ASEN 5519 - Algorithmic Motion Planning
Fall 2020

Homework 3

Assigned October 10; Due October 23

Exercise 1. (a) Give a definition for a *complete* planning algorithm. (b) Give a definition for an *optimal* planning algorithm. (c) Recall the wave-front planner from Lecture 8. Is it a complete planner? Is it an optimal planner? Justify your answers in part (c).

Exercise 2. Implement a gradient descent planning algorithm with a potential function of the form $U = U_{att} + U_{rep}$.

(a) Demonstrate the performance of your planner on a simple example in a 2D C-space ($C = \mathbb{R}^2$) with $q_{\text{start}} = (0, 0)$, $q_{\text{goal}} = (10, 0)$ and two square obstacles with side length of 1 centered at $(4, 1)$ and $(7, -1)$. Choose a radius of $\epsilon = 0.25$ centered at q_{goal} for the termination condition at goal.

i. Plot the vector field.

ii. How did you choose the values for d^*_{goal} and Q^*_i for $i \in \{1, 2\}$?

iii. Plot the path generated by the planner.

iv. What is the length of the path?

v. Would you expect the same path length for different values of d^*_{goal} and Q^*_i?

(b) Solve the planning problems in **Exercise 7** of **Homework 1** using your gradient descent planner. Unlike the Bug algorithms, assume the obstacles are known. Choose a radius of $\epsilon = 0.25$ centered at q_{goal} for the termination condition at goal.

i. How did you choose the values for d^*_{goal} and Q^*_i?

ii. Plot the paths generated by the planner.

iii. What are the lengths of the paths?

iv. Would you expect the same path lengths for different values of d^*_{goal} and Q^*_i?

Exercise 3. Implement the wave-front algorithm and solve the planning problems in **Exercise 7** of **Homework 1** with a grid of size 0.25 (i.e., square cells with length of 0.25 for each side). Define neighbors as the cells that share a facet.

(a) Plot the paths generated by the planner. (Assume the robot transverses the adjacent cells using a line that connects their centers.)

(b) What are the lengths of the paths?

(d) Would you expect the path lengths to get smaller as the grid size gets smaller?

(e) How does this wave-front planner perform in comparison to the gradient descent planner in **Exercise 2** part (b)?

Exercise 4. Use your front-wave planner from **Exercise 3** to plan a motion for the robotic manipulator in **Exercise 8** part (c) of **Homework 2** to move the end-effector from location $x_{\text{start}} = (2, 0)$ to $x_{\text{goal}} = (-2, 0)$ in the workspace. Plot the computed motion plan in the robot's C-space. Also, show the computed motion of the robot in the workspace in a series of snapshots in one plot.