

### Assignment no. 3

<http://www.cs.tau.ac.il/~danha/courses/rob02.html>

due: June 11th, 2002

**Exercise 3.1 (a)** Show that the maximum combinatorial complexity of the free configuration space for a line segment translating and rotating in the plane among polygonal obstacles with a total of  $n$  vertices is  $O(n^2)$ . To show this bound you have to bound the number of semi-free triple contacts (namely placements of the segment where it touches the obstacles boundaries in three points without penetrating into the obstacles). *Hint:* Use the result for the second arm in Exercise 2.1.

**(b)** Show that the above bound is tight in the worst case. That is, describe a scene where the complexity of the free space is  $\Omega(n^2)$ .

**Exercise 3.2 (p)** Write an efficient program to compute the free configuration space for the problem of Exercise 2.5: a convex polygon translating inside a convex room. See the TA's site for instructions for submission of the program.

**Exercise 3.3** Consider a ball moving in  $\mathbb{R}^3$  among convex polyhedral obstacles. Give a precise description of the configuration space obstacle induced by one workspace obstacle (convex polyhedron), in a configuration space where each point represents the placement of the ball by the coordinates of its center.

**Exercise 3.4 (bonus)** Give an efficient algorithm to solve the motion planning problem of Exercise 3.1: a segment translating and rotating among polygonal obstacles in the plane.