Intelligent Robotics - Assignment 1 Report

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1 Introduction

When programming robots using ROS, it is important to create a map of the surrounding area which can be used for challenges such as localisation and navigation.

This assignment required us to map the lower ground floor of the Computer Science building.

2 Method

We began by familiarising ourselves with ROS and initialising the environment. Firstly, we ran, in a terminal, the *roscore* command. This starts up a ROS Master and a ROS Parameter Server. Alternately, running the *roslaunch* commands starts a *roscore*, if there is not already one running.

The robot can be controlled with a USB joystick. This is plugged into the robot and the laptop and run using p2os. We used the joystick to move the robot around the lower ground floor. Whilst we drove it, we recorded a ROS bag file to record data from the laser range finder. By subscribing to the *base_scan* topic, we were able to capture data from the laser range finder. At the same time, we used Rviz to visualise the output of gmapping in real time by also subscribing to the *base_scan* topic and setting the frame to be the map that gmapping is generating.

Initially, we tested this method by driving the robot in a small loop (making sure that it ended in its start position). After this we ran gmapping software which uses Simultaneous Localisation and Mapping ($SLAM$) to create a 2D occupancy grid map from the laser and pose data that we stored in the bag file. The initial map was fairly successful. Static obstacles, such as walls, doors and tables, were represented well.

3 Map

The map initially generated is shown in **Figure1**. The edges are mostly well defined although there were a few regions of the map that were not accurate. Noteworthy artifacts include noise in the bottom right hand corner, skewing of the map on the right side, a black cluster in centre right and spurious hair line extensions into unexplored area.

4 Challenges and Evaluation

4.1 Hardware

The initial challenges we faced involved the hardware of the robots. We often received this error: "Could not open serial device" which indicated that the connection to the laser range finder or the USB controller was faulty. Whilst driving the robot around the room, the connection to the laser was lost. This caused the output to be an unfinished map which was unusable. There were also issues in regard to laser readings as sometimes the laser would not receive a reading, therefore it returned its maximum range; this can be seen on the map as white areas beyond edges. Another

issue that arose was occasional odometry errors caused by one of the wheels slipping on the carpet, thereby causing the odometry measurements to not match the true movement of the robot, which resulted in a slight skew of the map layout.

To mitigate these errors while we created the map, we used duct tape to secure loose wires in place, and to eliminate any spurious laser readings or odometry errors, we made sure to scan an area multiple times and whilst doing so in a controlled manner.

4.2 Environment

During our initial attempt, the lower ground floor was fairly busy. This introduced noise in the form of people walking in front of the sensors and occupying areas throughout the exploration. On the lower ground floor, there are also floor-to-ceiling windows which when scanned by the laser, a number of readings were recorded beyond the glass which could indicate there not being an edge present.

To reduce the effect of these environment issues, we performed multiple scans of the same area to collect overlapping measurements so *SLAM* was then able to remove any dynamic obstacles and re-confirm any static obstacles present in the environment. *SLAM* works by using Bayes' rule to update the probability of edges and obstacles, every time it scans a particular area. Therefore, the more readings that are taken, the more accurate the generated map will be. A further improvement we could have done to reduce the effect of the glass during mapping would be to place a solid object in front of the glass so that the laser would more consistently return values more representative of an edge which would allow *SLAM* to better determine that the glass window is in fact an edge. **Figure 2** shows the resultant map after following some of the improvements.

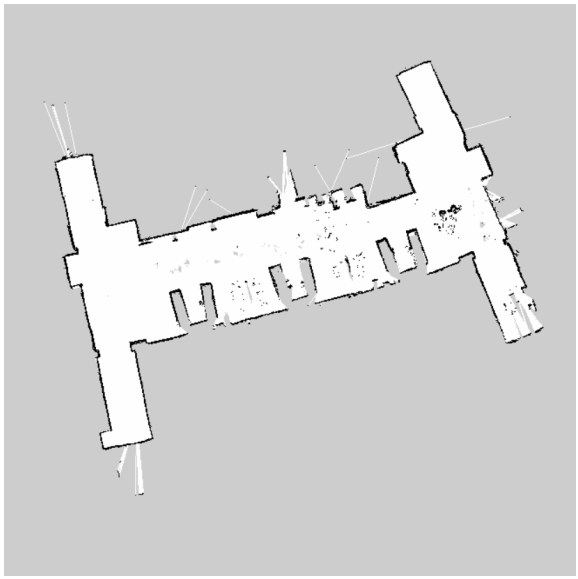

Figure 1: The map generated from the robot's exploration of the Lower Ground Floor (white = explored area, grey = unexplored area, black = defined edge)

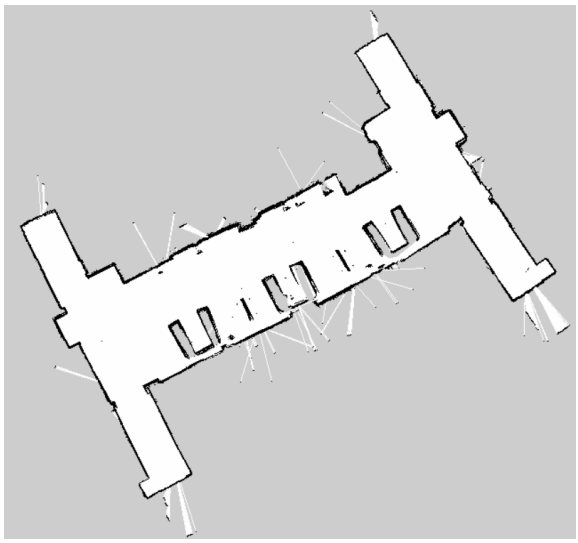

Figure 2: The map after following some of the suggested improvements (white = explored area, grey = unexplored area, black = defined edge)

5 Conclusion

In conclusion, programming the robot using ROS and generating a map was a success. Despite the challenges described, the overall mapping of the room was mostly representative of the lower ground floor.

In summary, it is essential to ensure the hardware is working reliably from the start, to reduce noise by clearing the environment of people and dynamic obstacles, and remapping areas that have been previously missed.