Robotic SLAM in ROS with RTAB-Map

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Abstract—Real-Time Appearance-Based Mapping (RTAB-Map) is a SLAM algorithm supporting Lidar and RGB-D Graph SLAM. RTAB-Map can be used within a ROS stack to map and localize a mobile robot, handheld Kinect, or lidar device by iteratively detecting loop closures through a hypothesis evaluation and acceptance process. To evaluate RTAB-Map's performance several mapped worlds were navigated by a teleop controlled mobile robot with their output 2D and 3D maps compared with the known Gazebo worlds for accuracy.

Index Terms—ROS, RTAB-Map, Gazebo, Graph SLAM.

1 Introduction

Simultaneous localization and mapping (SLAM) is a robotics challenge as it requires determining an estimated pose of the robot while also mapping the environment the robot resides within, which is difficult because usually to determine one of these the other is known and utilized. The Localization process, for example, is often completed by inferring the robot's location based on navigating through a known map. However, during SLAM there is not a known map to rely upon, hence the Simultaneous in SLAM. There are a number of algorithms and approaches to the challenge of SLAM, here the Real-Time Appearance-Based Mapping (RTAB-Map) method will be explored and evaluated. To provide comparison opportunity two different Gazebo worlds were utilized during this project (Kitchen and Mars Rover with Researcher).

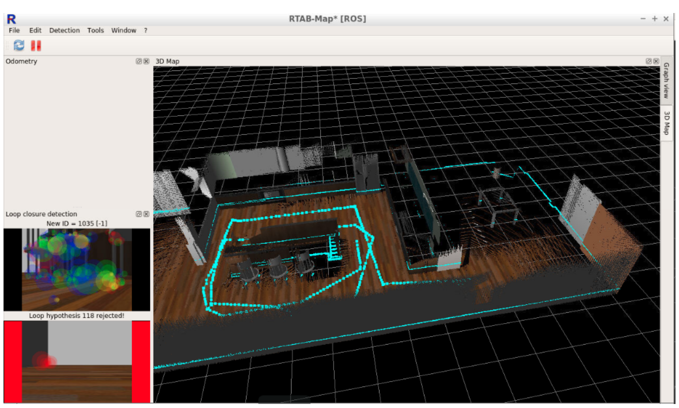

Fig. 1. RTAB-Map of Kitchen World.

2 Background / Formulation

SLAM algorithms are utilized across a variety of real-world environments including indoors (iRobot), space (Mars Pathfinder), and even in deep sea exploration. There are five common categories of SLAM algorithm:

- Extended Kalman Filter SLAM (EKF)
- GraphSLAM
- Extended Information Form (EIF)
- FastSLAM
- Sparse Extended Information Filter (SEIF)

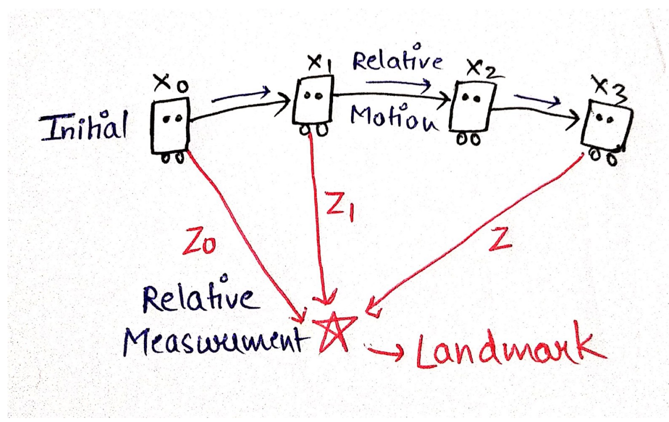

Fig. 2. GraphSLAM Diagram.

Within this project a GraphSLAM approach was utilized in the form of RTAB-Map.

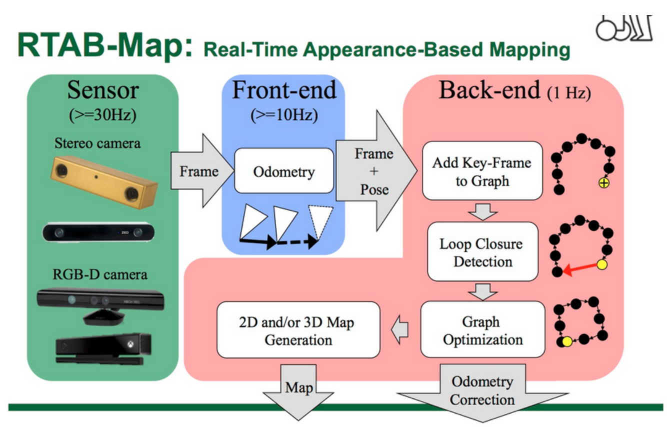

Fig. 3. RTAB-Map Diagram.

3 Robot Model

For this project a mobile robot with a cylindrical chassis, 2 casters, and an RGB-D camera was utilized with similar proportions to an iRobot base. Here the robot can be seen scanning a segment of the kitchen in full color via the RGB-D camera image stream.

