Map My World

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Abstract—This project aims to create ROS packages that create map of two different environments. Using mobile robot that navigate in the simulation environments by user to obtain data. The overview of the tasks can are as follows, creating map for the given environment, create a new environment and build the map of the new environment using RTAB-Map ROS package.

Index Terms—Robot, IEEEtran, Udacity, LaTeX, SLAM, RTAB-Map, ROS, Robot Model.

1 Introduction

THE problem here is that the robot can localize itself but the map is unknown so the goal for the robot is to create a map of the environment. In the localization problem, the robot knows the map, and the sensor measurements help the robot to localize itself. On the contrary, the map is not available in the mapping or the SLAM problem. SLAM stands for Simultaneous Localization and Mapping [?], and it needs to obtain the map to localize the robot and to localize the robot to create the map.

The most common algorithms are Fast SLAM and Graph SLAM. This project test the RTAB-MAP (Real-Time Appearance-Based Mapping) [?]. There are two different worlds to test the algorithm. The first one is the kitchen dining world provided in the lessons. The second test world is myworld, which was developed as a part of the project.

2 Background

The problem is to create a map of the environment, as mentioned earlier. Furthermore, localization of the robot is a requirement to complete the task. Since the sensors are not precise, there is noise to affect the measurements coming from the sensors, and the controls are not perfect to move the vehicle to the desired location. Therefore, the algorithm should handle the noise.

2.1 Occupancy Grid Mapping

Occupancy Grid Mapping is an algorithm that assumes the location of the robot is available when constructing the map [?]. During SLAM operation, then the algorithm builds the map of the environment and localize the robot relative to it. After, the algorithm uses the exact robot poses filtered from SLAM. Then, using the known poses from SLAM and noisy measurements from the sensors generates a fit for path planning and navigation.

2.2 Grid-based FastSLAM

FastSLAM estimates a posterior over trajectory using particle filters. It solves the Full SLAM problem. Full SLAM looks for the entire path up to time t, using all of the controls and measurements. It has the advantage of mapping with known poses and utilizes low dimensional EKF to solve independent features of the map.

Grid-based FastSLAM uses Monte Carlo Localization (MCL) instead of EKF. It first estimates the trajectory, then the map by assuming known poses and applying the occupancy grid mapping algorithm.

In the Grid-based FastSLAM technique, there are three steps. First one is sampling motion. In this step, the current location of a given particle is calculated using the previous one and the current controls. In the second step, which is map estimation, with the inputs of current measurements, the particles current location and the previous map, the next map is estimated. The last step updates the weights of the particles.

2.3 GraphSLAM

GraphSLAM uses a graph representation to the SLAM problem. It constructs graphs and then matrices. They help to determine different observations showing the same landmark. [?]. The main feature of GraphSLAM is graph optimization with maximum likelihood estimation (MLE). The procedure is as follows

1) Remove inconsequential constants.
2) Convert the equation from likelihood estimation to negative lo likelihood estimation
3) Calculate the first derivative of the function and set it to zero to find extrema.

The properties of the information matrix and vector are as follows

- A motion constraint ties together two poses.
- A measurement constraint ties together one feature and one pose.
- Each operation updates four cells in the matrix and two cells in the vector.
- All other cells are zero, therefore the matrix is sparse. Sparsity helps solving equations on limited hardware.

3 Simulations

The simulation environment consists of ROS (Kinetic), Gazebo and RViz. The main ROS package is the RTAB-Map package. There are two different environments to test on the simulation. The robot model in the tests is the mybot from the Where Am I project. The robot has been upgraded with an RGBD camera. It still has the hokuyo laser sensor. The inputs to the RTAP-Map package are the laser scan data and the raw image data from the RGBD camera.

3.1 The Kitchen Dining

The mybot has created the map of the Kitchen Dining world. Figure 1 shows the world and mybot on Gazebo. After the mapping completed, the visualization of the database can be seen from the Figure 2.

