EMG Workshop w/ IEEE pt. 2

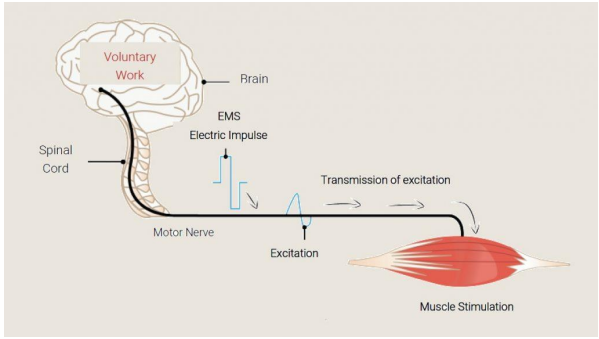
Neurotech

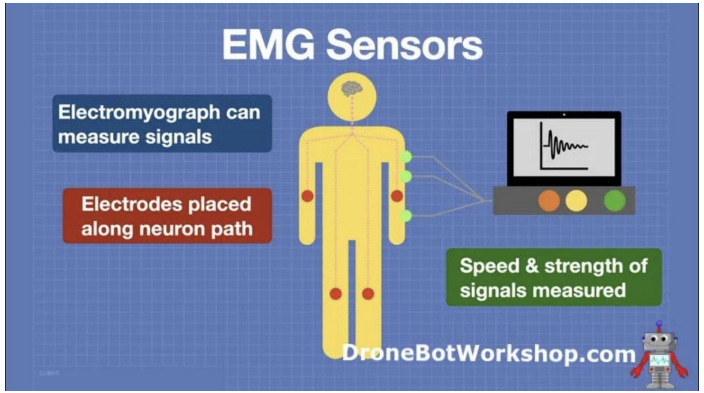
Computational NeuroSCience Society

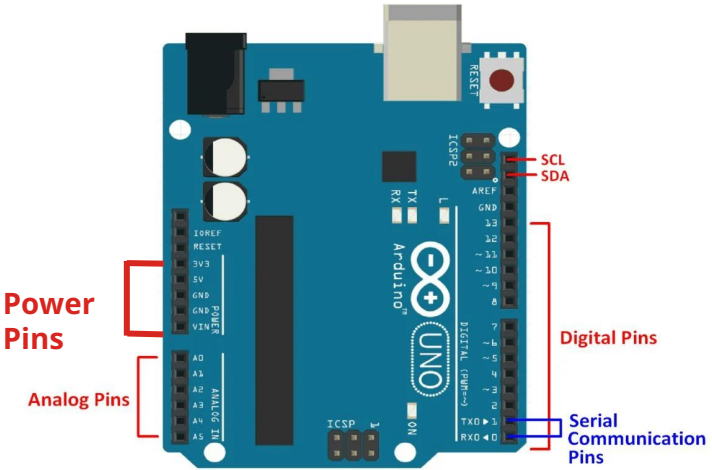
IEEE

Recap: (first meeting)

- Motor Neurons
- What is EMG?
- Circuit basics (voltage as a vector, etc.)
- Arduino pins/chip pins (A0, GND, V+, V-)







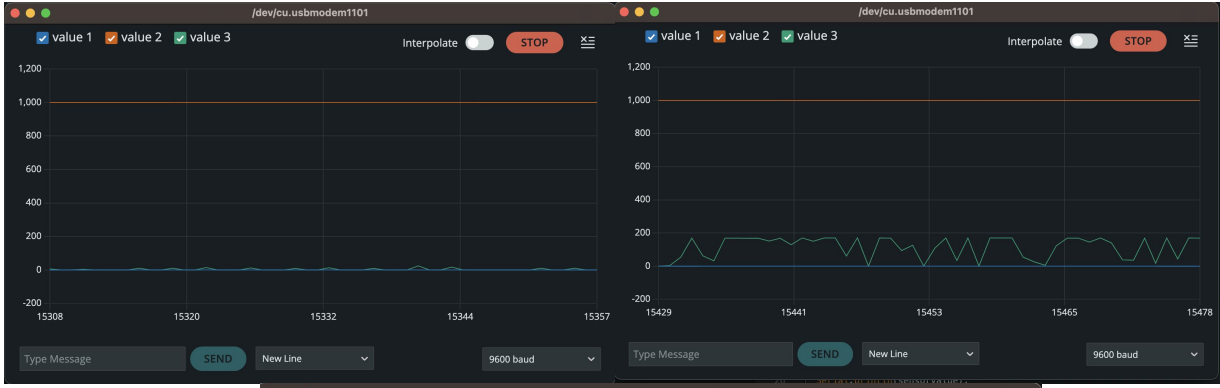
Before we begin:

It works!

