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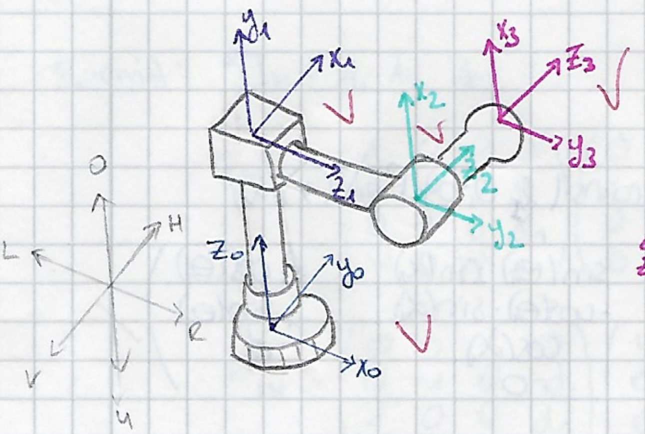
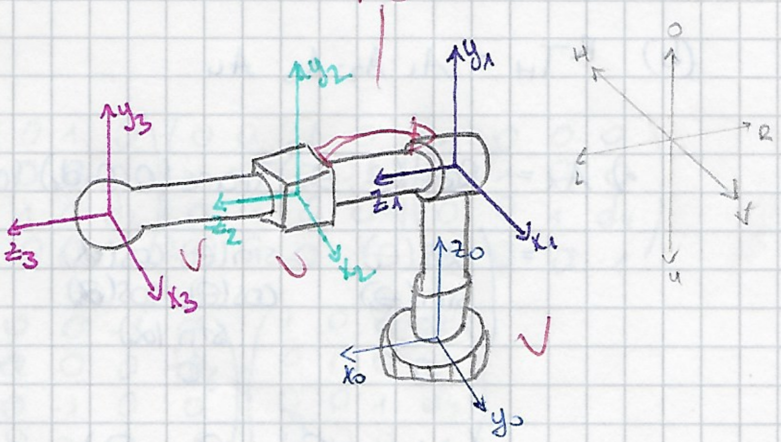
Übungsblatt 7

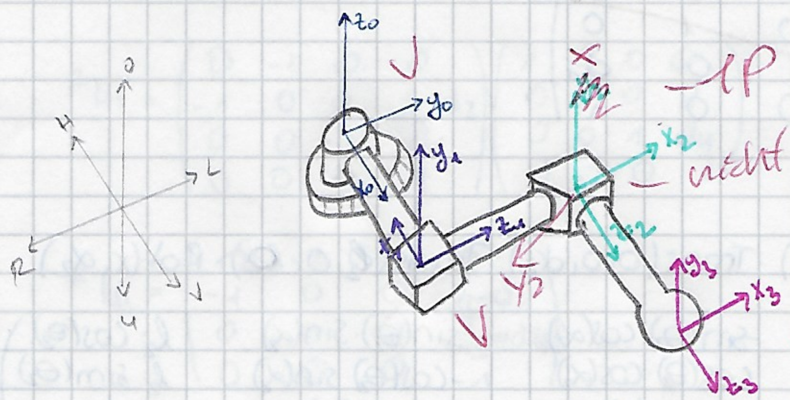
1	2	Σ
7	9	16

Aufgabe 1



Ursprung falsch −1P





−1P nicht Parallel zum Kreuzprodukt

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Aufgabe 2

			θ	α	l	d
(a) (i)	1.	θ_1	90°/ θ_1	90°	0	d_1
	2.	d_2	0°	−90°	0	d_2
	3.	θ_3	0°/ θ_3	0°	0	d_3
(ii)	1.	θ_1	90°	−90°	0	d_1
	2.	d_2	90°	90°	0	d_2
	3.	θ_3	0°	0°	l_3	0

You need draw the d/l in the figures.

