Assignment no. 4

Exercises 4.1 through 4.3 are due Thursday, January 23rd, 2020
Ex. 4.4 is due Thursday, January 16th, 2020

Exercises 4.1 and 4.2 are concerned with motion planning for two unit squares, a blue one and a red one, whose edges are parallel to the coordinate axes and which are translating in the plane among polygonal obstacles. A configuration of this moving system is a pair of points in the plane $(b_x, b_y), (r_x, r_y)$ describing the position of the center point of the blue square and the red square respectively. We assume that the square robots are open. A configuration is free if (i) the squares are disjoint, and (ii) each square is disjoint from the obstacles. Our goal is to plan a collision-free motion for this system between two free configurations: start and goal.

Exercise 4.1 (25%) Assume further, in this exercise only, that the obstacles are n axis-parallel interior-disjoint rectangles.
(a) Show that the free configuration space for a single square robot can be decomposed into $O(n)$ axis-parallel rectangles, each of which is bounded by at most four distinct expanded obstacles.
(b) What is the complexity of the free space? Consider the case where the two robots are (i) in close-by cells, including the same cell, (ii) in distant cells. (As the C-space is identical for the two robot, we can refer to the closeness of cells in C-space.)
(c) Design an efficient algorithm that computes a representation of the free space, and analyze its running time and storage requirement.

Exercise 4.2 (p2, 75%) In this exercise the obstacles are arbitrary pairwise disjoint simple polygons. Additionally, the workspace where the robots move is itself a simple polygon, which contains all the other obstacles inside it. (See precise details about the input in the "additional information" webpage for this exerice.) Devise and implement a sampling-based algorithm to find coordinated solution paths for the robots.

Exercise 4.3 (optional, bonus, p2) Enhance the solution of Exercise 4.2 such that the sum of the lengths of the paths is small.
Notice that there is no known algorithm to find an optimal solution to this problem. You can opt for any reasonable solution that is valid, namely consists only of free configurations.

Exercise 4.4 Choose a topic for your final personal assignment. It should include an experimental section. Write a short text, roughly 5 to 10 lines, about the problem you plan to address. Send your text by email to `danha@tauex.tau.ac.il` with the subject line "final project in robotics" by Thursday, **January 16th, 2020**.