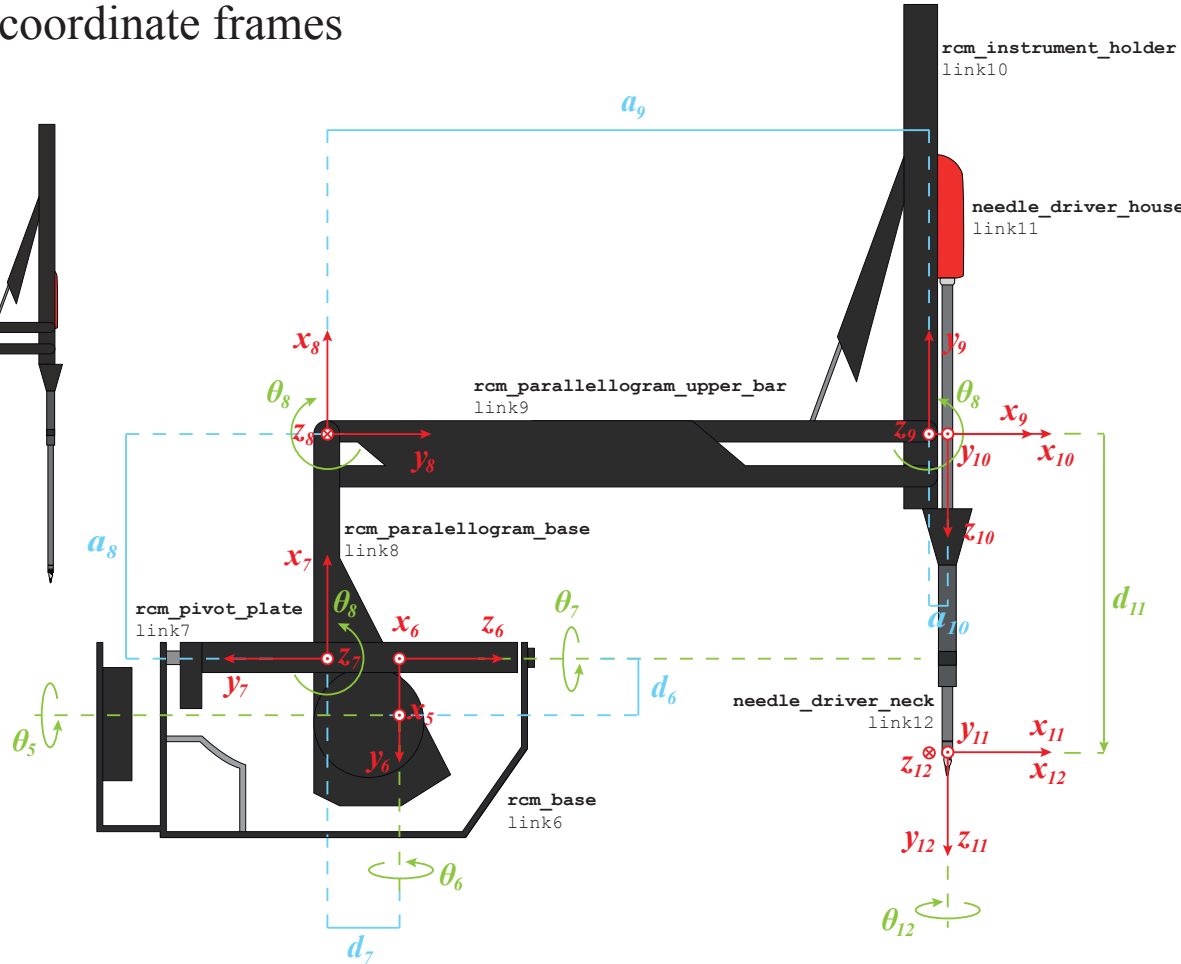
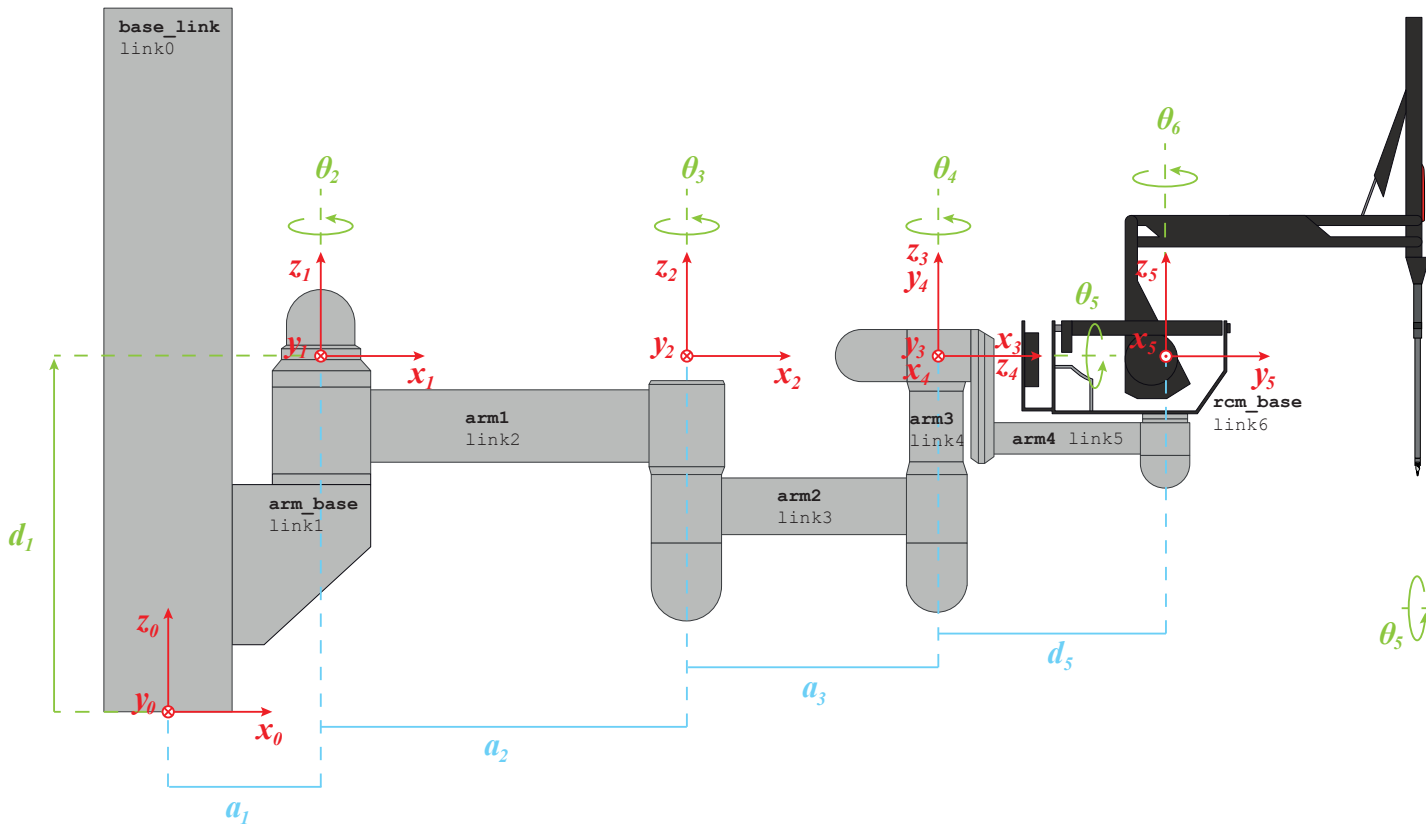


