Udacity Robotics Nanodegree Term 2

Where Am I?

Robert Aleck, 17th June 2019

# Abstract

In this paper, the author describes the steps taken to tune a number of ROS packages to correctly localize a robot in a simulated environment, and navigate inside a provided map to a given target. Simulation visualisation is provided by RViz and Gazebo.

# Introduction

The required robot consists of at least 2 actuators, a camera, and a laser sensor, although the camera is not used for localisation or perception tasks. It was required to use the Adaptive Monte Carlo Localization package (<https://wiki.ros.org/amcl>), and the standard ROS Differential Drive Controller (<https://wiki.ros.org/diff_drive_controller>), along with a simulated hokuyo laser sensor (<http://gazebosim.org/tutorials?tut=ros_gzplugins#Laser>).

The robot was placed in to a simulated maze at an arbitrary location. A global map was provided; the robot had to localize within that global map, and complete navigation to an arbitrary point (x,y,yaw) within the map, avoiding obstacles.

It was not required to test the robot against the “kidnapped robot” problem [1].

# Background

## Localization

Localization in robotics is “the process of determining where a mobile robot is located with respect to its environment” [2], including both location and orientation. Localization is a prerequisite for many successful mobile robotics systems, and so creating and maintaining an accurate model of the world, and the robot’s location and orientation within that is a foundational component of many autonomous mobile robotics systems.

Localization can be broken down in to three types, with increasing complexity:

* Position tracking – determining the pose of a robot, given a starting pose, and incremental sensor readings (e.g. odometry) relating to changes in that pose.
* Global localization – no initial pose is given, and the robot must determine its pose entirely using sensor readings.
* “kidnapped robot” – where “a well-localized robot is tele-ported to some other place without being told” [1] – requiring the robot to be able to recover from an absolute failure of localization.

In each scenario, the robot may be given a base (or reference) map, or have to determine one from scratch.

Explain the importance of localization for a robot. Explain, compare and contrast the two types of localization methods covered in the Classroom - Kalman and Particle filters. Student provides a sufficient background into the scope of the problem / technologically while also identifying some of the current challenges in robot localization and why the problem domain is an important piece of robotics. They further discuss and compare Kalman and Particle filters.

# Results

Results - Show the results of both of the robots' performances. Include charts, graphs, and tables as necessary. Compare the results from both robots.

Student should include the image of RViz with the robot at goal position and the PoseArray displayed. This will help gauge how well their parameters are tuned. For this, the student should submit the results for both the Classroom robot and the robot they developed.

# Model Configuration

Justify your choice of parameters, explain the size of your robot and choice of sensors locations.

Student describes the parameters, the choice of parameters as well as demonstrates an understanding of the impact of these parameters (for example, how do more/fewer particles impact the results?)

Discussion

What went well, what went wrong. Reflect upon the results of your robot's performance. Justify your answers with facts.

* The student presents an unbiased view of their results and justifies their stance with facts.
* The student discusses about whether AMCL would work well for the kidnapped robot problem and what kind of scenarios would need to be accounted for it.
* The student provides examples with very brief discussions on where they would use MCL/AMCL in an industry domain.

# Future Work

What types of enhancements could be made to the model to increase accuracy and/or decrease processing time?

The student can accurately and effectively explain the trade-offs in accuracy and processing time. The student identifies other areas of the robot for improvement including the addition of more sensors, different base size, etc.

[Optional] The student explains how they could deploy this project on actual hardware and what considerations would have to be made in that respect.

# References

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| [1] | S. Thrun, D. Fox, W. Burgard and F. Dellaert, “Robust Monte Carlo localization for mobile robots,” *Artificial Intelligence,* vol. 128, no. 1-2, pp. 99-141, 2001. |
| [2] | S. Huang and G. Dissanayake, “Robot Localization: An Introduction,” in *Wiley Encyclopedia of Electrical and Electronics Engineering*, J. G. Webster, Ed., John Wiley & Sons, Inc, 2016, pp. 1-10. |