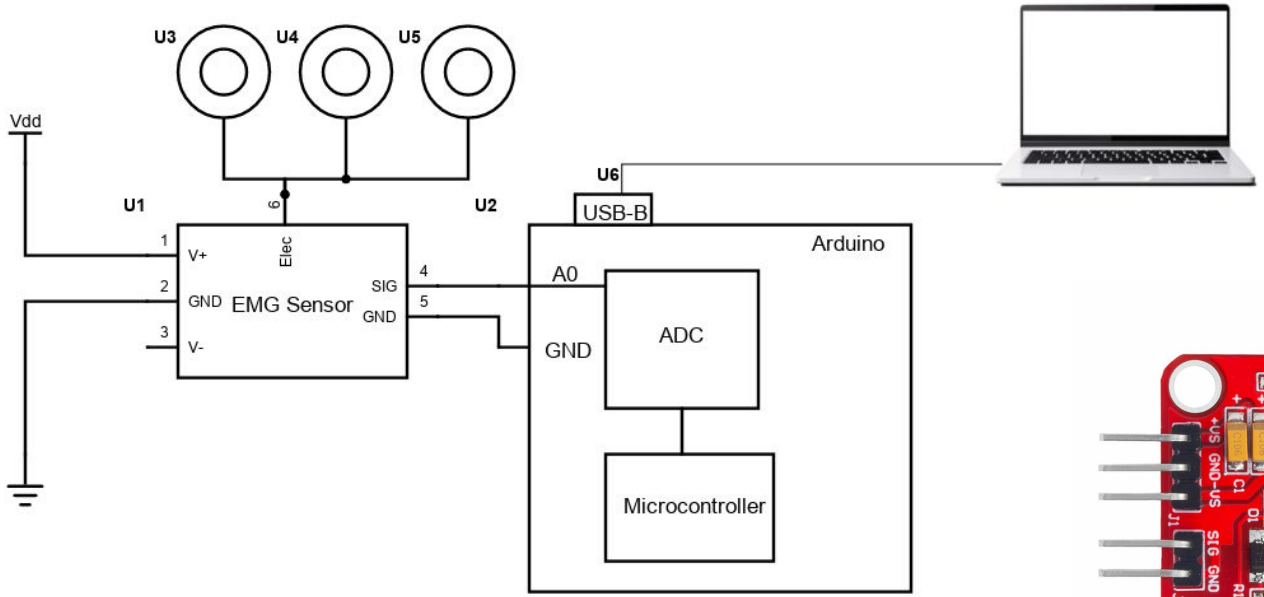
However,

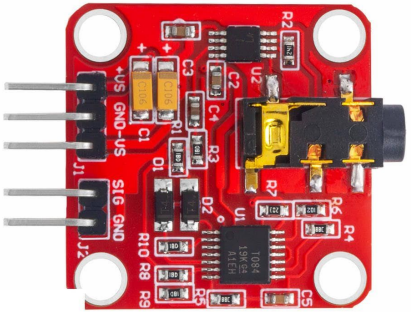
Buy cheap, get cheap results

So not perfect results or methods



Hardware





Schematic of EMG Circuit

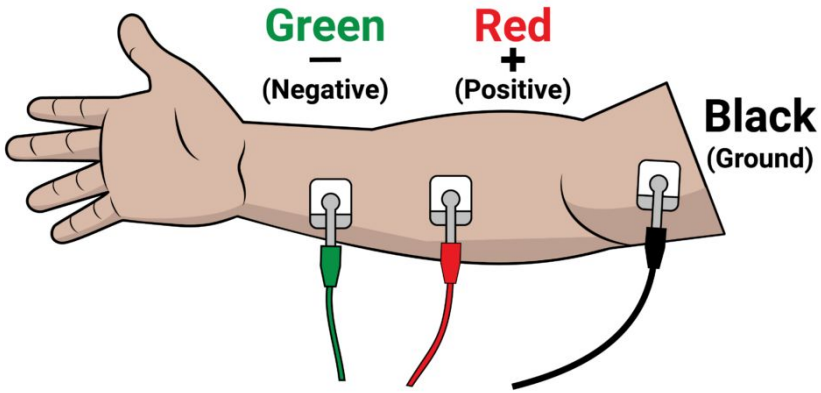
Hardware Setup

1. Connect the arduino to your laptop using the USB-A to USB-B cable. If required, use a USB-C to USB-A adapter.
2. Wire the EMG sensor to the arduino **GND** and **A0** pins. Use M-F jumper wires.
3. Connect the EMG sensor to the power supply via the breadboard. Use M-F jumper wires. (Be sure to use V-/V+)
4. Connect the electrodes to the EMG sensor.
5. Start up the Arduino IDE and connect to the Arduino board.
6. Attach the electrodes to the muscle. One for ground and two to measure the potential difference.
7. Put your code in the IDE and upload it to the Arduino.
8. Open the serial monitor or serial plotter to visualize the sensor readings.

