Utilizing Electromyography (EMG) as an Input Modality for Head-Mounted Displays (HMDs)
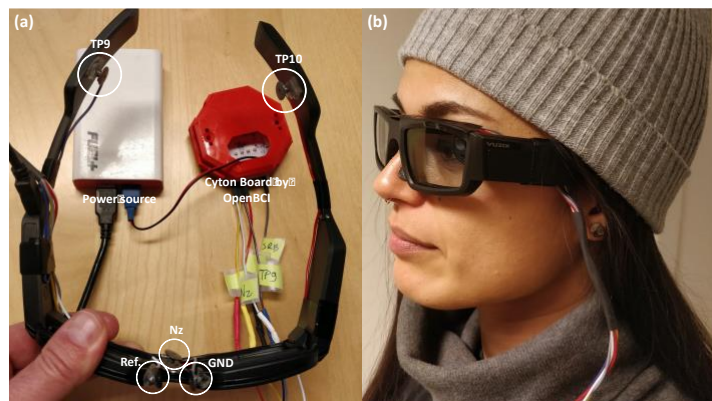
Supervisors: Michail Giannakos and Evangelos Niforatos
Place: LCI Lab: https://lci.idi.ntnu.no/
Suitable for: One student

Introduction

Interacting with an HMD (e.g., smart-glasses) has for long been a tantalizing problem with so far no effective solution. Current approaches utilize either touch surfaces on the side of the HMD (e.g., Google Glass), hand-held or worn controllers in the form of joysticks and rings (e.g., Focals), and some are still testing eye-tracking as an input modality. However, EMG—measuring the electric activity generated when muscles contract--may be a valuable alternative to efficiently providing input to HMDs. This thesis will use an existing EMG--HMD prototype for testing the idea of providing input to an HMD by contracting one's nasalis muscle (nose muscles).

Thesis Description

From the outset, the student will review the related literature in the fields of human factors, human face anatomy, and EMG to familiarize oneself with the fundamentals and the state of the art in the related fields. Next, the student will develop a wearable application prototype (in Android) that is able to connect to the OpenBCI board of the prototype (see Figure), detect and classify EMG signals (in Python), and enable one to perform simple interactions with the HMD (e.g., turn on display and navigate through the interface). The student will also develop the required back-end (e.g., in PHP/MySQL or Node.js) for collecting and storing the usage data (logs), and any additional metrics (e.g., EMG events and task completion times). The student will test the effectiveness of the proposed approach in lab settings by recruiting a sufficient number of participants (> 20). As a final step, the student will analyse the collected data and write up his/her thesis.

Requirements

The ideal candidate will have a strong background in Android application development and a strong will to develop for wearable and open hardware platforms such as smart-glasses and the OpenBCI development kit. Solid back-end programming skills (PHP/MySQL or Node.js), and an interest in hands-on development and experimentation is also a requirement. Knowledge in basic Machine Learning (ML) classification techniques is a plus. The recruitment of participants that will evaluate the proposed approach in a lab study is a strong requirement.

Programming skills: Android, Python, and PHP/MySQL or Node.js.

Norwegian University of Science and Technology

Expected Project Work Packages (WP)

- **WP1:** Literature study on human factors, human face anatomy, and electromyography.
- **WP2:** Develop a functional Android prototype that connects to OpenBCI board, detects and classifies EMG signals.
- **WP3:** Implement basic HMD interactions (e.g., turn on screen, navigate, launch app) and collect metrics.
- **WP4:** Recruit participants, conduct the lab study, collect data and analyze it.
- **WP5:** Write-up the thesis.

Thesis grading scheme

Grade	Description of the evaluation criteria
A	The candidate demonstrates excellent judgement and a high degree of independent thinking. **Significantly exceeded expectations** with original contribution.
B	The candidate demonstrates sound judgement and a very good degree of independent thinking. A very good performance, **the candidate has exceeded expectations.**
C	A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas, **the expectations are met but not surpassed.**
D	A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.
E	A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.
F	A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.