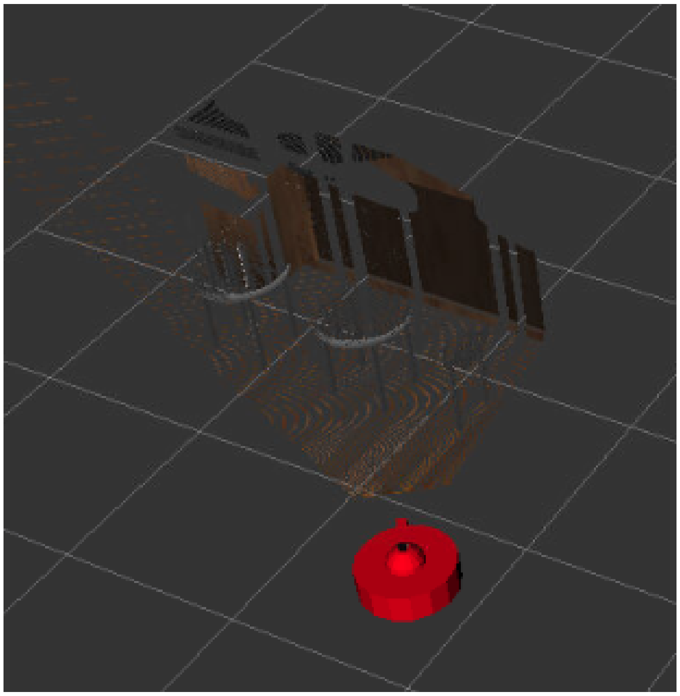

Fig. 4. Robot Model.

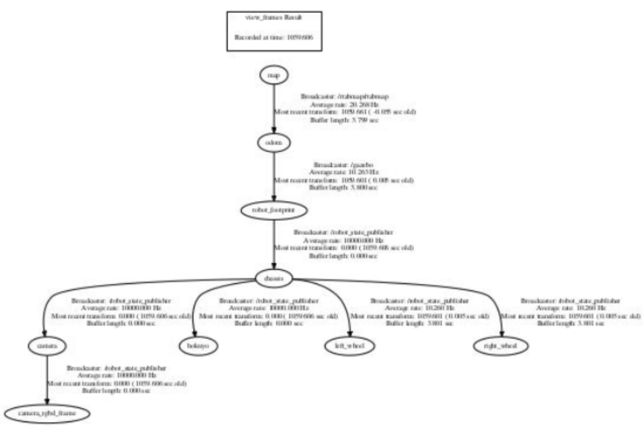

Fig. 5. Robot Transform Tree.

4 Gazebo Worlds for Mapping

- Kitchen World - Indoor kitchen environment with adjacent rooms and a primary obstacle in the form of the kitchen island and chairs.
- Mars Rover Area - Outdoor open environment with obstacles in the forms of a Mars rover, ATV, and standing person.

5 Results

In both worlds the mobile robot was navigated via teleop around the perimeter of the central obstacles in order to

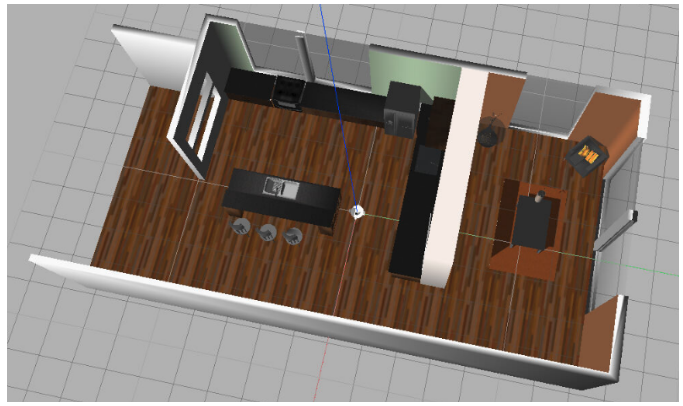

Fig. 6. Kitchen World.

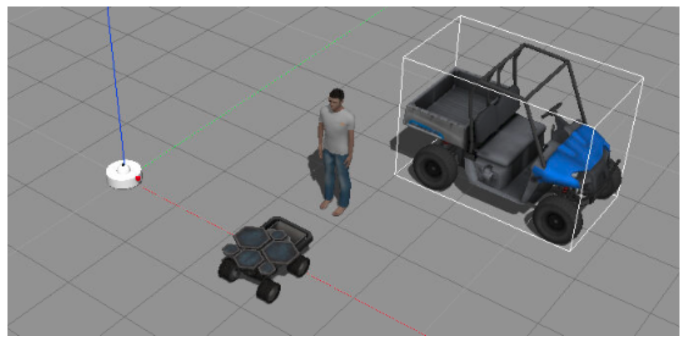

Fig. 7. Mars Rover World.

complete sufficient loop closures. As loops are closed the RTAB-Map 3D map increasingly accurately represents the known Gazebo worlds as can be seen in the diagrams.

