On-Campus Delivery System

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Summary

The Aerospace corporation works on space-based technologies that require low power, telemetry, and solar power. The purpose of this project is to assist the Aerospace corporation in advancing these technologies through the application of them in a classroom environment. The design developed was an on-campus food delivery vehicle powered by solar panels and controlled wirelessly. The efforts completed in this year-long project resulted in a bluetooth control vehicle and a solar powered charging station that recharges the battery used to power the vehicle. Future work can improve the autonomy of the vehicle and increase efficiency of the charging station.

Problem Statement

The problem statement developed is as follows:

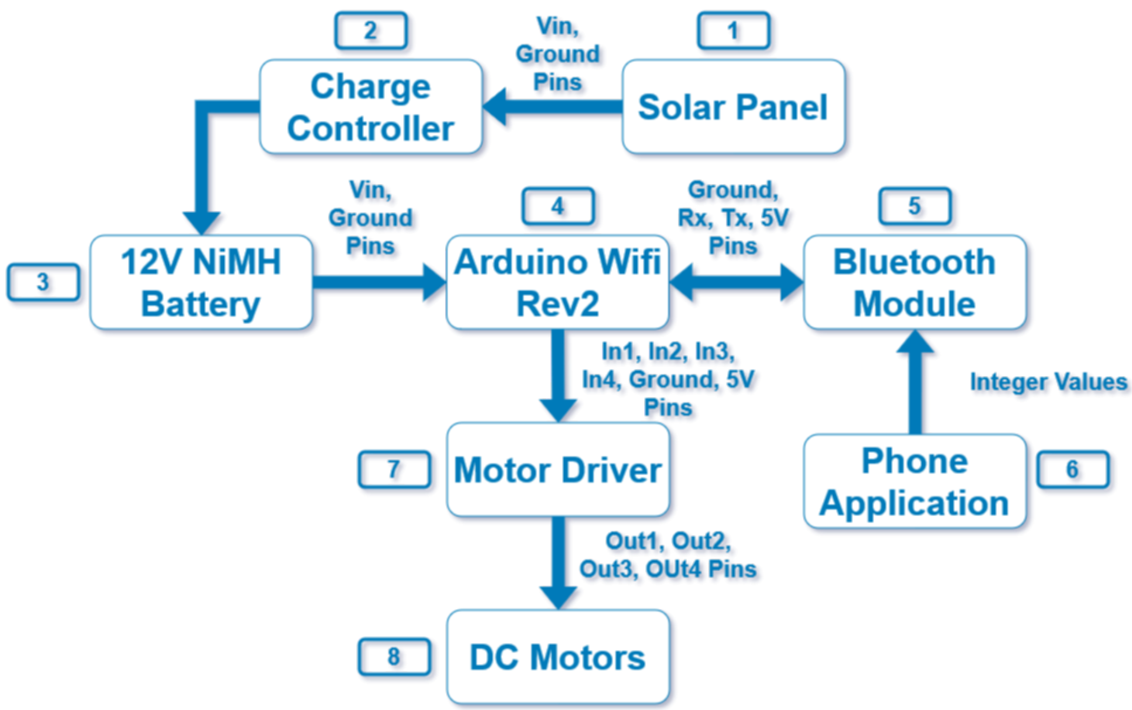
"The need of hungry students on campus who are too busy to get food on their own, would need a way to have it delivered to them autonomously."

Design Requirement

To make the solution design fit in with Aerospace's demands, there were a few design requirements to be met. The project consists of two separate parts, a solar-powered charging station and an autonomous vehicle. The charging station would require, most importantly, a solar panel. The charging station would also need a charge controller- to prevent overcharging, an interface between the vehicle and the battery, a charging platform with an enclosure for the vehicle and state of health monitoring. The vehicle would need a Wifi MCU, a motor driver, a basket to hold the food, a nickel metal hydride battery, and state of health monitoring as well.

Solution Design

Below is a diagram of the system developed as well as a description of each piece include:



1. The solar panel included on this project is a 10W 12V device connected to the charge controller. This panel was placed on top of the structure built to house and store the vehicle. The angle chosen was based on what would be the most efficient year round on our campus.

2. The charge controller used in this project is a “SmartSolar Charge Controller” from Victron Energy. This controller uses maximum power point tracking to safely and effectively charge the battery used.

3. The battery is a NiMH (nickel metal hydride) 12V with 2000mAh. This battery is connected to the charge controller to be charged while the battery is not being used by the vehicle.

4. The “Arduino Wifi Rev2” was programmed to receive bluetooth signals and would send controls to the motor driver based on the signal received from the bluetooth transceiver. The arduino was powered by the 12V NimH battery, while the arduino transferred this power to the bluetooth transceiver and motor driver.

