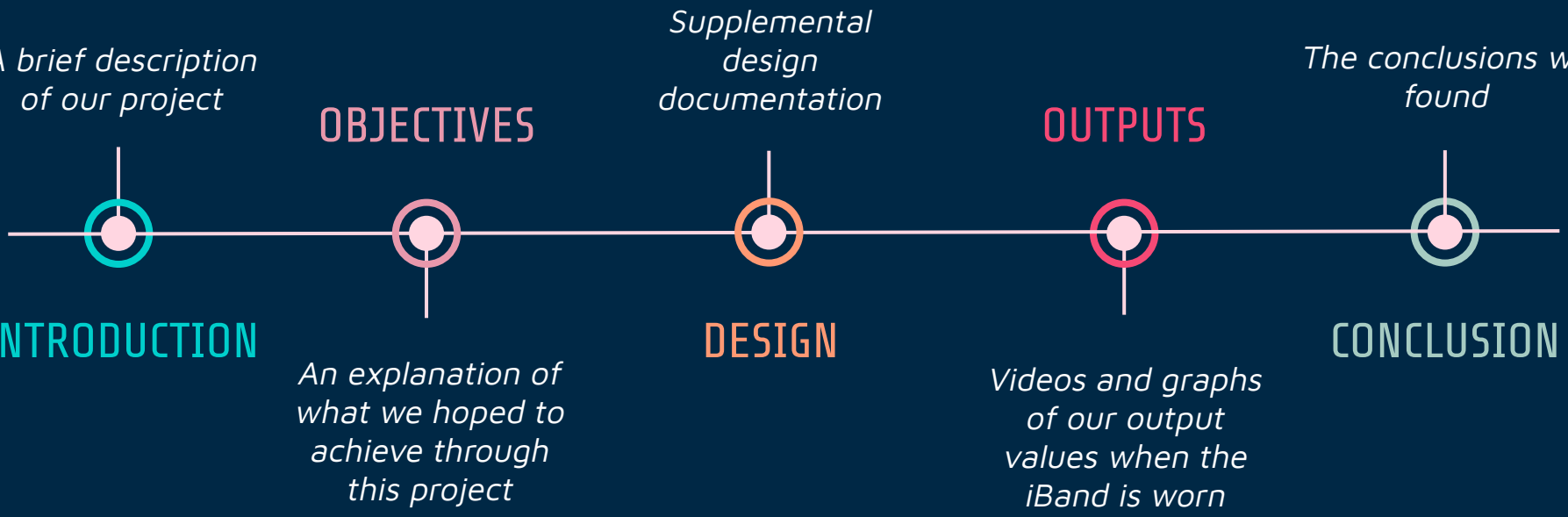
ECE 445: iBand

Saaniya Kapur, Rutu Brahmbhatt, Panav Munshi
Team 34


A brief description of our project
INTRODUCTION
OBJECTIVES
An explanation of what we hoped to achieve through this project
Supplemental design documentation
DESIGN
OUTPUTS
Videos and graphs of our output values when the iBand is worn
The conclusions we found
CONCLUSION

Introduction

01

Problem Statement

- Surface electromyography (sEMG) is a non-invasive computer based technique that utilizes electrodes placed on an user's forearm to record electrical impulses produced by the nerve's simulation of the skeletal muscle.

- Products that leverage the information provided through sEMG signals for rehabilitation, educational, and recreational purposes already exist in the market today.

However, these devices are unable to withstand continuous use, do not provide the user with an ability to understand the data being collected and are expensive – ranging from thousands of dollars with the cheapest option being discontinued.

Objectives

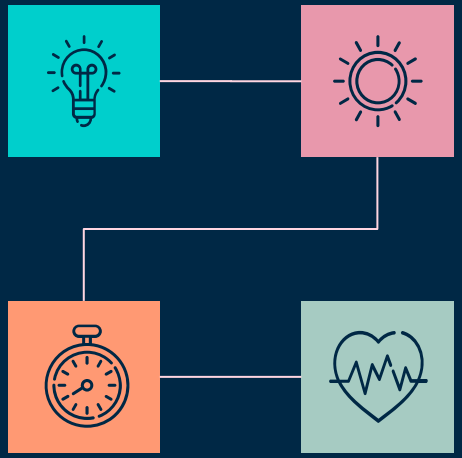
02

sEMG Sensor

Measures the electrical impulses that muscle groups make when contracted

GSR Sensor

Measures the skin's conductivity which is directly related to the presence of perspiration



IMU Sensor

Measures the angular and linear acceleration of the object it is placed on

Pulse Sensor

Measures heart rate through the use of infrared light

Solution

Our solution to increase public accessibility and understanding of sEMG devices is to create an **inexpensive**, **durable**, and **portable** replacement to the now discontinued Myo Armband.

This will be done through :

Six sEMG sensors coupled with medical grade electrodes

One Galvanic Skin Response Sensor (GSR)

One Inertial Measurement Unit (IMU)

One Pulse Sensor

High Level Requirements

Sensing and Size

between **22 cm and 44 cm**

have the ability to change circumference without the relative position between sensors changing

Compact Size

new design must be smaller and more compact than the current design **(14.8cm wide x 14.5cm long x 1cm tall)**

PCB must be less than 10 cm

Data Collection

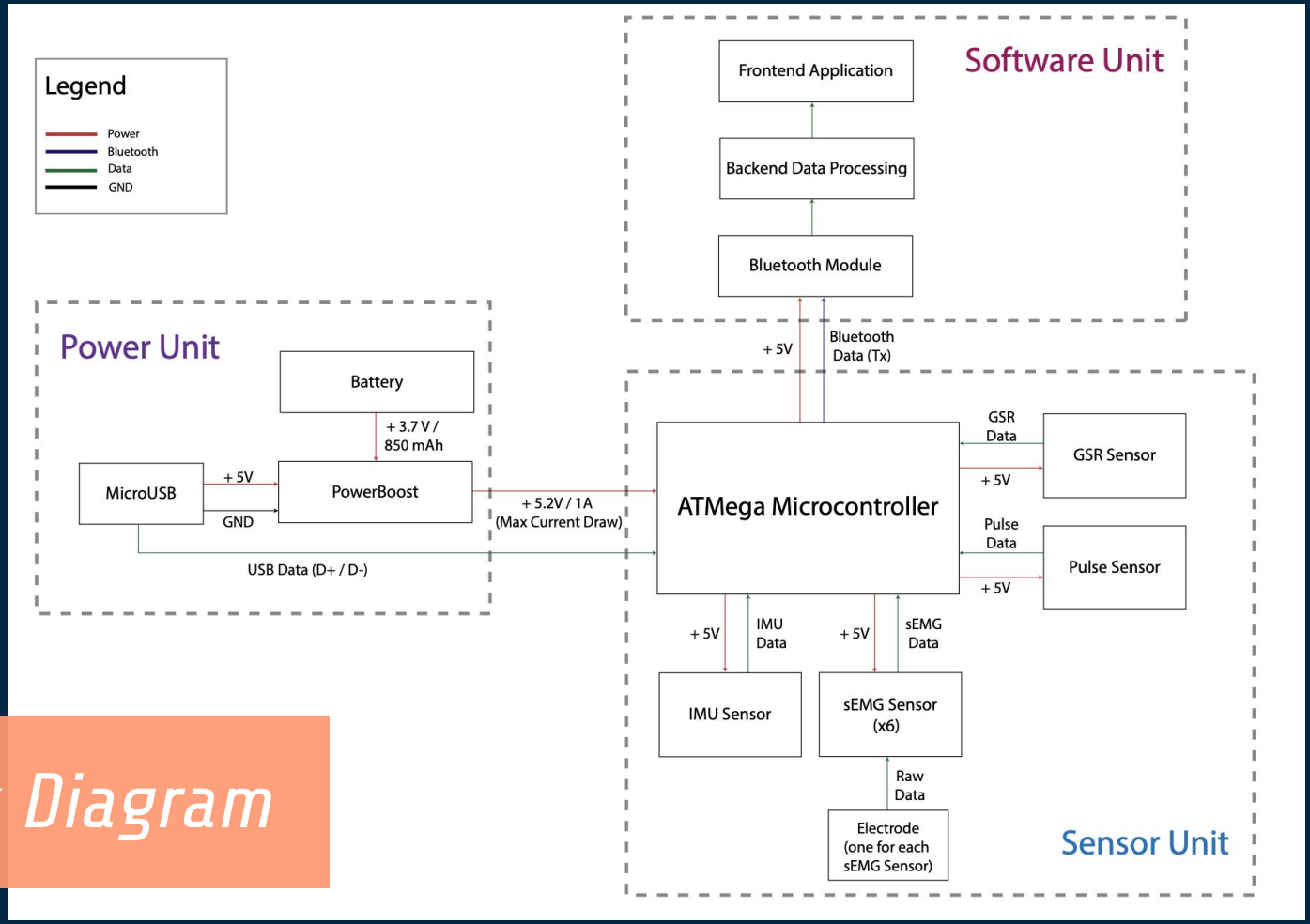
collect data for at least two hours with minimal to no discomfort put onto the user

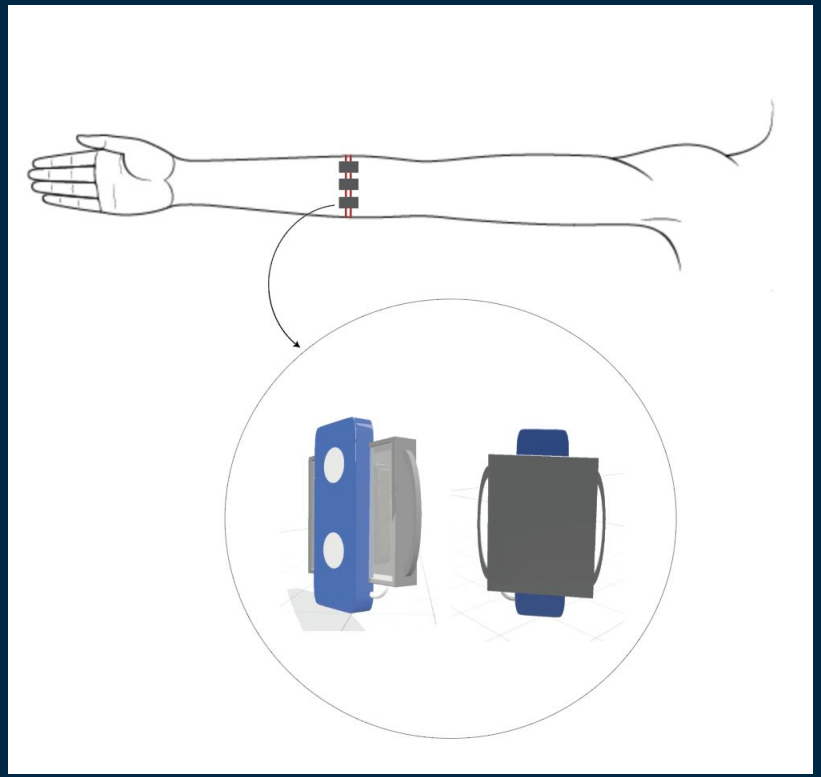
raw data from the sensors must be displaced in real-time

