README.md

RoboND-HomeServiceRobot-Project-P9

Home Service Robot

Abstract

SLAM or Simultaneous Localization and Mapping is an important topic within the Robotics community. It is not a particular algorithm or piece of software, but rather it refers to the problem of trying to simultaneously localize (i.e. find the position/orientation of) some sensor with respect to its surroundings, while at the same time mapping the structure of that environment.

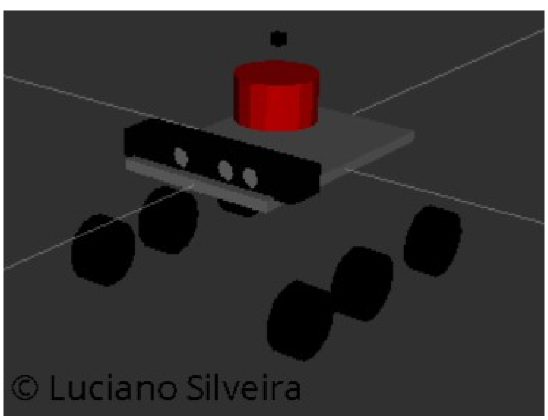
The Home Service Robot project creates a local world to deploy a rover programmed to go to a specific location to mimic picking up an object and then move it to a new location to a drop-off area.

Introduction

SLAM is central to a range of indoor, outdoor, in-air and underwater applications for both manned and autonomous vehicles. It is known to be a difficult problem because it is a chicken-or-egg problem where a map is needed for localization and a pose estimate is needed for mapping.

In our simulation environment a rover called `ls_bot` is equipped with a RGB-D camera and a Lidar sensor and is driven around two generate a map; the objective is to create a 2D representation of its surroundings.

The `ls_bot` is an extension from the rocker-bogie project. Several changes were needed to make to compile using the ROS Kinetic Kame default infrastructure. The sensory information was added using the Gazebo plugins reference. The visualization in Rviz is as follows:



The Home Service Robot project creates a world using the Gazebo simulator. The first task is to map it using a node called wall_follower. Once the mapping is done a map file is created and the AMCL node is used to localize the rover within the environment. Using the Move Base stack; the rover must navigate it's environment to pick up an object and go to a drop-off area. The simulation uses markers to signal pick-up and drop-off zones.

Background

The tasks required to complete the project are:

- Design a simple environment using the Building Editor in Gazebo.

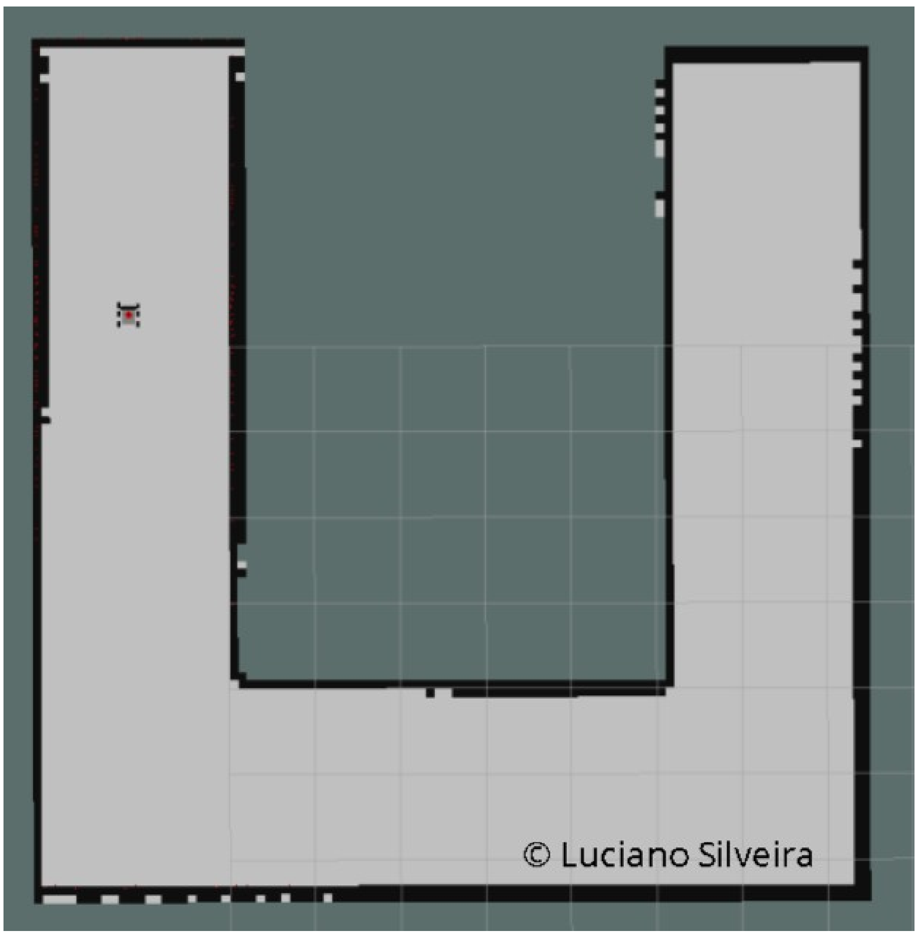
- Teleoperate the robot and manually test SLAM.
- Create a wall_follower node that autonomously drives the robot to map the environment.
- Use the 2D Nav Goal arrow in rviz to move to two different desired positions and orientations.
- Write a pick_objects node in C++ that commands the robot to move to the desired pickup and drop off zones.
- Write an add_markers node that subscribes to robot odometry keeping track of the robot pose, and publishes markers to rviz.
- Combine all of the forgoing to simulate a robot moving to a pick up point, and carrying a virtual object to a dropoff point.

