Senior Design
ENG EC 463

Memo

To: Professor Pisano
From: EV Builder Kit Team
Team: 18
Date: 03/18/22
Subject: 2nd Prototype Testing Report

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1.0 Summary of Equipment and Test Setup

1.1 Car Summary

On each car, there is a 3.7 volt lithium polymer(LiPo) battery used to power the vehicle. This battery is attached to a LiPo fuel gauge chip, which is able to take in the LiPo Battery's JST connector, and uses I2C to feed the Arduino Nano the battery life. connection. The fuel gauge chip also has output pins which are fed directly to a 5-volt Voltage Booster. The 5-volt voltage booster raises the 3.7 volt output from the battery to a 5 volt output, and feeds that voltage to power the Arduino Nano and dual H-Bridge motor controller. The motor controller is connected to two DC motors, while the Arduino Nano is connected to the motor controller. The Nano can then control the motors by applying Pulse Width Modulation(PWM) and shifting between logic high to logic low on the connections to the motor controller. A transceiver module is also attached to the Nano, allowing the external controller to control the signals sent to the motor controller, and thus control the motors as well.

On the larger car, an LCD display was also attached, along with the LiPo Charging chip. These were to showcase the fuel gauge's ability to detect and send out the battery data, along with the capability to charge the battery by simply plugging in a provided DC jack to the charging chip.

To set up the test, first connect each car's Arduino Nano to a computer that has an autonomous testing code loaded onto it, then upload that code to the board. The autonomous code consists of commands that make the car cycle through driving forwards, turning left and right, then reversing. Once the code is uploaded, then disconnect the Arduino from the computer, and clear out an area for the car to begin driving on, and the car will begin cycling through the various driving states. The LCD and LiPo Charging Chip are not utilized for the testing of the car itself, and instead used to showcase the properties of the other components of this project.

1.2 Controller Summary

On the controller, there are 2 PS2 type axial joysticks, which are connected to an Arduino Uno. The Uno is able to take in the inputs from these joysticks, and use an attached transceiver chip to transmit a 3 bit message to the transceiver on the car. This allows the car to read the 3 bit message from the controller, and adjust its state accordingly.

To set up the test, first connect the car's Arduino Nano to a computer that has the code for a receiver loaded onto it, then upload that code to the board. At the same time upload the controller code to an Arduino Uno. Once the code upload process is complete, place the car down onto a clear out area. This should enable the controller to control the car, with the car being able to drive forward, backwards, turn left and right, and speed based on the strength of the joysticks. The controller also had a toggle switch to let the user decide which car to use. The arduino detects if the switch has a high input which will indicate the switch is one to control one car and off to indicate another car. A complete controller will be able to control up to 3 cars if done correctly.

1.3.1 Charging Station Summary

For the charging station, there will be three main parts. Since our model will be indoors, an aluminum lamp with a hydroponic bulb is used to represent the sun. The hydroponic bulb mimics the visible light spectrum that would be expected from the sun, which is where most of the energy from the solar panels are derived. This lamp will be directed towards a solar panel, which is connected to a Lithium Polymer Charging Chip. This chip is capable of using the power from the solar panel to recharge the battery, while also load balancing to the output as well. The solar panel was mounted on a stand inside the kit at 45 degrees, which is the ideal degree. For this prototype, the main proof of concept is to show that using a lamp to power the solar panel is viable.

To set up the test, first plug in the lamp and clamp it on the edge of the kit. Turn the lamp towards the solar panel then connect the solar panel to the LiPo charging chip. The LiPo battery also has to be connected to the chip. To test the current and voltage, set the multimeter to 6m amps.

