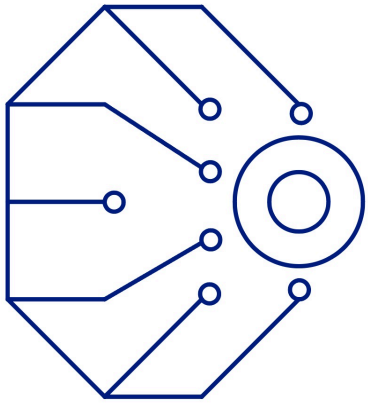
Boston University
Electrical & Computer Engineering
EC463 Senior Design Project

Final Prototype Testing Plan



NeuroToys

by

Team 9
NeuroToys

Team Members

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Required Materials

Hardware:

- ESP-WROOM-32 with Onboard LED, Breakout Board
- L298N Motor Driver
- 18650 3.7V Battery (2)
- 2S 18650 Battery Holder
- Muse 2 Non-invasive EEG headset and USB charger
- Personal computer with relevant project files installed
- Assembled RC car

Software:

- Python
    - Acquires EEG headset connection
    - Processes and classifies brainwave data
    - Bluetooth interface between EEG and ESP32, sending command signals
- C
    - Pre-uploaded to ESP32 to accept commands via Bluetooth

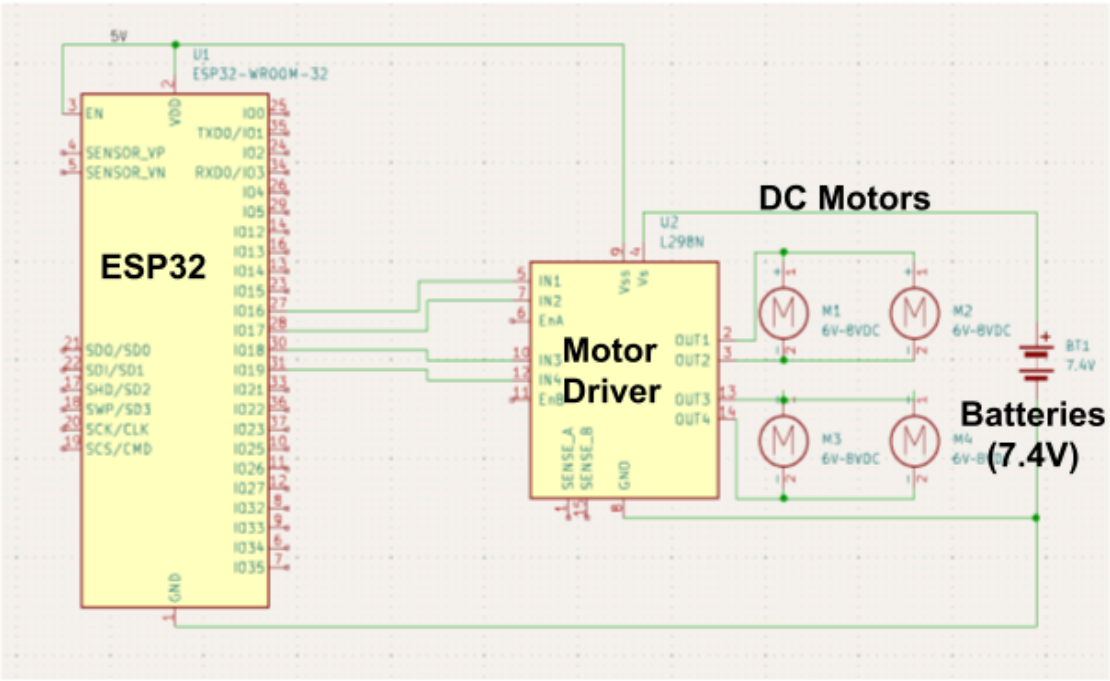
Set Up Summary

There are three primary components to our system: the Muse 2 EEG headpiece, a computer which runs the Python interface, and the ESP32. The headpiece transmits raw brain voltage data (μV). The Python interface processes this signal by performing a Fourier Transform to isolate the beta frequency band from the EEG data, which is associated with focus. The beta power is then calculated (expressed in μV^2), representing the user's focus level. A threshold is established to determine whether a command should be sent to the ESP32, which then controls the forward movement of the toy car. A similar signal processing technique is used for right and left control, where the AF7 and AF8 electrodes on either side of the forehead go through a band pass filter separately to isolate the gamma frequency band from the raw EEG data. Peak

detection algorithms are then used to classify between right and left eye blinks, which in turn send the right and left turn commands to the car.

Figure 1: Control flow diagram

Figure 2: RC car circuit including pinouts



Pre-testing Setup Procedure

1. Make sure the headgear is fully charged, muse repository is downloaded, and all packages are installed
2. Supply power to the toy via on/off switch
3. Turn on headset
4. On Terminal, run: `python main_gui.py` to open the Neurotoys application
5. Turn the headset on and place it along the middle of your forehead with the rubber ear sensors resting behind your ears. The earpieces should sit behind your ears like a pair of

glasses. Adjust both sides simultaneously to tighten it back up for a snug fit that feels comfortable.

6. Wait for connection to be established to begin testing procedure, ensuring plots are accurately displaying blinks and focus levels

Testing Procedure (Per User)

1. User sits comfortably in front of the path with the EEG headset on and calibrated.
2. Begin the trial. The user completes one full loop around the designated path using mental focus (beta band) to move forward and eye blinks (gamma band from AF7/AF8) to steer.
3. After completing the full loop, repeat the path in reverse direction with the same controls.
4. A second team member observes and records any deviations from the path (veering off course, incorrect turns, unresponsive commands).
5. Repeat the above steps for three distinct users.

Measurable Criteria

User 1	**# Path deviation Incidents**
Forward	
Reverse	

User 2	**# Path deviation Incidents**
Forward	
Reverse	

User 3	**# Path deviation Incidents**
Forward	
Reverse	