EE346 - Mobile Robot Navigation and Control

Fall 2023
Laboratory #3 (4%)
Date: October 25, 2023
Running TurtleBot3 and LDS Operation

Objectives

- Learn how to use the real robot called TurtleBot3
- Learn the ROS visualizer (RVis)
- Understand and evaluate the operation of a laser range finder (LDS)

Procedure

In this lab, you will begin to use the real robot called TurtleBot3 and learn how to operate the laser distance sensor (LDS) that comes with TurtleBot3. Before the start of the lab, each group should obtain a TurtleBot3 package from your TA that includes (a) the robot with a rechargeable battery (b) a laser range finder (HLS-LFCD2) (c) a charger and (d) RC-100 remote control. You will set up a ROS environment that allows you to tele-operate your TurtleBot3 from a keyboard and possibly from RC-100.

Part I: Setting up TurtleBot 3

In this part, you will set up your laptop PC to work with the Raspberry Pi on TurtleBot3 as one ROS environment so that the robot can be controlled from your laptop via tele-operation. Visit https://emanual.robotis.com/docs/en/platform/turtlebot3/overview/ and read Sections 1-3: Overview, Features and Quick Start Guide. Note that Sections 3.1.1 – 3.1.4 have been completed for you on TurttleBot3. What you need to do is to complete Sections 3.1.5 and 3.1.6, and Sections 3.2, 3.3. 3.5, and 3.6. Please note that when completing 3.5, you need to modify the file `/etc/hosts on both` the remote PC and the Raspberry Pi with the following two lines:

```
10.42.0.1 <PC's hostname>
10.42.0.2 <Raspberry Pi's hostname>
```

You can find the `<hostname>` of the PC and Raspberry Pi by running the command "hostname" on either machine.

In addition, you need to modify your `.bashrc` file on the PC by adding the following line:

```
export ROS_HOSTNAME=<PC's hostname>
```

Finally, on Raspberry Pi, you need to modify your `.bashrc` file by adding the following two lines:

```
export ROS_HOSTNAME=<Raspberry Pi's hostname>
export ROS_MASTER_URI=http://<PC's hostname>:11311
```

Once you can control TurtleBot3 from the keyboard of your laptop PC, demonstrate this to your TA, and show the ROS graph of the system that you produce with the rqt_graph. Optionally, read and complete 3.6.1.2 to tele-operate TurtleBot3 from RC-100.

Part II: **HLS-LFCD2**

In this part of the lab, you will work with the LiDAR sensor (HLS-LFCD2) on TurtleBot3. The sensor (shown on the right) is a laser distance sensor (LDS) with 360 points per scan or at a resolution of one degree per point on a single horizontal plane. For its detailed specifications, please refer to https://emanual.robotis.com/docs/en/platform/turtlebot3/appendix_lds_01/. Also a PDF version of the specifications is available at https://emanual.robotis.com/assets/docs/LDS_Basic_Specification.pdf. Read Section 8.5 of the textbook *ROS Robot Programming* to become familiar with LDS sensors. To make sure that you are able to operate HLS-LFCD2 correctly, follow the instructions in Sections 8.5.2 and 8.5.3 of the textbook until you are able to (a) echo the /scan topic and (b) duplicate the results in Figure 8-17, which displays the observe LiDAR scan or point cloud on RViz. Note that you need to read 6.1.3 of the textbook to become familiar with the ROS Visualizer RViz.

Then create ROS package called Lab3 so that you can print LiDAR readings at any desirable orientation from a ROS node. Please refer to the example on this page to learn how to LiDAR subscriber. Modify it so that the code works with HLS-LFCD2 on TurtleBot3.

Once you can operate HLS-LFCD2, design an experiment that uses your LiDAR subscriber to verify the following performance specifications of HLS-LFCD2.

1. Minimum and maximum ranges
2. Distance accuracy
3. Distance precision

Prepare a report that describes the design of your experiment and includes the data that are used to verify the distance accuracy and precision. Compare the performance of the LDS from your experiments with that described in the HLS-LFCD2 manual and explain any discrepancies between them.

Submit the Lab3 ROS package and report via either an online GitHub or as a PDF file through the class blackboard. Inform a TA of how you have submitted your report.

If you complete the lab before the end of the second week, you can begin to work on the next lab on robot SLAM, which will be based on the descriptions at https://emanual.robotis.com/docs/en/platform/turtlebot3/slam/#run-slam-node.

Marking

If you are able to complete the lab before the end of the second week, you will receive 2% for Part I and 2% for Part II. If you are not able to complete any parts of the demo within the lecture session, you will get a 20% penalty of the part weight, and an additional 20% for each day of delayed demo (checking by a TA).