

Thursday, March 19

Scaife Hall Auditorium

Room 125

4:30 p.m.

Refreshments at 4:00 p.m.



Professor George J. Pappas

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George J. Pappas is the Joseph Moore Professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania. He also holds a secondary appointment in the Departments of Computer and Information Sciences, and Mechanical Engineering and Applied Mechanics, and is member and former director of the GRASP lab. He currently serves as the Deputy Dean in the School of Engineering and **Applied Science**. His research focuses on control theory and in particular, hybrid systems, embedded systems, hierarchical and distributed control systems, with applications to unmanned aerial vehicles, flight management systems, distributed robotics, and **biomolecular networks**. He has published numerous publications and has won various awards, including the National Science Foundation Presidential Early Career Award for Science and Engineering (PECASE).

A Theory of Robustness for Cyber-Physical System

One of the great challenges in **cyber-physical systems** is to define appropriate measures of system robustness. How should we define the **robust execution of digital programs** by physical systems that will be subject to uncertainty and noise? By reversing roles, **how robust is the digital implementation** of physical controllers and sensors in distributed computing platforms? Can we define appropriate measures of robustness across the cyber and physical world, in a manner that leads to efficient algorithms for overall system verification and design?

In this talk, I will present an overview of our efforts towards addressing some of these challenges. Thinking of **temporal logics** as basic programming languages for physical systems, such as robots, we define robust, multi-valued semantics for temporal logic formulas, which capture not only the usual Boolean satisfy-ability, but also how robustly the physical system satisfies the digital specification. Based on this quantitative notion and using our recently developed notion of approximate bi-simulation functions, we develop a simulation-based verification algorithm for determining the robustness of the overall system.

The **interesting and promising feature** of our approach is that the more robust the system is with respect to the temporal logic specification, the less is the number of simulations that are required in order to verify the system. We then consider the problem of quantifying the performance gap between model-based controller design and platform-based implementation for modern embedded control systems. We first show that the performance gap between the model-level semantics of **proportional-integral-derivative (PID)** controllers and their implementation-level semantics can be rigorously quantified if the controller implementation is executed on a predictable time-triggered architecture.

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