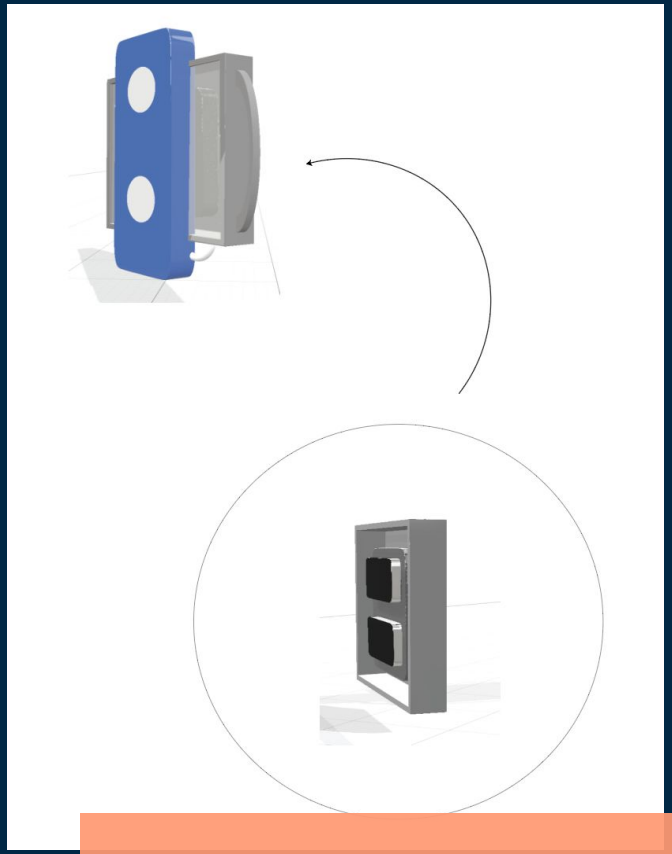
Design

03

Block Diagram

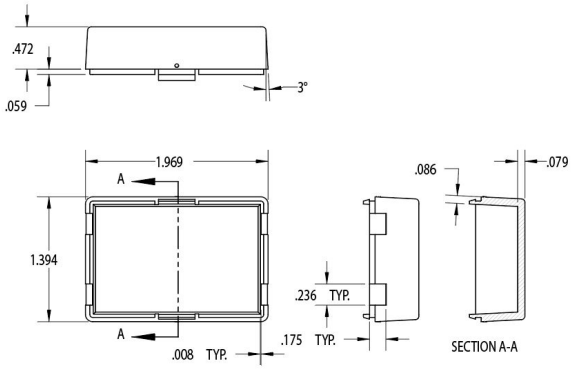


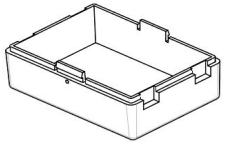




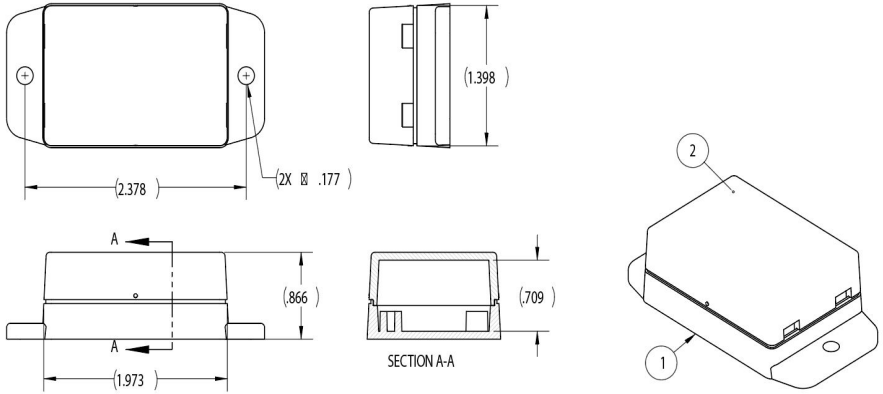
Design : Visual Aids

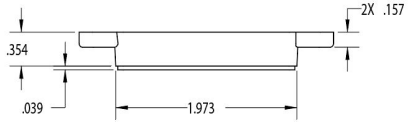
Design : Visual Aids

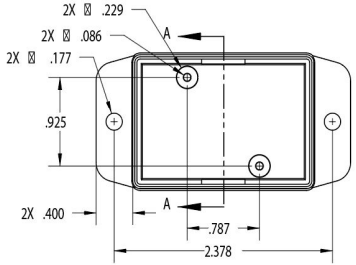


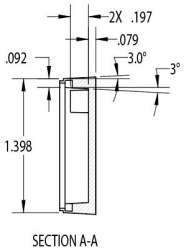


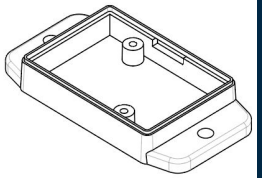
PART NUMBER: SN-20C-01
MATERIAL: ABS
COLOR: BLACK
FLAME RATING: UL94-HB











PART NUMBER: SN-20B-01
MATERIAL: ABS
COLOR: BLACK
FLAME RATING: UL94-HB

Requirements & Verification

Power Subsystem

Output voltage is 5.2V±50mV and output current is between 0-1A

Battery supplies power for 2 hours

Software Subsystem

The input voltage to the bluetooth module is 5 V ± 1V

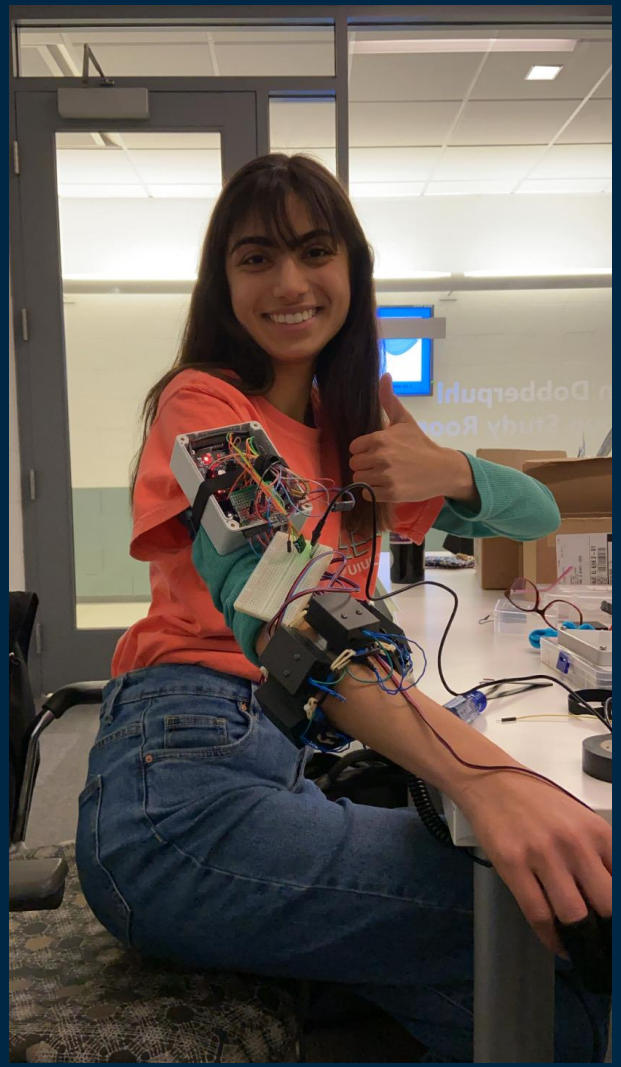
Bluetooth connection is enabled and exposed to external devices

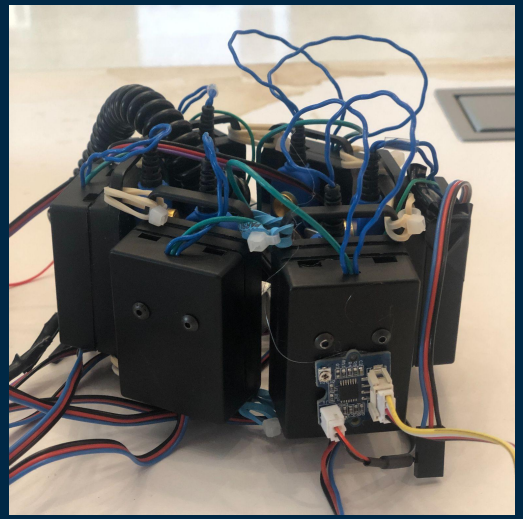
Sensor Subsystem

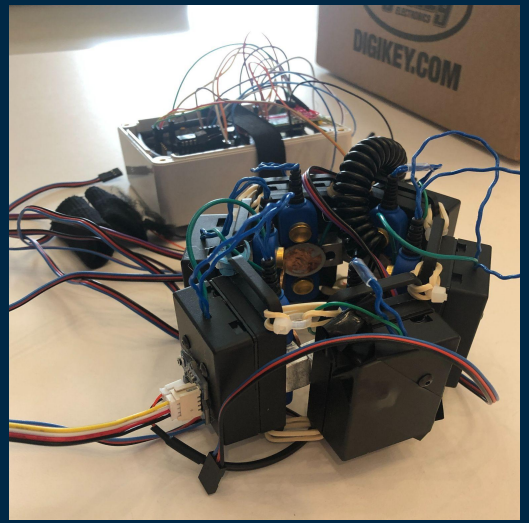
sEMG sensor outputs a filtered signal between |0-1000| units

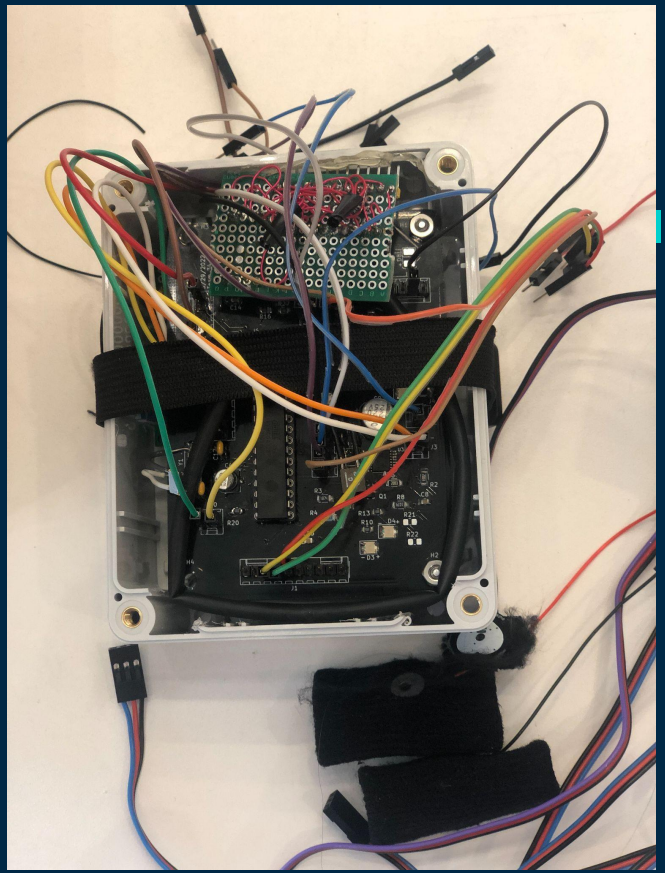
IMU sensor correctly reflects changes in spatial position

Pulse sensor measures values for BPM (Beats Per Minute) of the actual heart rate of the user





