



ISTITUTO ITALIANO DI TECNOLOGIA
ADVANCED ROBOTICS

Walk-man Dims and Inertia

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Last update on 10/04/2015

Date	Rev.
10/04/15	Pelvis update

Legs Link section

LEGS JOINT RANGES

LINK	DEG	RAD
hip roll		
ab	-50	-0.87222
ad	40	0.697778
hip yaw		
Sup.	-90	-1.57
Pron.	50	0.872222
hip pitch		
Ext.	-120	-2.09333
Flex.	60	1.046667
knee pitch		
Ext.	0	0
Flex.	140	2.442222
ankle pitch		
Ext.	-80	-1.39556
Flex.	40	0.697778
ankle roll		
ab	-45	-0.785
ad	45	0.785

Pelvis

Note: the origin is in the middle of the pelvis

VOLUME = 3.1991294×10^6 MM³

SURFACE AREA = 2.2254108×10^6 MM²

AVERAGE DENSITY = 3.4528397×10^{-6} KILOGRAM / MM³

MASS = 1.1046081×10^1 KILOGRAM

CENTER OF GRAVITY with respect to URDF_ORIGIN_FRAME coordinate frame:

X Y Z -2.2813402×10^1 -7.3935443×10^1 3.0422909×10^1 MM

INERTIA with respect to URDF_ORIGIN_FRAME coordinate frame: (KILOGRAM * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 1.0643775×10^5 -4.5505915×10^1 1.0792346×10^4

Iyx Iyy Iyz -4.5505915×10^1 1.1448384×10^5 3.8784444×10^2

Izx Izy Izz 1.0792346×10^4 3.8784444×10^2 9.2296517×10^4

INERTIA at CENTER OF GRAVITY with respect to URDF_ORIGIN_FRAME coordinate frame:

(KILOGRAM * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 9.6207978×10^4 1.4081043×10^2 3.1258127×10^3

Iyx Iyy Iyz 1.4081043×10^2 9.8511158×10^4 1.3938149×10^2

Izx Izy Izz 3.1258127×10^3 1.3938149×10^2 8.6541531×10^4

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM²)

I1 I2 I3 8.5618140×10^4 9.7108979×10^4 9.8533547×10^4

ROTATION MATRIX from URDF_ORIGIN_FRAME orientation to PRINCIPAL AXES:

-0.28300 0.95204 0.11635

-0.00728 -0.12344 0.99233

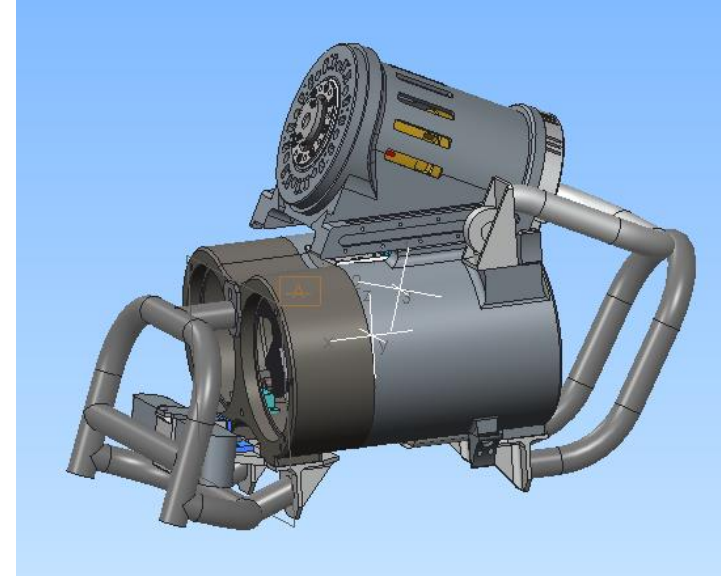
0.95909 0.27998 0.04186

ROTATION ANGLES from URDF_ORIGIN_FRAME orientation to PRINCIPAL AXES (degrees):

angles about x y z -87.584 6.681 -106.555

RADII OF GYRATION with respect to PRINCIPAL AXES:

R1 R2 R3 8.8039746×10^1 9.3761724×10^1 9.4446952×10^1 MM



HIP ROLL:

X:105.9 mm

Y:-60/+60 mm

Z: 0 mm

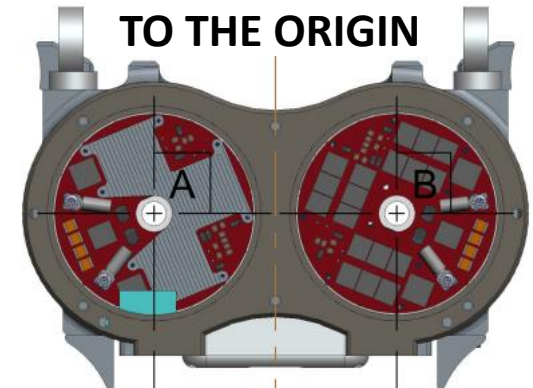
TORSO ROLL

X: 111mm

Y:0mm

Z: 196mm

**JOINT FRAME
LOCATION RESPECT
TO THE ORIGIN**

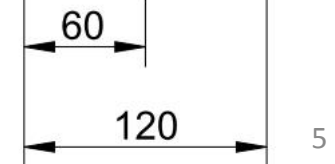


IMU LOCATION:

X: 71.99mm

Y:-60.98mm

Z:-45mm



HIP ROLL LINK (RX)

VOLUME = 1.0946176e+06 MM^3
SURFACE AREA = 6.2449456e+05 MM^2
AVERAGE DENSITY = 3.4677130e-09 TONNE / MM^3
MASS = 3.7958197e-03 TONNE

CENTER OF GRAVITY with respect to JOINT_URDF_AXIS coordinate frame:
X Y Z -1.0348188e+02 -1.0919813e+02 -6.4924056e+01 MM

INERTIA with respect to JOINT_URDF_AXIS coordinate frame: (TONNE * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 7.6901138e+01 -4.1042402e+01 -2.3111296e+01
Iyx Iyy Iyz -4.1042402e+01 8.0167166e+01 -2.9241106e+01
Izx Izy Izz -2.3111296e+01 -2.9241106e+01 1.0686341e+02

INERTIA at CENTER OF GRAVITY with respect to JOINT_URDF_AXIS coordinate frame: (TONNE * MM^2)

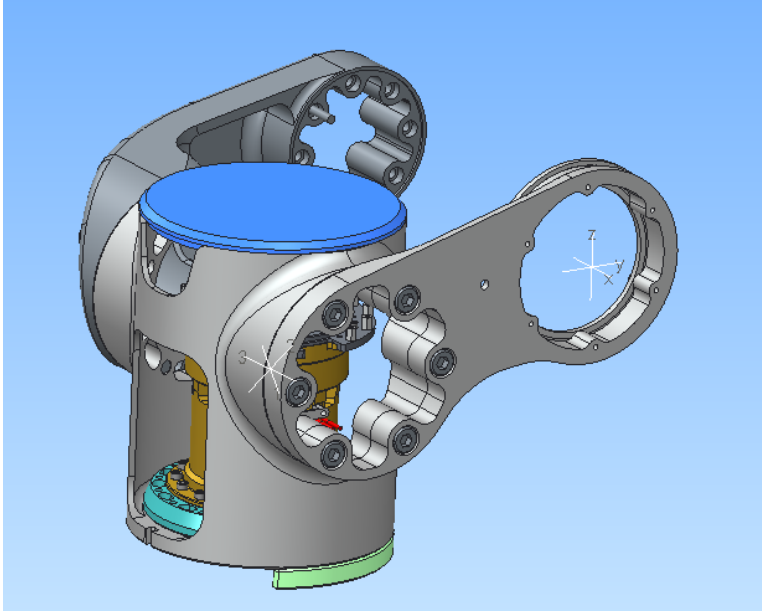
INERTIA TENSOR:
Ixx Ixy Ixz 1.5639017e+01 1.8504661e+00 2.3907793e+00
Iyx Iyy Iyz 1.8504661e+00 2.3519749e+01 -2.3303162e+00
Izx Izy Izz 2.3907793e+00 -2.3303162e+00 2.0953643e+01

