Albert-Ludwigs-Universität Freiburg
Institut für Informatik
Lecture: Introduction to Mobile Robotics
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Sheet 3

Topic: Locomotion, Bayes Rule

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Exercise 1: Differential Drive

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: Differential Drive Implementation

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: Differential Drive Evaluation

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: Bayes Rule

Suppose you are a witness to a nighttime hit-and-run accident involving a taxi in Athens. All taxi cars in Athens are blue or green. You swear, under oath, that the taxi was blue. Extensive testing shows that, under the dim lighting conditions, discrimination between blue and green is 75% reliable. Is it possible to calculate the most likely color for the taxi? (Hint: distinguish carefully between the proposition that the taxi is blue and the proposition that the taxi appears blue.) What is your resulting estimate, given that 9 out of 10 Athenian taxis are green?