Electromyographic Robotic Hand Control

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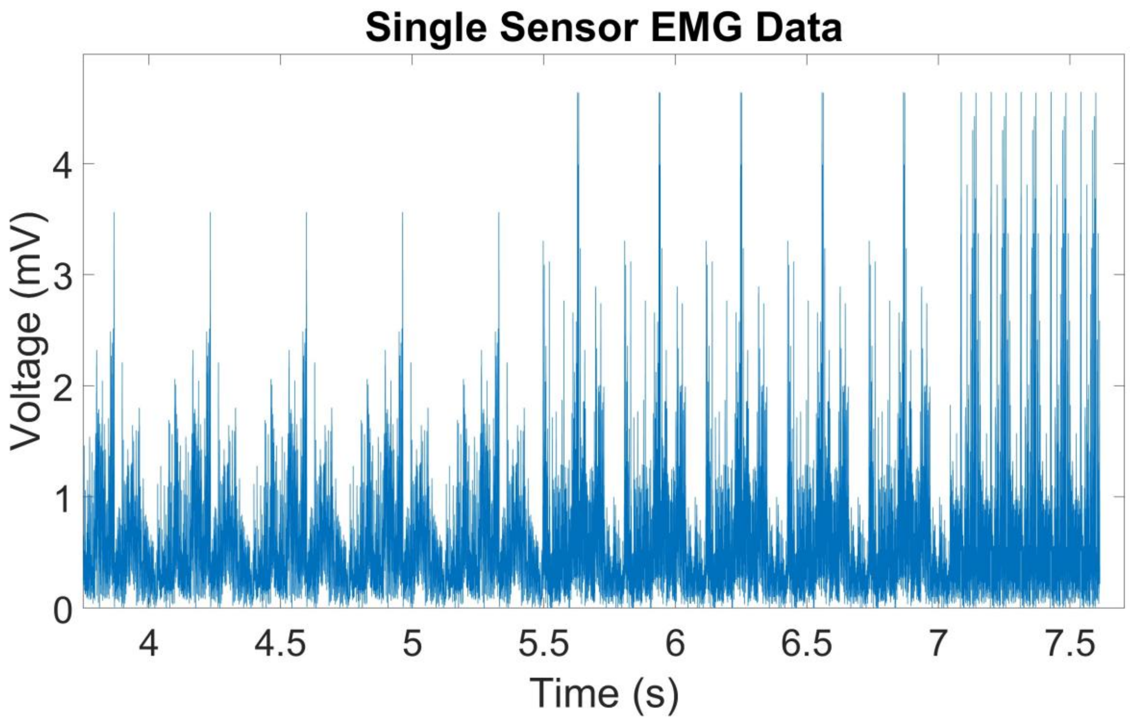
Problem

- Current products available to consumers are too simplistic or to expensive
- Offering limited positions or a lack of dynamic, real-time responsiveness

Methodology

Electromyography

- Initially developed in 1960s to measure muscle activation response due to electrical stimulation
- Current research suggests using multiple sensors around the forearm can identify specific grasps
- Available sensors lack the ability to read fine movements



Grasp Positions

- Rest (0)
- Cylinder (1)
- Pinch (2)
- Ball (3)
- Cone (4)

