Individual Lab Report #8

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Team H (PhoeniX)

October 10, 2019

Team-mates:

Shubham Garg
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Individual Progress

The tasks to be completed by the Progress Review 9 for me were: -

1. Work on a drone mission to fly through the window
2. Assist other team members to accomplish their goals for MBZIRC 2nd Progress Report
3. Work on the communication subsystem

Drone Mission to fly through a window:

As a goal for this progress review and the 2nd progress report, we aimed to fly the drone autonomously through a window. The window as ready from previous progress reviews and this time we had to fly through it, given the previous structure was built using wood and foam boards, it was heavy to transport it to Gascola or other locations on the campus outside NSH B-Level. Hence, I and Parv designed a new window just using the foam boards and anchor them to the ground using 2 tripods. This structure was taken to the cut to do outdoor testing as we can see in Figure 1.

Figure 1: New Window Opening

Quickly we realized that the Intel Realsense was not working properly due to lack of features on the window and also since it uses an IR for stereo it didn't work that well outside and we got a lot of noise in the depth images. Hence, we tried to add features by drawing some random lines on the foam board, but the results didn't improve. The depth images were important as the opening detection code relied on this data and without which the drone cannot do visual servoing!

As the progress report was due in 1 day, I quickly prototyped a solution using 4 Aruco markers to simulate the 4 corners of the window and since the marker detection works on normal RGB images we could test it indoors and outdoors. Finally, I wrote the code to detect 4 markers, publish their positions in image coordinates and also publish their depth from the camera to the visual servoing pipeline. In order to help us debug the scenario I also wrote image visualization tool which could help us to see the actual locations of the 4 corners and their desired locations. Before going airborne I and Parv tested it on the bench without props to confirm the behavior (published velocities) if they were as expected or not. Finally, we removed some bugs in the code and then we were ready to test.

During one of the flight tests, I accidentally crashed the drone as the drone had a different landing mechanism and I was not aware of that. Fortunately, the damage was just limited to the loss of 1 propeller. After this incident, I was nervous to fly the drone. Hence, initially I asked Lukas from Team RAMS to help us test our system and later on I started to do it on my own. When I'm not the pilot, I was in charge of running various commands on the drone. In various flight tests initially I didn't get the drone to follow the commands, I thought this was due to me not following the proper sequence of commands, but I confirmed with the other team and I was following the right order of execution to put the drone in autonomous mode.

Since I was the only team member working on the drone, Parv offered to help me with this issue. We went through the whole AirLab source code for the velocity controller and we realized that the rate at which velocities were being published was 20Hz instead of 50 Hz. Finally, we changed the publish rate and with further debugging we could get the drone follow our commands, but the results were not as expected or observed in simulation. The behavior was uncertain and after spending 5-6 days on getting this to work we decided to move onto a new approach.

Miscellaneous contribution:

Given that the second progress report for the competition was due, we had 1 personnel (Kevin Zhang, R.I. Ph.D. student) working on the husky for autonomous pickup of blocks to create a structure (similar to Team RAMS). I played multiple roles in helping him to reach his goal including testing, writing code for UR5e auto control, etc. Another team member (Anish Bhattacharya, R.I. MSR student) was struggling to run his code for his part of the challenge due to ROS OpenCV conflicts with OpenCV installed in the userspace. I helped him run his code by complete removal and proper installation of OpenCV which took us more than 6 hours as the embedded computer did not have enough memory and processing power to build and install OpenCV from source and it took us multiple tries.

Communication Subsystem:

Immediately after the last progress review, Shubham ordered a Wi-Fi router which would help us complete one of the performance requirements of the project. I took the responsibility to set up the router as a base station with a static IP assignment for all the robots and computers which would be connected to the router. The next task was to check if we could get a connection from the router for more than 25m. Hence, I and Parv did this test by measuring the distance from the MRSD cage to the MRSD lab: which was door to door 30m. We placed the drone inside the lab and tried connecting to the router and we could get more than 50% signal, hence the requirement was satisfied.

The next task was to write the code for the communication subsystem. I took an approach to have a common ROS Master on the husky and let the drone use the exported ROS master, but quickly I realized that this was not a feasible solution as that put a lot of processing overhead on the husky which would run out of juice if we started the 4 cameras connected to it! Thus, I dropped the idea and Shubham overtook this task by writing a simple socket program to help us communicate. His implementation worked fine but it was not bi-directional asynchronous as we would like the system to send or receive messages in any order they wanted. Hence, I modified his code with threads to send and receive data packets and now this system is behaving as per expectation and the messages are being stored in a database file.

Challenges:

1. Outdoor testing with the drone using Realsense Depth images
2. Debugging the case where visual servoing commands were ignored by the drone

3. Finding proper publish rate for our commands
4. Setting up of static IP for the devices
5. Export of ROS master with namespace conflicts

Teamwork:

Shubham was working on acquiring the proper router which will be apt for our case as other teams have faced the issue where they lost connection beyond a certain range. He also worked on writing the code for the communication pipeline. Parv was working on the husky to help Shubham with running the GMapping, move_base pipeline and he also did time filtering on the output of the opening detection algorithm. Parv and I also worked on the testing of the entire pipeline on the actual drone. Zhihao was working on the door detection algorithm as the challenge over there was slightly different compared to the window where we see all the 4 sides of the object to be segmented compared to the door where at a time we can just see only the 3 sides (mainly as the camera is mounted way close to the ground).

Future Plans:

The plans for the next presentation are to complete the UAV entering the opening test and showcase an improvised fire extinguishing subsystem:

1. Shubham & Parv – Selection of components for the new fire extinguishing subsystem, building and testing it.
2. Akshit –Continue working on the autonomous door entering test for the UAV
3. Zhihao – Continue his investigation with door detection using point cloud