2.0 Measurements Taken

2.1 Car Measurements

5.1 Car Scoring Sheet			
Test	**Observed Result for Car 1 (Larger)**	**Observed Results for Car 2**	**Failure? (Y/N)**
Driving Forward	No Issue	No Issue	N
Driving Backwards	No Issue	No Issue	N
Turning Left	Smooth Turn, but slow	Slightly Jerky, but managed to turn	N
Turning Right	Smooth Turn, but slow	Smooth Turn	N
Objects on Car Secure	Yes	Yes	N
LCD Display Battery State	Visible, and active	N/A	N
		Overall Result:	Successful

The tests showed that each car is able to drive itself forwards and backwards without any major issue. However, the process of turning was shaky for the smaller car, and slow for the bigger car. For the larger car, this slow turning was linked with a low battery, but nonetheless the turning was fine. As for the smaller car, the turning being shaky was linked to a lack of traction/torque for the car wheels. When additional weight was applied by pressing on the back of the car however, the turning was much smoother. At the same time none of the objects on the car fell apart during operation which indicates that the car is sturdy enough for operation. Additionally, when the LCD was tested, the proper data for battery life and mileage was displayed successfully, indicating that the fuel monitoring system works.

2.2 Controller Measurements

Controller Scoring Sheet		
Test	**Observed Result**	**Failure? (Y/N)**
Controller moves car forward and backwards	Both joysticks when pressed forward made the car go forwards. Both joysticks when pressed backwards made the car go back.	N
Controller switches between to different speeds and stop	When the joysticks are slightly moved forward or backwards, the car moves slower. When the joysticks are moved all the way forward or backwards, the car moves faster.	N
Controller can switch between two different cars	A toggle switch is able to switch between 2 separate cars successfully and see the controller controlling both of them	N
Controller can send inputs for left and right turns	When joysticks were inverse of each other, the car moved slightly left or right.	N
	Overall Result:	Successful

The controller of the car was successful in delivering the inputs needed for the car to move. The car had to ultimately do 4 directions which were forward, backwards, left, and right. The joystick was able to make the car go within all these directions and have adjustable speed which is only two. The toggle switches were able to successfully switch between the two cars. However, the toggle switches seem to be damaged so an order of new switches were placed to solve the issue. The next step is to successfully mount the LCD to the controller to display relevant information of the car.

2.3 Charging Station Measurements

Charging Station Scoring Sheet		
Test	**Observed Result**	**Failure? (Y/N)**
LiPo Charger “Good” light color should be green	The “Good” light turns green when the solar panel is connected to the chip.	N
LiPo Charger “Chg” light color should be red	The “Chg” light turns red when the LiPo battery is connected to the chip.	N
Multimeter measurement of the current of the charger output	When the multimeter is set up, the current measured should be 35mA	N
	Overall Result:	Successful

The test showed that the setup for the charging station successfully works. The “Good” and “Chg " LED lights of the LiPo battery charging chip turned to the colors they were supposed to, so that it shows the chip is working and there is a flow of electricity in the model.

For our first test plan, we came into a problem with an incorrect current. We measured a current of 0.0071mA, but that was not the current that was charging the LiPo battery. To get the actual current of the battery, we will need to have a resistor in series with the output and then measure the current.

For this second test plan, we successfully received the correct current that was charging the Lipo battery. We estimated the charging time needed to completely charge the battery is around 20 minutes.

3.0 Conclusions

3.1 Car Conclusion

The results of the test show that the prototypes of cars are working as intended, and that the car is capable of driving, turning, and displaying key battery information without issue. This indicates that the circuitry selected for each car's operation is working, and is proper for the final vehicles. This means that the circuits and hardware can be used for mass production. However, the car is not without flaws, as the car displayed some difficulty turning at the very beginning, and required additional weight applied to the back of the cars. So the electronics such as the microcontroller, control and transceiver chips, and motors are all functional and can be soldered directly onto the main breadboards for the final product. As for the body of the car, work must be done adding in weight and balancing the distribution on the prototypes, so that similar changes can be made to the final products to ensure that the car can turn properly.

The final steps for this part of the project is to create 4 more copies of the smaller car, adding in weight, and soldering all the components together. Once this is done, then the assembly of the cars is complete, and then the appearance of the car must be worked on. This entails creating a chassis, and making the entire car pleasant to look at.

