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Rotary Parking Tower with an Electrical Station

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Abstract
We conducted this research two groups of students called "robotics and solar/wind power". We collaborated to create a prototype of a revolutionary idea in parking systems, a rotary parking system. The robotics groups handled the overall mechanics of getting the platforms for the automobiles to be able to rotate at a controlled rate smoothly, while the solar/wind group handled the use of solar panels to power the rotation, and also the creation of electrical stations on each platform for hybrid electric vehicles. The study mainly deals with the solar/wind power aspect of this research. We studied the environmental benefits of having a rotary parking system that was based on renewable energy. In addition, our methodology included first-hand knowledge from previous solar/wind experiments and research. The main objectives of this research were the versatility of renewable solar energy and also its ability to store and produce massive levels of electricity. In our conclusion, we discussed the possible alterations to our research that would make it work in a more energy-efficient manner.
Keywords: *solar, wind, robotics, rotary, parking, electric*

1. Introduction

In today's society, especially in metropolitan areas, there is barely enough room for people to walk, let alone park their cars. The idea of a rotary parking tower solves the problem by occupying a minimal amount of space on the ground and by expanding upwards. Retrieval and parking of a vehicle is easy, safe, and reliable. There is also another aspect of environmental awareness that should be utilized more often, renewable resources. In order to increase the efficiency of the parking tower, we decided to place solar panels, divided into 2 sets, on the roof as a source of power for both the rotation device and the electrical charging station.

Solar cells make up a solar panel and are made from semiconductors. Solar cells are assembled into modules and then arrays in Fig. 1. Usually, the larger the area of the module/array the more energy that will be produced [1]. There are many different solar cells now available on the market, spanning a wide variety of materials, but most of them are crystalline silicon cells. In our research, we used two polycrystalline silicon panels.

A solar cell is based on the ability of semiconductors to convert sunlight directly into electricity using the photovoltaic effect. In the conversion process, light energy creates mobile, charged particles in the semiconductor. The particles are then separated by the device structure and produce electrical current. "Semiconductors can only conduct electricity if carriers are introduced into the conduction band or removed from the valence band" [2]. One way of doing this is through the process of doping, in which the semiconductor is alloyed with an impurity. Doping makes it possible to control the electronic properties of a semiconductor.

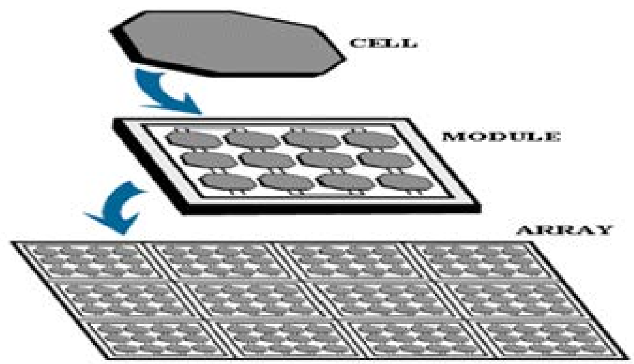

Fig. 1. Solar cells are assembled into module and then arrays [6].

it possible to control the electronic properties of a semiconductor.

The operation of solar cells is based on the formation of a junction. All junctions contain a strong electric field. The simplest junction is a p-n junction. A p-n junction is created by joining two pieces of semiconductor, one p-type and the other n-type in Fig. 2. The n-type is electron rich (negative) while the p-type is electron poor (positive), but rich in holes, which are the missing electrons that behave as positively charged particles that carry current [3].

Solar panels convert light energy into electrical energy. In other words, they produce direct current (DC) electricity. Since most items need to use mechanical energy (AC electricity), we had to attach the solar panel to an inverter to convert the electrical energy into mechanical energy. It is important to note that even the best solar cells can only absorb up to 20% of the sun's energy.

In addition, it is crucial to calculate the area of the solar panel and estimate the total electrical power that can be generated in order to determine how much of the energy demand of the parking tower could be met by solar energy.

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The original panel is 10.5" L x 5" W. Therefore the maximum possible area of the panel is 10.5 in x 5 in = 52.5 sq inches. The maximum power is therefore (0.2 watts/sq in) x 52.5 sq inches = 10.5 watts if the panel is fully illuminated. The actual usable area of the satellite's face is strictly the areas of the photovoltaic cells. The total area of the solar cells is then 9" L x 4" W = 36 sq inches. The maximum panel area is 52.5 square inches so (36/52.5) x 100% =68.57& of the panel is covered by solar cells. In addition the electrical power generated by the panel is 0.2 watts/sq in x 36 sq inches = 7.2 watts.

