Robotics

Assignment 5

by

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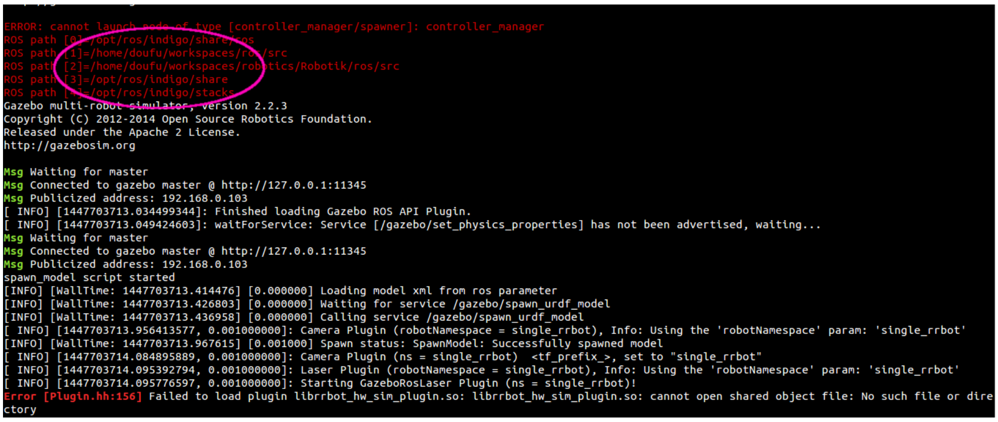
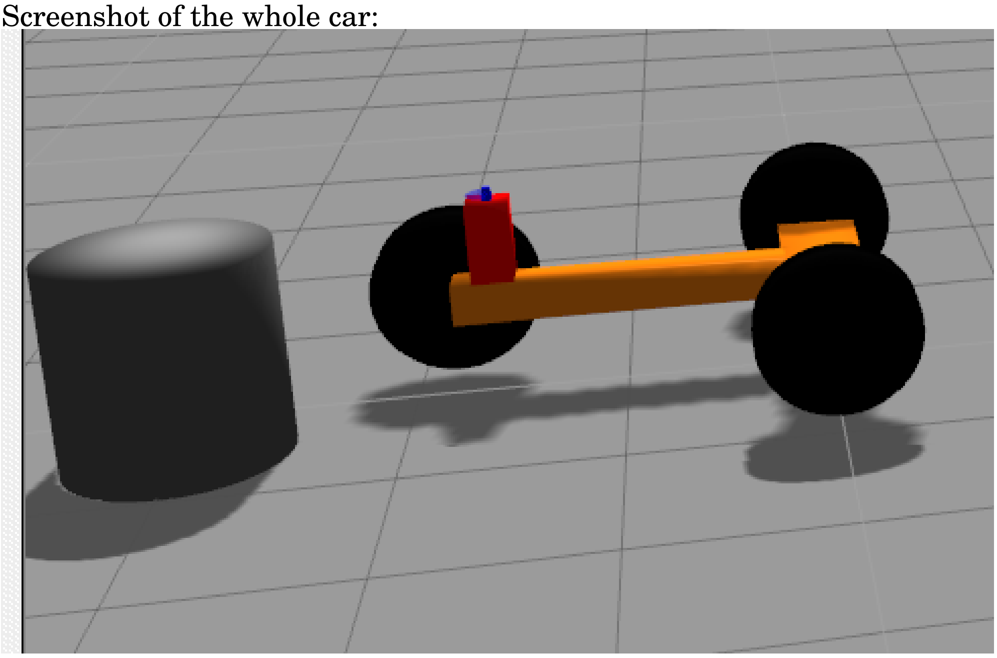
1.1 Task 1

We already switched from jade to indigo for the last assignment, as can be seen in the attached picture from last week.

