Optimal Filtering
Le 1: Introduction

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Course Information

Course Content

- Least-squares (LS) estimation:
  - Important properties.
  - Geometric interpretation.
- Wiener filter (discrete time)
- Kalman filter (discrete time):
  - State-space models and Markov process
  - The Kalman filter
  - The innovation process
  - Information Form
- Observability and controllability

Course Facts

Course activities:

- 6 lectures.
- 5 homework assignments.
- 1 project exercise.

Credits:

- 6 ETCS credits

Course homepage:

- `https://optfilt.edu.hendeby.se`

Course textbook:

- T. Kailath, A. H. Sayed, and B. Hassibi. *Linear Estimation*. Prentice-Hall, Inc, 2000. ISBN 0-13-022464-2.

Examiner:

- Gustaf Hendeby <gustaf.hendeby@liu.se>

Intended Learning Outcomes

- Understand to which type of estimation problems linear estimation can be applied.
- Understand the relationship between computational complexity, filter structure, and performance.
- Understand the relationship between optimal filtering, linear estimation, and Wiener/Kalman filtering.
- Approach estimation problems in a systematic way.
- Derive and manipulate the time discrete Wiener filter equations and compute the Wiener filter for a given estimation problem.
- Derive and manipulate the time discrete Kalman filter equations and compute the Kalman filter for a given estimation problem.
- Analyze properties of optimal filters.
- Implement Wiener and Kalman filters (time discrete) and state-space models using Matlab.
- Simulate state-space models and optimal filters, analyze the results, optimize the filter performance, and provide a written report on the findings.
- Formulate logical arguments, orally and in writing, in a way that is considered valid in scientific publications and presentations within the topic area.

Examination

Homework

- 5 homework (mostly theoretical) assignments (50 points each).
- Each homework comprises 5 tasks worth 10 points each.
- Passing requirement: 200 points (80 %).
- Peer-review corrected in groups.
  I'll assign groups and give you solutions to correct.

Project

- 1 (more practical) project assignment.
- "Conference paper" style report.
- Corrected by me.

Lecture Schedule (suggested)

Le	Topic	Date	
1	Intro. & LLMSE	Sept 19	15–17
2	LLMSE: geometric interpretation, Wiener filter	Oct 3	10–12
3	Bayesian estimation	Oct 17	10–12
4	Kalman filter	Nov 6	10–12
5	(Kalman) filter properties	Nov 21	13–15
6	Kalman filter variations	Dec 6	13–15

- Homework 5 review deadline: Dec 20
- Project deadline: Dec 20

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Before we leave today, we should have decided on the remaining dates!

Questions?

Gustaf Hendeby

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