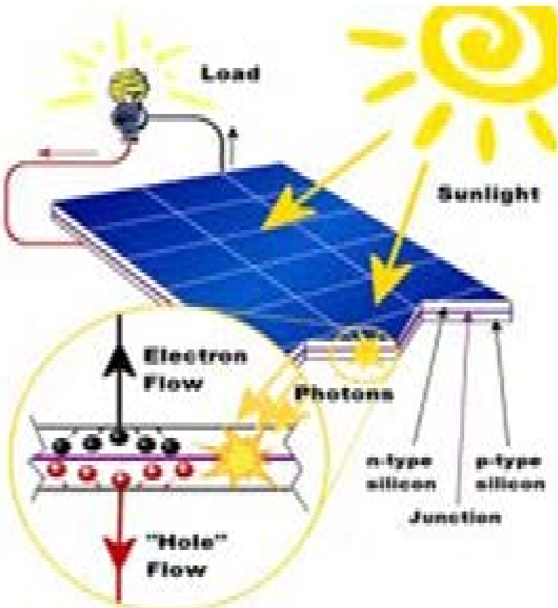

Fig. 2: A p-n junction has two pieces of semiconductor, one p-type, other n-type [7]

An electric vehicle charging station is a structure that supplies electric energy for the recharging of electric vehicles, such as some hybrids. There are four modes of power for the stations, with each one creating a faster and more powerful charging. Mode 1 is a "slow charging from a regular electrical socket" [4]. In addition, voltage is the measure of the energy of electricity, or energy per charge. Voltage is either direct or alternating (DC/AC) [5]. This is the type of station created in this research.

2. Experimental Procedure and Setup

After the robotics groups finished creating the framework and rotating device for the tower, the solar/wind group, worked to apply their parts of the project to the tower. In order to successfully complete the project, a series of materials was needed. The most obvious of these materials was two to three solar panels. We also needed an inverter, a soldering iron, and a hot glue gun. Gloves and goggles were needed as a precaution. Rubber bands are essential to keep all the wires organized and aid in securing the solar panels to the roof. Extra wires and diagonal/wire cutters were also required, in case the wires attached to the solar panel were too short. For the electrical station, the only additional supplies needed are a battery, a multimeter, and a cord to attach the car battery to the electric station/outlet.

After it was confirmed that the rotating device was working properly and smoothly when it was powered with a VEX battery, the first step was to attach the solar panels to the roof of the tower. They were secured with the glue adhesive from the glue gun and some rubber bands. The solar panels were already attached to wires their own alligator clips. The wires separated into two groups, those for the rotating mechanism and those for the electrical station, based on their location and distance from both destinations.

The destination for the "rotating" wires was in the back of the transmitter where the VEX transmitter battery was attached. However, the first step was to attach the wires to a super capacitor, through the use of the soldering iron, with one side holding the red wires and the other side holding the black ones. After carefully removing the battery from the transmitter, the VEX power connector that was attached to its wires was removed and placed on two extra wires, while still paying attention to the respective colors. Then the same wires were soldered to the same external terminals of the super capacitor as their respective wires from the solar panel. Afterwards, the power connector put back into its previous spot in the transmitter.

In some cases the wires from the solar panel did not reach the transmitter. Under these circumstances, it was necessary to remove the power connector, cut the extra wires in order to remove the rubber protective covering and expose the wires with the diagonal/wire cutters. The soldering iron was used to connect the desired wire to the solar panel one, which was then attached to the power connector and the transmitter.

