Brain-computer interfaces use brain signals to control assistive and prosthetic devices. We are developing brain-computer interfacing technology to identify different body movements. Specifically, we are trying to develop a system to identify different hand and arm gestures/postures/movements that can be used to control a prosthetic arm. Competing laboratories have brain-computer interfaces that are capable of differentiating arm, foot or tongue movements, but none of them can distinguish different grasping strategies such as palmar grasp, pinch grasp and tripod grasp -all needed to control a prosthetic arm. We recently developed the first generation of a system capable of identifying several upper limb movements using noninvasive brain recordings. This project will take this technology from the prototype stage and create a device to identify specific hand movements/grasps in real time. The developed process will require modifying the system’s current algorithms, designed to operate offline, and testing the system with a larger number of individuals to obtain an initial performance matrix. The system will be developed with data we have already collected and the results will be used to design a pilot trial with a patient population.

Objectives

- To design a system to identify the intention to perform specific movements from online noninvasive electroencephalographic (EEG) recordings

- To implement the designed system

- To measure the performance of the system

Proposed Approach

Phase 1 (students #1, #2 and #3): Acquiring the Knowledge and Skills Required

The first stage of this three-month project will consists of becoming familiar with the current offline implementation of the feature extraction and classification process. In parallel, the students will explore potential signal processing techniques suitable for the implementation of the on-line version of the system.

Phase 2 (student #1): Design of the online system for identifying specific hand movements

Once the student has a good understanding of the implementation of the existing offline classification system and has identified relevant signal processing techniques, he/she will generate an initial design of an online version of the system. This design will be discussed with all the research team.

Phase 3 (student #2): Development of the online system for identifying specific hand movements

The third stage will consist of the implementation of the designed system. It is expected that this portion of the project will be highly iterative; the student will be working closely with the research team during this process.

Phase 4 (student #3): Performance measurement

Finally, the project will require the student to measure the performance of the system to understand its behaviour with greater detail.

Environment

The project will take place at the Rehabilitation Engineering Laboratory at the Toronto Rehabilitation Institute, University Health Network in Toronto, Canada (www.toronto-fes.ca). Students will have access to a variety of software packages (e.g., National Instrument’s LabView and Mathwork’s Matlab) to complete the project as well as scientific instruments for the acquisition and recording of electroencephalographic (EEG) signals. The students will be part of an active research group that consists of 40+ individuals including 15+ graduate students, 10+ undergraduate students, 3-5 postdoctoral fellows, and 6 scientist, and where teamwork and collaboration is encouraged strongly. The Rehabilitation Engineering Laboratory is one of the leading research laboratories in the field of neuroprostheses development and implementation in the world.