Assignment E

due: Tuesday, June 21st, 2011

This is an extra assignment, which is completely **optional**. If you solve an exercise below correctly and *timely* you will get bonus points in the following strong sense: These points will be added to the final grade of the course, computed from all the other grade ingredients. As usual, the maximum final grade is 100.

Exercise E.1 (p2) optional, 8 extra points Solve the inverse kinematics problem for a planar arm with three rotational joints. Assume that each joint can freely rotate regardless of the location of the other joints. Also each joint is free to attain any orientation (2π).

A tool is attached to the last link of the robot. The tool frame F has its origin at the tip of the last link and its orientation is the angle α that the extension of the last link makes with the positive direction of the x-axis. See Figure 1 on the other side of the page for an illustration. A placement F_i of the tool frame is specified by three parameters (x_i, y_i, α_i) where (x_i, y_i) is the desired location of the tool frame's origin and α_i is the desired orientation.

Write a procedure linear_motion that plans a trajectory of the tool along a straight line segment in joint values. The input to the procedure is the links' lengths l_1, l_2, l_3, the start and goal frames F_1 and F_2 and a "resolution parameter" ε. The output of the procedure is a sequence of joint values $J_1, J_2, \ldots, J_n$ (each J_i is a triple of joint values $(\theta_1^i, \theta_2^i, \theta_3^i)$) that will move the robot from F_1 to F_2. (In particular in configuration J_1 the tool frame is at F_1 and in J_n the tool frame is at F_2.) The sequence should be computed such that $|\theta_k^{i+1} - \theta_k^i| < \varepsilon$ for all $1 \leq k \leq 3$, $1 \leq i < n$. All angles will be given in radians.

Devise a GUI where one can draw a query line segment for the tool to follow, and demonstrate the progress of the tool along the segment graphically.

Exercise E.2 (p2) optional, 12 extra points Extend Exercise 3.3 (PRM for a rod) to handle a snake-like robot with k links for small k ($k = 4$ will suffice, although you are encouraged to experiment with larger k values). The snake comprises k equal length line segments, it is free to move in the plane (not anchored), and each of the $k - 1$ rotational joints has full 2π rotation flexibility. However, during the motion links should not collide. (Consecutive links meet at end-points, but no intersection between the links is allowed otherwise.)

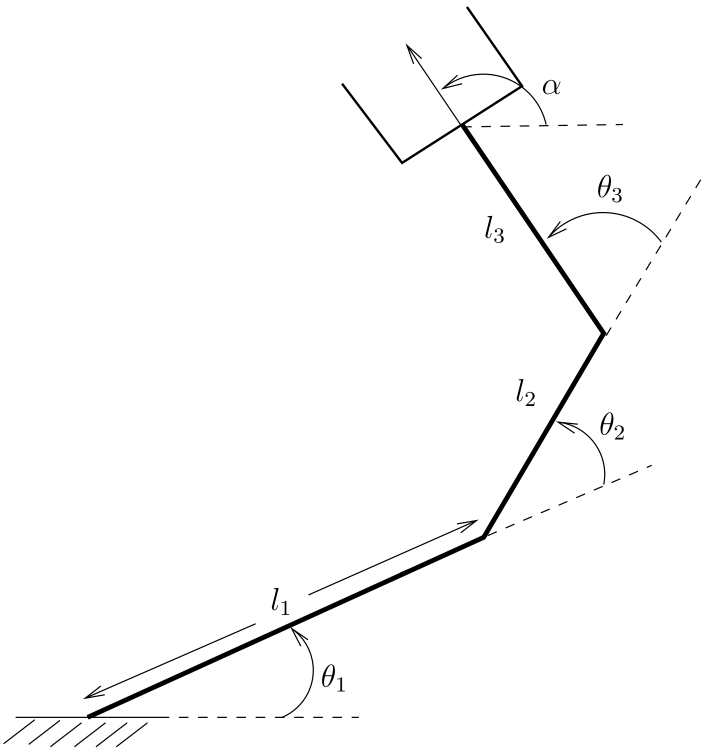

Figure 1: The three-link arm