Robotics WS 16/17 - Group *Pingu* 🐧

Assignment: 2

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1. Coordinate Transformation

a)

- $x_1 = L_1 \cdot cos(\theta_1)$
- $y_1 = -L_1 \cdot sin(\theta_1)$
- $x_2 = L_2 \cdot cos(\theta_2) + x_1$
- $y_2 = -L_2 \cdot sin(\theta_2) + y1$

b)

- $x_2 = L_2 \cdot cos(\theta_2) + L_1 \cdot cos(\theta_1)$
- $y_2 = -L_1 \cdot sin(\theta_2) - L_1 \cdot sin(\theta_1)$

Partial derivative for x_2:

- $\frac{\delta x_2}{\delta \theta_1} = -L_1 \cdot sin(\theta_1)$
- $\frac{\delta x_2}{\delta \theta_2} = -L_2 \cdot sin(\theta_2)$
- $\frac{\delta x_2}{\delta L_1} = -sin(\theta_1)$
- $\frac{\delta x_2}{\delta L_2} = -sin(\theta_2)$

Partial derivatives for y_2:

- $\frac{\delta y_2}{\delta \theta_1} = -L_1 \cdot cos(\theta_1)$

- $\frac{\delta y_2}{\delta \theta_2} = -L_2 \cdot cos(\theta_2)$
- $\frac{\delta y_2}{\delta L_1} = -sin(\theta_1)$
- $\frac{\delta y_2}{\delta L_2} = -sin(\theta_2)$

2. Rotation Matrix as an Operator

a)

3D-Rotation matrix has 3×3 values. The matrix is defined by three angles *pitch,yaw* and *roll*. Each value r_{xy} is defined by these angles combined with trigonomic functions:
$R(\alpha,\beta,\gamma) = R_z(\alpha)\,R_y(\beta)\,R_x(\gamma) =$
$$\begin{pmatrix} \cos\alpha\cos\beta & \cos\alpha\sin\beta\sin\gamma - \sin\alpha\cos\gamma & \cos\alpha\sin\beta\cos\gamma + \sin\alpha\sin\gamma \\ \sin\alpha\cos\beta & \sin\alpha\sin\beta\sin\gamma + \cos\alpha\cos\gamma & \sin\alpha\sin\beta\cos\gamma - \cos\alpha\sin\gamma \\ -\sin\beta & \cos\beta\sin\gamma & \cos\beta\cos\gamma \end{pmatrix}.$$

- You can simply choose three random angles to calculate R.

Let $(\alpha = 10°, \beta = 306°, \gamma = 164°)$ be three random angles.

Here is the Matrix:

$$R = \begin{pmatrix} 0.579 & -0.053 & 0.814 \\ 0.102 & -0.985 & -0.136 \\ 0.809 & 0.162 & -0.565 \end{pmatrix}$$

b)

Homogeneous transformation matrix. See the rotation part in the left top corner extendet by the translation part in the last column:

$$M = \begin{pmatrix} 0.579 & -0.053 & 0.814 & 3 \\ 0.102 & -0.985 & -0.136 & 2 \\ 0.809 & 0.162 & -0.565 & 5 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

c)

First make $(1,2,3)^T \rightarrow (1,2,3,1)^T$ then calc $M * (1,2,3,1)^T$:

$x = 0.579 * 1 - 0.053 * 2 + 0.814 * 3 + 3 * 1 = 5.915$

$$gitaddy = 0.102 * 1 - 0.985 * 2 - 0.136 * 3 + 2 * 1 = -0.276$$

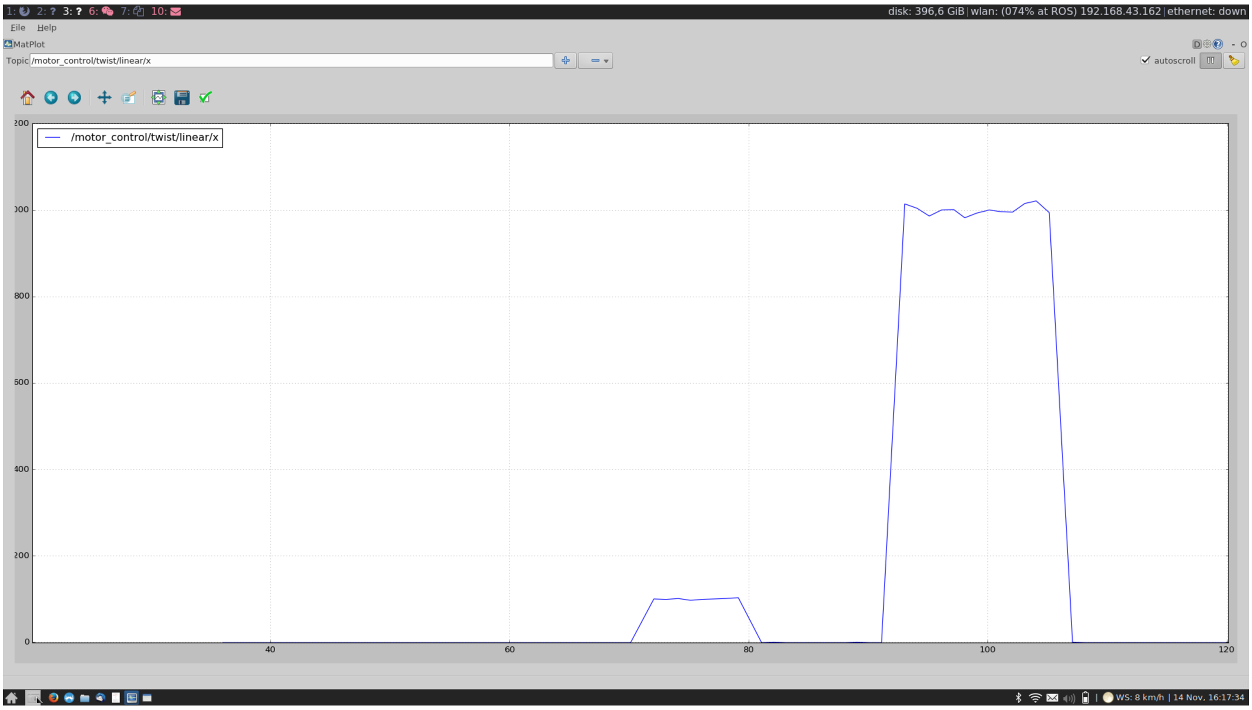
$$z = 0.809 * 1 + 0.162 * 2 - 0.565 * 3 + 5 * 1 = 4,438$$

