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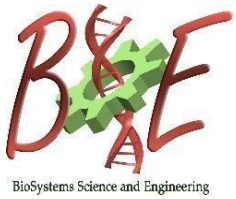

BSSE Colloquium

24 July 2019, 11:30 AM, MRDG Seminar Hall, 1st floor, Biological Sciences Building

A Control Systems Approach to Understand the Principles of Saccadic Eye Movements

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Abstract:

Movements, being critical for survival are usually efficiently carried out because they are well supported by a robust motor system. Although biological descriptions of the structure and function of the motor system are abundant, the knowledge of many fundamental principles underlying motor control remains elusive. Research in motor control has extensively used control systems approaches like optimal control, feedback control, and predictive control to understand the motor system. But these studies have largely been restricted to investigating the central tendencies of movements like mean kinematics. But owing to the inherent noise in the motor system, behavioral movements exhibit considerable variability even when carried out repeatedly to the same goal. Hence, it is imperative to study variability in movements and consider it an important aspect of motor control.

In this thesis, a type of voluntary eye movement called saccades is studied, with emphasis on mean trajectories as well as inter-trial variability. By investigating natural variability in saccade behavior and modelling the saccadic system in the presence of noise, more insights have been gained into principles of the saccadic system that enables it to be successful despite the noise. One approach that incorporates behavioral measures of variability in understanding principles of motor control is the stochastic optimal control framework. Using this framework, evidence of usage of a desired velocity-based trajectory plan in the saccadic system is provided. This is an important finding given that the dominant view in the field is that saccades are planned based on target displacement only. Saccade generation system is extensively modelled based on feedback control. Saccades cannot make use of sensory feedback since they are fast and hence are hypothesized to be performed using internal feedback. But the nature of this internal feedback signal has hitherto been unclear. This question is addressed in this thesis using a stochastic saccade generation model with internal feedback and behavioral variability in saccades. In particular, it is shown that the saccadic system may be using both velocity and displacement feedback information. This new dual model framework is also validated for an oblique saccade generation system with noise.

This work emphasizes how studying variability in movements using stochastic modelling can be an efficient approach to understanding motor control. The aim is to provide deeper insights into the principles of the motor system and enable development of therapy and technology that can improve rehabilitation of patients with movement disorders.