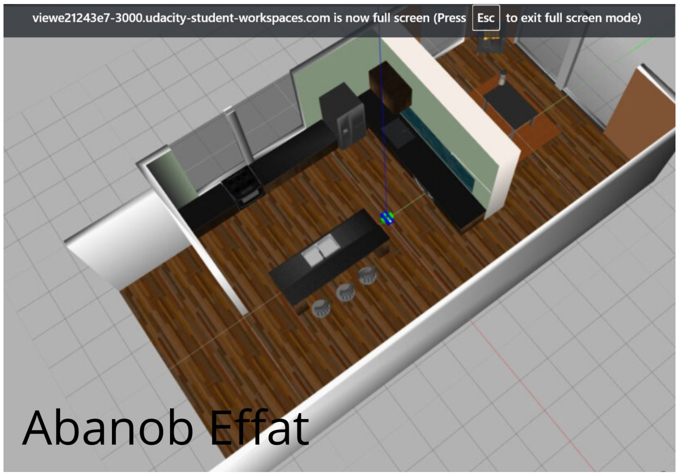

Fig. 1. Kitchen Dining in Gazebo

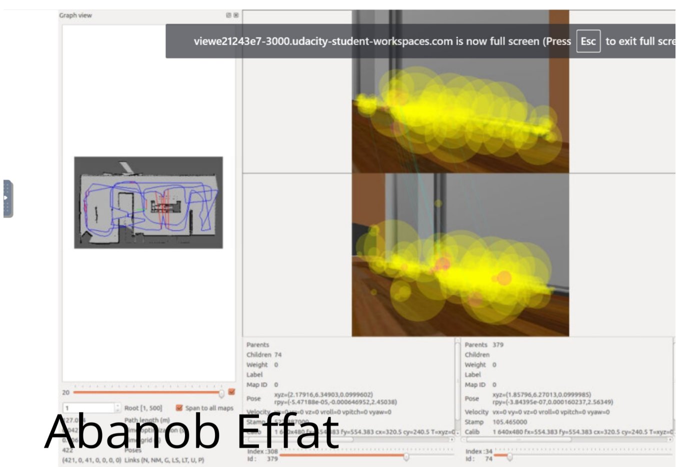

Fig. 2. Kitchen Dining in RTABMap DB Viewer

3.2 The myworld

The myworld was built as the custom environment. To increase mapping accuracy, different types of objects were distributed to the map. Figure 3 shows the custom world in Gazebo. The map from the mapping process is shown in Figure **??**. The screenshot from the RTAPMap database visualization is in the Figure 4.

3.3 Achievements

The algorithm was able to create maps for both of the environments, however, the maps were not perfect. There were little rotations and noises on the maps. Figure 5 shows the frame, and Figure 6 shows the topics and the ROS graph.