Denavit-Hartenberg coordinate frames

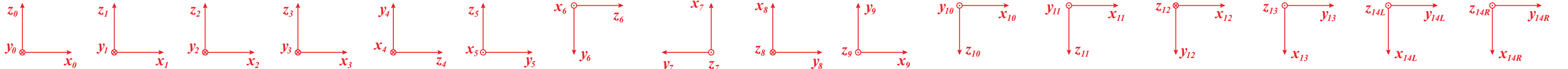
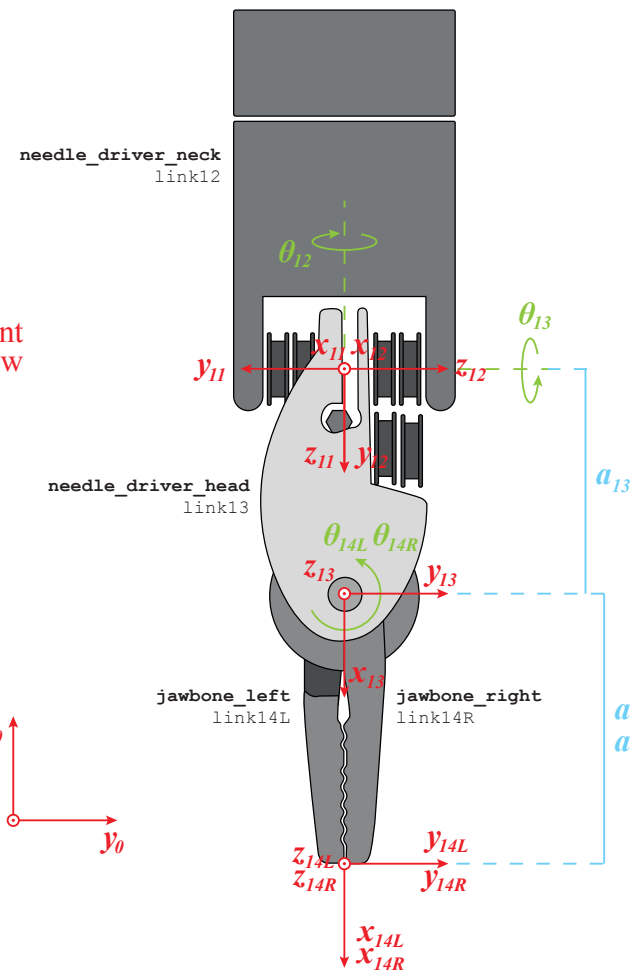
○ outward normal
⊗ inward normal

