

Jaco² 7 DOF with spherical wrist

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This document describes the main parameters of the Kinova Jaco2 7 DOFs with spherical wrist available at the [LAI Robotics](#) lab. Figure 1 shows the Jaco2 in home configuration.

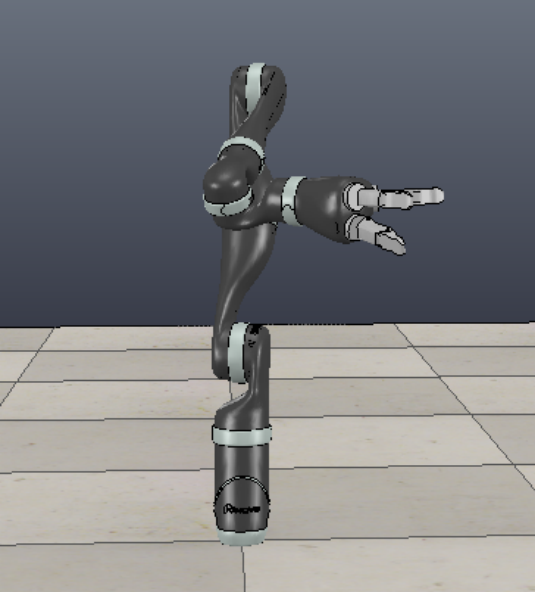


Fig. 1: Kinova Jaco2 7 DOFs Spherical Wrist in home configuration

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I. DENAVIT-HARTENBERG PARAMETERS

The Denavit-Hartenberg parameters in Table I have been identified according to [1]:

The frames are then positioned according to Fig. 2

joint	a (m)	α (°)	d (m)	θ (°)
1	0	90°	0.2755	θ_1
2	0	90°	0	θ_2
3	0	90°	-0.410	θ_3
4	0	90°	-0.0098	θ_4
5	0	90°	-0.3111	θ_5
6	0	90°	0	θ_6
7	0	0°	0.2638	θ_7

TABLE I: DH parameter

joint	
1	$\theta_{1_{Jaco}} = -\theta_{1_{DH}}$
2	$\theta_{2_{Jaco}} = \theta_{2_{DH}} + 180^\circ$
3	$\theta_{3_{Jaco}} = \theta_{3_{DH}}$
4	$\theta_{4_{Jaco}} = \theta_{4_{DH}}$
5	$\theta_{5_{Jaco}} = \theta_{5_{DH}}$
6	$\theta_{6_{Jaco}} = \theta_{6_{DH}} + 180^\circ$
7	$\theta_{7_{Jaco}} = -\theta_{7_{DH}}$

TABLE II: Mask DH → Kinova

II. CONVERSION BETWEEN DH AND KINOVA CONVENTIONS

In order to transform the coordinates from Kinova to DH conventions and vice-versa, the tables II-III should be used

For velocities, accelerations and joint torques it is needed to change the sign of the corresponding variables of joints 1 and 7.

The *vertical* position in Fig. 2 is thus obtained imposing the configurations in tables IV, V.

joint	
1	$\theta_{1_{DH}} = -\theta_{1_{Jaco}}$
2	$\theta_{2_{DH}} = \theta_{2_{Jaco}} - 180^\circ$
3	$\theta_{3_{DH}} = \theta_{3_{Jaco}}$
4	$\theta_{4_{DH}} = \theta_{4_{Jaco}}$
5	$\theta_{5_{DH}} = \theta_{5_{Jaco}}$
6	$\theta_{6_{DH}} = \theta_{6_{Jaco}} - 180^\circ$
7	$\theta_{7_{DH}} = -\theta_{7_{Jaco}}$

TABLE III: Mask Kinova → DH

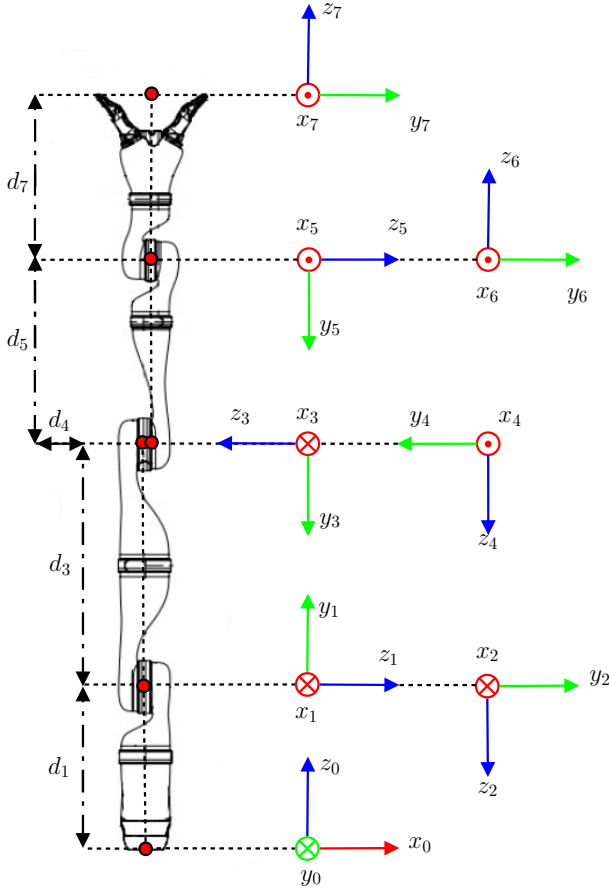


Fig. 2: Kinova Jaco2 7 DOFs Spherical Wrist scheme with reference frames in Denavit-Hartenberg convention.

