IR **UNIVERSΛL ROBOTS** Support

DH PARAMETERS FOR CALCULATIONS OF KINEMATICS AND DYNAMICS

Denavit Hartenberg Parameters - DH Parameters

🗓 Last modified on Jan 19, 2022

Denavit–Hartenberg parameters are used to calculate kinematics and dynamics of UR robots.
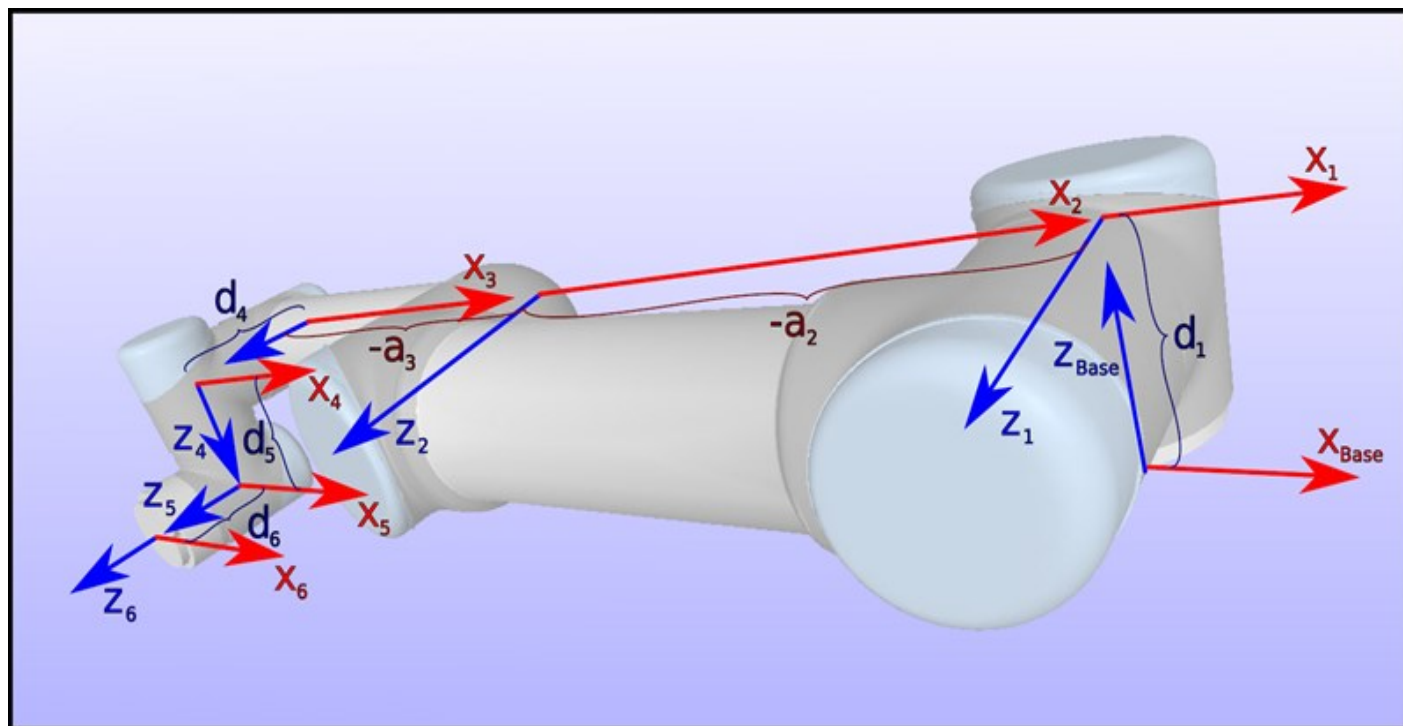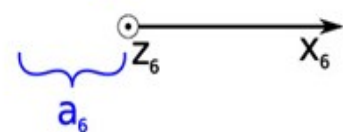
The definition of the Denavit–Hartenberg parameters can be found here: http://en.wikipedia.org/wiki/Denavit%E2%80%93Hartenberg_parameters

Animation to explain the Denavit–Hartenberg parameters: https://www.youtube.com/watch?v=rA9tm0gTln8

Note: UR "a" parameter = Wikipedia "r" parameter.