θ_i, d_i variables
 a_i, d_i parameters



side view

front view



z0 aligned with link1 actuation
W0 fixed in link0

z1 aligned with link2 actuation
W1 fixed in link1

z2 aligned with link3 actuation
W2 fixed in link2

z3 aligned with link4 actuation
W3 fixed in link3

z4 aligned with link5 actuation
W4 fixed in link4

z5 aligned with link6 actuation
W5 fixed in link5

z6 aligned with link7 actuation
W6 fixed in link6

z7 aligned with link8 actuation
W7 fixed in link7

z8 aligned with link9 actuation
W8 fixed in link8

z9 aligned with link10 actuation
W9 fixed in link9

z10 aligned with link11 actuation
W10 fixed in link10

z11 aligned with link12 actuation
W11 fixed in link11

z12 aligned with link13 actuation
W12 fixed in link12

z13 aligned with link14 actuation
W13 fixed in link13

x14L is LEFT end-effector frame
W14L fixed in link14L

x14R is RIGHT end-effector frame
W14R fixed in link14R

T01
 $\theta = 0$ (about z0, from x0 to x1)
 $d = d1^*$ (along z0, from o0 to x1)
 $a = a1$ (along x1, from z0 to z1)
 $\alpha = 0$ (about x1, from z0 to z1)

T23
 $\theta = \theta3^*$ (about z2, from x2 to x3)
 $d = 0$ (along z2, from o2 to x3)
 $a = a3$ (along x3, from z2 to z3)
 $\alpha = 0$ (about x3, from z2 to z3)

T45
 $\theta = \theta5^*$ (about z4, from x4 to x5)
 $d = d5$ (along z4, from o4 to x5)
 $a = 0$ (along x5, from z4 to z5)
 $\alpha = 90^\circ$ (about x5, from z4 to z5)

T67
 $\theta = \theta7^*$ (about z6, from x6 to x7)
 $d = d7$ (along z6, from o6 to x7)
 $a = 0$ (along x7, from z6 to z7)
 $\alpha = -90^\circ$ (about x7, from z6 to z7)

T89
 $\theta = \theta8^*$ (about z8, from x8 to x9)
 $d = 0$ (along z8, from o8 to x9)
 $a = a9$ (along x9, from z8 to z9)
 $\alpha = 180^\circ$ (about x9, from z8 to z9)

T1011
 $\theta = 0$ (about z10, from x10 to x11)
 $d = d11^*$ (along z10, from o10 to x11)
 $a = 0$ (along x11, from z10 to z11)
 $\alpha = 0$ (about x11, from z10 to z11)

T1213
 $\theta = \theta13^*$ (about z12, from x12 to x13)
 $d = 0$ (along z12, from o12 to x13)
 $a = a13$ (along x13, from z12 to z13)
 $\alpha = 90^\circ$ (about x13, from z12 to z13)

T1314R
 $\theta = \theta14R^*$ (about z13, from x13 to x14R)
 $d = 0$ (along z13, from o13 to x14R)
 $a = a14R$ (along x14R, from z13 to z14R)
 $\alpha = 0$ (about x14R, from z13 to z14R)

T12
 $\theta = \theta2^*$ (about z1, from x1 to x2)
 $d = 0$ (along z1, from o1 to x2)
 $a = a2$ (along x2, from z1 to z2)
 $\alpha = 0$ (about x2, from z1 to z2)

T34
 $\theta = \theta4^*$ (about z3, from x3 to x4)
 $d = 0$ (along z3, from o3 to x4)
 $a = 0$ (along x4, from z3 to z4)
 $\alpha = 90^\circ$ (about x4, from z3 to z4)

T56
 $\theta = \theta6^*$ (about z5, from x5 to x6)
 $d = d6$ (along z5, from o5 to x6)
 $a = 0$ (along x6, from z5 to z6)
 $\alpha = -90^\circ$ (about x6, from z5 to z6)

