CENG 460 - Introduction to Robotics
Spring 2017

Middle East Technical University
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Homework 4 - Probabilistic Roadmaps

Assigned - Jan 09, 2018, **Due - Dec 24, 2018**

1. Implement a Matlab script to determine if a line segment between two points $\mathbf{p}_1$ and $\mathbf{p}_2$ intersects a circle centered at $\mathbf{p}_c$ with radius r_c on the 2D plane. Your function should take these as arguments and return 1 if the objects intersect, 0 otherwise. Your report should briefly describe your method for computing this "intersection" function.

2. Implement a Matlab script to determine if two circles centered at $\mathbf{p}_1$ and $\mathbf{p}_2$, with radiuses r_1 and r_2 intersect on the 2D plane. Your function should take these as arguments and return 1 if the objects intersect, 0 otherwise. Your report should briefly describe your method for computing this "intersection" function.

3. Consider the simple mobile robot shown in Figure 1, consisting of a circular body on which a two-DOF robot arm is attached. The links for the arm consist of simple lines between joints and the end effector. The robot body has radius r_b and is located at $p_b = [x, y]$. The configuration of the entire robot is hence given by the vector $q := [x, y, \theta_1, \theta_2]$.

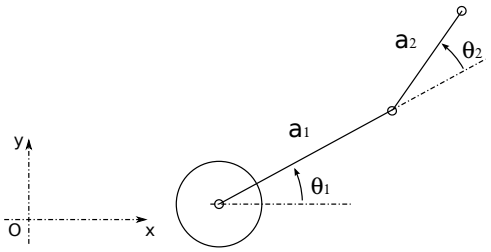

Figure 1: Circular robot wth a two-DOF robot arm.

Write a Matlab script that takes a particular configuration q, as well as the robot parameters r_b, a_1 and a_2 together with a circular obstacle located at p_o with radius r_o and determines whether any part of the robot is in collision with the obstacle or not. Your function should take these as arguments and return 1 if the objects intersect, 0 otherwise.

4. Consider a robot with the structure described above, with $r_b = 0.2m$, $a_1 = a_2 = 1m$ operating on the 2D plane. The environment has n obstacles, centered at p_i with radius r_i with $i = 1, ..., n$. Write a Matlab script that computes a collision-free path for this robot **in its four dimensional configuration space**, taking the robot from a given initial configuration q_0 to a given final configuration q_f. The "path" should be a sequence of intermediate configurations q_k which are sufficiently closely spaced so that a linear path from q_k to q_{k+1} is also collision free.

5. Using the script you have constructed above, generate a number of illustrative path planning examples for this robot. Include in your report detailed descriptions, discussions and figures related to these examples. Try to identify situations where PRM implementations will have trouble finding paths such as in the presence of narrow passages. Investigate the effect of increasing the total number of samples in the PRM on your overall solution. Please use good report writing principles, including captions for all of your figures (which should not be overly large/small/redundant/unnecesary). Please use the homework LaTeX examples as a starting point.

Submission

Submitted solutions must be typeset in a word processing environment such as LaTeX. Submissions are expected to be in the form of a ZIP file named `460_name_surname_hw#.zip`, including a PDF report with answers to theoretical questions with your name and student ID indicated clearly, as well as Matlab or other source files that are requested in the homework text. Late submissions will be penalized with a deduction of $8n^2$ points where n is the number of late days.

Note: You can discuss your discoveries and knowledge with your classmates but you must write your own answers and code for all questions above. If any significant similarities are found between your answers and other homeworks, you will be audited on your understanding of your own solutions.