EN.530.663: Robot Motion Planning
Homework Assignment 10

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Out: 04/12/2024;
Due: 04/19/2024, midnight EST

Problems

1 Write a Matlab function code for the *vertical cell decomposition* for planar rigid-body robot cases (as shown in the handout). Note that you can use vertical cell decomposition or cylindrical vertical cell decomposition. The specification of the code is the following:

- The input includes:
  - q_I and q_G: initial and goal position of the robot.
  - CB: C-obstacles (as a cell array; this includes the orientation of the robot already)
  - *bounds*: coordinates of the vertices of the rectangular box (environment or the world).
  - other inputs as necessary
- The output includes:
  - the set of vertices of the graph
  - the weighted adjacency matrix for the graph
  - n_{init}, n_{goal}: the node numbers for q_I and q_G in the graph.
  - other outputs as necessary

Specifically, implement:

- **function** [V, G, n_init, n_goal] = vertical_cell_decomposition(qI, qG, CB, bounds)
  - qI, qG: 2×1 array
  - CB: a cell array. Each element is a 2×1 array representing one C_obs.
  - bounds: 2×4 array. Start from the bottom left corner and in CCW order.
  - V: $2 \times n$ array of vertices
  - G: $n \times n$ array of the weighted adjacency matrix for the graph
  - n_init, n_goal: node numbers for qI and qG
  - You can have additional inputs and outputs if necessary.

- A MATLAB script *"RMP_HW10_VCD_test.m"* is provided for you to test your code. The script contains two test examples. The second test case is made a bit tricky and could be challenging. In this test case, the C-obstacles of two objects overlap.

2 Write a *Matlab script* file for the *potential field method* for planar point robot cases (as shown in the handout). In this problem, you are asked to consider the exact same situation as in the handout. Of course, you will need to write a Matlab function for computing the gradient of potential functions, which in turn should be used in your main script file. The specifications are as follows:

- Obstacles:
$$CB_1 = \begin{bmatrix} 0 & 50 & 50 & 0 \\ 25 & 25 & 50 & 50 \end{bmatrix};\ CB_2 = \begin{bmatrix} 80 & 80 & 70 & 70 \\ 50 & 100 & 100 & 50 \end{bmatrix}.$$
- initial and goal points: $q_I = \begin{pmatrix} 0.5 \\ 0.5 \end{pmatrix};\ q_G = \begin{pmatrix} 95 \\ 95 \end{pmatrix}.$

Submission Guideline

- Submit all your Matlab codes in a single .zip file. Name your single zip file submission as "YourName_HW10.zip". For example, "JinSeobKim_HW10.zip" for a single zip file. Submission will be done through the Gradescope.
- Please make sure to include *all the necessary files*, even files that were submitted in the previous homework assignments (of course the codes must be updated if necessary so as to be error-free). If TAs try to run your function and it does not run, then your submission will have a significant points deduction.
- Make as much comments as possible so that the TAs can easily read your codes.