Sensors and Sensing
Lab 3: Laser Scanner Noise Characterization

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1 Objectives and Lab Materials

The objective of this lab is to introduce you to using a time-of-flight laser sensor in ROS, processing of range measurements, and methodology for noise characterisation of range sensors.

For this lab you are given:

- MakeBlock kit assembly, including a MegaPi board and two DC motors. (we refer to the MegaPi board as **arduino** from now on).
- Raspberry Pi with Ubuntu and the Arduino IDE pre-installed. (we refer to the Raspberry Pi as **pi** from now on).
- A YDLidar F4 laser range finder (LRF).
- A desktop PC with ROS kinetic installed (we refer to this computer as **desktop** from now on).

The following tasks will guide you through setting up the ROS drivers of your LRF. You wil then devise a methodology for evaluating the accuracy and noise characteristics of your sensor. In your report, describe the steps you have taken to solve each task, as well as the results you obtained and the methods you used to verify that the system functions properly. Explain what experiments you performed, how and why. Provide your C++ source codes as an attachment and demonstrate the final system to the lab assistant. If you think it is necessary, you may take pictures of the system in action, and/or include screenshots.

1.1 Preliminaries

Before starting with this lab please verify you have performed these preliminary steps:

- Mount the LRF sensor onto your robot as per instructions from the lab assistant. Connect the USB data and power cables through the interface board and to your pi.
- Connect an Ethernet cable between the desktop and the pi.
- Using the network manager on your workstation, set up a static IP for the wired connection onto the subnet 192.168.100.255.
- On the pi: Clone the github code for this lab into your workspace.
  `git clone https://github.com/tstoyanov/sensors_lab3_2018.git`

2 Task 1: LRF ROS drivers (3 points)

On the Raspberry pi, clone the repository `https://github.com/EAIBOT/ydlidar.git` to the src directory of your workspace. Run `catkin_make` in your workspace. Once everything compiles successfully, modify the file in `launch/lidar.launch` to point to the correct USB port on which the Lidar is connected. To figure out the correct port, you might want to run `dmesg` and check the messages from the kernel. Launch the file by running `roslaunch ydlidar lidar.launch`. On your desktop, start an rviz window and examine the laser scan. Attach a screenshot of the rviz window showing the laser data.

3 Task 2: LRF ROS node (7 points)

Build and test the laser scan processing node provided with the lab. Modify the code to:

- Transform the laser range points from polar coordinates to (x, y) coordinates.
- Publish the transformed (x, y) points as a marker (set of points). Use a different color than the one used for displaying the laser scan message in rviz and verify that the transformation you are doing results in the same measurements as the one performed internally by rviz.
- Save the most recent laser scan to a file, whnever the service `save_data` is called.

4 Task 3: LRF Noise Characterization (15 points)

In this task you will perform laser scanner noise characterization. Your aim is to obtain an inverse beam model, which can later be used for occupancy mapping. To this end, your task is to:

- Select only the central beams of the laser scanner, so as to measure a narrow window of ranges.

- Place the scanner at a known distance in front of a flat wall.
- Accumulate measurements of the distance to the wall over a predetermined window of time.
- Compute the mean and standard deviation of the measurements.
- Repeat this procedure over different distances to the wall and diferent target materials.
- Make sure you are only using measurements on the target.
- To perform these steps you will need to modify the laser subscriber node and add some extra processing functionalities.
- The details of the error characterization procedure are up to you: motivate your choices and explain clearly your results.
- You may want to perform additional experiments to observe if there is a significant difference in the noise characteristics of the sensor depending on incidence angle to the target. Do not attmpt to characterize mixed measurements. You are however welcome to demonstrate examples when these can occur.