Parallel Coupled Joint Mechanism

The PCJM element allows translational as well as rotational movement by differential displacement of the two prismatic joints. It provides higher stiffness against mechanical disturbances than a serial configuration. Figure 2.5 shows one PCJM element. The angular offset θ is calculated as follows:

$$\theta = \arctan\left(\frac{L_2 - L_1}{d}\right) \tag{2.1}$$

where L_1 and L_2 are the linear displacements of each joint and $d = 17mm$ the distance from each other.

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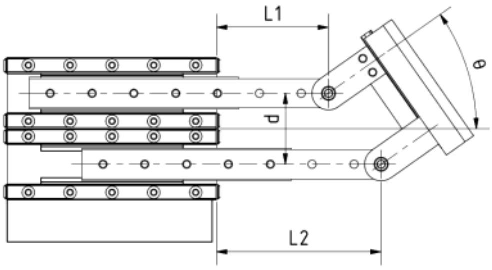

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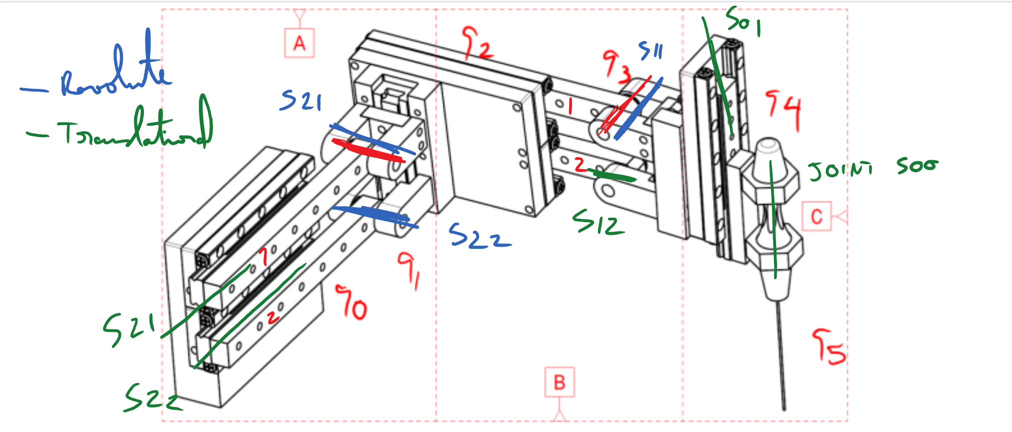

Figure 2.6.: The robotic assistant consists of: the first PCJM stage A, the second PCJM stage B and a simple prismatic stage C [35].

$q_0 = S22$

$q_1 = S21$

$q_2 = S12$

$q_3 = S11$

$q_4 = S01$

$q_5 = S00$

Parallel Coupled Joint Mechanism

The PCJM element allows translational as well as rotational movement by differential displacement of the two prismatic joints. It provides higher stiffness against mechanical disturbances than a serial configuration. Figure 2.5 shows one PCJM element. The angular offset θ is calculated as follows:

$$\boxed{\theta = \arctan\left(\frac{L_2 - L_1}{d}\right)} \tag{2.1}$$

where L_1 and L_2 are the linear displacements of each joint and $d = 17mm$ the distance from each other.

$$\theta = \mathrm{atan}\left(\frac{L_2 - L_1}{d}\right)$$

$$\tan\theta = \frac{L_2 - L_1}{d}$$

Furthermore, the mapping from L_i and θ_i of the PCJMs and the configuration of the prismatic and revolute joints from the serial robot is defined as

$$L_2 := q_0, \quad \theta_1 := q_1 \tag{2.9}$$
$$L_4 := q_2, \quad \theta_2 := q_3 \tag{2.10}$$

and

$$L_1 := L_2 - d * \tan(\theta_1) \tag{2.11}$$
$$L_3 := L_4 + d * \tan(\theta_2) \tag{2.12}$$

where the signs differ because of the flipped coordinate frames at the respective revolute joints.