Cylinder

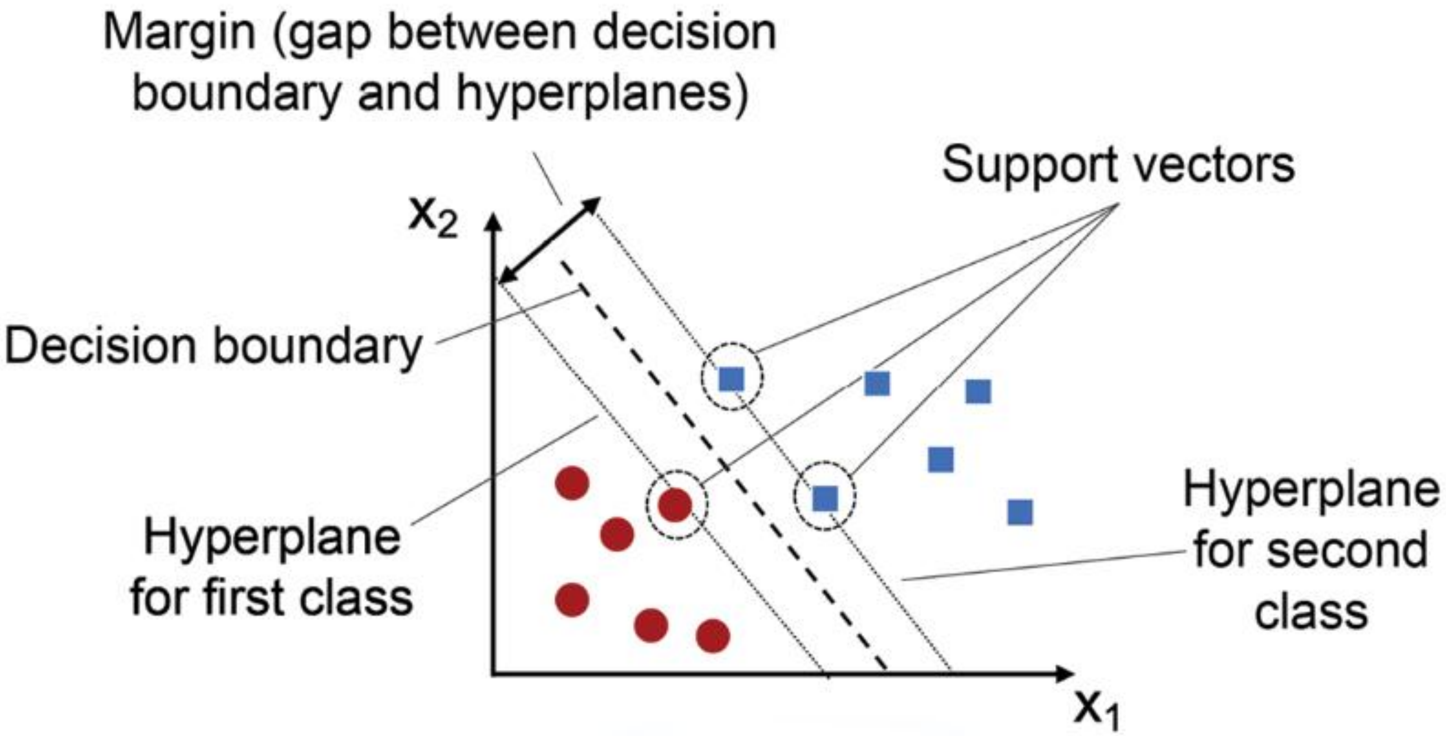
Ball

Pinch

Cone

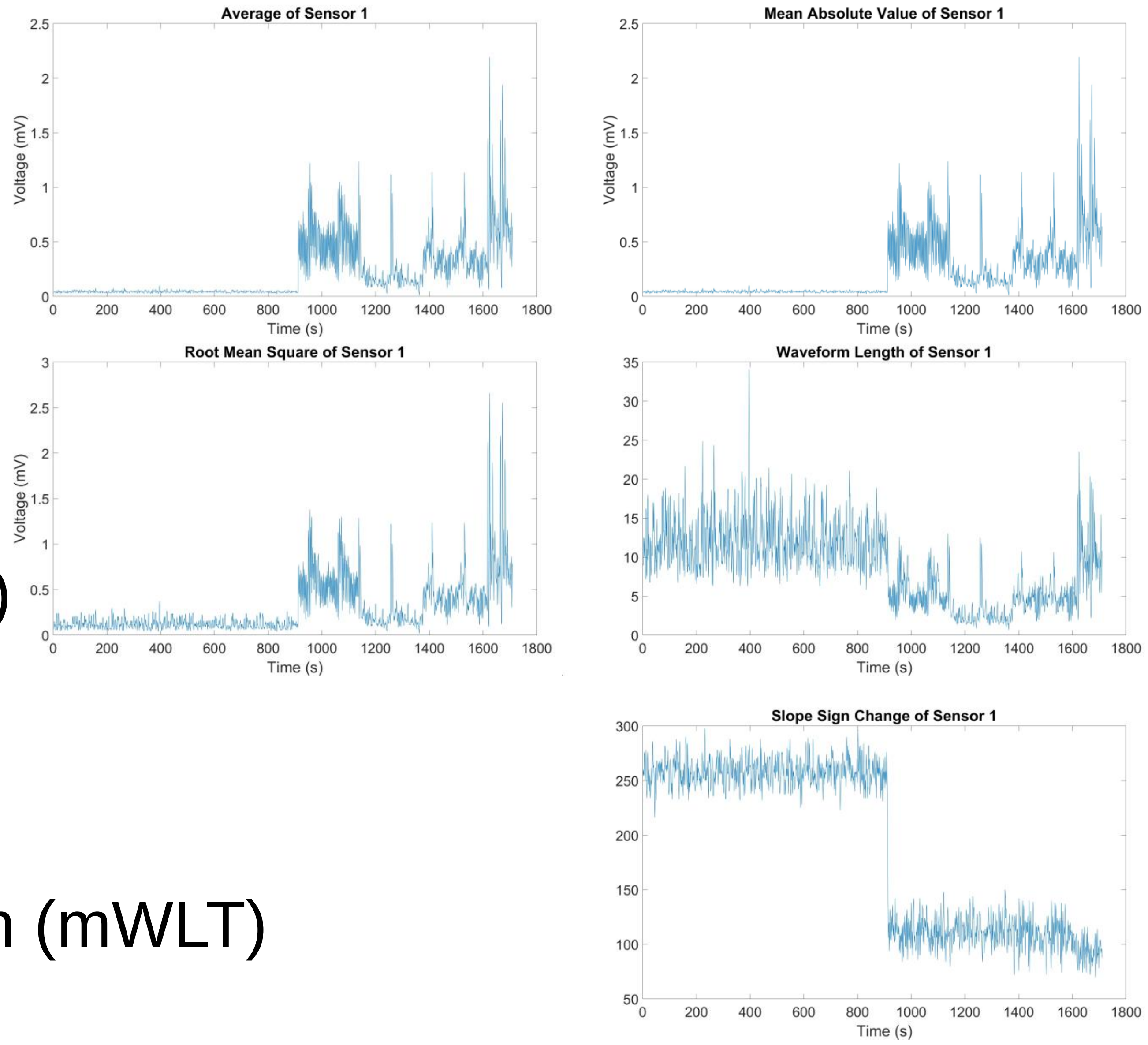
Classifier

- Linear Support Vector Machine
- Trained on NinaPRO DB1 open-source data
- Validation accuracy of 68.96%

