The Center for Control, Dynamical Systems, and Computation
University of California at Santa Barbara
Spring 2008 Seminar Series
Presents

Closing the Loop Around Networks of Embedded Devices

Bruno Sinopoli

Carnegie Mellon University

Friday, June 6, 2008 3:00-4:00pm Harold Frank Hall 1104

Abstract:

Recent technological advancements have given rise to a new class of computing and communication systems, composed of wired/wireless networked embedded subsystems. Use of these networked embedded devices for the coordination and control of large systems in the physical world, such as infrastructures, can improve performance of existing applications as well as pave the road to the conception of new ones. Applications like inventory monitoring and control, home and building automation, power systems, security systems, precision agriculture, can all benefit from the use of a network connecting its components, by reducing operating cost and improving performance.

This flexibility comes at the cost of complexity. In particular, when dealing with control applications, the effect of communication delays and loss of information in the control loop cannot be neglected, since data travel along unreliable communication channels in possibly large, wireless, multi-hop sensor network. In this talk, I will develop the rudiments of a theory of estimation and control for networked embedded systems to address these problems.

For the sake of motivation consider the following problem: We wish to navigate a fleet of vehicles using observations from a sensor web. Wireless sensor nodes collect vehicle sensor measurements and transmit them to a computing unit. The computing unit in turn generates state estimates for each vehicle and computes control commands, which are then delivered, using the same wireless channel, to the actuators onboard the vehicles. We then ask: What is the amount of data loss that the control loop can tolerate to reliably perform the navigation task? Can communication protocols be designed to satisfy this constraint?

We will show that the answer to these questions requires a generalization of classical control techniques that explicitly take into account the stochastic nature of the communication channel. Within this framework, we will show a variety of results on the validity of the separation principle under different protocol models, as well as analytical characterization of different transition behaviors that arise in the feedback loop when the packet loss rate rises above a certain critical level.

About the Speaker:

Bruno Sinopoli is assistant professor in the department of Electrical and Computer Engineering at Carnegie Mellon University. Previously he was a postdoctoral scholar both at Stanford University and the University of California at Berkeley. He received his Ph.D. in Electrical Engineering at U.C. Berkeley in 2005. His research interests are in the design and analysis of networked embedded systems, with particular focus on wireless sensor actuator networks, distributed estimation, control over unreliable networks and security. Applications include environmental monitoring, industrial automation, office and building automation, Supervisory Control and Data Acquisition (SCADA) systems, and the automotive industry.