



Hand-in date: February 17th, 23:00

The following problems are found in the physical book: "Robot Modeling and Control" (2006) by Spong et al.

1. Problem 4-18

Compute the jacobian J_{11} for the 3-link spherical manipulator in Figure 1, see Example 4.10. 2.5 Points.

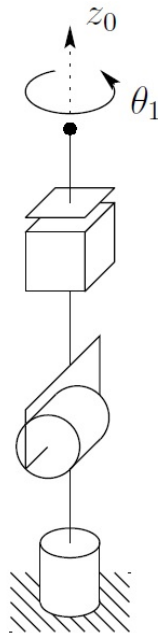


Figure 1: Singularity of spherical manipulator with no offsets.

2. Problem 4-19

Use Equation (4.102) on page 148

$$J_{11} = \begin{bmatrix} \alpha_1 & \alpha_3 & 0 \\ \alpha_2 & \alpha_4 & 0 \\ 0 & 0 & -1 \end{bmatrix} \quad (4.102)$$

to show that the singularities of the SCARA manipulator are given by Equation (4.104)

$$s_2 = 0, \quad \text{which implies} \quad \theta_2 = 0, \pi \quad (4.104)$$

2.5 Points.

3. Problem 4-20

Find the 6×3 Jacobian for the three links of the cylindrical manipulator of Figure 2 from page 85. Find the singular configurations for this arm. 2.5 Points.

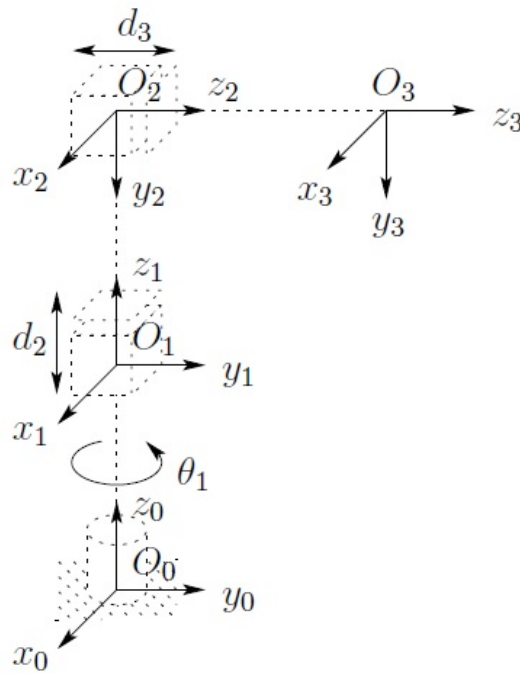


Figure 2: Three-link cylindrical manipulator.

4. Problem 4-25

Suppose that \dot{q} is a solution to Equation (4.110) on page 150 for $m < n$.

$$\xi = J\dot{q} \quad (4.110)$$

1. Show that $\dot{q} + (I - J^+J)b$ is also a solution to Equation (4.110) for any $b \in \mathbb{R}^n$.
2. Show that $b = 0$ gives the solution that minimizes the resulting joint velocities.

2.5 Points.