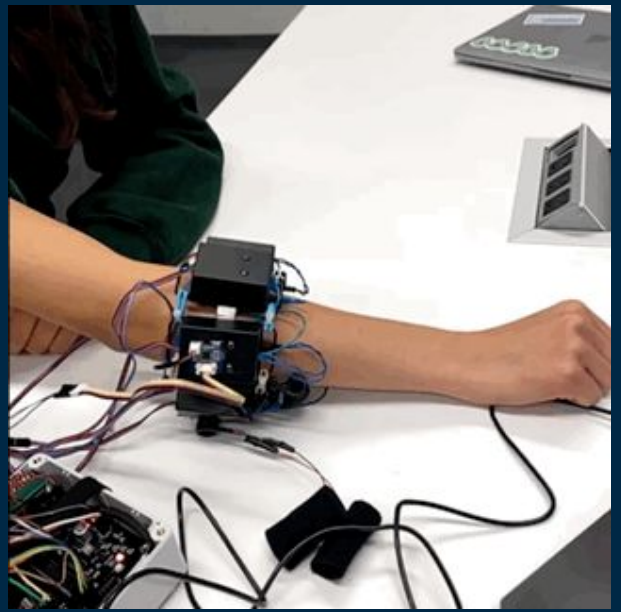

DIGIKEY.COM

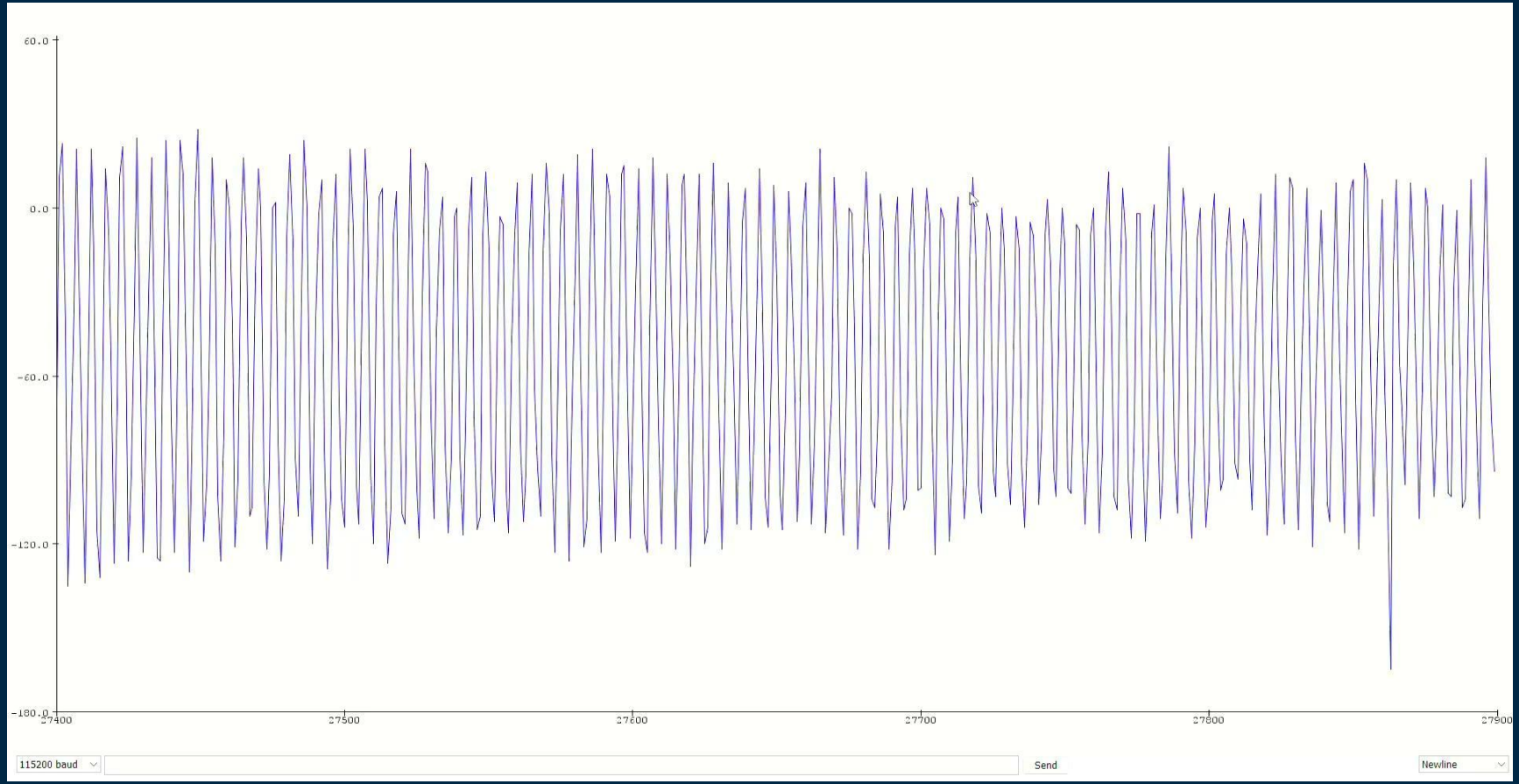


Outputs

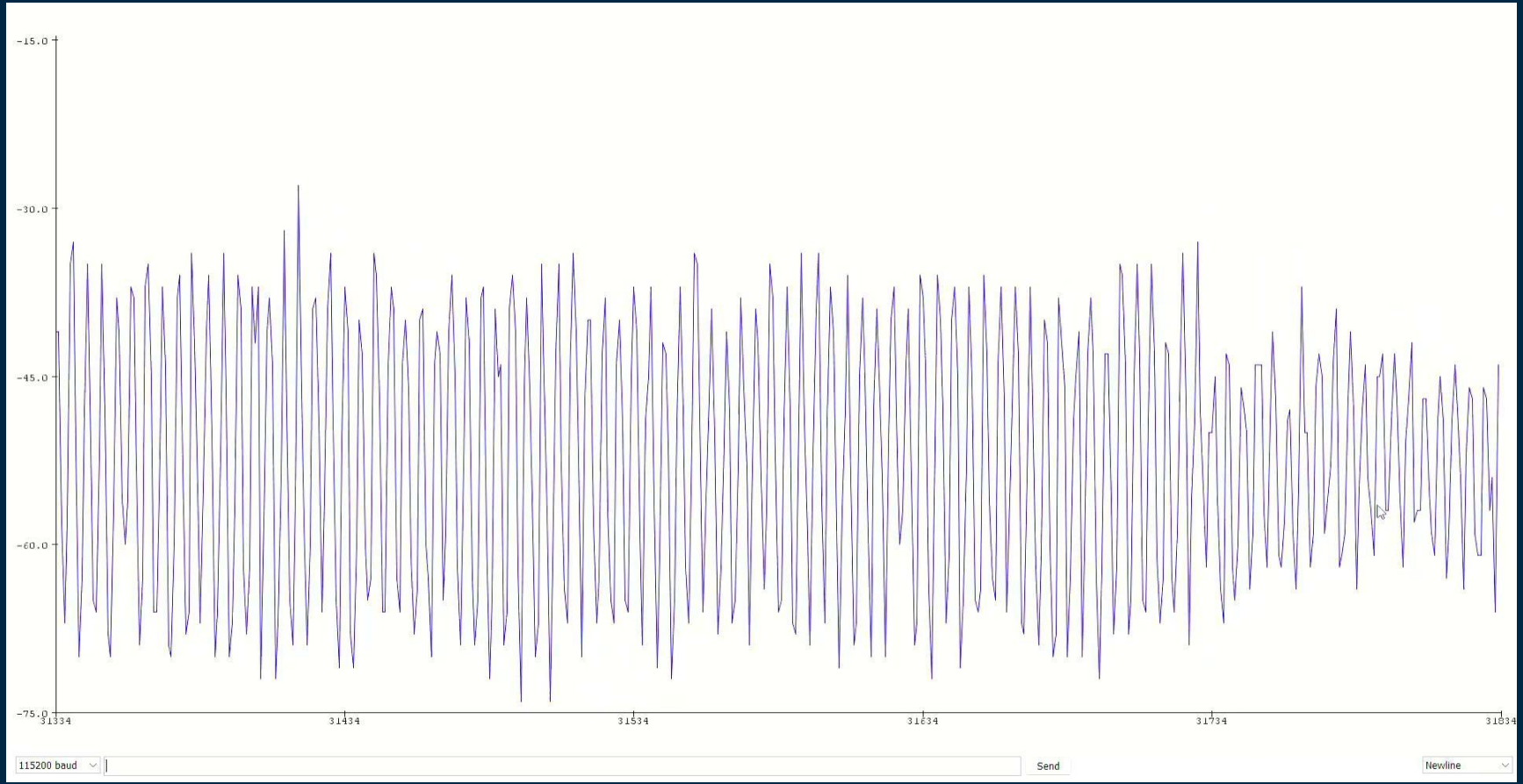
04

sEMG Sensor 1



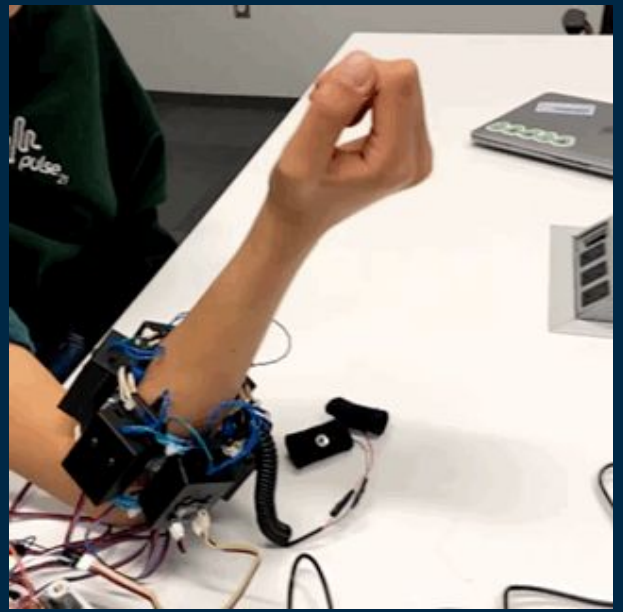

60.0
0.0
-60.0
-120.0
-180.0
27400
27500
27600
27700
27800
27900
115200 baud
Send
Newline

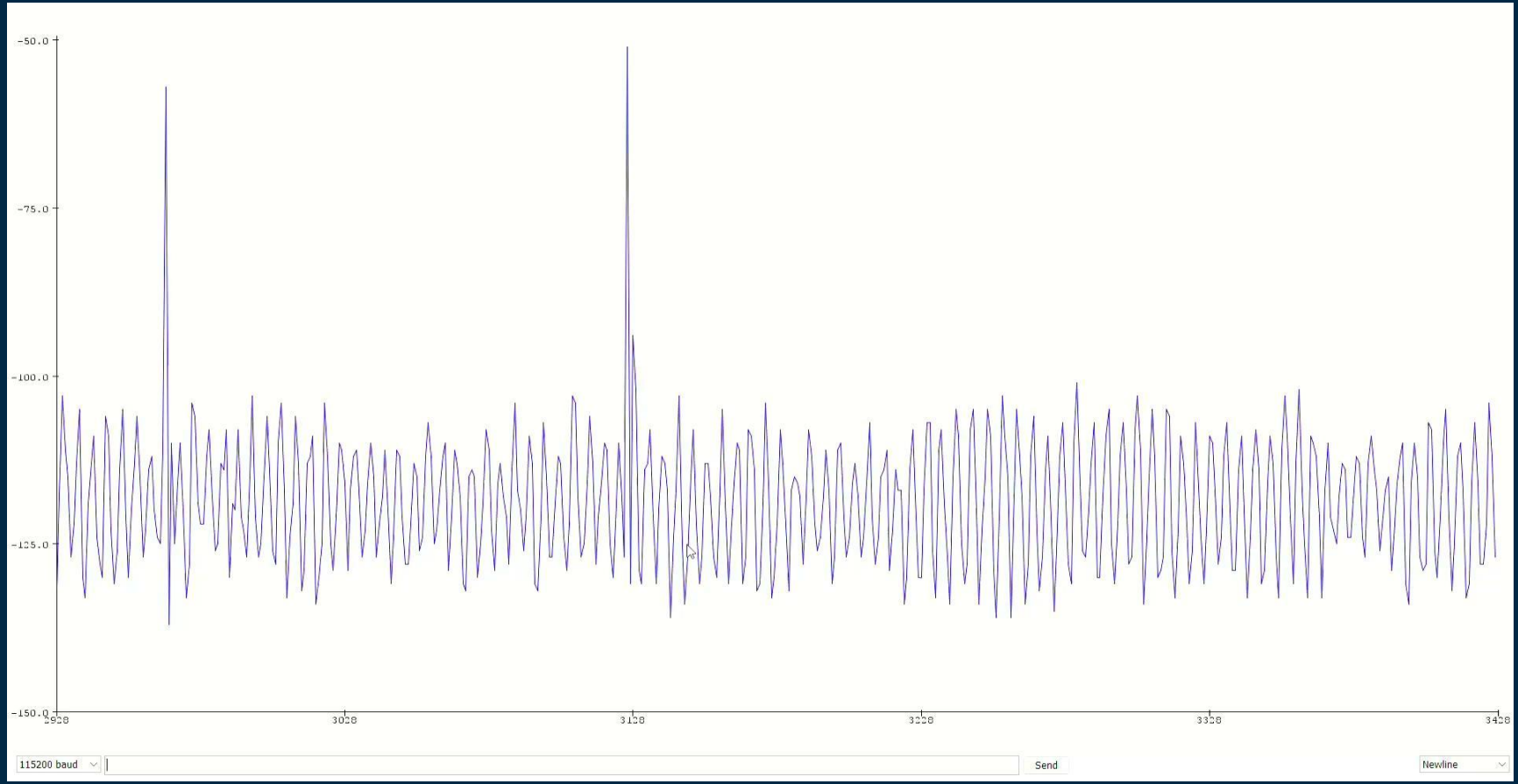
Unflexed


-15.0
-30.0
-45.0
-60.0
-75.0
31334
31434
31534
31634
31734
31834
115200 baud
Send
Newline

