Individual Lab Report #11

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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 12 for me were: -

1. Figuring out the extinguishing mechanism power issues on the DJI drone
2. Performing behavior tree missions on the UAV for the FVD
3. Miscellaneous tasks for husky missions for the FVD

Solving power issues on the UAV:

As mentioned in the last lab report that we were facing reboot issues on the computer mounted on the drone when the extinguisher pump tries to draw more power from the DJI battery interface. To mitigate this risk, we had two strategies: -

1. Open up the DJI drone and route the raw power for the pump directly from the battery.
2. Use a separate battery on the drone for just powering the pump.

I started with option one, where I was in contact with Weikun (a student in AirLab who had previous experience in resolving power issues) and started to take the drone apart. Particularly DJI has made it difficult to open the drone using very heavy-duty adhesives to make it “rain-proof”. Since the FVD was just in 3 weeks, I did not want to risk breaking the drone by applying more force, but the problem was a bottleneck in testing. I spoke to Sebastian Scherer and he told me to go ahead and thus with some help from Weikun, we could open up the whole drone and get to the circuit (as shown in Figure 1) which supplied power to the DJI power port. However, since we were using the newer version of the drone and Weikun did not have any idea about this version, we could not figure out the exact place to extract power from. He suggested splicing the power going to one of the motors and use it for the pump, but again I did not want to risk the FVD. Thus we went with the second strategy, which is shown in Figure 2.

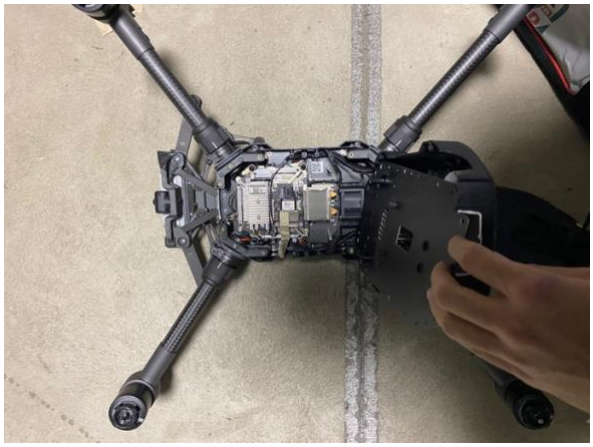

Figure 1: DJI Drone teardown

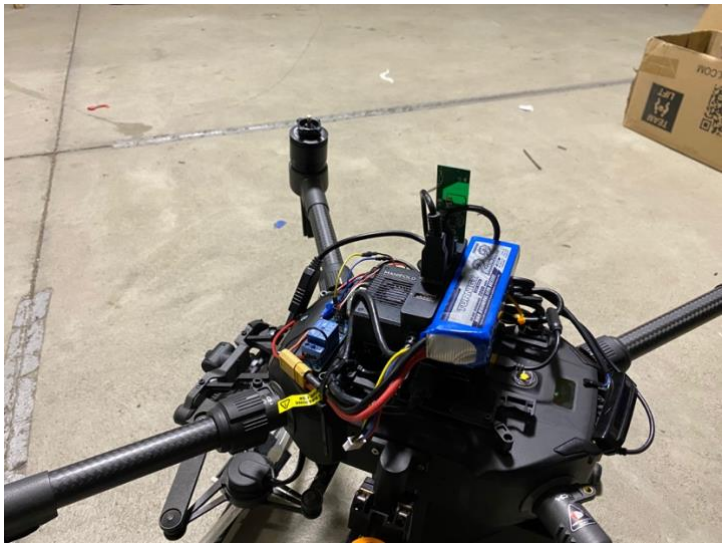

Figure 2: Battery mounted on the UAV

Behavior tree (UAV) mission testing:

1. The behavior tree for the FVD was designed as a part of the last progress review, we (me and Parv) needed to test it and refine the various modules for the mission.
2. Parv and Steve set up the tent for the FVD and we started to perform missions using the tent.
3. My task was to fine-tune the fire detection, localization and extinguishing subsystem based on the mission feedback.
4. I also acted as the safety pilot, to take over the control of the drone if I feel the drone may cause any damage to itself or to anyone/any property
5. During one of the missions, due to a bug in the landing code, the drone rotated 90 degrees which was supposed to be commanded 0 degrees in the local frame but instead, it rotated 0 degrees in the global frame! This bug led to a sudden change in the yaw of the drone, making it drift slightly. Since the tent is too small and we have a very low margin of error, a slight drift in position was enough for it to hit the wall and crash.
6. Post the crash Parv did a detailed analysis of the code and found the bug and fixed it.

