solar panel can then be moved using a dual axis system so that both the Azimuth and Zenith angles can be optimized.

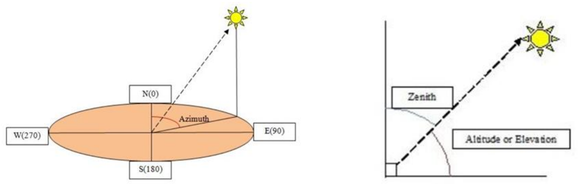

Figure 1. Angles for sun positioning [2]

Methodology

Method 1: Image Processing – Once the camera code was developed, testing the outputs was a priority. By placing if statements with the x and y coordinates, the desired direction is printed out, based the pixels deemed to be a light source. We tested by shining a light in view of the camera in multiple positions and seeing if the output matched where our solar panel should move.

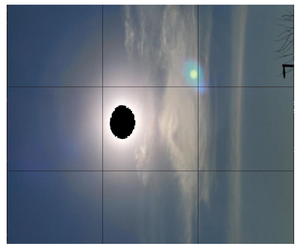

Figure 2. Processing done on Image

Method 2: Photoresistors – There are 4 photoresistors placed on each side of the solar panel. When light hits the photoresistors their resistance values decrease, and the increases resistance for less light. By using four photoresistors together, the system can determine where the sun is by comparing values read from the photoresistors.

System Block Diagram

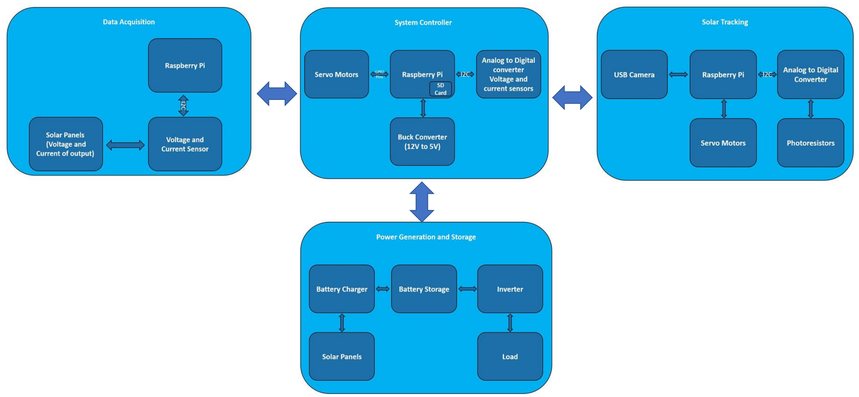

Figure 3. System Block Diagram

Prototype

A prototype was built in an effort to test the effectiveness of two methods. This included learning a plethora of technical skills such as 3D design and printing, soldering, welding, and circuit design. The components of this system were a combination of off the shelf parts for the electronics running the system, a designed base to prevent tipping, and a dual axis designed head which provides the movement required for maximum energy harvesting. However, it was found that the motors selected to move the panel could not reliably move the panel to the correct position.

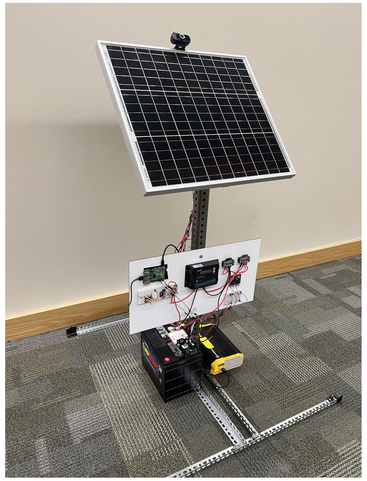

Figure 4. Prototype

Conclusion

It was found that the methods using the Image Processing and the Photoresistors could find the direction of a light source. Without the solar panel moving reliably according to inputs it is still to be tested whether a substantial gain of power efficiency could be achieved using these methods.

References

[1]. K. Jazayeri, S. Uysal and M. Jazayeri, "MATLAB/simulink based simulation of solar incidence angle and the sun's position in the sky with respect to observation points on the Earth," 2013 International Conference on Renewable Energy Research and Applications (ICRERA), 2013, pp. 173-177, doi: 10.1109/ICRERA.2013.6749746.
[2]. vlab.amrita.edu,. (2015). Solar PV Tracker. Retrieved 7 December 2021, from vlab.amrita.edu/index.php?sub=77&brch=298&sim=1629&cnt=1