The Denavit–Hartenberg parameters in UR robots are described as the below diagrams.
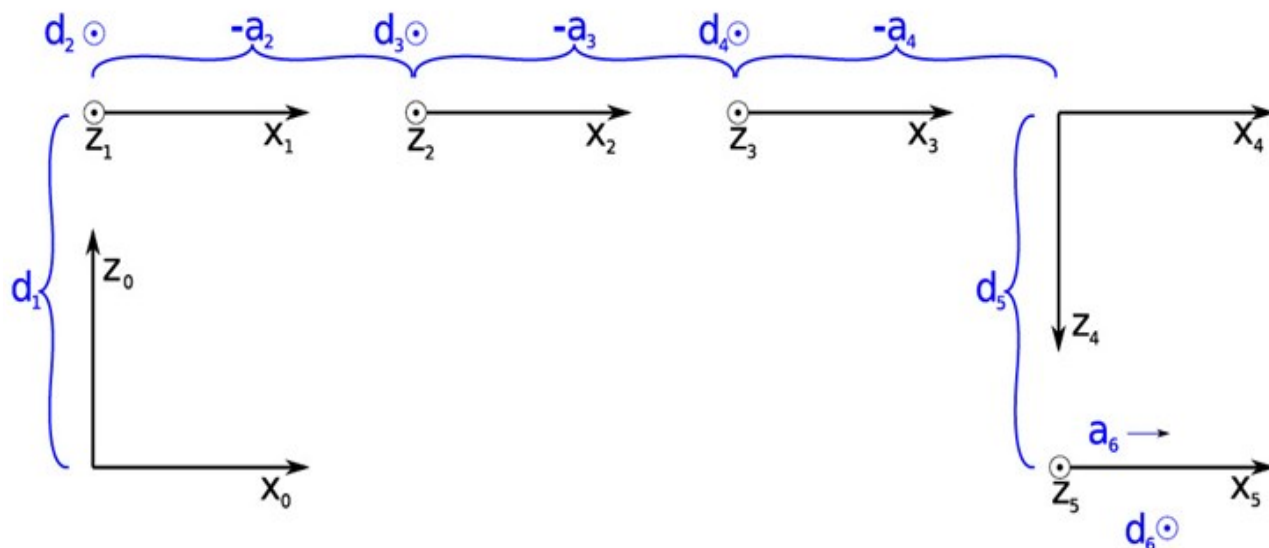
The Denavit–Hartenberg parameters of UR robots are shown as below.

UR3e							
Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	**Dynamics**	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.15185	$\pi/2$	Link 1	1.98	[0, -0.02, 0]
Joint 2	0	-0.24355	0	0	Link 2	3.4445	[0.13, 0, 0.1157]
Joint 3	0	-0.2132	0	0	Link 3	1.437	[0.05, 0, 0.0238]
Joint 4	0	0	0.13105	$\pi/2$	Link 4	0.871	[0, 0, 0.01]
Joint 5	0	0	0.08535	$-\pi/2$	Link 5	0.805	[0, 0, 0.01]
Joint 6	0	0	0.0921	0	Link 6	0.261	[0, 0, -0.02]

UR5e							
Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	**Dynamics**	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.1625	$\pi/2$	Link 1	3.761	[0, -0.02561, 0.00193]
Joint 2	0	-0.425	0	0	Link 2	8.058	[0.2125, 0, 0.11336]

Joint 3	0	-0.3922	0	0	Link 3	2.846	[0.15, 0.0, 0.0265]
Joint 4	0	0	0.1333	π/2	Link 4	1.37	[0, -0.0018, 0.01634]
Joint 5	0	0	0.0997	-π/2	Link 5	1.3	[0, 0.0018,0.01634]
Joint 6	0	0	0.0996	0	Link 6	0.365	[0, 0, -0.001159]

UR10e

Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	Dynamics	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.1807	π/2	Link 1	7.369	[0.021, 0.000, 0.027]
Joint 2	0	-0.6127	0	0	Link 2	13.051	[0.38, 0.000, 0.158]
Joint 3	0	-0.57155	0	0	Link 3	3.989	[0.24, 0.000, 0.068]
Joint 4	0	0	0.17415	π/2	Link 4	2.1	[0.000, 0.007, 0.018]
Joint 5	0	0	0.11985	-π/2	Link 5	1.98	[0.000, 0.007, 0.018]
Joint 6	0	0	0.11655	0	Link 6	0.615	[0, 0, -0.026]