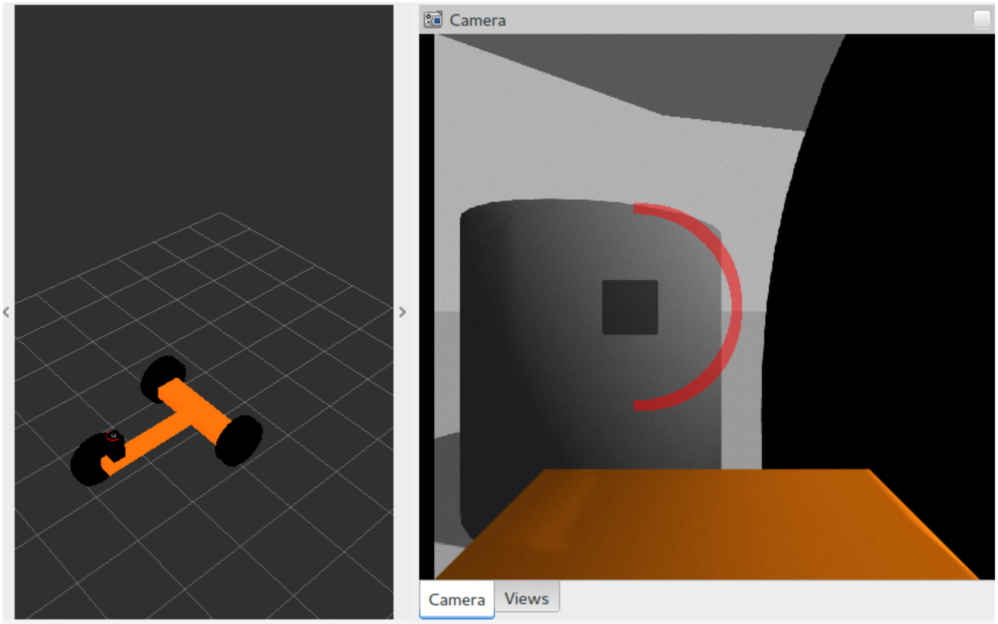


1.2 Task 2

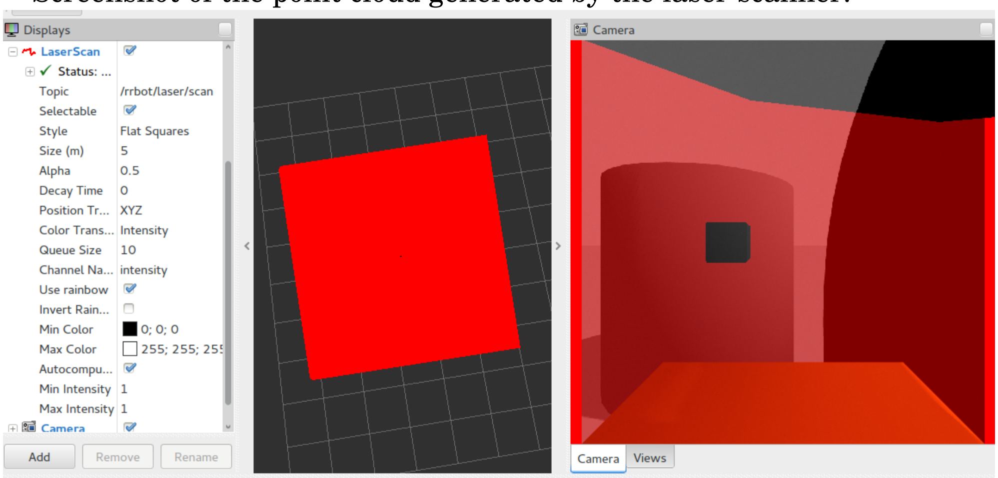
Screenshot of the whole car:



Screenshot of the camera-picture:



Screenshot of the point cloud generated by the laser-scanner:



1.3 Task 3

$$\begin{aligned}
\alpha_1 &= 0\\
d_1 &= L_1\\
\Theta_1 &= 180 \pm \epsilon_{\Theta_1}\\
a_1 &= 0\\
\\
\alpha_2 &= 90 \pm \epsilon_{\alpha_2}\\
d_2 &= 0\\
\Theta_2 &= 45 \pm \epsilon_{\Theta_2}\\
a_2 &= 0\\
\\
\alpha_3 &= 0\\
d_3 &= 0\\
\Theta_3 &= 45 \pm \epsilon_{\Theta_3}\\
a_3 &= L_2\\
\\
\alpha_4 &= 90 \pm \epsilon_{\alpha_4}\\
d_4 &= d_4\\
\Theta_4 &= 0 \pm \epsilon_{\Theta_4}\\
a_4 &= 0\\
\\
\Theta_1 &= 180 \pm \epsilon_{\Theta_1}\\
\Theta_2 &= 45 \pm \epsilon_{\Theta_2}\\
\Theta_3 &= 45 \pm \epsilon_{\Theta_3}
\end{aligned}$$

