电 气 工 程 学 院 讲 座

Reach Control Problem

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Abstract: We discuss a class of control problems for continuous time dynamical systems featuring synthesis of controllers to meet certain logic specifications. Such problems fall in the area of hybrid systems. Hybrid systems have been studied for some time; however, a comprehensive theory of control synthesis has remained elusive. Some work has been done on synthesis of controllers for logic specifications inspired by ideas from discrete event system theory and from computer science. These approaches do not confront where the deeper challenge lies: a structural characterization of the intrinsic limits of a continuous time control system to achieve a non-equilibrium specification.

We study affine systems and logic specifications encoded as inequality constraints. Mathematically, the model is an affine system defined on a polytopic state space, and control synthesis typically yields piecewise affine controllers. By studying this special model, some synthesis results have been achievable. The core synthesis problem has been distilled in the Reach Control Problem (RCP). Roughly speaking, the problem is for an affine control system xdot = A x + B u + a defined on a simplex to reach a pre-specified facet of the simplex in finite time without first exiting the simplex. The significance of the problem stems from its capturing two essential requirements embedded in logic specifications: state constraints and trajectories reaching a goal set of states in finite-time.

In this talk I will give highlights of more than 10 years of research on the RCP: solvability by affine feedback, continuous state feedback, time-varying affine feedback, and piecewise affine feedback; an associated Lyapunov theory; a geometric structure theory; and emerging applications.

Biography: Mireille Broucke obtained the BSEE degree in Electrical Engineering from the University of Texas at Austin in 1984 and the MSEE and PhD degrees from the University of California, Berkeley in 1987 and 2000, respectively. She was a postdoc in Mechanical Engineering at University of California, Berkeley during 2000-2001. She has six years of industry experience in control design for the automotive and aerospace industries. During 1993-1996 she was a program manager and researcher at Partners for Advanced Transportation and Highways (PATH) at University of California, Berkeley. Since 2001 she has been at the University of Toronto where she is a professor in Electrical and Computer Engineering. Her research interests are in hybrid systems, piecewise affine control, and control theory applied to neuroscience.

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