



# neurowarn

Enhancing Safety in EEG-Controlled  
Wheelchairs with an RNN-Based  
Warning System

**user manual**



**Billones • Andaya • Enarle • Nillos • Yanson**

WVSU - CICT - Computer Science



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Warning System

An Undergraduate Thesis  
Presented to the Faculty of the

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West Visayas State University  
La Paz, Iloilo City

In Partial Fulfillment  
of the Requirements for the Degree  
Bachelor of Science in Computer Science

by

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## **Disclaimer**

This software project and its corresponding documentation entitled "***NeuroWarn BCI: Enhancing Safety in EEG-Controlled Wheelchairs with an RNN-Based Warning System***" is submitted to the College of Information and Communications Technology, West Visayas State University, in partial fulfillment of the requirements for the degree, Bachelor of Science in Computer Science. It is the product of our own work, except where otherwise acknowledged.

This project is intended for academic and research purposes only and is not intended to be used for clinical or diagnostic purposes. The accuracy of the results produced by the NeuroWarn BCI system has not yet been fully validated and should not be relied upon for medical decision making or autonomous mobility solutions without proper supervision.

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\*Last Updated: May 2025\*



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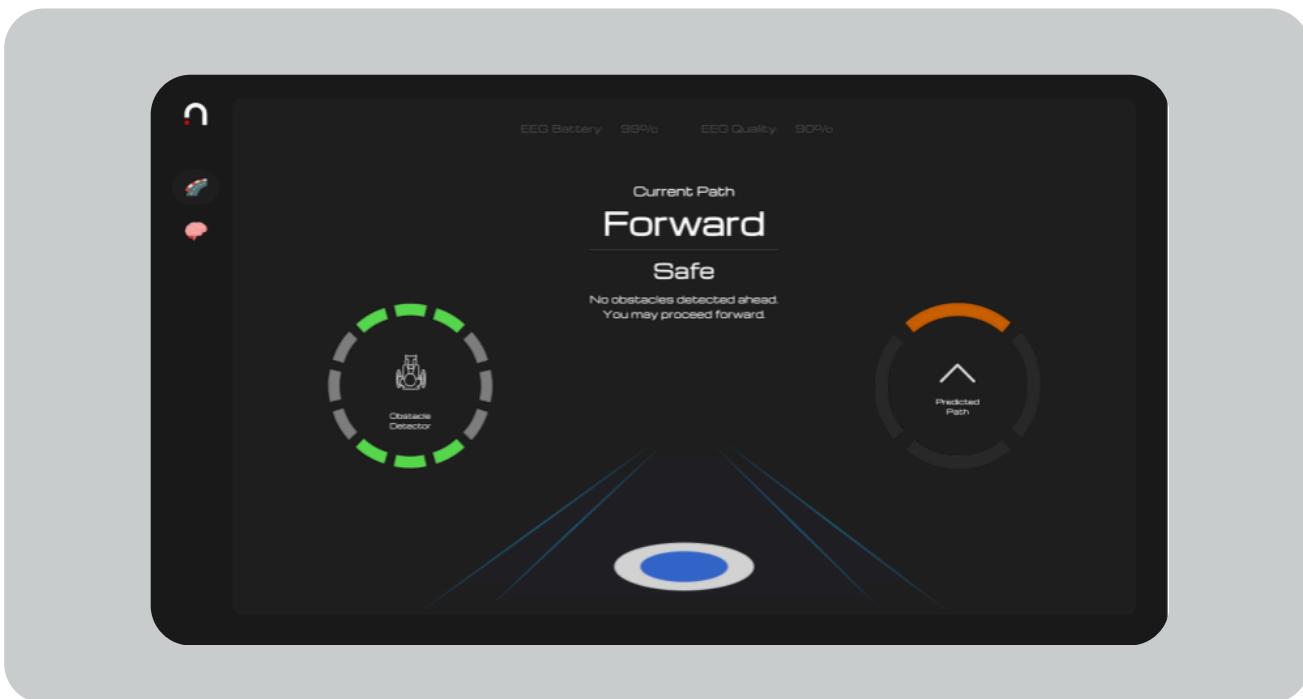
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## Getting Started

### Introduction

NeuroWarn BCI is a safety enhancement system for EEG-controlled wheelchairs that uses a Recurrent Neural Network (RNN) to predict potential hazards and provide warnings to users. The system integrates brain-computer interface technology with obstacle detection sensors to create a safer mobility experience for users with severe motor disabilities.



