

# CSCE 496/896: Robotics Homework 1

**Instructor: Carrick Detweiler**  
carrick\_at\_cse.unl.edu  
University of Nebraska-Lincoln  
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Started: Wednesday, October 26, 2011  
Due: Monday, November 14th, 2011

**Instructions:** This homework is an individual assignment, collaboration is not allowed. If you discuss any problems with others, please note this on the assignment as described in the syllabus. Also note any materials outside of lecture notes, course textbooks, and datasheets that you used. Answer all questions with **complete sentences** and describe your reasoning where appropriate for full credit. This homework is due on the date listed above before the start of class. Email submissions are preferred, however, paper copies in class will be accepted.

**Name:**

**Problem 1.** *Hovercraft*

a) (5pts). *What are the requirements for a robot to be omnidirectional?*

b) (5pts). *With uni-directional thrusters (as ours are) what is the minimum number of thrusters needed to create an omni-directional hovercraft? What if the thrusters are bi-directional? Explain.*

c) (5pts). *What are two problems that may occur if the center of mass of your hovercraft is not centered on the vehicle?*

**d)** (5pts). *How much current do the processors on the hoverboard use when the thrusters are not running (Hint: there is a ROS topic that gives information on this)?*

**Problem 2.** *ROS: In this problem, you will create a ROS node that will compute statistics for the Huskers' Football team. You don't need to actually create the node, but you should write the relevant code in response to the questions. For these questions, assume that there is a node called `rawStats` that defines and publishes a message of type `offensivePlay` on the topic `/plays/huskerOffensivePlay`, where `offensivePlay` is defined as:*

```
Header header
# true if the play was a pass, else it was a run
bool pass
# if this was a pass, true if it was completed
bool passCompleted
# number of yards gained/lost from the play
int32 yards
# true if this play resulted in a touchdown
bool touchdown
```

**a)** (5pts). *What ROS command-line command would you use to create a new node, called `offensiveStats` that is written in C++ and is able to subscribe to messages of type `play`?*

**b)** (5pts). *Write the code to compute the pass completion percentage (number completed passes divided by total number of passes attempted). Note this requires subscribing to the above message topic.*

**c)** (5pts). *Create a new message type that contains the pass completion percentage as well as the total passing and rushing (non-passing yards gained) yards for this game. How do you ensure that this message is compiled when you run `rosmake`?*

**d)** (5pts). *Write the code to create a publisher, populate, and send the above message. Make sure to comment your code.*

**e)** (5pts). *What command would you use to plot the total yards completed? Give the command and the proper arguments.*

**Problem 3.** *Sensing*

**a)** (5pts). *What is the difference between precision and accuracy? Which is more important for the gyroscope on the hovercraft? Why?*

**b)** (5pts). *How do you get position information from an accelerometer? What would the position error be if the accelerometer has a 1% error after moving 100 meters?*

**c)** (5pts). *(This question is optional for students in 496) The gyro on the hovercraft tends to drift. What additional sensor(s) could you add to the hovercraft to correct for this drift. How would this work?*