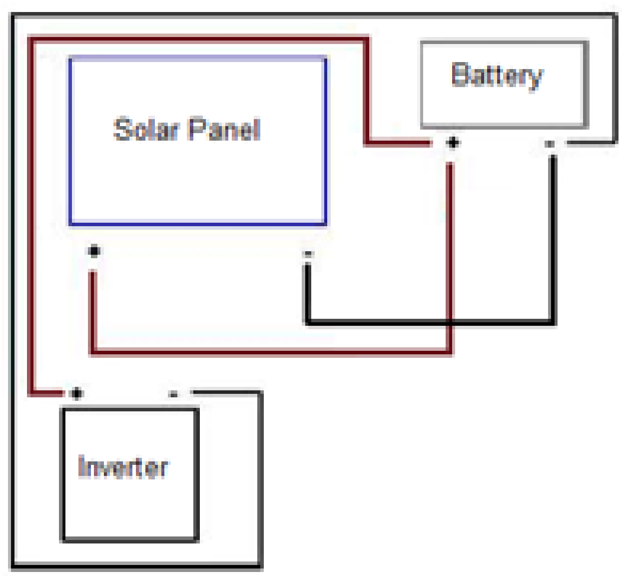

Fig.3. Schematic of the wire connections for the electrical charging station

For the electrical outlet, the majority of steps were simply soldering wires to certain terminals. The first step was to attach the wires from the solar panel to the battery. This step does not require soldering because there were alligator clips attached to the wires. Then using the spare wires, we attached the battery to the inverter as shown as in Fig.3. Throughout all of this, make sure that the black and red wires attached to their own respective terminals, with black on the negative end and red on the positive end. Afterwards, any wires attached to the power inverter guided to any vehicle platform, where they attached to an electrical outlet. From the outlet a cord attached connecting the car's hybrid battery to the outlet.

For data, we measured the number of volts emitted by each electrical station and also analyzed the speeds of various elements of the rotation device.

3. Results and Discussions

In the end both tasks assigned to the solar/wind groups functioned smoothly. The entire objective of the study was fulfilled: vehicles were safely put in and taken out through the use of solar power and the hybrid vehicles would have most likely been able to be charged. Although the reaction speed and speed of the rotation altogether tended to fluctuate from time to time, there was a general trend of consistency and stabilization. For instance, sometimes the tower started rotating the moment it was activated and other time, it took a few seconds . The speed of the rotation did not fluctuate as much as the rotation, but it still did minimally. None of the trials had a rotational speed that could be seen as considerably fast.

Table 1: The rotation and reaction speed of the solar powered rotary parking tower

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Reaction Speed	Medium 2,3s	Fast 0,1s	Slow 4,5,6 s	Slow 4,5,6 s	Fast 0,1s	Slow 4,5,6 s	Fast 0,1s	Medium 2,3s
Rotation Speed	Medi -um	Med -ium	Slow	Med -ium	Slow	Med -ium	Slow	Med -ium

It is more likely that the rotation speed was based more on the amount of electricity produced by the solar panel than on the reaction speed. The fluctuation in reaction speed is most likely due to signaling difficulties in the wires because of a less than perfect soldering. The rotation speed is most likely affected because the number of volts in all the solar panels combined was still considerably less than the number of volts supplied by the VEX battery, which was 9.6v compared to the solar panels' 5.6v. This theory is substantiated by the fact that the rotation was much quicker before the VEX battery was taken out.

On the other hand, it was impossible to actually charge a real car or a toy miniature one with the electrical station. As a result we used a multimeter to compare the voltages given off by each station; all the stations emitted the same number of voltages (around 0.5v). This is most likely because all the stations are connected to the same energy source and they divided the energy among themselves equally. Whether or not it would actually charge a real electric car is still unclear, but since voltages are being emitted, the car should charged, albeit, incredibly slowly.

4. Conclusions

The research was incredibly successful and corroborated all the benefits of solar power. Any errors in the final research would most likely be attributed to the weakness of the solar panels. The rotary parking system still worked effectively, but it could have been improved if there were more solar panels, although that would be impractical; or if the solar panels were stronger and could produce more volts. Also, while there was a super capacitor holding electricity for the rotating mechanism, there was not one for the electrical charging. Therefore, the system would still rotate if there was no light, but the charging would stop working. This could have been easily improved by adding a super capacitor to the wires for that part of the study.

The results for the speed of the rotating device are not very accurate. Since there was no stopwatch available at the time, the results are based more on our observations and an internal stopwatch. An easy way to make this more accurate would be to simply get a stopwatch and actually time it. However, it is even more important to do multiple trials in this circumstance, because it may not be the case that the stopwatch begins timing right when the system is activated.

Another suggestion for the future would be to either label the wires or to be very organized, as the multiples of wires do get incredibly difficult to differentiate among them. Another aspect is the fluctuations reaction speed and rotation speed. However, the reason for this cannot be determined without further investigation and research.

This research reemphasized the numerous benefits of solar power as well as its versatility. Solar power can even provide the energy needed to in the manner of a Ferris Wheel. While our model of a rotary parking tower still has a long way to go before it can actually be built, it has established the main concepts. It shows that being earth friendly is not as difficult as people believe that it is.

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