SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

OPTIMAL CONTROL AND SYNCHRONIZATION OF DYNAMIC ENSEMBLE SYSTEMS

DISSERTATION DEFENSE
By

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Abstract: Ensemble control involves the manipulation of an uncountably infinite collection of structurally identical or similar dynamical systems, which are indexed by a parameter set, by applying a common control without using feedback. This subject is motivated by compelling problems in quantum control, sensorless robotic manipulation, and neural engineering, which involve ensembles of linear, bilinear, or nonlinear oscillating systems, for which analytical control laws are infeasible or absent. My focus is on constructive control design methods for practical ensemble control problems.

The first result is an efficient numerical method based on the singular value decomposition (SVD) for the synthesis of minimum norm ensemble controls for time-varying linear systems. This method is extended to iterative techniques to accommodate bounds on the control amplitude, and to synthesize ensemble controls for unitary bilinear systems. Convergence properties for these methods will be discussed. Example ensemble systems include harmonic oscillators, quantum transport, and quantum spin transfers on the special orthogonal group SO(n), in particular the Bloch system on SO(3).

I will also discuss the control of ensembles of nonlinear oscillators, which occur in neuroscience, circadian biology, electrochemistry, and many other fields. The ability to optimally manipulate such systems provides insight into treatments for disorders such as Parkinson's disease and epilepsy. A key phenomenon is entrainment, which refers to the dynamic synchronization of an oscillating system to a periodic input. Phase coordinate transformation, formal averaging, and the calculus of variations are used to derive minimum energy and minimum mean time controls that entrain ensembles of non-interacting oscillators to a harmonic or subharmonic target frequency, and establish desired dynamical structures in collections of inhomogeneous rhythmic systems.

DATE: **Wednesday May 7, 2014**
TIME: **1:10 p.m.**
PLACE: **Green Hall, Room 0120**

Dissertation advisor:
Dr. Jr.-Shin Li

This seminar is in partial fulfillment
of the Doctor of Philosophy degree

Washington University in St. Louis
SCHOOL OF ENGINEERING & APPLIED SCIENCE