Annahme: Der Ursprung von Koordinatensystem 4 ist um d_4 vom Ursprung des Koordinatensystems 3 in der Tiefe (d) verschoben.

$$T_3^2(\alpha_2, a_2, \Theta_3, d_3) = \begin{pmatrix} cos(\Theta_i) & -sin(\Theta_i) & 0 & a_{i-1} \\ sin(\Theta_i)\cdot cos(\alpha_{i-1}) & cos(\Theta_i)\cdot cos(\alpha_{i-1}) & -sin(\alpha_{i-1}) & -sin(\alpha_{-1})\cdot d_i \\ sin(\Theta_i)\cdot cos(\alpha_{i-1}) & cos(\Theta_i)\cdot sin(\alpha_{i-1}) & cos(\alpha_{i-1}) & cos(\alpha_{i-1})\cdot d_i \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$T_3^2(\alpha_2, a_2, 45, d_3) = \begin{pmatrix} cos(45) & -sin(45) & 0 & 0 \\ sin(45)\cdot cos(45) & cos(45)\cdot cos(45) & -sin(45) & -sin(90)\cdot 0 \\ sin(45)\cdot cos(90) & cos(45)\cdot sin(90) & cos(90) & cos(90)\cdot 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$T_3^2(\alpha_2, a_2, 45, d_3) = \begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 & 0 \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{1}{\sqrt{2}} & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

1.4 Task 4

1.4.1 a)

$$
\begin{aligned}
{}^0_3A(q_1, q_2, q_3) &= {}^0_1A(q_1) \cdot {}^1_2A(q_2) \cdot {}^2_3A(q_3) \\
{}^0_3A &= \begin{pmatrix} cos(\Theta_1) & -sin(\Theta_1) & 0 & 0 \\ sin(\Theta_1) & cos(\Theta_1) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{pmatrix} \\
{}^0_3A &= \begin{pmatrix} cos(\Theta_1) & -sin(\Theta_1) & 0 & 0 \\ sin(\Theta_1) & cos(\Theta_1) & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{pmatrix} \\
{}^0_3A &= \begin{pmatrix} cos(\Theta_1) & -sin(\Theta_1) & 0 & 0 \\ sin(\Theta_1) & cos(\Theta_1) & 0 & 0 \\ 0 & 0 & 1 & d_2 + d_3 \\ 0 & 0 & 0 & 1 \end{pmatrix}
\end{aligned}
$$

Beschreibung der Koordinaten des Zielsystems:

$$
\begin{aligned}
&f : \mathbb{R}^3 \longrightarrow \mathbb{R}^3 \\
&f = B \\
&B = \begin{pmatrix} cos(\Theta_1) & -sin(\Theta_1) & 0 \\ sin(\Theta_1) & cos(\Theta_1) & 0 \\ 0 & 0 & d_2 + d_3 \end{pmatrix} \\
&x = cos(\Theta_1) - sin(\Theta_1) \\
&y = sin(\Theta_1) + cos(\Theta_1) \\
&z = d_2 + d_3
\end{aligned}
$$

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1.4.2 b)

$$\frac{x}{d\Theta_1} = -sin(\Theta_1) - cos(\Theta_1)$$
$$\frac{x}{dd_2} = 0$$
$$\frac{x}{dd_3} = 0$$

$$\frac{y}{d\Theta_1} = -sin(\Theta_1) + cos(\Theta_1)$$
$$\frac{y}{dd_2} = 0$$
$$\frac{y}{dd_3} = 0$$

$$\frac{z}{d\Theta_1} = 0$$
$$\frac{z}{dd_2} = 1$$
$$\frac{z}{dd_3} = 1$$

1.4.3 c)

$$J(q) = \begin{pmatrix} -sin(q_1) - cos(q_1) & -sin(q_1) + cos(q_1) & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{pmatrix}$$