AMR Assignment 1

Harm Manders en Micha de Groot

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Introduction

In this technical report explain what we've used to make a LEGO robot make a certain path. The path we followed is arbitrary and is loosely based on the image privded in the exercise. A fair share of our formulas are based on [1] which explaines the kniematics of a differential drive robot

Exercises

1

a)

Equation 1:
$\begin{bmatrix}\dot{x} & \dot{t} & \dot{\theta}\end{bmatrix}^T = f(\dot{\phi_1}, \dot{\phi_2}, l, r)$

If $\dot{\phi_1} = \dot{\phi_2}$ then $\dot{\theta}$ should be 0. The speed of both wheels is the same so the angle should stay the same. In that case the speed in the direction of θ is $\dot{\phi} * \rho$.

If $\dot{\phi_1} = 0$ then the robot rotates in a circle around wheel 1. In that case $\dot{\theta} = \dot{\phi_2}/l$. This is similar when $\dot{\phi_2} = 0$ but then negative because the distance l is negative with respect to the origin of the robot. This make sense, because the rotation change is reversed. The speed in the x and y directions are dependent on the orientation q, to map from the initial frame to the robot frame the data from the initial frame has to be multiplied by the rotation matrix, for the angle the robot has with the initial frame.

b)

The precision of the position estimate and the sampling time Δt are directly related, namely that when the sampling time gets smaller, the precision increases. This is because there are more measurements between each action.

The rotaion w is determined by de difference in speed of the wheels ϕ_1 and ϕ_2. By increasing the speed of one of the wheels the robot rotates around a point. For instance, when increasing the speed of the right wheel, the robot rotates around a point that is situated between the middle point of the wheel axis and a point that goes to infitity on the left side of the robot.

2

a)

To create a rotation we have to calculate the angular velocity of the robot. Because the angular velocoty (ω) in each wheel is the same as the angular velocity of the robot we can calculate the speed of each wheel with the following formulas:
$\omega(R + \frac{l}{2}) = V_r$ and $\omega(R - \frac{l}{2}) = V_l$

Where R is the distance between the center of rotation and the middle point of the axis between the wheels, l is the distance between the wheels and ω is the speed of the robot. Once we know the radius of the rotation we need to make we can use that as a the distance R.

To go in a straight line we should make the radius of rotation infinite. Practically this means that we should take a radius that creates a line that is within a measure of error. We calculated that if we accept an error of a millimeter on every meter we should at least have a radius of 12500 cm.

b)

To log the difference in position and angle of the robot we use the speed of the wheels. In each time interval we track how much rotations each wheel makes. With $(\phi_r - \phi_l)/l$ we calculate the rotation. Where ϕ is the speed of each wheel and l is the length of the axis. This formula is derived of the formulat earlier used in 2.a.

c)

In our MATLAB file we initialised the robot with certain variables. We set our speed at 40, base orientation at (0,0,0) with (x,y,θ). We measured the length of the wheel axis and wheel radius. The axis length is the length between the middle of each wheel.

We use a time interval of 0.1 sec, every interval we calculate the speed for each wheel based on if the robot should make a turn or not. We've made a predetermined sequence of straight and rotation segments trying to mimic the image in the assignment.

3 References

[1] https://chess.eecs.berkeley.edu/eecs149/documentation/differentialDrive.pdf