This user manual provides comprehensive guidance on setting up, configuring, and operating the NeuroWarn BCI system. Whether you are a user, caregiver, or technical support personnel, this guide contains all the information needed to effectively utilize the system's capabilities.

**More about Neurowarn here:**

[neurowarn.vercel.app](https://neurowarn.vercel.app)





## user manual

### System Requirements

	frontend	backend
OS	Any OS with a web browser	Any OS that runs Python
CPU	Basic processor	Basic modern processor
RAM	Minimum 2GB	Minimum 4GB
DISK	1GB free	5GB Free
INTERNET	Not Required	Needed for setup only

### Hardware Requirements:

EEG Headset	Emotiv Insight or any compatible with 5+ channels
Microcontroller	Arduino +
Sensors	2x LIDAR distance sensors
Smart Wheelchair	Any Smart Wheelchair with 2V wheelchair battery with voltage regulator
Connectivity	USB ports (minimum 1)

If interested in buying the module package, Contact Us for the **Access Assist** Module





## Hardware Setup

The Neurowarn BCI system consists of two main hardware components:

- The EEG Headset
- The Smart Wheelchair

This manual will guide you through setting up both components for proper use.

### Part One: EEG Headset Setup

This system utilizes the Emotiv Insight, a 5-channel EEG headset. However, it is compatible with any Emotiv headset model.

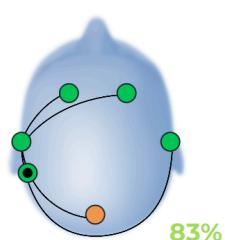
#### **What You Need:**

- A laptop with the Emotiv software installed
- An Emotiv headset (preferably Emotiv Insight)



#### **Setup Instructions:**

1. Attach the rear arm to the headset.
2. Attach the sensors to the headset.
3. Turn on the device by pressing the power button.
4. The headset will enter pairing mode. Open the Emotiv app and pair the device.
  - o (Refer to the Software Setup section for details on app installation and pairing.)
5. Correctly position the headset:
  - o Ensure the reference sensors make contact with the skin behind each ear. Gently adjust the arms if needed.
  - o Frontal sensors should sit above each eye, around three finger-widths above the eyebrows.
  - o If needed, re-moisten the sensor pads with the rehydration solution for better signal quality.
6. Once connected, the app will take you to the Mental Commands Dashboard — this means the headset is successfully set up.



***EEG Quality on different channels***



## Part Two: Smart Wheelchair Setup

This system uses a standard electric wheelchair, modified with custom modules to enable smart functionality. There are two major modules:

- The **Control** Module – for movement control
- The **Sensor** Module – for environmental sensing

### What You Need:

- An electric wheelchair
- Control module
- Sensor module
- A laptop with the Neurowarn BCI software installed



### Setup Instructions:

#### Control System:

1. Disconnect the original joystick/controller of the electric wheelchair.
2. Connect the control module to the motors and the battery.
3. Link the control module to your laptop via USB or serial connection.
4. Turn on the control system using the dedicated power switch.

#### Sensor Module:

1. Attach the sensor module securely to the wheelchair frame.
2. Place the LiDAR sensor at the front and the ultrasonic sensor at the rear.
3. Connect the sensor module to the laptop.

### Final Step

After setting up both the EEG headset and smart wheelchair, you may now proceed to run the **Neurowarn BCI software**.

