Mini-symposium “robotics and motor control”

June 8th, 2016, Louvain-la-Neuve, Belgium

Program at a glance

14:00 – Talk by **Prof. Jean-Jacques Orban de Xivry** (KULeuven) - http://jjodx.weebly.com

Place: Stevin building, floor 0, room b.044

Humans might not be as effective as robots for reaching movements

Movement planning consists of choosing the intended endpoint of the movement and selecting the motor program that will bring the effector on the endpoint. It is widely accepted that movement endpoint is updated on a trial-by-trial basis with respect to the observed errors and that the motor program for a given movement follows the rules of optimal feedback control. Here, we show clear limitations of these theories because of the existence of a switching cost for motor planning. First, this cost prevented participants from tuning their motor program appropriately for each individual trial. Second, we found that randomly changing the width of a target over the course of a reaching experiment prevents the motor system from updating the endpoint of movements on the basis of the performance on the previous trial if the width of the target has changed. These results provide new insights into the process of motor planning and how it relates to optimal control theory. It also highlights the limitations in using bio-inspired strategies for controlling robots.

14:50 – Talk by **Prof. Wisama Khalil** (Ecole Centrale de Nantes) - http://www.irccyn.ec-nantes.fr

Place: Stevin building, floor 0, room b.044

General Dynamic solution for Floating Base Tree Structure Robots with Flexible Joints and Links

This paper presents a general algorithm for solving the dynamics of tree structure robots with rigid and flexible links, active or passive joints, and with a fixed or floating base. The algorithm treats in a unified approach both the inverse and direct dynamics. It addresses also the hybrid case where each active joint is considered with known joint torque as in the direct dynamic case, or with known joint acceleration as in the inverse dynamic case. The main common feature of floating base, flexible joints, and links deformation degrees of freedom is that they are not actuated. Consequently, their accelerations cannot be prescribed, but rather have to be determined through the dynamic model. These three types of variables will be denoted as passive, and their accelerations must be determined in any dynamic problem. To that end, we propose a common framework based on the generalization of the efficient recursive Newton-Euler algorithms of Luh, Walker and Paul and of Featherstone, which are devoted respectively to the inverse and direct dynamic models of systems with rigid links and active joints. The link deformation is considered by the floating frame method, which is based on considering that the total motion of each flexible link is the result of the linear deformations of a mobile (and rigid) reference configuration to which is attached a rigid frame. The general algorithm is easy to program either numerically or using efficient customized symbolic techniques. It is of great interest for studying floating base systems with soft appendages as those currently investigated in soft bioinspired robotics or when a robotic system has to modify its structure for some particular tasks; such as transforming an active joint into a compliant flexible one, or modifying a task with a floating base into one with fixed base.

15:40 – Coffee break

16:00 – PhD public defense of **Virginia Ruiz Garate** (UCLouvain) - https://www.researchgate.net/profile/Virginia_Ruiz_Garate

Place: Auditoire BARB 91

Bio-Inspired motor primitives for controlling leg exoskeletons

Locomotion assistive devices have gained increasing attention during the last years. In order to enhance the control of these devices, an emerging approach deals with capturing biological principles to emulate desirable features of human locomotion.

In this thesis, a novel assistive controller based on the bio-inspired concept of motor primitives is presented. Motor primitives are seen as fundamental units of action, which through proper recombination can generate a high-dimensional set of stimulations. These stimulations activate the body muscles and thus generate movements. This work focuses on the particular use of primitives for assisting rhythmic locomotion tasks. Also, other bio-inspired locomotion mechanisms based on feedback are explored: short-loop reflexes and torso-balance control. In simulation, a bipedal walking model is developed by combining these different sources of muscular stimulation. This tool allows to explore the relative contributions of these mechanisms in human locomotion.

Next, this thesis focuses on the validation of the controller for delivering assistance using artificial primitives during different experiments. The first one illustrates that the controller is able to work in real-time while providing assistance. The second set of experiments tests the controller performance when being used with a gait-impaired subject. Finally, the last set of tests aims at challenging the full capability of the controller by assisting healthy subjects during different locomotion tasks.

These experiments highlight the capacity of volunteers to naturally interact with the device and generally benefit from the assistance. Importantly, when assisting different locomotion tasks, the controller is able to effectively handle the transitions between them without needing to stop in between.