Mini-symposium on "challenges for adaptive control and sensorimotor restoration in bionic prostheses"

January 21st, 2021, PM (14:30-18:00)

Part I – invited talks

The first part of this event can be attended via the following Microsoft Teams link.

14:30-15:15: Prof. Silvia Tolu, Technical University of Denmark – https://bioroboticsdtu.wordpress.com/

Title: **Brain-based Technologies For Adaptive Robotic Systems**

15:15-16:00: Dr. Benoît Delhaye, UCLouvain - https://delhayeben.github.io/

Title: **Restoring natural tactile feedback in bionic hands through a peripheral nerve interface**

Abstract: Tactile feedback is essential to achieve a dexterous bionic hand. Without touch, interactions with objects are slow and clumsy, and require constant attention. In this talk, I will describe advances toward restoring useful somatosensory feedback in bionic hands through electrical stimulation of the peripheral nerves using chronically implanted electrode arrays. First, I will show that the perceived intensity of a tactile stimulus can be systematically manipulated by modulating the aggregate response of tactile nerve fibers and discuss how this response can be systematically manipulated by controlling stimulation parameters. Second, I will demonstrate that electrical stimulation of the nerve is subject to adaptation – an adjustment of sensitivity – and that electrically induced adaptation is similar to its mechanically (naturally) induced counterpart. Third, I will discuss the advantages of the biomimetic approach to tactile restoration. In brief, the closer we can mimic the activity that would be produced in the nerve during natural tactile interactions with objects, the more natural and useful the evoked sensations will be. I describe an approach we have developed to convey such naturalistic tactile feedback.

Part II – public defense of the PhD of Sophie Heins, UCLouvain

From 16:15 to about 18:00. The second part of this event can be attended via the following Microsoft Teams link. The defense will be in French, with slides in English.

Title: **Design and Evaluation of Bio-inspired Control Strategies for Transfemoral Prosthesis**

Abstract: Despite recent developments in solutions for replacing the missing limb of transfemoral amputees and restoring natural locomotion, their use remains limited. An emerging trend for designing the control strategies for prosthesis actuators takes advantage of bio-inspiration, i.e. with control laws relying on biological principles that have been identified in healthy locomotion. In this dissertation, bio-inspired control strategies for a powered transfemoral prosthesis are developed. The following biological concepts are explored: (i) Central Pattern Generators (CPGs), which can be seen as coupled oscillators providing the rhythmic characteristics of locomotion; (ii) motor primitives, which are considered to be the principal components of muscles stimulations; and (iii) inverse internal models of the cerebellum, which plays an essential role in motor learning. This work presents the progressive development of three controllers for a representative compliant prosthesis. The first controller simply incorporates reference torque and angle profiles associated to healthy walking taken from the literature. The second controller includes artificial torque and angular primitives that, through proper recombination, generate the reference torque and angle patterns for both joints. It also integrates an artificial CPG implemented by an adaptive oscillator that continuously detects the locomotion parameters. The last controller incorporates an iterative learning mechanism implementing an inverse model for computing a prediction torque component for both joints. To validate the developed controllers, two experiments involved a transfemoral amputee walking on a treadmill, while a third experiment was performed with a simulated biped walker with a transfemoral amputation, as a first validation of the controller before its implementation on a real prosthesis.