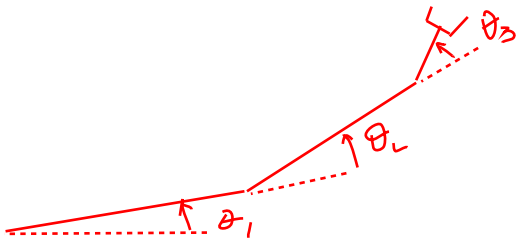
University of British Columbia
Department of Electrical & Computer Engineering
EECE 487 (Winter 2013): Introduction to Robotics
Assignment #1, due Thursday January 22^{nd}

Exercise # 1: Consider the following 3-DOF planar manipulator,



where $l_1 > l_2 > l_3$ and the rotation angles θ_1, θ_2 and θ_3 are unconstrained. Find the reachable and dextrous workspaces.

Exercise # 2: Find on the web videos or images of:

- Baxter from Rethink Robotics
- Cat 215B excavator
- Asimo walking.

Draw a schematic representation one of Baxter's arms, the CAT 215 arm and cab, and Asimo's right leg using our conventions for joints (dimensions not required).

Exercise # 3
Show that for any rotation matrix Q and any $s \in I\!R^3$, $(Qs)\times = Q(s\times)Q^T$ (same as showing that $(Qs) \times (Qt) = Q(s \times t)$, for all $s, t \in I\!R^3$).

Exercise # 4:
Let Q be a 3 by 3 matrix with orthonormal columns, *i.e.*, $Q^TQ = QQ^T = I$ (Q is also called unitary).
(a) Show that the set of eigenvalues of Q is $\{e^{j\theta}, e^{-j\theta}, 1\}$, or $\{e^{j\theta}, e^{-j\theta}, -1\}$, for some real θ.
(b) Show that the eigenvectors of Q that correspond to different eigenvalues are orthogonal.

Exercise # 5:
Find a general procedure to find the axis/angle representation of a rotation matrix Q. Program it in MATLAB or C and verify (by writing a procedure to find the rotation matrix given the axis and angle of rotation) that it works for a few examples. Clearly describe your algorithm and hand in your matlab code as well as the working examples.