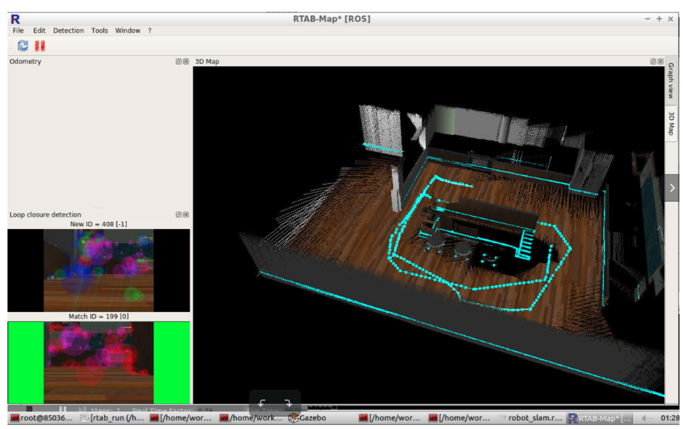

Fig. 8. Kitchen Mapped in RTAB-Map 3D.

After multiple trips around the kitchen the RTAB-Map shows 16 loop closures in total.

In addition to the 3D point clouds there are also exportable 2d Graph views.

6 Discussion

Generally speaking mapping with RTAB-Map was successful in both Gazebo worlds. I've included some of the useful findings below:

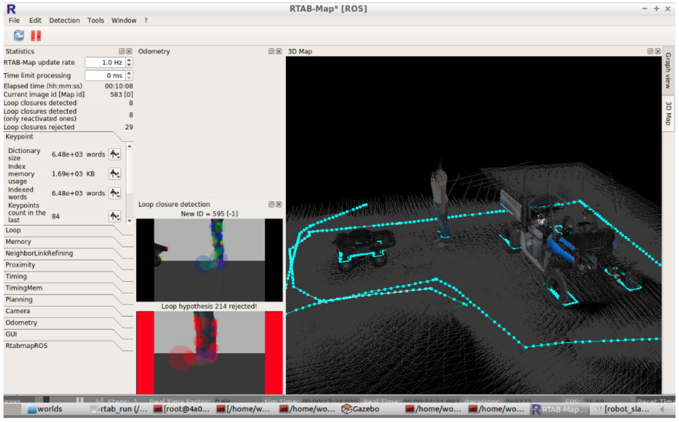

Fig. 9. Mars Rover Mapped in RTAB-Map 3D.

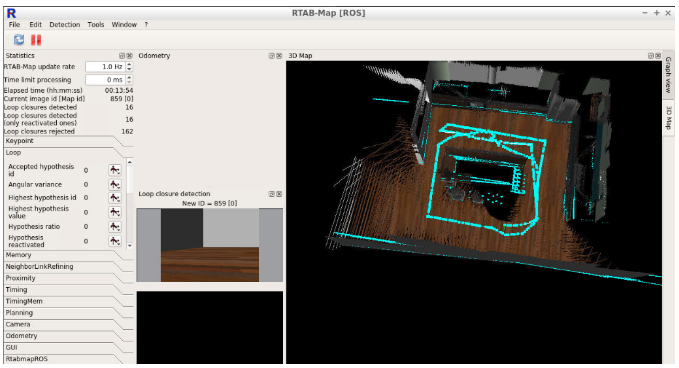

Fig. 10. Kitchen Mapped in RTAB-Map 3D

- It requires fewer loop closures and distance mapping to build an accurate 2D Graph of the mapped environment vs. 3D
- 3D mapping is particularly sensitive to speed of robot motion and turning

7 Conclusion / Future work

In the future it would be interesting to utilize RTAB-Map to perform mapping of an office environment using a Kinect/RealSense mounted to a TurtleBot.

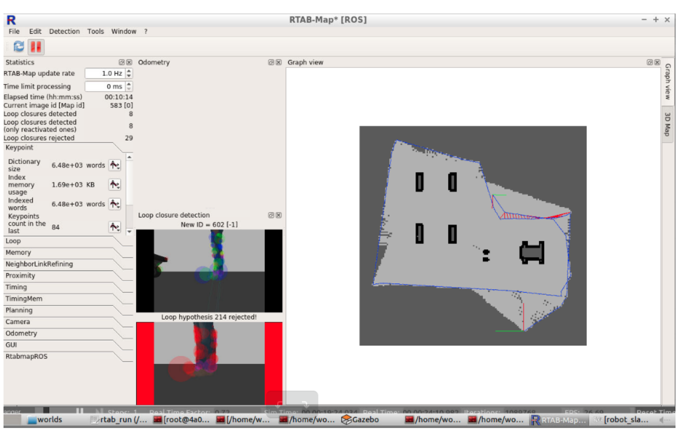

Fig. 11. Mars Rover Mapped in RTAB-Map Graph View.

References

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