Individual Lab Report #6

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Team H (PhoeniX)

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Team-mates:

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Individual Progress

The tasks to be completed by the Progress Review 7 for me were: -
1. Work on window and door opening detection algorithm
2. Make a dummy window setup so that we can test this algorithm
3. Data collection for the algorithm
4. Work with other MBZIRC teams using the new DJI Matrice platform and get educated on the interfaces and perform flight tests with this new interface

Opening Detection Algorithm:

I and Parv were assigned the task of developing the algorithm, we used the stereo images from the Intel Realsense 435 camera to segment the regions of interest. Inside this team of 2 members we divided the task such that I was working on the ROS side, mainly transporting the images from the ROS messages, converting them to an OpenCV Mat object, convert this image to binary i.e into foreground and background based on the disparities and a threshold; which would be processed on further by the algorithm which I and Parv decided to use and some parts of this algorithm were developed by Parv.

Algorithm Overview:
1. Get depth image feed from Realsense (Akshit)
2. Threshold the image into foreground and background (Akshit)
3. Apply morphological operations to close the small noisy regions in the image (mainly around edges of an object and the background) (Parv)
4. Find all the contours (majorly connected components of pixels pointing to background) (Parv)
5. Find the best contour which has an area within some threshold (Akshit + Parv)
6. Find the contour center and the distance of the center from the closest point on the contour boundary (Parv)
7. Generate an output image plotting the circle of the radius found in the previous step at the contour center (Parv)
8. Publish these output images as a ROS topic (Akshit)

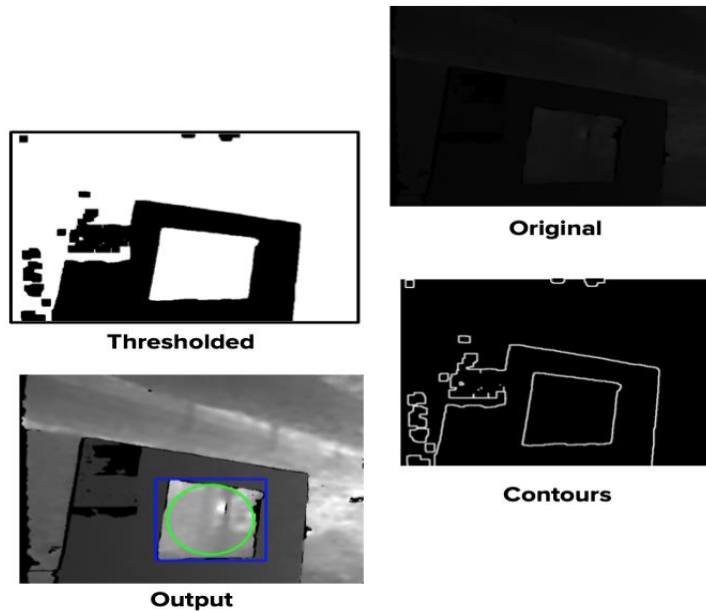These steps and the corresponding image outputs can be seen in Fig 1.

Figure 1: Opening detection algorithm pipeline

Making a dummy structure with a window:

Our sponsor Oliver had some foam boards lying in NSH B512 and asked us to use these boards to make a window to test the algorithm. During the SVD we used some wooden structures which had transparent openings in the center, we used these structures and the foam board combined to make a structure like the one shown in the picture below.

Figure 2: Sample Opening to test the algorithm

Data collection to test the algorithm:

The ideal case to test this algorithm was to get the feed of the front stereo cameras while the drone goes through an opening, but unfortunately there were issues in collecting a bag of the depth images on the DJI hence I used a handheld realsense setup and collected a rosbag by manually moving the camera at different angles.

Another task while collecting the data was to check if the drone remains stable while passing through an opening, we flew the drone manually through the opening outside NSH. I was involved in the testing and we noticed that the drone became unstable while it came out of the opening. I suspect 2 issues:

1. Pilot freaked out while going through the opening because there was a very small margin of error (as the distance between the props and the window was just 3 inches!) hence to keep it centered while coming out, he pushed the sticks hard and hence it became unstable.

