Memo

To: Professor Pisano

From: EV Builder Kit Team

Team: 18

Date: 03/01/22

Subject: Prototype Testing Plan

Table of Contents

1.0 Required Materials

1.1 Car Materials

Hardware Materials for Car 1

- Full Breadboard (1)
- Arduino 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)
- Wood Plank (1)
- LCD Display
- 22 AWG Wire of Assorted Colors
- Heat Shrink Tubing

Hardware Materials for Car 2

- Proto Breadboard (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)
- Standard Plastic 40mm Wheels (2)
- MDF Board (1)
- 22 AWG Wire of Assorted Colors

Software Materials

- Arduino Script
    - Cycle through various motor states to autonomously drive forward, backward, and turn left and right.
    - Read inputs from the fuel gauge chip, and send data via transceiver to display on the controller.

1.2 Controller Materials

Hardware Materials

- Joysticks (2)
- Breadboard (2)
- Arduino UNO (1)
- Arduino Nano (1)
- NRF24L01 Transmitter Chip (1)
- Assorted Dupont Wires
- Toggle Switches
- LCD Display

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

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.

Note: For this prototype the LCDs are not on the controller, as we ran into a little issue with transmitting and receiving at the same time. So one car will have an LCD attached to display battery state

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.

Charging Station:

For the 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. For this prototype, the main proof of concept is to show that using a lamp to power the solar panel is viable.

2.2 Car Pre-Testing Setup

1. Connect the Arduino Nano to a computer with the autonomous 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 the car that is operating using the Elegoo Nano.

2.3 Controller Pre-Testing Setup

1. Connect the Arduino Nano on the car to computer
2. Upload the code onto the Arduino Nano
3. Disconnect the Nano and place the car on ground
4. Connect the Controllers Arduino Uno to the computer for power.
5. Upload the code onto the Arduino Uno

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, and turn it on
5. Connect the solar panel to the LiPo battery charger
6. Connect the charger to the LiPo battery
7. Set up the multimeter, set it to 6m amps to test the current

3.0 Testing Procedure

3.1 Car Test Procedure

1. Place the car onto the cleared out area on the ground.
2. Plug the LiPo Battery on the car in.
3. Press reset on the Arduino Nano.
4. The code on the Arduino will now begin cycling through the different states, causing the car to drive forward, backwards, and turn left and right.
5. Repeat this for the Car with the Elegoo Nano.

3.2 Controller Test Procedure

1. Test that left joystick controls the front left wheel
2. Test that right joystick controls the front right wheel

3.3 Charging Station Test Procedure

1. Connect the car battery to the charging station
2. Verify that the LEDs on the charging chip have lit up
3. Put the black test probe of the multimeter on the negative load out source and the red test probe to the positive load out source
4. Measure the voltage readings from the multimeter
5. Measure the current readings from the multimeter

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 Car with the LCD must display the battery level
6. 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 shift between two different speeds and be able to stop
3. Joysticks must be able to cause the car to turn left and right
4. Controller must be able to control both cars
5. Controller must be able to switch between both cars

4.2 Charging Station Testing Criteria

1. The " GOOD" green light of the LiPo battery charger should be on when it is connected to the solar panel
2. The "CHG" red light should be on when the LiPo battery charger is connected to the LiPo battery
3. When the multimeter is set up, the current measured should be 35mA

