

DH Parameters of Mico

R&D

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Revisions

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1.0.1	A Lecours	First Draft	05-08-2013
1.0.2	A Lecours	Added joint limits	27-08-2013
1.0.3	A Lecours	Reset position and torque zero	18-10-2013



Review & Approval

Requirements Specification Approval History

Approving Party	Version Approved	Signature	Date
L.-J. Caron			

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Reviewer	Version Reviewed	Signature	Date
C. Deguire			

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1 Introduction

1.1 DH Parameters of Mico

Theses following parameters are all necessary DH values for kinematics of Mico.

Robot lenght values (meters)		
D1	0.2755	Base to elbow
D2	0.2900	Arm length
D3	0.1233	Front arm length
D4	0.0741	First wrist length
D5	0.0741	Second wrist length
D6	0.1600	Wrist to center of the hand
e2	0.0070	Joint 3-4 lateral offset

Alternate parameters	
aa	$((30.0 \cdot \text{PI}) / 180.0)$
ca	$(\cos(aa))$
sa	$(\sin(aa))$
c2a	$(\cos(2 \cdot aa))$
s2a	$(\sin(2 \cdot aa))$
d4b	$(D3 + sa/s2a \cdot D4)$
d5b	$(sa/s2a \cdot D4 + sa/s2a \cdot D5)$
d6b	$(sa/s2a \cdot D5 + D6)$

