Individual Lab Report #10

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Team D (CuBi)

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Individual Progress:

During the past two weeks, I mainly worked on:

1. Integrate the exploration module with the mobility and control subsystem.
2. Integrate the exploration module with the localization subsystem.
3. Integrate the exploration module into the state machine.
4. Repair the broken power distribution PCB.

We have had a good progress on the implementation of the exploration module. Previously, we mapped the new test area, and saved a map file on the hard disk. Then we extract the area of interest within the map, decompose it into cells, and generate a coverage plan to visit each cell. In this way, CuBi should be able to explore the room efficiently, searching for toys to pick up, while avoiding known obstacles that are marked in the map.

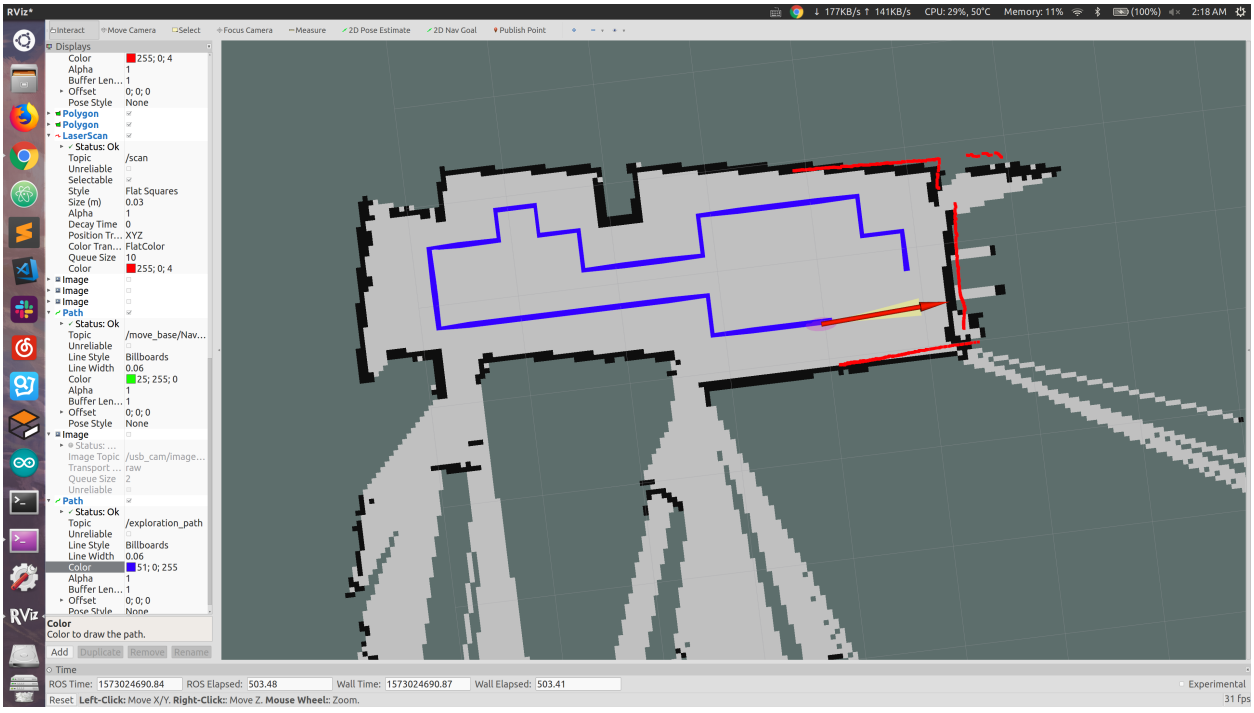

Figure 1. Visualization of the Exploration Path and Robot Odometry

However, since the exploration is written as a completely separate module without any ROS related component, we need to integrate this module with our current system. The current mobility and control requires input of waypoints

with respect to the odometry coodinate frame, and then transform the absolute pose of the point into relative pose with respect to the robot base. Therefore, we perform a query to the TF node every time a new waypoint is received. In addition, the update rate of the localization system should be high enough, and the accuracy should also be relatively high, since it keeps correcting the drift of odometry with respect to the map frame. Thus, the waypoints transformed back into the odometry frame will be consistent and accurate.

I also make some progress on integrating the exploration module into the current state machine. The "search for toy" mode with an in-place rotation that we used for SVD is replaced with the new exploration module. I am still working on implementing and testing the full control loop of the new state machine by adding pick-up and return to base and drop modes. Namely, when CuBi finds a toy during exploration, it interrupts the exploration itself and will resume after the toy is picked-up and dropped.

One extra thing is that the power distribution PCB was broken once, potentially because sometimes we need to charge our batteries, while keep working on the robot by using the wall plug power source, connecting it directly to the output terminals. While plugging the connector in to the sockets, occasionally there are sparks, that may cause a current spike and break-down the zener diode for over-voltage protection. Initially when this happened we smelled something from the board, and the output LED was blinking abnormally. Since we may not have enough time to reproduce the board and replace it, but the entire onboard electronics system relies on it. So I decided to try to repair the board. I used digital multimeter to figure out that the output side was shorted. Then I removed "unnecessary" components, such as filtering capacitors and the zener diodes one-by-one, and test for short circuit after removing each component. After the removal of one zener diode for over-voltage protection, the basic functionalities of the power distribution board resumes normal.

Challenges:

One major challenge that we faced was the motion constraints raised from the size of the robot, especially the front tray.

While testing the integrated exploration mode, we noticed that some waypoints appeared to be too close to the obstacle boundaries, even if we applied a large

inflation radius to all the obstacles. Sometimes going to such waypoints may result in crash, either directly into the wall, or hit side obstacles while rotating in place. This happens because the position feedback control command of the robot base is with respect to the center of the base. However, with the current design, we have a maximum turning radius of around 60cm, which is large comparing to our constrained test space. We also tried commanding the front tray of CuBi to reach a certain position, however when the robot rotates, the position of the tray changes significantly even with a small rotation movement, resulting in undesired oscillations. After evaluating the trade-off between these two control strategies, we decided to resolve this issue by inflating the obstacles more. Although this may result in smaller feasible area to traverse, we do not need to modify our low-level controller much such that we could reduce the potential risks it may bring.

Teamwork:

I have been working together with Jorge and Paulo most of the time last week, on the integration of exploration module, the local planner, and the current system. Jorge developed and implemented the exploration module, that generates a number of waypoints, with x and y coordinates with respect to the map frame. I discussed with Jorge about the necessary interface between the exploration module and the other subsystems, and then implemented and integrated it. We also tested the integrated system together, by making sure it is able to traverse each waypoint efficiently, without crashing into obstacles or walls.

I also discussed with Paulo regarding an additional waypoint-to-waypoint local planner that we need for generating a collision-free trajectory for the robot to follow. This work is still in progress, and we will keep working together on it.

Future Plans:

Our plan for the last 20 days is mainly to integrate and test all the individual subsystems developed recently. We are also aiming to finish implementing any remaining modules, to fix any critical issues, and to perform mock-up FVD experiments as soon as possible. As my individual work plan, I will work closely with other teammates on the integration tests, as well as fixing all the remaining critical issues, such as control jerkiness and localization accuracy.