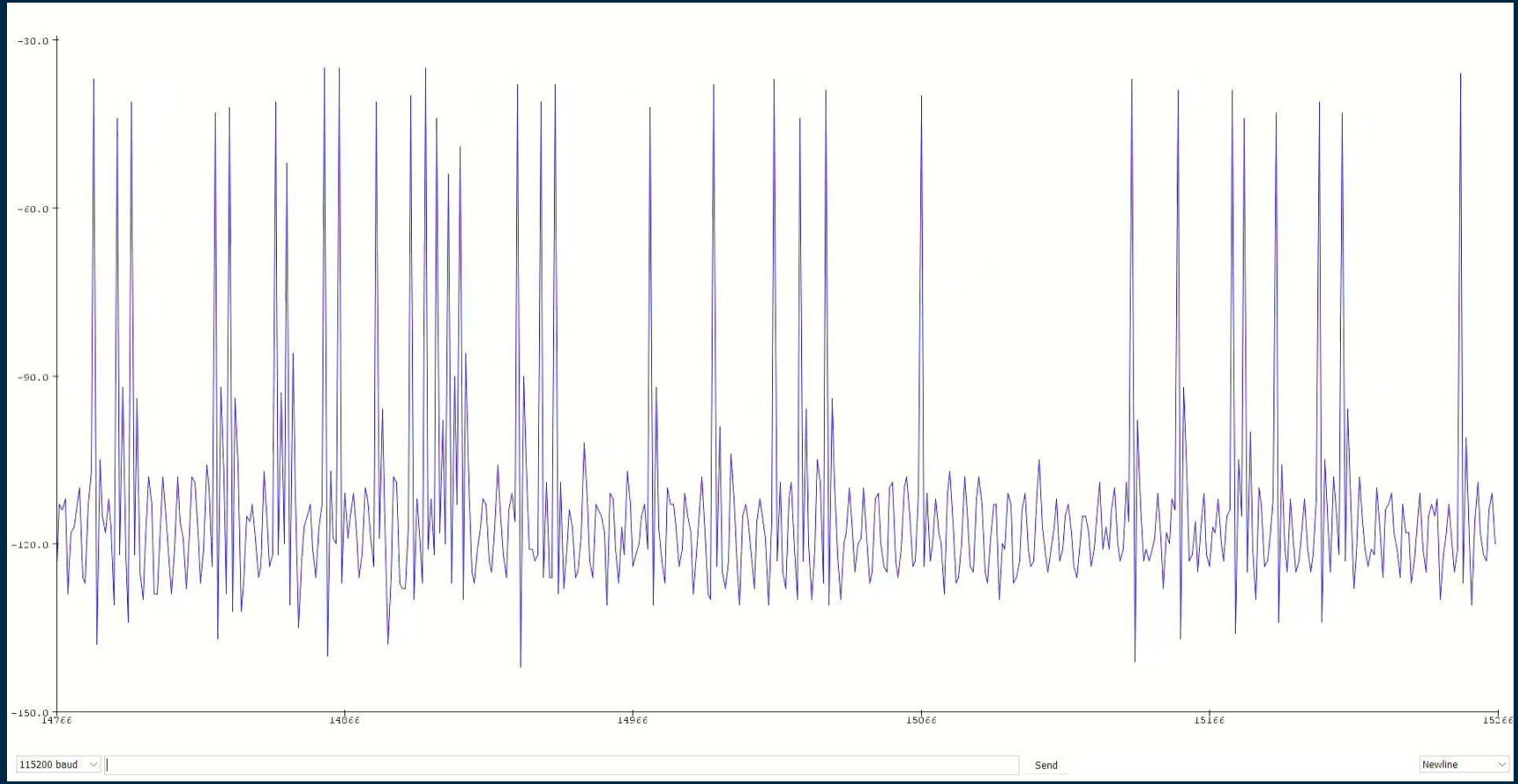
Flexed

sEMG Sensor 2



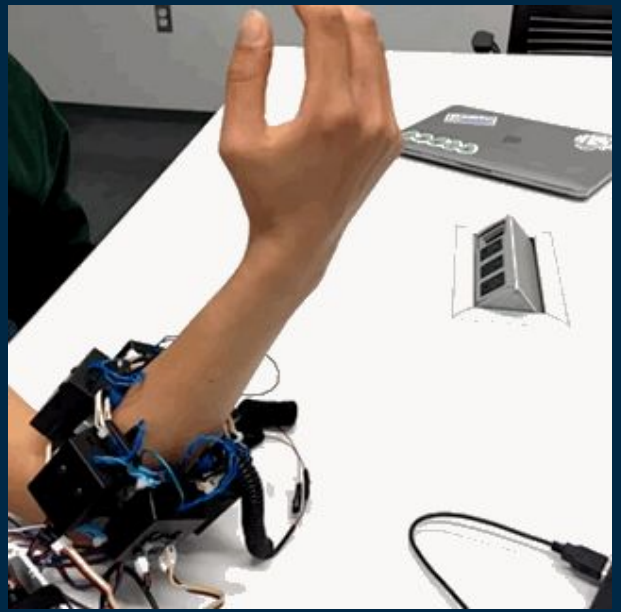

-50.0
-75.0
-100.0
-125.0
-150.0
2928
3028
3128
3228
3328
3428
115200 baud
Send
Newline

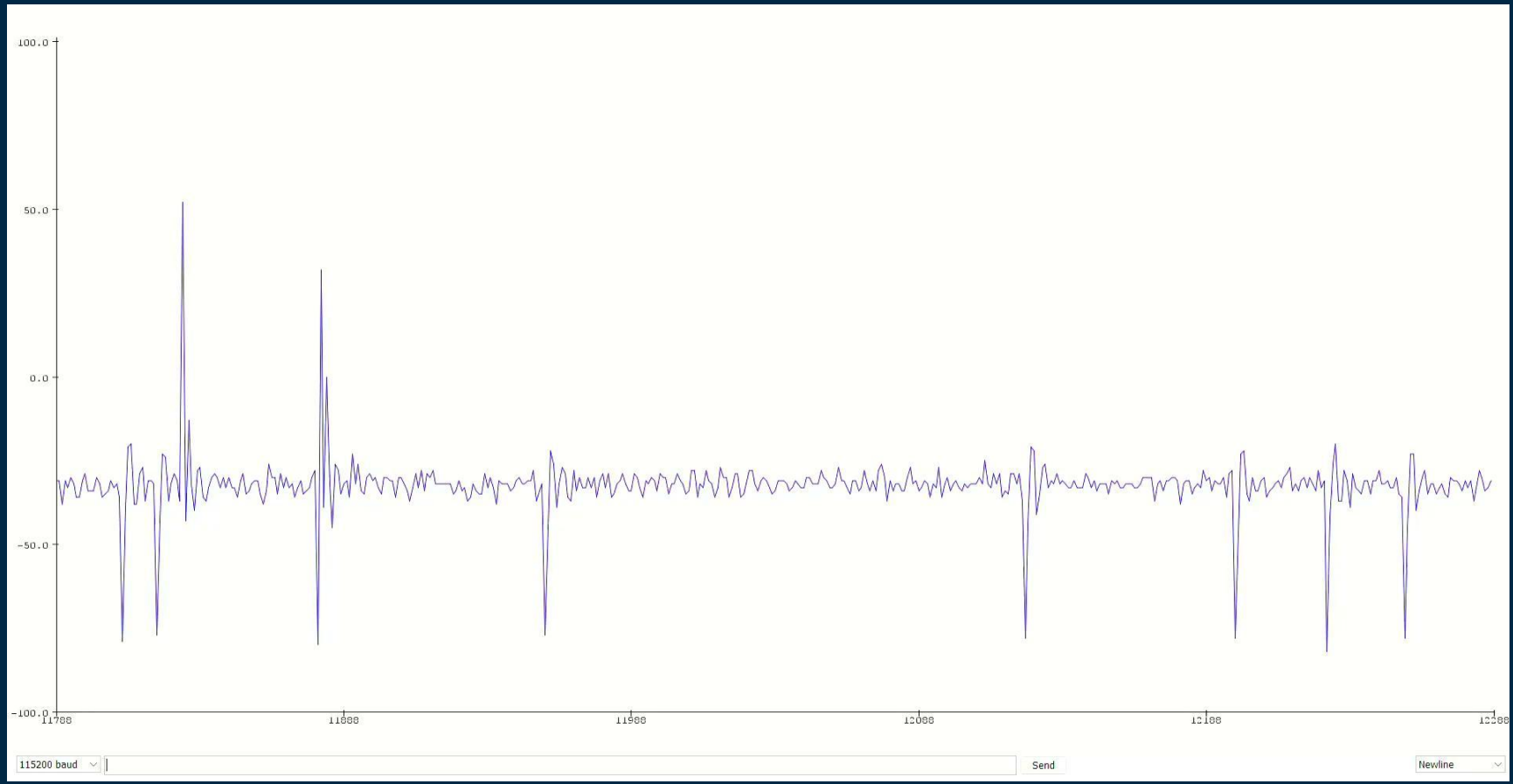
Unflexed



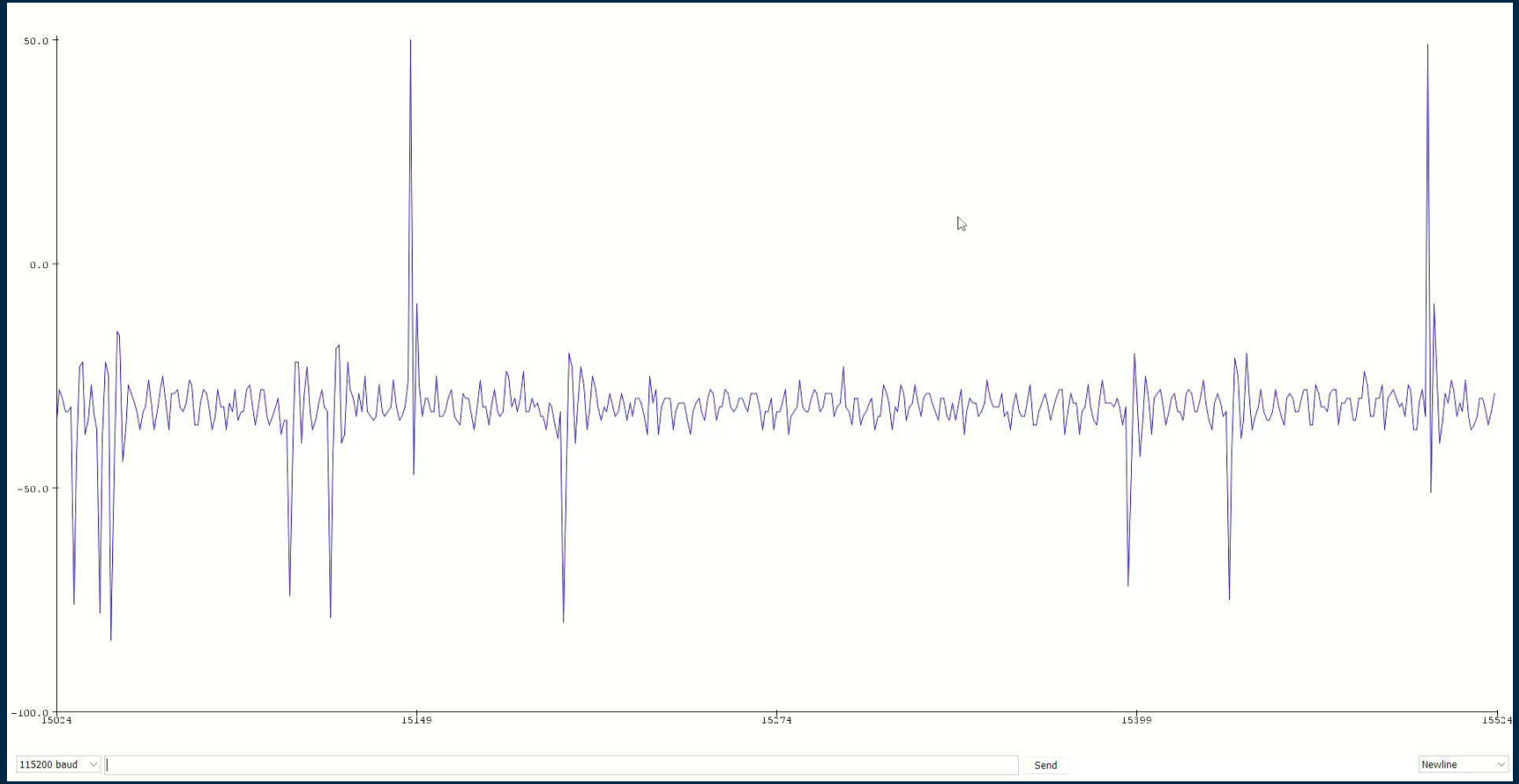
Flexed

sEMG Sensor 3



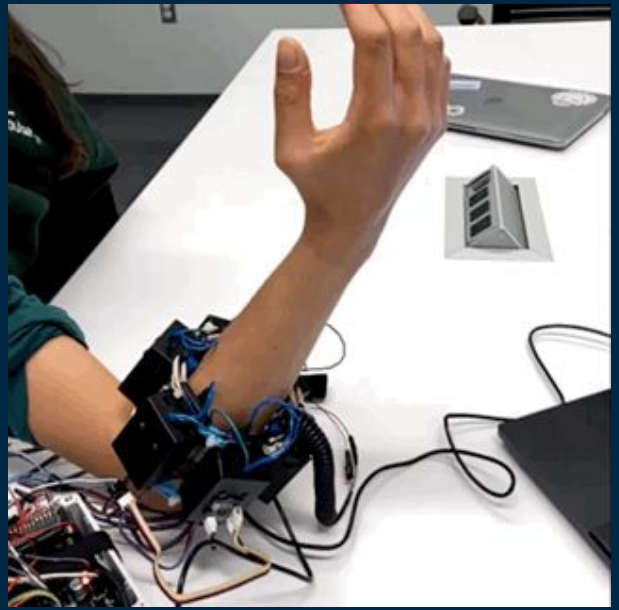

100.0
50.0
0.0
-50.0
-100.0
11788
11888
11988
12088
12188
12288
115200 baud
Send
Newline

