LABORATORY IV
Particle Filter Localization and Mapping for Lidars

PRA0102 - Group4

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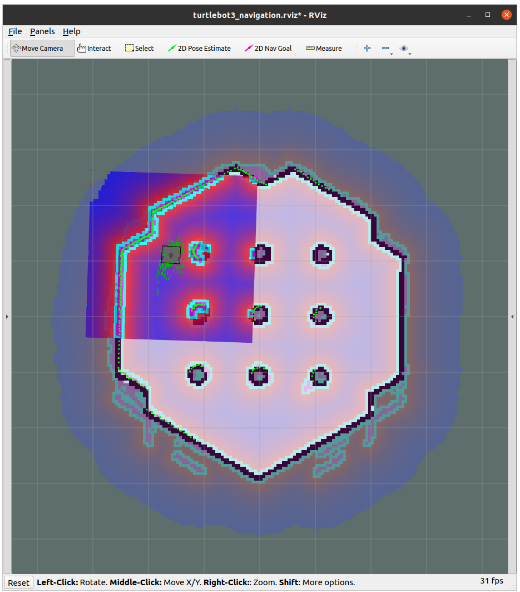
ROB521 Particle Filter Localization and Mapping for Lidars Spring 2024

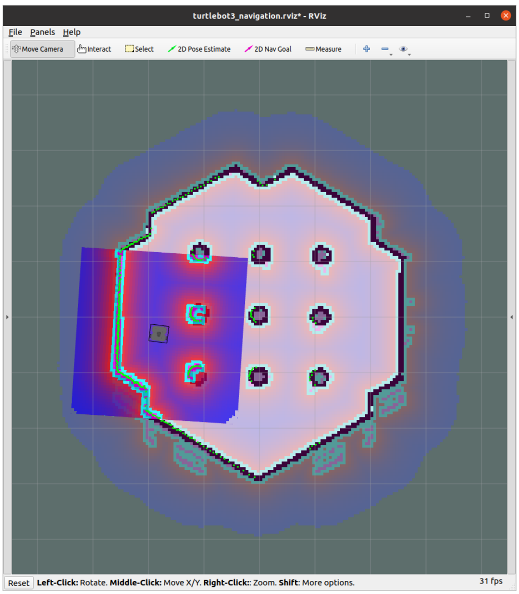
Part 1 : turtlebot3_world localization

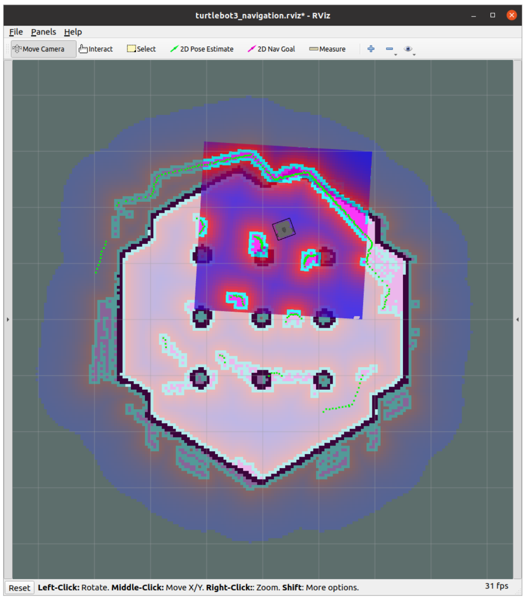
- **Present a picture of the AMCL rviz window with a converged filter**



- **What was the minimum number of particles for successful localization? Are your results repeatable (i.e if you give the robot a new initial pose estimate does the particle filter converge)?**

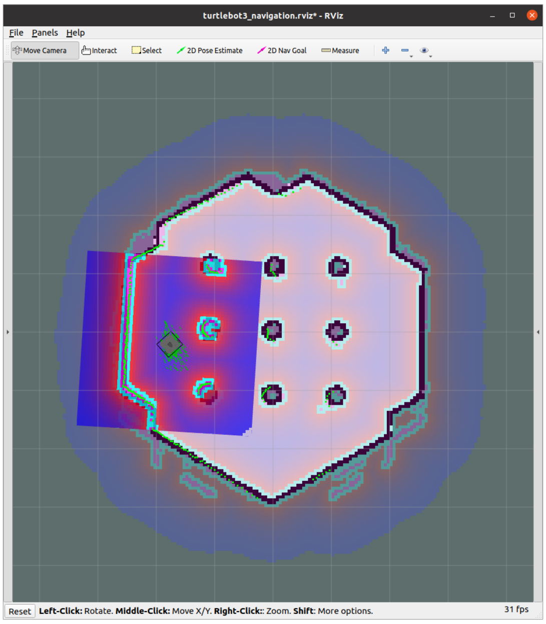
The minimum number of particles for successful localization was 50. The left image shows successful localization with 50 particles and the right image shows the localization failing with 25 particles. Yes, we checked the results are repeatable with new initial pose estimating.

