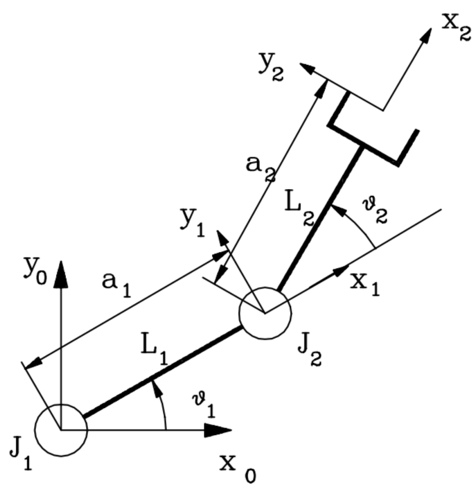
total 50pt + 5pt for extra credit problem.
Review trajectory generation for point-to-point motion.
http://ttuadvancedrobotics.wikidot.com/trajectory-planning-for-point-to-point-motion

Problem 1

Consider the two-link robotic arm (not a planar):



Using the provided matlab code for a two-link arm manipulator.
Let $\mathbf{q} = [q_1, q_2]^\intercal$ where $q_1 = \theta_1$ and $q_2 = \theta_2$. The dynamic model of the system is given by

$$M(\mathbf{q}, \dot{\mathbf{q}})\ddot{\mathbf{q}} + C(\mathbf{q}, \dot{\mathbf{q}})\dot{\mathbf{q}} + N(\mathbf{q}) = \tau$$

Using the provided matlab code, which include the symbolic expressions for matrices $M(\cdot)$, $C(\cdot)$, $N(\cdot)$.

- 10pt. Implement a feedback controller to drive the system from $q(0) = [\pi, \pi/2]^\intercal$ to $q_f = [0, 0]^\intercal$.
- 20pt. Given $q(0) = [0, 0]^\intercal$ and $q(T) = [\pi/3, \pi/4]^\intercal$, for $T = 10$. Generate the desired trajectories of the system. Note that the system (after feedback linearization) is decoupled in the joints. You can plan the trajectories separately as two separate subsystems. Consider quintic or cubic polynomial trajectories.
- 20pt. Implement a controller that allows the system to track the desired trajectory asymptotically. Test the controller performance given initial error, say starting from $\mathbf{q}(0) = [0.11, 1.4]^\intercal \neq \mathbf{q}_0^d$. Please feel free to select different initial state. Plot both state trajectories (actual versus desired) for both joints, as well as the input trajectories.

You are expected to implement: ode functions for simulating the system dynamics under the closed loop control and demonstrate the performance of controllers. NOTE: The following codes in matlab are provided:

- TwoLinkArm.m: main file. Include some instructions.
- ode2linkTracking.m: An example of ode file to simulate the closed loop system (incomplete and need to be modified based on the control design methods.)

Extra credit (5pt): Develop the same controller with integral action, and compare the performance with the one without integral action. What do you observe? conclude your findings.