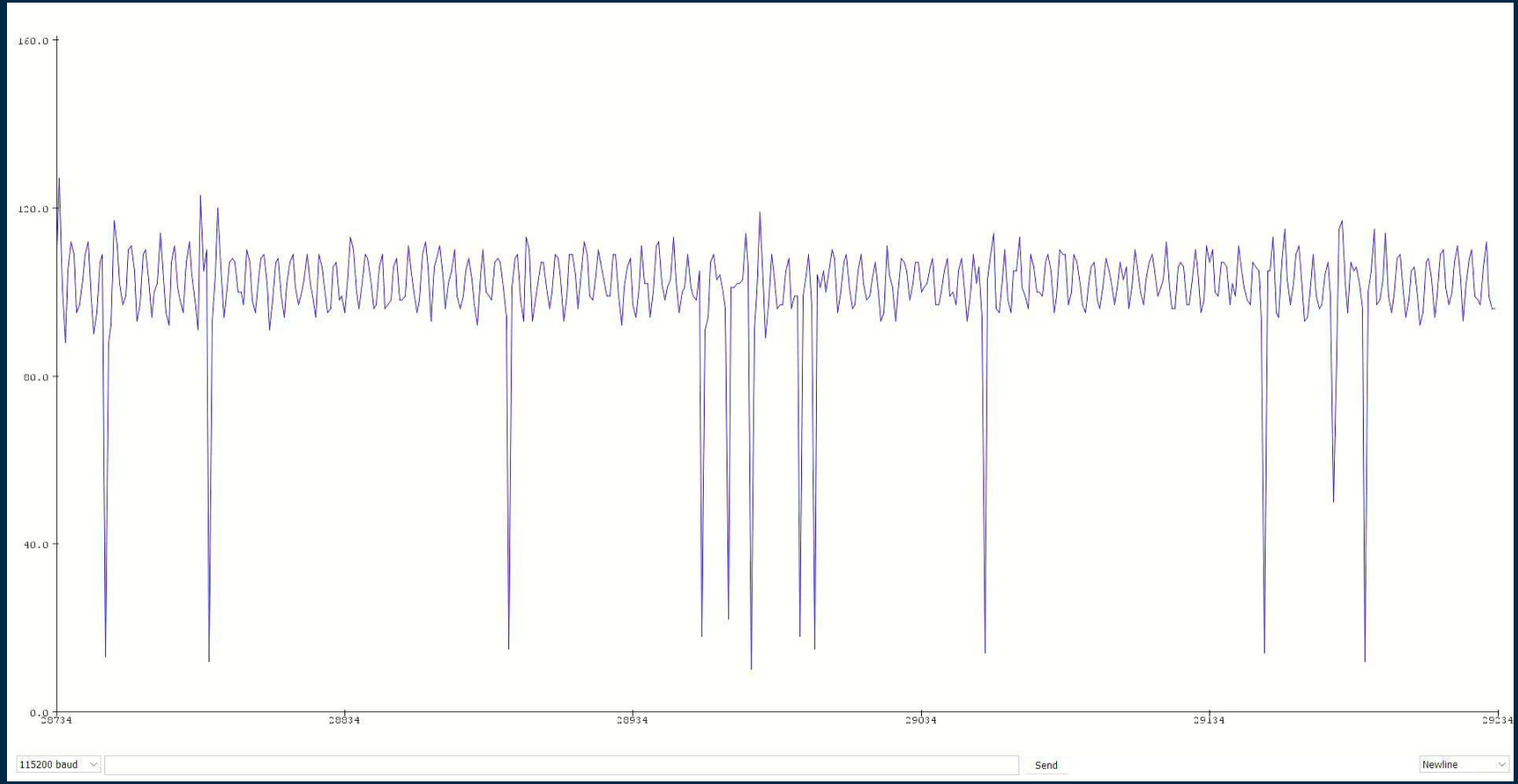
Unflexed


50.0
0.0
-50.0
-100.0
15024
15149
15274
15399
15524
115200 baud
Send
Newline

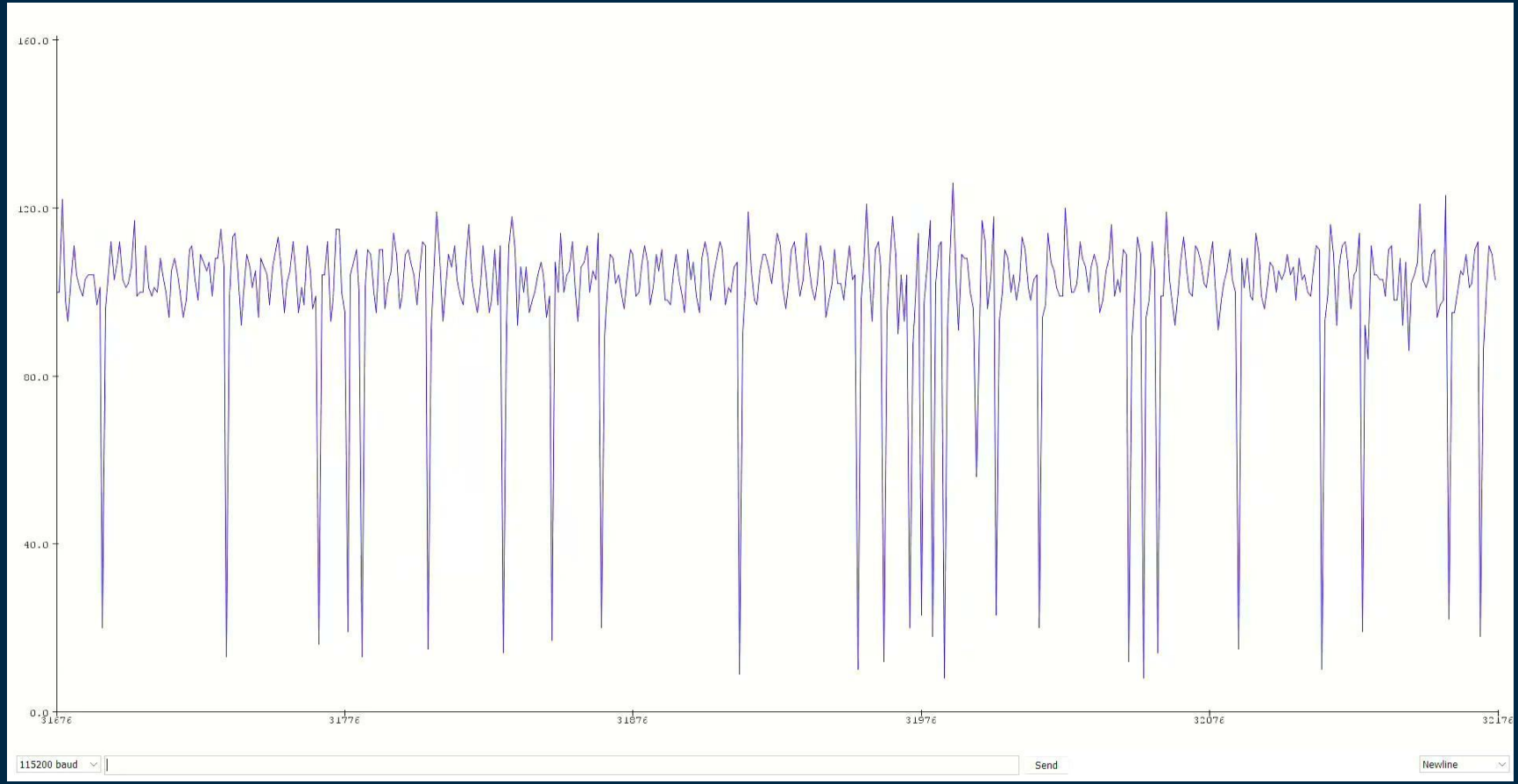
Flexed

sEMG Sensor 4



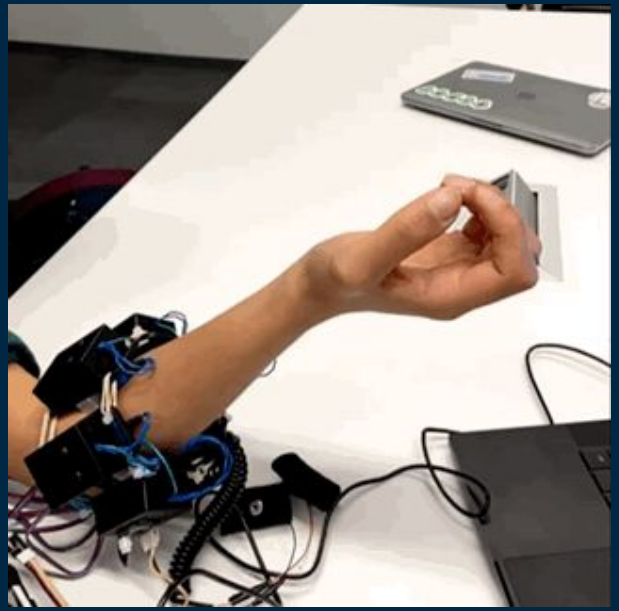

160.0
120.0
80.0
40.0
0.0
28734
28834
28934
29034
29134
29234
115200 baud
Send
Newline

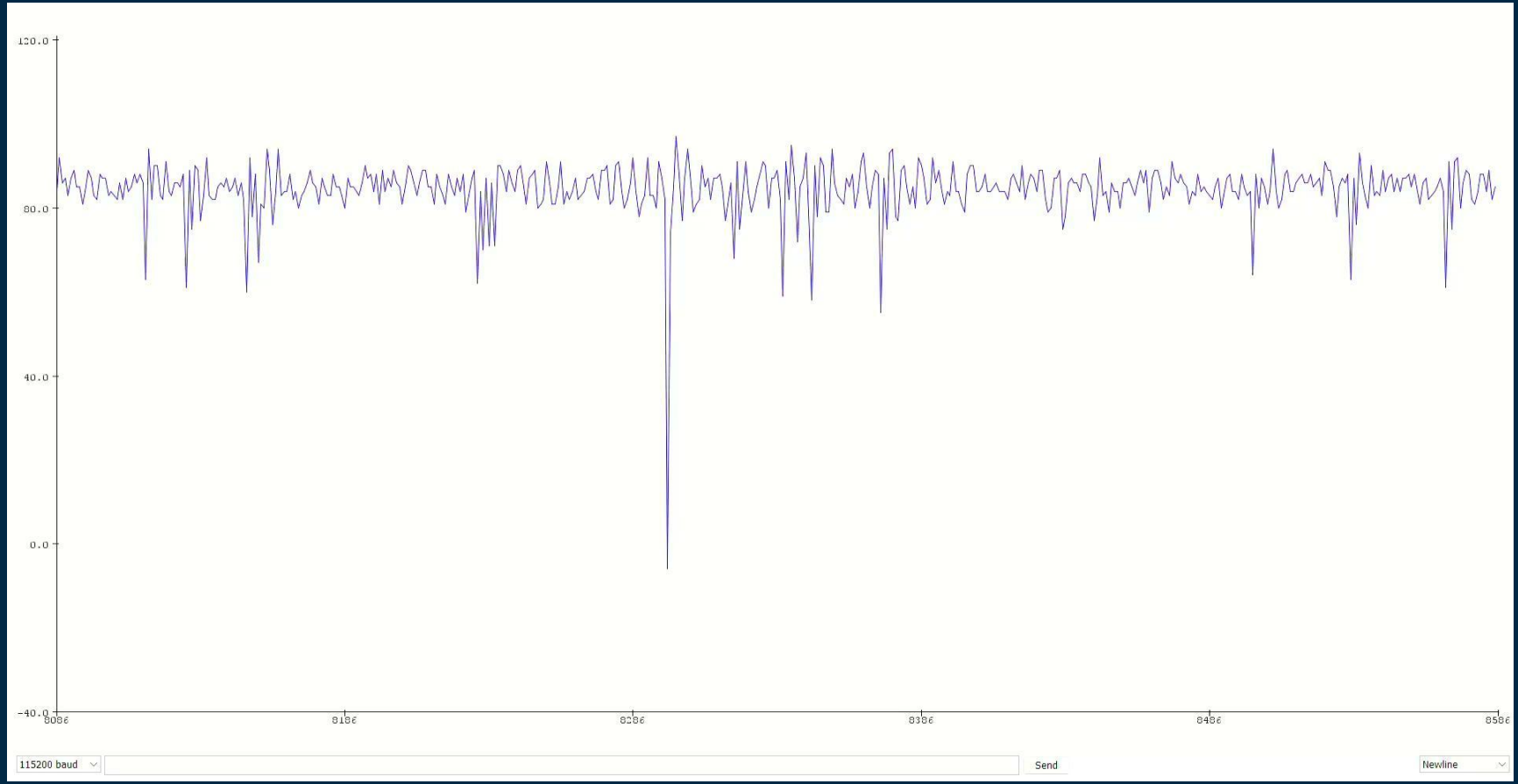
Unflexed


160.0
120.0
80.0
40.0
0.0
3167ε
3177ε
3187ε
3197ε
3207ε
3217ε
115200 baud
Send
Newline

