Nick Crispie
Team C: FlySense
Shivang Baveja
Joao Fonseca
Hari Suresh
Nihar Tadichetty
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Personal Progress

This week I worked on coordinating flight testing, improving the Gazebo Simulator, and helping to finish implementing the obstacle avoidance simulator in the DJi environment. As a team, we had a major test flight with NEA at Nardo Airfield where we tested the integrated system with David Murphy, a pilot employed by NEA.

For that flight test, I was in charge of flight planning and managing the schedule of testing. After a meeting with the team and NEA the previous week to walk through the test, I created a detailed test plan in order to spell out exactly what we wanted to test when we got to the test site and who would be in charge of what.

I detailed 5 different tests, each progressing in difficulty. One main challenge was that David hadn't flown with an FPV camera for a drone before, only within line of site. Since our system is meant to aid pilots in the perception of their surroundings, we wanted to make sure he was comfortable with the setup first before trying anything too complicated. The test sequence was planned as follows:

Personel:

- David Murphy (Pilot in Command)
- Shivang Baveja (backup pilot and test engineering lead)
- Nick Crispie (Test Director)
- Joao Fonseca: Videographer
- Hari Suresh: Videographer
- Nihar Tadichetty: Test engineer

Test 1:

- Objective:
    - System Familiarization
- Procedure:
    - Pilot will fly quadcopter into the container area with line of sight of the vehicle at all times
    - Pilot flies vehicle into back of enclosed area, turns around and comes back
    - Pilot will run trial again with FPV view and Bird's Eye View

Test 2:

- Objective:
    - System familiarization (a little harder this time)
- Procedure:
    - Pilot will fly quadcopter around the container area
    - Pilot will lose line of sight around back, flying with FPV and Bird's eye view
    - Pilot will land back at start location

Test 3:

- Objective:
    - System Familiarization
- Procedure:
    - Pilot will fly quadcopter along route, looping around containers before flying *head first* into enclosed area. Pilot flying exclusively with FPV and BEV
    - Pilot flies vehicle into back of enclosed area and lands

Test 4:

- Objective:
  - Demo dry run
- Procedure:
  - Pilot will fly quadcopter along route around the containers **forward**
  - At opening of container enclosure, pilot yaws the vehicle around so the front (FPV side) is facing away from the back
  - Pilot navigates **backward** to back of enclosed area, and lands
  - Pilot navigating exclusively by FPV and BEV