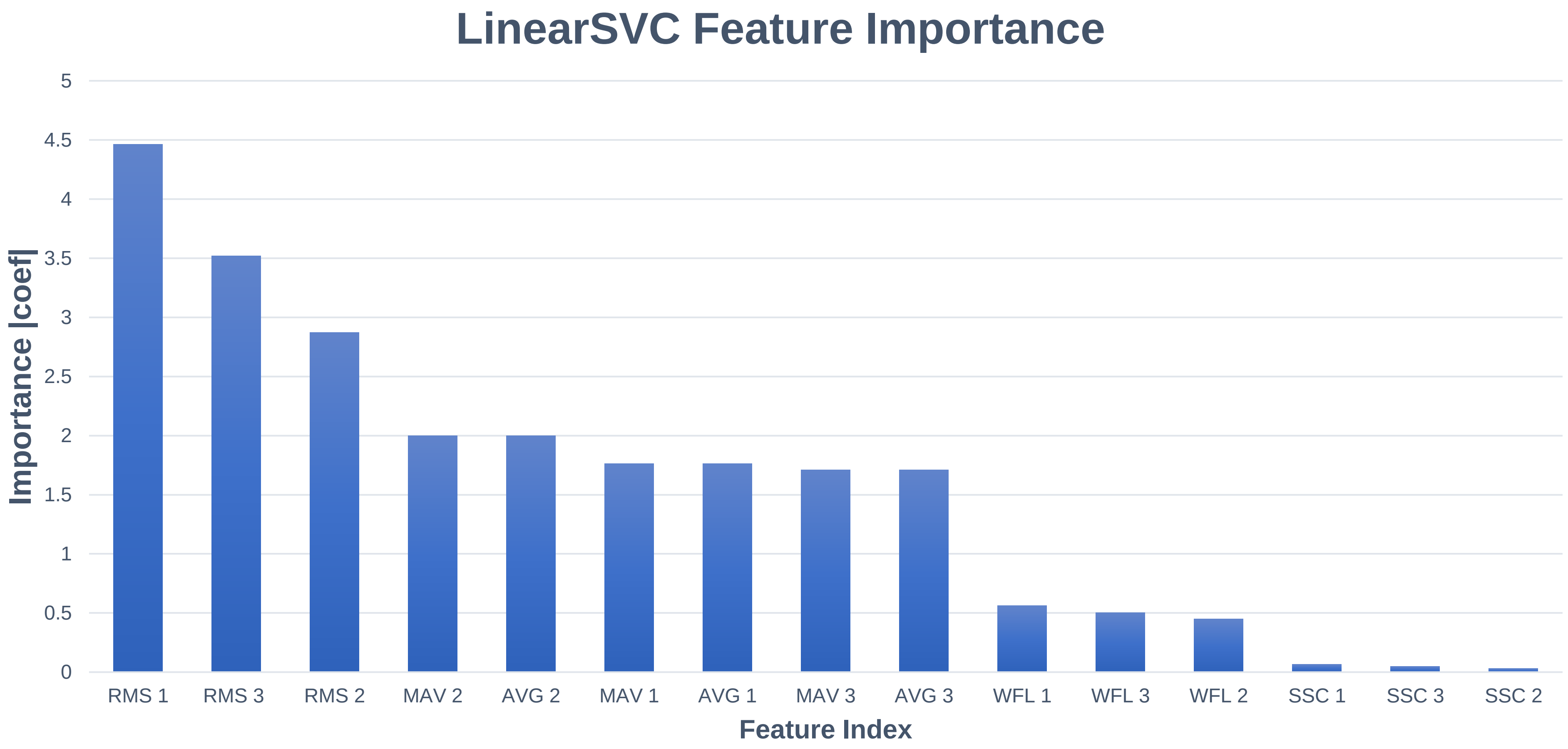


Features

- Average (AVG)
- Root Mean Square (RMS)
- Mean Absolute Value (MAV)
- Waveform Length (WFL)
- Slope Sign Change (SSC)
- Marginal Wavelet Transform (mWLT)
    - Currently not implemented



Features


LinearSVC Feature Importance
Importance |coef|
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
RMS 1
RMS 3
RMS 2
MAV 2
AVG 2
MAV 1
AVG 1
MAV 3
AVG 3
WFL 1
WFL 3
WFL 2
SSC 1
SSC 3
SSC 2
Feature Index