UR16e

Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	Dynamics	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.1807	π/2	Link 1	7.369	[0.000, -0.016, 0.030]
Joint 2	0	-0.4784	0	0	Link 2	10.450	[0.302, 0.000, 0.160]
Joint 3	0	-0.36	0	0	Link 3	4.321	[0.194, 0.000, 0.065]
Joint 4	0	0	0.17415	π/2	Link 4	2.180	[0.000, -0.009, 0.011]
Joint 5	0	0	0.11985	-π/2	Link 5	2.033	[0.000, 0.018, 0.012]
Joint 6	0	0	0.11655	0	Link 6	0.907	[0, 0, -0.044]

UR3

Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	Dynamics	Mass [kg]	Center of Mass [m]

Joint 1	0	0	0.1519	π/2	Link 1	2	[0, -0.02, 0]
Joint 2	0	-0.24365	0	0	Link 2	3.42	[0.13, 0, 0.1157]
Joint 3	0	-0.21325	0	0	Link 3	1.26	[0.05, 0, 0.0238]
Joint 4	0	0	0.11235	π/2	Link 4	0.8	[0, 0, 0.01]
Joint 5	0	0	0.08535	-π/2	Link 5	0.8	[0, 0, 0.01]
Joint 6	0	0	0.0819	0	Link 6	0.35	[0, 0, -0.02]

UR5							
Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	**Dynamics**	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.089159	π/2	Link 1	3.7	[0, -0.02561, 0.00193]
Joint 2	0	-0.425	0	0	Link 2	8.393	[0.2125, 0, 0.11336]
Joint 3	0	-0.39225	0	0	Link 3	2.33	[0.15, 0.0, 0.0265]
Joint 4	0	0	0.10915	π/2	Link 4	1.219	[0, -0.0018, 0.01634]
Joint 5	0	0	0.09465	-π/2	Link 5	1.219	[0, 0.0018,0.01634]
Joint 6	0	0	0.0823	0	Link 6	0.1879	[0, 0, -0.001159]

UR10							
Kinematics	theta [rad]	a [m]	d [m]	alpha [rad]	**Dynamics**	Mass [kg]	Center of Mass [m]
Joint 1	0	0	0.1273	π/2	Link 1	7.1	[0.021, 0.000, 0.027]
Joint 2	0	-0.612	0	0	Link 2	12.7	[0.38, 0.000, 0.158]
Joint 3	0	-0.5723	0	0	Link 3	4.27	[0.24, 0.000, 0.068]
Joint 4	0	0	0.163941	π/2	Link 4	2	[0.000, 0.007, 0.018]
Joint 5	0	0	0.1157	-π/2	Link 5	2	[0.000, 0.007, 0.018]
Joint 6	0	0	0.0922	0	Link 6	0.365	[0, 0, -0.026]

-0,984807753	0,173648178	0	0,418543295
-0,173648178	-0,984807753	0	0,073800476
0	0	1	0
0	0	0	1

Interim result →

-0,52187	0,09202	-0,84805	0,22179
0,83516	-0,14726	-0,52992	-0,35494
-0,17365	-0,98481	0,00000	0,23630
0,00000	0,00000	0,00000	1,00000

* 2T3

2T3

0,515038075	-0,857167301	0	-0,20199793
0,857167301	0,515038075	0	-0,33618102
0	0	1	0
0	0	0	1

Interim result →

-0,18991	0,49472	-0,84805	0,29628
0,30391	-0,79172	-0,52992	-0,47414
-0,93358	-0,35837	0,00000	0,60245
0,00000	0,00000	0,00000	1,00000

* 3T4

3T4

-0,945518576	1,99435E-17	-0,32556815	0
-0,325568154	-5,792E-17	0,945518576	0
0	1	6,12574E-17	0,1333
0	0	0	1

Interim result →

0,01849	-0,84805	0,52960	0,18323
-0,02960	-0,52992	-0,84753	-0,54478
0,99939	0,00000	-0,03490	0,60245
0,00000	0,00000	0,00000	1,00000

* 4T5

4T5

-0,5	-5,30505E-17	-0,8660254	0
0,866025404	-3,06287E-17	-0,5	0
0	-1	6,12574E-17	0,0997
0	0	0	1

Interim result →

-0,74368	-0,52960	0,40801	0,23603
-0,44413	0,84753	0,29059	-0,62928
-0,49970	0,03490	-0,86550	0,59897
0,00000	0,00000	0,00000	1,00000

