Map my world

Erick Ramirez

Abstract—This paper describes the implementation of a simulation of mapping. The objective is to accurately map an indoor environment. The robot model has a Kinect RGB-D camera and a Hokuyo laser range finder. A RTAB-Map (Real-Time Appearance-Based Mapping) node has been configured to perform a RGB-D SLAM (Simultaneous localization and mapping) approach based on a global loop closure detector with real-time constraints. The expected output is to generate a 2D occupancy grid and 3D octomap from a provided simulated environment.

Index Terms—RTAB-Map, RGB-D, SLAM.

1 Introduction

THINK about a domestic robot like a vacuum cleaner which has the to move through an unknown environment, in the best of the scenarios this unknown environment is static. The vacuum has to know its position and constantly update the map of an indoor environment. A way to perform a solution for this problematic is using Simultaneous localization and mapping(SLAM) which is the process of updating a map of an unknown environment and simultaneously it is setting the robot's position in that map.

In this paper,the RTAB-Map ROS package is used to perform SLAM in two simulated environments. The robot collects information from RGB-D camera images and laser range scans. The RTAB-Map node creates 2D occupancy grid maps. The RTAB-Map database viewer is used to reconstruct 3D point clouds from the recorded mapping data. The source software for this project can be found in https://github.com/Erickramirez/RoboND-SLAM-Project.

2 Background

2.1 GraphSLAM

The GraphSLAM algorithm address the full SLAM problem, because it recovers the full path of the robot and the entire map of the environment, it can also detect correlations between current and previous poses. It uses a graph to represent the problem, each note in the graph represent either a robot pose x_t at a specific time t or the localization of a feature in the environment. The goal of GraphSLAM is to find a configuration of the nodes that minimize the error introduced by the constraints.

RTAB-Map (Real-Time Appearance-Based Mapping) is a Graph-Based SLAM approach that uses image data collected from the RGB-D camera. With this algorithm it is expected to localize the robot and map the environment and detect loop closures.

2.2 Occupancy grid mapping algorithm

The Occupancy grid mapping algorithm implements binary Bayes filter to estimate the occupancy value of each cell, this is useful in order to map the undiscovered areas. This algorithm address the problem of generating maps from noisy and uncertain sensor measurement data, with the assumption that the robot pose is known. Then it determines the posterior probability distribution and it has the assumption that the cells can be considered independent of each other (occupied or free). In this application, the maps generated by the algorithm can be visualized in RViz. The occupancy grid mapping algorithm is used as a post-processing step for SLAM. It is using the poses obtained by SLAM and the noisy measurements and generates a redefined map that in the future will be useful for path planning and general navigation. a practical approach can be the following [1]:

- Connect a cell corresponding the sensor position with the hit cell.
- Set all cells on the line as empty
- Set the hit cell as occupied. Note: in this case the range of the sensor will
- Apply Bayes rule to update the grid.
- Apply a line drawing algorithm to set the map.

3 Model Configuration

The robot is model composed of Kinect RGB-D camera and a Hokuyo laser range finder, with a chassis and 2 wheels to move, check the Fig.1.

The definition of this model is in the urdf directory and file `udacity_bot.xacro` and `udacity_bot.gazebo`. the Wold directory includes the file `cafe.world` and `kitchen_dining.world`, each one defines a custom indoor environment that expect to be mapped.

3.1 World Creation

The `cafe.world` has been created in Gazebo, using the cafe model and adding a table, wall from the and other objects from Gazebo Database. The main issue here was to set a correctly value for `z` pose of the cafe model.

4 Results

The simulations show the actual performance of the robots. and the result of the mapping is the following:

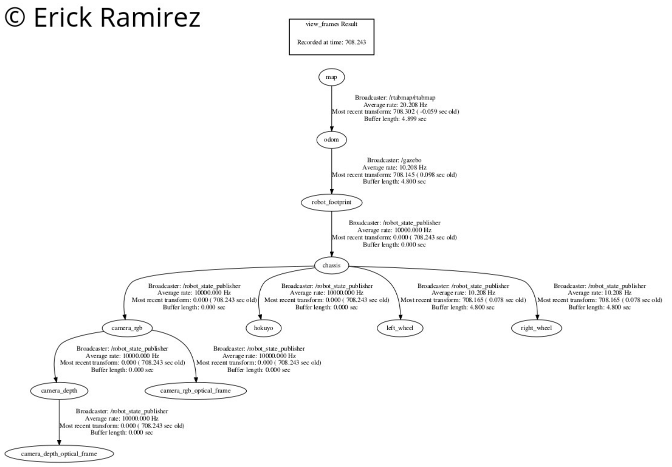

Fig. 1. Transform tree of the rover model. Output from rosrun tf view_frames.

