Albert-Ludwigs-Universität Freiburg Institut für Informatik Introduction to Mobile Robotics Summer term 2023 mobilerobotics@informatik.uni-freiburg.de Dr. Tim Welschehold Dr. Daniel Büscher Dr. Lukas Luft Adriana Gómez Chenguang Huang

Sheet 8: Mapping with Known Poses

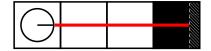
July 6th, 2023

Exercise 1: Counting Model

A robot applies the so-called simple counting approach to build a grid map of a 1D environment consisting of the cells c_0, \ldots, c_3 . While standing in cell c_0 , the robot integrates four measurements z_{t_0}, \ldots, z_{t_3} . After integrating these measurements, the resulting belief of the robot with regards to the occupancy of the four cells is $b_0 = 0$, $b_1 = \frac{1}{4}$, $b_2 = \frac{2}{3}$, $b_3 = 1$. Given that the first three measurements are $z_{t_0} = 1$, $z_{t_1} = 2$, $z_{t_2} = 3$, compute the value of the last measurement z_{t_3} .

Exercise 2: Occupancy Mapping

A robot has to build an occupancy grid map (cells $c_0, \ldots c_n$) of a simple onedimensional environment using a sequence of measurements from a range sensor.



Assume a very simple sensor model: every grid cell with a distance (based on its coordinate) smaller than the measured distance is assumed to be occupied with p = 0.3. 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. Calculate the resulting occupancy grid map using the inverse sensor model (see mapping lecture slide 32) using Python.

Assign the cell coordinates, which span from 0 to 200 (both endpoints included) with increments of 10, to one array c and the belief values to another array m. Use matplotlib.pyplot.plot(c,m) to visualize the belief. The measurements and the prior belief are given in the following table.

Grid resolution	$10\mathrm{cm}$
Map length (1D only)	2 m
Robot 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

Exercise 3: Occupancy Mapping

Prove that in the occupancy grid mapping framework the occupancy value of a grid cell $P(m_j|x_{1:t};z_{1:t})$ is independent of the order in which the measurements are integrated.