AE 240/ CDS270-2 Control and Estimation for Swarm Autonomy

Spring 2019: MW 14:00-15:25, Lee-Kubota Lecture Hall (GUG 133)

Instructor: Soon-Jo Chung (sjchung@caltech.edu) and Yisong Yue (yyue@caltech.edu)

Course Catalog Description:

Ae 240. Control and Estimation for Swarm Autonomy. 9 units (3-0-6); Prerequisites: CDS 112 (or Ae103a) and CDS 232, or permission of instructor. Various control and estimation tools for analysis and design of distributed autonomous robots and cooperative control of aerospace vehicles. Input-output stability tools including passivity and contraction theory. Synchronization and consensus theory for networked nonlinear systems. Learning, optimal control, and estimation for distributed autonomous agents.

Topics:

- Introduction to cooperative control and estimation with application to multi-vehicle systems, formation flying, and autonomous mobile sensors.
- Review of nonlinear input-output tools including comparison lemma, passivity, finite-gain Lp stability, input-to-state stability, and KYP lemma (1 week)
- Contraction-based incremental stability analysis for nonlinear synchronization, control, and estimation. Synchronous oscillators and central pattern generators (2 weeks)
- Synchronization and consensus stability for linear systems and nonlinear systems (1 week)
- Distributed optimal control and real-time solutions using sequential programming (1 week)
- Distributed task assignment in application to real-time optimal control (Hungarian, binary log-linear learning, and distributed auction algorithm) (1 week)
- Learning for distributed agents (Yisong Yue; 1 week)
- Distributed estimation (distributed Bayesian filters with a simplification to distributed Kalman filtering and distributed reinforcement learning) (1 week)
- Probabilistic density-based swarm control using Markov chains and distributed Partially-Observable Markov Decision Processes (POMDPs) (1 week)

Grading: Pass or Fail based on attendance and homework problem sets