Memo

To: Professor Pisano
From: EV Builder Kit Team
Team: 18
Date: 03/31/22
Subject: Final Testing Plan

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1.0 Required Materials

1.1 Car Materials

Hardware Materials for the Heavy Duty Car

- Solderable Half Breadboard (2)
- Elegoo Nano (1)
- 3.7 Volt 500 mAH Lithium Polymer Battery (1)
- Dual H-Bridge Motor Controller (1)
- NRF24L01 Transceiver Chip (1)
- Adafruit LC709203F LiPoly Fuel Gauge (1)
- 5-Volt Voltage Booster Chip (1)
- N20 DC Motors and Mounts (2)
- Lego Cross Wheels (2)
- Standard Plastic 40mm Wheels (2)
- MDF Board
- PCB Screws
- 7 Gram Weights
- 22 AWG Wire of Assorted Colors and Wire Wrap

Hardware Materials for each Light Duty Car

- Solderable Half Breadboards (2)
- Elegoo Nano (1)
- 3.7 Volt 500mAH Lithium Polymer Battery (1)
- Dual H-Bridge Motor Controller (1)
- NRF24L01 Transceiver Chip (1)
- Adafruit LC709203F LiPoly Fuel Gauge (1)
- 5-Volt Voltage Booster Chip (1)
- Pololu Plastic Motors and Mount(2)
- Pololu 32mm Plastic Wheels (2)
- Eudax Plastic Wheels (2)
- MDF Board (1)
- PCB Screws
- 7 Gram Weights
- 22 AWG Wire of Assorted Colors and Wire Wrap

Software Materials

- Arduino Script
    - Read inputs from the controller and use that to drive forwards, backwards and turn.
    - Read inputs from the fuel gauge chip, and send battery data via transceiver to display on the controller.

1.2 Controller Materials

Hardware Materials for both Controllers

- Joysticks (2)
- Breadboard (2)
- Arduino UNO (1)
- Arduino Nano (1)
- NRF24L01 Transmitter Chip (2)
- 20x4 LCD with I2C Module (2)
- Toggle Switches
- 22 AWG Wire of Assorted Colors and Wire Wrap

Software Materials

- Arduino Script
    - Code to get the input from both joysticks.
    - Send the inputs from the controllers through a 3-bit message sent to the Car
    - Interpret inputs and convert to mileage and battery life

1.3 Charging Station Materials

Hardware Materials

- Cardboard Stand (1)
- 6V 2W Solar Panel (1)
- 5.5’ Aluminum Reflector Lamp (1)
- 9W Hydroponic Bulb (1)
- Wood Light Stand (1)
- Li-Po Battery Charging Circuit Chip (1)
- 3.7 Volt Lithium Polymer (LiPo) Battery (1)
- Digital Multimeter (1)
- Industrial cardboards

2.0 Testing Setup and Explanation

2.1 Introduction

The tests can be split up into three categories: testing the cars, testing the controllers, and testing the charging station. The cars act as the main body of interest for all three of these tests, as they are set up with motors, transceivers, and a battery. This allows the car to interact with the charging station and controller, and produce visible outputs from the test directly.

Car:

On each 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, sending that data to the transceiver, so that it can be displayed properly on the Controller's LCD display. 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. Additionally the Nano will also use the transceiver to send the battery data to display on the controllers.

Controller:

On the controller, there are 2 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 an 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. Furthermore, the controller will have a toggle switch you use to switch between which car you want to control. There is an LCD attached to the controller displaying the miles and battery life of the car being driven.

Charging Station:

For the solar charging station, an aluminum lamp with a hydroponic bulb is used. This is as 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. Additionally a DC adapter and a USB-C cable can also interface with this chip to provide power as well.

2.2 Car Pre-Testing Setup

1. Connect the assorted Nanos to a computer with the correct addressed code loaded onto it
2. Upload the code from the computer to the Arduino Nano
3. Disconnect the computer from the Arduino Nano
4. Clear out an area on the ground for the car to operate on
5. Repeat steps 1-4 with each car.

