

INSTITUTO TECNOLÓGICO DE AERONÁUTICA
 MP-208: Optimal Filtering with Aerospace Applications
 Computational Exercise 4

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Consider the navigation problem defined in Chapter 8. Assume that, in the scenario described there,

- there are 5 markers horizontally fixed on the ground, at the following positions

$$\begin{aligned}\mathbf{r}_G^{1/G} &= \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}^T \\ \mathbf{r}_G^{2/G} &= \begin{bmatrix} 2 & 0 & 0 \end{bmatrix}^T \text{ m} \\ \mathbf{r}_G^{3/G} &= \begin{bmatrix} -2 & 0 & 0 \end{bmatrix}^T \text{ m} \\ \mathbf{r}_G^{4/G} &= \begin{bmatrix} 0 & 2 & 0 \end{bmatrix}^T \text{ m} \\ \mathbf{r}_G^{5/G} &= \begin{bmatrix} 0 & -2 & 0 \end{bmatrix}^T \text{ m}\end{aligned}$$

- the platform motion, $\forall t \geq 0$, is described by

$$\begin{aligned}\mathbf{r}_G^{B/G}(t) &= \begin{bmatrix} 5 \sin(0.1\pi t) \\ 5 \cos(0.1\pi t) \\ \sin(0.5\pi t) + 20 \end{bmatrix} \text{ m} \\ \boldsymbol{\alpha}^{B/G}(t) &= \frac{\pi}{18} \begin{bmatrix} \sin(\pi t) \\ \cos(\pi t) \\ \sin(0.25\pi t) \end{bmatrix} \text{ rad}\end{aligned}$$

The sensor platform data are given in Table 1.

Table 1: Sensor platform parameters.

Description	Values
Camera pose	$\mathbf{r}_B^{C/B} = [0 \ 0 \ -0.05]^T \text{ m}$, $\mathbf{D}^{C/B} = \mathbf{D}_1(\pi)\mathbf{D}_3(\pi/2)$
Initial bias (acc)	$\beta_B^a(0) = [0.35 \ -0.20 \ 0.20]^T \text{ m/s}^2$
Initial bias (gyro)	$\beta_B^g(0) = [0.05 \ -0.02 \ 0.02]^T \text{ rad/s}$
Noise std.dev (acc)	$\sigma^a = 0.0039 \text{ m/s}^2$
Noise std.dev (gyro)	$\sigma^g = 0.001 \text{ rad/s}$
Noise std.dev (acc bias)	$\sigma^{\beta_a} = 1.0 \times 10^{-5} \text{ m/s}^2$
Noise std.dev (gyro bias)	$\sigma^{\beta_g} = 1.0 \times 10^{-6} \text{ rad/s}$
Noise std.dev (marker pos.)	$\sigma = 1.0 \times 10^{-1} \text{ m}$
Sensor sampling time	$T_s = 0.01 \text{ s}$

Question 1. Simulate the scenario using a Simulink diagram.

Question 2. Design and implement (in a MATLAB script) a CDEKF to estimate $\{\mathbf{x}(t)\}$. This script has to contain a Monte Carlo loop with an arbitrary number of realizations. It also has to read and process the simulated measures and true states from the Simulink diagram (Question 1) by one call per Monte Carlo realization.

Question 3. Implement another MATLAB script like in Question 2, but using the CDUKF instead of the CDEKF.

Question 4. Using the MATLAB scripts and Simulink diagram of the above questions, conduct a simulation study comparing the performance of the CDEKF and CDUKF over 100 realizations.