Basic geometric parameters - 6 DOF curved wrist

This section describes the basic geometric parameters of the 6 DOF curved wrist configuration.
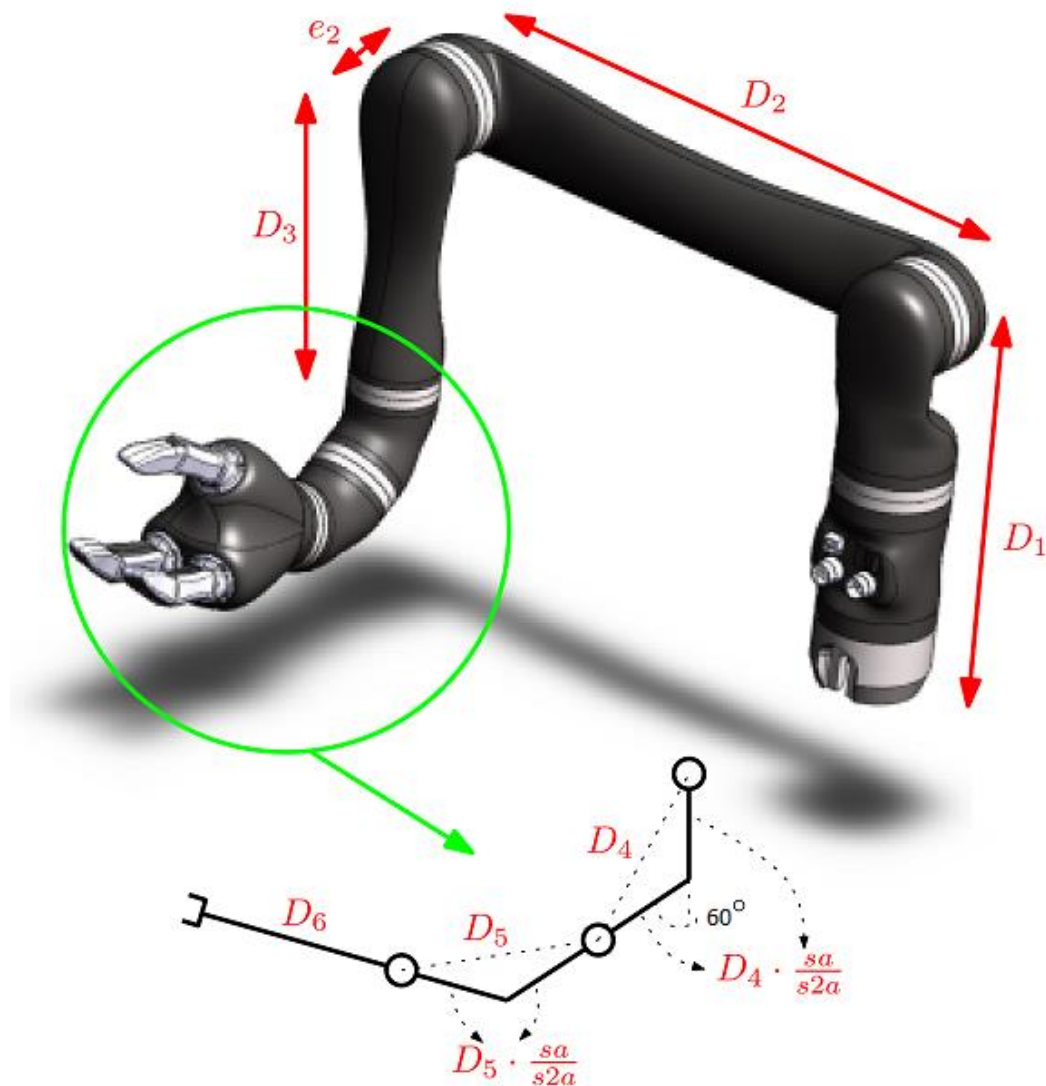

Table 21: 6 DOF curved wrist basic geometric parameters

| Parameter	Description	Length (m)
D1	Base to shoulder	0.2755
D2	Upper arm length (shoulder to elbow)	0.4100
D3	Forearm length (elbow to wrist)	0.2073
D4	First wrist length (center of actuator 4 to center of actuator 5)	0.0741
D5	Second wrist length (center of actuator 5 to center of actuator 6)	0.0741

