CptS 483 Fall 2017, Homework 1

Note, for all these questions, but especially for questions 2–5, it is important for you to explain *how* you got your answer, which will typically mean showing the math you needed to do to get the answer.

Note also that partial credit will be given, so if you have the math mainly correct, but don't get the right answer, you will still get most of the credit for the question.

You are welcome to work in groups. However, everyone should: 1) Submit their own copy of the work (I believe making you write it out will help ensure you ask questions of your teammates if something is unclear), and 2) Write the names of all collaborators on the submitted homework.

You are also welcome to submit conceptual questions to Piazza (i.e., not "what's the answer to #2" or "is the answer 3m/s", but "how do you go from how θ changes in the robot's frame to how θ changes in the initial frame" or "on what day and slide number did matt explain X" would both be totally fine). If you submit questions/answers via Piazza, these do not need to be noted on the homework since I can see the interactions.

1. You are the chief robot designer for U.S. Robots and Mechanical Men, Inc. You have to design robots that will operate in the following environments:

   (a) A delivery robot that will carrying supplies to different departments in a hospital.

   (b) A supply robot that will carry heavy loads across loose soil and sand.

   (c) A security robot that has to secure a wooded, hilly, area.

   (d) A butler robot that will greet guests in a home and bring them drinks.

   For each environment, write down the kind of locomotion that you think will work best for the robot and say why you think that this is the case.

   (20 points)

2. A Create robot has wheels with a 5cm radius and which are 30cm apart. A Segway robot has wheels with a 30 cm radius and which are 60cm apart. Both robots have a differential drive.

   For both robots, compute the velocity of the robot, measured in terms of $\dot{x}_R$, $\dot{y}_R$, and $\dot{\theta}_R$, when the robot's wheels are rotating as follows:

   (a) Both wheels are rotating clockwise (when viewed from position A in Figure 1, on the next page) at a speed of 1 radian per second.

   (b) The right wheel is rotating clockwise (when viewed from position A in the figure) at a speed of 1 radian per second, and the left wheel is rotating in the opposite direction at the same speed.

   (c) The right wheel is rotating clockwise (when viewed from position A in the figure) at a speed of 1 radian per second, and the left wheel is rotating in the opposite direction at a speed of 0.5 radians per second.

   Your answer should give $\dot{x}_R$ and $\dot{y}_R$ in meters per second, and $\dot{\theta}_R$ in radians per second.

   (20 points)

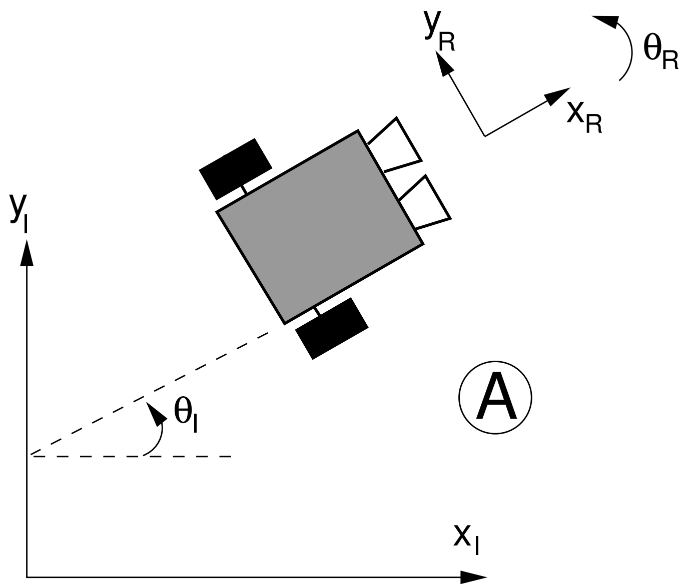

Figure 1: The setup for the robots in Questions 2–5.

3. Consider the Create, as described in the previous question. If both its wheels are rotating clockwise (when viewed from position A in Figure 1, on the next page) at a speed of 1 radian per second (as in part (a) of the previous question), and θ_I is 35 degrees, what is the velocity of the robot in terms of $\dot{x}_I$, $\dot{y}_I$, and $\dot{\theta}_I$?

   (20 points)

4. If the robot from the previous question starts at a location of $x_I = 2$ and $y_I = 1$ (both coordinates in meters), and drives for 10 seconds with both wheels rotating at 1 radian per second, what will its final location be?

   (20 points)

5. If the robot from the previous question finishes its 10 seconds with its wheels rotating at 1 radian per second, and then drives another 10 seconds with its wheels now rotating at 2 radians per second, what will its final location be after the combined motion described in Questions 4 and 5?

   (20 points)