MP-208
Optimal Filtering with Aerospace Applications
Syllabus

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São José dos Campos - SP
2024

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Objectives

The subject **MP-208** "Optimal Filtering with Aerospace Applications" aims at teaching:

- fundamentals of stochastic estimation of parameters and states
- formulation of state estimators for:
  - Attitude determination
  - Navigation
  - Target/object tracking

Course Summary

Review of linear systems, random variables and stochastic processes. Parameter estimation criteria: maximum likelihood (ML), maximum a posteriori probability (MAP), least squares (LS) and minimum mean square error (MMSE). Properties of estimators: bias, covariance, consistency, and efficiency. Optimal estimation of linear systems with Gaussian inputs: discrete and continuous Kalman filter formulations. State estimation for nonlinear systems: extended Kalman filter (EKF), cubature Kalman filter (CKF), unscented Kalman filter (UKF), introduction to particle filters. State Estimation for dynamic systems with state-space constraints. Applications: sensor fusion for attitude determination, navigation, and target tracking. (Version: 2016)

Course Summary

- First month:
  - Introduction
  - Fundamentals review
  - Parameter estimation
- Second month:
  - Kalman filter: discrete and continuous-discrete formulations, information filter, square-root filter, sequential update.
- Third month:
  - EKF, UKF, EnKF
- Fourth month:
  - A navigation problem

Methodology

- First bimester:

  Lectures (with interaction!), using slides and white board.

- Second bimester:

  Lectures interleaved with computational exercises.

Evaluation

- Grade 1:

Exam 1	90 %
Computational Exercises	20 %

- Grade 2:

Exam 2	80 %
Computational Exercises	30 %

- Final Exam:

Work	100 %

Bibliography

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- MARKLEY, F. L.; CRASSIDIS, J. L. **Fundamentals of Spacecraft Attitude Determination and Control.** Springer, 2014.
- BROWN, R.G.; HWANG, P.Y.C. **Introduction to Random Signals and Applied Kalman Filtering.** New York: John Wiley & Sons, 1997.
- ANDERSON, B. D. O.; MOORE, J. B. **Optimal Filtering.** New York: Dover, 2005.
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Bibliography

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- Gustafsson, F. **Statistical Sensor Fusion**. Gavle: Studentlitteratur, 2012.
- Papers about UKF, CKF e EnKF (the reference you be given along the course).