3.2 Controller Conclusion

The results of the prototype testing were satisfactory because it accomplished everything that needed to be done. The controller is simple enough that any user can easily control the car. In addition, with the implementation of the switches, the controller is now able to control separate vehicles. Another thing the prototype showed was that the controller did not demonstrate portability which can be easily accomplished with a battery connected to the arduino. This is another thing that would be easily worked on. The last portion of the controller that needs to be complete is the visuals and successfully implementing the LCD which wouldn't be too hard. The only problem that needs to be solved is to make the transmitters and receivers to transmit at the same time which needs further research. For the visuals we just need to find a shell of a controller so it can be comfortable for the users.

3.3 Charging Station Conclusion

The results of the test show that the charging chip works and the solar lamp is sufficient in providing enough energy for the smaller battery on the vehicles to be recharged. Our model is supposed to display how a real charging station works at a smaller scale, so the current should be strong enough to charge the battery in a small amount of time.

Moving forward we will work on the alternative charging method for the second charging station. For this second charging station, we might have an induction charging method or DC to AC charging method. We also need to focus on the visual aspect of the station.

For the first prototype, we made a wood stand (shown in Figure 1) and just put the solar panel on top of that. For this second prototype, we made the stand in the kit made of cardboard (shown in Figure 2) and just put it on top of it. For the lamp, we designed a detachable area under the solar panels (shown in Figure 3) so the kit can be more portable. This section of the kit will be mainly for charging stations and our EVs can drive in to recharge the batteries.

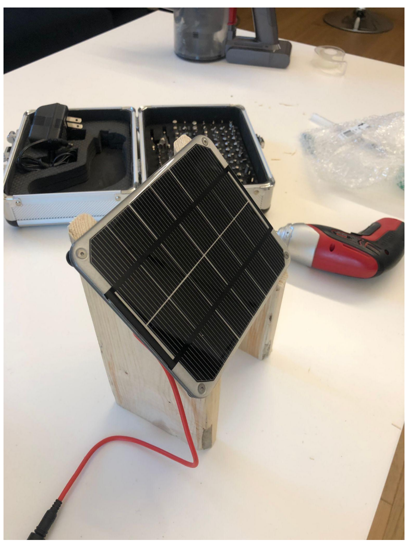

Figure. 1

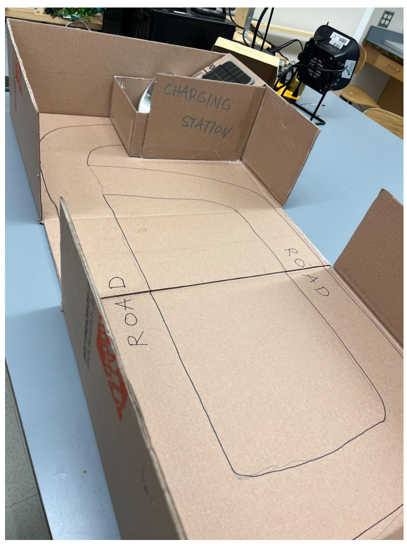

Figure.2

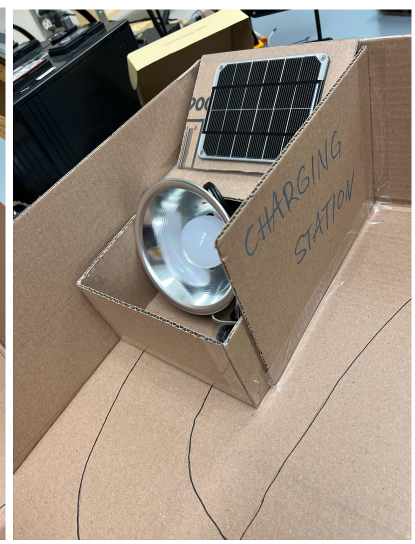

Figure.3