Individual Lab Report #9

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Team A / Team Avengers

Teammates: Tushar Agrawal, Sean Bryan

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I. Individual Progress

Last PR, I demonstrated first steps towards the integration of the Navigation Stack with the UAV system. I established link between the pixhawk and the navigation stack using the mavros as the medium. For the past couple of weeks, I have worked on further integrating the obstacle avoidance subsystem with the onboard system of the UAV - Odroid.

I have divided my work from the past few weeks into the below mentioned sections:

1. Getting complete Obstacle Avoidance subsystem functioning on the UAV

2. Testing the complete obstacle avoidance sub-system on the UAV and tweaking Navigation Stack parameters

1. Getting complete Obstacle Avoidance subsystem functioning on the UAV

Previously, I had the Navigation Stack running on laptop and communicating with the Pixhawk. Base local planner that is used in Navigation stack controlled the motion of robot by passing rotational velocity commands. However, by doing tests in simulation and on actual UAV I found out that the APM flight firmware did not support control via rotational velocities. Hence, we had to change to PX4 flight firmware on Pixhawk.

Tushar changed the firmware and moved the Navigation Stack code onto the Odroid. We then tested UAV navigation from point A to B using the navigation stack. The result wasn't good. The UAV could not reach a goal of 4m exactly in front of it. It kept on moving in different directions and rotating. As a solution to this problem, I replaced the default Base Local Planner of Navigation Stack with the Dynamic Window Approach Planner - DWA Planner.

DWA Planner generated better trajectories and gave better intuitive gain parameters to tweak when compared to the default Base Local Planner of Navigations Stack. With this successful change I got the obstacle avoidance subsystem functioning on UAV.

2. Testing the complete obstacle avoidance sub-system on the UAV and tweaking the Navigation Stack parameters

Even after I shifted to the DWA Planner the UAV could not reach the goal position. Though the trajectory generated was smooth the UAV kept rotating and move in different directions. I tweaked the parameters of the planner and other subparts of the navigation stack to get good smooth movement of the UAV over the trajectory. Then I placed an obstacle of around 1.5 m X 1.5 m size in the path of UAV and the UAV avoided it while moving towards the goal.

Here is a video showing a demo of the UAV doing autonomous navigation to the goal position while avoiding obstacles - https://www.youtube.com/watch?v=r1X6UWgTfsM. The UAV can detect an obstacle from a distance of 3m and it maintains a distance of 0.5m from the obstacle at all time.

Challenges faced

1. As described in section 1 I faced issue of the UAV not accepting angular velocity command. As a solution we had to shift to PX4 from APM firmware
2. On APM I used simulation to test functioning of navigation stack. However, to do the same for PX4 in simulation wasn't trivial. The documentation for installing PX4 simulator is poor and it took considerable amount of time and effort.
3. One of the reason why the UAV didn't follow trajectory was because of slow update rate of odometry. Odometry data was published at a rate of 0.5Hz. Tushar worked on it and changed the baud rate of the mavros system so that we obtained a update rate of 30 Hz. With this the UAV started to better follow the trajectory.
4. As described in section one and two above I had to try with Base Local Planner and DWA planner to generate good paths. Though DWA planner theoretically promised to generate better trajectories I had to tune many parameters. I believe I will need to tune the parameters again as I integrate lawn mover search with obstacle avoidance.
5. While testing autonomous takeoff and landing subsystem our UAV crashed from a height of around 15 meters! We had multiple ripped off motors, electrical connections, mechanical connections and broken propellers. Getting the UAV up and running again was quite a challenge. However we got it functioning again and successfully carried out more than 7-8 tests for the obstacle avoidance and autonomous takeoff and landing subsystem.

II. Teamwork

For this PR I worked along with Tushar. Tushar installed navigation stack on Odroid. We worked together to test the obstacle avoidance. He solved the above mentioned critical issue of slow update rate of odometry. Tuhar also got entire autonomous takeoff and landing pipeline working.

We as a team worked on brainstorming ideas to make mock obstacles for SVE Test. Sean is taking lead on this aspect and is building the obstacles for the test.

III. Future Work

Currently, I demonstrated point A to B navigation with obstacle avoidance.

Next, I will integrate lawn mover search with obstacle avoidance. That implementation will complete the obstacle avoidance subsystem integration with the complete UAV system. The UAV should then be able to search for a marker and land on the marker while avoiding any obstacle that comes in its entire path.