Individual Lab Report #10

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Team A / Team Avengers

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I. Individual Progress

Last PR, I demonstrated the lawn mover search implementation with obstacle avoidance. I faced issue in lawn mover search implementation at lower heights. Apparently when we recorded the data to debug the issue we found out a major issue with our obstacle avoidance system. We obtserved lot of noise in the lidar data. I had tested the lidar indoor before but not outdoor. Previously I had concluded that the improper functioning of the navigation stack was related with tuning the parameters. But the lidar data being noisy explained a lot about non-satisfactory functioning of obstacle avoidance system. Last couple of weeks i worked on solving this issue. Currently the status is that I have overcome the issue as explained below. I will over this week now test the complete obstacle avoidance pipeline with the fix for the sensor issue.

Below mentioned sections describes in detail about the sensor issues that I faced and the solution that I implemented.

1. Our obstacle avoidance sensor - Hokuyo URG04lx generating noisy data in outdoor environment

2. Solution part 1:

- Replacing our current sensor (Hokuyo URG04lx) with outdoor sensor UTM30lx

3. Solution part2

- Filtering the lidar data
- Solving the Navigation stack raytracing issue

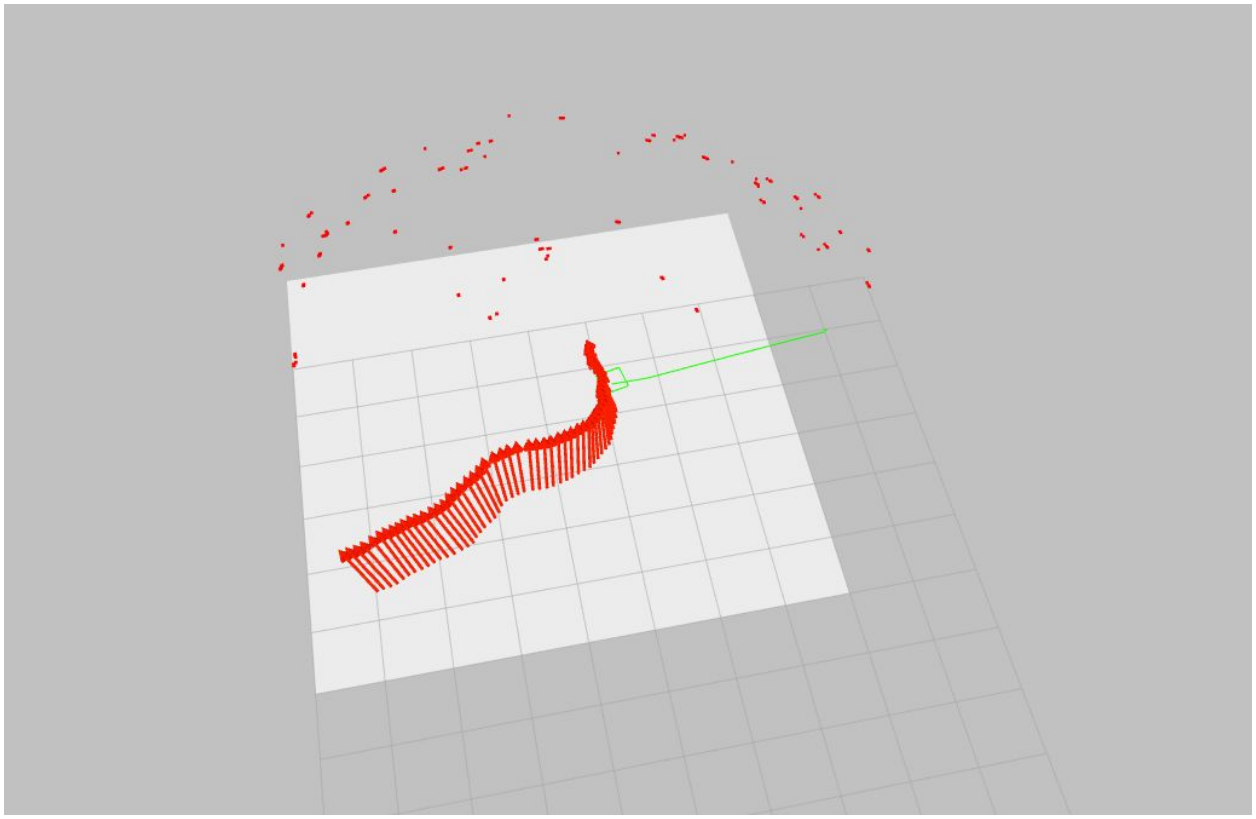
1. Our obstacle avoidance sensor - Hokuyo URG04lx generating noisy data outdoor

In my previous ILR I had mentioned that I faced three issues when I did lawn mover search with obstacle avoidance for the UAV.

