MANIP Lab report (M1 CORO/JEMARO)

Joseph Webb - Thursday 17 November 2022

1 Modified DH-Tables

1.1 Turret Robot

$r_1 = 0.5, \quad r_2 = 0.1$

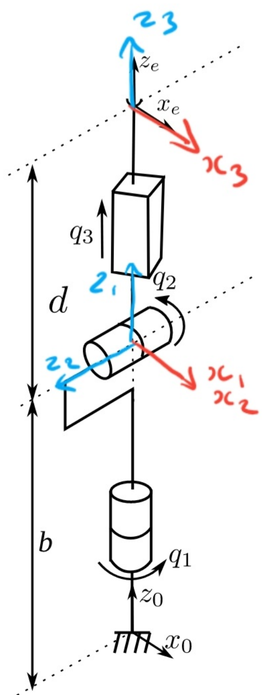

Figure 1: schematic of turret robot with intermediary frames

Joint	a	α	θ	r
1	0	0	q_1	b
2	0	$\pi/2$	q_2	0
3	0	$-\pi/2$	0	$q_3 + d$
e	0	0	0	0

Table 1: Modified DH-table for turret bot

1.2 KR-16 Robot (KUKA)

$r_1 = 0.675, \quad r_2 = 0.26, \quad r_3 = 0.68, \quad r_4 = 0.035, \quad r_5 = 0.67, \quad r_e = 0.158$

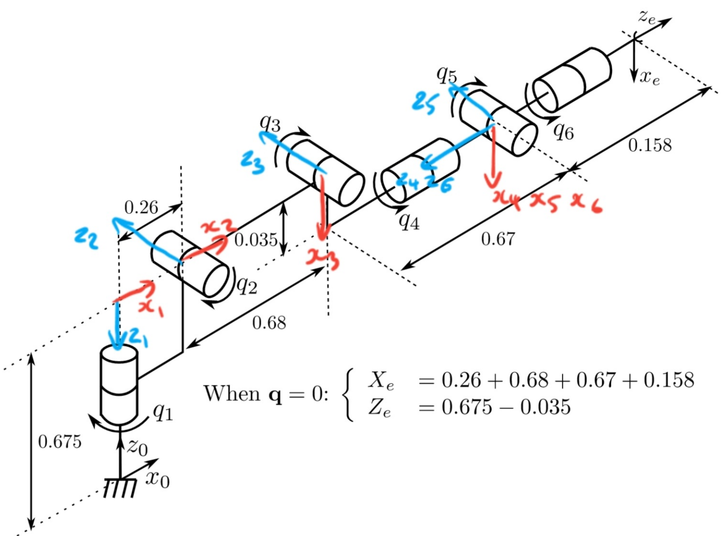

Figure 2: schematic of KUKA with intermediary frames

Joint	a	α	θ	r
1	0	π	q_1	$-r_1$
2	r_2	$\pi/2$	q_2	0
3	r_3	0	$q_3 + \pi/2$	0
4	r_4	$-\pi/2$	q_4	$-r_5$
5	0	$\pi/2$	q_5	0
6	0	$-\pi/2$	q_6	0
e	0	π	0	r_e

Table 2: Modified DH-table for KUKA

1.3 UR-10 Robot

$r_1 = 0.1273, \quad r_2 = 0.612, \quad r_3 = 0.5723, \quad r_4 = 0.1639, \quad r_5 = 0.1157, \quad r_e = 0.1922$

