ECE 489 Robotic Dynamics and Control

Spring 2007

Lab # 1: Robot Dynamics Using Mathematica

Due Date: Thursday, February 8, 2007

In this lab you will compute the dynamic models of robot arms using *Robotica*. *Robotica* is a Mathematica package for symbolic computation of robot dynamics. A *Robotica* manual can be found in the GE Robotics Laboratory, room 306 TB.

Procedure:

- Consider a uniform rectangular solid of mass m and dimensions $a \times b \times c$ as shown in the figure below.

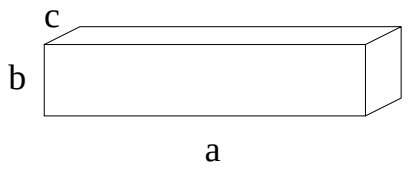

Figure 1: a) A two–link RP manipulator

- Compute the inertia tensor in terms of a,b,c, and m with respect to a coordinate frame located at the geometric center of the solid.

For each of the two–link planar robots shown on the next page, assume that the links are uniform rectangular solids as above. Let $a = 1$, $b = 0.2$, and $m = 2$ in each case. The value of c does not matter since the motion is planar. You may take $c = 0$ for simplicity. Assume that the gravity vector is in the direction of the negative y–axis.

1. Create a *Robotica* input data file containing the kinematic and dynamic parameters of the robot. You will need to compute the inertia tensor and center of mass vector for each link as well as the gravity vector.
2. Compute the Euler–Lagrange dynamic equations using *Robotica*.
3. Output the inertia matrix $D(q)$, the Coriolis/centrifugal matrix $C(q, \dot{q})$, and the gravity vector $g(q)$ for each robot.
4. Compute the expression $\dot{D}(q) - 2C(q, \dot{q})$ for each robot and verify that it is a skew symmetric matrix.

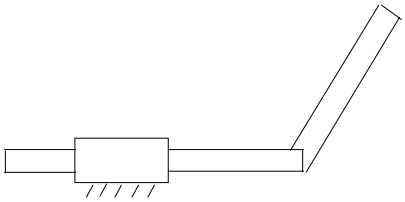

Figure 2: a) A two–link PR manipulator

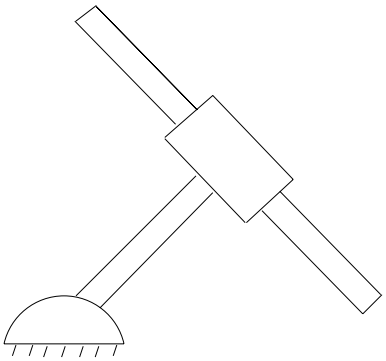

Figure 3: b) A two–link RP manipulator

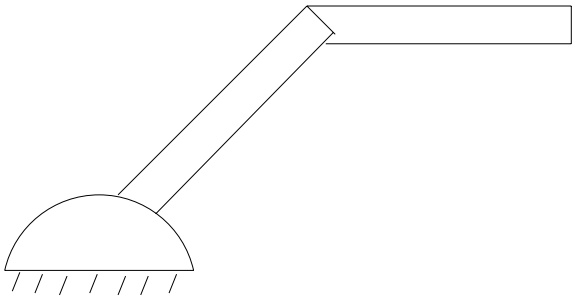

Figure 4: c) A two–link RR manipulator