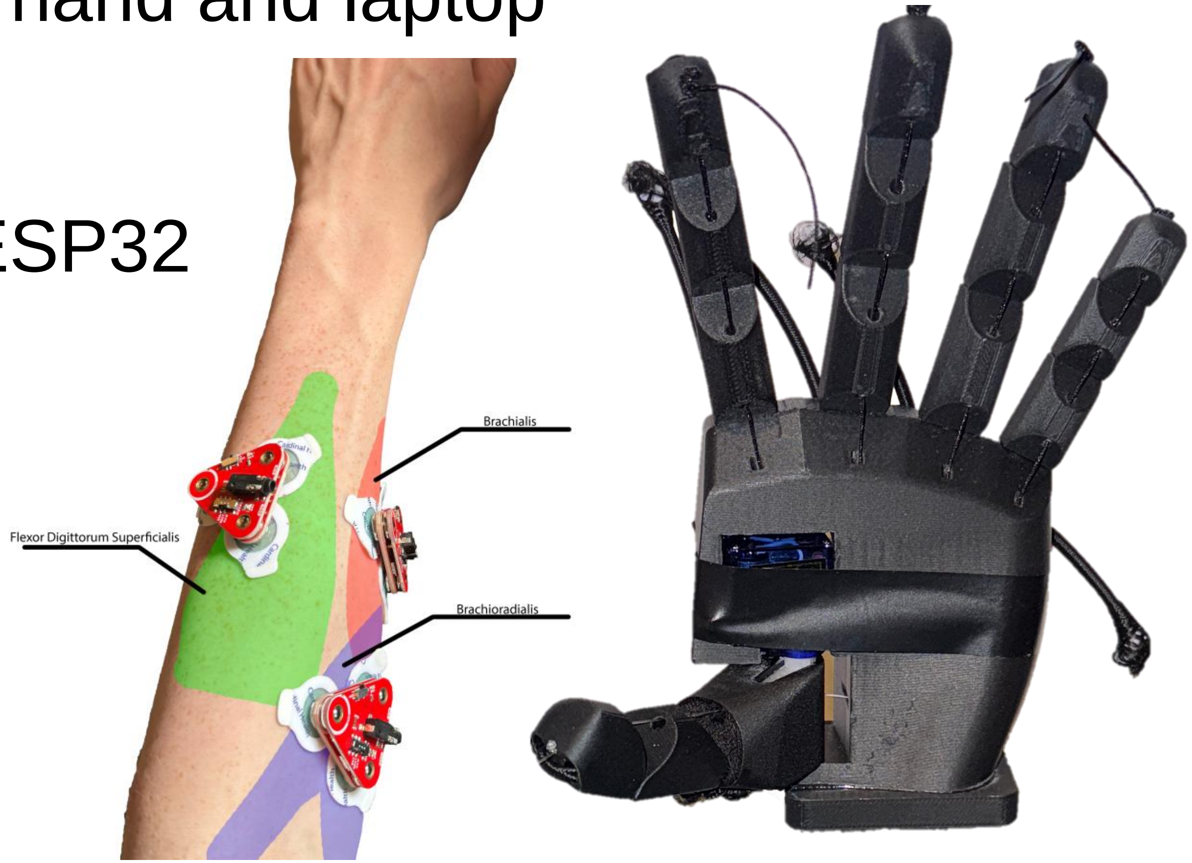
Robotic Hand

- Created by Sam Orgeldinger
- 3 Servo Motors mounted in the wrist
- Powered by an ESP32 microcontroller
- Currently has 5 distinct grasp positions

