* HW - 5

The dynamic eq^n for the robot is:

$$M(q)\ddot{q} + C(q,\dot{q})\dot{q} + g(q) = z + J^T(q) F$$

Here, the robot-motion is assumed quasi-static. Therefore, $\dot{q} = \ddot{q} \cong 0$.

Thus, according to the dynamic eq^n, joint torque is

$$\boxed{z = g(q) - J^T(q) F}$$

* Calculation for $g(q)$:-

$$g(q_k) = \frac{\partial P}{\partial q_k}$$

As, velocity is 0.

where $P = \sum_{i=1}^{n} m_i g^T r_{ci}$

where, $P = \sum_{i=1}^{n} m_i g^T r_{ci}$

* External force :-

$$F = \begin{bmatrix} -5 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

The only force is acting ~~to~~ in $-x$ direction.

⊛CPA

* Velocity equations :-

☆ Trajectory eqⁿ :-

$x = 67.9$ cm

$y = 10\cos(\theta)$ cm $y = -10\cos(\theta + \pi/2)$ cm

$z = 72.5 + 10\sin(\theta)$ z ~~cm~~ $= 72.5 + 10\sin(\theta + \pi/2)$ cm

where, $\dot{\theta} = 2\pi/200$ $\left(\theta \in [0, 2\pi] \right)$

$\Rightarrow$ velocity vector $\dot{X} = \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \\ \dot{\phi} \\ \dot{\theta} \\ \dot{\psi} \end{bmatrix} = \begin{bmatrix} 0 \\ +0.1 \times \pi \times \sin(\theta + \pi/2) \\ 0.1 \times \pi \times \cos(\theta + \pi/2) \\ 0 \\ 0 \\ 0 \end{bmatrix}$

* Assumptions / Data :-

★ Mass :- (According to panda_arm.xacro)

Mass of link 0 = 3.06 (kg)

Mass of link 1 = 4.97 (kg)

Mass of link 2 = 0.64 (ky)

Mass of link 3 = 3.22 (kg)

Mass of link 4 = 3.58 (kg)

Mass of link 5 = 1.22 (kg)

Mass of link 6 = 1.66 (kg)

Mass of link 7 = 0.73 (kg)

Mass of link 8 = 0 (kg)

Also, according to hand.xacro file,

Mass of hand = 0.73 (kg)

Mass of left finger = 0.1 (kg)

Mass of Right finger = 0.1 (kg)

According to to our configuration,
fingers fingers' masses will be added to
hand.

Final mass distribution will be:

Link	Mass (kg)	Center of gravity (Height) (m)
1	3.06	0.07
2	4.97	0.2326
3	0.64	0.425
4	3.22	
5	3.258	
6	1.22	
7	1.66	
8	0.93 (Gripper)	

The link lengths are measured from
"FRANCA_movable.SLDASM" which matches
with the dimensions in given product
manual.
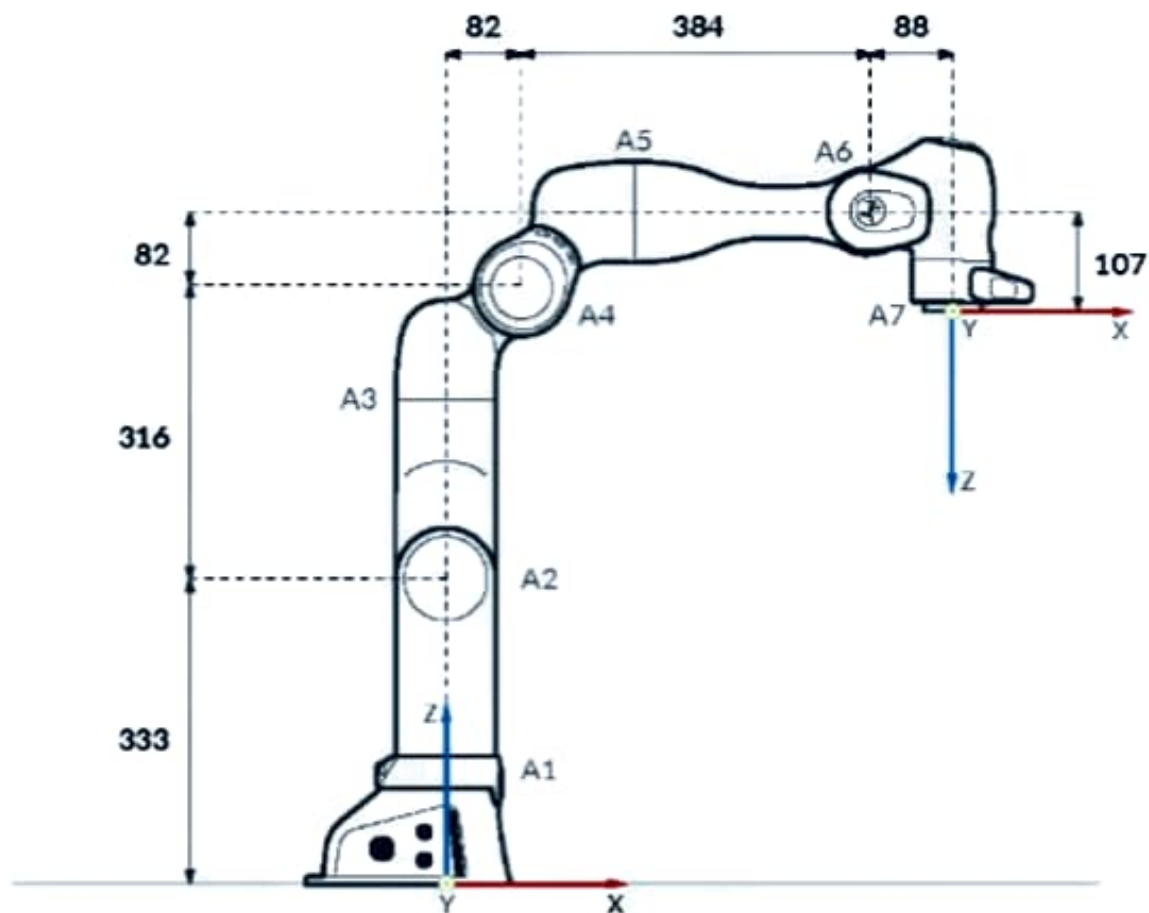
Axes names with joint lengths [mm]