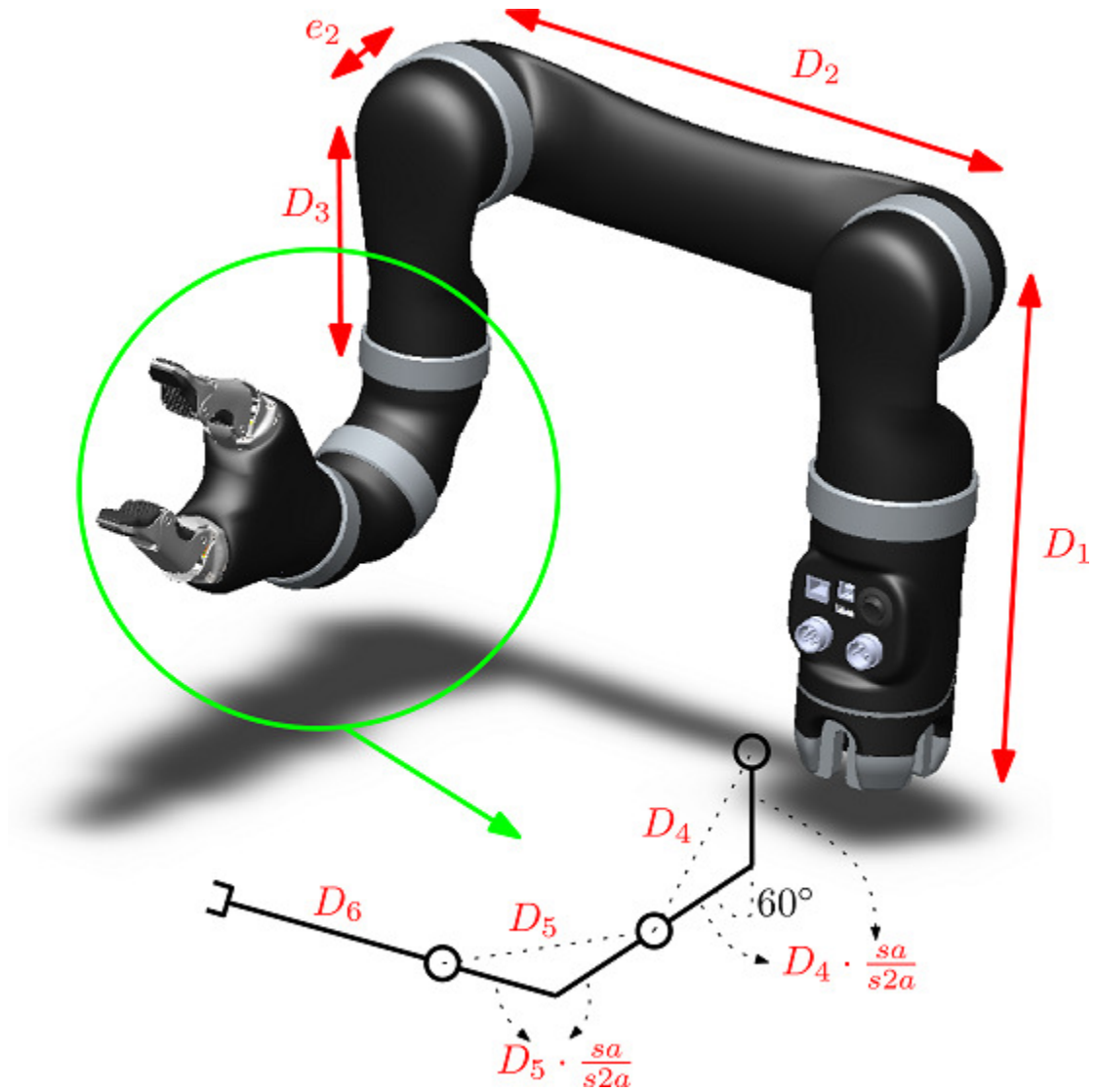


Figure 1 : Robot length values

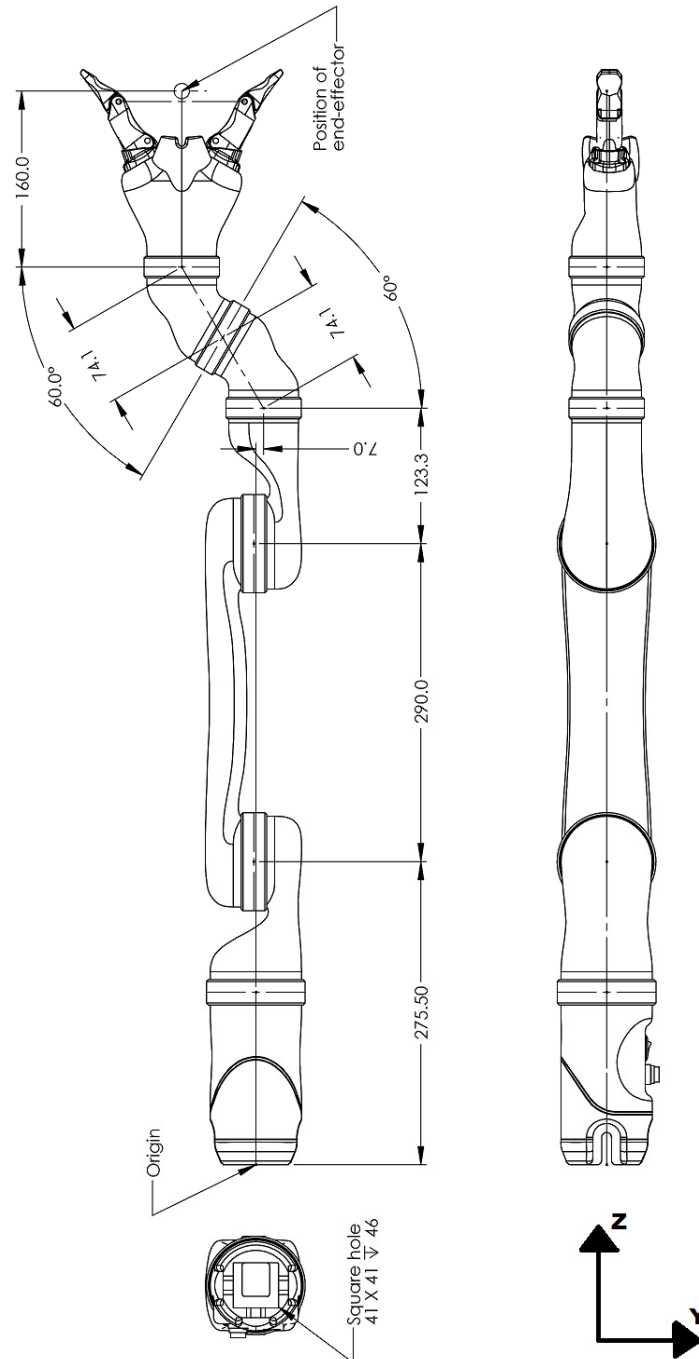


Figure 2 : Robot length values (units in mm)

Angular position is : [270, 180, 180, 0, 0, 180]

