EMG Signal Processing for Wearable Devices

Current classification techniques for many electromyography (EMG) based gesture controllers do not easily classify new gestures and struggle with generalizability across users.

Classifying new gestures allows EMG controllers to support more features and functionality. If the classifier is unable to accurately identify gestures performed across users, then long-term training may be required for new users. This can hinder a device's success and application to a broader audience.

Commodity wearable EMG controllers are a relatively new technology. Although myoelectric EMG prostheses have existed since the 1970s, prostheses are customized and user-specific. When used in prosthetics, assumptions are made about the data, such as: where the EMG sensors are placed, what muscle groups are being measured, and the physiological characteristics of the user in proportion to the device.

These assumptions should not be made for a wearable EMG device. New classification techniques must address when the sensor placement is not consistent between uses or users each time the device is worn. This data preprocessing step has yet to be fully addressed by current EMG research, limiting the potential of such technologies.

Classification of EMG signals often relies on a set number of known labeled gestures that the user can perform. This is done because it is often reliable and accurate for a specific user, and less computationally expensive compared to alternative methods. However, to create a more robust solution, online machine learning (ML) methods can be applied to the classification stage to allow variations of gestures, such as gestures made by new users or completely new gestures, to be categorized.

This project addresses the problem of new gesture classifications and robustness across users. It tackles the specific technical issues in real-world settings which are variations in sensor placement and inefficient machine learning algorithms.

If funded, this research will result in an algorithm that will be able to determine the location and orientation of the EMG device as it is worn in reference to its ideal position on the wearer. For example, if a user puts their wearable device on their wrist upside down and rotated, our preprocessing methodology will ensure the data will be usable and classifiable. The algorithm will then adapt the data to allow for better changepoint detection of partial actuation. Finally, the project will optimize and parallelize the chosen ML approach to enable real-time processing of incoming data.

Assuming a two-year time frame the research is scheduled as follows:
1st Quarter to 2nd Quarter: Collecting (using available open-source MyoWare), denoising, and preprocessing data
2nd Quarter to 4th Quarter: Classifying and validating data using real-time learning techniques

4th Quarter to 8th Quarter: Optimizing and parallelizing algorithms

Facebook’s research in wearable wrist-based interaction is directly applicable to the above research efforts. With Facebook’s funding, my time and resources will be dedicated to advancing EMG signal processing which will help progress the field of human computer interaction (HCI) in augmented and virtual reality (AR/VR).