ELEE 4200/5200: Autonomous Mobility Robotics
Term I, 2019
Homework 1: MATLAB-ROS Connectivity (OR Let's Jump into the Water!)

Note:

- The broad goals of this assignment are:
  - To understand the various software components necessary for this course, as installed in the laboratory computers.
  - To develop a fundamental ability to exploit the MATLAB-ROS connectivity to operate a simulated robot in Gazebo from within the MATLAB environment.
- Guidelines:
  - Due date: Thursday, September 19, 2019 by 12 Noon.
  - You are permitted to work in groups of no more than two students. State the full names and T# of the students in the group on the cover page of every document that you submit.
  - Submit the report by responding to this assignment posting in Blackboard.
  - The submission should at least include the following documents, bundled together into a single zip file with the name *YourNameHW1* (use one of the group member's names).
    - The main report in 'pdf' form (using the LaTeX template provided).
    - The MATLAB program code (as an m-file, so that it can be executed!).
  - A hard copy (printout) of the 'pdf' report with MATLAB code; staple all pages together and follow the TA's instructions on how to submit the hardcopy.
  - Each group must work on its own in completing this assignment! Feel free to consult with others in developing solution ideas, but the final code implemented must be your work product alone. Refer to the Syllabus, where the policy on academic integrity is clearly outlined, our classroom discussions on this topic, and consult with me and/or the TAs if you have any questions!

Other Instructions:

- In any assignment there are always parts whose details are not exactly specified and I am not referring here to missing information that should have been provided. In such situations you can ask the TAs or Instructor for hints, but you are generally expected to use your creative abilities to complete what is necessary. This is how one develops one's abilities!
- The following should help you complete this assignment:
  - Basic interaction with RViz so that you can see how the robot is moving.
  - Subscribing to robot odometry from within MATLAB.
  - This basic equation of motion: $\Delta s = v * \Delta t$
  - How to do video capture.

Part A

a) Construct a program in MATLAB that continuously drives a simulated Turtlebot (in Gazebo) at the following forward velocity and turn rate:

$$v = 0.5\frac{m}{s} \& \ \omega = 0.5\frac{rad}{s}$$

Estimate the radius of curvature of the path followed by the robot.

b) Change the velocities of the robot to the new set of values below and drive the robot again:

$$v = 0.25\frac{m}{s} \& \ \omega = 0.125\frac{rad}{s}$$

Re-estimate the radius of the robot path.

c) Change the velocities of the robot to the third set of values below and once again drive the robot:

$$v = 1.0\frac{m}{s} \& \ \omega = 1.0\frac{rad}{s}$$

Comment on the behavior of the simulated robot for this last experiment.

Part B

d) Drive the Turtlebot in Gazebo appropriately so that the path generated produces an approximate reproduction of the letter 'L' as shown below. Line thickness is not important! It is important that you develop a strategy to address this task and explain it in your report! Capture a video of the robot motion in a video and include this in your report as proof of having achieved the desired result. It is good policy to restrict the size of the video file as much as possible; otherwise it might be diffifult to upload it!

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References:

1. Use the classroom discussion entitled “Introduction to ROS” and the demonstrations as a starter.
2. Then, go to the following site which pertains to MATLAB R2019a:
   https://www.mathworks.com/products/robotics/code-examples.html
   Look at the following link within this page:
   - Get Started with ROS
   - Connect to a ROS Network
   - Exchange Data with ROS Publishers and Subscribers
   - Work with Basic ROS Messages
   - Get Started with Gazebo and a Simulated TurtleBot
   - Get Started with a Real Turtlebot” (for those who are curious about how an algorithm tested in a simulator can be implemented on corresponding hardware; the Turtlebot is a real robot that can be purchased!)

   Note: Not all of the information contained in the above documents is needed for you to finish Homework 1. However, to improve overall knowledge and understanding, I strongly recommend that you go through them all!