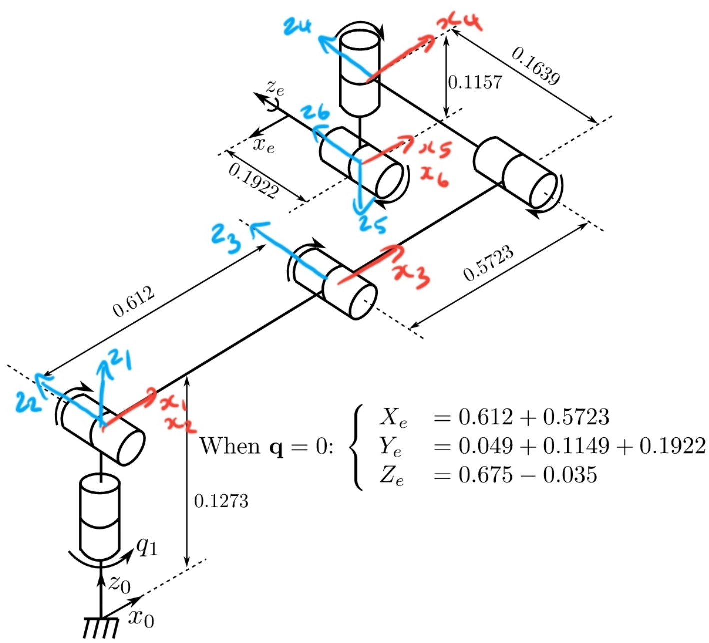

Figure 3: schematic of UR10 with intermediary frames

Joint	a	α	θ	r
1	0	0	q_1	r_1
2	0	$-\pi/2$	q_2	0
3	r_2	0	q_3	0
4	r_3	0	q_4	r_4
5	0	$-\pi/2$	q_5	r_5
6	0	$\pi/2$	q_6	0
e	0	0	π	r_e

Table 3: Modified DH-table for UR-10

2 Inverse Geometric Models

2.1 Turret Robot

$$
{}^{f}M_w = \begin{pmatrix} c_1c_2 & -s1 & -s2c1 & (-q_3 - r_2)s_2c_1 \\ s_1c_2 & c_1 & -s_1s_2 & (-q_3 - r_2)s_1s_2 \\ s_2 & 0 & c_2 & r_1 + (q_3 + r_2)c_2 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} x_x & x_y & x_z & t_x \\ y_x & y_y & y_z & t_y \\ z_x & z_y & z_z & t_z \\ 0 & 0 & 0 & 1 \end{pmatrix}
$$

2.2 KR-16 Robot (KUKA)

$$
{}^{f}t_w = \begin{pmatrix} (a_2 + a_3c_2 - a_4s_{23} + r_4c_{23})c_1 \\ (-a_2 - a_3c_2 + a_4s_{23} - r_4c_{23})s_1 \\ -a_3s_2 - a_4c_{23} + r_1 - r_4s_{23} \\ 1 \end{pmatrix} = \begin{pmatrix} t_x \\ t_y \\ t_z \\ 1 \end{pmatrix}
$$

$$
P^* = {}^{f}M_e^* = {}^{f}M_w{}^{w}M_e
$$

using ${}^{f}t_w$:

$$
q_1 = \text{solveType2}(t_x, t_y, 0) \tag{1}
$$

$$
q_2, q_{23} = \text{solveType7}(0, -a_3, (r_1 - t_z), (a_2 - {}^{t_x}\!/_{c_1}), a_4, r_4) \tag{2}
$$

$$
q_3 = q_{23} - q_2 \tag{3}
$$

we can compute:

$$
{}^{0}R_3 = \begin{pmatrix} -s_{23}c_1 & -c_1c_23 & s_1 \\ s_1s_23 & s_1c_23 & c_1 \\ -c_23 & s_23 & 0 \end{pmatrix} \quad \text{and} \quad {}^{3}R_6 = {}^{0}R_3^{-1}{}^{f}R_w = \begin{pmatrix} x'_x & y'_x & z'_x \\ x'_y & y'_y & z'_y \\ x'_z & y'_z & z'_z \end{pmatrix}
$$

$$
q_5 = \text{solveType2}(0, 1, z'_y) \tag{4}
$$

$$
q_4 = \text{solveType3}(0, -s_5, z'_x, s_5, 0, z'_z) \tag{5}
$$

$$
q_6 = \text{solveType2}(0, s_5, x'_y) \tag{6}
$$