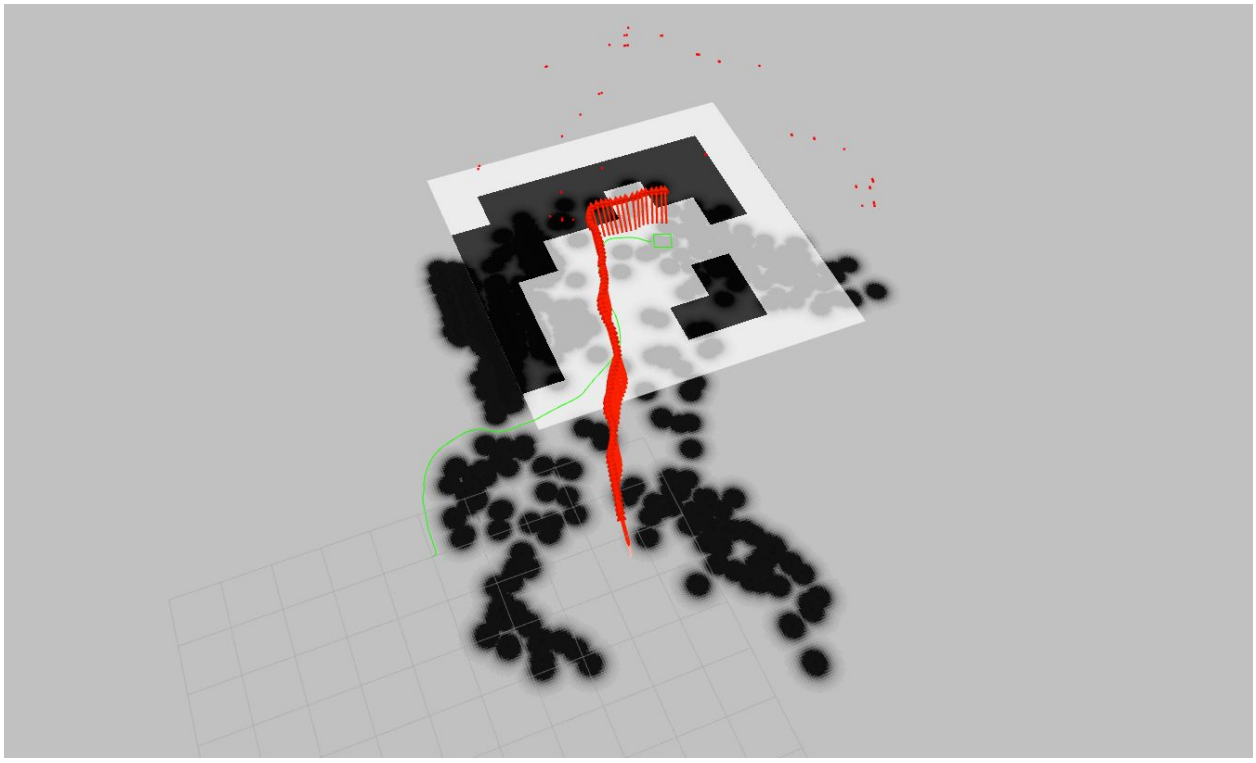
First, the UAV kept lowering its height at low altitudes of around 3m. Tushar solved this issue by writing an PID control for z axis. With this we now have stable flight at low altitudes.

Second issue was that the UAV kept on rotating at low height. And third issue was the DWA planner was frequently unable to generate path. To solve these issues I redid the lawn mover search with obstacle avoidance test and recorded the data this time. On analysing the data I found

a major issue. The data generated by our obstacle sensor Hokuyo URG04lx contained lot of noise as shown below.



As a result of the above shown noisy data the costmap though there are many obstacles around the UAV and so the navigation stack generated a path avoiding all those obstacles which resulted to the issue of UAV rotating arbitrary or the planner failing to produce path considering there are obstacles all around the UAV.



The black spots show the obstacles as registered by the costmap. The red dots are lidar value when there is no obstacle in front of it. The green path is the path generated by the navigation stack.

Going through the datasheet of the lidar I came to know that the sensor is rated as an indoor sensor and it is not recommended for outdoor use. It faces IR interference and as a result generates non-reliable data.

3. Solution part 1:

- Replacing our current sensor (Hokuyo URG04lx) with outdoor sensor UTM30lx

There were two solution to the sensor problem.