ESP32

Integration

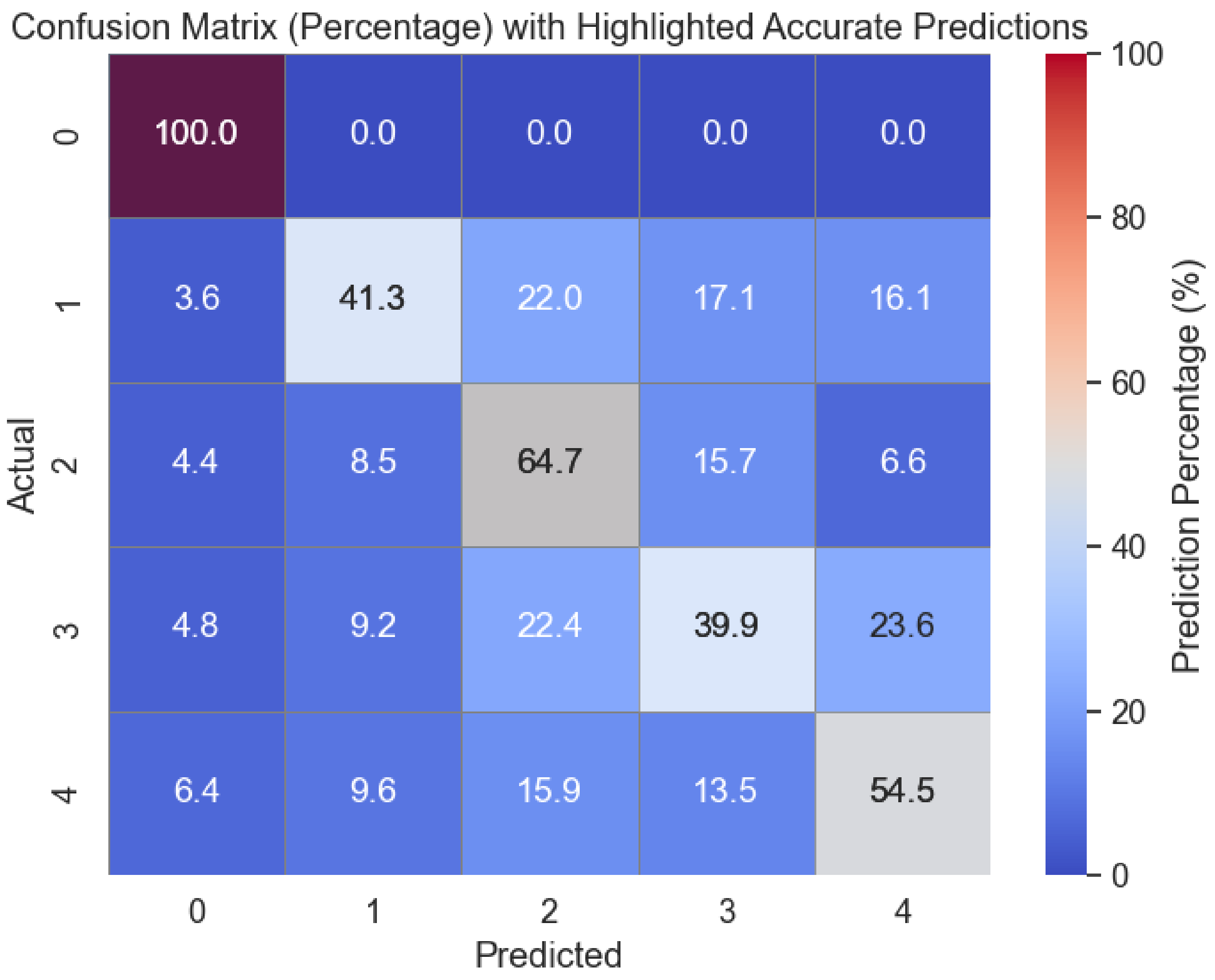
- Serial communication between hand and laptop
- 100ms between readings
- Sends classification output to ESP32



Results

Accuracy

- Accuracy: 63.4%
- Rest class achieved 100% accuracy
- Issues distinguishing between Ball and Cone



Demonstration

Future Work and Applications

Interpolation

- Interpolate between discrete grasp types
- Will allow for finer motor control
- Give more responsive control to user

Live EMG Testing

- Currently tested with prerecorded EMG data
- Testing with live data can show differences between prerecorded training data and real user data.

Further Integration

- Upload classifier and classification algorithm to ESP32
- More rigorously test hand positions

Applications

- Affordable prosthetics
- One size fits all approach