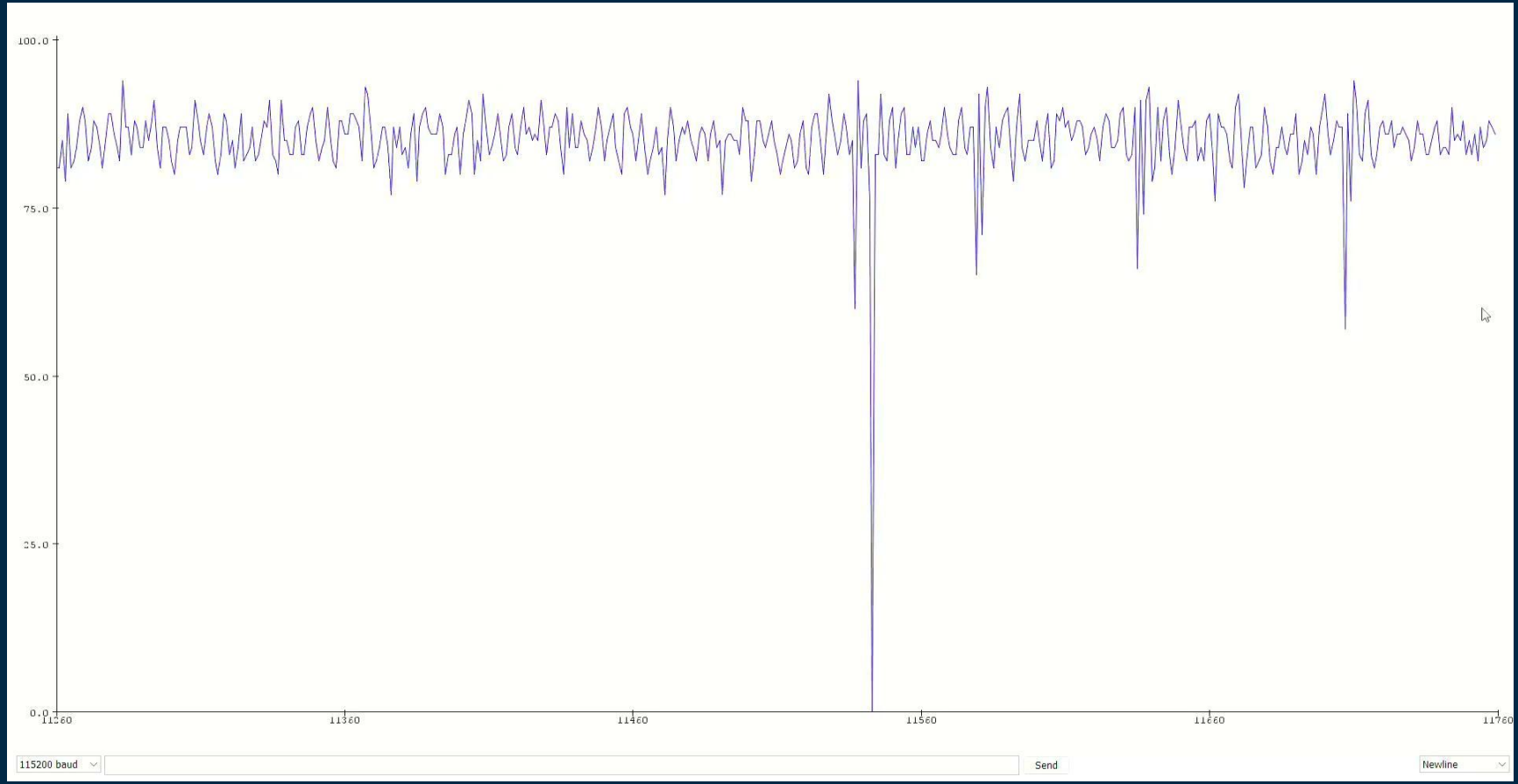
Flexed

sEMG Sensor 5



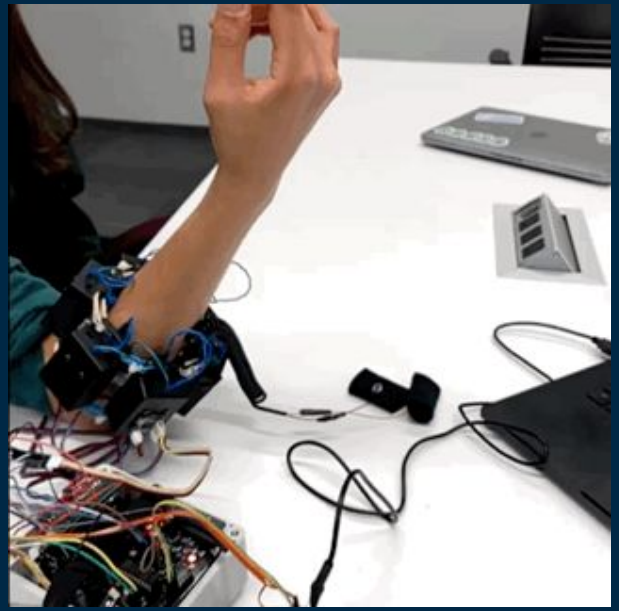


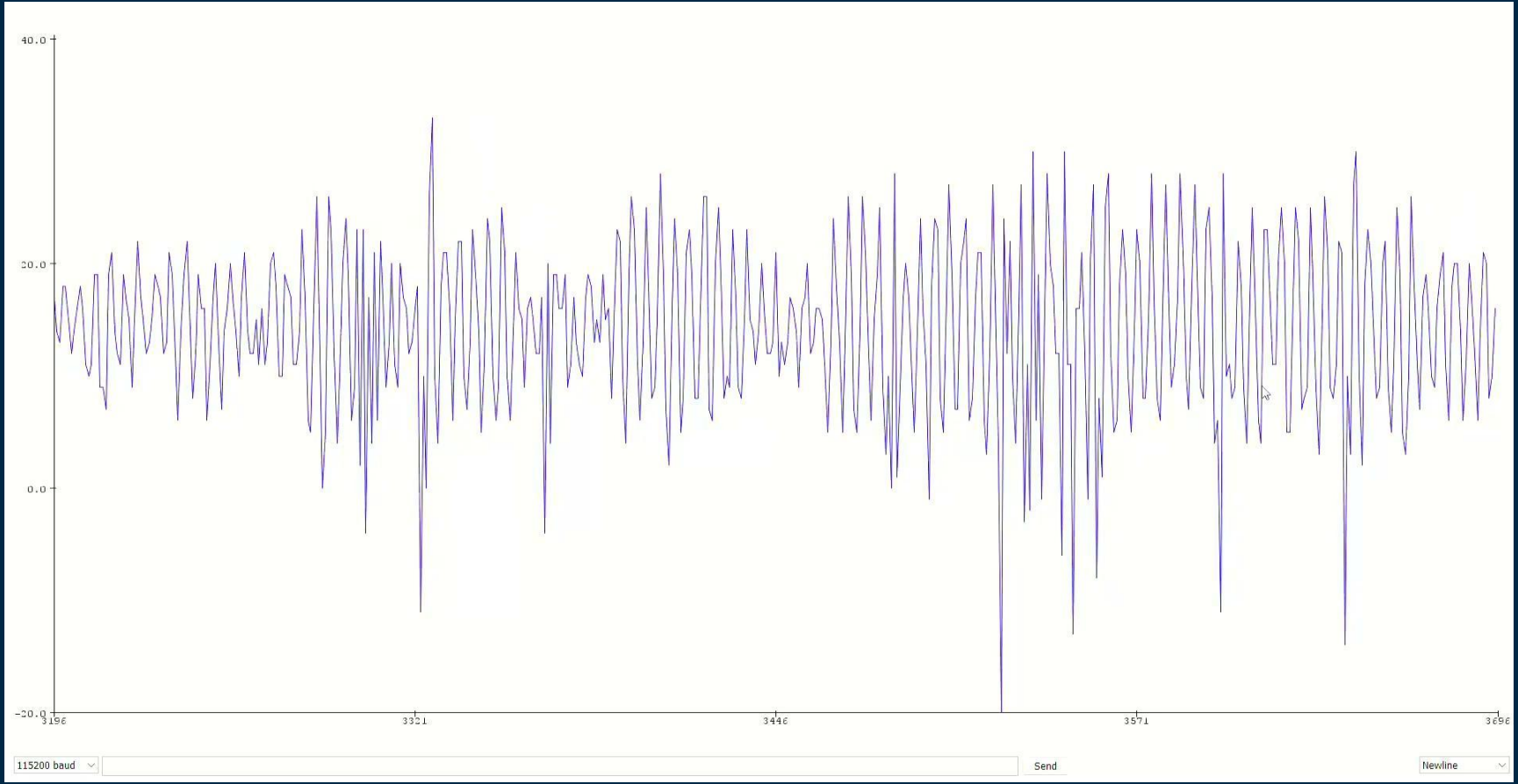
Unflexed


100.0
75.0
50.0
25.0
0.0
11260
11360
11460
11560
11660
11760
115200 baud
Send
Newline

