



The Center for Control, Dynamical Systems, and Computation
University of California at Santa Barbara
Presents

Ensemble Control: New Directions in the Mathematics and Applications of Control

Jr-Shin Li
(Faculty candidate)

Wednesday, April 22, 2009 9:30 am HFH 4164

Abstract:

Many applications in control of quantum systems involve controlling a large ensemble, on the order of Avogadro's number, by using the same control input. In practice, the elements of an ensemble could show variations in the parameters that characterize the system dynamics. A canonical problem in such applications is to develop external excitations (control signals) that can simultaneously drive an ensemble of systems with distinct dynamics from an initial state to a desired final state. From a viewpoint of mathematical control theory, this is a very challenging state transfer problem because it requires steering a continuum of parameterized dynamical systems between points of interest in an infinite dimensional state space with the same control function that is insensitive to the parameters. We call such problems Ensemble Control. This rising area raises new and unexplored questions about controllability, computation, and optimal control of such systems. A systematic study of these systems has immediate applications to promising areas, such as Nuclear Magnetic Resonance (NMR) spectroscopy and imaging (MRI), and moreover it makes new methods to analyze dynamical systems with parameter uncertainties, which are ubiquitous in all areas of science and engineering. In this talk, I will introduce ensemble control and the notion of ensemble controllability. In particular, ensemble control will be motivated by pulse sequence design problems in NMR and MRI. I will present new methods to study controllability of ensemble control systems. This work leads to the design of compensating pulse sequences in magnetic resonance research and coherent spectroscopy. I will then extend the concept of ensemble control to general control systems, e.g., finite dimensional time-varying linear systems, and to uncertain dynamical systems. Finally, I will discuss how to synthesize optimal control designs for ensemble control systems based on pseudospectral approximations.

About the Speaker:

Jr-Shin Li is currently an assistant professor in the Department of Electrical and Systems Engineering at Washington University in St. Louis. He joined Washington University in 2006 and has held a joint appointment in its Division of Biology & Biomedical Sciences since 2008. He received his B.S. and M.S. degrees from National Taiwan University and his PhD degree in Applied Mathematics from Harvard University (2006). His research interests lie in the areas of control and optimization with applications to biomedical and physical systems such as Nuclear Magnetic Resonance (NMR) spectroscopy and imaging (MRI). He is a recipient of the NSF Career Award in 2007.