*Refer to the [Software Installation](#) section for instructions on running the program and performing initial tests.*

**Interested in getting the all in one package  
(control and sensor module)?**

Contact us at:  
[enarlem10@gmail.com](mailto:enarlem10@gmail.com)





## Software Installation

### Pre-requisites

- Before setting up the NeuroWarn BCI backend, ensure you have the following prerequisites installed on your system:

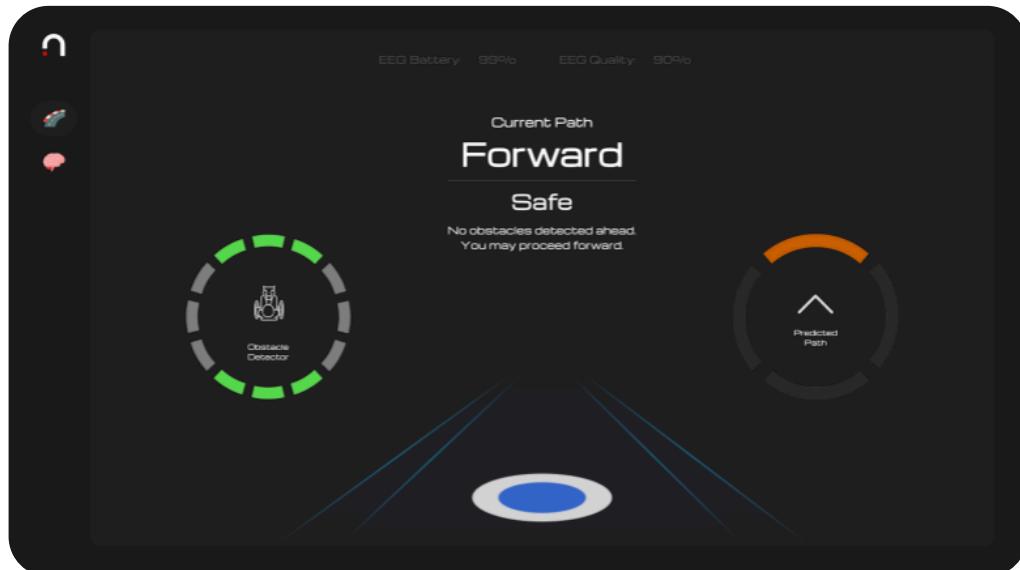


### 1. Installation: Frontend

- Open any CLI to clone the repository and run the following commands:

```
# Clone the repository  
git clone https://github.com/mattenarle10/neurowarn.git  
cd neurowarn/src/frontend  
  
# Install dependencies  
npm install  
  
# Start development server  
npm run dev
```

- Navigate to the localhost:3000, Where you can now see the app's interface





## 2. Installation: Backend

- Whilst the frontend is running on localhost:3000 open another terminal in the same directory and go to the backend in order to start the python app locally:

```
# Clone the repository  
git clone https://github.com/mattenarle10/neurowarn.git  
cd neurowarn/src/backend
```

```
# Windows  
python -m venv .venv  
.venv\Scripts\activate
```

```
# macOS/Linux  
python3 -m venv .venv  
source .venv/bin/activate
```

```
# Install required Python packages  
pip install -r requirements.txt
```

```
# Make sure your virtual environment is activated  
# Windows: .venv\Scripts\activate  
# macOS/Linux: source .venv/bin/activate
```

```
# Go to the backend's neurowarn directory  
cd neurowarn/src/backend/neurowarn
```

```
# Start the main program  
python wheelchair_drive.py
```



