4-1-2019

Implementation of Solar Car Technology

Greg McCartney
Pittsburg State University

Marcus Allen
Pittsburg State University

Dedrick Cooper
Pittsburg State University

Lelan DeLissa
Pittsburg State University

Eric Mayer
Pittsburg State University

Implementation of Solar Car Technology

Greg McCartney, Marcus Allen, Dedrick Cooper, Lelan DeLissa, Jonathan Harris, Alex Fries, Steven Kirkland, Matt Krantz, Zachary Westfall, and Dr. Erik Mayer

Pittsburg State University

Introduction

Pittsburg State University will be hosting the inaugural Kanas Solar Race competition at the Kansas Technology Center on April 27, 2019. For this competition, student teams from regional universities will be designing and racing remote-controlled solar cars. The competition will consist of a drag race and a road race.

Design Requirements

The design requirements for the solar cars are:

- The maximum solar panel area is 6 ft^2.
- The car will be remote-controlled.
- No batteries are allowed in the car.

Body

PSU's solar car is shown in Fig. 1. The body of the solar car was built using pieces from Pitsco and Vex robotics kits which provide a rigid structure for the car and support the solar panel.

Remote Control

Initially, it was decided to use Wi-Fi to control the car. However, this turned out to be an involved process that required a microcontroller running a real-time operating system. Thus, it is planned to use a commercially available spread-spectrum system for remote-controlled cars for the competition. It is planned to continue researching the Wi-Fi option in the future.

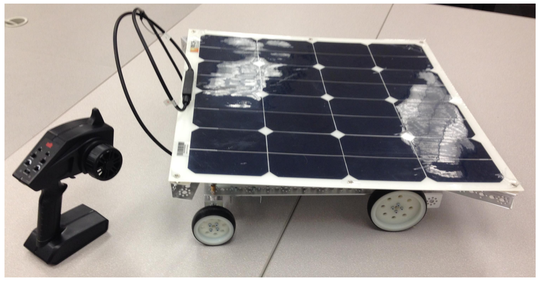

Fig. 1 PSU's solar car

Solar Panel

To minimize the weight of the car, it was decided to use a 3.3 ft^2 flexible solar panel that only weighed 2.4 lbs. The solar panel has a maximum power of 50 W and was mounted in a fixed position on the top of the car to maximize the amount of sunlight received. It was discussed whether or not the solar panel would be mounted on a mechanism that would allow it to continually point directly at the sun. It was decided that this would probably not increase the power enough to offset the weight of the added mechanism.

An important step in designing the solar car was to measure the current-voltage (I-V) characteristic curve for the solar cell and identify its maximum power point which is the voltage and current at which the solar panel will deliver the maximum power.

To measure the I-V curve, the high-wattage resistor decade box shown in Fig. 2 was designed and built. The decade box allowed different values of resistors to be connected in parallel using switches. When the solar panel was connected to the box, it allowed the current drawn from the solar panel to be varied incrementally. Fig. 3 shows the resulting I-V curved measured with the decade box.

Multiplying the voltage of the solar panel by the current drawn from it results in the power the solar panel is delivering. Doing this for each measurement in Fig. 3 results in Fig. 4. It can be seen in Fig. 4 that there is a maximum power point which occurs at the "knee" of the I-V curve in Fig. 3.

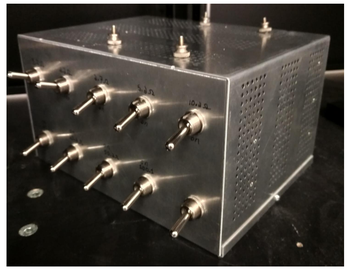

Fig. 2. High wattage decade box for measuring I-V curve of solar panel

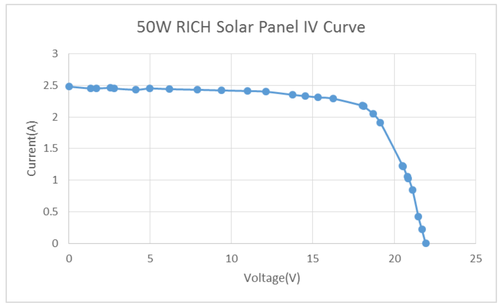

Fig. 3 I-V curve of solar panel.

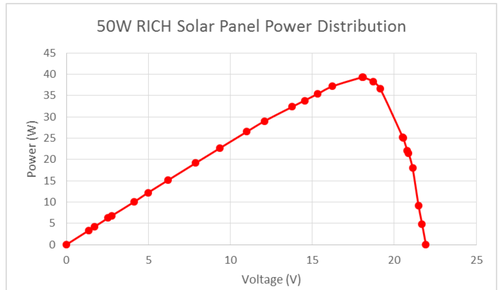

Fig. 4 Power vs. voltage curve of solar panel

Electric Motor

It was proposed to use a permanent magnet dc motor for the solar car. For the this type of motor, the voltage applied to the motor is approximately proportional to speed and the current drawn by the motor will be approximately proportional to the torque it produces. Thus, Figs. 3 and 4 can be used to choose a motor and design the motor controller.

A permanent magnet dc motor that is used in remote-controlled cars was chosen. However, the starting current of the motor was 5 A and was larger than the solar panel could provide. In order to get the motor to start and run using the solar panel, several potential solutions are being considered.

Potential solutions to supply high starting current to motor

- Ultracapacitors could theoretically supply the high current required for the motor to start.
- A Battery eliminating circuit (BEC) would theoretically stepping down the voltage while increasing the current available.
- Use a different motor that requires a lower starting current.

Motor Controller

Initially, it was proposed to use a motor controller using gallium nitride (GaN) transistors. GaN transistors will have low conduction and switching losses which will save energy. Due to time constraints, a commercially available motor controller will be used for the competition. It is proposed to continue researching using GaN transistors in the future.

Conclusion

It can be seen that students designing the solar car are being exposed to real-world problems to which they need to find solutions. It is anticipated that student participation in the Kanas Solar Race will be a success. Not necessarily because of how the competition will go, but because of all the learning and interest that was gleaned throughout the competition. Additionally, the high wattage decade box was created that can be used used to measure I-V curves for solar panels. The decade box can potentially be used in a Electronics Engineering Technology (EET) class.

Acknowledgment

This work was supported by a subaward of the National Space Grant College and Fellowship Program (SPACE Grant) Training Grant 2015-2018.