PRINCIPAL MOMENTS OF INERTIA: (TONNE * MM^2)
I1 I2 I3 1.4009617e+01 2.1187212e+01 2.4915580e+01

ROTATION MATRIX from JOINT_URDF_AXIS orientation to PRINCIPAL AXES:
0.87992 0.47253 -0.04955
-0.26744 0.40641 -0.87368
-0.39270 0.78202 0.48398

ROTATION ANGLES from JOINT_URDF_AXIS orientation to PRINCIPAL AXES (degrees):
angles about x y z 61.016 -2.840 -28.236

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 6.0751966e+01 7.4710926e+01 8.1018223e+01 MM



HIP YAW JOINT FRAME LOCATION RESPECT TO THE ROLL JOINT AXIS

X:-88.9 mm
Y:-121.032mm
Z:-217.872 mm

JOINT RANGE:
-50deg abduction/ -0.872 rad
+40deg adduction/ 0.698 rad

PEAK TORQUE: 220Nm

HIP YAW LINK (RX)

VOLUME = 8.2179047e+05 MM^3
SURFACE AREA = 5.4269426e+05 MM^2
AVERAGE DENSITY = 3.9428625e-06 KILOGRAM / MM^3
MASS = 3.2402068e+00 KILOGRAM

CENTER OF GRAVITY with respect to URDF_JOINT_AXIS coordinate frame:
X Y Z -5.2929709e+00 -2.2561833e+01 5.6701669e+00 MM

INERTIA with respect to URDF_JOINT_AXIS coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:

Ixx	Ixy	Ixz
1.1855656e+04	-2.7835780e+02	3.5015913e+02
Iyx	Iyy	Iyz
-2.7835780e+02	6.9096514e+03	4.9796466e+02
Izx	Izy	Izz
3.5015913e+02	4.9796466e+02	1.2225289e+04

INERTIA at CENTER OF GRAVITY with respect to URDF_JOINT_AXIS coordinate frame:
(KILOGRAM * MM^2)

INERTIA TENSOR:

Ixx	Ixy	Ixz
1.0102097e+04	1.0858487e+02	2.5291395e+02
Iyx	Iyy	Iyz
1.0858487e+02	6.7147000e+03	8.3447072e+01
Izx	Izy	Izz
2.5291395e+02	8.3447072e+01	1.0485130e+04

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)

I1	I2	I3
6.7097129e+03	9.9774679e+03	1.0614747e+04

ROTATION MATRIX from URDF_JOINT_AXIS orientation to PRINCIPAL AXES:

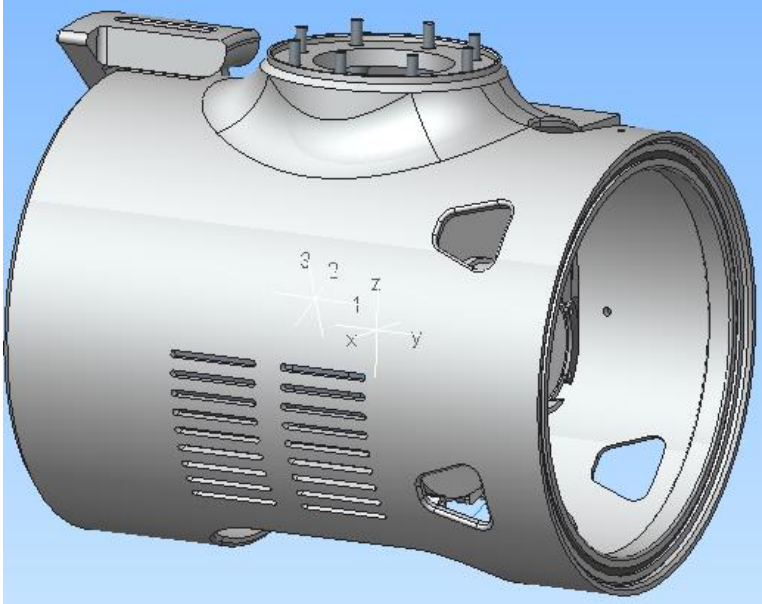
-0.03049	-0.89372	0.44759
0.99933	-0.01828	0.03158
-0.02005	0.44825	0.89368

ROTATION ANGLES from URDF_JOINT_AXIS orientation to PRINCIPAL AXES (degrees):
angles about x y z -2.024 26.589 91.954

RADII OF GYRATION with respect to PRINCIPAL AXES:

R1	R2	R3
4.5505679e+01	5.5491160e+01	5.7235892e+01

MM



HIP PITCH JOINT FRAME LOCATION RESPECT TO THE YAW JOINT AXIS

X:0 mm
Y:0mm
Z: 0mm

JOINT RANGE:
-90deg / -1.57rad
+50deg / 0.872rad

PEAK TORQUE: 120Nm

HIP PITCH LINK (RX)

VOLUME = 1.5735748e+06 MM³
SURFACE AREA = 1.0039812e+06 MM²
AVERAGE DENSITY = 3.2378974e-06 KILOGRAM / MM³
MASS = 5.0950736e+00 KILOGRAM

CENTER OF GRAVITY with respect to URDF_PITCH_JOINT coordinate frame:
X Y Z 3.7746286e+01 -2.8539939e+01 -1.9310133e+02 MM

INERTIA with respect to URDF_PITCH_JOINT coordinate frame: (KILOGRAM * MM²)

INERTIA TENSOR:
Ixx Ixy Ixz 2.4574367e+05 7.7141514e+03 3.9590247e+04
Iyx Iyy Iyz 7.7141514e+03 2.4159425e+05 -3.2180155e+04
Izx Izy Izz 3.9590247e+04 -3.2180155e+04 3.4783904e+04

INERTIA at CENTER OF GRAVITY with respect to URDF_PITCH_JOINT coordinate frame:
(KILOGRAM * MM²)

INERTIA TENSOR:
Ixx Ixy Ixz 5.1607858e+04 2.2253472e+03 2.4529790e+03
Iyx Iyy Iyz 2.2253472e+03 4.4349153e+04 -4.1006942e+03
Izx Izy Izz 2.4529790e+03 -4.1006942e+03 2.3374453e+04

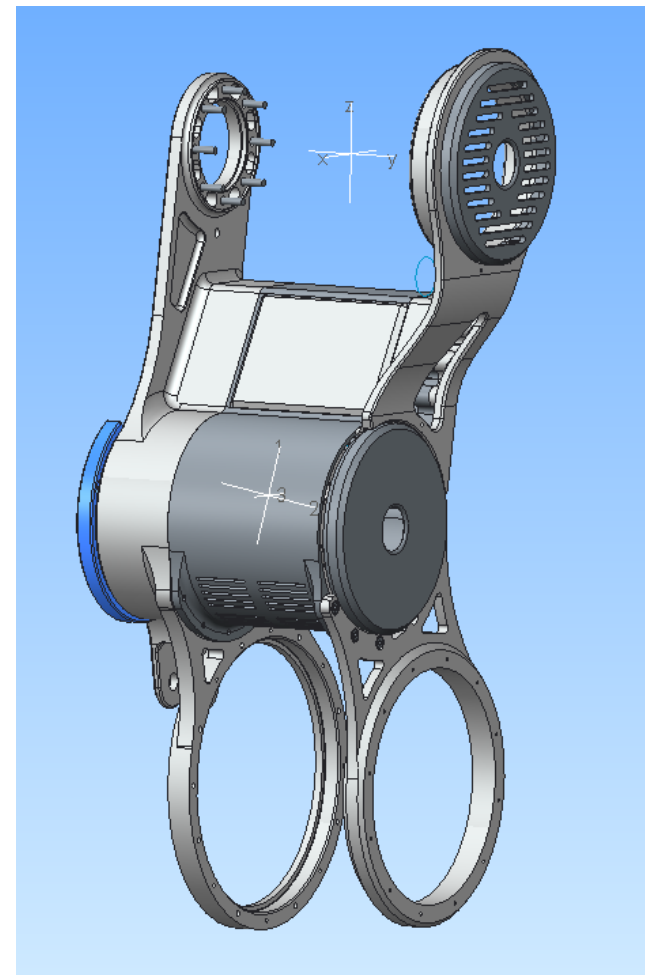
PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM²)
I1 I2 I3 2.2327869e+04 4.4708982e+04 5.2294613e+04