## Usage

### ⚙️ Setting Up Your System

#### 1. Turn on your wheelchair

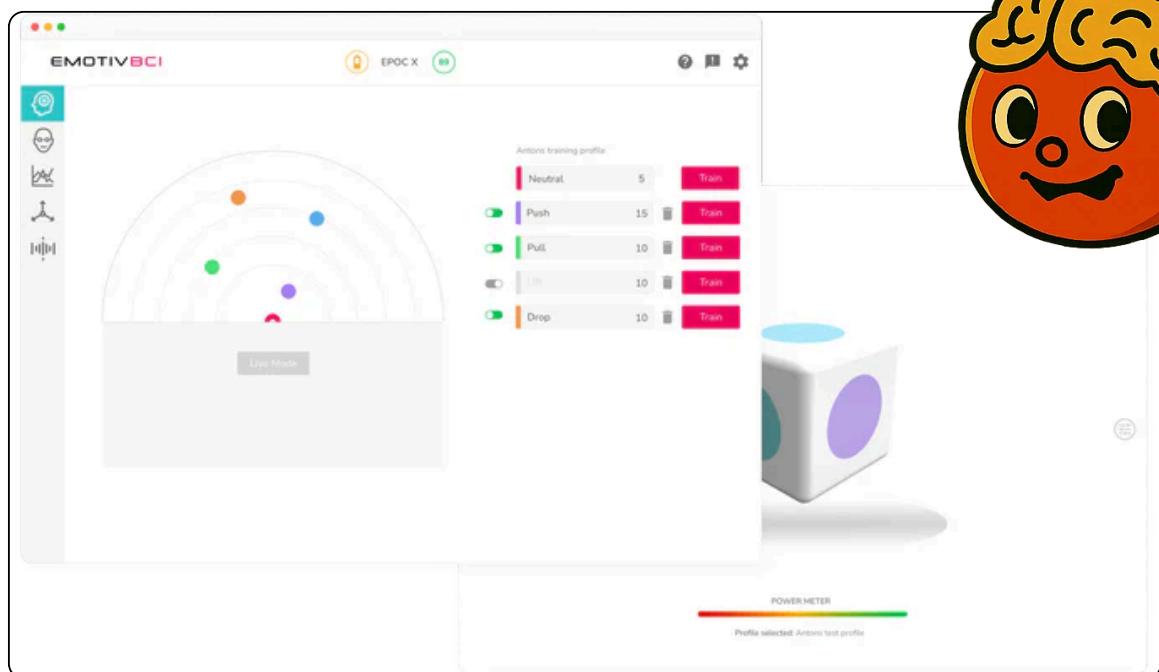
- Press the power button on the side of the wheelchair and wait for the startup sound (a single beep).

#### 2. Put on your headset

- Ensure the sensors are slightly damp, then place the headset on your head with the front sensors above your eyebrows. Make sure the sensors behind your ears touch your skin.

#### 3. Start the software – Refer to the *Software Installation* guide

### 🧠 Training Your Mental Commands



#### 1. Access the training mode

- Click the "Training" button on the main screen to see options for different commands to train.

#### 2. Train your neutral state

- Select "Neutral" from the list.
- Relax your mind completely. Avoid thinking about movement.
- Hold this state for 8 seconds while the progress bar fills.
- Repeat 2-3 times for better results.



### 3. Train your forward command

- Imagine pushing an object away from you and visualize the wheelchair moving forward. Hold this thought for 8 seconds and repeat 2-3 times.

### 4. Test your commands

- Click "Test Commands" on the screen and try each mental command. The system will display which command it detects. Retrain if accuracy is below 70%.

### 4. Save your profile

- Click "Save Profile," give it a memorable name, and save your brain patterns for future use.



## Using Neurowarn



### Basic Controls

- **To move forward**
  - Think about pushing something forward. The wheelchair will move
  - The screen will show "Forward" as your current path.
- **To stop**
  - Relax your mind (neutral thought).
  - The wheelchair will gradually slow to a stop.
- **To turn left or right**
  - Tilt your head slightly in the direction you want to go.
  - The wheelchair will begin turning.
  - The screen will show "Turning Left" or "Turning Right."



