Robotics II

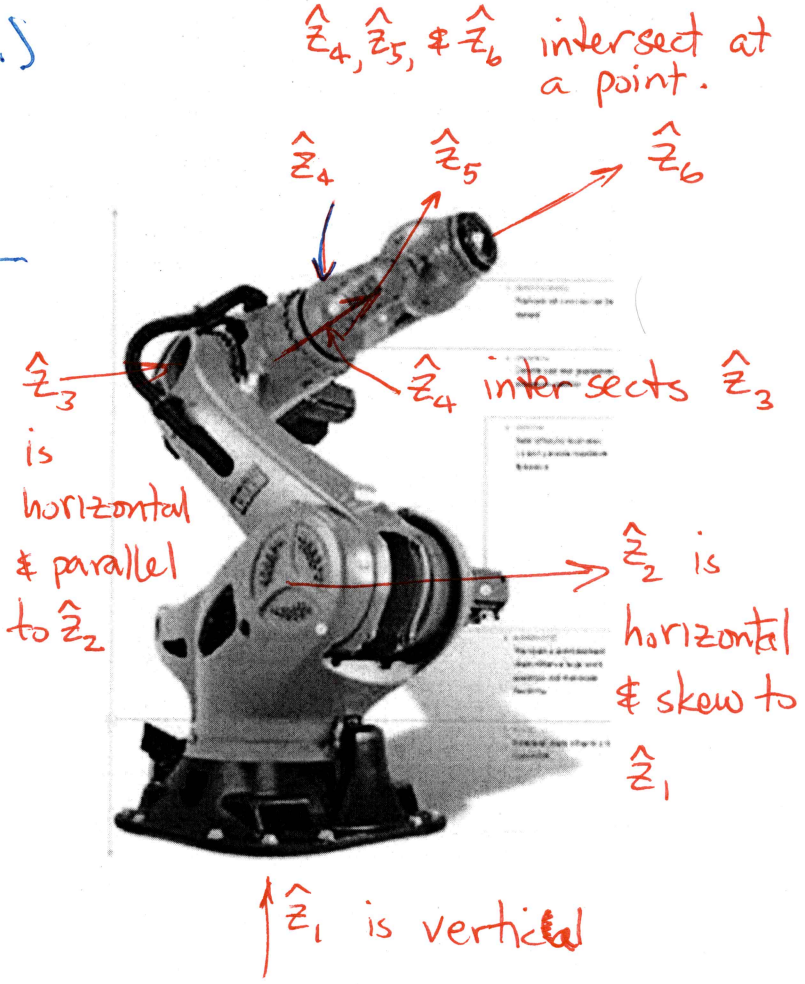
HW1

Due midnight 2/15/2018

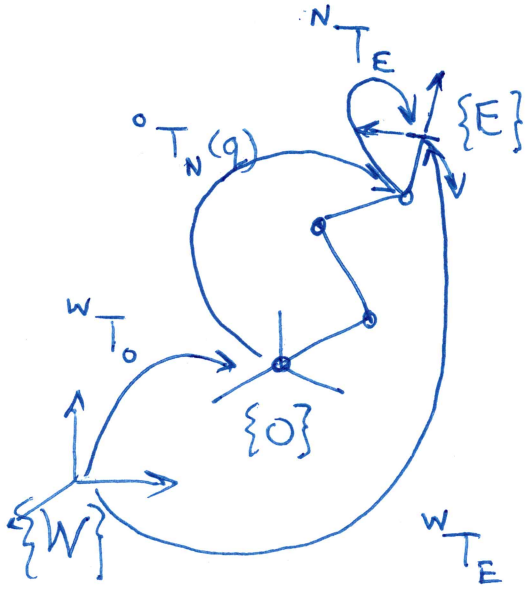
1. Find the DH parameters following the definitions given in class (and LaValle's text).

   (The wrist is spherical.)

i	α_{i-1}	a_{i-1}	d_i	θ_i
1				
2				
3				
4				
5				
6				



2. Write a function that accepts as input a DH table of params, ${}^{W}T_{0}$, and ${}^{N}T_{E}$ and outputs ${}^{W}T_{E}$.



(You may find it useful to create some kind of visualization of the robot and {E}.)

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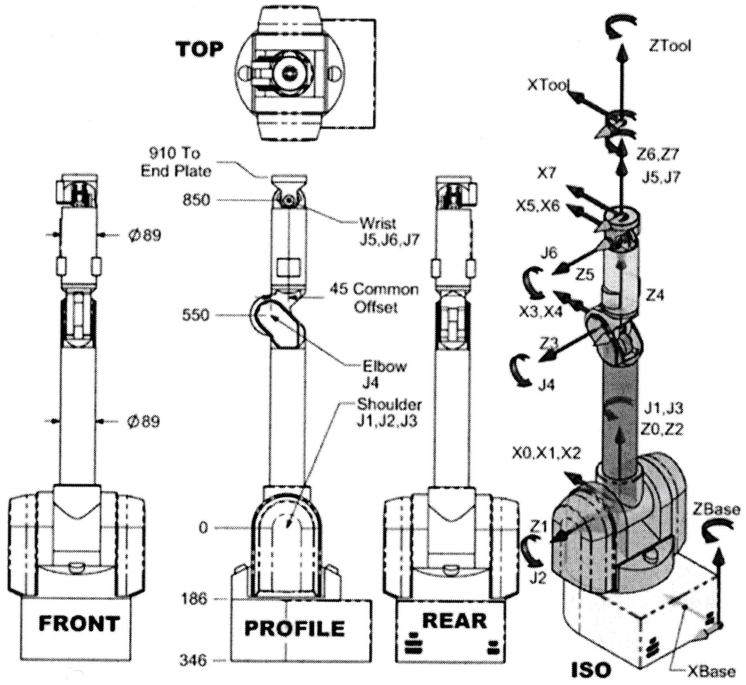
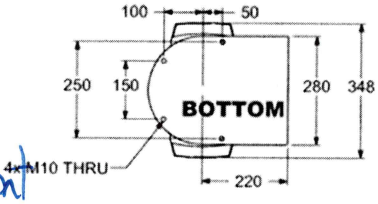
(3)

3. WAM IK.

3.a) Given the WAM DH params given below, solve the generic IK problem analytically.