Parameter	Description	Length (m)
D6	Wrist to center of the hand	0.1600
e2	Joint 3-4 lateral offset	0.0098

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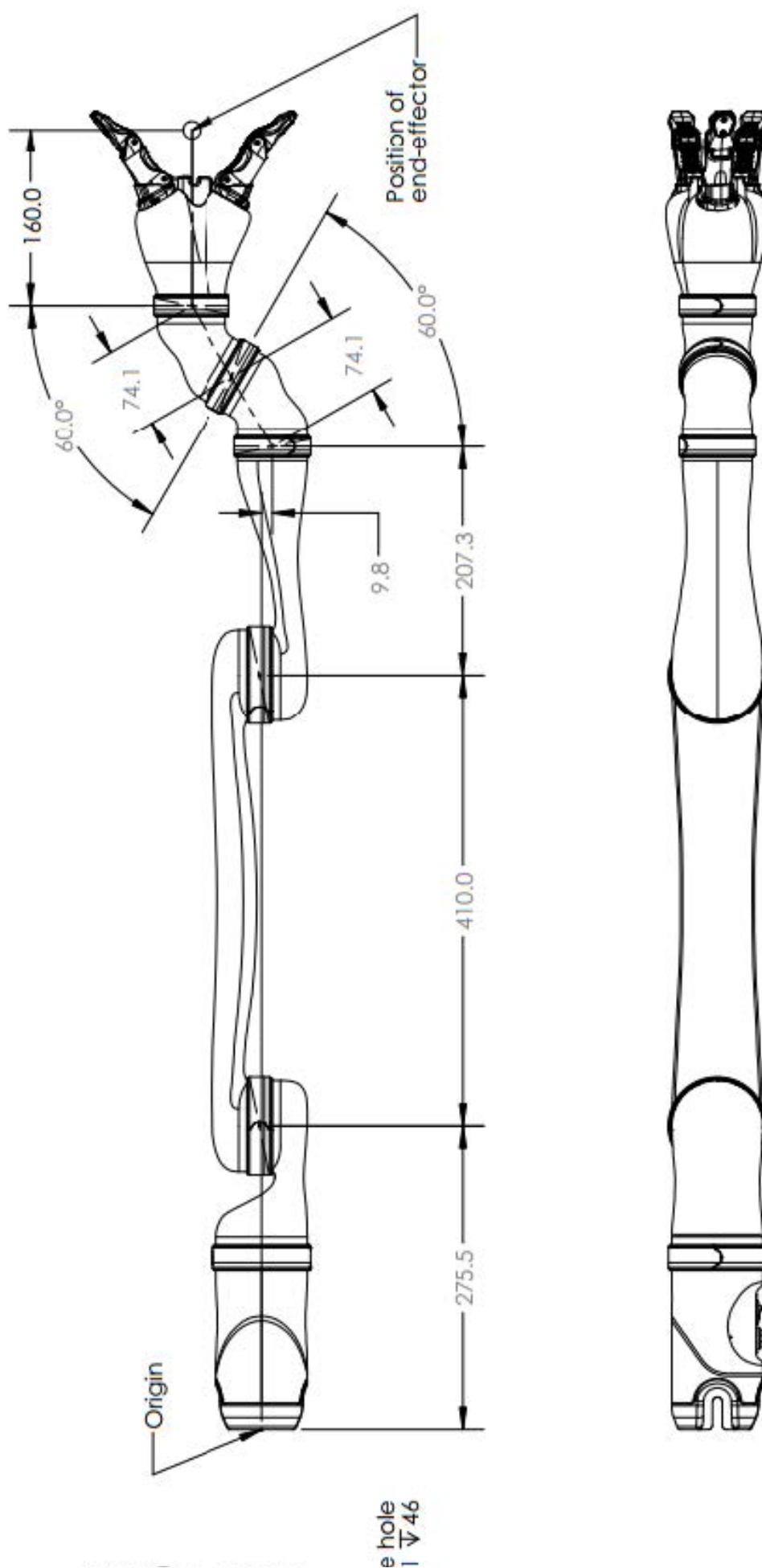
Alternate geometric parameters - 6 DOF curved wrist

This section describes alternate parameters that are useful for describing the geometry for kinematics of the 6 DOF curved wrist configuration.

