CMPE-633 : Topics in Robotics and Control
Problem Set # 1

Fall 2010

Due Date : Sept 20, 2010.
Total Points : 100.

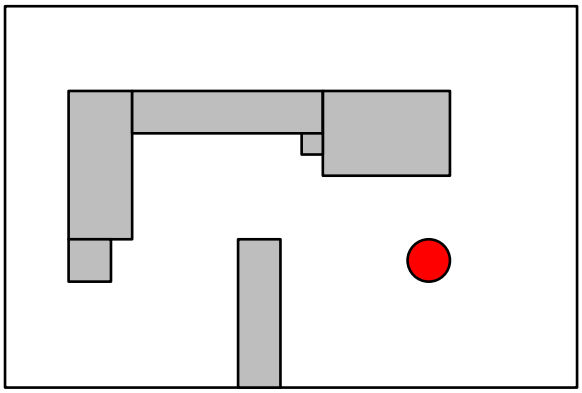
Problem 1 (10 Points)

Give examples (different from those given in the textbook) for each of the following situation.

1. Bug0 fails.
2. Bug1 beats Bug2.
3. Bug2 beats Bug1.

Problem 2 (10 Points)

Consider a disc-shaped robot in a 2D workspace, as shown in Figure. Assume that the robot does not have an orientation. Sketch the configuration space of this robot. (**Hint.** See Section 3.2.1 of Choset.)



Problem 3 (10 Points)

Look up Jordan's curve theorem. Use this theorem to prove that the Bug1 algorithm is complete. (**Hint.** See book slides for a sketch of the proof.)

Problem 4 (15 Points)

Write small computer programs (e.g. MATLAB scripts or C functions) to determine whether or not a point robot in a 2D workspace, located at position (x, y), collides with an obstacle of the following form.

1. A circular obstacle, parameterized by a center (x_1, y_1) and radius R.
2. A rectangular obstacle described by coordinates of the four corners $(x_1, y_1), (x_2, y_1), (x_1, y_2), (x_2, y_2)$.
3. A triangular obstacle described by the three corners $(x_1, y_1), (x_2, y_2), (x_3, y_3)$.

Hint. What is the set of points in the plane that satisfy $ax + by + c \leq 0$?

Problem 5 (20 Points)

Write a procedure (e.g. a MATLAB or C function) to predict the output of an ultrasonic array mounted on a point robot situated at $(0, 0)$. The various obstacles are given by

1. A circle of radius 5 centered at $(10, 10)$.
2. A rectangle given by $(-10, -5), (-10, 5), (-5, 5), (-5, -5)$
3. A circle of radius 6 centered at $(0, -8)$.

Plot the outputs when

1. Range is 3 units, range resolution is 0.25 and angular resolution is 5 degrees.
2. Range is 10 units, range resolution is 0.25 and angular resolution is 2.5 degrees.
3. Range is infinite, range resolution is 0.5 and angular resolution is 10 degrees.

Hint. Use the saturated raw distance function. Do not assume pre-knowledge of obstacles by the robot.

Problem 6 (35 Points)

Implement the Tangent Bug algorithm for a 2D point robot in a computer program. Produce robot trajectories in different scenarios for obstacles and goal. Demonstrate completeness in the presence of obstacles.

Hint. Reuse code from previous examples. Use rectangular and circular obstacles as primitives to build more complex scenarios.