ROTATION MATRIX from URDF_PITCH_JOINT orientation to PRINCIPAL AXES:

-0.09639	-0.23201	-0.96793
0.19162	0.94994	-0.24678
0.97672	-0.20926	-0.04711

ROTATION ANGLES from URDF_PITCH_JOINT orientation to PRINCIPAL AXES (degrees):
angles about x y z 100.807 -75.449 112.561

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 6.6198539e+01 9.3674668e+01 1.0131022e+02 MM



**KNEE PITCH JOINT FRAME
LOCATION RESPECT TO THE HIP
PITCH JOINT AXIS**

**X:0 mm
Y:0mm
Z: -356mm**

JOINT RANGE:

**-120deg / -2.093rad
+60deg / 1.046rad**

PEAK TORQUE: 220Nm

KNEE PITCH LINK (RX)

VOLUME = 1.5350398e+06 MM^3
SURFACE AREA = 8.4278252e+05 MM^2
AVERAGE DENSITY = 3.4552450e-06 KILOGRAM / MM^3
MASS = 5.6495309e+00 KILOGRAM

CENTER OF GRAVITY with respect to CALF_URDF coordinate frame:
X Y Z -5.0828668e+00 3.7732093e+00 -7.2605017e+01 MM

INERTIA with respect to CALF_URDF coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 1.3521729e+05 -4.7364144e+02 -4.1055231e+02 Iyx Iyy Iyz -4.7364144e+02 1.2778519e+05 -1.8293069e+03 Izx Izy Izz -4.1055231e+02 -1.8293069e+03 2.1080478e+04

INERTIA at CENTER OF GRAVITY with respect to CALF_URDF coordinate frame: (KILOGRAM * MM^2)

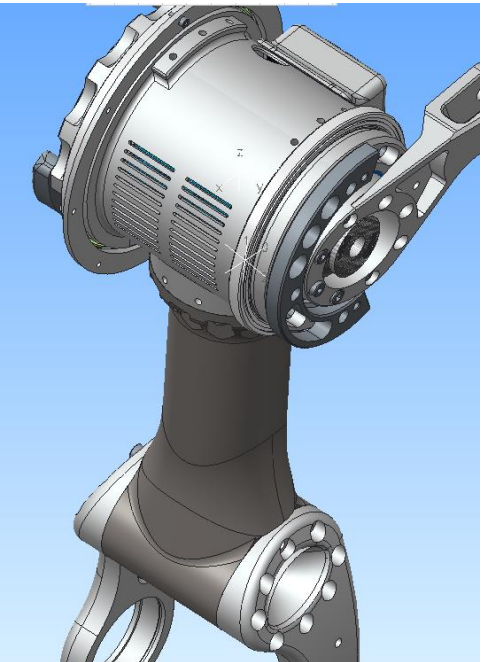
INERTIA TENSOR:
Ixx Ixy Ixz 1.0535542e+05 -5.8199221e+02 1.6743598e+03 Iyx Iyy Iyz -5.8199221e+02 9.7857796e+04 -3.3770181e+03 Izx Izy Izz 1.6743598e+03 -3.3770181e+03 2.0854086e+04

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 2.0674223e+04 9.7948028e+04 1.0544505e+05

ROTATION MATRIX from CALF_URDF orientation to PRINCIPAL AXES:
-0.01945 0.08762 -0.99596
0.04356 0.99528 0.08671
0.99886 -0.04169 -0.02318

ROTATION ANGLES from CALF_URDF orientation to PRINCIPAL AXES (degrees):
angles about x y z -104.964 -84.850 -102.516

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 6.0493457e+01 1.3167146e+02 1.3661768e+02 MM



ANKLE PITCH JOINT FRAME
LOCATION RESPECT TO THE
KNEE PITCH JOINT AXIS

X:0mm
Y:0mm
Z: 400mm

JOINT RANGE:
0deg / 0 rad
+140deg / 2.442rad

PEAK TORQUE: 220Nm

ANKLE PITCH LINK (RX)

VOLUME = 7.9991704e+05 MM^3
SURFACE AREA = 5.1081364e+05 MM^2
AVERAGE DENSITY = 4.1059456e-06 KILOGRAM / MM^3
MASS = 3.2844159e+00 KILOGRAM

CENTER OF GRAVITY with respect to ANKLE_PITCH_URDF coordinate frame:
X Y Z -2.2024173e+01 2.5677238e+00 9.4588455e-01 MM

INERTIA with respect to ANKLE_PITCH_URDF coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 7.5796613e+03 8.6062318e+02 1.2675491e+02 Iyx Iyy Iyz 8.6062318e+02 1.2837254e+04 -1.5349790e+02 Ixz Izy Izz 1.2675491e+02 -1.5349790e+02 1.5006672e+04

INERTIA at CENTER OF GRAVITY with respect to ANKLE_PITCH_URDF coordinate frame:
(KILOGRAM * MM^2)

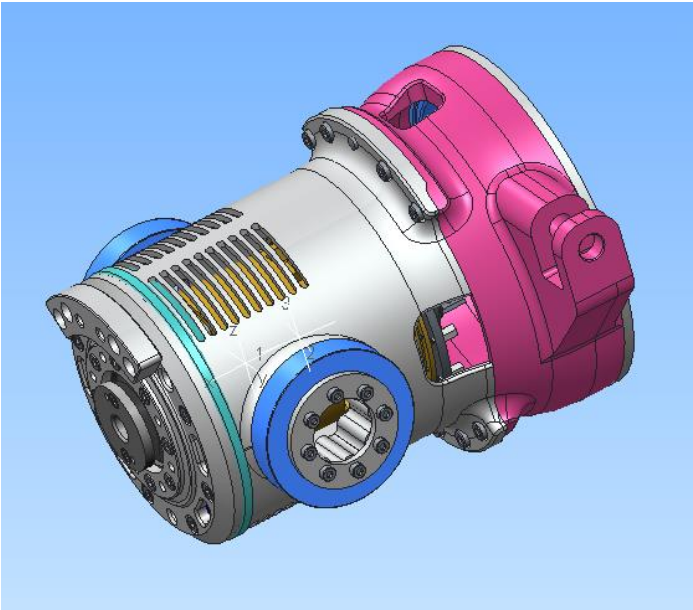
INERTIA TENSOR:
Ixx Ixy Ixz 7.5550679e+03 6.7488292e+02 5.8332889e+01 Iyx Iyy Iyz 6.7488292e+02 1.1241163e+04 -1.4552081e+02 Ixz Izy Izz 5.8332889e+01 -1.4552081e+02 1.3391865e+04

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 7.4342371e+03 1.1352163e+04 1.3401695e+04

ROTATION MATRIX from ANKLE_PITCH_URDF orientation to PRINCIPAL AXES:
0.98446 0.17559 0.00228
-0.17505 0.98231 -0.06649
-0.01392 0.06506 0.99778

ROTATION ANGLES from ANKLE_PITCH_URDF orientation to PRINCIPAL AXES (degrees):
angles about x y z 3.813 0.131 -10.113

RADI OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 4.7576132e+01 5.8790918e+01 6.3877925e+01 MM



ANKLE ROLL JOINT FRAME LOCATION RESPECT TO THE YAW JOINT AXIS

To check with lewis,
Below there is the placement
I suggest

X:0mm
Y:0mm
Z: 0mm

JOINT RANGE:
-80deg / -1.395 rad
+40deg / 0.697rad

PEAK TORQUE: 220Nm

ANKLE ROLL LINK (RX)

OTHER DATA
FROM Lewis

JOINT RANGE:

-45deg / -0.785 rad

+45deg / 0.785rad

PEAK TORQUE: 120Nm

Whole leg (RX)

VOLUME = 5.5988820e+06 MM^3
SURFACE AREA = 2.3068547e+06 MM^2
AVERAGE DENSITY = 2.5630589e-06 KILOGRAM / MM^3
MASS = 1.4350264e+01 KILOGRAM