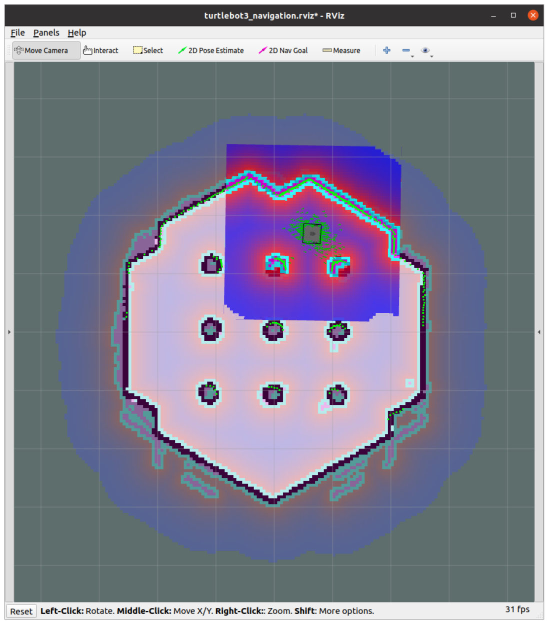




- **What were the maximum odom_alpha parameters before localization failed?**

The maximum odom_alpha parameters was 1.4, and it failed with odom_alpha 1.5. Left image shows successful localization with odom_alpha 1.4 and the right image shows the result failing with odom alpha 1.5.





Part 2 : turtlebot3_world mapping

- Present a picture of your Lab 3 map and your new map.

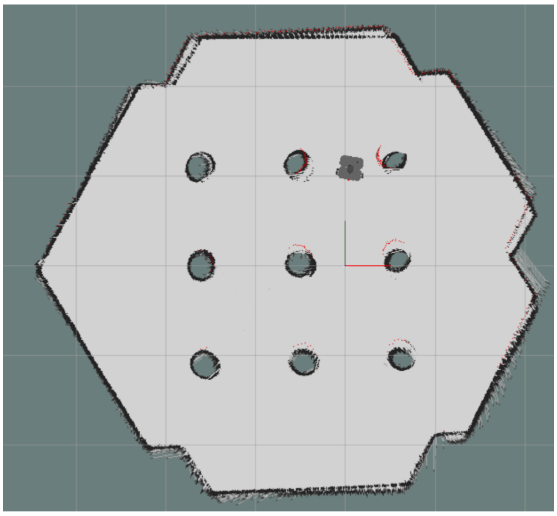
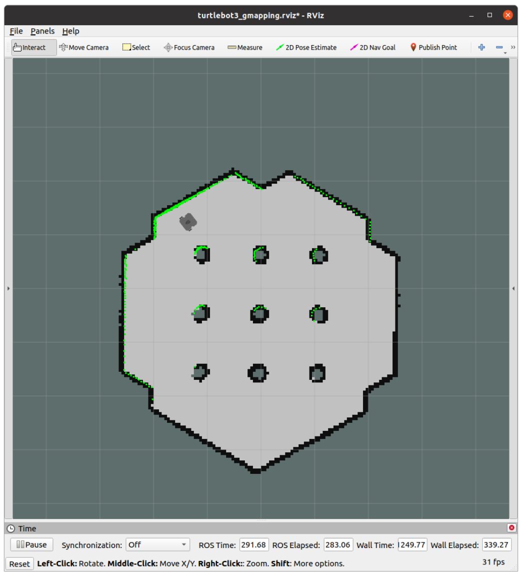


Figure 2: Lab 3 Lidar map solution.



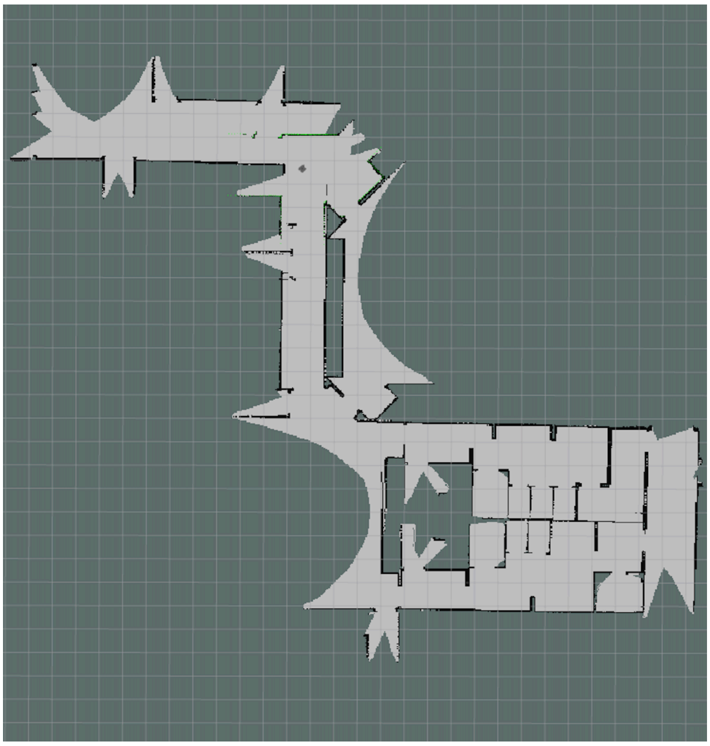
The left image shows a picture of lab3 map and the right image is our new map.