1.1.1 Classic DH Parameters

DH Parameters				
i	$\alpha(i-1)$	$a(i-1)$	d_i	θ_i
1	$\pi/2$	0	D1	q1
2	π	D2	0	q2
3	$\pi/2$	0	-e2	q3
4	$2 \cdot a_a$	0	-d4b	q4
5	$2 \cdot a_a$	0	-d5b	q5
6	π	0	-d6b	q6

Equations for transformation from DH algorithm to Mico physical angles
$Q1(\text{Mico}) = -Q1(\text{DH Algo})$
$Q2(\text{Mico}) = Q2(\text{DH Algo}) + 90$
$Q3(\text{Mico}) = Q3(\text{DH Algo}) - 90$
$Q4(\text{Mico}) = Q4(\text{DH Algo})$
$Q5(\text{Mico}) = Q5(\text{DH Algo}) + 180$
$Q6(\text{Mico}) = Q6(\text{DH Algo}) - 90$

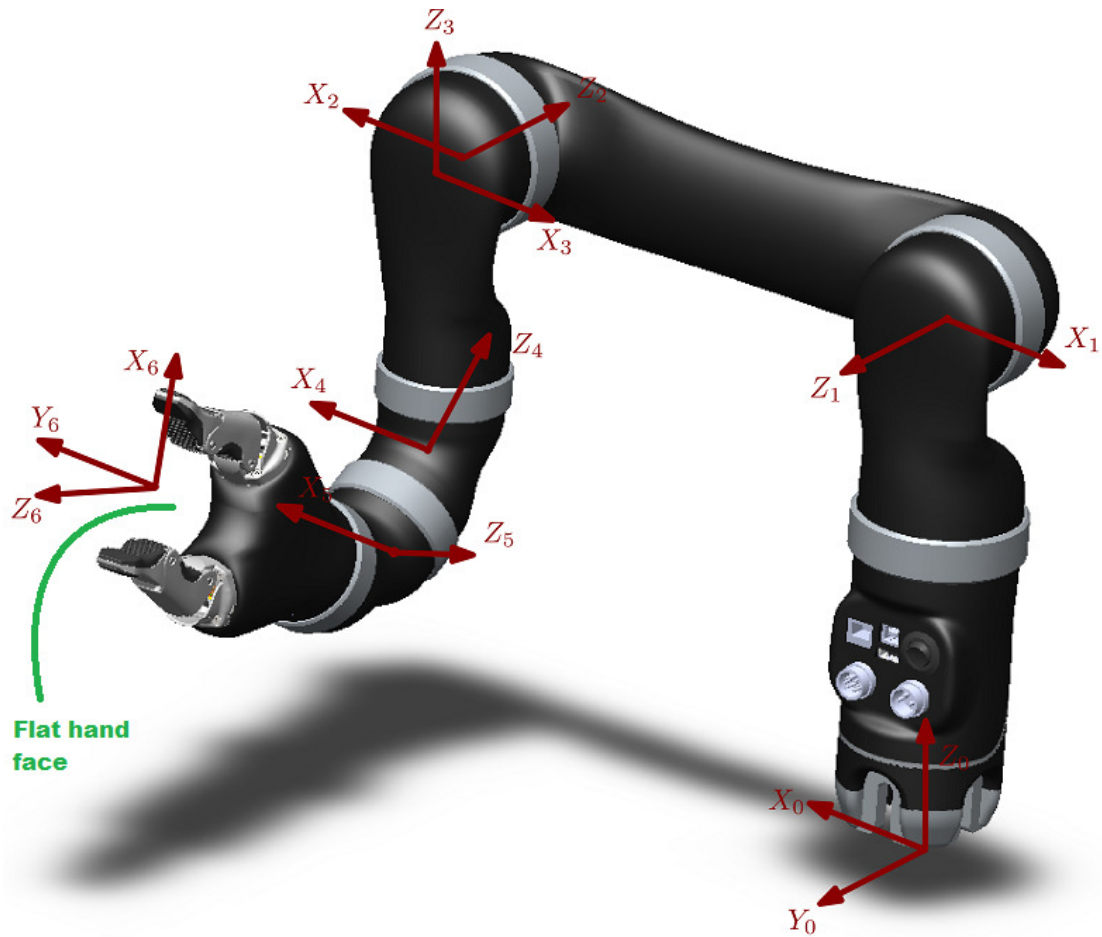


Figure 3 : Classic DH parameters frame position

Angular position is : [180, 270, 90, 180, 180, 0]

