MAE 547: Modeling and Control of Robots

Final Project

A 7 degree of freedom robot arm (LBR iiwa 7 R800, KUKA) (Fig. 1) is mounted on a base as seen in Fig. 2. The robot starts from location (A) and needs to go to location (B) as seen in Fig. 3, maintaining the orientation of the end-effector throughout the motion. In the workspace of the robot a rectangular obstacle is located as shown in Fig. 3. Design the trajectory in joint space so that the robot arm moves from location (A) to location (B) without hitting the obstacle. As the robot moves from location (A) to location (B), its end-effector orientation should remain constant.

When creating the robot trajectory make sure you don't exceed the angular position and angular velocity limits of all the robot joints. The robot motion from point (A) to (B) should not last for more than 30 seconds.

Deliverables:

- Provide the Matlab Code (in a LastName_FirstName.zip file) and a Technical Report (max. 5 pages) of the methods used to design the desired robot joint trajectory.
- Provide a LastName_FirstName.txt file that will have n rows and 7 columns of data. Each row will correspond to the robot configuration in radians from joints 1 to 7. Use 4 decimal points for the joints angles and a single space between the values for two joints. Each of the n rows corresponds to a robot configuration commanded to the robot every 5 ms. Therefore, you need to check if the resulted trajectory exceeds the velocity limits when commanded every 5ms. The first row of your file should be the initial robot configuration $\mathbf{q_A}$. No other characters should be included in the .txt file. A sample file is attached (sample.txt).
- Each student will present his/her work in a 5-minute meeting with the instructor. All the deliverables (code, report, trajectory file) should be sent to the instructor before the presentation at a date that will be announced. You should be able to show/prove that the robot executes the motion task along the guidelines, i.e. the orientation of the end-effector is constant, and the robot does not hits the obstacle, while staying within position and velocity limits.

The manual of the robot is attached. You can use any information you need from the manual. Make sure you use technical details of the LBR iiwa 7 R800 robot and not the LBR iiwa 14 R820 that is also included in the manual. The configuration and the pose of the robot with respect to its base frame for points (A) and (B) are shown below. The orientation is denoted in Euler ZYX notation.

$$\mathbf{p_A} = \begin{bmatrix} 0.58412 \\ -0.48572 \\ -0.23206 \end{bmatrix} (m), \begin{bmatrix} \varphi_z \\ \vartheta_y \\ \psi_x \end{bmatrix}_A \simeq \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\mathbf{p}_B = \begin{bmatrix} 0.55020 \\ 0.37742 \\ -0.22219 \end{bmatrix} (m), \begin{bmatrix} \varphi_z \\ \vartheta_y \\ \psi_x \end{bmatrix}_B \simeq \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\mathbf{q_A} = \begin{bmatrix} -109.19 & 80.81 & 64.66 & 70.93 & 0.25 & -88.23 & 63.10 \end{bmatrix} \quad \text{(deg)}$$
$$\mathbf{q_B} = \begin{bmatrix} -53.41 & 112.63 & -13.84 & 92.16 & -41.09 & -97.44 & -23.31 \end{bmatrix} \quad \text{(deg)}$$

The obstacle coordinates (in m) with respect to the robot base frame are shown below:

a (0.55, -0.1, -0.1)
b (0.60, 0, -0.1)
c (0.55, 0.1, -0.1)
d (0.50, 0, -0.1)
e (0.55, -0.1, -1.5)
f (0.60, 0, -1.5)
g (0.55, 0.1, -1.5)

