Norwegian University of Science
and Technology
Department of Engineering
Cybernetics

TTK4195 Modeling and Control of Robots Spring 2015

Exercise set 7

Hand-in date: March 10th, 23:00

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

1. Problem 7-7

Compute a 3-link cartesian manipulator,

(a) Compute the inertia tensor J_i for each link $i = 1, 2, 3$ assuming that the links are uniform rectangular solids of length 1, width $\frac{1}{4}$, height $\frac{1}{4}$, and mass 1.

(b) Compute the 3×3 inertia matrix $D(q)$ for this manipulator.

(c) Show that the Christoffel symbols c_{ijk} are all zero for this robot. Interpret the meaning of this for the dynamic equations of motion.

(d) Derive the equations of motion in matrix form: $D(q)\ddot{q} + C(q, \dot{q})\dot{q} + g(q) = u$

(5 Points)

2. Problem 7-9

Derive the Euler-Lagrange equations for the planar RPR robot in Figure 1 from page 116.

1. This task shall be solved with symbolic software such as Maple. A Maple worksheet example (Dynamics_2DOF.mw) will be presented in Problem Solving Session 7 and is posted along with this assignment. The worksheet can be edited in order to solve the task, but you may also use MATLAB if you like. Submit your worksheet along with the rest of your work.
   (3 Points)

   (The SpaceLIB-library is used to compute the homogeneous transformations from the DH table. This library might not be installed on the university computers that have Maple, but a link to a zip-file containing the relevant files can be found in the exercise description on It's Learning. SpaceLIB is not needed when the transformations are computed using the basic transformations in the DH convention.)

2. Demonstrate derivation of one of the rows of the equations of motion by hand. Notice that for this planar manipulator one can express kinetic and potential energy in x-y coordinates.
   (2 Points)

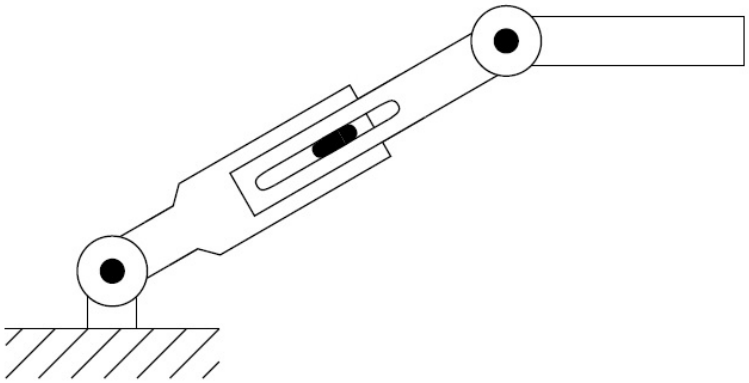

Figure 1: Three-link planar robot with prismatic joint.