Development of a Deep Learning Based Online EMG Classifier for Hand Movements Using Mentalab Explore

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

Electromyography(EMG) is biopotential that signifies the electric signal of muscle. EMG based classifiers are used in a lot of applications, both in clinical and research fields. In this project we aim to build an online hand-and- finger movement classifier for EMG signals using the Mentalab Explore(MLX) device that can interface with a virtual reality application.

Background and Motivation

Mentalab Explore (MLX)[1] is a versatile, high-end solution for biomedical recordings that provides research-grade precision in a mobile format. It offers different options to automate data pipelines: Data can be streamed to a Bluetooth device for real-time applications, or recorded for later offline processing. MLX contains various sensors for the acquisition of ExG, movement and orientation data.

Electromyography, or EMG, is a technique used to assess muscle electrical activity, typically involving the placement of electrodes on or within muscles. It serves dual roles in clinical diagnostics, where it helps diagnose neuromuscular conditions and assess nerve and muscle function during surgical procedures, and in research, where it plays a pivotal role in understanding muscle physiology, biomechanics, and motor control. EMG's versatility makes it invaluable in fields such as rehabilitation, sports science, and robotics, shedding light on the intricacies of muscle activity and function.

One interesting application of EMG is hand and finger gesture recognition. Convolutional neural network(CNN) and Recurrent neural network(RNN) based hand gesture classifiers have shown very good accuracy[2] compared to conventional machine learning methods. Finger movement recognition poses additional challenges as muscle activity and finger movement correlation is not straightforward in general. Deep learning based techniques have shown good accuracy in classifying movements based on hand and finger poses[3] recorded in EMG. However, these studies are not generalised and use different hardwares. They also report significant differences in online and offline classifiers[4].

Student's Tasks Description

The first part of the project involves recording the EMG with the aim of developing an online classifier based on hand gesture and finger movement based EMG signal using MLX device.

In the second part, the student will interface the classifier with a simple Unity based game as a proof of concept. A bonus feature would be a

multiplayer game based on the developed classifier.

The student will learn how to tackle a real-world problem, as well as to implement and evaluate the solution. He/she will gain hands-on experience in processing biological time-series, feature extraction, as well as in training and evaluating a machine learning model.

Technical Prerequisites

These skills are recommended for this project.

- Knowledge on basic deep learning techniques.
- Knowledge on Python based deep learning frameworks.
- Knowledge of signal processing and filtering techniques.
- Knowledge/motivation on Unity application development.

References

[1]https://mentalab.com/

[2] M. A. Ozdemir, D. H. Kisa, O. Guren, A. Onan, and A. Akan, "EMG based Hand Gesture Recognition using Deep Learning," in 2020 Medical Technologies Congress (TIPTEKNO), Antalya, Turkey: IEEE, Nov. 2020, pp. 1–4.

[3] M. A. Ozdemir, D. H. Kisa, O. Guren, A. Onan, and A. Akan, "EMG based Hand Gesture Recognition using Deep Learning," in 2020 Medical Technologies Congress (TIPTEKNO), Antalya, Turkey: IEEE, Nov. 2020, pp. 1–4.

[4] Ortiz-Catalan M., Brånemark R., Håkansson B. BioPatRec: A modular research platform for the control of artificial limbs based on pattern recognition algorithms. Source Code Biol. Med. 2013;8:1–18.