

# Hybrid Control Systems Theory

***Ricardo Sanfelice designs control systems that could help prevent aircraft collisions and guide autonomous vehicles***

Ricardo Sanfelice, assistant professor of aerospace and mechanical engineering and director of the Hybrid Dynamics and Control Laboratory, is developing mathematical analysis and design methods that could radically advance the capabilities of unmanned aircraft and ground vehicles, as well as many other systems that rely on autonomous decision making.

Sanfelice's research focuses on mathematical analysis and design of control systems that have applications in robotics, biology and aerospace engineering. "What we do here in our lab is mainly theory," said Sanfelice. "We model dynamical systems, analyze them mathematically, devise ways to control them, test them in simulations and, when possible validate them in our test bed."

Sanfelice and his students currently are studying ways to extract energy from wind gusts and thermals to gain altitude without using power. "This is very different from traditional control system design, where you want to nullify the effects of perturbations. Here, we're exploiting them," he said.

Hybrid control system theory is a relatively new field, having evolved during the past 20 years or so. As a result, theoretical tools for analysis, design, and simulations of hybrid control systems are in the early stages of development. "We are developing a toolbox for simulation of such systems, to make the more designer- and user-friendly," he said. "We hope that this toolbox will eventually become part of a commercial simulation product."



**Assistant Professor  
Ricardo Sanfelice**