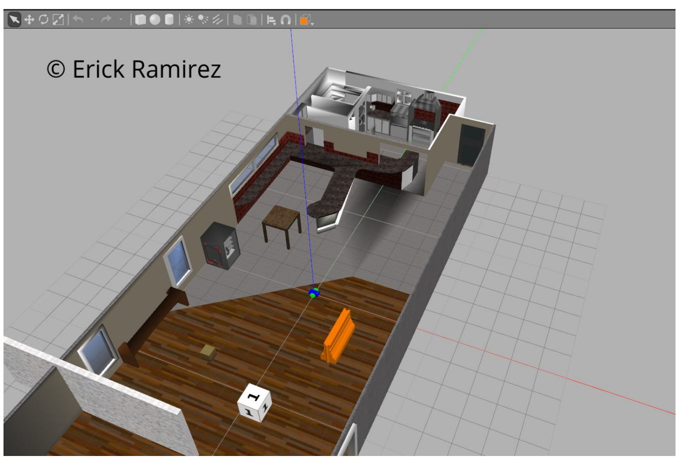

Fig. 2. Cafe (world created) and rover model viewed from the top. Screenshot taken in Rviz.

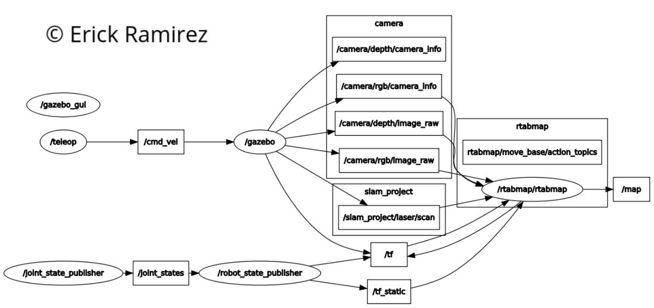

Fig. 3. Active topics for the nodes launched. Output from rqt_graph

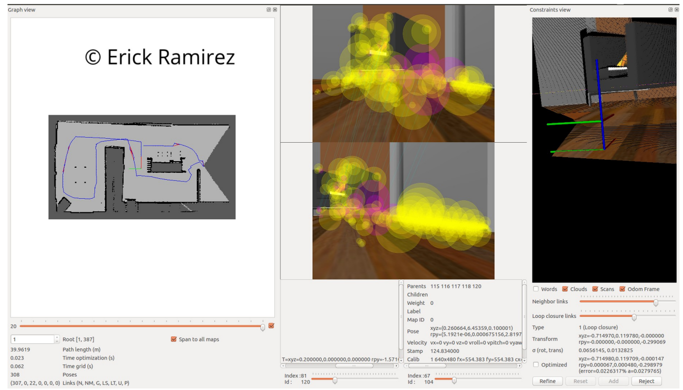

Fig. 4. RTAB-Map Database Viewer.

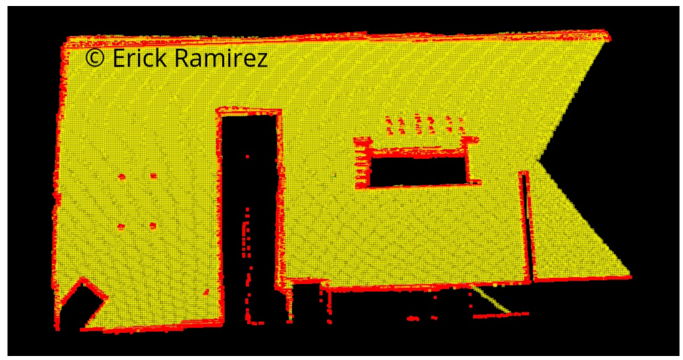

Fig. 5. Occupancy grid of kitchen_dining world created during mapping. Screenshot taken in RTAB-Map Database Viewer.

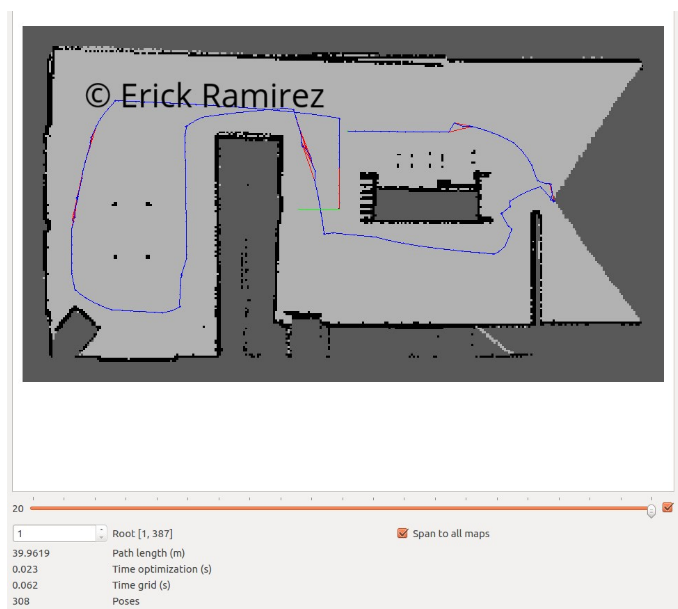

Fig. 6. Loop closures generated in kitchen_dining world created during mapping. Screenshot taken in RTAB-Map Database Viewer.