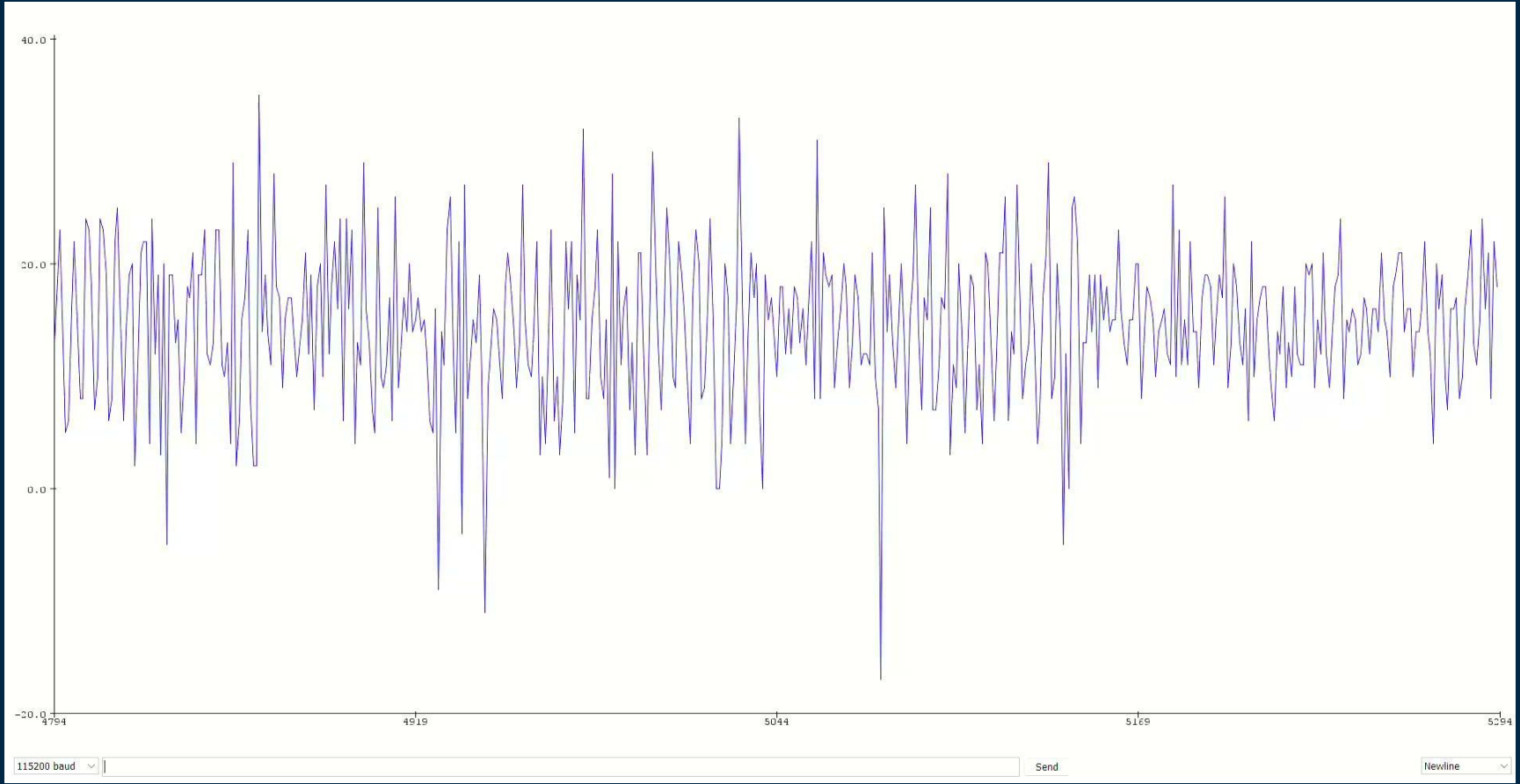
Flexed

sEMG Sensor 6




40.0
20.0
0.0
-20.0
3196
3321
3446
3571
3696
115200 baud
Send
Newline

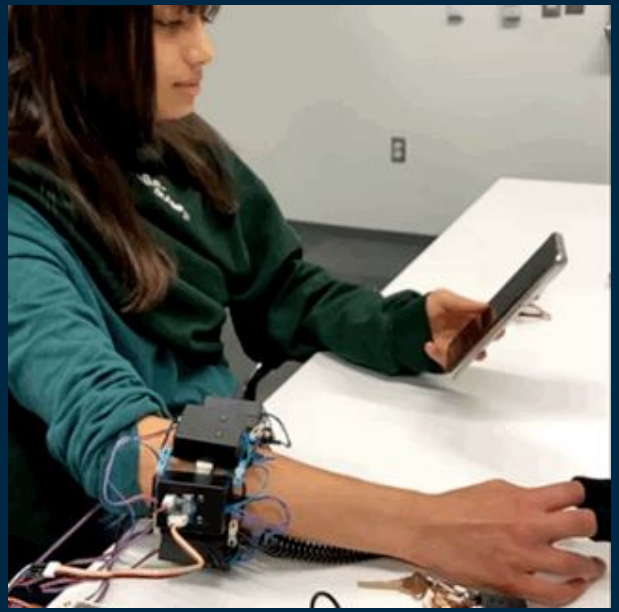
Unflexed


40.0
20.0
0.0
-20.0
4794
4919
5044
5169
5294
115200 baud
Send
Newline

Flexed

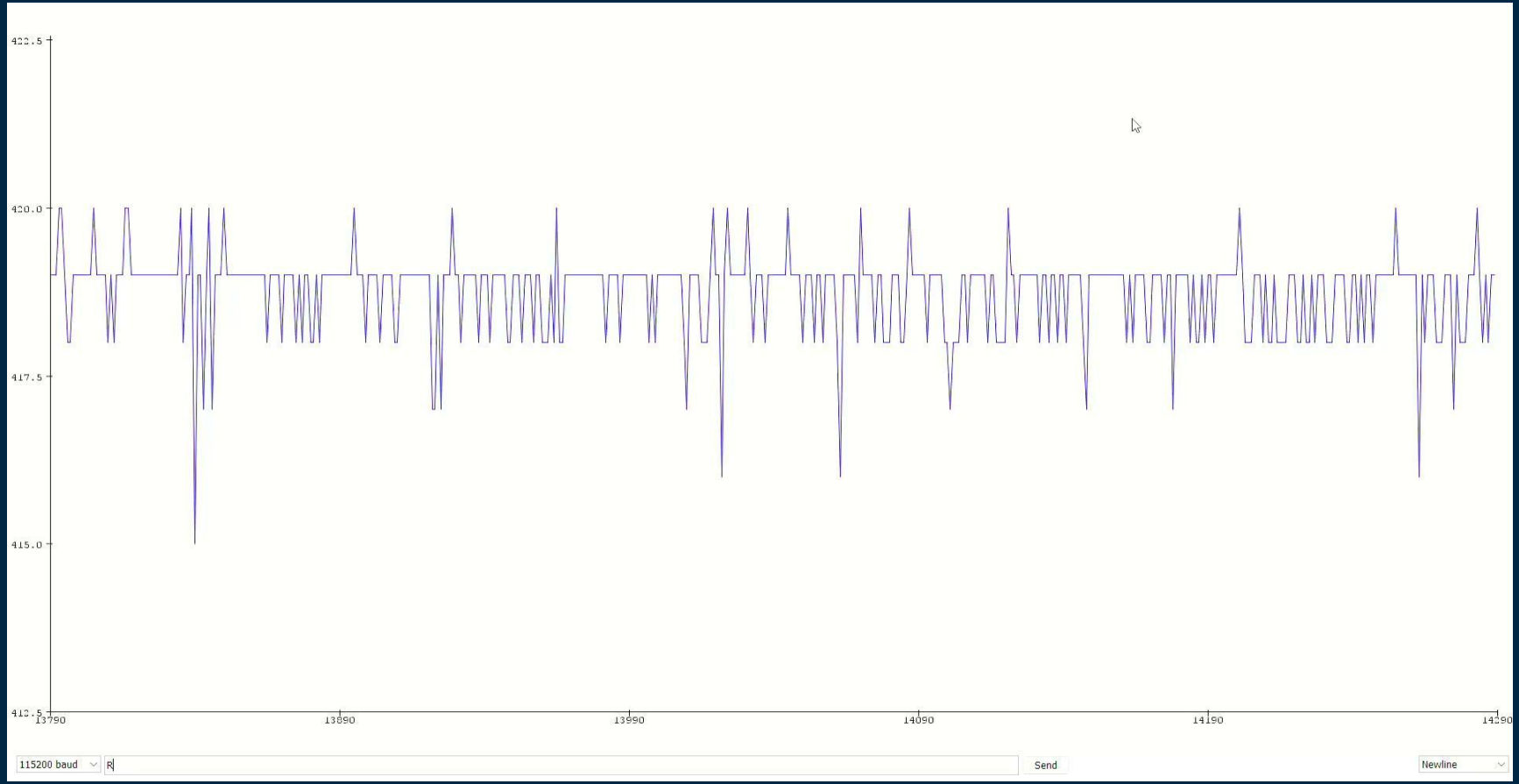
GSR

relaxed

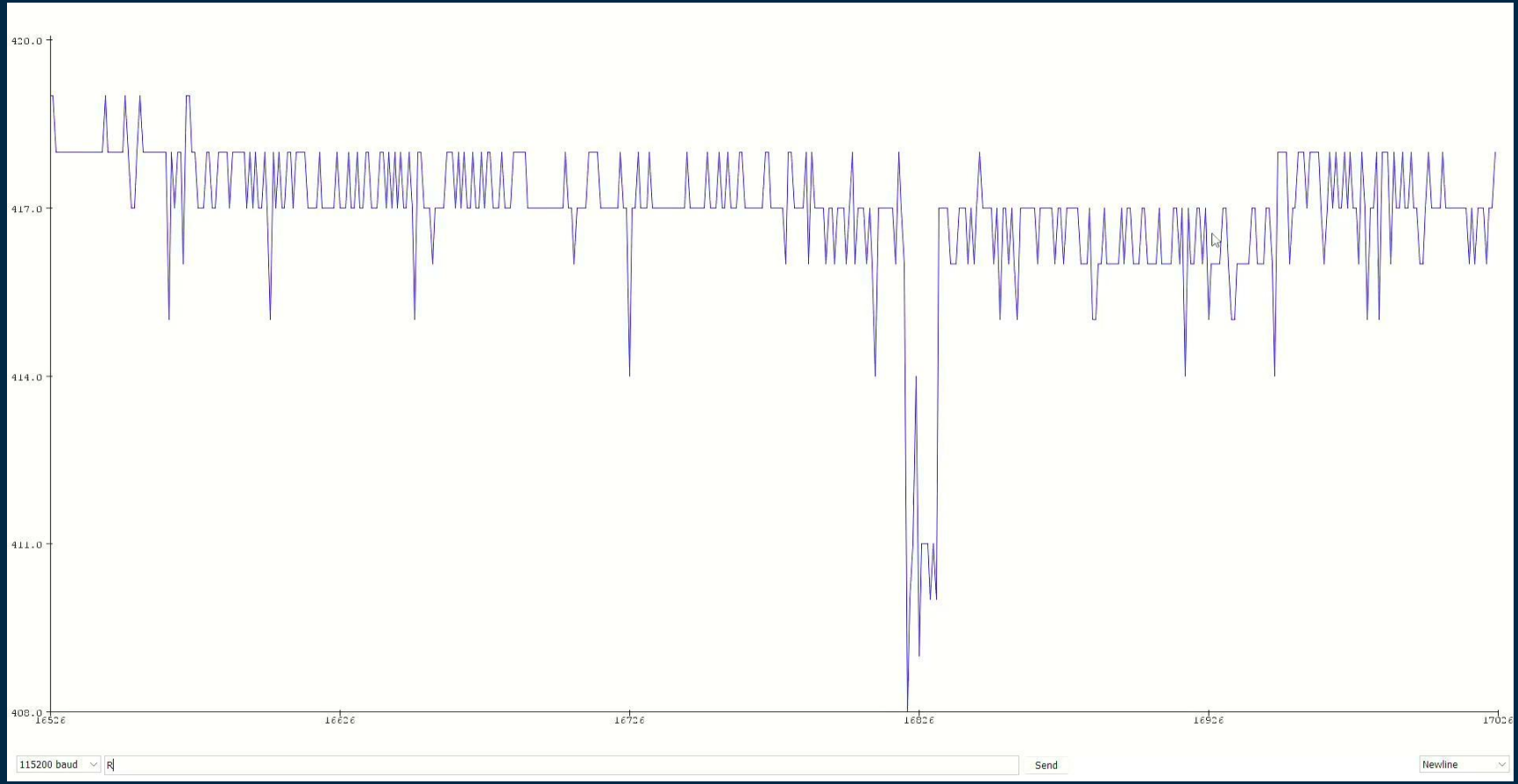


GSR

stressed


422.5
420.0
417.5
415.0
412.5
13790
13890
13990
14090
14190
14290
115200 baud
R
Send
Newline