FRANKA_movable (MOVABLE) <Anzeigest
Historie
Sensoren
Beschriftungen
Ebene vorne
Ebene oben
Ebene rechts
Ursprung
(f) BA_J1_adapted<1> (Standard) <<St
(f) SH_J1J2_adapted<1> (Standard) <<
(f) SH_J2J3_adapted<1> (Standard) <<
(f) EL_J3J4_adapted<1> (Standard) <<
(f) EL_J4J5_adapted<1> (Standard) <<
(f) LA_J5J6_adapted<1> (Standard) <<
(f) WR_J6_adapted<1> (Standard) <<S
(f) WR_J7_adapted<1> (Standard) <<Stan
CLAMPING_PROTECTOR_ELBOW_adapt
CLAMPING_PROTECTOR_ELBOW_adapt
CLAMPING_PROTECTOR_ELBOW_SMAL
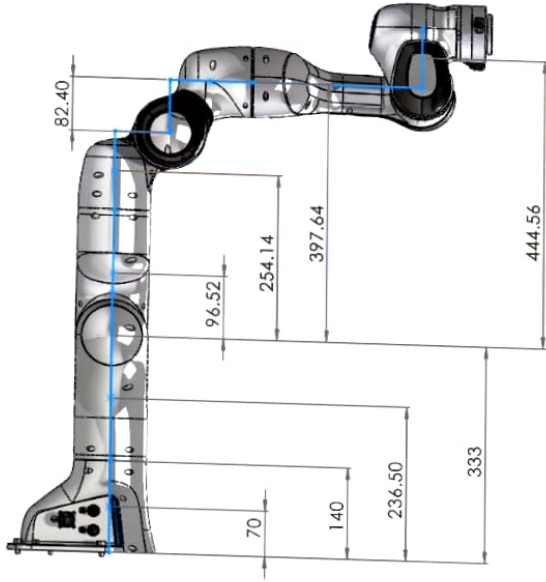CLAMPING_PROTECTOR_ELBOW_SMAL
ELBOW_PROTECTOR_adapted<1> (Star
ELBOW_PROTECTOR_adapted<2> (Star
LOWER_ARM_PROTECTOR_adapted<1>
Verknüpfungen
(-) Sketch2

82.40
397.64
444.56
254.14
96.52
333
236.50
140
70

z
Y

Model   3D Views   Bewegungsstudie 1

s to selected entities

$$h_1 = 0.07$$

$$h_2 = 0.236$$

$$h_3 = 0.333 + 0.096 \cos(\theta_2)$$

$$h_4 = 0.333 + 0.254 \cos(\theta_2)$$

$$h_5 = \theta_2 \, h_4 + 0.082 \cos(\theta_4)$$

$$h_6 = h_5$$

$$h_7 = h_5 - 0.088 \cos(\theta_6)$$