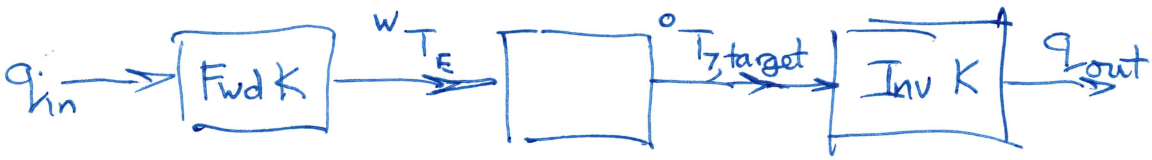


(Hint: Treat joint 3's displacement as known, then the IK can be solved as done in class.)

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	var
2	$-\pi/2$	0	0	var
3	$\pi/2$	0	0.55	var
4	$-\pi/2$	0.045	0	var
5	$\pi/2$	-0.045	0.3	var
6	$-\pi/2$	0	0	var
7	$\pi/2$	0	0.06	var

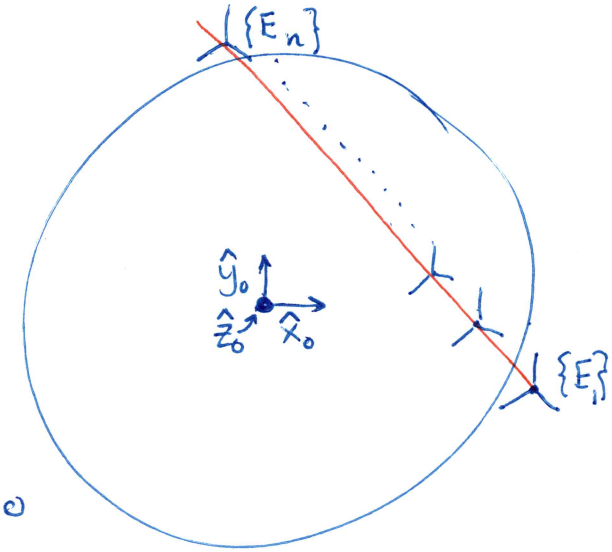
3 WAM IK (continued)

3.b) Code you solution to 3.a.) and test by inputting random joint angles to the code from question 2).



Compare q_{in} and q_{out}

3.c.) Generate a trajectory for the end effector that crosses the WAM's workspace as shown below.



3.c.i) Plot the joint angles holding θ_3 to a fixed value.

3.c.ii) Plot the joint angles again when allowing θ_3 to vary so as to smooth the joint angle trajectories.

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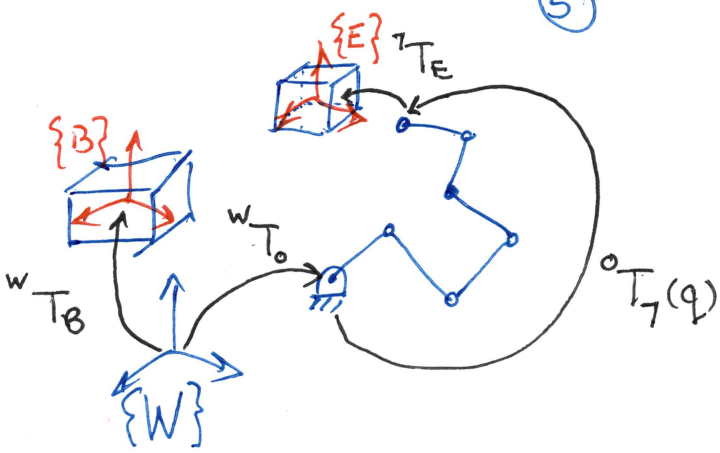
(5)

4. Collision detection.



Write a function that accepts a list of joint angle vectors, $\bar{q}_1, \bar{q}_2, \cdots, \bar{q}_{1000}$, where $\bar{q}_i = [\theta_{i,1}\ \theta_{i,2} \cdots \theta_{i,7}]$, and outputs a file with one character per line. "0" means collision free. "1" means collision.

output file

0
0
1
0
1
1
0
1
.
.
.

The geometric data and the t'forms ${}^WT_B$ and ${}^7T_E$ are available on the class web page.

Only check box-box collisions.

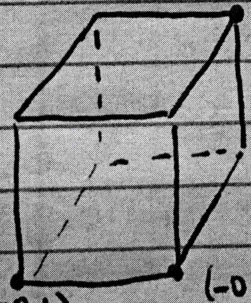
i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	Var
2	$-\pi/2$	0	0	Var
3	$\pi/2$	0	0.55	Var
4	$-\pi/2$	0.045	0	Var
5	$\pi/2$	-0.045	0.3	Var
6	$-\pi/2$	0	0	Var
7	$\pi/2$	0	0.06	Var

$$^{W}T_{Base} = \begin{bmatrix} 1 & 0 & 0 & 0.22 \\ 0 & 1 & 0 & 0.14 \\ 0 & 0 & 1 & 0.346 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{W}T_{Table} = \begin{bmatrix} 1 & 0 & 0 & 0.8 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0.1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{7}T_{Box} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0.21 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Box :



Coordinates are in Box frame

Table :

Coordinates are in Table frame