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| Title: | **EEG Controlled 3D Printed Prosthetic Hand** |
| **Supervisor:** | Kaushik Mahata |
| **Level of Difficulty:** |  Easy (Pass type project),   Medium Difficulty (Pass to Credit),   Difficult (Credit to Distinction),  🗹 Challenging (Distinction to High Distinction). |
| **Assumed knowledge:** | ELEC3730, ELEC4410, ELEC3400, ELEC3240, ENGG3500, ELEC3850, ELEC2440 |
| **Type of Project:** | 🗹 Hardware  🗹 Software   Simulation  🗹 Literature Search |
| **No. of Students:** | 🗹 Single   Group |
| **Description**:  The aim of this project is to design and construct a 3D printed prosthetic hand controlled by decoding neural activity. The device will amplify and filter real-time electroencephalography (EEG) data from an EEG cap, conduct a frequency analysis, then use classification techniques to determine the state of the wearer’s hand (open or closed). This classification will be used to drive the servos in the prosthetic device. This will enable grasping of items such as umbrellas, water bottles, and cutlery, which would have a dramatic effect in the lives of people living with upper limb amputations, spinal cord injuries, or degenerative diseases.  **Outcomes Expected:** Real-time neurally controlled grasping. This will be achieved through binary classification of EEG data.  **Resources:**   * An EEG Cap and electrodes * A 3D Printed Prosthetic Hand and Wrist   + STL Files are available in the references section, however electronic components will be required.   **References:**  <https://pdfs.semanticscholar.org/c864/6a15245732a8f91fb74294562b99d19628df.pdf>  <http://inmoov.fr/hand-and-forarm/>  <https://ieeexplore.ieee.org/document/6564011> | |

# Scope

## Context

Across the globe, thousands of people suffer from upper limb disabilities. These disabilities may be due to amputation, stroke, spinal cord injuries, or degenerative diseases. In many cases, the patients’ motor cortical function remain intact, however due to their condition, the neural signals to not reach their destination with enough integrity to enable the desired action. The solution to this problem is neuroprosthetic devices. These experimental devices decode the neural activity of the patient to enable classification of motor intent. These classifications are then used to control a robotic prosthetic device. Such devices are currently being researched, and with continued endeavor, will be clinically available in our lifetime. A survey conducted by Engdahl et al concluded that participants showed the most interest in simple prosthesis features (such as opening and closing the hand slowly), rather than fine motor control and touch sensation. This indicates that there is a real-world interest in the development of devices similar to that proposed in this project.

## Nature of Work

The project will involve:

* Analog Electronics (for filtering and amplification of the EEG signals),
* Embedded System Software Development (for the implementation of an AAR, or SVM classification approach, or similar),
* Signal Processing (to conduct a frequency analysis of the EEG signals),
* Project Management (to ensure all outcomes are met and the project remains on schedule),
* Systems Engineering (to interface the data acquisition and processing modules with the prosthetic), and
* Control Systems (to convert the classification into a joint angle).
  1. **Relationship to Other Courses Completed**

It is anticipated that this project will draw on knowledge developed during:

* ELEC3730 – Digital and Computer Electronics 2
* ELEC3400 – Signal Processing
* ELEC3240 – Analog Electronics
* ENGG3500 – Managing Engineering Projects
* ELEC3850 – Electrical Engineering Design and Practice
* ELEC2440 – Modelling and Control
  1. **Goals of the Project**

The goal of the project is to achieve real-time neurally controlled grasping, by decoding EEG signals to control a 3D printed prosthetic hand.

# Supervision

Dr Kaushik Mahata has graciously agreed to supervise this project.

# Commercial Confidentiality

It is not anticipated that any aspect of this project will be subject to any commercial-in-confidence agreements.

# Intellectual Property

To preserve the student’s ability to pursue subsequent development in this area, the respective contributions of parties involved will be clearly documented.

# Equipment and Consumables

To achieve real-time online processing, an EEG cap would be required. Dry electrodes would be preferred, due to their easier set-up. It is anticipated that an appropriate cap will be sourced by the student, who will then claim a reimbursement from the Final Year Project Budget. Thus, the University will have claim to these items at the completion of the project.

The prosthetic hand and wrist can be 3D printed using the .STL files available to download from inMoov. It is anticipated that the University can 3D print these files. As such, the University would have claim to the printed components at the completion of the project.

Additional electronics such as servos will be claimed under the project budget, so will remain property of the University.