Senior Design
ENG EC 463

Memo

To: Professor Pisano
From: EV Builder Kit Team
Team: 18
Date: 11/21/21
Subject: Prototype Testing Report

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1.0 Summary of Equipment and Test Setup

1.1 Car Summary

On the car, there is a 3.7 volt lithium polymer(LiPo) battery which is used to power the vehicle. This battery is attached to a LiPo fuel gauge chip, which is able to take in a LiPo Battery connection. The fuel gauge chip has output pins which are fed directly to the Arduino Nano, as well as into a 5-Volt Voltage Booster. The direct feed to the Arduino Nano is for the purpose of measuring battery state, and displaying that state using LEDs, where the green LED is on if the charge is above 50%, the yellow LED is on if the charge is between 50% and 10%, and the red LED is on if the battery is below 10%. 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 an external controller to control the signals sent to the motor controller, and thus the motors from there.

To set up the test, first connect the 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.

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.

1.3.1 Charging Station Summary

For the charging station, an aluminum lamp with a hydroponic bulb is used to represent the sun, since our model will be indoors. 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 wooden stand 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 turn it 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

Car Scoring Sheet		
Test	**Observed Result**	**Failure? (Y/N)**
Driving Forward	Car drove forward with no issue	N
Driving Backwards	Car drove backwards with no issue	N
Turning Left	Turning left was initially shaky, however following a couple of cycles of the code stabilized	N
Turning Right	Turning right was also initially shaky but stabilized after cycles of the code. Car orientation did not change following a cycle of turning left and turning right which is desirable	N
Objects on Car Secure	The car never bumped into any objects while operating, however all components on the	N
LEDs Display Battery State	Car LEDs only displayed above 50% charge, as only the green LED was lit.	N
	Overall Result:	Successful

The tests show that the car is able to drive itself forwards and backwards without any major issue. While the process of turning was initially shaky, the car was able to turn its orientation left and right after a few cycles without any issue. Additionally the process of turning left and then right for the same amount of time resulted in the car facing the same direction as it was before it started turning, indicating that the effectiveness of . 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, and the Battery Display LEDs were always powered, indicating that the charge is being properly detected.

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 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. One weird event happened to the wireless controller where at a certain distance the car stopped listening to the controller, which happened at around 20ft. However, during the prototype testing, this error didn't happen at all. Furthermore, even though the car was able to do a turn, it was a bit inefficient. These are one of the areas that the controller should be improved on, so the turn radius of the car is improved.

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	We measured a current of 0.07mA, but the current that was measured was not the current going through the battery.	Y
	Overall Result:	Semi successful

The test showed that the setup for the charging station works, but we measured the wrong current. 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.

The problem with the test was that we did not measure the correct 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. Once we have this measurement we will be able to calculate how much time is needed to charge the battery and if the light bulb is a good choice for a charging source.

3.0 Conclusions

3.1 Car Conclusion

The results of the test show that the prototype is working as intended, and that the car is capable of driving, turning, and displaying key battery information without issue. However, the car is not without flaws. The car displayed difficulty turning at the very beginning, and required a couple of cycles of operation to settle into a smooth turning pattern. What is encouraging is that even when the car was struggling to turn, the rate at which the car turned in each direction was still the same, so the orientation of the car remained unchanged when driving forwards and backwards between cycles. So the electronics such as the microcontroller, control and transceiver chips, and motors are all functional, and the main thing to focus on now is the body that they will be powering.

The next steps forward for this part of the project is to improve the body of the car, and downsize. The main reason why the car was struggling to turn was tied to the body of the car, instead of the motors or electronics itself. The axles for the free spinning wheels were not well aligned, and the way the motors were attached made the motors angle themselves relative to the body. This made the wheels misaligned, which caused the turning difficulties. At the same time, the car body was made of a 7” by 3” by ¾” wood block to accommodate the electronics. The next step would be to move the electronics off the breadboard, and create a mounting system so that they can be stacked onto eachother, instead of being laid out flat. This would allow for a smaller car body, which would decrease the weight, and increase the car's mobility as well.

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. Now that these basic essential functions have been met, we can work on the more specific components such as a switch to change the different channels to control different cars. 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. Lastly, the aesthetic aspect of the controller should be worked on. However, this can be worked on in the second semester since it isn’t as big of a priority compared to the other functions. Overall, the controller in the functionality can be considered to be completed.

3.3 Charging Station Conclusion

The results of the test show that the charging chip works, but we are still not sure if the lamp will be sufficient in providing enough energy for the battery to be recharged. We need to measure the correct current to be able to calculate the total time needed to charge a battery and if it will be enough for the model. 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 get this calculation and decide if using the hydroponic light bulb is the right choice. If it is not the right choice, then we will have to talk to the client about not using the solar panel but using a plug on the wall. We also need to focus on the visual aspect of the station.

For the first prototype we made a wood stand (shown below) and just put the solar panel on top of that. The next step will be making sure the wire of the solar panel is not sticking out where someone could grab it. The lamp post will also need to be altered because it was just a wooden block. The lamp should be more stable and visually appealing.

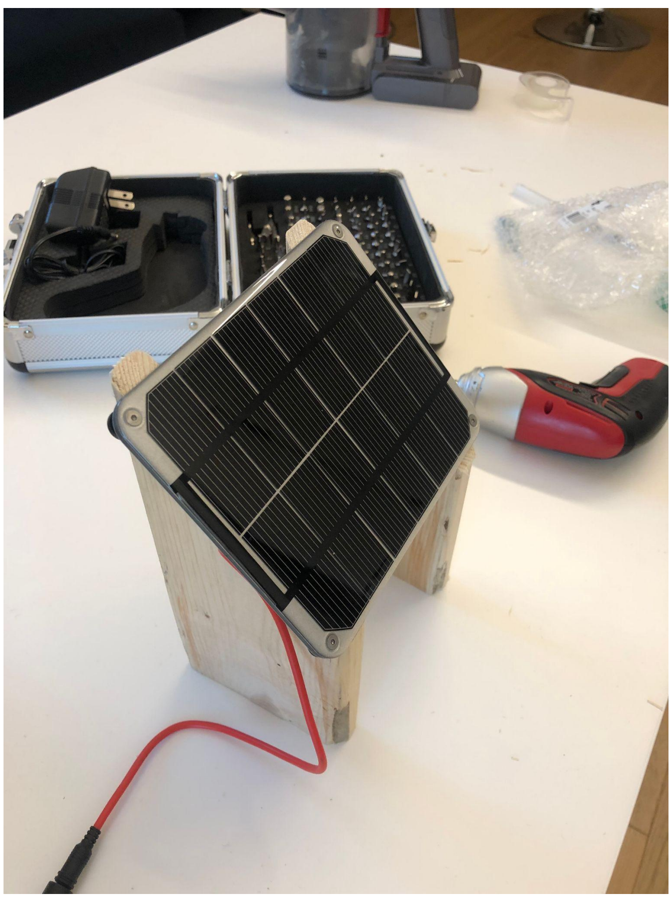

Figure. 1