Robotics
Problem Sheet 6

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Notes

The homework serves as preparation for the exams. It is strongly recommended that you solve them before the given deadline - but you do not need to hand them in. Feel free to work on the problems as a group - this is even recommended.

1 Problem

A differential drive robot has two drive units, each with

- a left respectively right motor with a variable speed s_L, respectively s_R measured in rounds per minute (rpm).
- a planetary gear box with a 1:100 reduction, i.e., the wheel axis turns 100 times slower than the motor axis (but it has 100 times the torque)
- a wheel with a radius $r = 10$cm

The distance D between the two wheels is 30cm. The speeds of the two motors are measured by quadrature encoders at a frequency of 100 Hz, i.e., 100 times per second.

The coordinate frame of the robot follows the standards, i.e., it is as follows. The x-axis points from the center of motion of the robot to its front and it is co-aligned with zero degrees; angles are measured counterclockwise.

Suppose the robot drives with constant (motor-)speeds $N_L = 18849$ rpm, $N_R = 15708$ rpm over 40 msec. Suppose its initial pose is $(0, 0, 0)^T$. Derive its pose after 40 msec.

2 Problem

Given an omni-drive robot with 4 motors with omni-wheels W_i that are evenly spaced apart at 90^o starting with 0^o, i.e., W_1 is at 0^o, W_2 is at 90^o, and so on. The distance from the center of motion to each wheel is R, the wheel radius is r and the angular velocity of each wheel is ω_i.

Derive the inverse Kinematics of this robot, i.e., derive the matrix M with

$$\begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{pmatrix} = M \cdot \begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{pmatrix}$$

for the translational velocity $V_t = (V_x, V_y)^T = (\dot{x}, \dot{y})^T$ and angular velocity $\omega = \dot{\theta}$ of the robot.