Fundamentals of Robotics: Assignment 2

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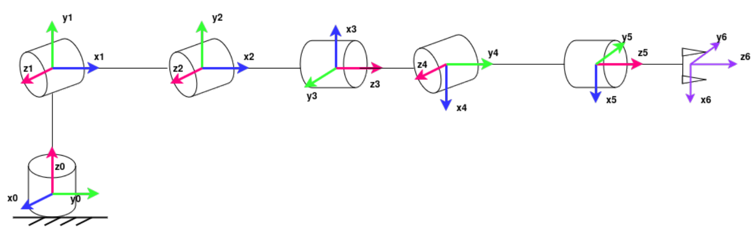
1 Link

Colab

2 Configuration of the chosen robot

Manipulator with anntropomorphic elbow and a spherical wrist.



Forward kinematics:

$$^{0}T_{1} = R_z(\theta_1^*)T_z(l_1)R_z(\frac{\pi}{2})R_x(\frac{\pi}{2})$$

$$^{1}T_{2} = R_z(\theta_2^*)T_x(l_2)$$

$$^{2}T_{3} = R_z(\theta_3^*)T_x(l_3)$$

$$^{3}T_{4} = R_z(\theta_4^*)T_z(l_4)R_x(-\frac{\pi}{2})R_z(-\pi)$$

$$^{4}T_{5} = R_z(\theta_5^*)T_y(l_5)R_x(-\frac{\pi}{2})$$

$$^{5}T_{6} = R_z(\theta_6^*) * T_z(l_6)$$

$$^{0}T_{6} = {}^{0}T_{1}{}^{1}T_{2}{}^{2}T_{3}{}^{3}T_{4}{}^{4}T_{5}{}^{5}T_{6}$$

3 Task 1. Derive inverse kinematics for your robot model

Given: End-effector position O_6 and orientation R_6.
Position P_c equals $0T_3$:

$$^0T_3 = {}^0T_1{}^1T_2{}^2T_3$$

The translation column corresponds to the position of the wrist center. Thus,

$$x_w =$$
$$y_w =$$
$$z_w =$$

Since we have already calculated q_1, q_2, q_3, we can calculate q_4, q_5, q_6.

$$^3R_6 = {}^0R_3^{-1 0}R_6$$

4 Task 2. Solve inverse kinematics for multiple positions

1. Solve the first 3 joints for positioning the wrist
2. Solve the last 3 jooints for orienting the tool

Target reference frame:

$$T = R_T t_T$$

Target wrist point: $p_w = t_T - l_6 z_T$
Since $0R_6 = 0R_3 \cdot 3R_6$.

5 Task 3. Track the number of solutions along the way and choose the correct one and closest to the previous (current) configuration.

6 Task 4. Derive the jacobian matrix for your robot model.

7 Task 5. Plan a synchronized trajectory for all 6 joints between two poses. (consider 20Hz controller frequency)

8 Task 5. Use the Jacobian matrix to check for singularities along the planned trajectory