JHU BCIS NTX Competition 2023 Project Proposal

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I. Introduction

A. Background, problem statement, and objective

Current combinations of EMG signal acquisition and prosthetic limbs allow amputated patients to recover a significant amount of their lost limb function. One major area of research concerns the connection between bioelectrical currents generated by the muscle and movements of the robotic limb. However, current research faces a tradeoff between the accuracy and efficiency of movement prediction, but both aspects are crucial to the patient experience while using the prosthetic limb.

Current research that achieves smooth movement prediction with regression typically suffers from low response time due to the complexity of the algorithm. On the other hand, researchers who achieved fast response time typically used pattern recognition algorithms, classifying EMG signals into categorical movements instead of smooth movements, resulting in less mobility for the amputee.

Our team aims to achieve both high smoothness and efficiency of movement prediction, such that the amputee may enjoy only brief delay to their intended movement and nonrigid, natural movement simultaneously, mimicking the function and mobility of a natural limb.

II. Methodology

Our goal is to develop an algorithm to smoothly and quickly map EMG data to finger joint angles in real time. EMG signal from the forelimb will be captured in 8 channels from a MyoBand (originally developed by Thalmic Labs), and the output will be reflected on a simple mechanical hand with 5 servo motors each controlling a finger. The algorithm will be run on a laptop, data will be sent from the MyoBand to the laptop via bluetooth, and we expect to send data from the laptop to the mechanical hand through bluetooth as well.

In order to train the algorithm, we plan to record EMG data from the forelimb while the finger movements are simultaneously captured and analyzed through MediaPipe Hand Landmarker. We will feed in recorded angles of the finger and the corresponding EMG time-series data, and then train the algorithm to map the former to the latter.

To validate this algorithm, we plan to eventually perform hand movements while forelimb EMG data is being recorded, and observe if the mechanical hand can accurately reflect human hand movement quickly.

III. Project Goals

1. Achieve continuous EMG signal collection
2. Achieve data streaming from the computer to the mechanical hand
3. Achieve continuous finger angle data using MediaPipe
4. Develop a functional regression model
    a. Accept training data from steps 1 & 3
    b. Take input of desired format (EMG signal)
    c. Produce output of desired format (mechanical hand finger angles)
5. Enhance model to reach desired accuracy
6. Enhance model to reach desired efficiency