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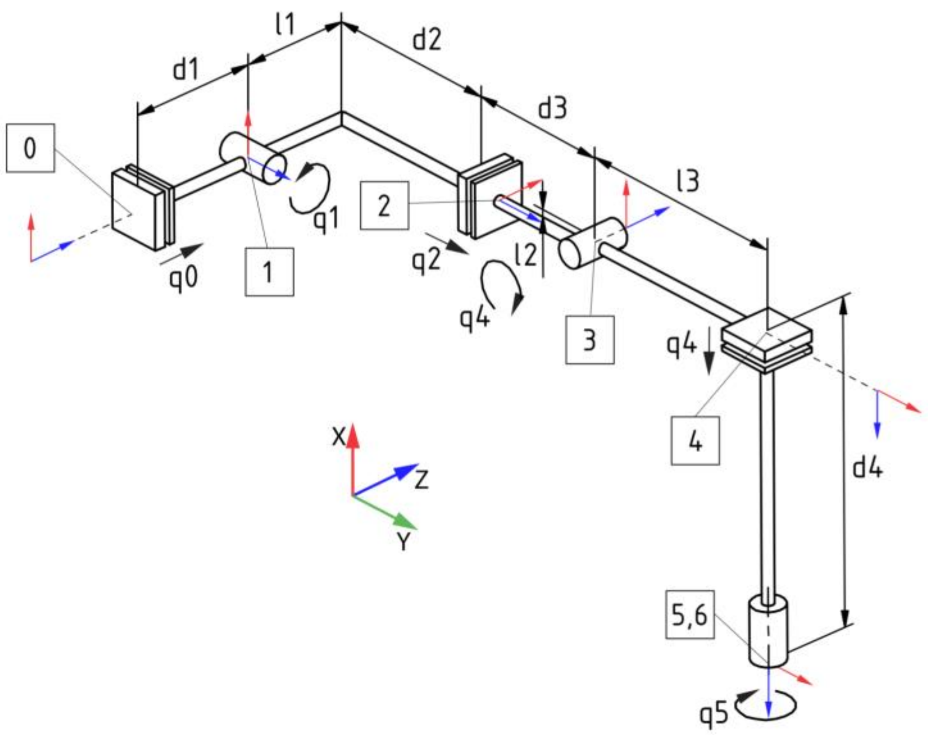

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Table 2.1.: The Denavit-Hartenberg parameters for the serial robot.

Link	ϕ_i	d_i	a_i	α_i
1	0	$d_1 + q_0$	0	$-\frac{\pi}{2}$
2	$q_1 - \frac{\pi}{2}$	d_2	l_1	0
3	$\frac{\pi}{2}$	$d_3 + q_2$	l_2	$\frac{\pi}{2}$
4	$q_3 + \frac{\pi}{2}$	0	l_3	$-\frac{\pi}{2}$
5	0	$d_4 + q_4$	0	0
6	q_5	0	0	0

Offsets	mm
l_1	32.5
l_2	1.33
l_3	40.5
d_1	22
d_2	20
d_3	22
d_4	55.35

given as

$$T_0^6 = \begin{pmatrix} -s_1s_5 - c_1c_5s_3 & c_1s_3s_5 - c_5s_1 & -c_1c_3 & l_2c_1 + l_1s_1 - c_1c_3(d_4+q_4) - l_3c_1s_3 \\ c_3c_5 & -c_3s_5 & -s_3 & d_2 + d_3 + q_2 - s_3(d_4+q_4) + l_3c_3 \\ c_5s_1s_3 - c_1s_5 & -c_1c_5 - s_1s_3s_5 & c_3s_1 & d_1 + q_0 + l_1c_1 - l_2s_1 + c_3s_1(d_4+q_4) + l_3s_1s_3 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{2.3}$$

with $s_i := sin(q_i), c_i := cos(q_i)$.

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