Project 1

Learning Robot Operating System (ROS)

Assigned: January 29, 2019

Deliverable 1 (Task 1) Due Date: February 5, 23:59:59

~~**Deliverable 2 (Tasks 2 & 3) Due Date: February 17, 23:59:59**~~

Deliverable 2 (Tasks 2 & 3) Due Date: February 19, 23:59:59

Note: Project 1 has a four-day late submission period for each deliverable.
Late submissions will lose 25% points per day of that specific deliverable.

Introduction

In this project, the objective is to setup the ROS development environment, write a "Hello World" program using ROS, get a robot simulation working, and test the mapping capability provided by ROS. This project provides an opportunity for you to understand open-source software for robotics applications and become ready for future course projects.

Project 1 must be done **individually**, although group discussion is encouraged.

Task 1: Setup Development Environment

You are required to finish the following steps:
1. Install **Ubuntu 18.04 LTS**:
https://ubuntu.com/download/desktop/thank-you?country=US&version=18.04.3&architecture=amd64
Download the ISO file named: ubuntu-18.04.3-desktop-amd64.iso
IMPORTANT NOTE: Please install the 18.04 version, you may have issues if other versions of Ubuntu are installed.

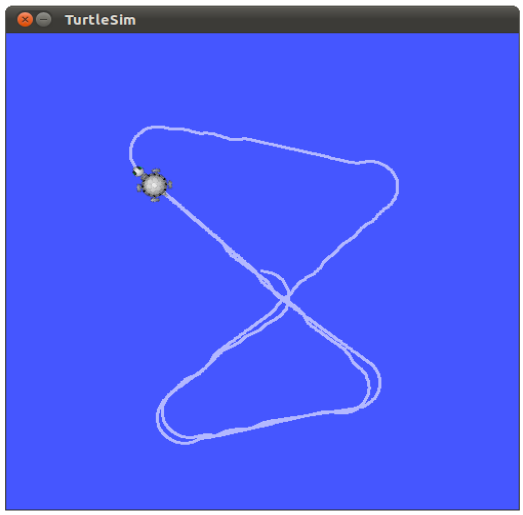


Figure 1. Snapshot of a working turtlesim in ROS.

Note: A physical installation is preferred, either Ubuntu only or a dual boot system. If you don't want a physical installation, you can use Amazon Web Services (AWS) to launch a virtual machine. The connection with AWS can be slow depending on your Internet speed. Instructions of using AWS are also provided on the course website: http://inside.mines.edu/~hzhang/Courses/CSCI473-573/assignment.html

2. Install **ROS Melodic**, and Make sure to perform "**Desktop-Full Install**":
http://wiki.ros.org/melodic/Installation/Ubuntu

IMPORTANT NOTE: Please install the exact ROS version and follow the exact steps!

3. Go through ROS tutorial 1.1.1-1.1.9, i.e., "Beginner Level" from the beginning (1.1.1) to "Using rosed to edit files in ROS" (1.1.9). The tutorial is available at: http://wiki.ros.org/ROS/Tutorials. Follow the tutorial: http://wiki.ros.org/turtlesim to play with the Turtlesim tool and understand how ROS works (to some extent). For Turtlesim, make sure you follow the tutorial under ROS Melodic.

What to submit:

You are required to submit a screenshot of a working turtlesim window for grading, similar to Figure 1. Name the figure T1_*firstname_lastname*.png (or jpg) and submit to the Canvas portal named P1-T1.

Task 2: Understand the Gazebo Simulator

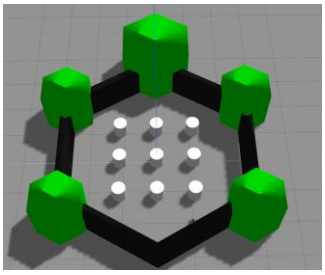
Install ROS packages for simulating Turtlebot3 in Gazebo, mapping, and planner:
sudo apt-get install ros-melodic-turtlebot3*
sudo apt-get install ros-melodic-slam-gmapping
sudo apt-get install ros-melodic-dwa-local-planner

Go through Gazebo beginner tutorial 1-3:
http://gazebosim.org/tutorials?cat=guided_b&tut=guided_b2

Go through TurtleBot3 Simulation tutorial from 11.2.1.1 "Simulate in Various World" to 11.2.1.5 "Virtual Navigation with TurtleBot3":
http://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/#simulation

Note: Choose waffle_pi as your TURTLEBOT3_MODEL since it is equipped with a camera.

You will need to (1) load a pre-defined simulated world and customize it, (2) execute RViz to visualize the robot sensing, and (3) build a map of your simulated world, as shown in Figure 2-4 respectively.



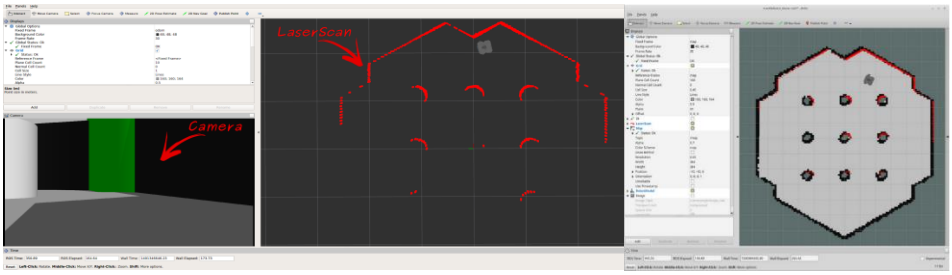


Figure 2. Simulation world *Figure 3. Simulated 3D scene* *Figure 4. Mapping simulation*

What to submit:

You are required to submit snapshots of (1) your customized simulation world, (2) visualization of the simulated robot sensing, and (3) simulated mapping result, as shown in Figures 2-4, respectively. Include all files in a tar or zip file named T2_*firstname_lastname*.tar (or zip) and submit to the Canvas portal named P1-T2.

Task 3: Write a ROS "Hello World"

You need to go through ROS Tutorial 1.1.11 (if you use C++) or 1.1.12 (if you use Python), as well as complete 1.1.13.

Write a ROS node that uses the turtlesim simulator to draw the **inner-boundary of the Mines' logo** shown by the **RED CURVE** in Figure 5:

- Create a new package called mines_lastname_firstname (e.g., mines_zhang_hao). Your package should contain an executable with the same name as the package.
- Your program should assume that roscore and turtlesim_node have been started independently.
- The drawing should not take longer than two minutes to complete.
- You should NOT use the teleport services offered by turtlesim.

For CSCI 473:

- An open-loop control can be implemented (i.e., only tell the turtle driving directions without pose feedback).

For CSCI 573:

- A close-loop control is required (i.e., designing a subscriber to receive turtle's pose data and use it to improve navigation accuracy).

Figure 5. Logo of Mines. The red curve is the trajectory the turtle needs to draw.

What to submit

You are required to submit (1) your code, (2) a README to detail how to compile and run your code (and other information), and (3) a snapshot of the result. Include all files in a tar or zip file named T3_*firstname_lastname*.tar (or zip) and submit to the Canvas portal named P1-T3.

Submission and Grading

Project 1 has two due dates, with a four-day late submission period for each of the two deadlines. The project deliverables must be submitted to the **Canvas**, but you are encouraged to use version control systems (GitHub or GitLab) to manage your code.

Grading: Your report will be graded as follows.

- 2/10: Task 1.
- 3/10: Task 2.
- 5/10: Task 3.