Lab 9

School of Architecture, Civil and Environmental Engineering

EPFL, WS 2023-2024

https://disal.epfl.ch/teaching/signals_instruments_systems/

Outline

- Contents
  - Odometry with non-deterministic uncertainties
  - Feature based navigation
  - Sensor Fusion

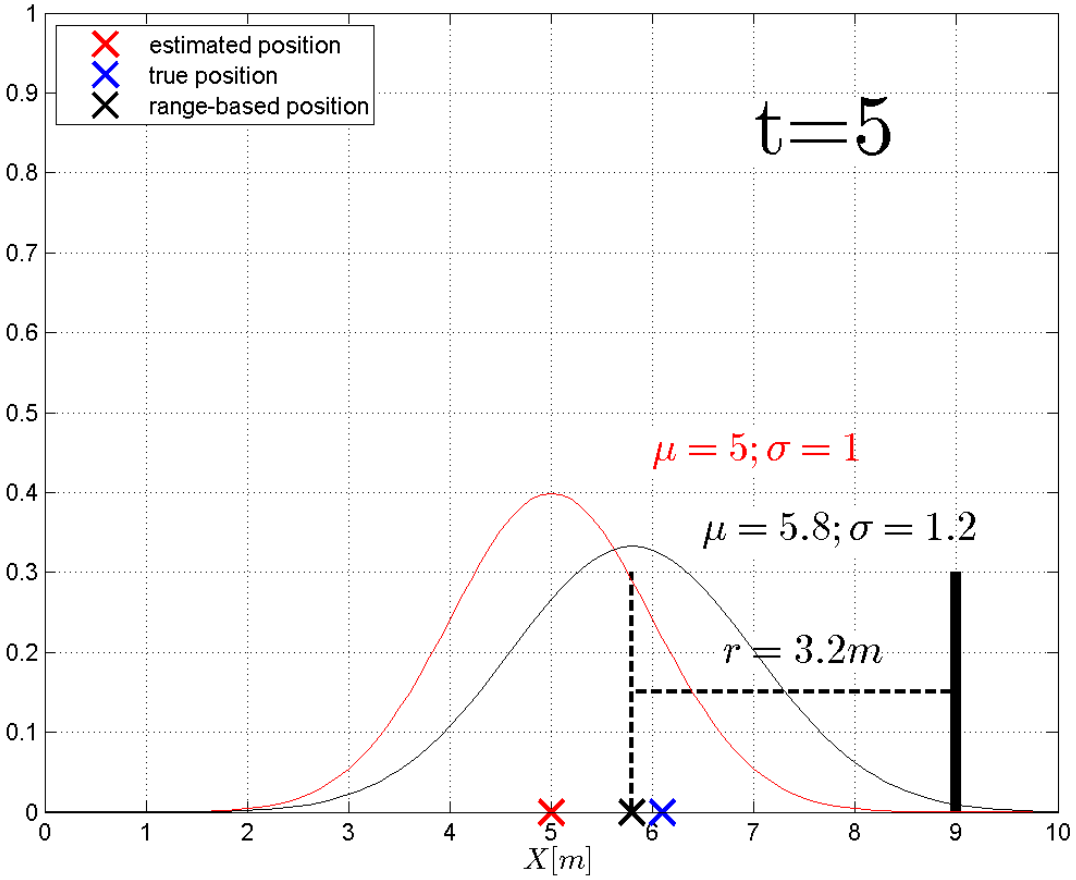
- Tools
  - Webots
  - C compiler
  - MATLAB

Getting Started

- Installation
  - Go to moodle and download:

    Lab09 (.zip) and the assignment
- Starting with Webots
  - Launch Webots
  - Open World file for lab9
  - Clean + Build robot controller

Feature based navigation



1D Kalman Filter

Estimation Based on Motion Model

$$\hat{x}_{k'} = \hat{x}_k + u[t_{k+1} - t_k]$$

$$\sigma_{k'}^2 = \sigma_k^2 + \sigma_w^2[t_{k+1} - t_k]$$

Kalman Filter
for Sensor and Motion Model Fusion

$$\hat{x}_{k+1} = \hat{x}_{k'} + K_{k+1}(z_{k+1} - \hat{x}_{k'})$$

$$\sigma_{k+1}^2 = \sigma_{k'}^2 - K_{k+1}\,\sigma_{k'}^2$$

$$K_{k+1} = \frac{\sigma_{k'}^2}{\sigma_{k'}^2 + \sigma_z^2}$$

N-D Kalman Filter Algorithm

Algorithm **Kalman_filter**($\mu_{t-1}, \Sigma_{t-1}, u_t, z_t$)

1. Prediction:
2. $\bar{\mu}_t = A_t \mu_{t-1} + B_t u_t$
3. $\bar{\Sigma}_t = A_t \Sigma_{t-1} A_t^T + R_t$

4. Correction or update:
5. $K_t = \bar{\Sigma}_t C_t^T (C_t \bar{\Sigma}_t C_t^T + Q_t)^{-1}$
6. $\mu_t = \bar{\mu}_t + K_t (z_t - C_t \bar{\mu}_t)$
7. $\Sigma_t = (I - K_t C_t) \bar{\Sigma}_t$

8. Return μ_t, Σ_t

[Adapted from Thrun et al., 2005]

Feedback for Lab 9

Please help us improve the labs by giving us feedback.

Thank you and enjoy the lab!