Mechanical Engineering Graduate Program
School of Engineering
University of California, Merced

ME Graduate Program Seminar Series -- Fall 2013

November 1, Friday, 1:00 - 2:00 p.m.
Science and Engineering Building, Room 270 *

Consensus in Networks: Coordination and Control of Cyber Physical Systems from Unmanned Vehicles to Energy-Efficient Buildings

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Abstract

In this talk we discuss the consensus variable approach to the coordination and control of cyberphysical systems (those with a tight integration of physical dynamics, sensors and actuators, and computing infrastructure). We begin with an overview of motivating problems and a summary of key results related to the consensus (or agreement) paradigm. We illustrate the application of this idea to several problems, including simulation of swarms, experimental demonstration of formation control of mote-based robots, and experimental demonstration of robotic autonomous mobile radio nodes for wireless tethering between a base station and a leader in a tunnel exploration scenario. We note that a consensus protocol can be represented as a graph with (static) weighted edges and nodes that are integrators. Generalizing this idea, we next present what we call dynamic consensus networks. Such networks are graphs whose nodes are integrators and whose edges are real rational functions representing dynamical systems that couple the nodes. We show that the modeling of thermal processes in buildings motivates such a system and from this motivation we generalize the notions of interconnection matrices and Laplacians to the case of graphs with integrating nodes and dynamic edges. We give conditions under which such graphs admit consensus, meaning that in the steady-state the node variables converge to a common value. Finally, we consider the collective description and properties of the interconnection of one dynamic graph (the plant) with another (the controller). We conclude with a discussion of research questions related to these ideas and to their application to energy-efficient control of buildings and other systems, such as the power grid.

Speaker

Kevin L. Moore the Dean of the College of Engineering and Computational Sciences at the Colorado School of Mines. He received the B.S. and M.S. degrees in electrical engineering from Louisiana State University and the University of Southern California, respectively. He received the Ph.D. in electrical engineering, with an emphasis in control theory, from Texas A&M University in 1989. He has been an Assistant and Associate Professor at Idaho State University (1989-1998); an Associate and Full Professor of Electrical and Computer Engineering at Utah State University, where he was the Director of the Center for Self-Organizing and Intelligent Systems, directing multi-disciplinary research teams of students and professionals developing a variety of autonomous robots for government and commercial applications (1998-2004); a senior scientist at Johns Hopkins University's Applied Physics Laboratory during a one-

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year research stay, where he worked in the area of unattended air vehicles, cooperative control, and autonomous systems (2004-2005); and a Full Professor and the G.A. Dobelman Distinguished Professor at the Colorado School of Mines (2005-present), where he was Director of the Center for Robotics and Distributed Intelligence (2005-2011). He also worked in industry for three years pre-Ph.D as a member of the technical staff at Hughes Aircraft Company. His research interests include iterative learning control, autonomous systems and robotics, and applications of control to industrial and mechatronic systems, including the cooperative control of networked systems. He is the author of the research monograph Iterative Learning Control for Deterministic Systems, co-author of the book Sensing, Modeling, and Control of Gas Metal Arc Welding, and co-author of the research monograph Iterative Learning Control: Robustness and Monotonic Convergence for Interval Systems. He is a licensed professional engineer, involved in several professional societies and editorial activities, and is interested in engineering education pedagogy, particularly capstone senior design. He is an ABET Program Evaluator, a senior member of IEEE, a member of the IEEE Control System Society Technical Committee on Intelligent Control, and serves on several editorial boards.

Coffee and Cookies served at 12:45pm.