

## EE368 Robotic Motion and Control

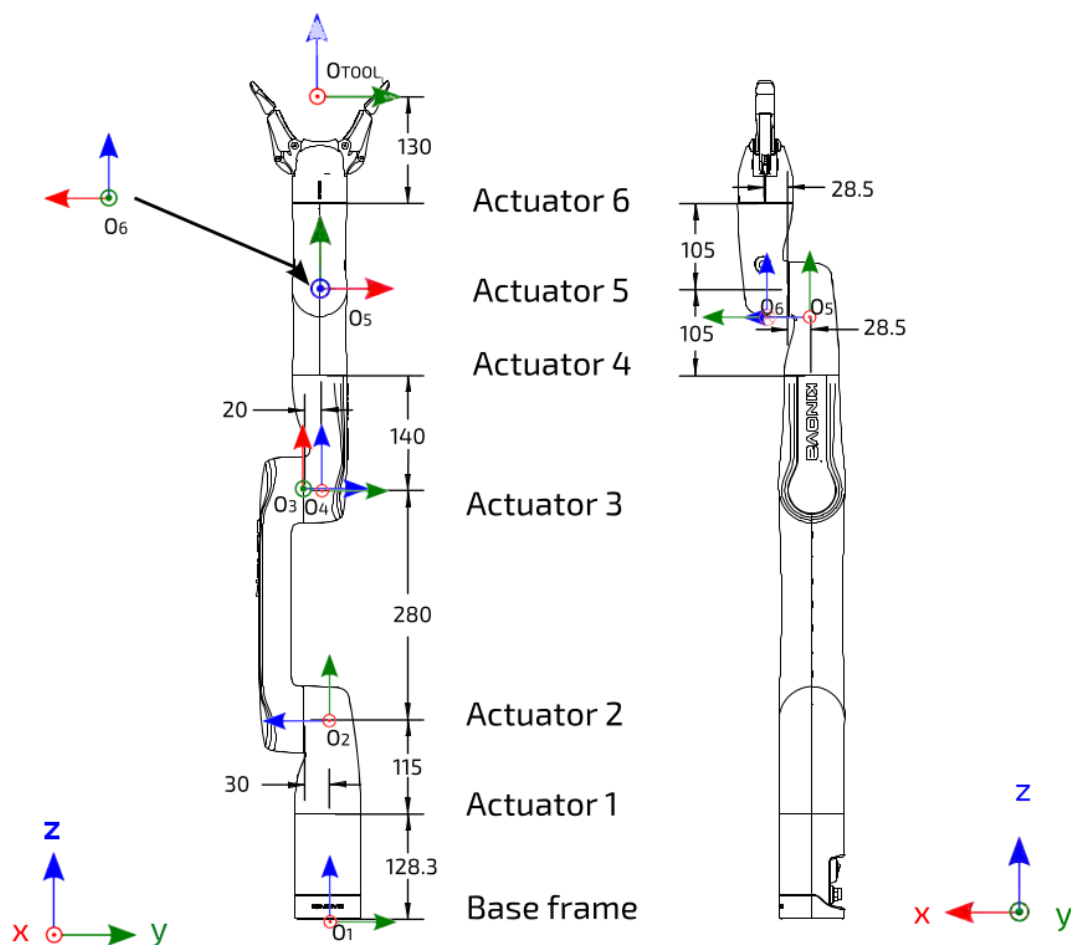
Spring 2024

Project: Kinematics (5%)

Date: 4.14 24:00

### Task:

1. Number the links and joint axes from the Base frame to Tool frame, attach link frames to each link (You may refer to page 135 of Gen3\_lite\_USER\_GUIDE\_R03.pdf).
2. Give the D-H table.
3. Write a kinematics program (python or C++) to calculate it.
  - Input form:  $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6$
  - Outputform:  ${}^{Base}T_{Tool}$  or  $\{p_x, p_y, p_z, \alpha, \beta, \gamma\}$



- *Hint: it is encouraged to check your program and result on Kinova Gen3 Lite Robot arm.*
- *Hint: you can use some third-part packages or libraries like numpy and Eigen.*
- **Attention: The definition and formula of DH model given in user guide which is different from them in textbook. Please refer to the textbook for the exam.**
- **Attention: The Tool frame on page 135 is different from which in actual use (on page 133).**

### Samples:

#### Input:

name	$\theta_1$	$\theta_2$	$\theta_3$	$\theta_4$	$\theta_5$	$\theta_6$
HOME	0	345	75	0	300	0
ZERO	0	0	0	0	0	0
RETRACT	357	21	150	272	320	273
PACKAGING	270	148	148	270	140	0
PICK	20.5	313.5	100	265.5	327	57

#### Output:

name	$p_x$	$p_y$	$p_z$	$\theta_x$	$\theta_y$	$\theta_z$
HOME	435	194	457	90	0	150
ZERO	57	-10	1003	0	0	90
RETRACT	130	-69	118	11	178	83
PACKAGING	-67	299	71	-180	-40	90
PICK	349.6	48.6	-0.6	-179.0	2.3	147.3

or:

name	$\begin{smallmatrix} Base \\ Tool \end{smallmatrix} T$
HOME	$\begin{bmatrix} -0.866 & 0 & 0.5 & 434.969 \\ 0.5 & 0 & 0.866 & 193.516 \\ 0 & 1 & 0 & 456.759 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
ZERO	$\begin{bmatrix} 0 & -1 & 0 & 57 \\ 1 & 0 & 0 & -10 \\ 0 & 0 & 1 & 1003.3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
RETRACT	$\begin{bmatrix} -0.125 & -0.973 & 0.192 & 130.292 \\ -0.991 & 0.13 & 0.012 & -68.607 \\ -0.037 & -0.189 & -0.981 & 118.362 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
PACKAGING	$\begin{bmatrix} 0 & 1 & 0 & -67 \\ 0.766 & 0 & 0.643 & 299.432 \\ 0.643 & 0 & -0.766 & 70.826 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
PICK	$\begin{bmatrix} -0.841 & 0.541 & 0.024 & 349.545 \\ 0.54 & 0.841 & -0.036 & 48.626 \\ -0.04 & -0.017 & -0.999 & -0.568 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

- $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_x, \theta_y, \theta_z$  are in deg.
- $p_x, p_y, p_z$  are in mm.

### Submission:

Submit your program code on Blackboard system.