2.3 Controller Pre-Testing Setup

1. Connect the Controller Microcontrollers to the computer for power.
2. Upload the code onto the Arduinos of each controller
3. Toggle the switches to select the initial cars for use.

2.4 Charging Station Pre-Testing Setup

1. Solar lamp is stored in the kit for portable use
2. Take the solar lamp out and clamp it on the side of the kit
3. The kit wall is able to hold the weight of the lamp
4. Turn the lamp towards the solar panel.
5. Plug the DC Adapter into the wall outlet, and fit the correct DC jack.
6. Connect the USB-C Cable to the USB Power Supply

3.0 Testing Procedure

3.1 Car and Controller Test Procedure

1. Place the car onto the cleared out area on the ground.
2. Switch on the power switch.
3. Test that left joystick controls the front left wheel
4. Test that right joystick controls the front right wheel
5. Test that the cars are properly sending battery data to the controller, and is being displayed

3.2 Charging Station Test Procedure

1. Connect the cars to the Solar Charging station.
2. Turn on the Solar Lamp
3. Disconnect the Solar Charging station, and plug in the DC adapter
4. Disconnect the DC adapter and plug in the USB-C Cable.
5. Verify that the LEDs on the charging chip have lit up in each case.

4.0 Measurable Criteria

4.1 Car Testing Criteria

1. Each Car must be capable of driving forwards
2. Each Car must be capable of driving backwards
3. Each Car must be capable of turning left
4. Each Car must be capable of turning right
5. The Components on each car must not fall off during operation.

<u>If any of criteria 1-5 fail to be met, then the test is considered to be a failure.</u>

4.2 Controller Testing Criteria

1. Joysticks must detect forwards and backwards inputs
2. Joysticks must be able to cause the car to turn left and right
3. Controller must be able to switch between both cars
4. When no inputs are sent, cars should stop
5. LCD shows the miles and battery level

4.2 Charging Station Testing Criteria

1. The " GOOD" green light of the LiPo battery charger should be on when it is connected to any power supply.
2. The "CHG" red light should be on when the LiPo battery charger is connected to a LiPo battery that is not fully charged.