The kinematics of the 6 DOF curved wrist configuration are more complicated than for a spherical wrist due to the more complicated geometry. To simplify the analysis, it is useful to break down each of the two curved wrist segments into two component straight-line sub-segments of equal length, with the second sub-segment angled 60° from the first.
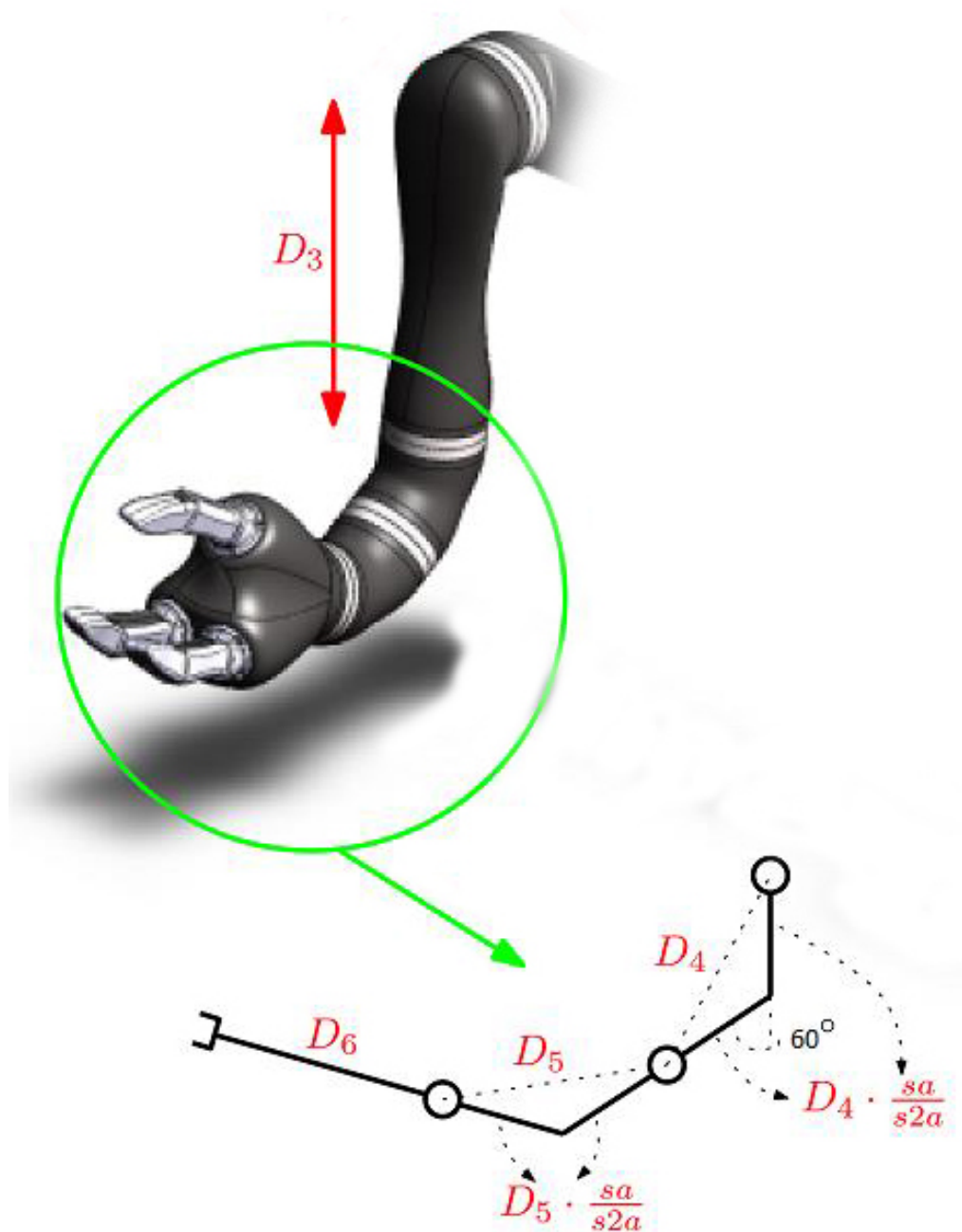

In this way, the arm from the elbow to the center of the hand can be analyzed as three straight-line segments:

- d4b - distance from elbow to end of first sub-segment of first wrist segment
- d5b - distance from end of first sub-segment of first wrist segment to end of first sub-segment of second wrist segment
- d6b - distance from end of second sub-segment of second wrist segment to center of hand

