MSc Internship project proposal 2021

“Augmented reality for upper limb amputee patients”

Who we are:

Campus Biotech is a Swiss center of excellence in biotechnology and life sciences research focusing on three domains: Neuroscience & Neurotechnology, Digital Health and Global Health.

The Virtual Reality Facility (https://hnp.fcbg.ch/home/virtual-reality/) at the Fondation Campus Biotech Geneva (FCBG) is part of the Human Neuroscience Platform and provides researchers with state-of-the-art equipment and expertise in the field of immersive interaction and motion analysis in virtual reality for experimental research and clinical applications (e.g., cognitive and affective assessment, cognitive and behavioral therapy, neurological rehabilitation, gait and upper limb neuro-prostheses).

Project description:

Despite the advances in Robotic Prosthetic Hand (RPH) for amputee patients, we are still far from a solution that permits to restore the level of dexterity of the natural hand. Three domains are particularly hot research areas for this purpose: a) Development of light, robust RPH with many degrees of freedom, b) Decoding algorithms permitting real-time detection of motor intensions (ideally for continuous single finger movement), and c) realist sensory feedback (e.g., tactile, proprioceptive) to inform the subject of the interaction of the RPH with the surrounding world (extrinsic feedback) and the state of the RPH (intrinsic feedback). The increase of the sophistication of the algorithm for motor decoding and sensory encoding comes at the price of the complexity of the subject’s training to master the system.

We want to implement an Augmented Reality Hand (ARH) and virtual objects for the training and the validation of decoding and stimulation strategies with amputee patients. The final setup should include a HoloLens 2, the real-time tracking of the patient stump, easy to adapt rendered hand (different amputation height, hand size) that can be controlled and visualized in real-time, and a set of virtual objects for manipulation. One of the goals will be to simulate the Action Research Arm Test assessment (ARAT) 2 using this setup. The advantage of such a strategy is that it is independent of the chosen RPH and permits to test different decoding strategies in an ideal environment. The candidate should also
implement the physical interactions between the ARH and the objects and simulate objects with different stiffness, shapes, and sizes. The candidate will work closely with the project's scientific supervisor to integrate the ARH with EMG-decoding (Electromyography, i.e., recording of muscular activity) and non-invasive sensory feedback. Tests with healthy subjects will be done to validate the system. If successful, the setup will be used for the training with transradial amputee patients.

Project planning:

The project requires to:

- Create a 3D model of a Robotic Prosthetic Hand
- Develop the AR reaching task
- Mask the real hand (for healthy subjects) and replace it by the RPH 3D model
- Manage the interaction between the AR task, EMG-decoding and non-invasive sensory feedback

Who should apply:

We are looking for excellent candidates with a strong engineering background and interest or initial training in neuroscience. Prior experiences in virtual reality, physics simulations and signal processing are recommended. This project will involve software development (C++/C#, Unity3D) and to conduct a behavioral experiment involving signal processing and analysis (Python/MATLAB).

The internship is for MSc level students performing their 5/6-months final research project in 2021. The position is full-time at FCBG in Campus Biotech.

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