**Problem 4. Path Planning**

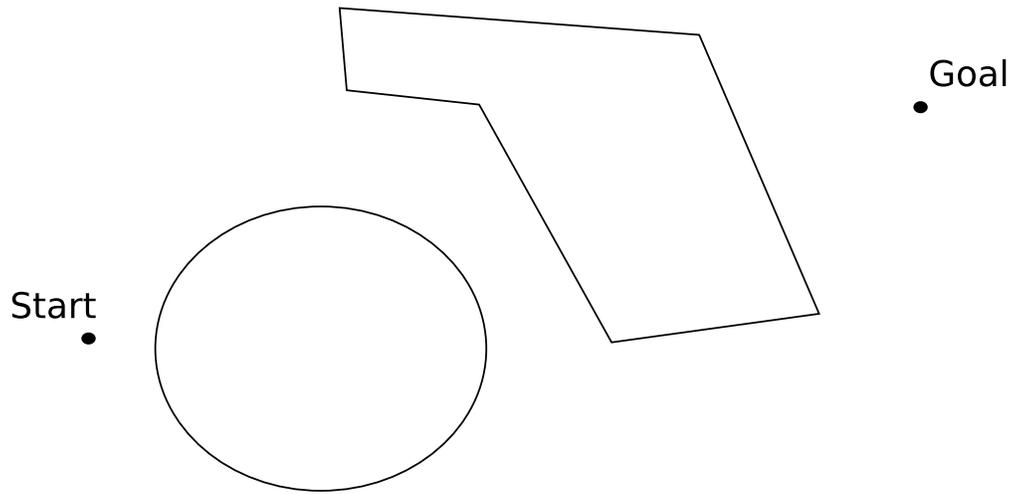


Figure 1: Bug algorithms

a) (5pts). *In Figure 1, draw the path the Bug1 algorithm would take. Explain the algorithm.*

b) (5pts). *In Figure 1, draw the path Tangent Bug would take (in a different color/style line). Explain the algorithm.*

c) (5pts). *(This question is optional for students in 496) In Figure 1, one of the Bug algorithms outperformed the other. Draw a different figure where the performance is reversed. Explain what happens.*

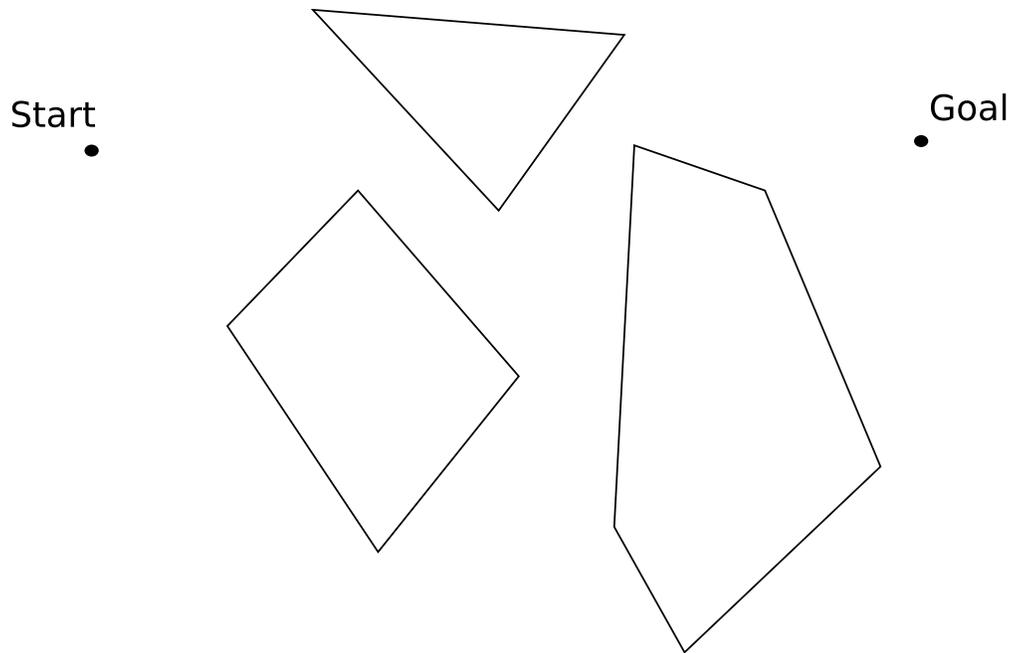


Figure 2: Visibility Graph

**d)** (5pts). Draw the visibility graph for Figure 2 and indicate the path that the robot follow from the start to the goal. Explain.

**Problem 5. PID**

**a)** (5pts). Write the equations for a PID controller and explain the impact of each of the P, I, and D terms.

**b)** (5pts). In a controller running at 10Hz with  $P=10$ ,  $I=0.1$ , and  $D=4$  (without any loop time compensation), what would you set the parameters to if the loop rate was increased to 20Hz? Why?

**c)** (5pts). *(This question is optional for students in 496) List and explain 2 different problems that can occur with PID controllers and how you can mitigate these problems in a PID controller.*

**Problem 6** (5pts). *Which question took the most time on this assignment?*

**Problem 7** (5pts). *Approximately how much time did the total assignment take?*