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Table 22: Alternate parameters

Parameter	Description	Value
aa	Half of the angle of curvature of each wrist segment (60°), measured in radians	(30.0 * PI) / 180.0
sa	Sine of half the angle of curvature of wrist segment	sin(aa)
s2a	Sine of angle of curvature of wrist segment	sin(2*aa)
d4b	Length of straight-line segment from elbow to end of first sub-segment of first wrist segment.	D3 + (sa / s2a) * D4
d5b	Length of straight-line segment consisting of second sub-segment of first wrist segment and first sub-segment of second wrist segment	(sa / s2a) * D4 + (sa / s2a) * D5
d6b	Length of straight-line segment consisting of second sub-segment of second wrist segment and distance from wrist to the center of the hand	(sa / s2a) * D5 + D6

The DH parameters for the lower part of the robotic arm are most naturally expressed in terms of these alternate parameters.
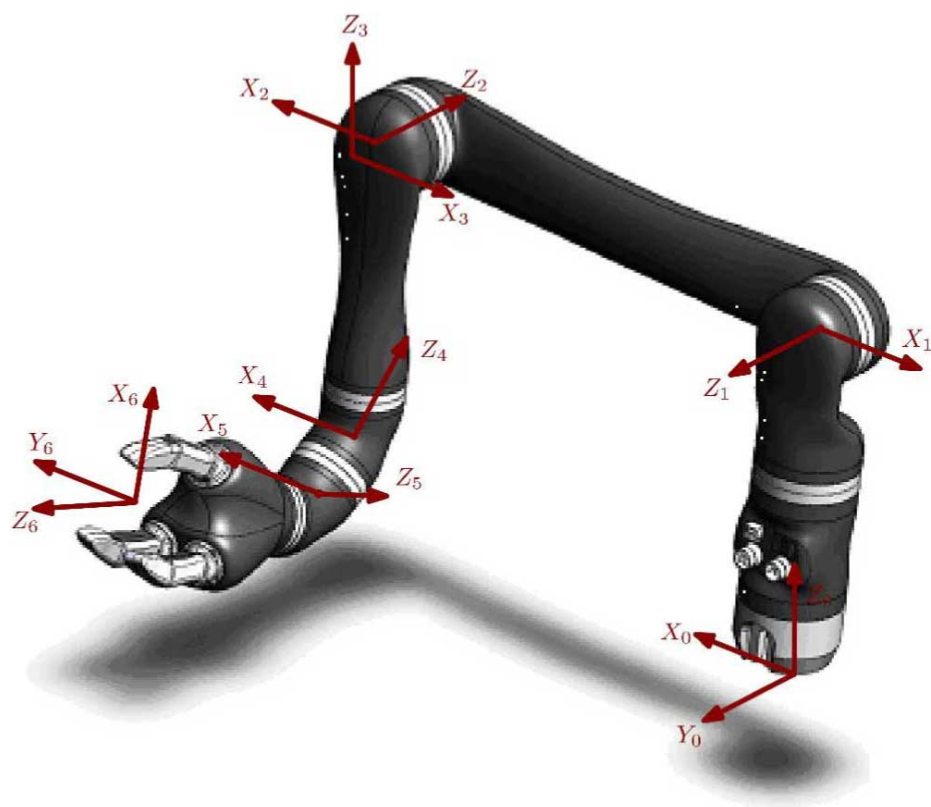
Represented
angular position:

(180, 270, 90, 180, 180, 0)

Classic DH parameters - 6 DOF spherical

This section describes the Classic DH parameters for the 6 DOF spherical.

Table 29: 6DOF spherical DH parameters

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	π / 2	0	D1	q1
2	π	D2	0	q2
3	π / 2	0	-e2	q3
4	π / 2	0	-(D3 + D4)	q4
5	π / 2	0	0	q5
6	π	0	-(D5 + D6)	q6

Table 30: Transformation from DH algorithm to robotic arm physical angles

Q1(physical) = -Q1(DH algo) + 180
Q2(physical) = Q2(DH algo) - 90
Q3(physical) = Q3(DH algo) - 90
Q4(physical) = Q4(DH algo)
Q5(physical) = Q5(DH algo)
Q6(physical) = Q6(DH algo) + 90