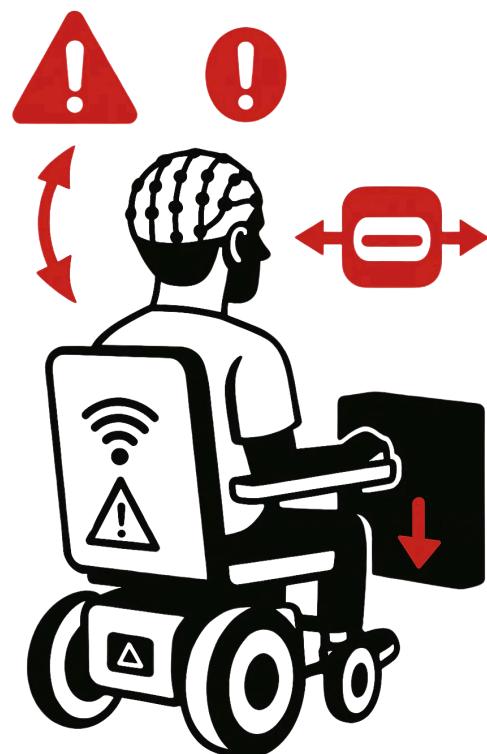
## Safety Features

- **Obstacle Detection**

- If something is in your path, the wheelchair will stop automatically.
- You'll hear a warning sound and The screen will show "**Not Safe!**"

- **Changing Direction After Stopping**

- When stopped by an obstacle, think about going in a different direction.
- Tilt your head left or right to choose a new path.
- Once the path is clear, think "**Forward**" again to continue moving.



