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BME 511 Final Proposal

1. What is the scientific question/biomedical/clinical application you will address and why is it important?

Since most wrist and hand movement is initiated by forearm muscles, a wrist bracelet EMG theoretically could be used to control robot/prosthetic hand movement. Robotic hands could be used to add an extra line of defense when working with dangerous chemicals or pathogens. Additionally, creating hand prostheses that are controlled by remaining forearm muscles could lead to a simple, noninvasive, and cheap hand prosthetics that are functional. EMG data is noisy and subject to large movement artifacts. I aim to use methods that reduce the noise while being able to actively predict muscle activation. The goal is to predict hand gestures of a healthy individual efficiently and effectively via forearm EMG data to showcase capability of achieving the above scenarios. In the long run, this gesture prediction can be applied to more fine motor movements, creating a more realistic human control.

2. What data you will use and where it will come from? Briefly describe the dataset.

The dataset is raw EMG data from the forearm of a single subject. The data is split into 4 files, each file relating to trials pertaining to one hand gesture: rock - 0, scissors - 1, paper - 2, ok – 3. The data itself is 8 trials of 8 sensors. Each gesture was held for 20 seconds per trial while voltage was recorded at a sampling frequency of 200Hz. This dataset is coming from an independent individual named Kirill Yashuk found here. The data is containing noise from the EMG and other unknown sources.

3. Formulation of the scientific question in signal processing problem terms, and how success will be evaluated.

Given such a large amount of recording time, the host of the data set was able to accurately predict the gesture 100% of the time. The goal is to determine how much data/time is needed to accurately predict the gesture after the gesture is initiated to see how responsive an actively recording forearm EMG could become. Success will be evaluated by training the data on 6 of the 8 trials and then testing it on the last 2 trials per gesture. Success is 99% confidence in gesture prediction with the testing group while reducing the time it takes for a gesture to be confirmed from 20 seconds to anything less than 20 seconds.

4. What approaches (signal processing techniques) will you try?

I plan to use an active filter on the white noise from the data. After filtering, a threshold can be set for each sensor to determine if an action potential has occurred. It should be noted that the threshold should be used with data that has low variance (as random variance may activate a static threshold), and therefore a model with bias towards prior constraints may be used to reduce noise and false positives of action potentials. Additionally, the specific combinations of sensors with action potentials can be used to map specific gestures. Lastly, as mentioned previously, I will create the model with training groups and then test it on testing files to show success at evaluating the correct gestures. The time value of when the model is 99% confident in the gesture will be recorded.

*Another potential idea for a threshold is the rate of change of voltage rather than just a raw voltage number. This could likely solve the variance issue and I will try both.

5. Describe two project objectives/aims that outline the extent of implementation for your project to earn an "A" grade for content; similarly describe what you would complete to earn a "B" grade.

An "A" for this project would be to specifically handle the data and accurately determine the gesture with 99% confidence as soon as possible rather than using all 20 seconds of data. A "B" for the project would be to use the whole 20 seconds of data and predict the gestures with 99% accuracy. In summary, accuracy of predictions should be 99% accurate and ideally the time it takes to predict the gesture should be less than 20 seconds. Both an A or B grade involve a detailed explanation and depiction of the strategies attempted within the project.

6. Any other relevant issues, literature, and factors influencing feasibility.

Any potential issues are out of my foresight at the current moment. I will be communicating on Slack if any issues arise. The smaller sample size makes this data less statistically significant, but with the number of trials performed, a model created from this data likely would suffice on other subjects.