1. Obtain an outdoor lidar from other labs at CMU
2. Filter out noisy data from our current sensor

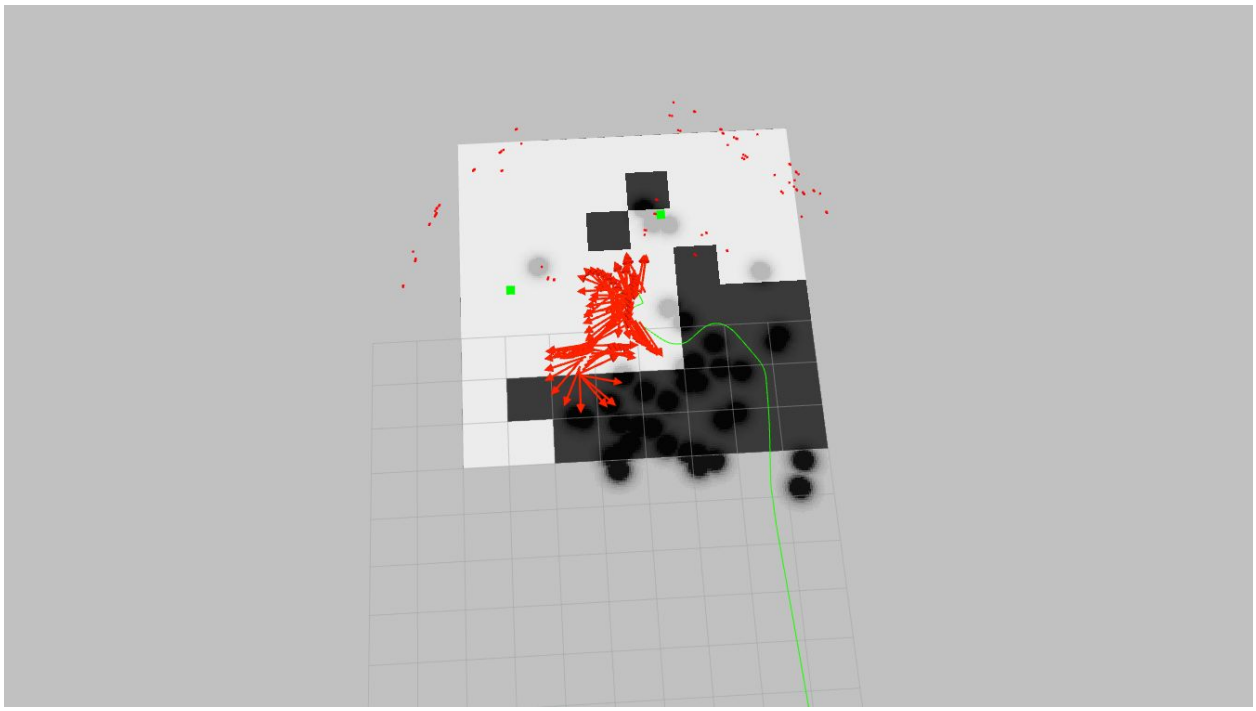
After talking to many people at different UAV labs at CMU today (13 April 2016) we obtained an outdoor lidar (UTM30lx) sensor. I along with Tushar worked on setting up the new lidar. The new lidar wasn't a plug and play sensor as it required 12v supply and all the outputs that we were aware from the X8 plus UAV gave unregulated 14-16 v (from our lipo battery) or regulated 5v supply from BEC. Understanding the power circuitry of the X8 plus in depth we found a

solution. We found and used output designed to power gimbal. It satisfied the voltage and current specification need by the UTM30lx sensor. After successfully mounting the new lidar we tested it indoors. It gave reliable reading. Next step in this area is to test the sensor outdoors. I will be doing this test this week.

3. Solution part2

3.1.Filtering the lidar data

Though we obtained new outdoor lidar all the lidar rated as input or output face IR interference issues. To solve this issue I implemented median filter on the lidar scan data.



In the above figure the red spots are unfiltered output from our previous indoor sensor. The 2 green dots are the filtered output. As seen the noise is greatly reduced by median filter.

3.2 Solving Navigation stack raytracing issue

As visible in the above mentioned figure even though the lidar sees less noisy data after filtering the costmap remembers all the noisy data as obstacles and does not clear them later. I solved this issue by understanding and implementing the raytrace feature which clears the costmap based on lidar data.

Challenges faced

The above section majorly describes all the technical issues that I faced. Other Than the technical issues I faced issue obtaining the new lidar data! I had to reach out to many professors and graduate students to find a spare outdoor lidar. Finally I did obtain a spare lidar.

II. Teamwork

Tushar worked on running the whole project pipeline from starting to end without obstacle avoidance. He also wrote PID control code for z position hold and increased the fps of marker search algorithm. We worked together to figure out issues of indoor lidar, obtaining new sensor and mounting it.

Sean worked on developing code of z control and setting up simulation for testing.

III. Future Work

I will now firstly test the new lidar outdoors. Then I will test the complete project pipeline with obstacle avoidance.