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SEMINAR NOTICE

Time-Varying and Parameter-Varying Methods to Identify Ankle Joint Dynamic Stiffness

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1:00 p.m. Room 267
Macdonald Engineering Building,
817 Sherbrooke St. W.

Joint stiffness is the dynamic relation between the position of a joint and the torque about it. Understanding and modelling the dynamic behavior of the joint stiffness can provide insight on the mechanisms behind the control of posture and movement. Joint stiffness represents the load that the central nervous system must control and the immediate response to perturbations. Joint stiffness has two main components: intrinsic stiffness due to mechanical properties of the joint and muscles; and reflex stiffness due to reflex activation of the muscles acting on the joint. Joint stiffness is a Non-Linear Time Varying System, where the parameters of the system change with the activation level and position. People have tried to identify the system using different forms of linearization (when the operating point is constant). However, these models cannot be applied to activities of daily living (ADL), where the ankle undergoes rapid changes of position and activation level. To overcome this issue, time-varying (TV) methods using temporal expansion have been developed at Robert Kearney's lab by Diego Guarin. This method produces a better and more general model. However, TV models require many parameters (some of which do not even have physical relevance), and cannot predict the response to new trajectories. As an alternative, a linear parameter varying (LPV) algorithm has also been developed at this lab by Ehsan Tehrani. The LPV method assumes that the system is not directly TV, but depends on one or more scheduling variables (SV) that are TV. The LPV algorithm can predict the behavior of the system depending on its SV's. However, the LPV method requires more a priori information to identify the SV's that are going to be used for identification.

During my project, I want to explore how robust are these methods and under which conditions they can be applied. My project will consist in using these methods to identify a model of ankle stiffness, where the conditions vary with time. First, I will assess the accuracy and precision of each method for different SV trajectories. Then I will explore how the TE method can hint us on the nature of the SV and the order of dependence between the system and SV. Finally, I will explore how the LPV method reduces the complexity of the system only when the SV is well chosen and how the accuracy and precision vary when the SV is chosen incorrectly.

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