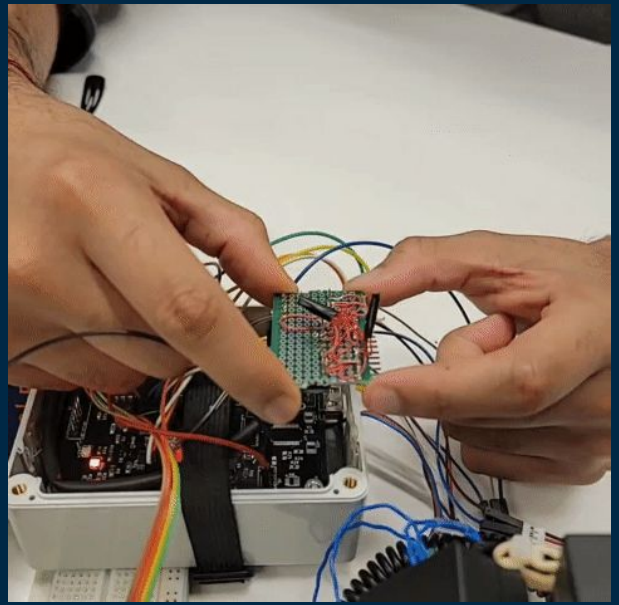
Unstressed



Stressed

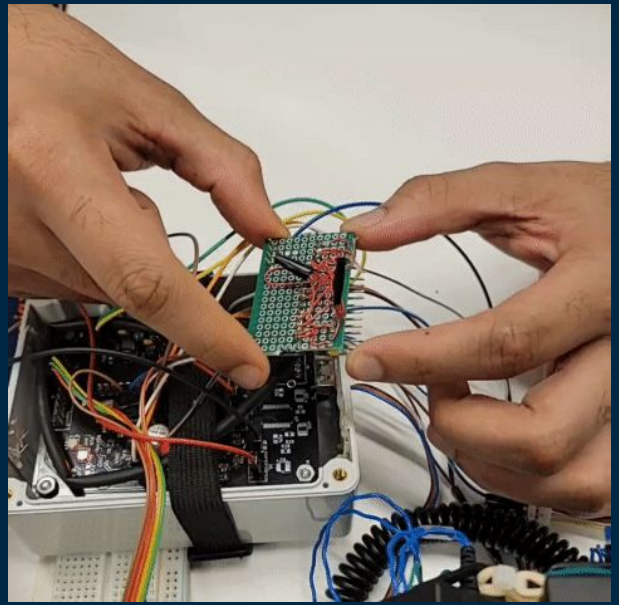
IMU

pitch



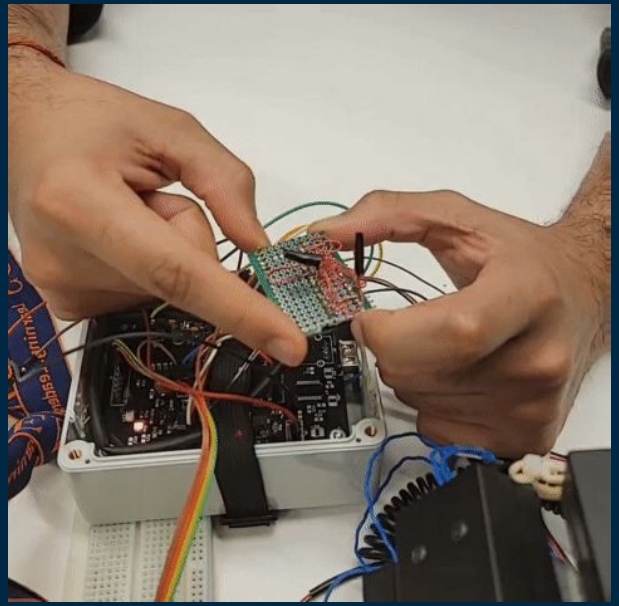
IMU

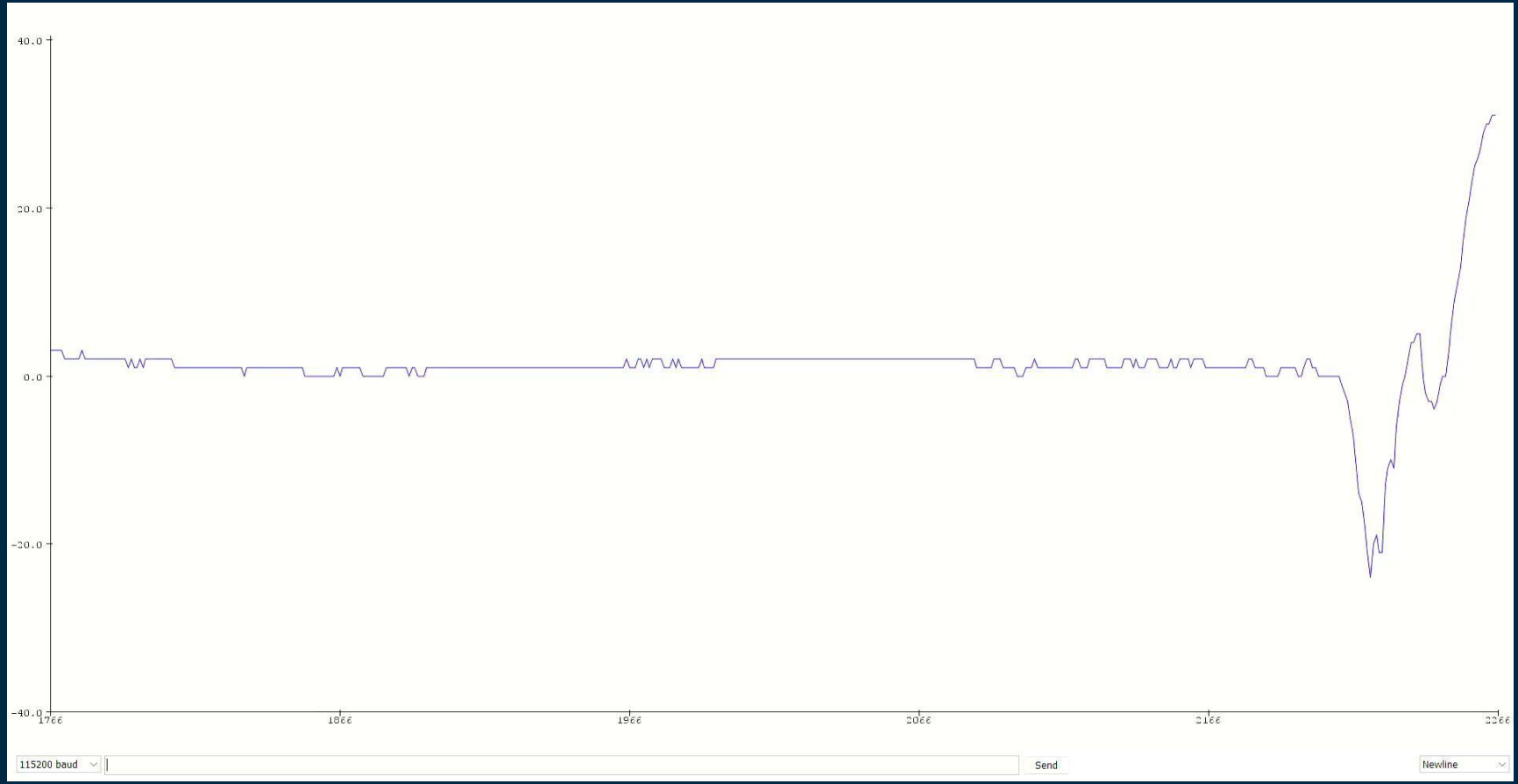
yaw



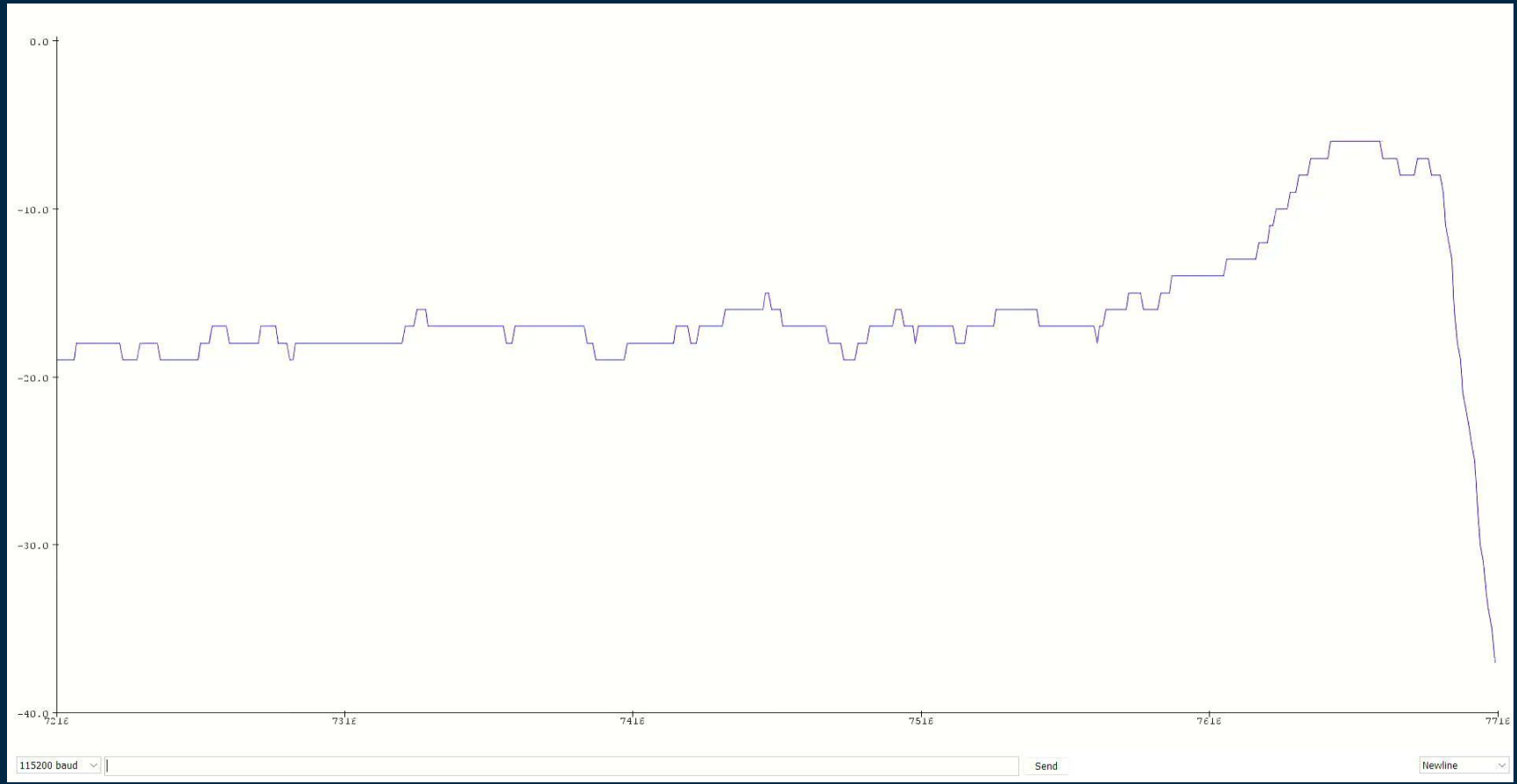
IMU

roll

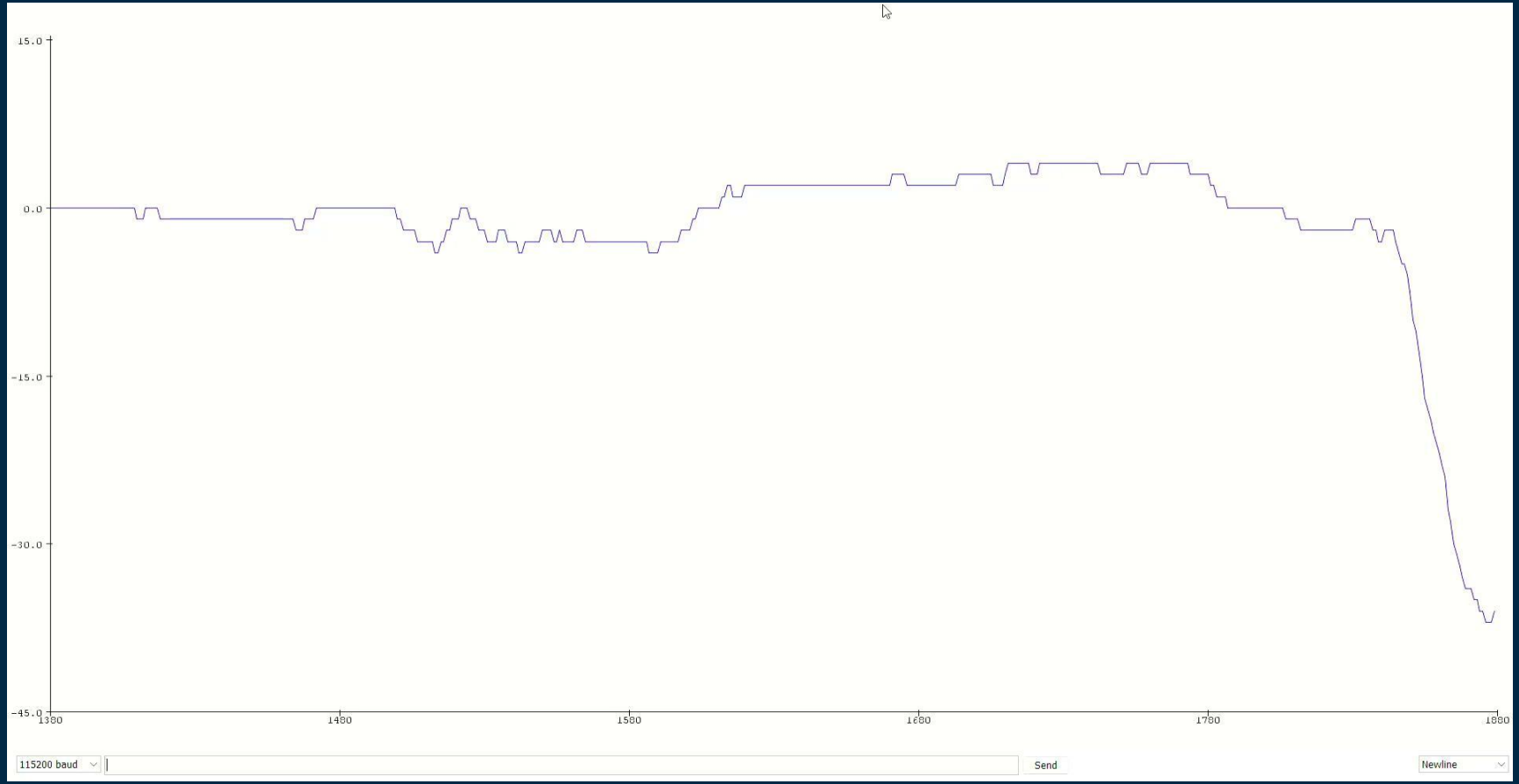




Pitch



Yaw


15.0
0.0
-15.0
-30.0
-45.0
1380
1480
1580
1680
1780
1880
115200 baud
Send
Newline

Roll

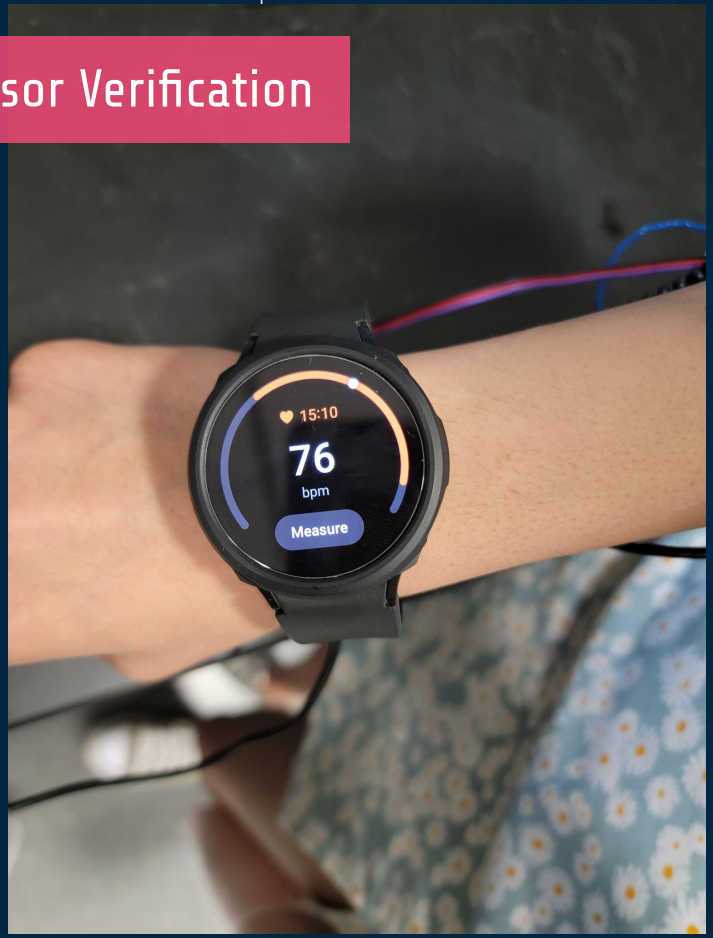
Pulse

COM9

```
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
{"p":76}
```

Pulse Sensor Reading

Pulse Sensor Verification



Conclusion

04

Problems Encountered

1. **USB-to-UART IC** was not properly designed on the PCB
   a. **DTR and DSR** are not supposed to be connected together
   b. The **CTS** is an input signal that should be high in order to control data transmission over the **UART** interface.

2. **ADC** had pull-down resistors but needed pull-up resistors for **SCL** and **SDA** for proper serial communication

Summary

1. All sensors gave reliable and accurate data
2. Calibrated all sensors and filtered the data
3. Project met all the high-level requirements

Future Plans

1. Down-size PCB and fix errors
   a. **USB-to-UART IC** as well as **ADC**
2. Move from hardware to software filtering for sEMG sensors
3. More research needs to be done on sensors
   a. Placement may not be ideal for certain use cases
4. Continuous polling in real-time can be improved upon and made instantaneous

Special Thanks

Gregg and the Machine Shop Team

Hojoon Ryu

Hajar Sharif

Senior Design Staff and TA’s