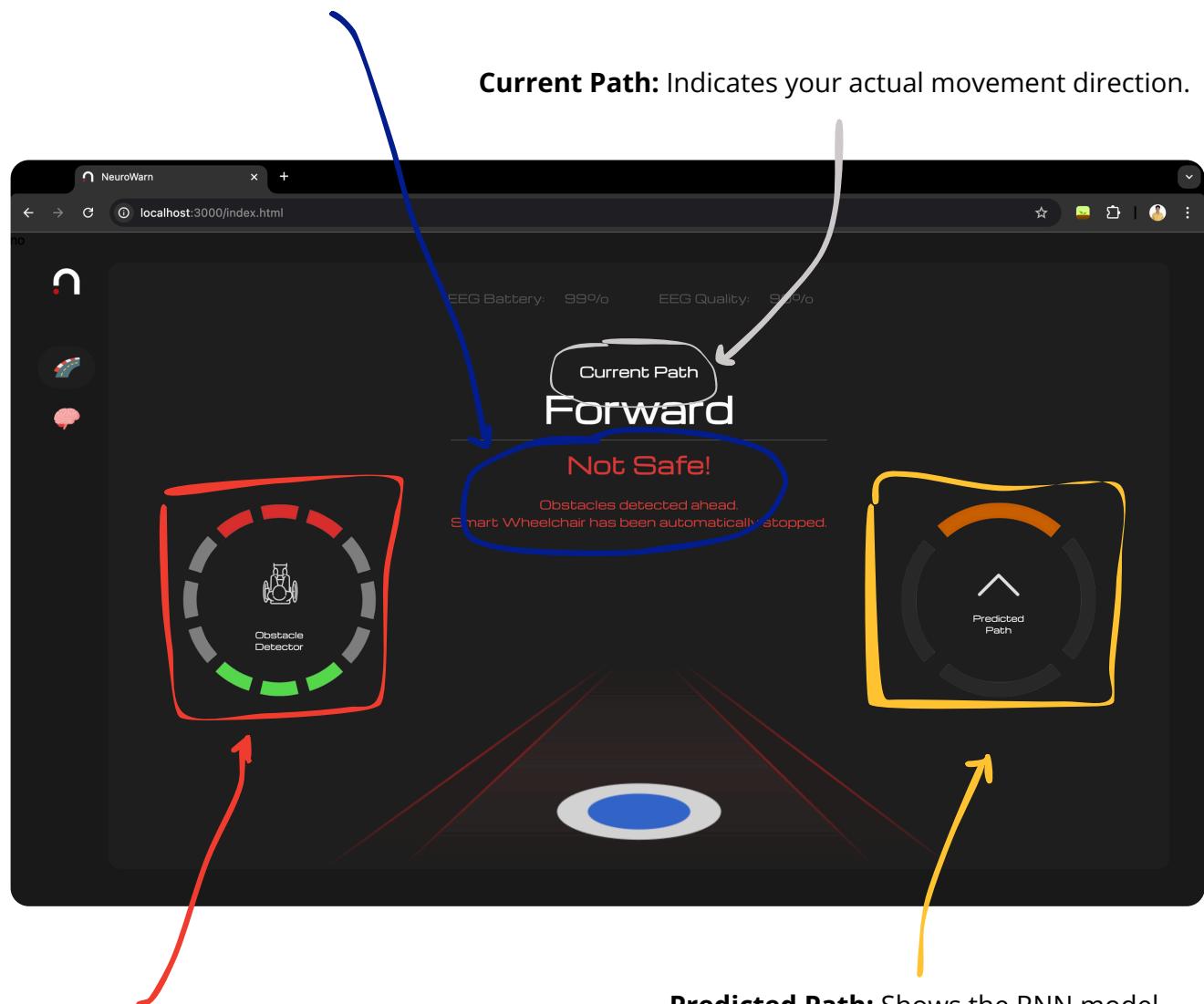
### **Tips for Success**

- **Practice in an open area first:** Get comfortable with the controls before navigating tight spaces. Practice stopping and starting until it feels natural.
- **Keep your thoughts clear and consistent:** Focus on one command at a time, holding the same thought until the wheelchair responds. Use the same mental imagery as during training.
- **Improve your mental command accuracy:** Train in a quiet environment with minimal distractions. Use vivid, consistent mental imagery, and retrain commands if accuracy decreases over time.
- **If the wheelchair isn't responding:** Check your headset position, ensure the sensors are making good contact, and verify the signal quality is good.
- **For better turns:** Combine head tilting with your forward thought. Use small, subtle head movements—no need to tilt too far.



### Understanding the Dashboard 🖥️

**Safety Status:** Indicates whether it is safe to move in your current direction.



**Obstacle Detector:** Displays objects around your wheelchair (green = clear, red = blocked).

**Predicted Path:** Shows the RNN model prediction of your intended direction

### ⚡ Shutting Down

- Make sure to stop the wheelchair completely, Close the app on your laptop. Turn off the wheelchair using the power button. Most Importantly, remove and charge your headset.



## Troubleshooting

For any bugs and issues encountered in the application or the hardware, Please consider the following approach/solutions:

### E01 : "Failed to start LiveAdvance" error

**Cause:** Connection to Emotiv service failed or credentials issue.

**Solution:**

- 1.Verify your app\_client\_id and app\_client\_secret in wheelchair\_drive.py.
- 2.Ensure Emotiv software (EMOTIV App) is installed and running.
- 3.Check your internet connection as authentication requires online validation.

### E02: Mental Commands Not Being Recognized Consistently

**Cause:** Insufficient training or profile mismatch.

**Solution:**

- 1.Train your mental commands more thoroughly in the Emotiv software.
- 2.Ensure you're using the same profile name that you trained with.
- 3.Try to maintain consistent mental focus when using commands.

### E03: "Failed to connect to Arduino. Error: could not open port X"

**Cause:** Arduino not connected or incorrect port specified

**Solution:**

- 1.Make sure Arduino is connected via USB
- 2.Check for correct port in Device Manager (Windows) or run (macOS)  
a.ls /dev/tty.\*
- 3.Ensure no other program (like Arduino IDE) is using the port
- 4.Try unplugging and reconnecting the Arduino

### E04: "Invalid JSON" errors in the console

**Cause:** Communication protocol issues between Arduino and Python

**Solution:**

- 1.Check Arduino code for proper JSON formatting
- 2.Verify serial baud rate matches (115200) in both Arduino and Python code
- 3.Restart both the Arduino and the Python script



## E05: LIDAR sensors showing constant 0 or extreme values

**Cause:** Sensor connection or calibration issues

**Solution:**

1. Check physical connections to VL53L0X sensors
2. Verify I2C addresses are correctly set in Arduino code
3. Make sure sensors aren't blocked or covered