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(iii)

		θ	α	l	d
1.	θ_1	$0°$	$90°$ θ_1	0	d_1
2.	θ_2	$90°$	$90°$ θ_2	0	d_2
3.	θ_3	$90°$	$-90°$ θ_3	$-l_3$	0
4.	d_4	$0°$	$0°$	0	d_4

(b) $^{R}T_{H} = A_1 \cdot A_2 \cdot A_3 \cdot A_4$

- $A_1 = Rot(z, \theta_1) Trans(0,0,d_1) Trans(l_1,0,0) Rot(x, \alpha_1)$

$$= \begin{pmatrix} \cos(\theta_1) & -\sin(\theta_1)\cdot\cos(\alpha_1) & \sin(\theta_1)\cdot\sin(\alpha_1) & l_1\cos(\theta_1) \\ \sin(\theta_1) & \cos(\theta_1)\cdot\cos(\alpha_1) & -\cos(\theta_1)\cdot\sin(\alpha_1) & l_1\sin(\theta_1) \\ 0 & \sin(\alpha_1) & \cos(\alpha_1) & d_1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

- $A_2 = Rot(z, \theta_2) \cdot Trans(0,0,d_2) \cdot Trans(l_2,0,0) \cdot Rot(x, \alpha_2)$

$$= \begin{pmatrix} \cos(\theta_2) & -\sin(\theta_2)\cdot\cos(\alpha_2) & \sin(\theta_2)\cdot\sin(\alpha_2) & l_2\cdot\cos(\theta_2) \\ \sin(\theta_2) & \cos(\theta_2)\cdot\cos(\alpha_2) & -\cos(\theta_2)\cdot\sin(\alpha_2) & l_2\cdot\sin(\theta_2) \\ 0 & \sin(\alpha_2) & \cos(\alpha_2) & d_2 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

- $A_3 = Rot(z, \theta_3) \cdot Trans(0,0,d_3) \cdot Trans(l_3,0,0) \cdot Rot(x, \alpha_3)$

$$= \begin{pmatrix} \cos(\theta_3) & -\sin(\theta_3)\cdot\cos(\alpha_3) & \sin(\theta_3)\cdot\sin(\alpha_3) & l_3\cdot\cos(\theta_3) \\ \sin(\theta_3) & \cos(\theta_3)\cdot\cos(\alpha_3) & -\cos(\theta_3)\cdot\sin(\alpha_3) & l_3\cdot\sin(\theta_3) \\ 0 & \sin(\alpha_3) & \cos(\alpha_3) & d_3 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & -l_3 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

•) $A_4 = Rot(z,\theta_4)\cdot Trans(0,0,d_4)\cdot Trans(l_4,0,0)\cdot Rot(x,\alpha_4)$

$$= \begin{pmatrix} \cos(\theta_4) & -\sin(\theta_4)\cdot\cos(\alpha_4) & \sin(\theta_4)\sin(\alpha_4) & l_4\cdot\cos(\theta_4) \\ \sin(\theta_4) & \cos(\theta_4)\cdot\cos(\alpha_4) & -\cos(\theta_4)\cdot\sin(\alpha_4) & l_4\cdot\sin(\theta_4) \\ 0 & \sin(\alpha_4) & \cos(\alpha_4) & d_4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_4 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Somit: ${}^R T_H = A_1 \cdot A_2 \cdot A_3 \cdot A_4$

$${}^R T_H = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & d_2 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & +l_3 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$${}^R T_H = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & -d_2 \\ 1 & 0 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & +l_3 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$${}^R T_H = \begin{pmatrix} 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & l_3-d_2 \\ 0 & 0 & -1 & d_1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

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$${}^R T_H = \begin{pmatrix} 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & l_3-d_2 \\ 0 & 0 & -1 & d_1-d_4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Note: You should compute the ${}^R T_H$ with Link Variables instead of the Auslenkung value.

For example: for Type I Link; the ${}^R T_H$ should be:

$${}^R T_H = \begin{bmatrix} C_{12} & -S_{12} & 0 & L_1C_1 + L_2C_{12} \\ S_{12} & C_{12} & 0 & L_1S_1 + L_2S_{12} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$