1.1.2 Modified DH Parameters (Craig)

DH Parameters				
i	$\alpha(i-1)$	$a(i-1)$	d_i	θ_i
1	0	0	D1	q1
2	$-\pi/2$	0	0	q2
3	0	D2	e2	q3
4	$-\pi/2$	0	d4b	q4
5	$2 \cdot a_a$	0	d5b	q5
6	$2 \cdot a_a$	0	d6b	q6

Equations for transformation from DH algorithm to Mico physical angles
$Q1(Mico) = -Q1(DH Algo) + 180$
$Q2(Mico) = Q2(DH Algo) + 270$
$Q3(Mico) = -Q3(DH Algo) + 90$
$Q4(Mico) = -Q4(DH Algo) + 180$
$Q5(Mico) = -Q5(DH Algo) + 180$
$Q6(Mico) = -Q6(DH Algo) + (180 + 90)$

1.2 Directions of each joints in angular space

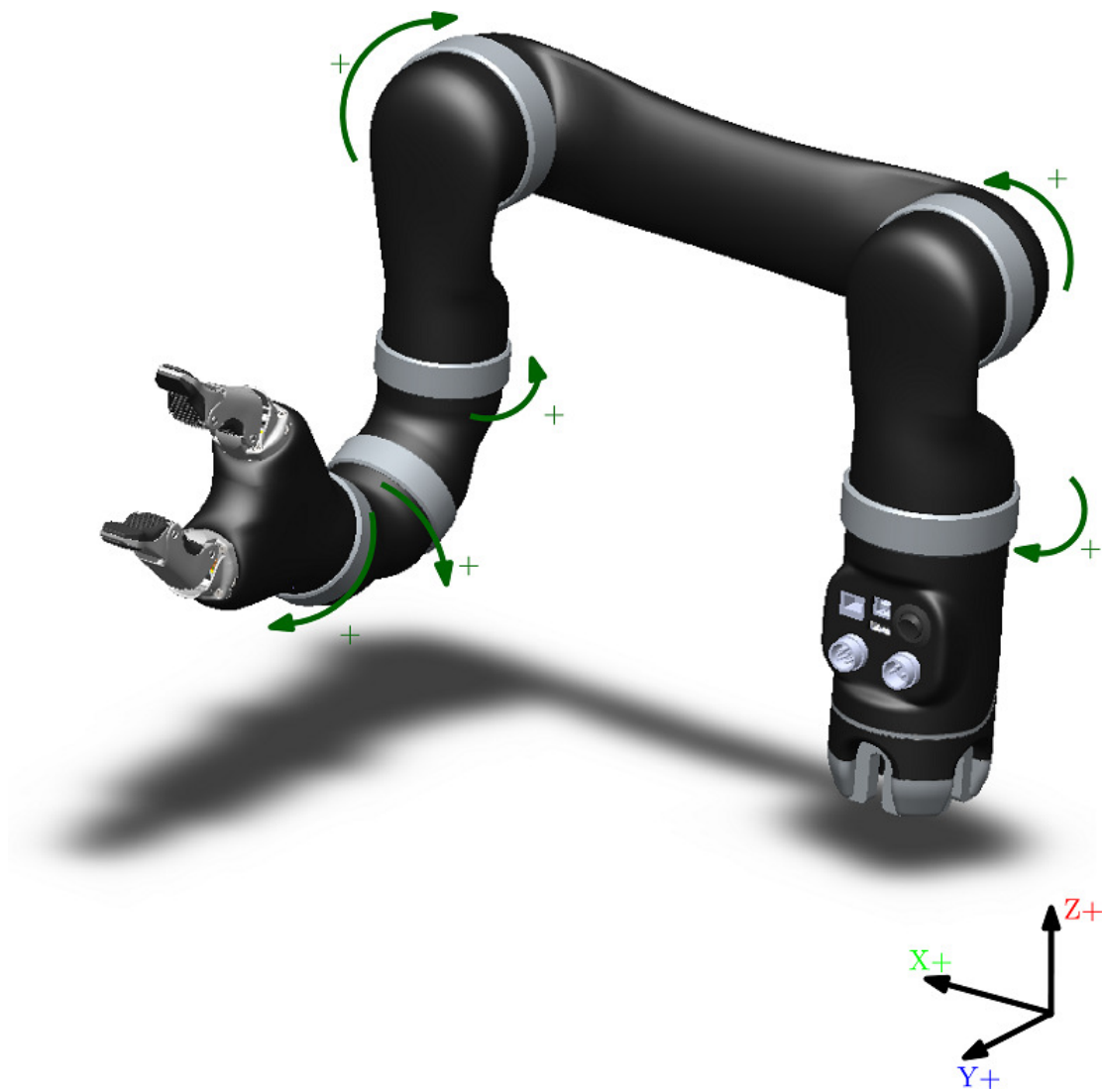


Figure 4 : Directions of each joint in the angular space of the robot

1.3 Inertial parameters (PRELIMINARY)

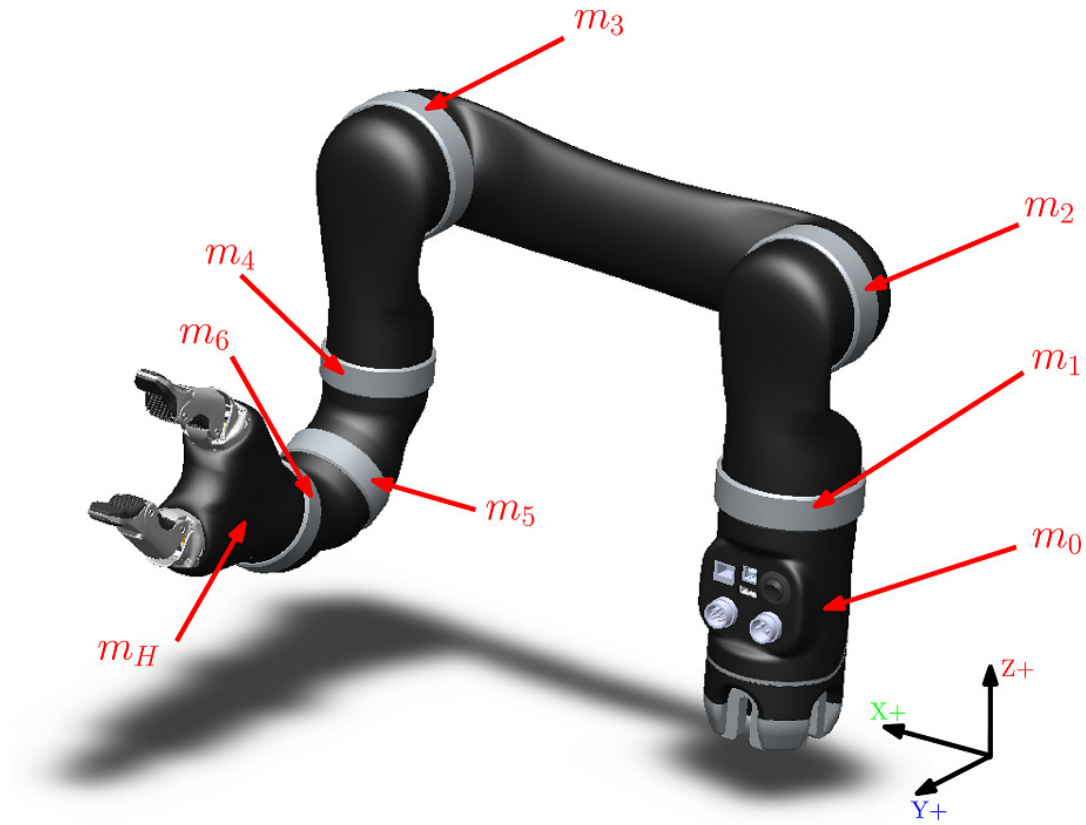


Figure 5 : Inertial parameters

Inertial parameters	
m0	0.64 kg
m1	0.76 kg
m2	0.76 kg
m3	0.76 kg
m4	0.40 kg
m5	0.40 kg
m6	0.40 kg
mH	0.40 kg

From Joint 6 to center of mass of the hand: ~7.5 cm

1.4 Joint limits

Joint	Minimum (degrees)	Maximum (degrees)
1	-10 000	10 000
2	50	310
3	35	325
4	-10 000	10 000
5	-10 000	10 000
6	-10 000	10 000

