CSCI 7000: Foundations of Cyber-Physical Systems (Fall 2012)

Details

Timing: Tuesday-Thursday 11-12:15 a.m.
Classroom: ECEE 283
Instructor: Sriram Sankaranarayanan (`srirams@colorado.edu`)

Description

The course will focus on modeling and reasoning about computer systems that interact with a continuous environment. Such systems are increasingly found in cars, airplanes, medical devices, manufacturing facilities, power plants and many other settings. In this course, we will learn the foundations of modeling designs for these systems and verifying that our designs are "correct". They do not fail under the influence of a continuously varying, uncertain physical world that they intearct with.

Topics

1. Introduction to Cyber-Physical Systems
2. Synchronous Models: Dataflow languages.
3. Safety and Liveness Specifications: ω-automata and temporal logics.
4. Asynchronous Models: Communicating machines and synchronization.
5. Continuous Dynamical Systems.
6. Timed and Hybrid Systems.
7. Techniques for reasoning about dynamical systems.
   (a) Symbolic model checking.
   (b) Flowpipe construction.
   (c) Invariant Synthesis.
8. Modeling and reasoning about human interactions in CPS.
9. Advanced Topics: mostly driven by student interests.
10. Tools: Simulink/Stateflow, Upaal and Spacex.
11. Applications: Airtraffic control, Autonomous highways and Infusion pumps.

Prerequisites

The following pre-requisites are important.

1. Knowledge of automata theory (for CS students) or control theory (for students from other Engineering disciplines).
2. Mathematical maturity (previous exposure to theory classes).

Course Format

The first two-thirds of the course will consist of instructor lectures in class and weekly assignments. The last month will consist mainly of presentations by students on special topics of their interest. Topics chosen during a previous offering of the course included:

1. Guaranteeting timing in embedded systems.
2. Human-Machine interations: Cognitive Modeling.
3. Logics, Automata and Game theory.
4. Models of Self-Assembling systems.
5. Stochastic models of reaction kinetics.
6. Markov Decision Processes.

Textbook

A large part of the course will also rely on instructor provided notes. We will use textbooks

1. Principles of Embedded Computation – Lecture notes for CIS 540 @ UPenn by Rajeev Alur.
2. Introduction to Embedded Systems – A Cyber-Physical Systems Approach by Edward A. Lee and Sanjit Seshia
3. Verification and Control of Hybrid Systems: A Symbolic Approach by Paulo Tabuada