UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Thesis Project Form

Title (tentative): Neural correlates of learning to control a Body Machine Interface

Thesis advisor(s): Canessa Andrea, Maura Casadio Fabio Rizzoglio

E-mail: Andrea.Canessa@unige.it

Address: Via All'Opera Pia, 13 - 16145 Genova Pad E piano 1

Phone: (+39) 010 3532789

Description

Motivation and application domain

Body-Machine Interfaces (BoMIs) decode upper-body motion for operating devices, such as computers and wheelchairs. Body signals allows people with motor disabilities to operate the device by using motor skills that are still available to them. The use of the body instead of the neural signal is typically preferable because the magnitude of the former is an order higher compared to that of the latter. However, neurodegenerative pathologies, such as Amyotrophic lateral sclerosis (ALS), imply the progressive loss of those motor functions, thus requiring bypassing the motor system altogether. One possibility would be to learn a body-driven control at an initial stage of the pathology, and then seamlessly transition to a neural-driven one according to its progression. In this study, we want to assess the underlying correlates between neural and muscular signals to evaluate a candidate decoder for gradually shifting from a well-practiced body to a novel neural-driven control.

General objectives and main activities

The aim of the thesis is to perform a high-density electroencephalographic (hdEEG) â€“ electromyographic (EMG) study on a population of healthy subjects while performing a variety of learning tasks with a movement/muscle-based BoMI. The study will target different cortical areas (e.g., presupplementary and supplementary motor cortex, motor cortex, parietal cortex) and upper body muscles to assess cortico-muscular correlation and coherence. Moreover, the candidate will evaluate the neural correlates of learning with a BoMI both at a cortical and a muscular level. The analysis of the neural correlates in different neurodegenerative or traumatic pathologies (such as ALS, MS, Spinal Cord Injuries, Parkinsonâ€™s Disease) could help to find specific functional modifications/reorganizations at the level of the brain activity that could be used to develop new BoMIs tailored on the specific individual needs. The definition of these protocols, together with the experimental setup, will be part of the thesis work too.

Training Objectives (technical/analytical tools, experimental methodologies)

The candidate will learn to:
â€¢ manage, pre-process and analyse neurophysiological data (hdEEG and electromyographic signals) and kinematic data;
â€¢ develop the control of an external device based on signals coming from neurophysiological and kinematic sources;
â€¢ perform non-parametric statistical analysis;
The candidate will have the possibility to improve his/her knowledge of different programming languages such as MATLAB (Brainstorm toolbox, SPM, ...), Python (MNE Python toolbox), C#.

Place(s) where the thesis work will be carried out: DIBRIS, University of Genova

Additional information

Pre-requisite abilities/skills: The successful candidate should demonstrate the ability to acquire relevant skills reasonably fast. He/She should be willing to perform experiments with human participants. Desirable qualities in candidates include intellectual curiosity, a background in maths, skills in programming (e.g., C#, C/C++, Python, Matlab) and signal processing and analysis. Further assets are a creative mind, good problem solving skills and a collaborative and collegial attitude.

Maximum number of students: 2