* 5T6

5T6

6,12574E-17	-1	0	0
1	6,12574E-17	0	0
0	0	1	0,0996
0	0	0	1

Result 0T1*1T2*2T3*3T4*4T5*5T6 →

-0,52960	0,74368	0,40801	0,27667
0,84753	0,44413	0,29059	-0,60033
0,03490	0,49970	-0,86550	0,51277
0,00000	0,00000	0,00000	1,00000

X	Y	Z
0	0	0,1625
0,22179	-0,35494	0,23630
0,29628	-0,47414	0,60245
0,18323	-0,54478	0,60245
0,23603	-0,62928	0,59897
0,27667	-0,60033	0,51277
beta	alpha	gamma
1,60570	2,58309	2,09440
92,00000	148,00000	120,00000

0,9

0,7

0,5

-0,5

-0,7

-0,9
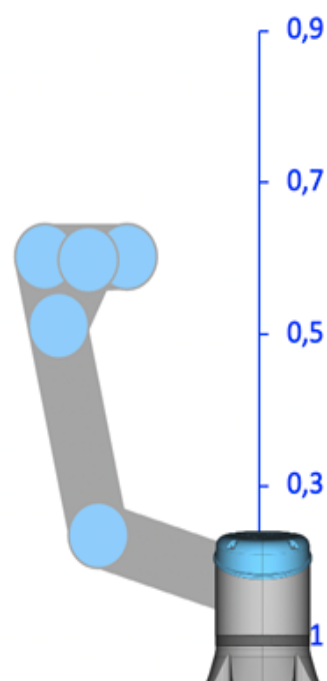