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MATH. - NATURWISS. FAKULTÄT
FACHBEREICH INFORMATIK
KOGNITIVE SYSTEME · PROF. A. ZELL

Mobile Robots

Summer Semester 2013
Assignment 2

due to: 07.05.2013, presentation: 14.05.2013
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Exercise 1 (6 Points)

For every in the lecture mentioned wheel configuration of mobile robots, find a commercially available robot, which uses this drive. State the name of the robot, its drive, its price and its main field of application.

Exercise 2 (7 Points)

(a) The equations for the kinematic position model of a differential drive proposed in the lecture are not defined for $s_l = s_v$. Determine a model $x_t = f(x_{t-1}, u_t)$ which is valid just for $u_t = (s_l, s_r), s_l = s_r$. (2 Points)

(b) Derive the equation for the inverse kinematic velocity model of a differential drive. For this, solve the equation system stated in the lecture. (2 Points)

(c) Determine the equation for the velocity of a differential drive robot in world coordinates ${}^{W}v = (v_x, v_y, \omega)^T$, with respect to the speed of the wheels v_l and v_r. Hint: ${}^{W}v = \frac{\partial x_t}{\partial t}$. Also v_l, v_r and therefore r are constant. (3 Points)

Exercise 3 (4 Points)

(a) Explain in own words the meaning of the vector u_t of the kinematic position model of the differential drive. (1 Point)

(b) You are given the following information of a differential drive robot at time $t-1$: $x_{t-1} = (1, 1, \pi/2)^T$, $u_t = (0{,}1\,\mathrm{m}, 0{,}2\,\mathrm{m})^T$ and $l = 0{,}1\,\mathrm{m}$. Determine the deterministic state x_t of the robot at time t. (1 Point)

(c) The differential drive robot should drive with the velocity ${}^{R}v = (0{,}1\,\frac{\mathrm{m}}{\mathrm{s}}, 0{,}3\,\mathrm{s}^{-1})^T$. Determine the appropriate vector $u_t = (v_l, v_r)^T$. (1 Point)

(d) State the three sources of uncertainty for the estimation of x_t using the probabilistic kinematic model of a differential drive. (1 Point)

Exercise 4 (3 Points)

Use the Taylor series to linearize the equation for the radius of a differential drive with respect to the distance of the wheels $s = (s_l, s_r)^T$:

$$r(s) = \frac{s_l + s_r}{s_r - s_l} \cdot \frac{l}{2} \quad , \tag{1}$$

at the point $\bar{s} = (\bar{s}_l, \bar{s}_r)^T$.