Scalable Computational Control Tools for Cyber-Physical Systems

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Abstract: Cyber-physical systems are the class of systems where physical and computational components interact in a tight coordination, such as the electrical power grid, autonomous cars driving in uncontrolled environments, and the control of bipedal robots. Common characteristics of these systems are a large number of state variables, nonlinearities in the dynamics, and the necessity of real-time sensor data to understand the environment. Under these conditions, their control and analysis requires advanced tools that can take advantage of our ability to process large amounts of data using computers. Among these tools, fast scalable methods to compute an optimal control and numerical algorithms that guarantee the safety of a system given sensor data are crucial.

In this talk I will present one such tool, designed to compute the optimal control of switched dynamical systems under state space constraints. We applied this tool to solve problems in several systems, including the safe back-flip of a quadrotor helicopter, and the steering of a bevel-tip flexible needle through obstacles. We prove the convergence of our algorithm to a control that satisfies an optimality condition compatible with this type of system.

Also, I will briefly present other computational tools that I have developed, such as an algorithm for the efficient computation of pseudospectral approximations of an optimal control, a learning-based model predictive control scheme with safety guarantees, and a simulation scheme for hybrid dynamical systems.

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Host: Dr. Arye Nehorai

Short Bio: Humberto Gonzalez is a Ph.D. Candidate in the department of Electrical Engineering and Computer Sciences at the University of California, Berkeley. In addition, he received the B.S. and M.S. degrees in electrical engineering from the University of Chile in 2005. His research interests are in the broad area of dynamical systems, with an emphasis on computational tools for cyber-physical systems.