Applied Geometric Computing — Spring 2000 — Dan Halperin

Assignment no. 3

given: May 1st, 2000
due: May 29th, 2000

The frame program files for Ex. 3.1 will appear in the coming days on the course's web site.

Exercise 3.1 (r) Consider the following motion planing problem. An L-shaped robot L consists of two line segments: vertical and horizontal, whose length are l_v and l_h respectively. It is translating (namely it can only move parallel to itself) in the plane among n point obstacles.

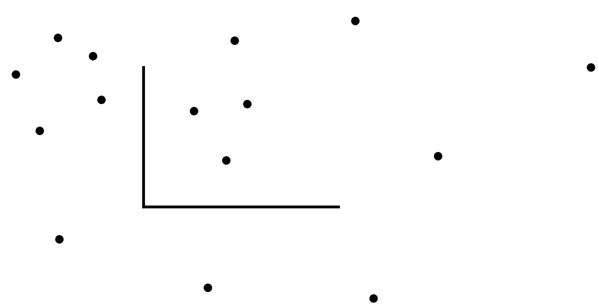
(a) Describe the shape of the C-space obstacles and list all possible degeneracies in the configuration space.

(b) Perturb the input points *slightly* to remove all degeneracies such that for a given $\varepsilon > 0$ the C-space obstacle features are at least ε away from being degenerate.

(c) Construct a representation of the free space.

(d) Use this representation to efficiently answer queries of the form: Given an initial and final placement of the robot determine whether the robot can move freely from one to the other.

(e) If the answer to the query in (d) is positive, plan a collision-free path for the robot between the initial and final positions.



The solutions to (b) through (e) should be implemented, and the solutions to (c) and (e) should be displayed graphically. The input file to the program consists of l_v, l_h, n, followed by n pairs of numbers describing the coordinates of the point obstacles.

Exercise 3.2 We next let the robot L translate *and rotate* in the same setting.

(a) Choose a parameterization of the configurations of the robot in this motion planning problem. Describe the C-space obstacles in this parameterization.

(b) What is the maximum complexity of the free space? Give upper and lower bounds.

(c) Describe an algorithm to solve the motion planning problem for given initial and final robot placements.

Exercise 3.3 (optional) In Exercise 3.1(e), give an optimal solution, namely find the shortest path for the robot from the initial to final placements.

Exercise 3.4 (optional) Implement a solution to Exercise 3.2(c).