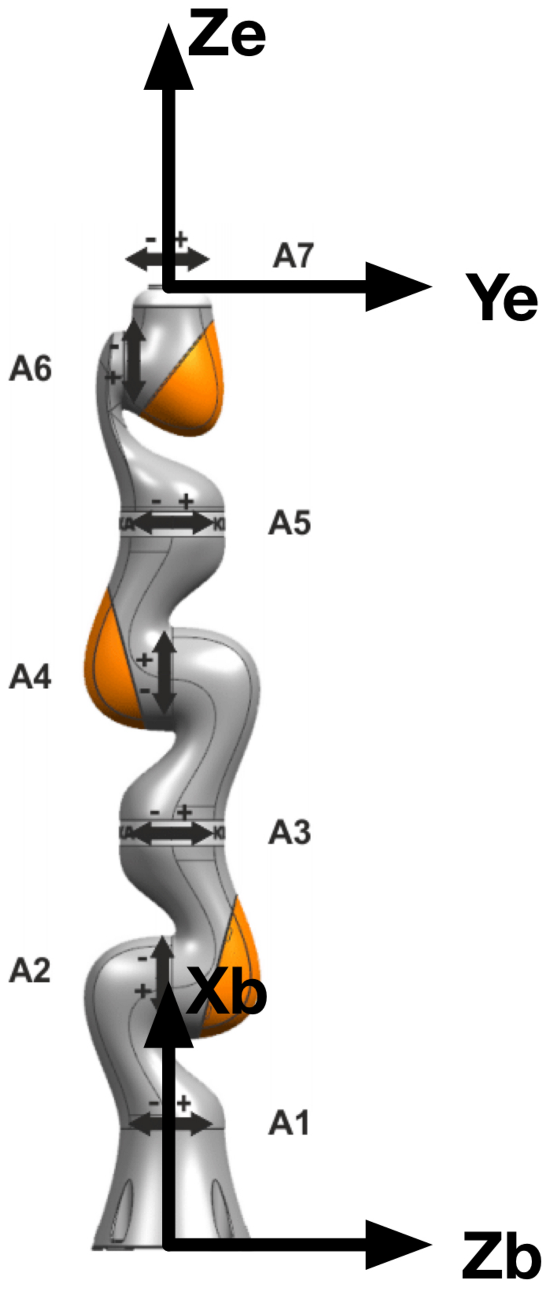

Figure 1: LBR iiwa 7 R800 robot arm, KUKA. Base and end-effector frames are shown.

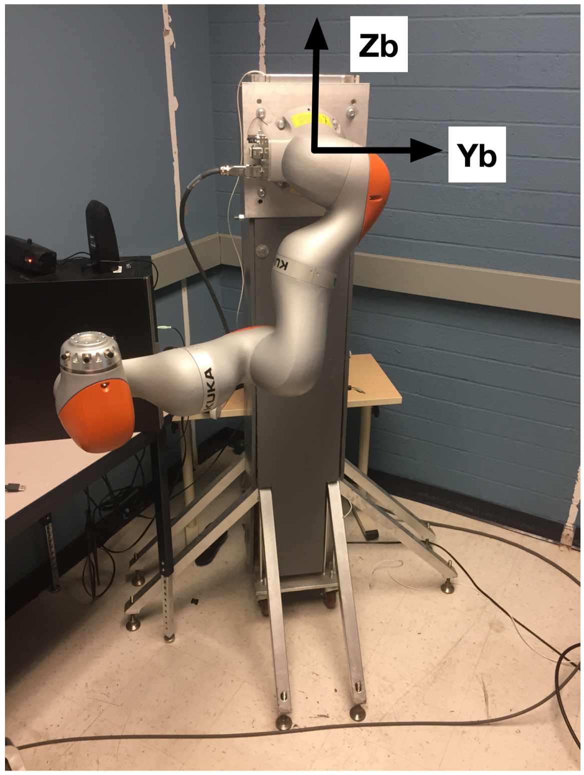

Figure 2: Robot mounting.

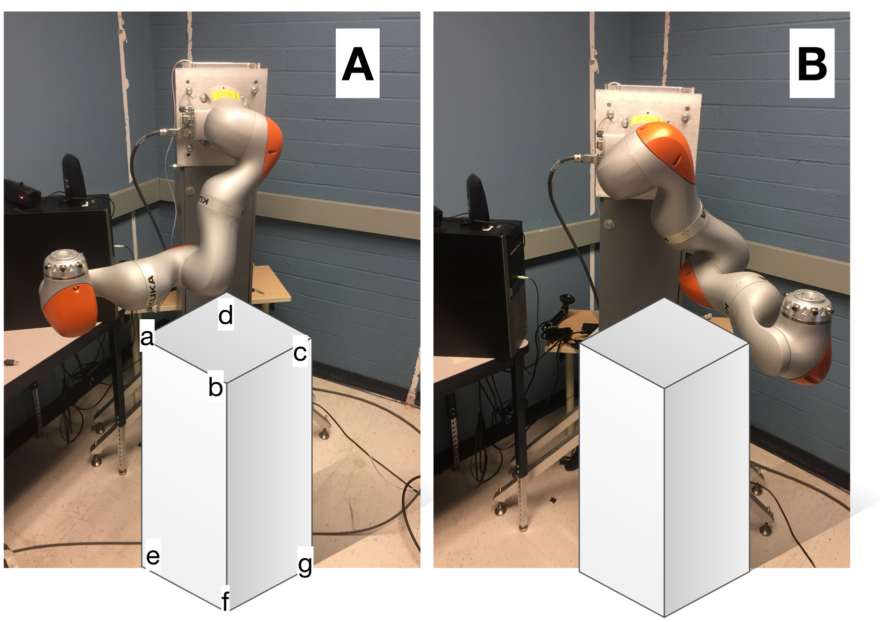

Figure 3: (A) and (B) poses of the robot and obstacle.