CENTER OF GRAVITY with respect to URDF_PITCH_JOINT coordinate frame:
X Y Z 6.4640765e+00 -8.2717266e+00 -4.4120439e+02 MM

INERTIA with respect to URDF_PITCH_JOINT coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 3.6178762e+06 9.1443944e+03 -2.5926725e+04
Iyx Iyy Iyz 9.1443944e+03 3.5981939e+06 -1.7613277e+04
Izx Izy Izz -2.5926725e+04 -1.7613277e+04 8.1547801e+04

INERTIA at CENTER OF GRAVITY with respect to URDF_PITCH_JOINT coordinate frame: (KILOGRAM * MM^2)

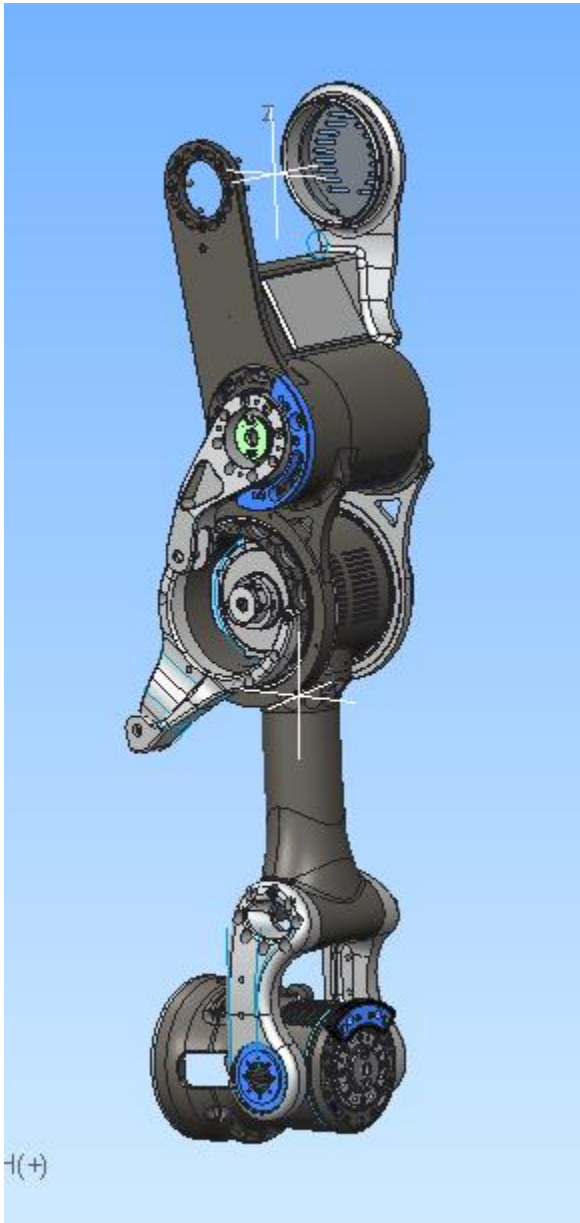
INERTIA TENSOR:
Ixx Ixy Ixz 8.2345303e+05 8.3770991e+03 -6.6853377e+04
Iyx Iyy Iyz 8.3770991e+03 8.0415296e+05 3.4758330e+04
Izx Izy Izz -6.6853377e+04 3.4758330e+04 7.9966319e+04

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 7.2293769e+04 8.0474491e+05 8.3053362e+05

ROTATION MATRIX from URDF_PITCH_JOINT orientation to PRINCIPAL AXES:
0.08908 -0.20309 -0.97510
-0.04827 0.97696 -0.20789
0.99485 0.06559 0.07723

ROTATION ANGLES from URDF_PITCH_JOINT orientation to PRINCIPAL AXES (degrees):
angles about x y z 69.621 -77.187 66.317

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 7.0977465e+01 2.3680953e+02 2.4057398e+02 MM



Forearm Link section

FOREARM JOINT RANGES

LINK	DEG	RAD
ELBOW PITCH	CHECK WITH JERRYLL	
yaw		
	-145	-2.52944
	145	2.529444
pitch		
	-85	-1.48278
	-85	-1.48278
roll		
	-85	-1.48278
	-85	-1.48278

ELBOW PITCH LINK (RX)

VOLUME = 2.5885496e+05 MM^3
SURFACE AREA = 1.6712451e+05 MM^2
AVERAGE DENSITY = 3.3518919e-06 KILOGRAM / MM^3
MASS = 8.6765385e-01 KILOGRAM

CENTER OF GRAVITY with respect to URDF_FRAME_FA_RX_JOINT1 coordinate frame:
X Y Z -5.5754915e+01 -7.5826040e+00 -4.3820396e+01 MM

INERTIA with respect to URDF_FRAME_FA_RX_JOINT1 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 5.7555028e+03 -1.7084442e+01 -2.8038587e+03
Iyx Iyy Iyz -1.7084442e+01 6.6093465e+03 1.4674364e-01
Izx Izy Izz -2.8038587e+03 1.4674364e-01 7.2365871e+03

INERTIA at CENTER OF GRAVITY with respect to URDF_FRAME_FA_RX_JOINT1 coordinate frame: (KILOGRAM * MM^2)

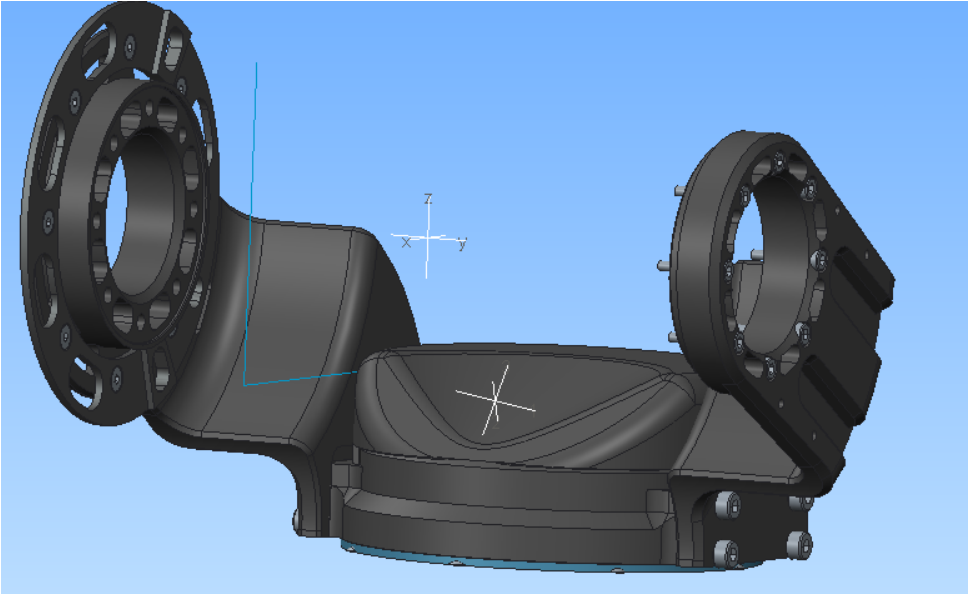
INERTIA TENSOR:
Ixx Ixy Ixz 4.0395238e+03 3.4973136e+02 -6.8400465e+02
Iyx Iyy Iyz 3.4973136e+02 2.2460561e+03 2.8844444e+02
Izx Izy Izz -6.8400465e+02 2.8844444e+02 4.4895027e+03

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 2.1036983e+03 3.6864985e+03 4.9848858e+03

ROTATION MATRIX from URDF_FRAME_FA_RX_JOINT1 orientation to PRINCIPAL AXES:
-0.23713 -0.77674 -0.58348
0.95402 -0.29953 0.01102
-0.18333 -0.55404 0.81206

ROTATION ANGLES from URDF_FRAME_FA_RX_JOINT1 orientation to PRINCIPAL AXES (degrees):
angles about x y z -0.777 -35.695 106.977

RADI OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 4.9240049e+01 6.5182915e+01 7.5797408e+01 MM



ELBOW PITCH JOINT FRAME
LOCATION RESPECT TO THE
PREVIOUS
JOINT AXIS:

X:0mm
Y:0mm
Z: 0mm

FOREARM YAW JOINT
FRAME LOCATION
RESPECT TO THE ELBOW
PITCH JOINT AXIS:

X:-75mm
Y:0mm
Z: -195.5mm

JOINT RANGE:
- deg / rad
+ deg / rad

PEAK TORQUE: 60Nm

FOREARM YAW LINK (RX)

VOLUME = 5.0098507e+05 MM^3
SURFACE AREA = 4.5291385e+05 MM^2
AVERAGE DENSITY = 4.4168355e-06 KILOGRAM / MM^3
MASS = 2.2127686e+00 KILOGRAM

CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT2 coordinate frame:
X Y Z 1.2625599e-02 -4.2975381e+00 4.4717986e+01 MM

INERTIA with respect to URDF_FRAME_FA_JOINT2 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 1.1008574e+04 4.1317030e+01 2.0234169e+00
Iyx Iyy Iyz 4.1317030e+01 1.0012699e+04 4.3571063e+00
Izx Izy Izz 2.0234169e+00 4.3571063e+00 2.5191699e+03

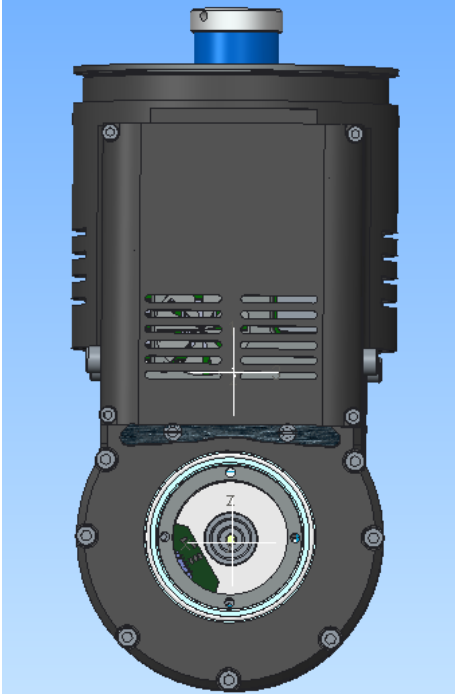
INERTIA at CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT2 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 6.5428368e+03 4.1196967e+01 3.2727270e+00
Iyx Iyy Iyz 4.1196967e+01 5.5878290e+03 -4.2088668e+02
Izx Izy Izz 3.2727270e+00 -4.2088668e+02 2.4783023e+03

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 2.4223225e+03 5.6419782e+03 6.5446673e+03

ROTATION MATRIX from URDF_FRAME_FA_JOINT2 orientation to PRINCIPAL AXES:
-0.00211 -0.04481 -0.99899
0.13183 0.99026 -0.04469
0.99127 -0.13179 0.00382

ROTATION ANGLES from URDF_FRAME_FA_JOINT2 orientation to PRINCIPAL AXES (degrees):
angles about x y z 85.112 -87.429 92.690



FOREARM PITCH JOINT FRAME LOCATION RESPECT TO THE FOREARM YAW JOINT FRAME

X:0mm
Y:0mm
Z: 0mm

JOINT RANGE:
- 145 deg / -2.529 rad
+ 145 deg / 2.529 rad

PEAK TORQUE: 60Nm

FOREARM PITCH LINK (RX)

VOLUME = 3.2699490e+05 MM^3
SURFACE AREA = 2.9031925e+05 MM^2
AVERAGE DENSITY = 3.9260773e-06 KILOGRAM / MM^3
MASS = 1.2838072e+00 KILOGRAM

CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT2 coordinate frame:
X Y Z 9.8193770e+00 -1.3797184e+00 -8.0380065e+01 MM

INERTIA with respect to URDF_FRAME_FA_JOINT2 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 1.0291188e+04 -8.3040721e+00 1.1877215e+03
Iyx Iyy Iyz -8.3040721e+00 1.0593938e+04 -2.1366732e+01
Izx Izy Izz 1.1877215e+03 -2.1366732e+01 1.9566048e+03

INERTIA at CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT2 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 1.9941240e+03 -2.5697060e+01 1.7443538e+02
Iyx Iyy Iyz -2.5697060e+01 2.1755329e+03 1.2100987e+02
Izx Izy Izz 1.7443538e+02 1.2100987e+02 1.8303760e+03

PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 1.6915312e+03 2.0896682e+03 2.2188335e+03

ROTATION MATRIX from URDF_FRAME_FA_JOINT2 orientation to PRINCIPAL AXES:
-0.50035 0.84716 0.17878
-0.23492 -0.33158 0.91371
0.83335 0.41517 0.36492

ROTATION ANGLES from URDF_FRAME_FA_JOINT2 orientation to PRINCIPAL AXES (degrees):
angles about x y z -68.229 10.299 -120.567

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 3.6298618e+01 4.0344911e+01 4.1573103e+01 MM



FOREARM ROLL JOINT FRAME X:0mm
LOCATION RESPECT TO THE Y:0mm
FOREARM PITCH JOINT AXIS Z: -92mm

JOINT RANGE:
- 85deg / -1.48 rad
85deg / 1.48 rad

PEAK TORQUE: 60Nm

FOREARM ROLL LINK (RX)

VOLUME = 1.1050500e+05 MM^3
SURFACE AREA = 8.4192099e+04 MM^2
AVERAGE DENSITY = 3.8732590e-06 KILOGRAM / MM^3
MASS = 4.2801447e-01 KILOGRAM

CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT_4 coordinate frame:

X Y Z 7.0380706e+00 1.0811188e-02 -3.9669274e+01 MM

INERTIA with respect to URDF_FRAME_FA_JOINT_4 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 9.5974713e+02 -8.5138036e-02 8.0325351e+01
Iyx Iyy Iyz -8.5138036e-02 1.4073655e+03 2.7858368e-01
Izx Izy Izz 8.0325351e+01 2.7858368e-01 6.3564409e+02

INERTIA at CENTER OF GRAVITY with respect to URDF_FRAME_FA_JOINT_4 coordinate frame: (KILOGRAM * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 2.8620156e+02 -5.2570457e-02 -3.9174213e+01
Iyx Iyy Iyz -5.2570457e-02 7.1261855e+02 9.5020266e-02
Izx Izy Izz -3.9174213e+01 9.5020266e-02 6.1444258e+02

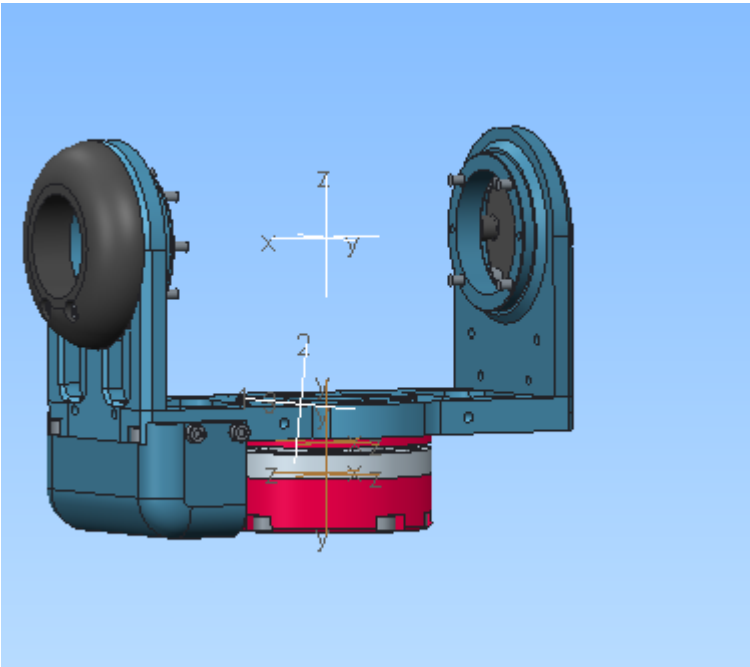
PRINCIPAL MOMENTS OF INERTIA: (KILOGRAM * MM^2)
I1 I2 I3 2.8159103e+02 6.1905299e+02 7.1261866e+02

ROTATION MATRIX from URDF_FRAME_FA_JOINT_4 orientation to PRINCIPAL AXES:

0.99315	-0.11689	0.00022
0.00010	-0.00107	-1.00000
0.11689	0.99314	-0.00106

ROTATION ANGLES from URDF_FRAME_FA_JOINT_4 orientation to PRINCIPAL AXES (degrees):
angles about x y z 90.060 0.000 6.712

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 2.5649576e+01 3.8030732e+01 4.0803683e+01 MM



Hand JOINT FRAME LOCATION
RESPECT TO THE FOREARM roll
JOINT frame X:0mm
Y:0mm
Z: 0mm

JOINT RANGE:
- 85deg / -1.48 rad
85deg / 1.48 rad

PEAK TORQUE: 60Nm

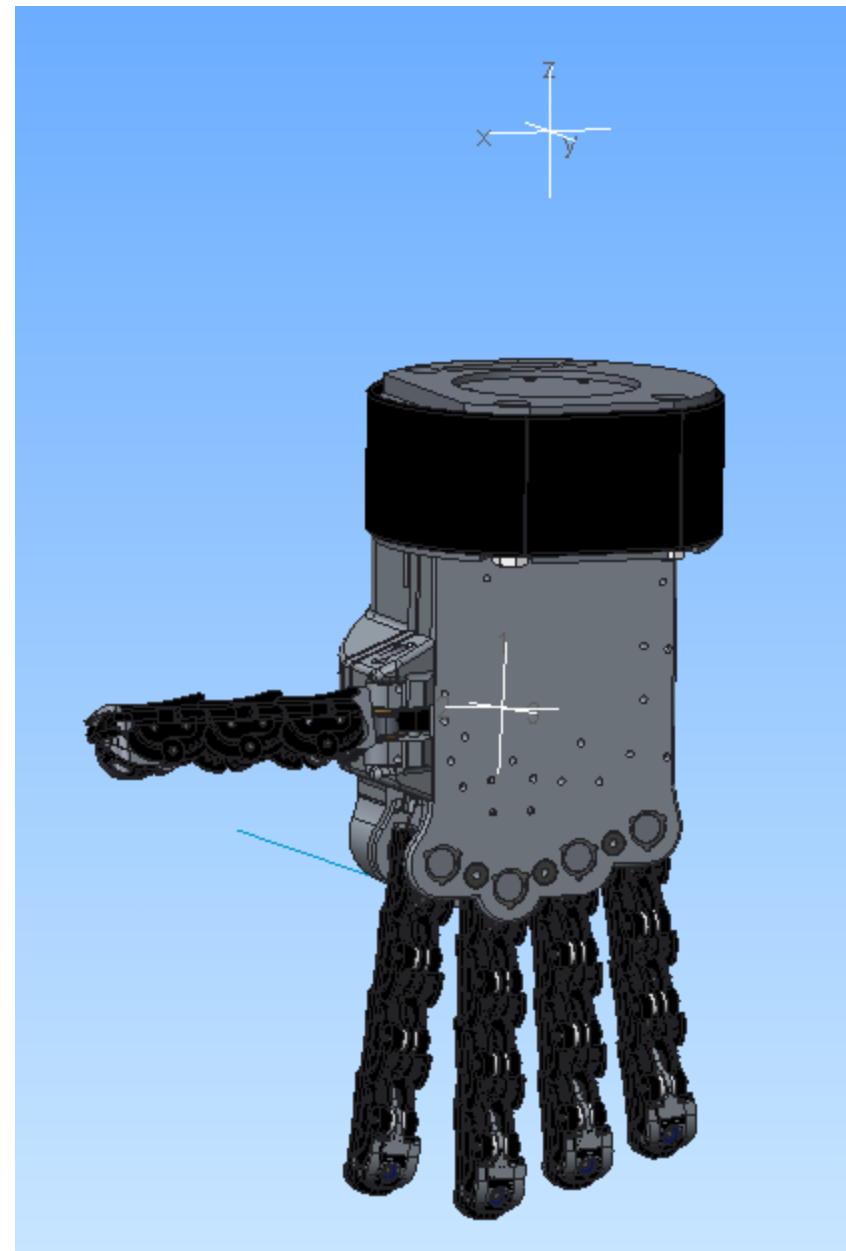
HAND LINK (RX)

MASS = 5 e-01 KILOGRAM

CENTER OF GRAVITY with respect to URDF_FRAME
coordinate frame:

X Y Z 1.1908576e+01 2.1833446e+00 -1.5361558e+02 MM

PEAK Grasping Force: 130N



“Stick” placement (RX)

VOLUME = 3.5554428e+05 MM^3
SURFACE AREA = 1.0689603e+05 MM^2
AVERAGE DENSITY = 3.8783756e-09 TONNE / MM^3
MASS = 1.3789343e-03 TONNE

CENTER OF GRAVITY with respect to ASM_DEF_CSYS
coordinate frame:
X Y Z 7.2667838e+00 -1.2370624e+00 -6.9076044e+01 MM

INERTIA with respect to ASM_DEF_CSYS coordinate frame: (TONNE * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 1.2518567e+01 -3.7752916e-03 7.3954036e-01
Iyx Iyy Iyz -3.7752916e-03 1.9921386e+01 1.4051597e-02
Izx Izy Izz 7.3954036e-01 1.4051597e-02 9.6627562e+00

INERTIA at CENTER OF GRAVITY with respect to ASM_DEF_CSYS coordinate
frame: (TONNE * MM^2)

INERTIA TENSOR:
Ixx Ixy Ixz 5.9368721e+00 -1.6171173e-02 4.7369581e-02
Iyx Iyy Iyz -1.6171173e-02 1.3268985e+01 1.3188343e-01
Izx Izy Izz 4.7369581e-02 1.3188343e-01 9.5878298e+00

PRINCIPAL MOMENTS OF INERTIA: (TONNE * MM^2)
I1 I2 I3 5.9362140e+00 9.5837405e+00 1.3273732e+01

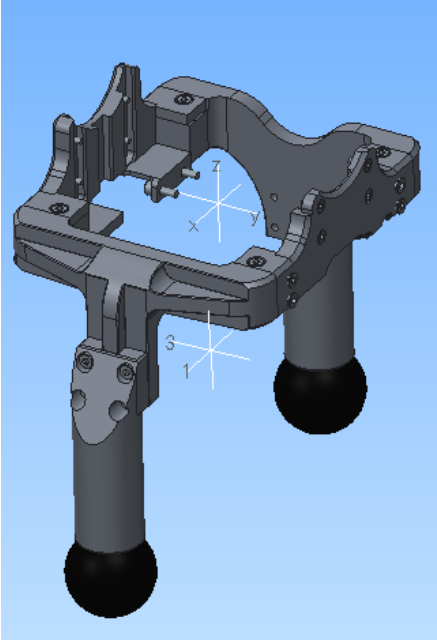
ROTATION MATRIX from ASM_DEF_CSYS orientation to PRINCIPAL AXES:
0.99991 0.01314 0.00197
0.00244 -0.03570 -0.99936
-0.01306 0.99928 -0.03573

ROTATION ANGLES from ASM_DEF_CSYS orientation to PRINCIPAL AXES (degrees):
angles about x y z 92.048 0.113 -0.753

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 6.5611957e+01 8.3367301e+01 9.8112591e+01 MM

Stick origin frame respect to the pitch link:

x=0 mm
y=0 mm
z=-50.5mm



Top ball surface reference respect to the origin frame :

x=97 mm
y=0 mm
z=-132mm

Bottom ball surface reference respect to the origin frame :

