ILLINOIS INSTITUTE OF TECHNOLOGY

Mechanical, Materials And Aerospace Engineering Department

MMAE SEMINAR

WEDNESDAY, March 22, 2006
E-1 BUILDING – CRAWFORD AUDITORIUM
3:30 – 4:30 PM

Synchronization Control of Multiple Dynamical Systems

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This talk elaborates on synchronization of multiple dynamical systems using contraction theory, with applications to cooperative control of multi-agent systems and oscillation synchronization of interconnected dynamics such as tethered formation flight spacecraft. Inspired by stable combinations of biological systems, contraction nonlinear stability theory provides a systematic method to reduce arbitrarily complex systems into simpler elements. The proposed tracking control law synchronizes a large swarm of robots exponentially to form a certain formation pattern from any initial conditions. And then it makes the formation follow the common trajectory exponentially fast. Numerical simulations are presented to show the effectiveness of such control law.

Another application of oscillation synchronization is a fully decentralized nonlinear control law for spinning tethered formation flight by synchronizing model reduction. We use contraction theory to prove that a control law stabilizing a single-tethered spacecraft can also stabilize arbitrary large circular arrays of spacecraft, as well as the three inline configuration. The convergence result is global and exponential due to the nature of contraction analysis. Numerical simulations and experimental results validate the exponential stability of the tethered formation arrays by implementing a tracking control law derived from the reduced dynamics.