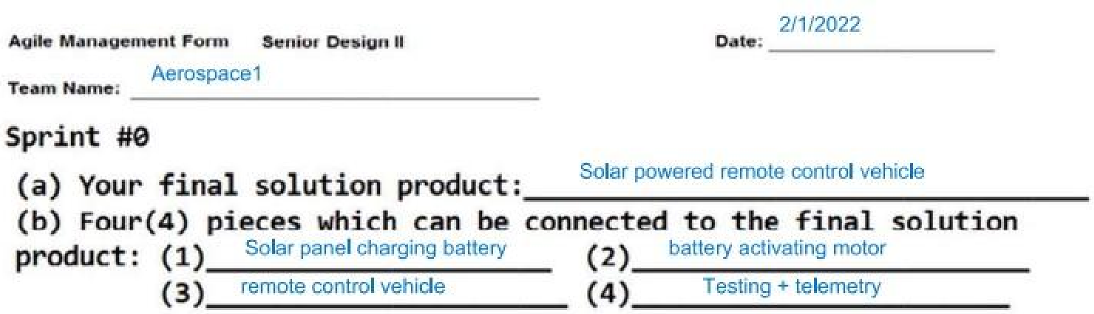
5. The HC-05 bluetooth module was used to receive signals from the phone app. It is able to receive signals from an outside source or the arduino then transmit information to the arduino or an outside source.

6. The phone application allowed for a user to send information to the bluetooth transceiver, indicating which direction the vehicle would be able to move. The phone was connected to the bluetooth transceiver and the app then allowed a user to type anything to the arduino.

7. The L289N motor driver was used in this application. The 5V input powers the motor driver and is received by the arduino. The In1, In2, In3, and In4 pins are connected to digital pins in the arduino. The Out1 and Out2 pins are connected to the left front and back motor drivers. The Out3 and Out4 pins are connected to the left and right

8. Four DC motors were used to control the car. The left front and back motors were controlled together and the right front and back motors were also controlled together. This was efficient as the motors on one side were always going the same direction as each other. This also saves power and space as only one motor driver was used instead of two.

Agile Plan



Agile Management Form Senior Design II Date: 2/1/2022

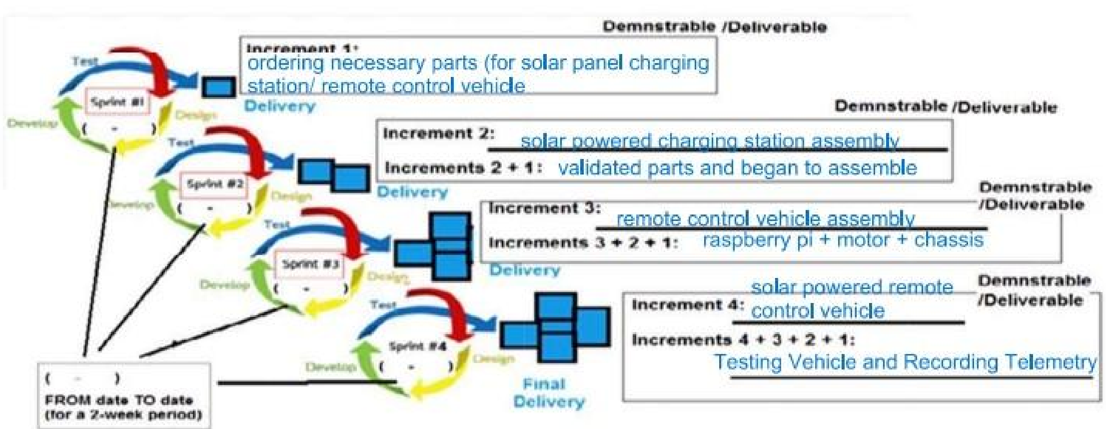
Team Name: Aerospace1

Sprint #0

(a) Your final solution product: Solar powered remote control vehicle

(b) Four(4) pieces which can be connected to the final solution product: (1) Solar panel charging battery (2) battery activating motor