Results

Initially the U-shaped world was created with the Building Editor in Gazebo.

Mapping

The provided `teleoperation` utility was used to move the rover; the steering plugin from the rqt ROS utilities was tested and the `wall_follower` node generating a map. The result is the following map:



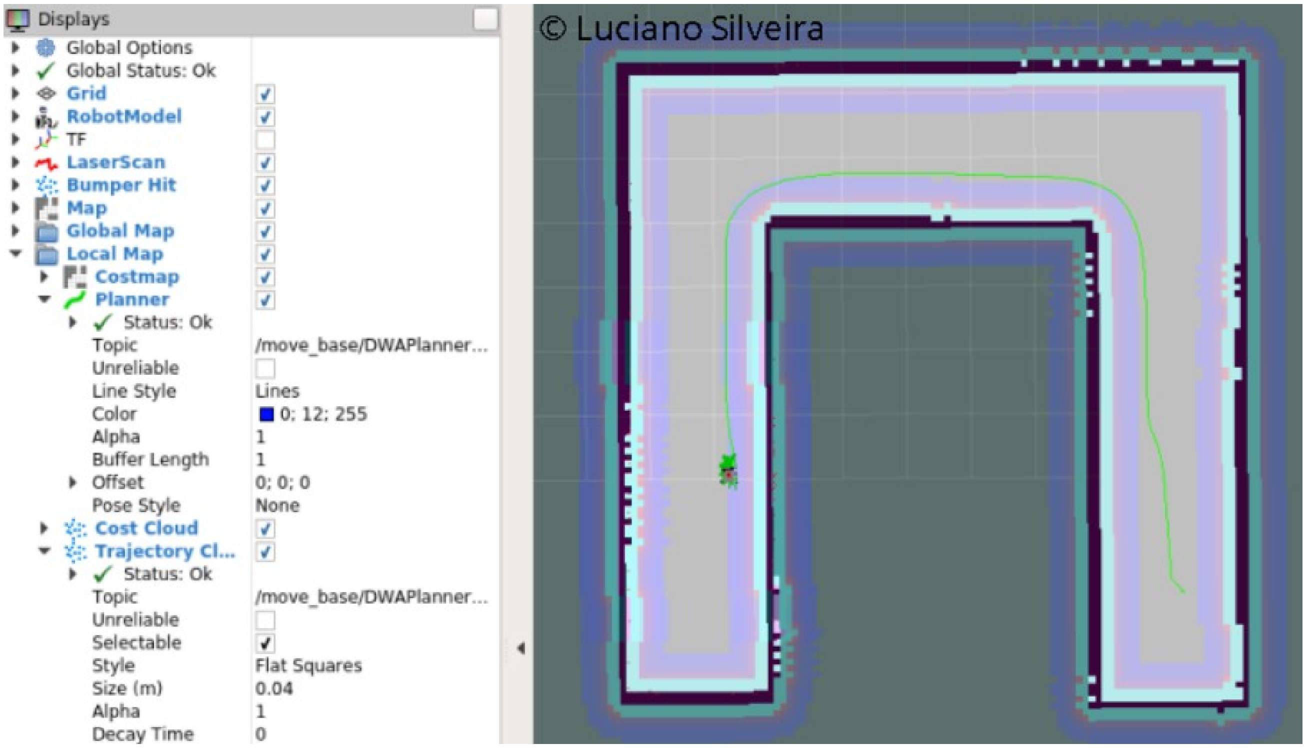

```
cd ~/<ProjectName>/ros
./src/ShellScripts/test_slam.sh
```