Fig. 7. 2d map of kitchen dining world and rover model viewed from the top. Screenshot taken in Rviz.

Fig. 8. 3D map of kitchen dining world and rover model viewed from the top. Screenshot taken from RTAB-Map Database Viewer.

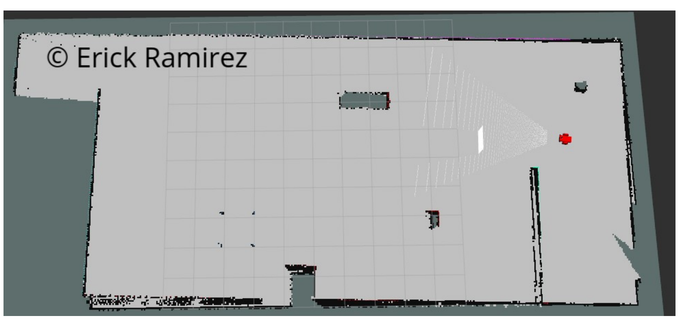

Fig. 9. 2D map of cafe world and rover model viewed from the top. Screenshot taken in Rviz.

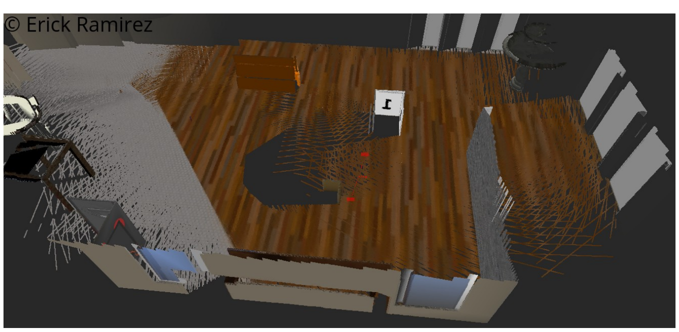

Fig. 10. 3D map of cafe world and rover model viewed from the top. Screenshot taken from RTAB-Map Database Viewer.

4.1 kitchen_dining map

4.2 cafe map

5 DISCUSSION

Both robots performed a very good job about the mapping task. The generated 2D and 3D maps have some discrepancies with the real world, and it changes according the navigation. in the Kitchen world I got discrepancies once I reached the free space.for instance some relationship on elements or corners and even the wall. The manual task for mapping is difficult and in some points I have a collision. For a better accuracy it will be necessary have more scanning on multiple areas of the world. Also, a challenge for the SLAM will be in environments with similitudes in both sides, for instance a symmetric environment it will be challenging for this.

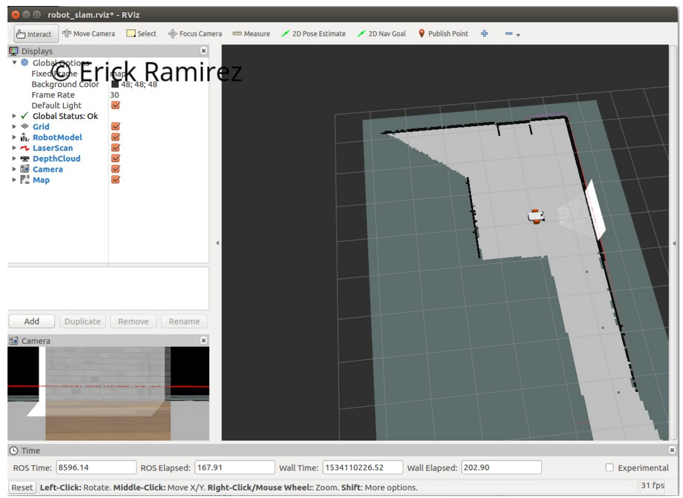

Fig. 11. Initial mapping. Screenshot taken in Rviz.

6 FUTURE WORK

I would like to create a real mobile robot using the Jetson TX2, the motion planning will be a feature to add to this project and the tuning of a real sensors where the noise will be different. Other areas to implement mapping is in outdoor environments, for instance the self driving cars, they have to challenge the SLAM problem because of the accurate needed to drive the car. Also, Robots with an specific task and in indoor environments needs localization, for instance a tour robot inside of a museum.

REFERENCES

[1] M. Kulich, *Bayes filter for mapping*. Czech Technical University in Prague, 2012.