HW#3, 11/1/17

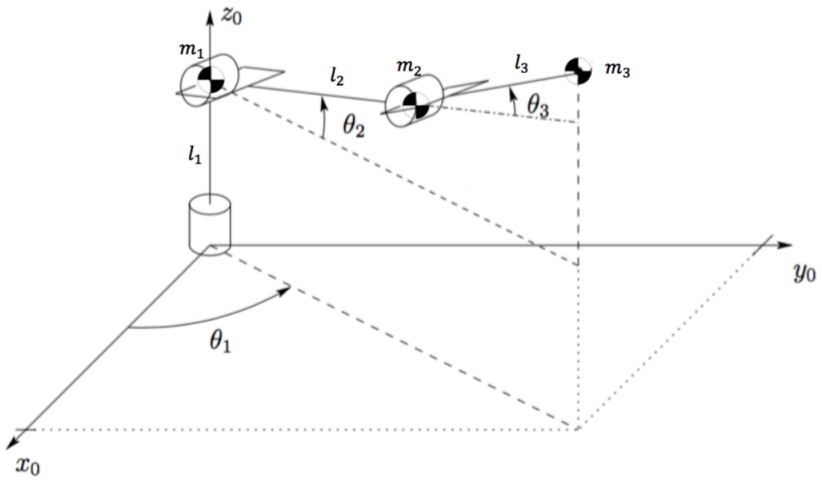
Robot Dynamics

Extended Due Date: Sunday, 11/12/2017 @11:59 PM

Problem#1

Derive the Euler-Lagrange equations of motion i.e. dynamical model for the three-link RRR elbow manipulator shown in the below figure. Consider the links to be massless, that is, consider point masses at the end of each link similar to what we had in the lecture for the two-link arm.

For this problem, you need to explore the use of symbolic software, such as Maple, Mathematica, MATLAB, or any other software that you feel comfortable with.



Problem#2

For the 2-link arm shown below, let l_1, l_2 be the distances of the centers of mass of the two links from the respective joint axes and a_1, a_2 be the length of the two links. Also let m_1 , m_2 be the masses of the two links. Finally, let I_1, I_2 be the moments of inertia relative to the centers of mass of the two links, respectively. Derive the dynamical model of the robot using Lagrange's equation and finally write a MATLAB code that calculates the joint torques for any given configuration/state of the robot. Consider $l_i = \frac{a_i}{2}$ for simplicity. It is very important that you show your work with all details!

Note: In the lecture, we derived the dynamical model of the 2-link arm robot using the Lagrange's equation. However, we considered the links to be massless. Instead, we considered point masses at the end of each link (similar to figure of Problem 1). That is why we did not see the effect of the mass moment of inertia of the links in the equations i.e. the rotational kinetic energy was not taken into consideration.

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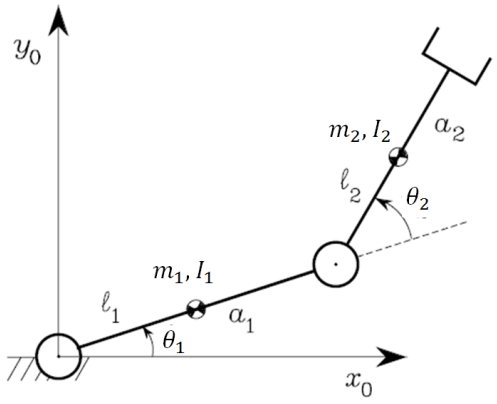
In Problem 2, we do not have point masses but the masses of the links are taken into account with the center of masses shown in the figure below. Therefore, you need to take into consideration both the translational and rotational kinetic energies. The latter includes *the mass moment of inertia of the link around its center of mass* (I_i). Therefore, $K_i = K_{i,trans} + K_{i,rot} = \frac{1}{2} m_i v_i^2 + \frac{1}{2} I_i \dot{q}_i^2$. While this topic is discussed in your reading assignment, Chapter 6, another useful example of a similar robot is also attached as reference.



Good Luck!