Miscellaneous tasks for the husky

Shubham was the only one primarily working on the husky with Parv taking up tasks between the UAV and UGV. Due to good state-estimation and limited issues with the drone, we (me and Parv) could do a lot of testing on it and thus it enabled us to provide more of our effort on the UGV. Particularly the team was facing issues with uneven weight distribution on the UGV which made it wobble around while rotating in place! I changed the indoor wheels to outdoor autonomy wheels, but it didn't bring significant improvement. I reached out to Josh to get a mechanical engineer's perspective on solving the issue, he tried some stuff, but it didn't work

out. We tried filling in the air into the tires, but that approach was also unsuccessful. Finally, we went back to indoor wheels and used T-REX duct tape and it worked!

Shubham was facing issues with the local DWAPlanner where he was not able to get the husky out of the doorway consistently/reliably. I started to dig through the husky_navigation package to uncover the parameters that weren't tuned properly for our husky. I tried many-many approaches, almost spent 4 hours debugging the issue. Finally, when I went back through the online documentation, I figured out about the no_static_map parameter which was set to False. Digging more, I found that this param, when set to false, does not update the map as the robot moves and thus when I changed it to True, everything started to work consistently, and the system actually became more robust because of the other parameters I tuned.

Simultaneously Parv, me and Shubham were working on the behavior tree for the husky where I had less work to do as my fire detection, localization and extinguishing pipeline was ready from the UAV and very little changes were required for the UGV. When the full tree was integrated we started to do missions with the husky as we showed in the progress reviews. We started to see issues during the fire extinguishing time, where the UR5e arm could not locate any fire regions and we thought that we need to finetune some thresholds and hence I and Shubham spent some time doing that only to realize that the multi-ros setup was not working properly. To describe the issue: Nvidia Jetson is connected to the thermal camera, it runs the detection and localization pipeline and published the joint angles for moving the arm. The NUC runs the behavior tree and acts as the ROS master, listens to the target angles from the Jetson and controls the UR5e arm, it is also connected to an Arduino which is used to actuate the water pump. The problem over here was that the Jetson was not able to receive any messages from the NUC even though the ROS Master was exported to the IP of the NUC! Due to limited knowledge on multi-ros setup, we gave up the whole idea of having two computers and switched everything on a single NUC. We realized that running the thermal camera was not possible on the NUC as it was already running 4 cameras and it did not have enough processing power. Thus, we went back to square one where I finally figured out that the ROS IP on the NUC was still the localhost whereas it was supposed to be the private IP of the NUC. Just making this small change everything started to work seamlessly and we could achieve the goals for the PR.

Challenges:

1. Testing the behavior tree on the drone.
2. Dealing with nervous moments as a safety pilot when the drone is inside the tent where it has to fight with its own turbulence!
3. Husky DWAPlanner parameter tuning
4. Missions on the husky using multi-ros setup
5. DJI drone teardown and repair

Teamwork:

Shubham was working on the husky behavior tree primarily. He was also looking into the planner issues. Parv was helping me and Shubham with UAV and UGV behavior tree missions and testing. He also set up the cage with the help of Zhihao. Finally, Zhihao was also helping us out in testing the husky missions.

Future Plans:

The plan now is to do a collaborative mission on both the systems. Make the system more robust, figuring out the FVD logistics and do a lot of testing!

1. Shubham – Work on the collaboration subsystem to share the fire locations
2. Parv – Work on creating a single map frame between the UAV and UGV
3. Akshit – Work on a better fire exploration strategy for both the robots
4. Zhihao – Help everyone with the FVD missions and logistics