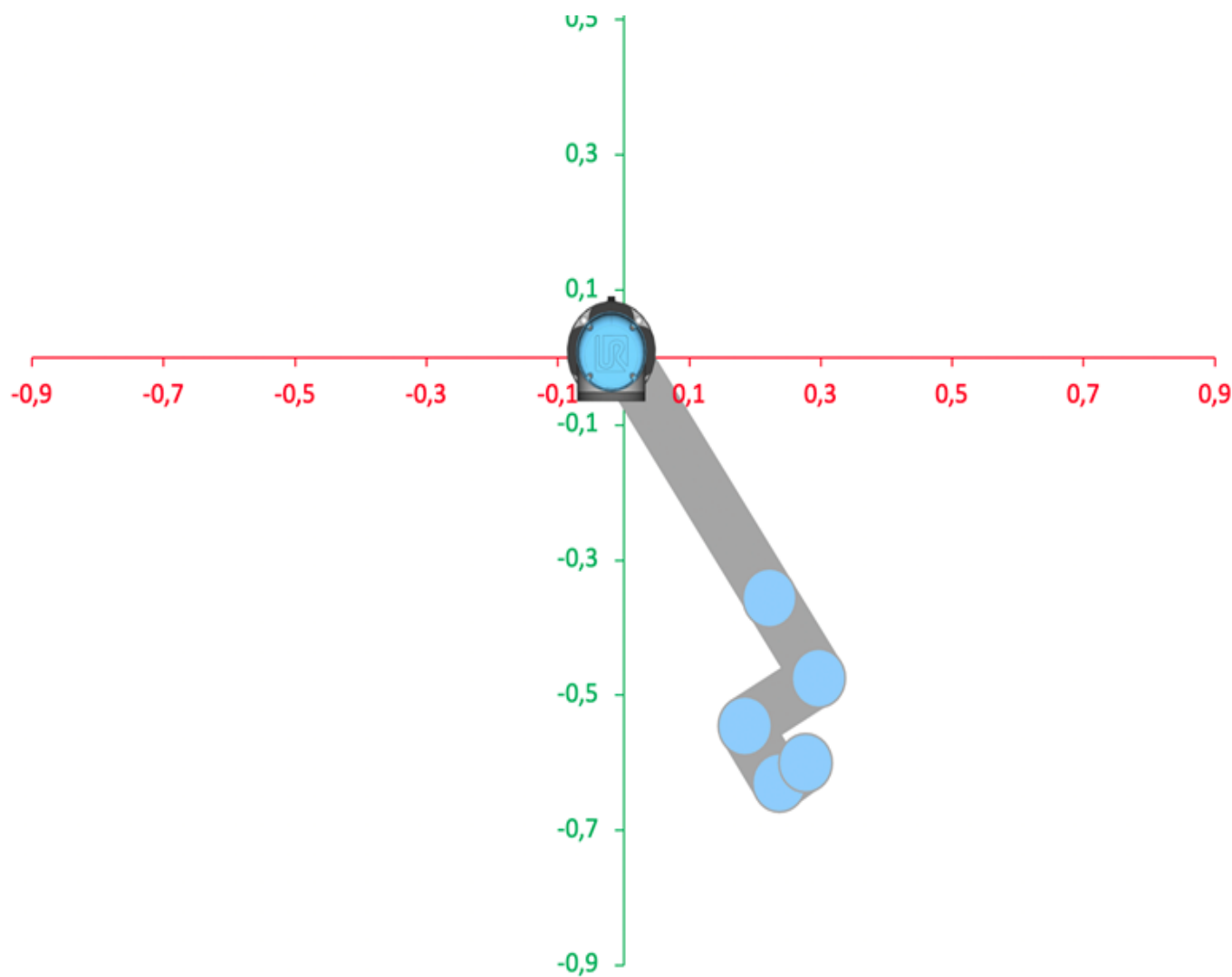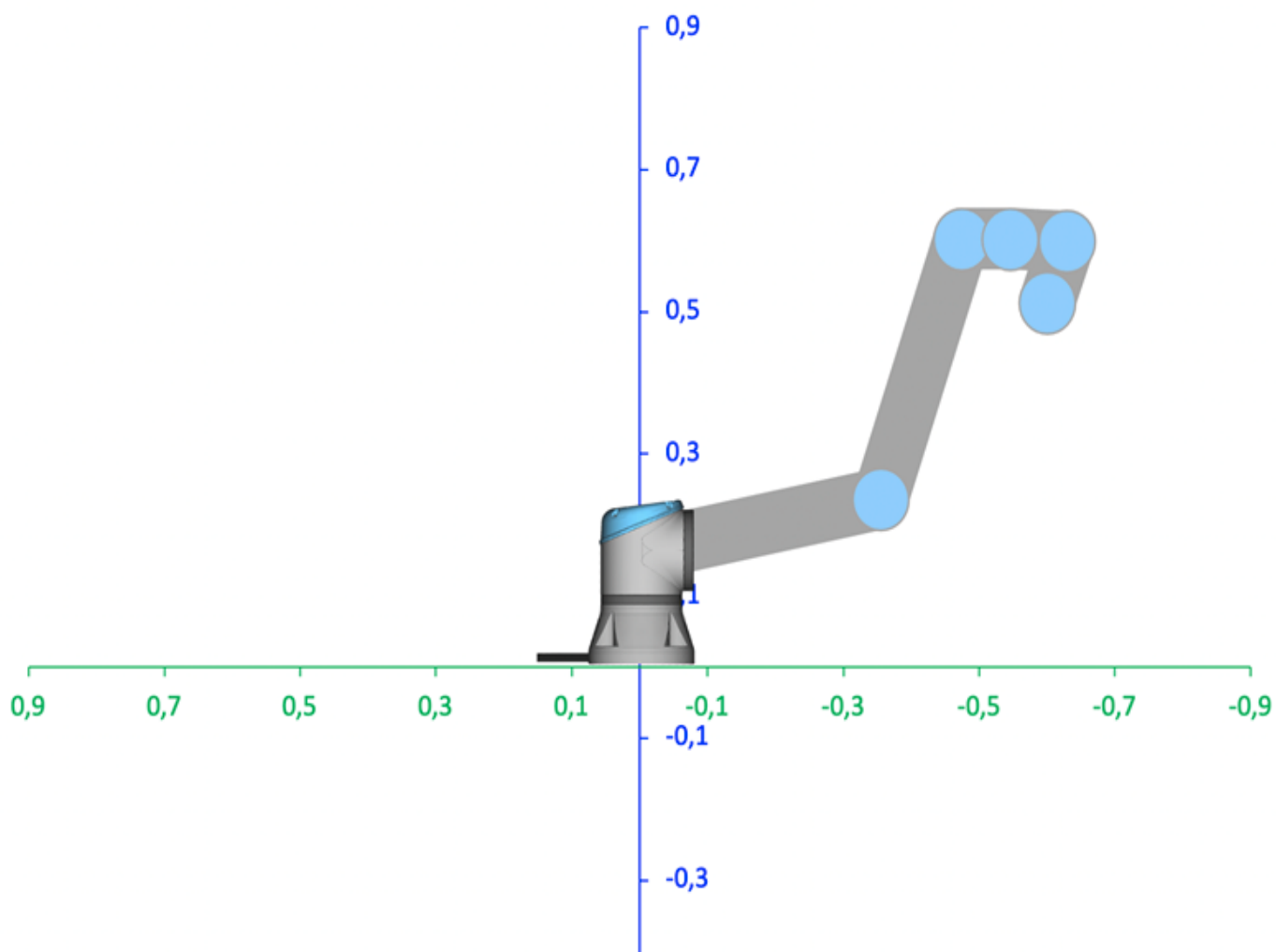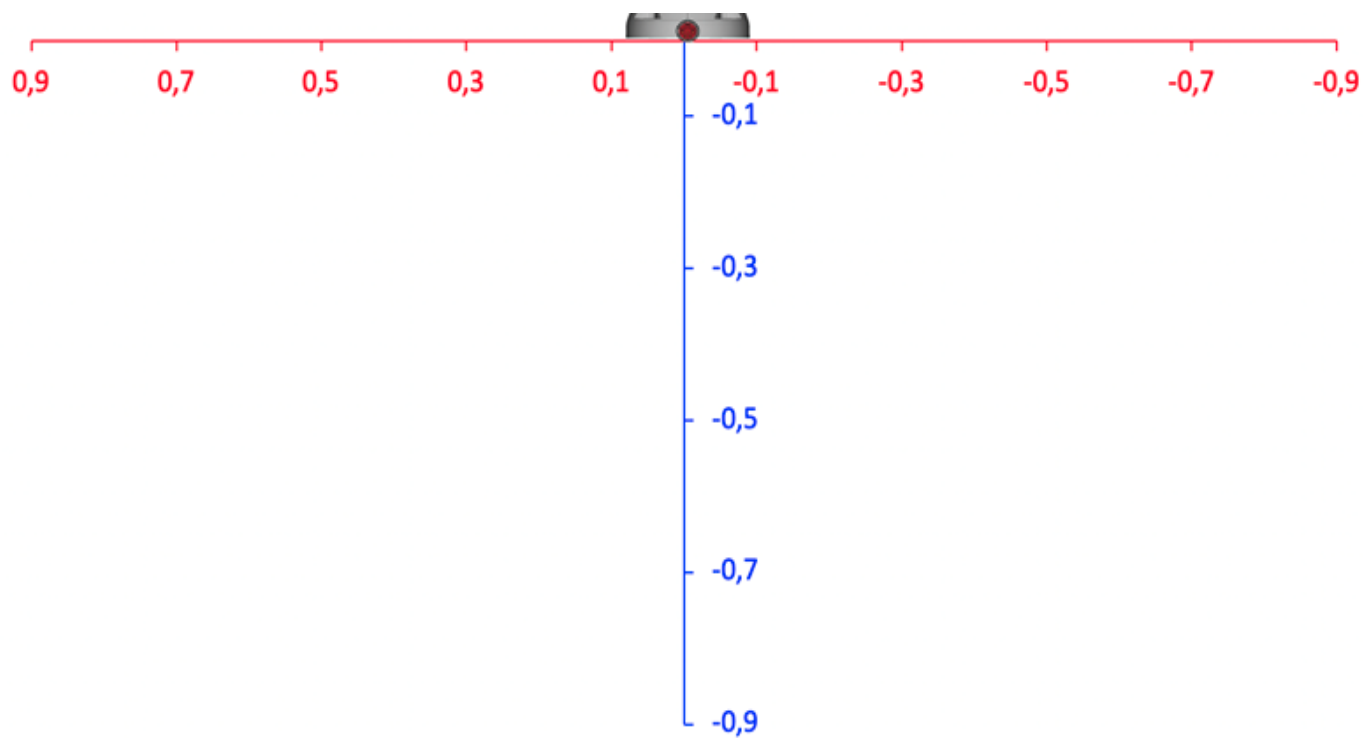
Download the excel file below for an overview and understanding how the transformation is done in regards to the position of the robot's joints.