Norwegian University of Science
and Technology
Department of Engineering
Cybernetics

TTK4195 Modeling and Control of Robots Spring 2015

Exercise set 3

Hand-in date: February 3rd, 23:00

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

1. Problem 3-10

Consider the PUMA 260 manipulator shown in Figure 1. Derive the complete set of forward kinematic equations, by establishing appropriate DH coordinate frames, constructing a table of link parameters, forming the A-matrices, etc.
It's not needed to show the complete calculation $T_0^6 = A_1A_2A_3A_4A_5A_6$.
2 Points

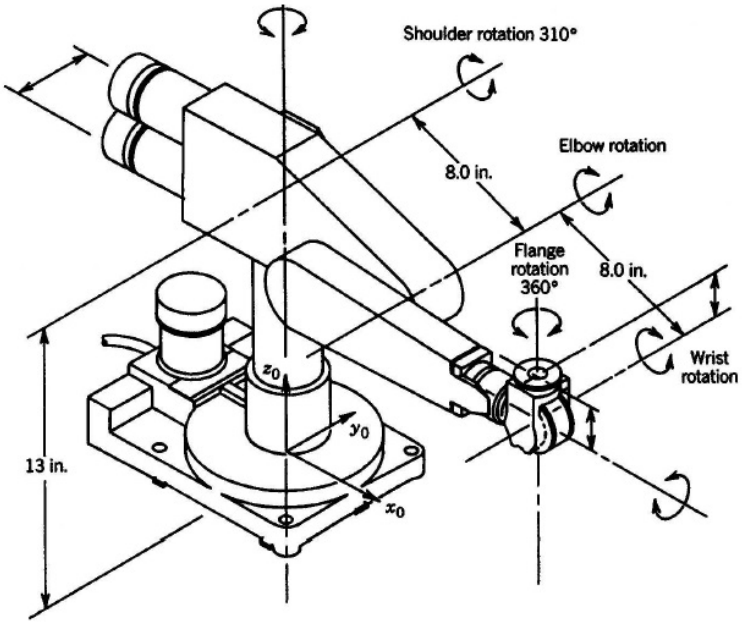

Figure 1: PUMA 250 manipulator

2. Problem 3-15*

Add a spherical wrist to the three link cylindrical arm in Figure 2 and write the complete inverse kinematics solution. 3,5 Points

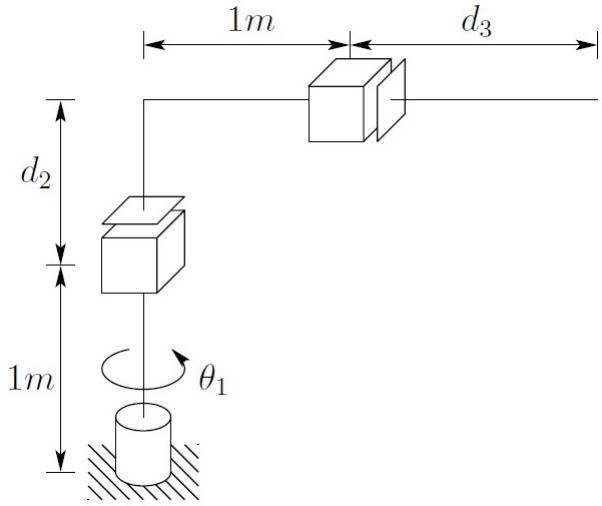

Figure 2: Cylindrical configuration

3. Problem 3-16*

Add a spherical wrist to the Cartesian manipulator in Figure 3 and write the complete inverse kinematics solution. 3,5 Points

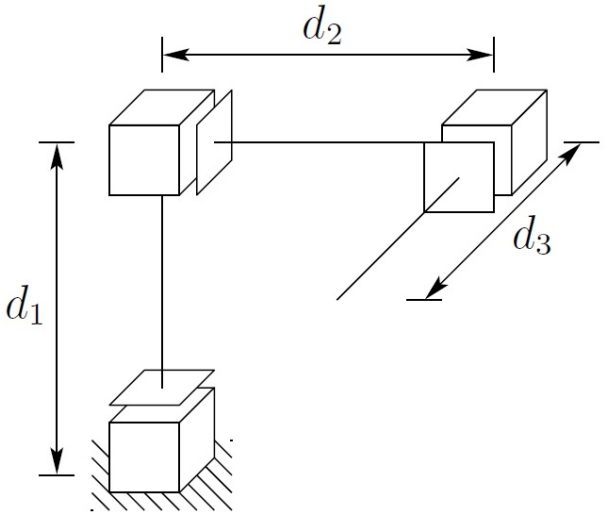

Figure 3: Cartesian configuration

4. Problem 4-7

Given $R = R_{x,\theta}R_{y,\phi}$, compute $\frac{\partial R}{\partial \phi}$. Evaluate $\frac{\partial R}{\partial \phi}$ at $\theta = \frac{\pi}{2}$, $\phi = \frac{\pi}{2}$.
1 Point.

* Hints

Use steps 1-3 on page 111 (101-102 in the PDF-version of the book) in the text book (chapter summary):

- Step 1: Describe the wrist center with the given (desired) position and orientation of the end-effector, see also Equation (3.79) in the book. Spherical wrist with end-effector: See Example 3.3.
- Step 2: As described on page 111.
- Step 3: As described on page 111, see also pages 54 and 55.

The process is shown in detail in Example 3.8 on page 106 (97 in the PDF-version).