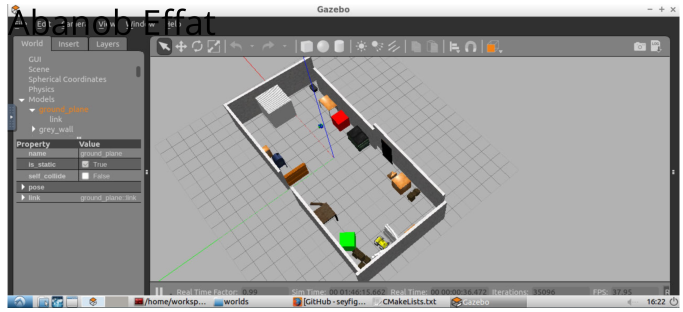

Fig. 3. myworld in Gazebo

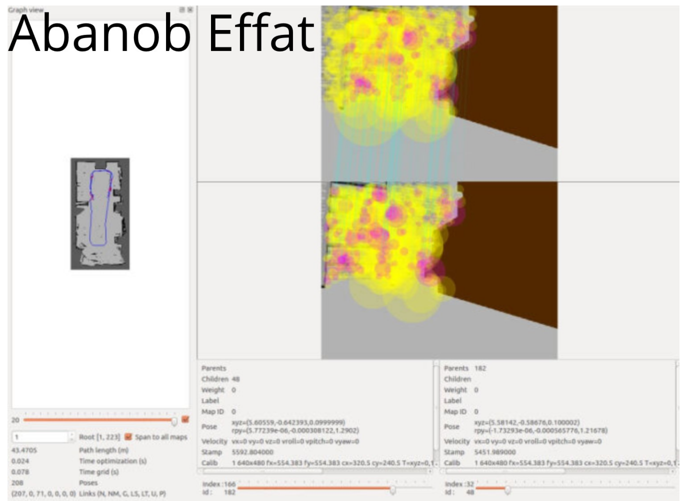

Fig. 4. myworld in RTABMap DB Viewer

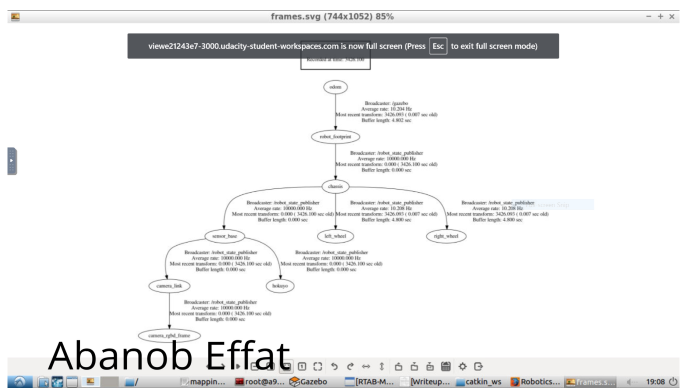

Fig. 5. TF Frames

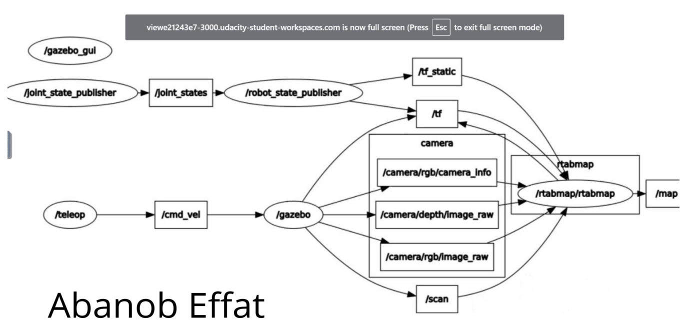

Fig. 6. ROS Graph and Topics

4 RESULTS

4.1 Mapping Results

4.1.1 *The Kitchen Dining*

The map as an image file is shown in Figure 7. The image file does not show an image as successful as the RTAPMap viewer. There exist rotations in the map.

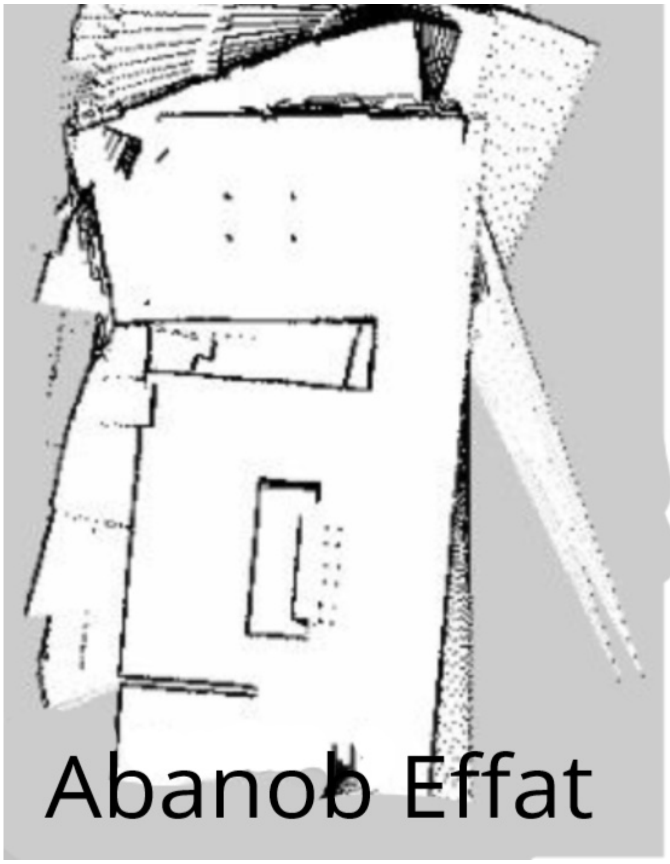

Fig. 7. Kitchen Dining Map

4.1.2 *mybot*

Figure 9 shows the image file saved with map_server map_saver. Again, the saved map is not as successful as the image on the RTAPMap viewer. The map is skewed from the horizontal middle line.

Fig. 8. myworld Map

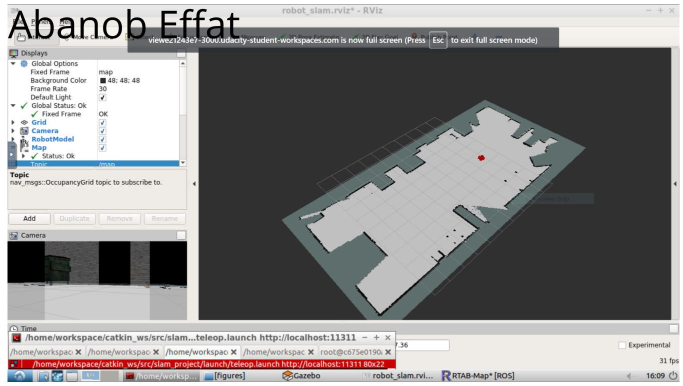

Fig. 9. myworld Map

4.2 Technical Comparison

The first world is a more realistic world. It has objects to serve as landmarks which lead to a better mapping for the algorithm. There are several objects in the custom map, but still, it is harder to create the map of the myworld.

5 DISCUSSION

The algorithm needed more tuning but due to the limit time i will consider it in future work

6 CONCLUSION / FUTURE WORK

It is required to tune the parameters for mapping. Besides, a more complex environment should be created for further tests.
Future work is to set an objective to the robot then let the robot to move freely and do Slam on it's own