1.5 Reset Position

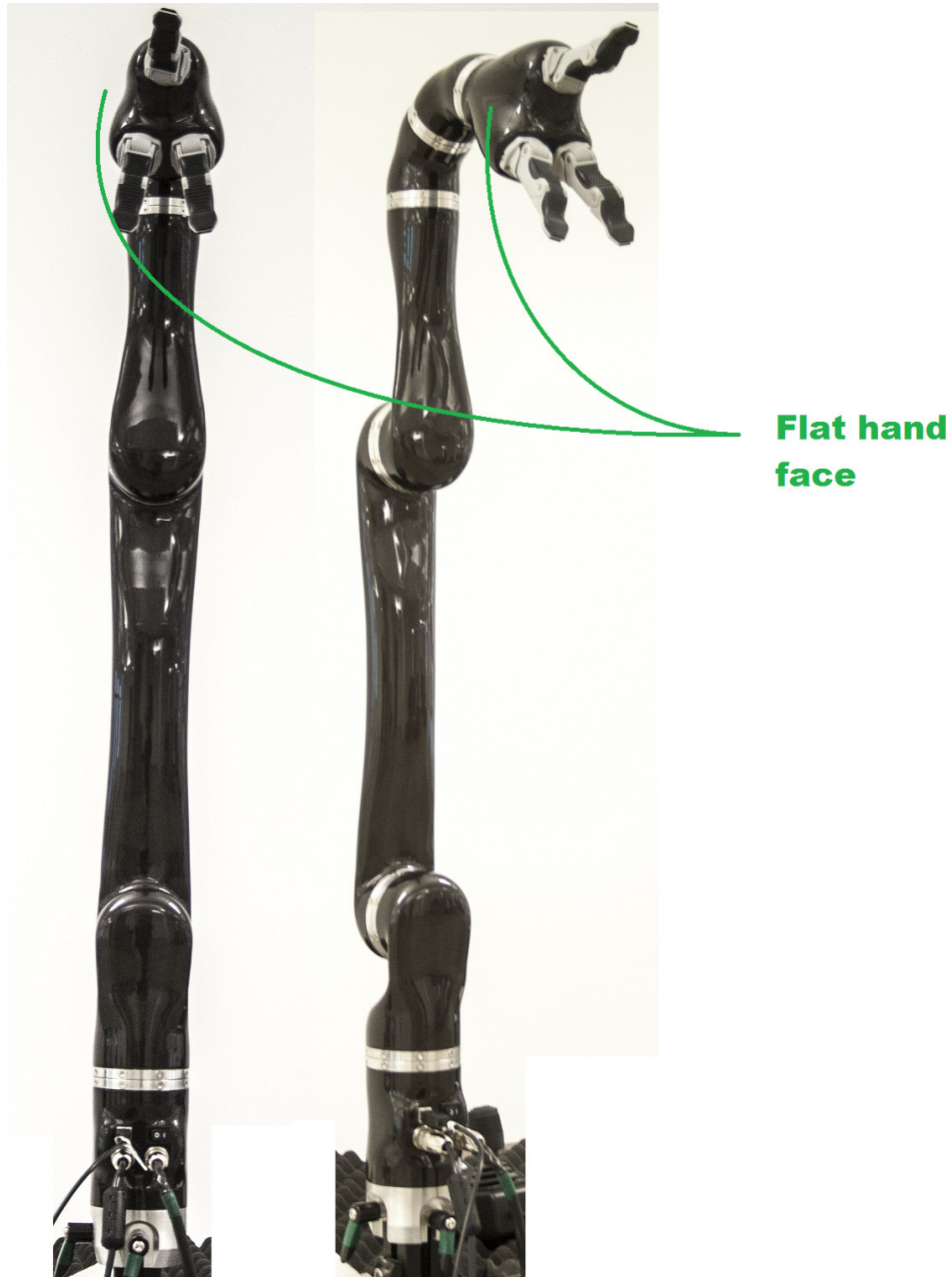


Figure 6 : Reset position (To be replaced by Mico picture)

Angular position is : [180, 180, 180, 180, 180, 180]

1.6 Reset Torque

In order to reset the torque sensors zero, you must first place the arm in a position where gravity does not influence joint torques. The set zero position [180, 180, 180, 180, 180, 180] is good but it is suggested to use the position [*, 180, 180, 0, 0, 180] since this position also limits perpendicular torques on the actuators.