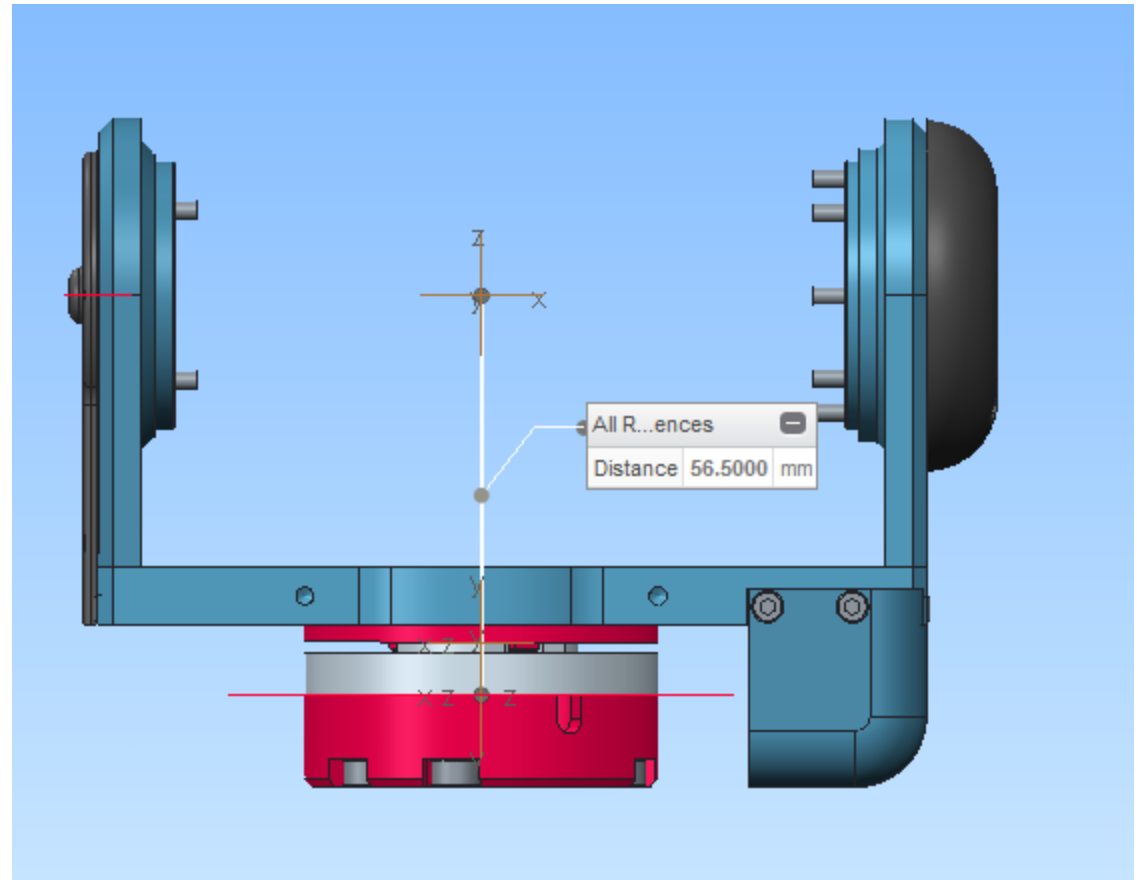
x=-81 mm
y=0 mm
z=-132mm

Ball Diameter: 40 mm

F/T SENSOR PLACEMENT (RX)

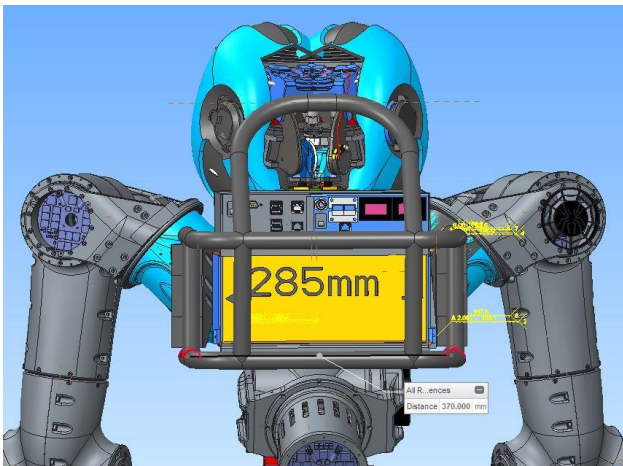
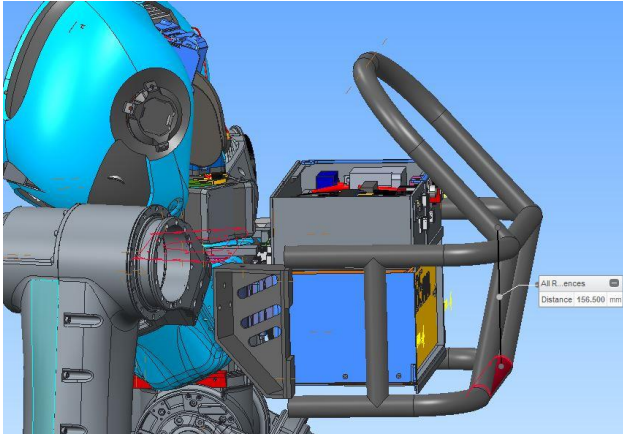
**F/T SENSOR FRAME LOCATION
RESPECT TO THE FOREARM roll
JOINT frame**

**X:0mm
Y:0mm
Z: 56.5mm**



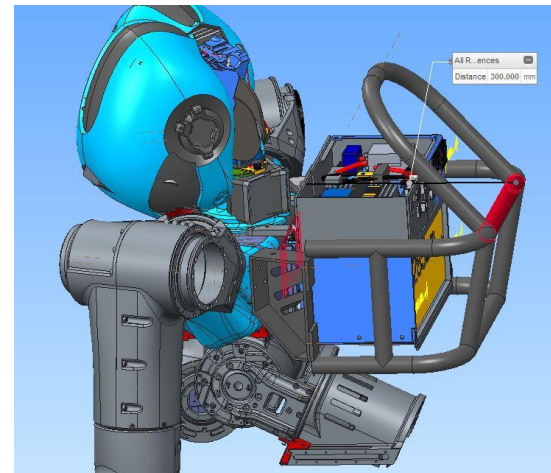
Torso rough estimation

il box ha un ingombro di
294 (larghezza) x 213 (altezza) x 189



Posizione indicativa:
X attaccato alla schiena
Y=0
Z=-20 mm dal piano delle spalle

Peso indicativo: backpack +rollbars
15kg.



torso YAW LINK rough estimation

Averaged density: $2.97 \cdot 10^{-6} \text{ kg/mm}^3$

VOLUME = $2.2950292 \cdot 10^6 \text{ MM}^3$

Mass: 6.8 kg

INERTIA at CENTER OF GRAVITY with respect to ACS0 coordinate frame: (da moltiplicare per densità * MM^2)

INERTIA TENSOR:

$I_{xx} \ I_{xy} \ I_{xz}$ $5.7664530 \cdot 10^{10}$ $1.3715268 \cdot 10^8$ $-4.2065472 \cdot 10^8$

$I_{yx} \ I_{yy} \ I_{yz}$ $1.3715268 \cdot 10^8$ $8.0988074 \cdot 10^9$ $5.9498211 \cdot 10^8$

$I_{zx} \ I_{zy} \ I_{zz}$ $-4.2065472 \cdot 10^8$ $5.9498211 \cdot 10^8$ $5.8408026 \cdot 10^{10}$

Actuators section

Big actuator: Shaft before gear box

VOLUME = 2.0455367e+04 MM^3
SURFACE AREA = 2.1304325e+04 MM^2
AVERAGE DENSITY = 3.1174016e-09 TONNE / MM^3
MASS = 6.3767593e-05 TONNE

CENTER OF GRAVITY with respect to _ROTOR_ASSEMBLY coordinate frame:
X Y Z 0.0000000e+00 -5.8448818e-02 3.2146704e+00 MM

INERTIA with respect to _ROTOR_ASSEMBLY coordinate frame: (TONNE * MM^2)

INERTIA TENSOR:

Ixx	Ixy	Ixz	3.8595581e-02	0.0000000e+00	0.0000000e+00
Iyx	Iyy	Iyz	0.0000000e+00	3.8675520e-02	3.3875902e-05
Izx	Izy	Izz	0.0000000e+00	3.3875902e-05	2.1059873e-02

INERTIA at CENTER OF GRAVITY with respect to _ROTOR_ASSEMBLY coordinate frame: (TONNE * MM^2)

INERTIA TENSOR:

Ixx	Ixy	Ixz	3.7936382e-02	0.0000000e+00	0.0000000e+00
Iyx	Iyy	Iyz	0.0000000e+00	3.8016539e-02	2.1894374e-05
Izx	Izy	Izz	0.0000000e+00	2.1894374e-05	2.1059656e-02