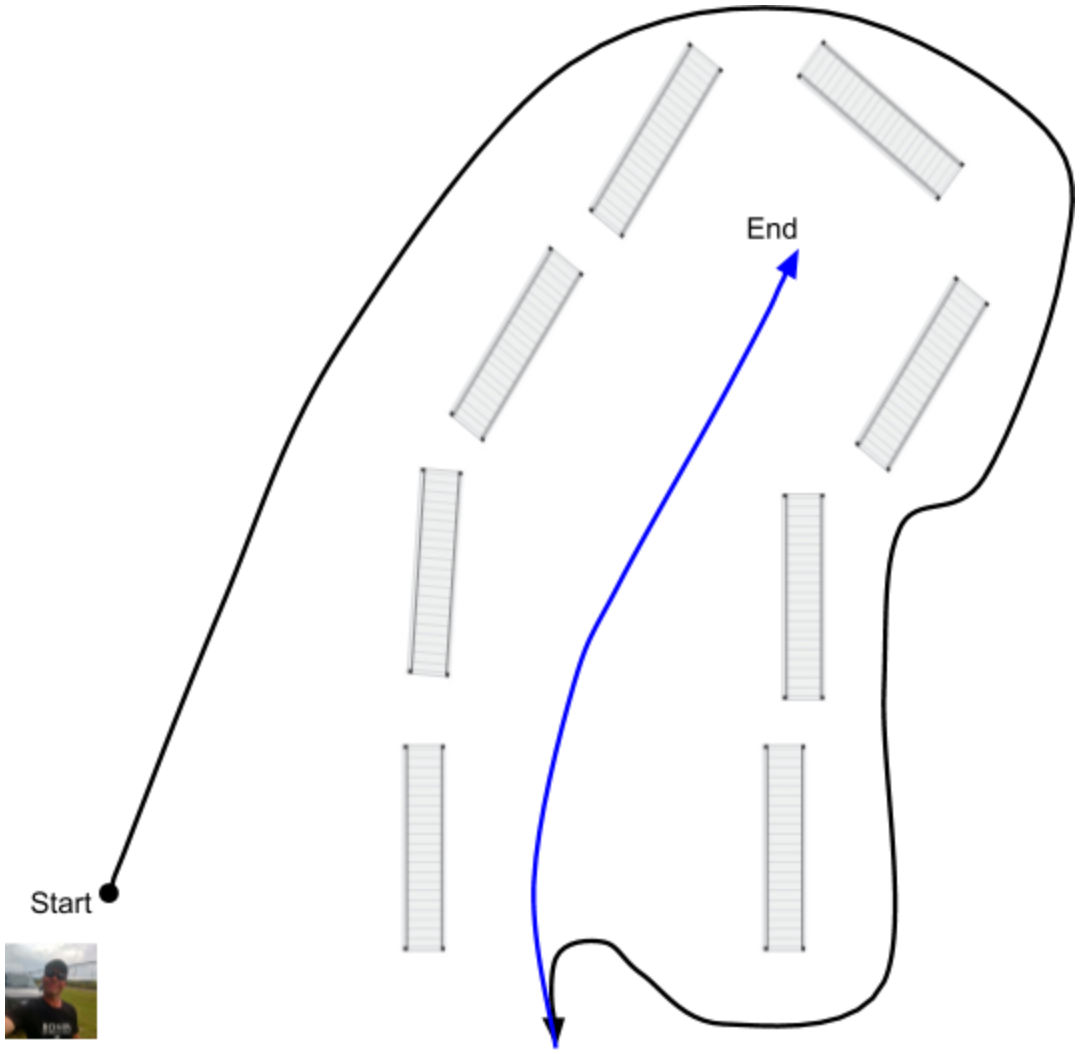

Figure 1: Nardo flight diagram for test 4

Test 5:

- Objective:
  - Challenge run

- Procedure:
    - Pilot will fly quadcopter along route, first around the containers **forward**
    - At opening of container enclosure, pilot yaws the vehicle around so the front (FPV side) is facing away from the back
    - Pilot navigates **backward** to back of enclosed area, and lands
    - Pilot takes off, turns 180 deg around, then flies **backward** out of enclosure
    - Pilot navigates vehicle **forwards** around the enclosure back to the start
    - Pilot navigating exclusively by FPV and BEV

