Lab 3
Embedded Systems with ROS

February 23, 2022

Learning Objectives

1. Configure nodes to exchange information via topics within the publisher/subscriber framework of ROS.
2. Write a custom subscriber node in ROS to listen to a topic and perform computation when new information is published to that topic.
3. Learn how to interact and control a small, mobile robot such as the Turtlebot.
4. Network a remote workstation to a mobile robot within the ROS environment so that messages can be wirelessly exchanged between nodes on either computer.
5. Leverage pre-existing hardware drivers and other nodes in the ROS repository and integrate them together with custom-written nodes as part of a robot application.

Overview

The primary objective of this lab is to introduce you to how the Robot Operating System (ROS) interfaces with other devices to make embedded systems. Similar to other operating systems, ROS provides various services including hardware abstraction, low-level device control, implementation of commonly-used functionality, message-passing between processes, and package management[1]. In this lab, you will use the aforementioned services of ROS to program a robotic vehicle (i.e. a Turtlebot) to respond to commands from a remote computer that has a keyboard controller connected to it. Your robot will also include sensor feedback to the end user.

A hardware-driver node for interfacing with keyboard controllers already exists in ROS and will be leveraged in this lab for publishing the velocity commands to a ROS topic. Your node running on the robot will subscribe to the published topic of the joystick and will drive the robot accordingly. You will complete a number of tutorials to gain familiarity with control of a mobile robot. The keyboard will be connected to a laptop which communicates to the Turtlebot subscriber node over Wi-Fi. As you will see in this lab, ROS enables nodes running on different computers to communicate over the same wireless network, thus abstracting much of the networking challenge.

[1] ROS Introduction, `http://wiki.ros.org/ROS/Introduction`

Lab Requirements

Create a tele-operation system for controlling the Traxxas robot from a computer that has a keyboard connected to it. Use ROS as the framework that supports the message-passing between nodes and provides the driver for interfacing with the keyboard. Connect a low-level microcontroller (i.e. Arduino) to handle sensor feedback (i.e. range finder). Use ROS tools such as rosserial to communicate between the computer and microcontroller. Select appropriate sensor(s) to provide ranging information back to the user in a terminal window. Provide video feedback to the user.

Below are some steps for helping you complete this lab. They are not intended to be a step-by-step set of instructions for the assignment, but instead, they are intended to assist you with various portions of the exercise.

1. Go through the rosserial tutorials to understand communications between computer and microcontroller. `http://wiki.ros.org/rosserial_arduino/Tutorials`
2. Using the keyboard, generate velocity commands to control the Turtlebot.
3. Test the range finder separately using the Arduino and range finder sketch `http://wiki.ros.org/rosserial_arduino/Tutorials/IR%20Ranger`.
4. Integrate a range finding sensor and display the feedback to the user (terminal window, RViz).
5. Generate a video stream using your built-in camera and display the feed to the user (RViz).
6. Use a roslaunch file to execute all of your nodes.

Deliverables

- Demonstrate the successful tele-operation of the Turtlebot using a keyboard connected to a computer. The user should be able to press keys to increase/decrease throttle, steer, and stop.
- Select an on-hand distance sensor, study the datasheet, integrate the sensor into your system, and provide the sensor data back the user.
- Provide video feedback to the user.
- All code for your project should be submitted as part of your lab report's appendix section, as well as uploaded to Canvas.
- Sign the coversheet of your lab report to cite and document any sources you used to complete this report.