SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

ANALYZING AND CONTROLLING DYNAMIC STRUCTURES IN COMPLEX NETWORKS

PhD Preliminary Research Examination

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Abstract: Population of dynamical systems are prevalent in nature and engineered systems, where each individual unit plays a crucial role in the functioning of the entire system. Robust control of such a large collection of dynamical units is challenging, and is made more difficult when the individual units interact with each other and form a complex network. Often, these units have to work in tandem to achieve a desired dynamic behavior, e.g., maintaining synchronization of generators in a power grid, or conveying information in a neuronal network. Such dynamic structures in complex systems can be affected and manipulated by the application of exogenous inputs. For example, in biological systems, when a population of dynamical units deviates from its normal behaviors, e.g., a neuron population during epileptic seizure is synchronous, an external stimulus, in the form of a drug or electrical signal, can be applied to re-establish its normal functions. This inspires the need to devise optimal control laws for a given objective subject to the available resources. Optimization of resources used for control is of particular interest for the general public as it can provide significant savings in costs, for instance, for seizure patients or customers of power utilities.

In this talk, I will address the problems of controlling a collection of complex, uncoupled and coupled dynamical units, described by bilinear and nonlinear systems. Furthermore, I will present my work on the resource optimization problem that is cast as an optimal control problem for some classes of ensemble systems, or as a problem of optimal placement of driver nodes in networked systems under a pinning control strategy. Relevant applications in biological, social, and engineered networks will be discussed. In particular, I will present an iterative method for designing optimal tracking controls for bilinear systems. The conditions for the existence and convergence of the iterative control law will be given, followed by various numerical examples demonstrating the effectiveness of the method. I will further discuss extensions of this control approach to nonlinear networked systems and ensembles of phase models. Potential applications include, synchronization, desynchronization, phase assignment and entrainment of limit cycle oscillators, as well as clustering and pattern formation for such oscillatory systems. The talk will be concluded by discussions of future work, including the control of thermostatically controlled loads for demand response application using a phase modelling and control approach.

DATE: Friday, October 20, 2017
TIME: 10:00 a.m.
PLACE: Green Hall, Room 0120

Dissertation advisor:
Dr. Jr-Shin Li

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

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SCHOOL OF ENGINEERING & APPLIED SCIENCE