Assignment 5 – Manipulator Dynamics

Assignment 5 covers manipulator dynamics. The problem in this assignment will help you revisit the steps needed to obtain the equations of motion for more complicated robot mechanisms. It will also expose you to symbolic math programs.

After completing this assignment, you should be able to compute the equations of motion of manipulators.

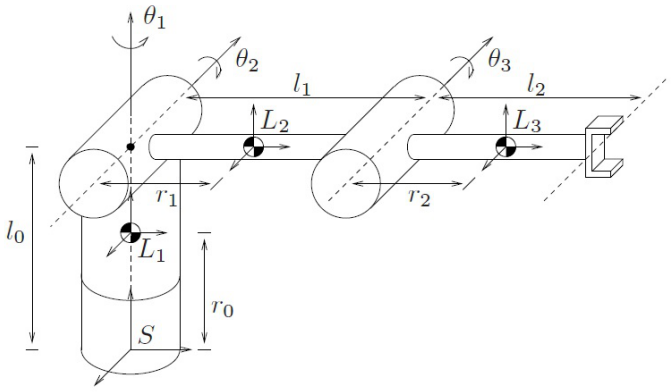

Figure 1: The 3-link elbow manipulator.

1. Computing Manipulator EOMs (6+2pts)

In class, we had outlined the computational procedure of getting the EOMs for the 3-link elbow manipulator shown in Figure 1 (example 4.3 on pages 172-175 in MLS). Use Mathematica or Matlab's Symbolic Toolbox to implement this procedure with the help of screw kinematics and compute the equations of motion for the elbow manipulator.

1. (2pts) What are the components of the resulting manipulator inertia matrix $M(\theta)$ (provide the result for element M_{11})?
2. (2pts) What are the components of the resulting Coriolis matrix $C(\theta, \dot{\theta})$ as defined in the equation (4.23) of the book (provide the result for element C_{21})?
3. (2pts) What are the components of the vector $N(\theta, \dot{\theta})$ (provide the result for element N_3)?
4. (+2pts) Use the EOMs to implement the forward dynamics of the elbow manipulator. Devise and demonstrate a control that drives the end-effector from the position given in Figure 1 into a vertical position with the end-effector pointing skywards.

Please submit a file of source code with your answer. In the file, make sure you comment all the steps of computing these matrices.