Electrode Placement

3 electrodes:

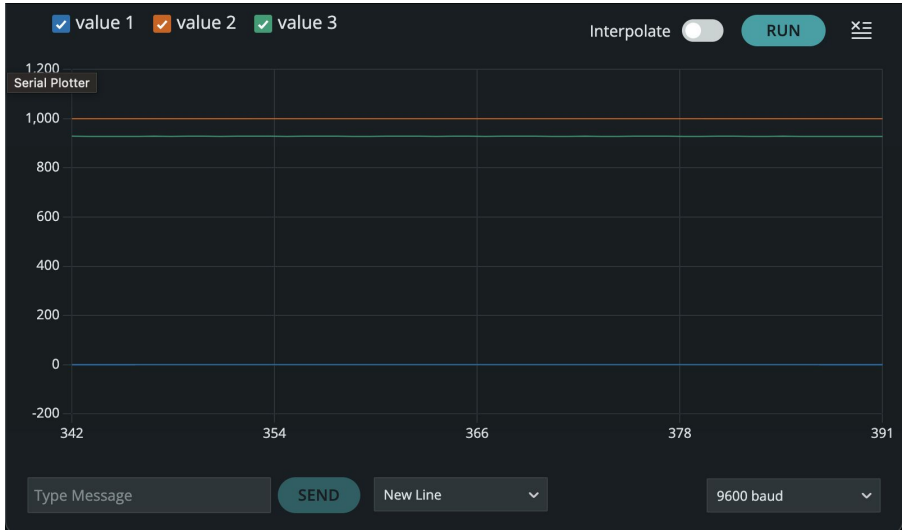
- 1 GND (Yellow)
  - Boney part of the body
    - As a reference to muscle voltage
- 2 on muscle pathway for potential difference (Red/Green)*
  - Forearm muscle
  - Bicep brachii
    - Green in front of red



*Ensure same muscle for both electrodes

Output - Define Limits

- In order to view the measured output of the sensor, we need to view the info in a set point of reference.
- Do this by defining two constant Serial values, 1 and 2.

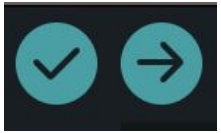


Code - Define Limits

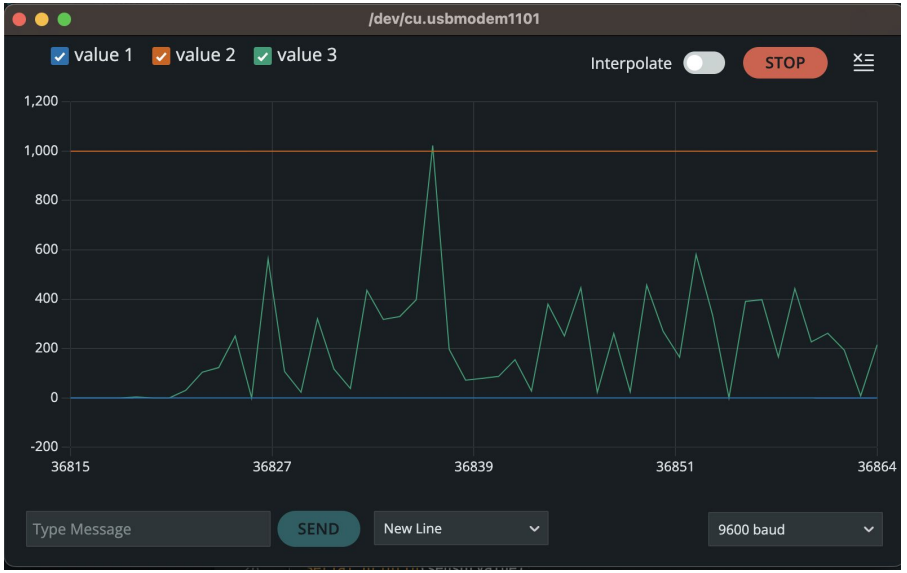
- Add two bounds:
  - One lower
  - One upper
- Use the “Serial.print(#)” function
  - Creates constant “limit” on serial monitor
- Change the numbers according to your data
  - Anywhere between 300-900 range

```
// Add "fake" plots to stabilize Y axis
Serial.print(0); // To freeze the lower limit
Serial.print(" ");
Serial.print(1000); // To freeze the upper limit
Serial.print(" ");
```