Navigation

The localization is solved with the AMCL node and Navigation uses the Move Base stack.

```
cd ~/<ProjectName>/ros
./src/ShellScripts/test_navigation.sh
```

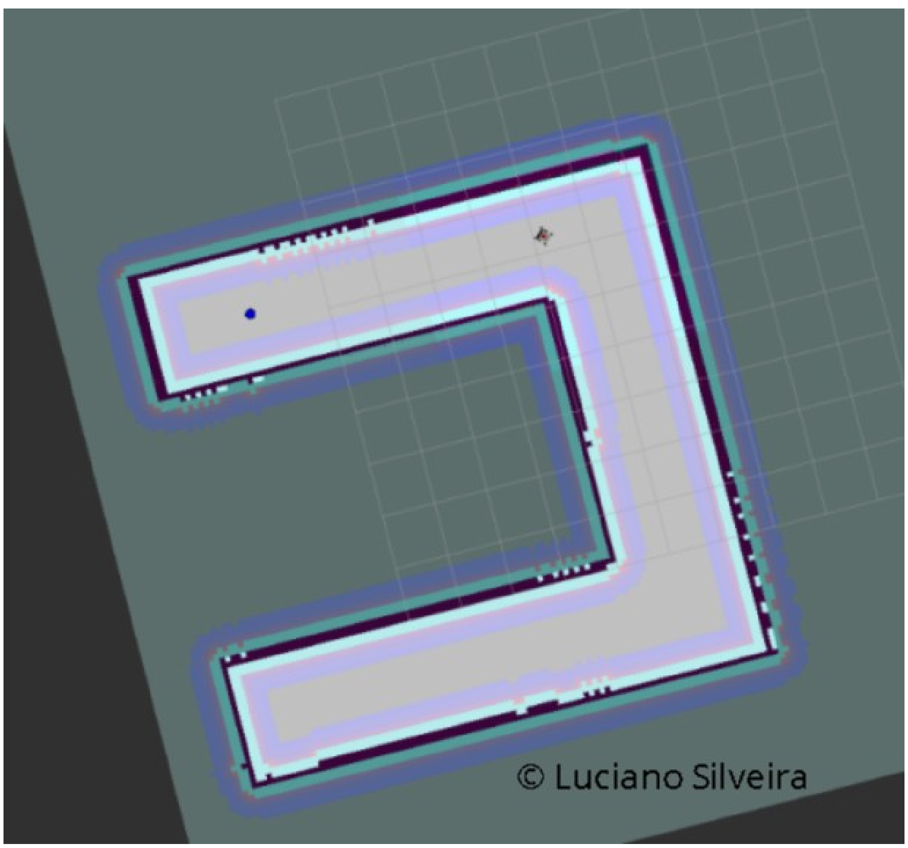
A sample result using th 2D Rviz options is detailed as follows:



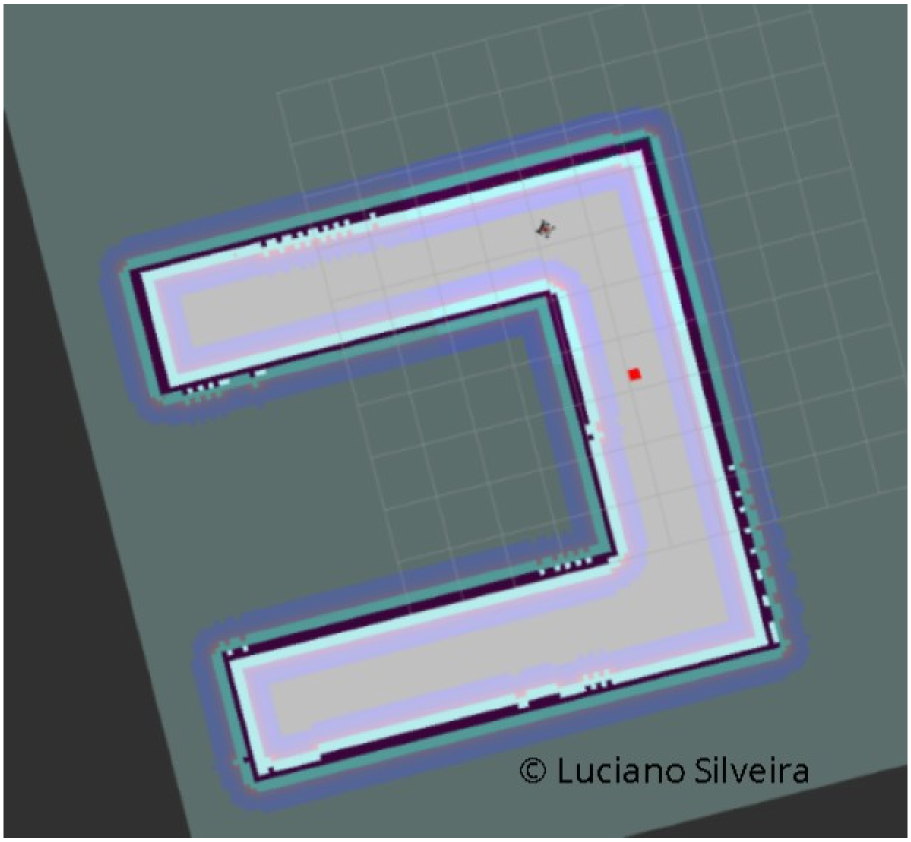
Pick up, Drop off objects and Markers

To write the pick_objects node some ideas were taken from here.

The pick-up location `'x': -6.44562959671, 'y' : 1.26055216789` is marked as follows:



While the drop-of location `'x': 0.128987312317, 'y' : -1.71386241913` using the `/markers/path` topic.



To execute it:

```
cd ~/<ProjectName>/ros
./src/ShellScripts/pick_objects.sh # pick objects only
./src/ShellScripts/add_markers.sh # markers only
```

The following output is detailed:

```
$ rosrun add_markers add_markers.py
[INFO] [1552959857.090800, 2475.324000]: Pick Up marker (-6.44562959671, 1.26055216789)
[INFO] [1552959868.123470, 2485.325000]: Drop-off marker (0.128987312317, -1.71386241913)
```

The following steps were followed:

- Publish the marker at the pickup zone and use Move Base to navigate.
- When the rover reaches the pickup zone, hide the marker and wait for 5 seconds.
- Publish the marker at the drop off zone and use Move Base to navigate.

Home Service

The Home Service script combines everything; simulating a robot moving to a picking point, waiting for 5 seconds and carrying a virtual object to a drop-off location.

```
cd ~/<ProjectName>/ros
./src/ShellScripts/home_service.sh
```

A sample result can be validated here.

Discussion

The project successfully navigates the environment once the map is created.

Instead of using odometry information to signal pick-up and drop-off locations a different strategy was followed. Use two new topics passing a Bool parameter to signal it, called `pick_flag` and `drop_flag` . The add_markers node will subscribe to both and add/remove the marker when needed:

```
def pick_callback(self, b):
    ''' pick up flag '''
    if b.data is True:
        rospy.loginfo("Received pick-up marker (%s, %s)", self.pick_position['x'], self.pick_position['y'])
        self.publish_marker(self.pick_position, 1., 0., 0., 1., 1, 0, scale=0.2) # Blue sphere
    else:
        rospy.loginfo("deleting pick-up marker")
        self.delete_marker(1)

def drop_callback(self, b):
    ''' drop off flag '''
    if b.data is True:
        rospy.loginfo("Received drop-off marker (%s, %s)", self.drop_position['x'], self.drop_position['y'])
        self.publish_marker(self.drop_position, 1., 1., 0., 0., 2, 1, scale=0.2) # Red cube
    else:
        rospy.loginfo("deleting drop-off marker")
        self.delete_marker(2)
```

Considerations

Python was used to move the rover using the standard Move_Base infraestructure. The default tolerance parameters were changed to discard rover orientation using the following answer.

```
yaw_goal_tolerance: 3.14
xy_goal_tolerance: 0.3
```

Conclusion / Future Work

The objective to create a Home service robot was achieved.

The project was run on the Virtual Machine provided. To minimize the usage of resources it was decided to run the Gazebo environment without a GUI and only use RViz for validation through sensory information.

In order to get a better localization, `ls_bot` used the Dynamic Window Approach `dwa_local_planner/DWAPlannerROS` local planner instead of the default `base_local_planner/TrajectoryPlannerROS` . In this way, the rover better navigated the environment using AMCL plus Move Base stacks.

Links:

- Gazebo
- Gazebo Model creation
- RViz
- Gazebo plugins
- SetupOnYourRobot withb rtabmap
- What is SLAM?
- Sending Simple Goals
- Udacity wall_follower
- gmapping
- turtlebot_teleop
- turtlebot_rviz_launchers

- turtlebot_gazebo