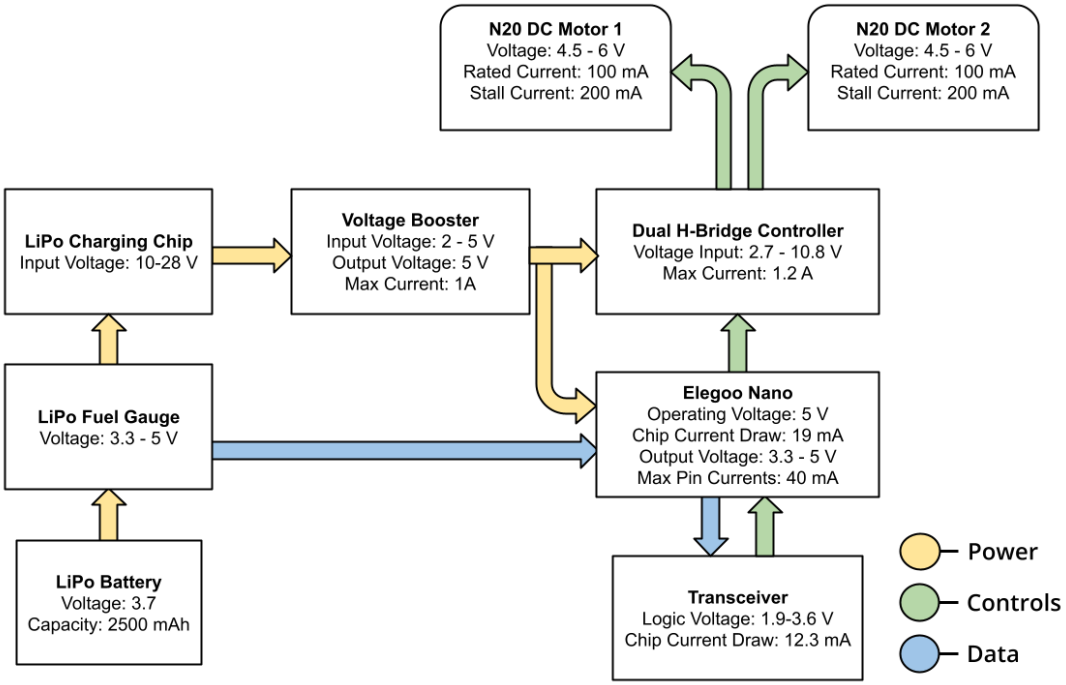
5.0 Scoring Sheets

5.1 Car Scoring Sheet			
Test	**Observed Result for HDV**	**Observed Results for LDVs 1-5**	**Failure? (Y/N)**
Driving Forward			
Driving Backwards			
Turning Left			
Turning Right			
Objects on Car Secure			
		Overall Result:	

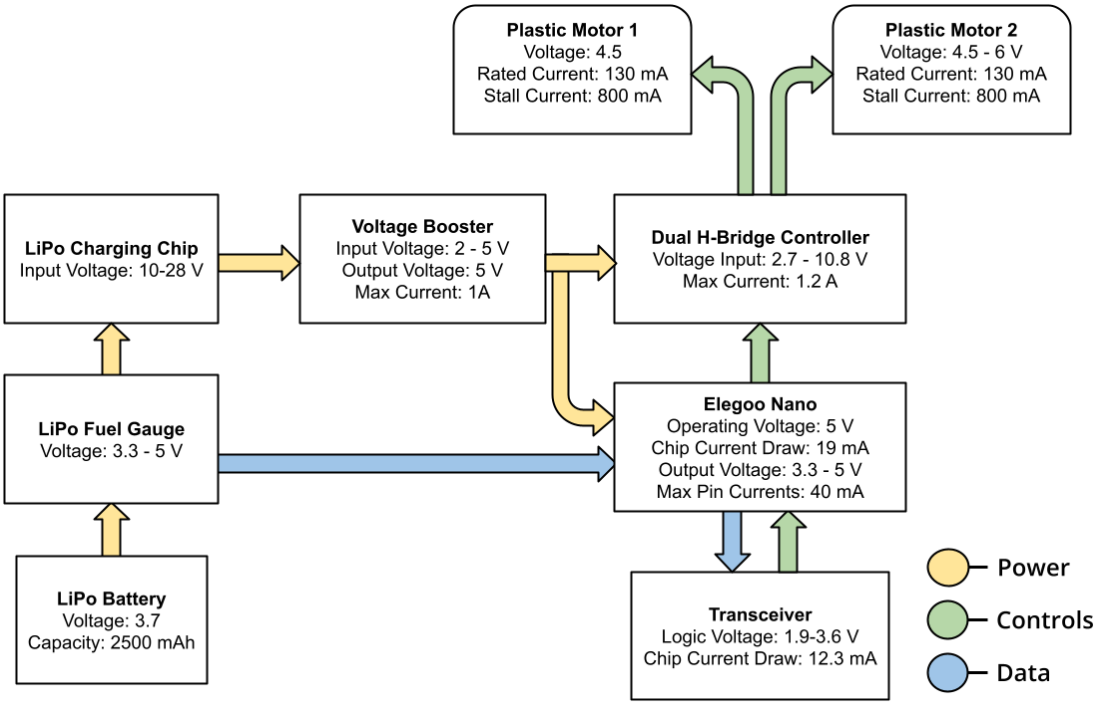
5.2 Controller Scoring Sheet			
Test	**Controller 1**	**Controller 2**	**Failure? (Y/N)**
Controller moves car forward and backwards			
Controller can send inputs for left and right turns			
Controller can switch between the two cars			
When controller untouched, cars should stop			
LCD is displaying the miles and battery life			
		Overall Result:	

5.3 Charging Station Scoring Sheet				
Test	**Solar**	**DC Adaptor**	**USB-C**	**Failure? (Y/N)**
LiPo Charger “Good” light color should be green				
LiPo Charger “Chg” light color should be red				
			Overall Result:	

A.1 Circuit Diagram Abstraction of Heavy Duty Vehicle



A.2 Circuit Diagram Abstraction of Light Duty Vehicle



A.3 Solar Panel Charging Station Test Set-Up