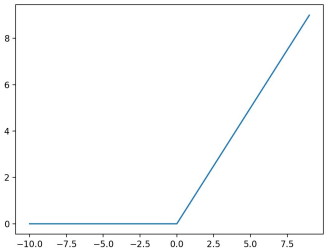
Output:



- After pressing run, open serial plotter or monitor
- Before flexing muscle, let the sensor sit to adjust to the voltage of the muscle.
  - It won't be exactly stable (due to noise)



Refining Signal



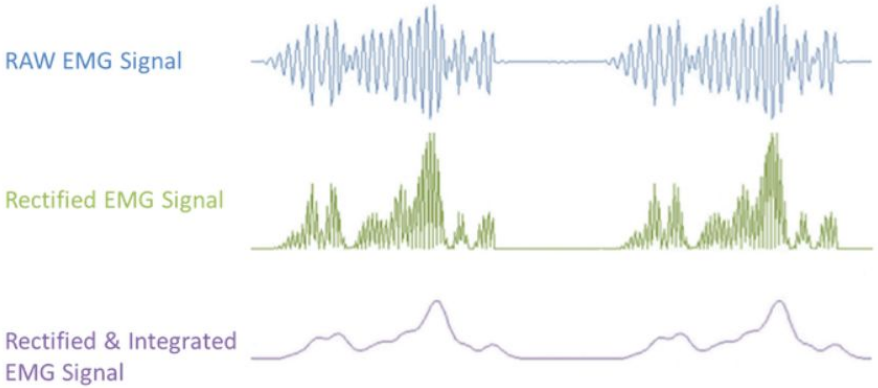
Rectified EMG signal:

- Applied ReLU (ramp function)
  - Holds positives, converts negative to 0
  - Remove negative polarity to simplify data

Integration

- Envelope Detection
  - Calculates areas under rectified curve
  - Captures general trend/energy content

Varies by application

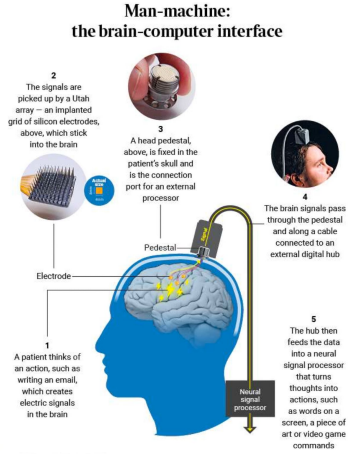


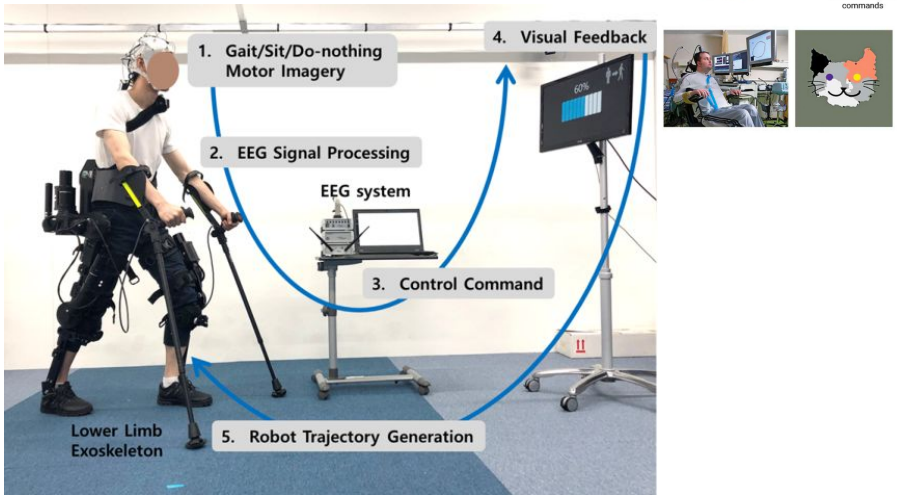
So What?

- Numbers on a graph are only interesting for so long

Neurotechnology Applications

- Emerging neurotechnologies rely on the principles performed today, just more complex
  - Locate Signal
  - Record
  - Read/visualize data in an coherent way
  - Use data to manipulate external system
- Technologies including:
  - BCI
    - Communication, limb/muscle control, everyday interaction, etc.
  - EEG
    - Understanding brain waves (Neurbale and focus state)





Need for Diverse Studies within Neurotechnology

- **Electrical Engineers:**
  - Circuitry design, transferring electrical signal from body into computer data, etc.
- **Biomedical Engineers/Neuroscientists:**
  - Understanding of nervous system to implement technologies in an effective/safe manner
- **Data/Computer Scientists:**
  - Extract and decode data in a readable manner to use with external systems like prosthetics
- **And Others!**