ECE 6XXX: Foundations of Cyber-Physical System Design

Summary

This course introduces key concepts in the design of cyber-physical systems, including physical scales ranging from single-node systems to global-scale networked cyber-physical systems. The course will develop; models for key design parameters, including accuracy, stability, delay, energy; design of both single-node and networked embedded systems; the relationship between computational delay/latency and control system stability/performance in both single-node and networked control systems; simulator-in-the-loop control; control and power management in computing systems; and design methodologies.

Topical Coverage and Outline

1. Challenges in cyber-physical systems.
2. Models for single-node CPS: closed-loop delay and stability, sources of delay.
3. Single-node cyber models: computation time, energy.
4. Stability criteria for single-node CPS.
5. Accuracy in control: Kalman filter convergence, numerical issues.
6. Distributed control problems.
7. Stability of networked CPS.
8. Models for network delay.
9. Multi-level modeling of physical systems.
10. Simulator-in-the-loop control.
11. Modeling approximations for large-scale physical systems.
12. Model/algorithm co-design.
13. Discrete-event systems.

Grading

Homework: 10%
Midterm: 15%
Final exam: 35%
Project: 40%