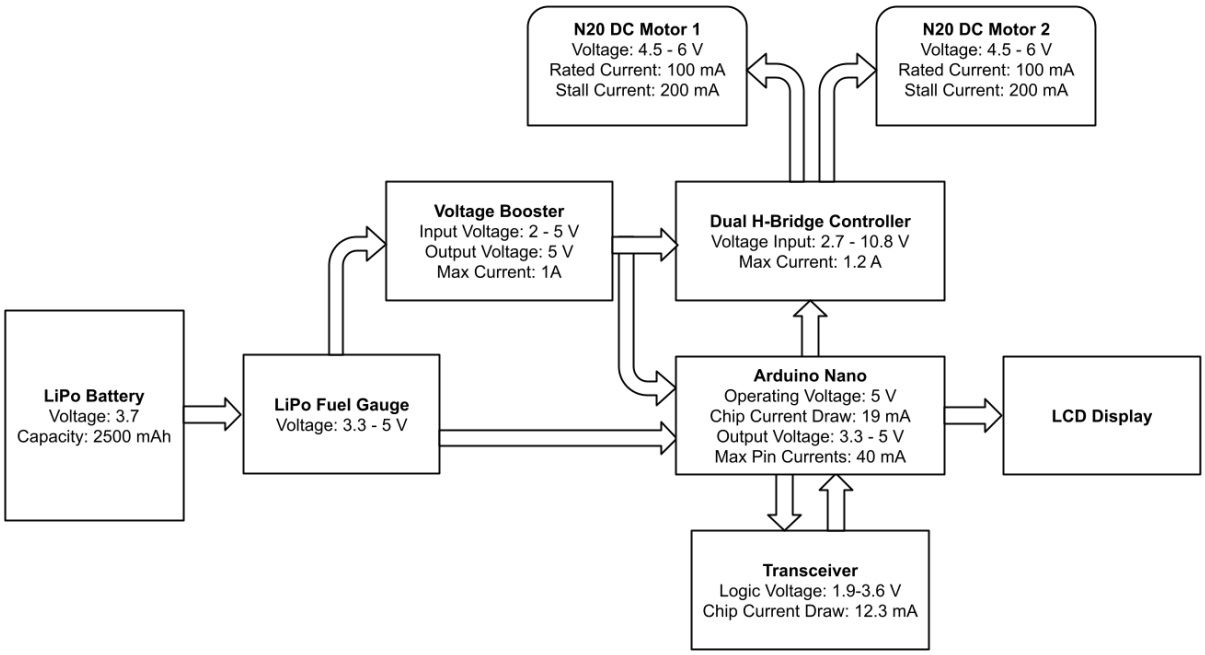
5.0 Scoring Sheets

5.1 Car Scoring Sheet			
Test	**Observed Result for Car 1**	**Observed Results for Car 2**	**Failure? (Y/N)**
Driving Forward			
Driving Backwards			
Turning Left			
Turning Right			
Objects on Car Secure			
LCD Display Battery State		N/A	
		Overall Result:	

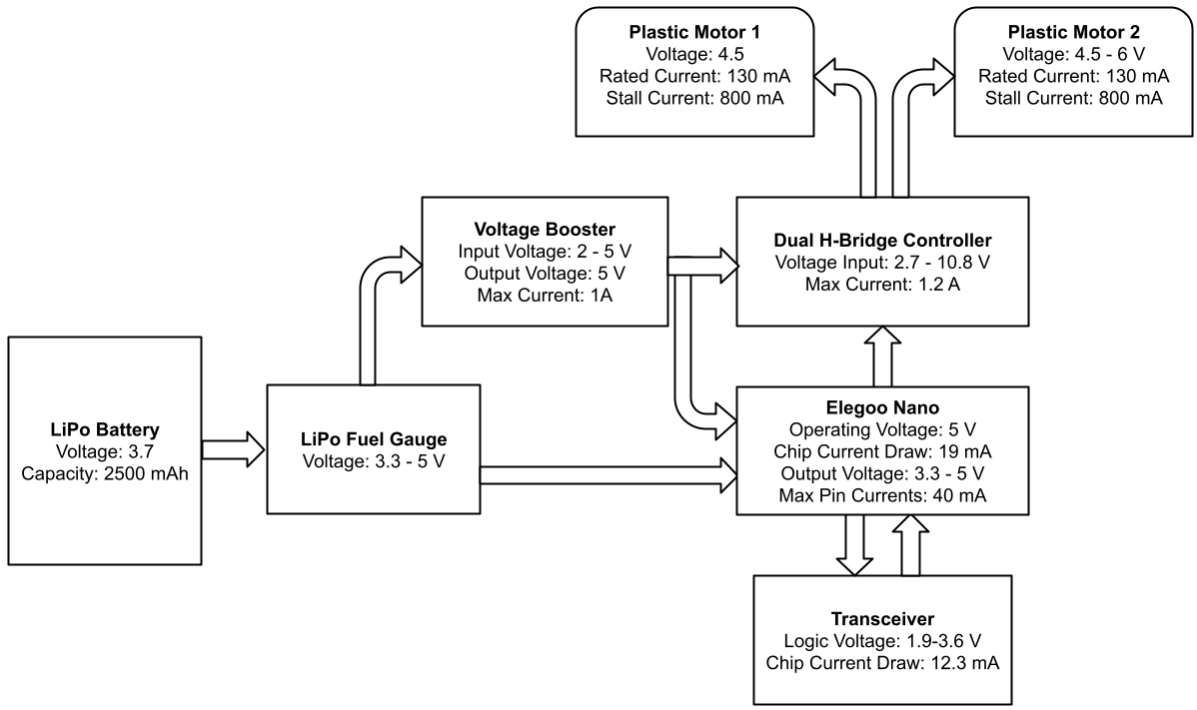
5.2 Controller Scoring Sheet		
Test	**Observed Result**	**Failure? (Y/N)**
Controller moves car forward and backwards		
Controller switches between to different speeds and stop		
Controller can send inputs for left and right turns		
Controller can switch between the two cars		
	Overall Result:	

5.3 Charging Station Scoring Sheet		
Test	**Observed Result**	**Failure? (Y/N)**
LiPo Charger “Good” light color should be green		
LiPo Charger “Chg” light color should be red		
Multimeter measurement of the current of the charger output		
	Overall Result:	

A.1 Circuit Diagram Abstraction of Arduino Nano Car



A.2 Circuit Diagram Abstraction of Elegoo Nano Car



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A.3 Charging Station Test Set-Up