## E06: System crashes after running for a while

**Cause:** Memory leaks, resource exhaustion, or hardware disconnection

**Solution:**

1. Check for disconnections in the headset or Arduino
2. Monitor CPU and memory usage while running
3. Try running components separately to isolate the issue
4. Update all Python packages and Arduino libraries

## 🛠 Having Other Problems? Try These Simple Fixes!

- Close everything and start fresh! Turn off the Emotiv software, close your Python program, and restart the Arduino. Sometimes this is all you need!
- Make sure all cables are firmly plugged in, your headset is making good contact with your head, and all Arduino wires are secure
- Check if your computer is running too many programs. Close unnecessary apps to free up resources.
- Delete your temporary profiles and retrain your mental commands from scratch. Sometimes a fresh training session works wonders!

### SOS Still Stuck? Let's Get You Help!

- Visit our help center:  
<https://github.com/mattenarle10/neurowarn/issues>
  - Click the green "New Issue" button
  - Give your problem a short, clear title (Example: "Wheelchair stops responding after 5 minutes")
- Our friendly team usually responds within 1-3 days to help solve your problem!





## FAQs (Frequently Asked Questions)



### EEG Headset Issues

#### **Q: My Emotiv headset isn't connecting to the software. What should I do?**

**A:** First, ensure the headset is charged and powered on. Check that Bluetooth is enabled on your computer. Make sure you've installed Emotiv software and created an account. If problems persist, try restarting both the headset and your computer, or try a different USB port for the dongle.

#### **Q: My Emotiv headset isn't connecting to the software. What should I do?**

**A:** Check the electrode contact quality in the Emotiv software. Poor contact quality (orange or red indicators) will prevent proper signal detection. Try readjusting the headset, moistening the sensors slightly, or ensuring there's no hair between the sensors and your scalp.

#### **Q: Do I need to create my own mental commands profile or use an existing one?**

**A:** You'll need to enter a profile name when starting the system. If you're using this for the first time, we recommend creating a new profile in the Emotiv software first and training your mental commands (push, pull) before using NeuroWarn.



### Hardware and Connection Issues

#### **Q: My LIDAR sensors aren't providing readings. What's wrong?**

**A:** Check the serial output for errors. Ensure the LIDAR sensors are properly connected to the Arduino and that the Arduino code is correctly uploaded. The serial monitor should show readings from LIDAR1 and LIDAR2 if properly connected.

#### **Q: The wheelchair isn't responding to commands. What should I check?**

**A:** First, verify the Arduino is properly connected and the correct port is selected. Check that the motors are powered. Verify connections between the Arduino and motor controllers. Look for any error messages in the Python terminal. Make sure the EEG headset is correctly transmitting commands.



## FAQs (Frequently Asked Questions)

### Software Setup and Operation

**Q: I'm getting "ModuleNotFoundError" when running the system. How do I fix it?**

**A:** This usually happens when required Python packages aren't installed. Make sure you've activated your virtual environment and visit the Software Installation: Backend of the User Manual.

**Q: What mental commands control the wheelchair?**

**A:** Based on the code, the system recognizes:

- "push" thought command moves the wheelchair forward
- "pull" thought command moves the wheelchair backward
- Head tilting left/right (detected via motion sensors) steers the wheelchair
- When there is no command or when an obstacle is detected, the wheelchair stops

### Dashboard and Monitoring

**Q: The web dashboard isn't showing any data. What's wrong?**

**A:** Make sure the frontend server is running and connected to the same network as the backend. Check that the WebSocket connection is established. The default connection is to 'ws://localhost:3000'. If running on different machines, you may need to update the WebSocket URL to the correct IP address.

**Q: How can I customize what data appears on the dashboard?**

**A:** The current logic on the dashboard is configured to respond on the current path and the predicted path of the user, also the activity and the data being sent by the sensors and the RNN model. Customizing the data may include risks of portraying the wrong info to the user thus, you are required to (proceed with safety) and customize depending on what your needs are.



## The Team behind Neurowarn



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Software Package

<https://github.com/mattenarle10/neurowarn>



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