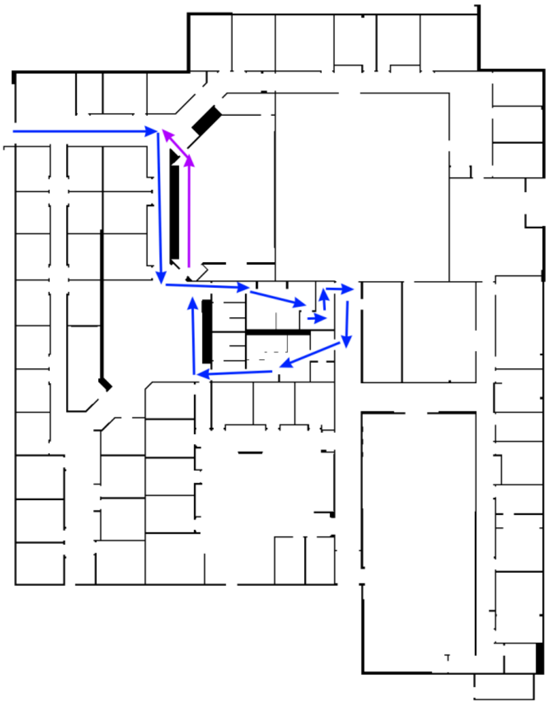
- **Discuss how the localization component of gmapping improved your new map compared to the map from Lab 3.**

The map generated with gmapping presents a clearer and more accurate representation of the environment compared to the original map from Lab 3. gmapping estimates more accurate position of robot and this reduce the accumulation of errors and it results better fidelity. Also overall map quality elevated through error correction like loop closure and map optimization.

Part 3 : willowgarage_world Mapping

- Present your map and the map provided for Lab 2.





- Compare your map to the corresponding part of the map from Lab 2.

From the images above, it is clear that the gmapping package has successfully and quite precisely mapped the willowgarage_world environment. There's a minor distortion in the lower right section of the map, but this is an acceptable, given that it is the most distant area from the starting point and is probably due to the cumulative odometry errors.

- **Describe any mapping issues you encountered and discuss their cause / describe any issues that you encountered when you attempted to close a loop. If the loop closed perfectly, describe issues that you expect you could have encountered.**

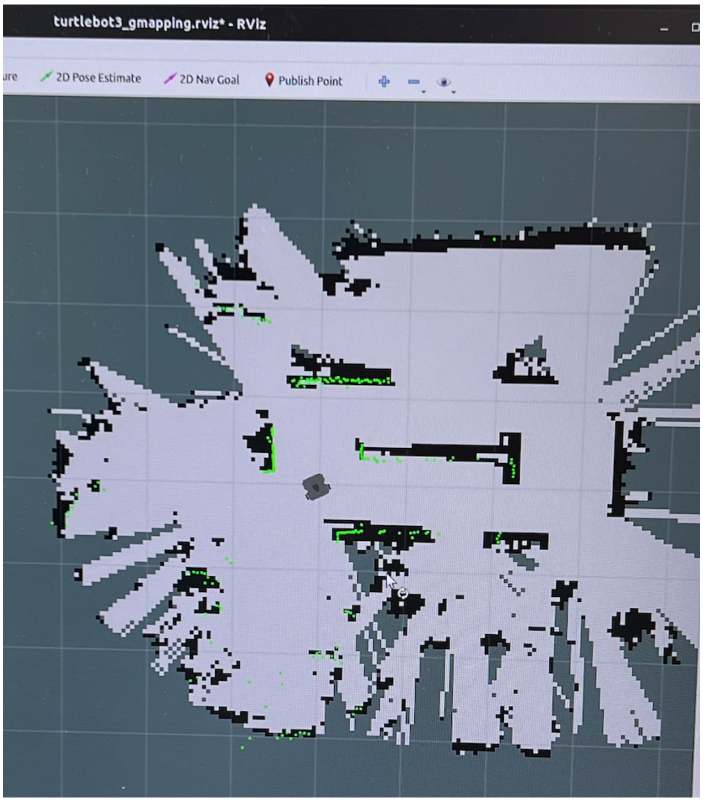
Mapping issues includes discrepancies in room shapes and hallway widths, due to sensor noise or drift in odometry as the robot move through.

For loop closure, there was misalignments which might be due to robot's limitaion in recognizing previously visited areas, often by sensor data not matching up accurately.

If the loop closed perfectly, we might have expected misalignment of features, resulting from variations in sensor readings at different times.

Part 4 : Myhal environment mapping

– Present your map of Myhal.



– Describe any mapping issues you encountered and discuss their cause. Discuss any differences between the real-life deployment and simulation.

In the Myhal environment mapping, challenges included fragmented wall outlines and inconsistent area density, likely due to sensor noise. Real-life deployment also faces variables not present in simulations, such as changing lighting and uneven surfaces, which can lead to inaccuracies in the mapped environment and highlight the gap between simulated predictability and real-world variability.