Switched Systems: Mixing Logic with Differential Equations

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As computers, digital networks, and embedded systems become ubiquitous and increasingly complex, one needs to understand the coupling between logic-based components and continuous physical systems. This prompted a shift in the standard control paradigm—in which dynamical systems were typically described by differential or difference equations—to allow the modeling, analysis, and design of systems that combine continuous dynamics with discrete logic. This new paradigm is often called *hybrid or switched control.*

This talk deals precisely with systems that result from the interconnection of differential equations with logic-based decision rules. Such systems are hybrid in the sense that some of the variables that describe their behavior take continuous values (e.g., the state of a differential equation) whereas others take discrete values (e.g., a Boolean value, or the state of a finite automaton). We are particularly interested in switched system. These are systems for which the continuous dynamics are effectively determined by the values of one or more discrete variables.

In the talk, we present several mathematical tools that have been developed to understand the behavior of switched systems. These tools are introduced in the context of specific applications where both logic and differential equations arise naturally. We draw these examples from areas as diverse as computer networks, vision-based robotics, and adaptive control. The goal of this talk is twofold: (i) demonstrate that switched systems are ubiquitous and of significant practical application, and (ii) show that a unified theory of switched systems is becoming available.

Speaker's biographical information:

João P. Hespanha was born in Coimbra, Portugal, in 1968. He received the Licenciatura and the M.S. degree in electrical and computer engineering from Instituto Superior Técnico, Lisbon, Portugal, in 1991 and 1993, respectively, and the M.S. and Ph.D. degrees in electrical engineering and applied science from Yale University, New Haven, Connecticut, in 1994 and 1998, respectively. For his PhD work, Dr. Hespanha received Yale University's Henry Prentiss Becton Graduate Prize for exceptional achievement in research in Engineering and Applied Science.

Dr. Hespanha holds an Associate Professor position at the University of California in Santa Barbara. Previously he was an Assistant Professor at the University of Southern California, Department of Electrical Engineer (from 1999 to 2001); and a visiting Post-doctoral Research Engineer at the University of California at Berkeley (from 1998 to 1999).

Dr. Hespanha is a member of the Sigma Xi Society. He is the author of over 70 technical papers, the recipient of a National Science Foundation CAREER award, and the PI and co-PI in several US federally funded projects. Dr. Hespanha is the author of over 70 technical papers and his research interests include hybrid systems, switching control, nonlinear and adaptive control, vision-based robotics, computer networks, and game theory.