

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

Examiner:

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

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.

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

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

Questions?