AAE 590W
Applied Optimal Control and Estimation
Spring 2009

Lecture Information
Lectures: ARMS 1028, TTH 9:00-10:15 am

Contacts
Professor Inseok Hwang
ARMS 3211
ihwang@purdue.edu
Office hours: TTH 10:15 – 11:15 pm

Prerequisites
Linear system theory (AAE564/ECE602 or equivalent) and linear algebra (MA511 or equivalent)

Course Materials
The course is based on a set of lecture notes and articles which will be made available during the class.

Course Description
The main objective of this course is to study analysis and synthesis methods of optimal controllers and estimators for stochastic dynamical systems. Optimal control is a time-domain method that computes the control input to a dynamical system which minimizes a cost function. The dual problem is optimal estimation which computes the estimated states of the system with stochastic disturbances by minimizing the errors between the true states and the estimated states. Combination of the two leads to optimal stochastic control. Applications of optimal stochastic control are to be found in science, economics, and engineering. The course presents a review of mathematical background, optimal control and estimation, duality, and optimal stochastic control.

Topics covered in this course:
- Review of some mathematical background
- Classical estimation
    - Minimum variance unbiased estimation
    - Least squares estimation
    - Maximum likelihood estimation
    - System Identification*
- Optimal control
    - Pontryagin's Maximum/Minimum principle
    - Hamilton-Jacobi-Bellman equation
    - Dynamic Programming
    - Linear Quadratic (LQR) problems

- Stochastic optimal control and estimation
    - Stochastic dynamic programming
    - Kalman Filter: discrete/continuous-time filters
    - Duality of LQR with Kalman filter (LQE)
    - Linear Quadratic Gaussian (LQG)

References

- B.D.O. Anderson and J. Moore, *Optimal Control: Linear Quadratic Methods*, Prince Hall.
- A. Gelb, *Applied optimal Estimation*, MIT press.
- P. Maybeck, *Stochastic Models, Estimation, and Control*, Academic Press
- L. Ljung, *System Identification: Theory for the User*, Prentice Hall.
- R. Stengel, *Optimal Control and Estimation*, Dover.
- R. Brown and P. Hwang, *Introduction to Random Signals and Applied Kalman Filtering*, Wiley.
- A. E. Bryson and Y.C. Ho, *Applied Optimal Control*.

Homework

- A couple of problem sets per semester.
- No late homework will be accepted.

Class Project

The projects could be an extension of existing algorithms in the literature or, preferably, involve the original research ideas related to your current research. Project should be chosen in consultation with Prof. Hwang. The schedule is as follows:

- Project Proposal (two page summary) **due March 26 (Thursday)**
- Project report (10-12 pages) **due the dead week of classes**
- Project presentation: 15-minute presentation in the dead week of classes

The proposal and report should be written in 11-size font with a single line space and should have a technical paper format: abstract, introduction, main body, conclusions, and references.

Evaluation

- Homework 30%
- Class Project 70%

Class webpage: http://cobweb.ecn.purdue.edu/~ihwang/teaching/AAE590W.html