Maximizing Voltage Output from Lego MindStorm Solar Kit

***Abstract*—In this experiment, we were tasked with finding the best way to maximize the voltage output from a solar cell. Solar panels are an alternative source for generating electrical energy but can be less efficient if not properly aligned to receive maximum light. Our build consisted of a motor attached to the solar cell that would track and follow light to ensure maximum exposure.**

I. Introduction

SOLAR energy is a renewable resource that is gaining popularity in private and public use with estimates totaling 1 million installations as of 2016 in America, with that number expected to double by 2020.[1] The solar power sector is also the fastest growing energy resource in America, employing more than largest Silicon Valley companies combined.[2] The sun is an almost inexhaustible source producing magnitudes more energy than the total consumption of the world. [3] Solar panels work by converting energy released by the sun into electrical energy by using photovoltaic, PV, cells. Most PV panels consist of two layers of silicon doped with impurities that allow for the normally nonconducting silicon to shed electrons when hit with wavelengths of light. The electrons can then travel through a circuit to generate electrical energy. [4] See Figure 1.

In order for solar panels to work, they must have access to sunlight. However, the amount of light received by panels in America is not consistent, with states in the southwest achieving higher voltage output than those in the northeast.[5] Aside from geographical constraints, the amount of light a panel receives within a day can vary greatly.[6] The sun is constantly moving across the sky and therefor affects how much light hits the panel. Fixed panels can be angled on a rooftop to optimize the amount of light absorbed, but the best way to maximize light hitting the panel is to use a solar tracker, a device attached to the cell that positions and angles the cell according to the movement of the sun.[7]

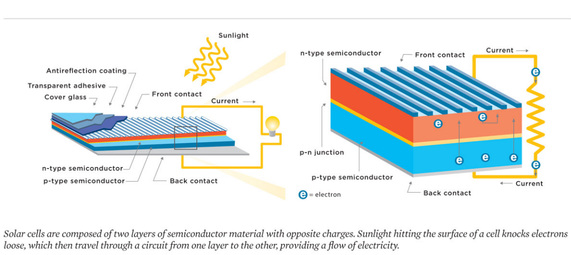

Fig. 1. Diagram showing composition of solar panels [4]

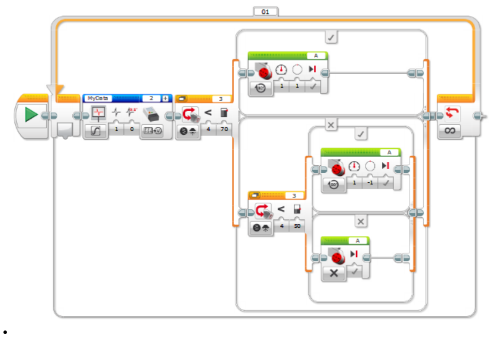

Fig. 2. Code for the Lego MindStorm

II. Method

Two solar panels from the Lego MindStorm Renewable Energy Add-on Set are set on a rotating gimble with a light sensor attached. A mirror is angled so that light hits the panels. The mirror remains in a fixed location during the test. The light sensor measures the amount of light received, which in turn affects the angle of the panel. The panel rotates to ensure the most light possible is hitting the cells. The amount of voltage is measured and compiled. The results of the moving panels are then compared to a pair of stationary panels to determine the effectiveness of using a solar tracker.

The code for the robot is seen in figure 2. A picture of the experiment is seen in figure 3 The initial design for the solar tracker came from Argyro.[8]

III. Results

Unfortunately, the way the code was written caused the data to be rewritten every fifteen seconds.

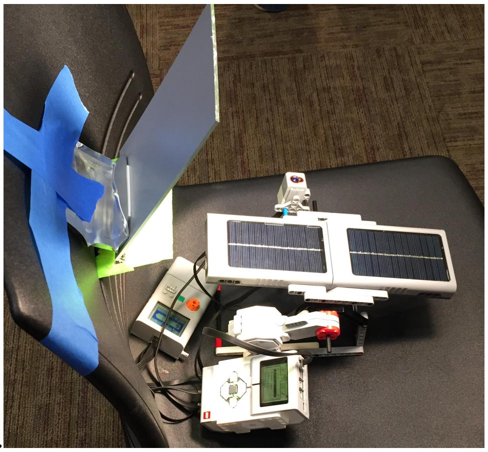

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Fig. 3. The setup of the MindStorm with Solar Panels and a mirror.

The data collected was only for the first fifteen seconds. The robot continued to track the movement of the light, however.

$$\sum_{i=1}^{N}(x_i - \overline{x})^2 \tag{1}$$

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2} \tag{2}$$

IV. Conclusion

By using a motor to rotate the solar panels, the panel stayed in the path of light for longer periods of time than the control. The code will need to be changed to compile datasets instead of overwriting them.

References

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