Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
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Sheet 4

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Exercise 1: Use A Kalman Filter To Observe Persons

Consider a laser range finder observing a walking person in an environment. The laser range finder provides only informations about the position of the observed person. A Kalman Filter is used to track the person. It should estimate the person's position (x, y) and velocity $(\dot{x}, \dot{y})$ (no action can be executed by the system, it just observes and estimates). Consider that a new measurements can be incororated every $\Delta t = 0.5s$.

(a) Specify the dimensions of the state vector.

(b) Specify the matrix A.

(c) Specify the matrix C.

Exercise 2: Kalman Filter Example

Consider the situation in Exercise 1 and use your definitions for A and C. The initial state $\hat{x}_0$ of the system is given by: $(x = 0.8, y = 0, \dot{x} = 0.4, \dot{y} = 0)^T$. The estimate error covariance matrix $\overline{\Sigma}$ and the measurement error covariance matrix Q is given by:

$$\overline{\Sigma} = \begin{pmatrix} 0.5 & 0.2 & 0.3 & 0.3 \\ 0.2 & 0.5 & 0.3 & 0.3 \\ 0.3 & 0.3 & 0.5 & 0.2 \\ 0.3 & 0.3 & 0.2 & 0.5 \end{pmatrix}, \quad Q = \begin{pmatrix} 0.05 & 0.0 \\ 0.0 & 0.05 \end{pmatrix} \tag{1}$$

The Kalman Gain K is computed by: $K = \overline{\Sigma} C^T (C \overline{\Sigma} C^T + Q)^{-1}$. Since not everyone of you has access to MatLab, the result of this computation is:

$$K = \begin{pmatrix} 0.8952 & 0.0381 \\ 0.0381 & 0.8952 \\ 0.4000 & 0.4000 \\ 0.4000 & 0.4000 \end{pmatrix} \tag{2}$$

Consider that in this example the matrixes $\overline{\Sigma}$ and Q stay constant over time and are not updated. The first measurement, which is taken after time Δt is $(x = 1, y = 0.1)$. **Compute the next state of the system $\hat{x}_1$.**