$$w = 0 * 1 + 0 * 2 + 0 * 3 + 1 * 1 = 1$$

3. Working with the Car

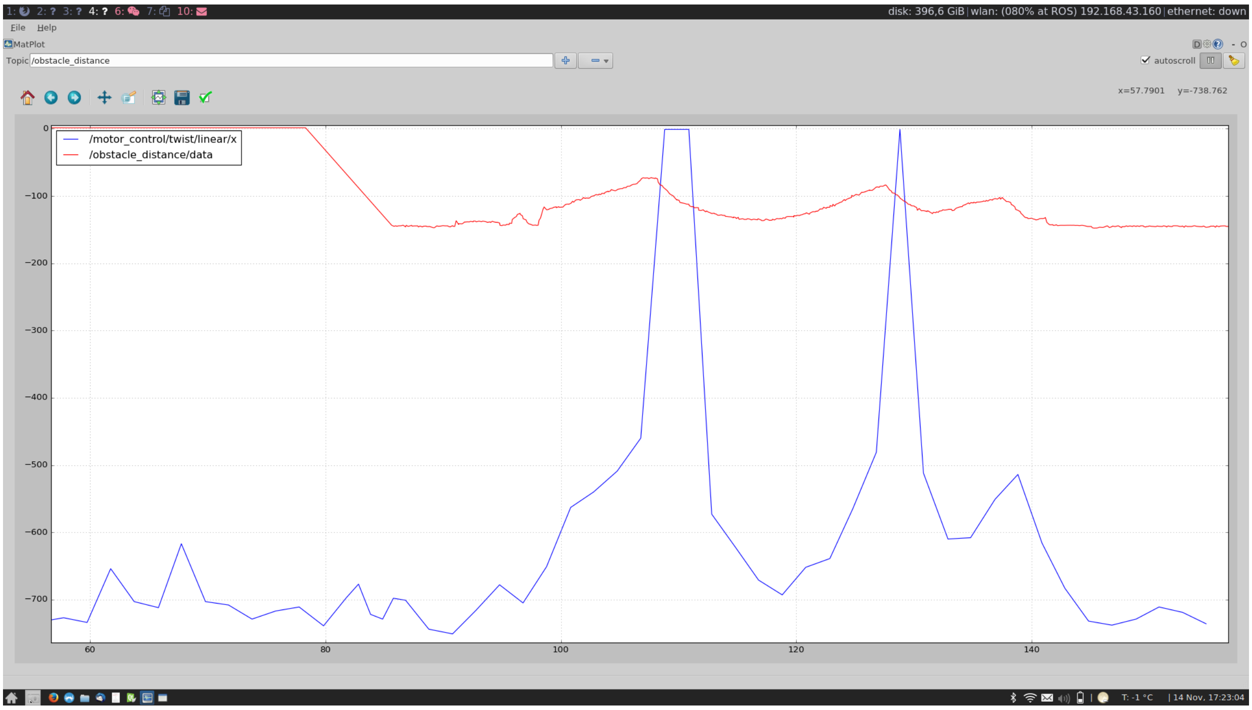
a)

We hade some problems while publishing the new speed. Thats why we set the speed to `1000` instead of `500`:



b)

To move the car foreward, we need to publish a negative speed. Thats why the plot of the speed is negative. We also negated the distance in the plot to make it visible. Note how the speed goes down at time 110 where the the distance is very low:



disk: 396,6 GiB | wlan: (080% at ROS) 192.168.43.160 | ethernet: down
File Help
MatPlot
Topic /obstacle_distance
autoscroll
x=57.7901 y=-738.762
/motor_control/twist/linear/x
/obstacle_distance/data
0
−100
−200
−300
−400
−500
−600
−700
60
80
100
120
140
T: -1 °C
14 Nov, 17:23:04