Albert-Ludwigs-Universität Freiburg
Institut für Informatik
Lecture: Introduction to Mobile Robotics
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Sheet 6

Topic: Grid Mapping, Extended Kalman Filter

Submission deadline: Tue 17.6.2008, 11:00 a.m. (before class)

Exercise 1:

The binary Bayes filter (for a static state)

$$\text{bel}_{t+1}(c) = \eta p(z_t \mid c)\text{bel}_t(c)$$

assumes that a cell c is either occupied $c = 1$ or unoccupied $c = 0$, and the sensor provides noisy evidence for the correct hypothesis. We want to build an alternative estimator for a grid cell: Suppose the sensor can only measure "0 = unoccupied" or "1 = occupied", and it receives a sequence

$$0, 0, 1, 0, 1, 1, 1, 0, 1, 0.$$

(a) What is the maximum likelihood probability p for the next reading to be 1? Derive the formula for an arbitrary sequence of observations.

(b) Discuss the difference of this estimator to the binary Bayes filter (all for a single cell only).

Exercise 2:

A map of the cells $c_0, \ldots, c_3$ of a 1D environment has been built using the "simple counting" approach (see mapping lecture PDF, slide 21). The belief values b_i of the cells c_i are $b_0 = 0,\ b_1 = \frac{1}{4},\ b_2 = \frac{2}{3},\ b_3 = 1$. The robot was standing in cell c_0. Four measurements $z_0, \ldots, z_3$ have been integrated. Here a measurement is defined by the *cell number* where the measuring beam has ended. If $z_0 = 1,\ z_1 = 2,\ z_2 = 3$, what is the value of the last measurement z_3?

Exercise 3:

Programming task: Consider the simulated robot of the particle filter programming task (Ex. 3, Sheet 4). Track the pose (x, y, θ) of the robot using an **extended Kalmen filter**. Thus, complete the the method *update* in the *EKF* class. Since

no observations are available this time, implement the prediction step only. Use the same motion model as before:

Motion model: The forward translation δ_{trans} and the rotation δ_{rot1} are given. Use the odometry model with $\alpha = (0.05, 0.1, 0.1, 0.05)$. Assume that $\delta_{rot2} = 0$ all the time.

Remark: A sample solution for the particle filter programming task is included in the stub. (The sensor model is commented out.)