2. Or the drone was genuinely unstable due to aerodynamic effects

The reaction in the picture below says it all, on how close it went to the window edge.
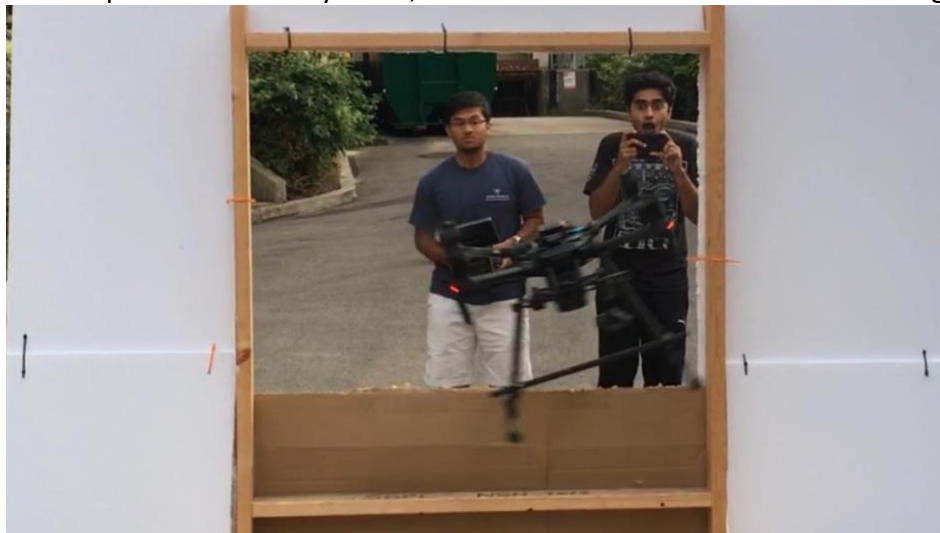

Figure 3: Drone flying through the opening

Working with other MBZIRC teams:

As a part of keeping our team in the loop as we perform the platform change, the team decided to play safe and not port to the new platform right away. Hence we are waiting for other teams to figure out issues with software interfacing, porting the code to DJI SDK, flight stability issues, etc; once these issues seem to be solved we would port but we needed someone to be in the loop while this happens hence I am the point of contact from my team. As a part of this exercise I and Parv went to Gascola on Sunday (September 9, 2019) to test the new platform, test the autonomy stack and overall check the performance of the drone in outdoor environment coupled with data collection for other teams working on the challenge.

In the Gascola test we couldn't get the autonomy stack to work hence we tested it again on Tuesday (September 10, 2019) at the CMU racetrack. We confirmed that the drone follows all the commands and executed multiple trajectories and it was successful. Now I will start going through the code and execute some basic arming/disarming + takeoff and land commands on the new drones as they arrive for our team since we just have 1 drone at the moment.

Other minor tasks:

1. Testing the localization on husky outdoors and indoors: Since the other half of the team was working to get the localization running, I helped them in collecting ROS bags of the odometry data after it's fused by the EKF. My task was to just drive the husky around using the controller manually in some closed-form trajectory which would help us visualize the accuracy of the localization package using rviz. Hence I spent some time driving the husky around; both outdoors and indoors.

Challenges:

Initially, for the opening detection algorithm, we developed the algorithm to check on a sample image as we didn't have the rosbag for the opening images. We verified that the algorithm works but when we ported to ROS we faced a lot of issues especially with the image data types like 16UC1 and 8UC1 as ROS messages had a different encoding compared to what was used by our OpenCV algorithm. Hence we spend some time in converting everything to the right format and got the ros package working.

Apart from this, since we have some hyperparameters in our approach: we had to fine-tune these so that we get very good results out of the algorithm. This tuning was also a challenge and took a decent amount of time.

Teamwork:

Zhihao and Shubham worked on the localization package for the husky by using the new GPS + IMU sensor provided by the sponsor. They had some tough time figuring out this new sensor as it had a lot of functionalities already built in. Parv was helping me with the opening detection algorithm and also came for the field test to Gascola to help me and the other MBZ teams quickly reach conclusions on the new drone platform. Additionally, Shubham is also working on the local planner using the off-the-shelf packages available for husky.

Future Plans:

The plans for the next presentation are:
1. Find the opening center global coordinates

2. Align the drone in front of the opening using a planner/simple waypoint in front of the opening
3. Move the husky using the planner through the opening
4. Develop a local planner for husky