

Sheet 7

Topic: Grid Mapping, SLAM

Submission deadline: Tue 24.6.2008, 11:00 a.m. (before class)

Exercise 1:

Programming task: Implement a Simple Mapping Algorithm A robot has to build an occupancy grid map (cells c_0, \dots, c_n) of a simple one-dimensional environment (see the figure below). The robot is standing in the grid cell c_0 and performs a sequence of measurements.



Assume a very simple sensor model: every grid cell with a distance smaller than the measured distance is assumed to be occupied with $p = 0.4$. Every cell behind the measured distance is occupied with $p = 0.6$. Every cell located more than 20cm behind the measured distance should not be updated. (Hint: Use the update formula on slide 10 of the mapping lecture slides.)

Some constants:

| | |
|--|--|
| grid resolution | 10cm |
| map length (1d only!) | 2m |
| robot's position | c_0 |
| orientation (of the sensor) | heading to c_n (see figure) |
| measurements (in cm) | 101, 82, 91, 112, 99, 151, 96, 85, 99, 105 |
| prior | 0.5 |
| $P_{occupancy_{cell-distance < measured-distance}}$ | 0.4 |
| $P_{occupancy_{cell-distance \geq measured-distance}}$ | 0.6 |

Write a program, which updates the occupancy grid map for the robot. Please use the Java template and data files linked on our web page. You can use gnuplot with the pm3d extension and our scripts on the web page to obtain a nice visualization of your mapping results (use: `gnuplot -persist plot.gp`).

Exercise 2: Landmark-based SLAM

Consider a mobile robot that has to map office and outdoor environments using a landmark-based SLAM approach. For both environments, think of five different types of landmarks that might be well suited. How useful are your landmarks in combination with the following sensors: sonar, laser, monocular vision, stereo vision? Please submit your ratings¹ (“++” very useful, “+” useful, “-” not useful, “--” not possible) in a 10×4 table and give short explanations for not-obvious ratings.



Exercise 3: Rao-Blackwellization

Explain the idea of Rao-Blackwellization in general. How is the principle utilized for landmark-based SLAM, how for grid-based SLAM and where does the performance gain come from in both cases?

¹Please note, that different ratings might be possible under different assumptions (e.g. lighting-conditions). The optimal choice of landmarks is still an open research question.