Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
Summer term 2009

Institut für Informatik

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Sheet 2

Topic: Locomotion, Bayes

Submission deadline: Tuesday 5.5.2009 (before class)

Exercise 1:

A robot equipped with a differential drive starts at position $x = 1.0m$, $y = 2.0m$ and with heading $\alpha = \frac{\pi}{2}$ ($\frac{\pi}{2}$ is the direction of the y-axis). It has to move to the position $x = 1.5m$, $y = 2.0m$, $\alpha = \frac{\pi}{2}$. The movement of the vehicle is described by steering commands (v_l = speed of left wheel, v_r = speed of right wheel, t = driving time).

(a) What is the minimal number of steering commands (v_l, v_r, t) needed to guide the vehicle to the desired target location?

(b) What is the length of the shortest trajectory under this constraint?

(c) Which sequence of steering commands guides the robot on the shortest trajectory to the desired location if an arbitrary number of steering commands can be used?

(d) What is the length of this trajectory?

Note: the length of a trajectory refers to the traveled distance along the trajectory.

Exercise 2:

Write a function in *Octave* that implements the forward kinematics for the differential drive as explained in the lecture. The input parameters of the function should be

1. the pose of the robot x, y, and θ,
2. the speed of the left and right wheel v_l and v_r,
3. the driving time t,
4. and the distance between the wheel of the robot l.

The output of the function is the new pose of the robot x', y', and θ'.

Exercise 3:

After reaching position $x = 1.5m$, $y = 2.0m$, and $\alpha = \frac{\pi}{2}$ the robot introduced in Exercise 1 executes the following sequence of steering commands:

1. $c_1 = (v_l = 0.3m/s, v_r = 0.3m/s, t = 3s)$
2. $c_2 = (v_l = 0.1m/s, v_r = -0.1m/s, t = 1s)$
3. $c_3 = (v_l = 0.2m/s, v_r = 0m/s, t = 2s)$
4. $c_4 = (v_l = 0.1m/s, v_r = 0.2m/s, t = 3s)$

Use the function implemented in Exercise 2 to compute the position of the robot after the execution of each command in the sequence (the distance between the wheels of the robot is $0.5m$). Indicate what is the rotational velocity ω, curvature radius R and instantaneous center of curvature ICC of the robot during each command.

Exercise 4:

A robot equipped with a sensor for detecting whether a door is open or closed obtains a reading $z = 42$ from the sensor. From previous experience you know that $P(z = 42|open) = 0.6$ (the conditional probability obtaining a reading $z = 42$ given that the door is open) and that $P(z = 42|\neg open) = 0.3$. The door can only be either completely open or completely closed and since you have no prior knowledge about the state of the door at the moment of the measurement, you assume that $P(open) = P(\neg open) = 0.5$.

Using the given information and Baye's rule compute the probability $p(open|z = 42)$ of the door being open given the reading $z = 42$.