(3) remote control vehicle (4) Testing + telemetry

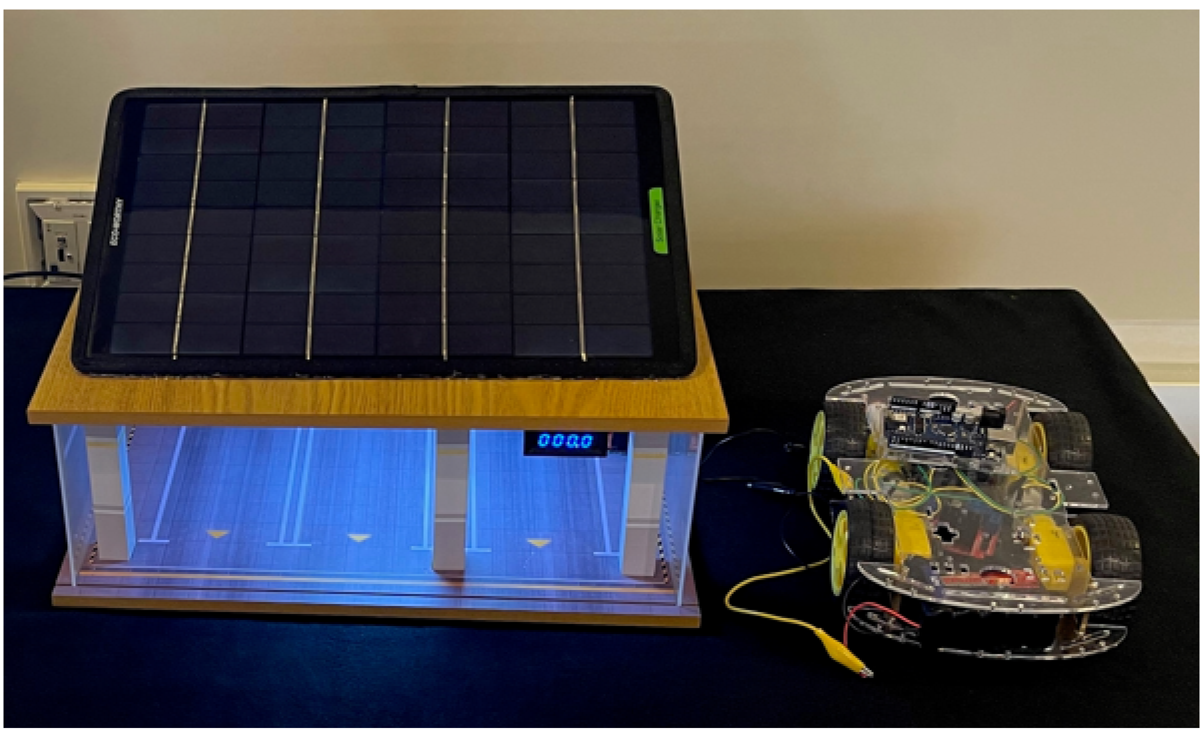


At the beginning of the semester, the team came up with an agile plan to come to their final solution. After coming up with the agile plan, the team was able to section the final solution into four separate parts, which would be considered sprints.

Project Implementation Process

Weekly Project Implementation Plan				
Team Name	Aerospace1			
Final Solution Product		Solar powered remote control vehicle		
		Dates		
Sprint #	Increments	From[MM/DD/YY]	to [MM/DD/YY]	Weekly development tasks
1	Solar Panel Charging Battery	2/8/2022	2/19/2022	building solar panel charging station
				working out dc-dc converter
2	Battery activating motor	2/22/2022	3/5/2022	assembling vehicle (chassis/motor etc)
				wiring vehicle/motor
3	Remote moving vehicle	3/15/2022	3/26/2022	wiring vehicle to move around
				connecting vehicle to wifi/controller
4	Testing and telemetry	3/29/2022	4/9/2022	test running the vehicle
				creating code for the telemetry report

The team created a project implementation plan to keep on track with the sprints, and to clearly outline the steps that should be taken with each one. Due to receiving many of the physical parts late, much of the sprint goals were delayed.



Pictured above is the completed charging station with the vehicle attached. The solar panel is placed on top of the charging station which houses the charge controller and an additional battery (both not pictured). The digital display is that of a voltmeter. The vehicle contains the motor driver and battery on a lower level and the arduino on the top level. As discussed in the solution design, four dc motors control the movement of the vehicle.

Conclusion

At the end of this project, the vehicle was able to function using the planned design. The arduino acted successfully as a microcontroller to interface with the motor drivers, bluetooth module, and battery. The phone application was able to send signals through bluetooth to move the motors. Future work on this project should develop the vehicle to become better capable of transporting food over rough terrain as well making the vehicle more autonomous. The rough terrain of the college campus may require a larger vehicle chassis or additional compartments to safely store food. The process to make the vehicle more autonomous would answer the question of “how the vehicle navigates across a given terrain without assistance” through more complex programming.

References

1. Chihchiang Hua and Chihming Shen, "Control of DC/DC converters for solar energy system with maximum power tracking," Proceedings of the IECON'97 23rd International Conference on Industrial Electronics, Control, and Instrumentation (Cat. No.97CH36066), 1997, pp. 827-832 vol.2, doi: 10.1109/IECON.1997.672008.
2. V.C. Kotak and Preti Tyagi, “DC To DC Converter in Maximum Power Point Tracker,” International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2013, vol 2, issue 12.
3. Mohammad Kamil, “Switch Mode Power Supply (SMPS) Topologies”, Microchip Technologies, 2007