joint	
1	$\theta_{1_{\text{Jaco}}} = -90^\circ$
2	$\theta_{2_{\text{Jaco}}} = 180^\circ$
3	$\theta_{3_{\text{Jaco}}} = 0^\circ$
4	$\theta_{4_{\text{Jaco}}} = 180^\circ$
5	$\theta_{5_{\text{Jaco}}} = 0^\circ$
6	$\theta_{6_{\text{Jaco}}} = 180^\circ$
7	$\theta_{7_{\text{Jaco}}} = 0^\circ$

TABLE IV: Vertical configuration in Kinova convention

The *home* position in Fig. 1 is thus obtained imposing the configurations in tables VI, VII.

Figure 3 shows the positive directions according to DH convention.

III. POSITION AND VELOCITY LIMITS

Table VIII reports the mechanical joint limits in DH convention.

Table IX reports the mechanical joint velocity limits (due to the symmetry those are valid in both conventions).

joint	
1	$\theta_{1_{\text{DH}}} = 90^\circ$
2	$\theta_{2_{\text{DH}}} = 0^\circ$
3	$\theta_{3_{\text{DH}}} = 0^\circ$
4	$\theta_{4_{\text{DH}}} = 180^\circ$
5	$\theta_{5_{\text{DH}}} = 0^\circ$
6	$\theta_{6_{\text{DH}}} = 0^\circ$
7	$\theta_{7_{\text{DH}}} = 0^\circ$

TABLE V: Vertical configuration in DH convention

joint	
1	$\theta_{1_{\text{Jaco}}} = -76.9301^\circ$
2	$\theta_{2_{\text{Jaco}}} = 162.8906^\circ$
3	$\theta_{3_{\text{Jaco}}} = 0.1103^\circ$
4	$\theta_{4_{\text{Jaco}}} = 43.3456^\circ$
5	$\theta_{5_{\text{Jaco}}} = -94.4318^\circ$
6	$\theta_{6_{\text{Jaco}}} = 257.1818^\circ$
7	$\theta_{7_{\text{Jaco}}} = -71.7273^\circ$

TABLE VI: Home configuration in Kinova convention

joint	
1	$\theta_{1_{\text{DH}}} = 76.9301^\circ$
2	$\theta_{2_{\text{DH}}} = -17.1094^\circ$
3	$\theta_{3_{\text{DH}}} = 0.1103^\circ$
4	$\theta_{4_{\text{DH}}} = 43.3456^\circ$
5	$\theta_{5_{\text{DH}}} = -94.4318^\circ$
6	$\theta_{6_{\text{DH}}} = 77.1818^\circ$
7	$\theta_{7_{\text{DH}}} = 71.7273^\circ$

TABLE VII: Home configuration in DH convention

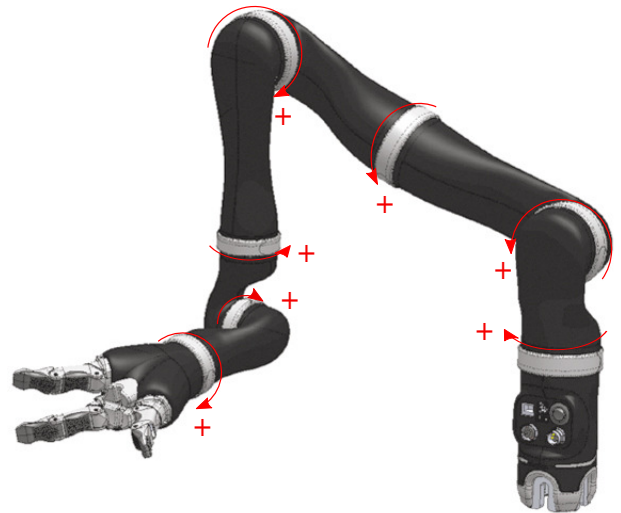


Fig. 3: Positive directions according to Jacobian convention.

joint	Min (rad)	Max (rad)
1	$-\infty$	∞
2	0.82	5.46
3	$-\infty$	∞
4	0.52	5.76
5	$-\infty$	∞
6	1.13	5.14
7	$-\infty$	∞

TABLE VIII: Mechanical joint limits in Kinova convention

joint	Min (rad/s)	Max (rad/s)
1	-0.81	0.81
2	-0.81	0.81
3	-0.81	0.81
4	-0.81	0.81
5	-1.11	1.11
6	-1.11	1.11
7	-1.11	1.11

TABLE IX: Velocity joint limits (in both convention)

IV. COPPELIASIM SIMULATIONS

CoppeliaSim (substitute for V-rep) can be downloaded from the producer web site [2].

The documentation, the *scene* to upload in Vrep and the template code to run a simulation is available in Classroom and at the address <http://webuser.unicas.it/lai/robotica>, in the software section.

Notice that the masks for positions, velocities, accelerations and torques are the same as for the real robot, i.e., the transformations DH to/from Kinova should be used.

REFERENCES

- [1] B. Siciliano, L. Sciacicco, L. Villani, and G. Oriolo, *Robotics: modelling, planning and control*. Springer Verlag, 2009.
- [2] “V-rep,” in <http://www.coppeliarobotics.com>.