PRINCIPAL MOMENTS OF INERTIA: (TONNE * MM^2)

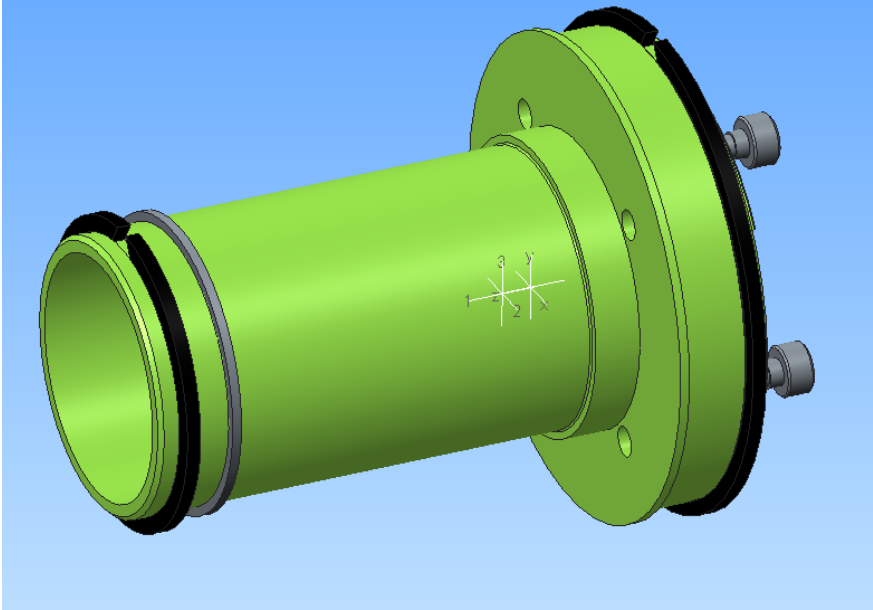
I1	I2	I3	2.1059627e-02	3.7936382e-02	3.8016567e-02
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ROTATION MATRIX from _ROTOR_ASSEMBLY orientation to PRINCIPAL AXES:

0.00000	1.00000	-0.00011
-0.00129	0.00011	1.00000
1.00000	0.00000	0.00129

ROTATION ANGLES from _ROTOR_ASSEMBLY orientation to PRINCIPAL AXES (degrees):
angles about x y z -89.926 0.000 -90.000

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1 R2 R3 1.8172946e+01 2.4390906e+01 2.4416670e+01 MM



Inertia of the motor rotor:
5.43 x10-5 kg m^2
from the datasheet

Inertia of the harmonic drive:
0,263 x 10 -4 kg m^2 from the
datasheet

Reduction ratio: 80.

Big actuator: Shaft after gear box

VOLUME = 8.3525405×10^4 MM³
SURFACE AREA = 9.0330408×10^4 MM²
AVERAGE DENSITY = 4.0560145×10^{-9} TONNE / MM³
MASS = 3.3878025×10^{-4} TONNE

CENTER OF GRAVITY with respect to _WM0028A0 coordinate frame:
X Y Z 1.8150407×10^{-4} $-1.8434214 \times 10^{-4}$ 1.7579705×10^1 MM

INERTIA with respect to _WM0028A0 coordinate frame: (TONNE * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 1.1302565×10^0 7.2527702×10^{-6} 1.7490136×10^{-6}
Iyx Iyy Iyz 7.2527702×10^{-6} 1.1299437×10^0 $-1.7573702 \times 10^{-6}$
Izx Izy Izz 1.7490136×10^{-6} $-1.7573702 \times 10^{-6}$ 1.7595213×10^{-1}

INERTIA at CENTER OF GRAVITY with respect to _WM0028A0 coordinate frame: (TONNE * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 1.0255578×10^0 7.2527589×10^{-6} 2.8299896×10^{-6}
Iyx Iyy Iyz 7.2527589×10^{-6} 1.0252450×10^0 $-2.8552488 \times 10^{-6}$
Izx Izy Izz 2.8299896×10^{-6} $-2.8552488 \times 10^{-6}$ 1.7595213×10^{-1}

PRINCIPAL MOMENTS OF INERTIA: (TONNE * MM²)

I1 I2 I3 1.7595213×10^{-1} 1.0252448×10^0 1.0255580×10^0

ROTATION MATRIX from _WM0028A0 orientation to PRINCIPAL AXES:

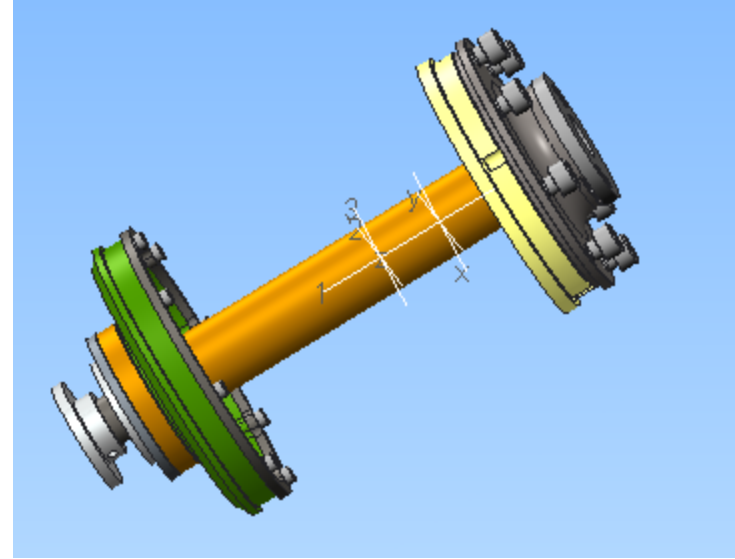
0.00000	-0.02317	-0.99973
0.00000	0.99973	-0.02317
1.00000	0.00000	0.00000

ROTATION ANGLES from _WM0028A0 orientation to PRINCIPAL AXES (degrees):

angles about x y z 90.008 -88.673 90.008

RADII OF GYRATION with respect to PRINCIPAL AXES:

R1 R2 R3 2.2789679×10^1 5.5011660×10^1 5.5020061×10^1 MM



Big actuator: Shaft after gear box with test rig parts

VOLUME = 4.0397776e+05 MM³

SURFACE AREA = 1.5604711e+05 MM²

AVERAGE DENSITY = 5.5858351e-09 TONNE / MM³

MASS = 2.2565532e-03 TONNE

CENTER OF GRAVITY with respect to _WM0028A0 coordinate frame:

X Y Z 4.8974444e+01 1.1826665e+02 -6.3984696e+01 MM

INERTIA with respect to _WM0028A0 coordinate frame: (TONNE * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 7.2036101e+01 -2.4397073e+01 8.9323242e+00

Iyx Iyy Iyz -2.4397073e+01 2.3241235e+01 2.1568499e+01

Izx Izy Izz 8.9323242e+00 2.1568499e+01 6.9434852e+01

INERTIA at CENTER OF GRAVITY with respect to _WM0028A0 coordinate frame: (TONNE * MM²)

INERTIA TENSOR:

Ixx Ixy Ixz 3.1235271e+01 -1.1327020e+01 1.8611555e+00

Iyx Iyy Iyz -1.1327020e+01 8.5904790e+00 4.4925850e+00

Izx Izy Izz 1.8611555e+00 4.4925850e+00 3.2460110e+01

PRINCIPAL MOMENTS OF INERTIA: (TONNE * MM²)

I1 I2 I3 3.0921155e+00 3.3265314e+01 3.5928431e+01

ROTATION MATRIX from _WM0028A0 orientation to PRINCIPAL AXES:

0.37763 0.06262 0.92384

0.91143 0.15088 -0.38279

-0.16336 0.98657 -0.00009

ROTATION ANGLES from _WM0028A0 orientation to PRINCIPAL AXES (degrees):

angles about x y z 90.014 67.493 -9.415

RADII OF GYRATION with respect to PRINCIPAL AXES:

R1 R2 R3 3.7017328e+01 1.2141519e+02 1.2618169e+02 MM

