Project 2: Controlling a Mouse with EMG

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Sensor Placement:

Locations for sensor placement were left forearm, left gastrocnemius, and right gastrocnemius (Figure 1). These locations provide close contact to the muscle belly for a clear EMG signal reading and avoid cross talk between sensors.

Figure 1: Sensor placement on each limb.

Predictor Calculation:

An epoch length of 0.2 seconds was chosen to generate a high response smoothness. Given the duration of each activity (2s), this epoch length reduced inaccuracy occurrence during transition periods. Each sensor's EMG variance was calculated over the duration of the epoch. This variance was then used as the predictor of activity.

Thresholds:

The thresholds were chosen by plotting three histograms consisting of the variances in epochs for channel 0 (arm), channel 1 (left leg) and channel 2 (right leg). Using the histograms seen in Figures 2, 3 and 4, the thresholds were chosen to be 0.000014, 0.00003, and 0.000085 for the arm, left leg, and right leg, respectively. These values limit the number of false positives and negatives to optimize the accuracy.

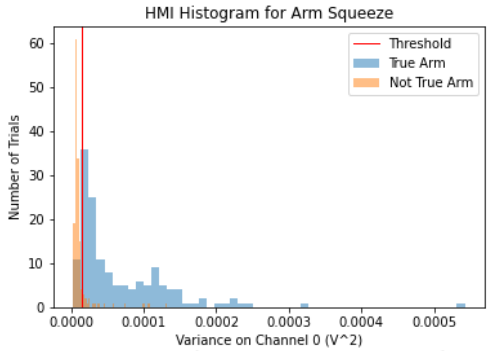

Figure 2: Histogram of variance data collected for the arm.

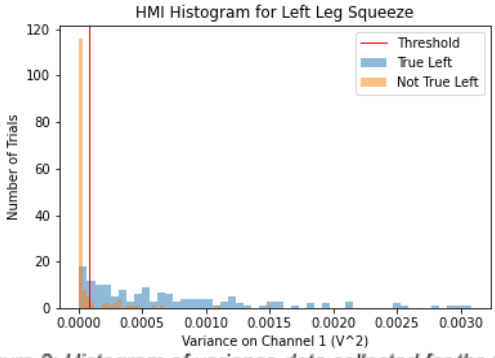

Figure 3: Histogram of variance data collected for the left leg.

Decision Mapping:

A 6 choice HMI was made by relating the actions performed during data collection to 6 different mouse movements based on the thresholds chosen. A correct prediction of the action(s) based on the thresholds for only the intended movement(s), would result in the mouse movement as seen in Figure 5. The relationship between these two events were made intuitively to limit errors that the user might make. Flexion of the left leg or right leg would move the mouse left and right, respectively. Flexion of the left leg and arm would move the mouse down. Flexion of the right leg and arm would move the mouse up. Lastly, flexion of all muscles would make the HMI click.

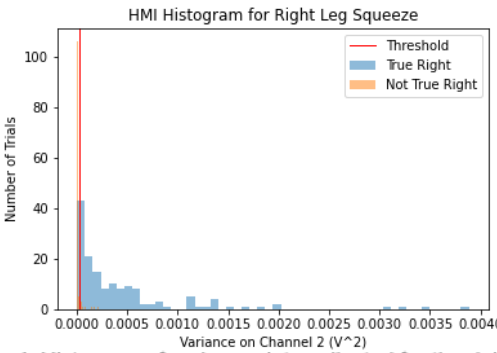

Figure 4: Histogram of variance data collected for the right leg.

Testing Protocol:

Participants were directed to perform six different actions including rest, left leg flexion, right leg flexion, left leg and arm flexion, right leg and arm flexion, and left leg, right leg, and arm flexion. Each action was performed for 2 seconds for a total of 60 seconds during the data collection process in Part B.

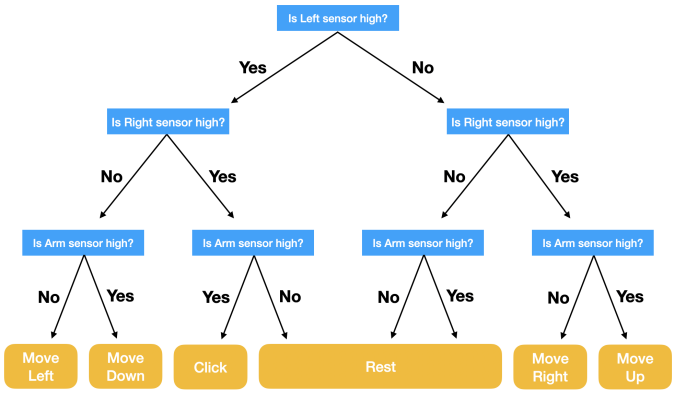

Figure 5: Decision Tree sorting EMG variances into GUI movements.

Performance:

The data collection process and evaluation of the HMI shows high accuracy for each action performed in Part B of the project. Figure 6 shows the HMI confusion matrix for the data collected which indicates that the greatest accuracy was in predicting rest compared to the other movements. In addition, there were fewer trials that properly predicted down and up. These could be from the difficulty of flexing either the left leg and arm or right leg and arm at the same time.The overall accuracy calculated was 72.3% and the Information Transfer Rate (ITR) was 5.46 bits/second.

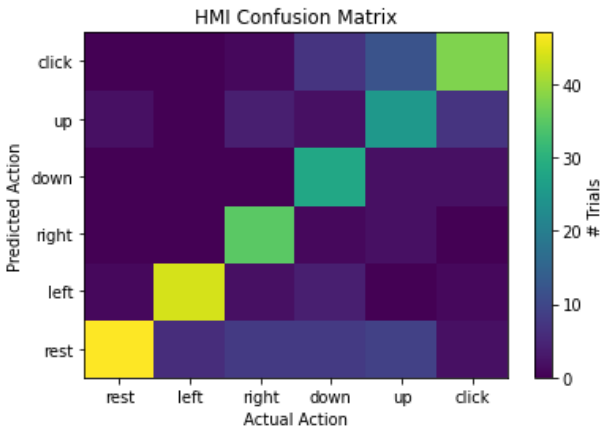

Figure 6: Confusion matrix of obtained data.