T78
 $\theta = \theta8^*$ (about z7, from x7 to x8)
 $d = 0$ (along z7, from o7 to x8)
 $a = a8$ (along x8, from z7 to z8)
 $\alpha = 180^\circ$ (about x8, from z7 to z8)

T910
 $\theta = \theta8^*$ (about z9, from x9 to x10)
 $d = 0$ (along z9, from o9 to x10)
 $a = a10$ (along x10, from z9 to z10)
 $\alpha = 90^\circ$ (about x10, from z9 to z10)

T1112
 $\theta = \theta12^*$ (about z11, from x11 to x12)
 $d = 0$ (along z11, from o11 to x12)
 $a = 0$ (along x12, from z11 to z12)
 $\alpha = 90^\circ$ (about x12, from z11 to z12)

T1314L
 $\theta = \theta14L^*$ (about z13, from x13 to x14L)
 $d = 0$ (along z13, from o13 to x14L)
 $a = a14L$ (along x14L, from z13 to z14L)
 $\alpha = 0$ (about x14L, from z13 to z14L)

	parameters	parameters	variables physical limits	variables low-level controller limits	variables ROS xacro limits
1	$a_1 = 0.1885$ m		$d_1 = []$ m	$d_1 = []$ m	$d_1 = [0, 1]$ m
2	$a_2 = 0.5820$ m		$\theta_2 = []^\circ$	$\theta_2 = []^\circ$	$\theta_2 = [-1.5708, 1.5708]$ rad
3	$a_3 = 0.4287$ m		$\theta_3 = []^\circ$	$\theta_3 = []^\circ$	$\theta_3 = [-2.8000, 2.8000]$ rad
4		$\alpha_4 = 90^\circ$	$\theta_4 = []^\circ$	$\theta_4 = []^\circ$	$\theta_4 = [-2.8000, 2.8000]$ rad
5	$d_5 = 0.4122$ m	$\alpha_5 = 90^\circ$	$\theta_5 = []^\circ$	$\theta_5 = []^\circ$	$\theta_5 = [-1.5708, 1.5708]$ rad
6	$d_6 = 0.0474$ m	$\alpha_6 = -90^\circ$	$\theta_6 = []^\circ$	$\theta_6 = []^\circ$	$\theta_6 = [-2.8000, 2.8000]$ rad
7	$d_7 = 0.0350$ m	$\alpha_7 = -90^\circ$	$\theta_7 = [-95.7, 95.7]^\circ = [-1.6703, 1.6703]$ rad	$\theta_7 = [-76.4, 81.6]^\circ = [-1.3334, 1.4242]$ rad	$\theta_7 = [-1.5708, 1.5708]$ rad
8	$a_8 = 0.1900$ m	$\alpha_8 = 180^\circ$	$\theta_8 = [-54.5, 52.3]^\circ = [-0.9512, 0.9128]$ rad	$\theta_8 = [-46.5, 44.3]^\circ = [-0.8116, 0.7732]$ rad	$\theta_8 = [-0.8000, 1.0000]$ rad
9	$a_9 = 0.5230$ m	$\alpha_9 = 180^\circ$			
10	$a_{10} = 0.0400$ m	$\alpha_{10} = 90^\circ$			
11			$d_{11} = [0.1690, 0.4100]$ m	$d_{11} = [0.1700, 0.4090]$ m	$d_{11} = [-0.1200, 0.1200]$ m
12		$\alpha_{12} = 90^\circ$	$\theta_{12} = [-249, 273]^\circ = [-4.3459, 4.7647]$ rad	$\theta_{12} = [-246, 253]^\circ = [-4.2935, 4.4157]$ rad	$\theta_{12} = [-4.7124, 4.7124]$ rad
13	$a_{13} = 0.0095$ m	$\alpha_{13} = 90^\circ$	$\theta_{13} = [-84.0, 88.0]^\circ = [-1.4661, 1.5359]$ rad	$\theta_{13} = [-56.0, 52.0]^\circ = [-0.9774, 0.9076]$ rad	$\theta_{13} = [-1.5000, 1.5000]$ rad
14L	$a_{14L} = 0.0095$ m		$\theta_{14L} = [-106, \theta_{14R}]^\circ = [-1.8500, \theta_{14R}]$ rad	$\theta_{14L} = [-45.0, 76.5]^\circ = [-0.7854, 1.3352]$ rad	$\theta_{14L} = [-1.8000, 1.8000]$ rad
14R	$a_{14R} = 0.0095$ m		$\theta_{14R} = [\theta_{14L}, 97.5]^\circ = [\theta_{14L}, 1.7017]$ rad	$\theta_{14R} = [?, ?]^\circ = []$ rad	$\theta_{14R} = [-1.8000, 1.8000]$ rad