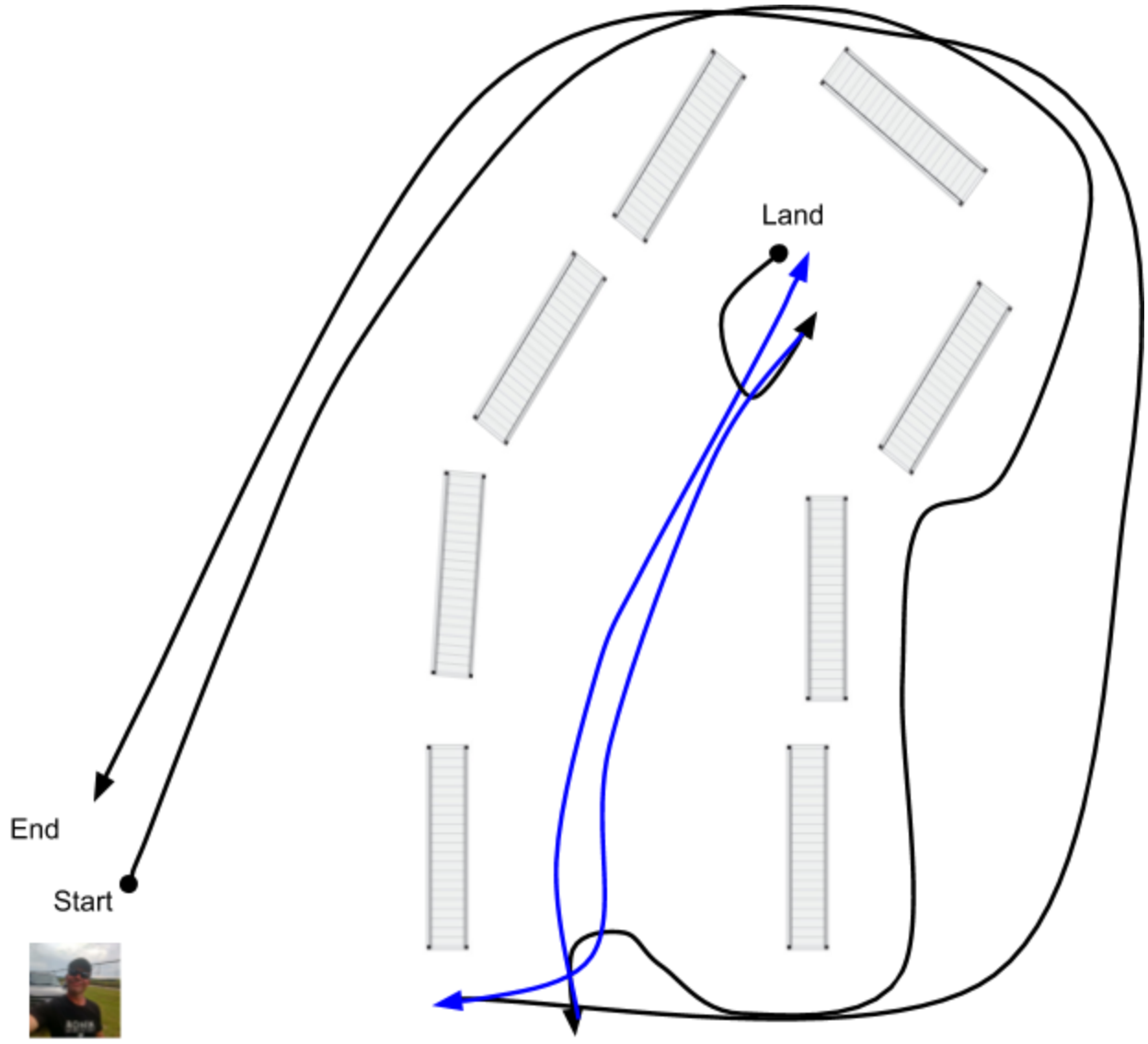

Figure 2: Nardo flight test plan 5

What ended up happening is we quickly progressed through Tests 1 and 2 with David feeling very comfortable with the system. We then progressed to modified versions of Tests 4 and 5, with David looping around the containers and going in and out, outside of his field of view and not in the direction

the FPV camera was facing in order to demonstrate the system. We were not able to get as close to obstacles as we would have liked, and our testing time was cut short by gusts of wind up to 15-20 knots by the time that we left. In total, it was a great team success and everyone did their part in making it happened.

Figure 3: FlySense drone getting ready for one of its flights at Nardo Airfield

Another key work product for me from this week was improvements to the Gazebo simulator that I has started before the last PR. From last IRL, I had set up the software to be able to get data from a bag file, and move the DJI quadcopter around and get LIDAR data, though it was coming in flashes since the ROS time was messing up with the bag file time. This time around, I was able to filter out the tf data from the bag file to avoid this timing issue, confirming that the setup worked with the bag file. I then worked with Shivang and integrated the software with the DJi controller. We encountered a few issues along the way, namely slow loading and occasional crashes. I'll describe these issues and their solutions in more detail in the challenges section. We also added an FPV camera to the drone in order to show the FlySense system live, and I constructed a Gazebo World to replicate what we flew in at Nardo. This is what we are planning on showing for National Robotics Week.

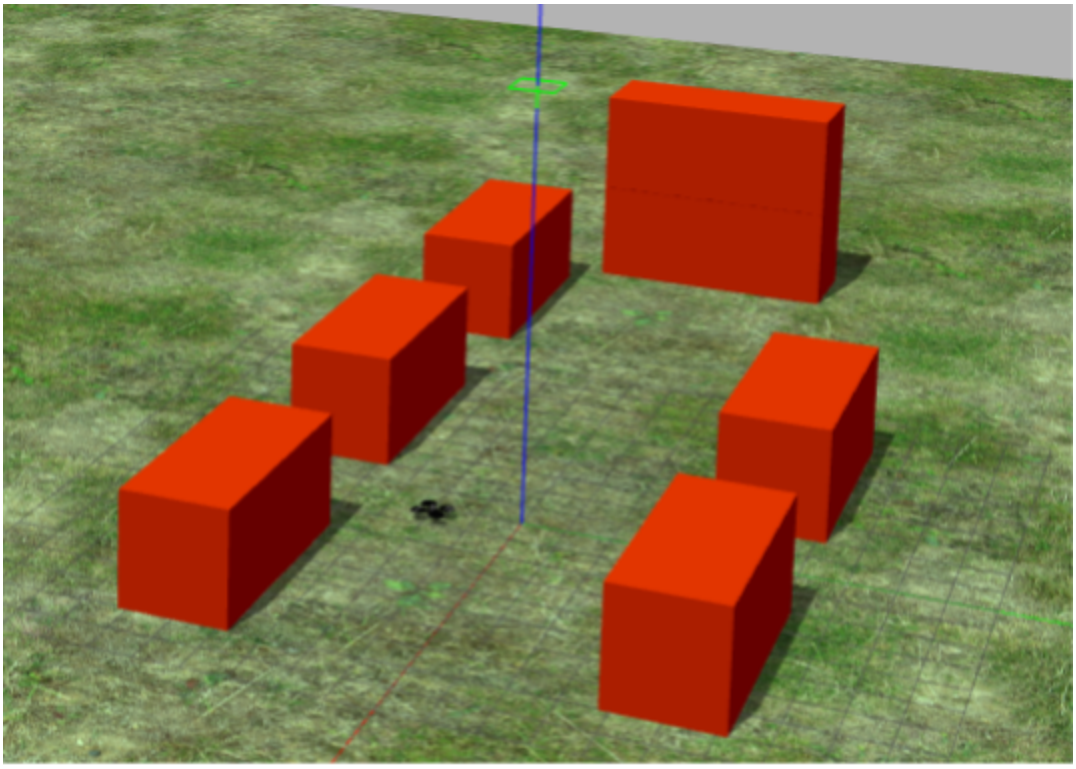

Figure 4: Drone flying in Nardo Airfield Gazebo model with shipping containers arranged in a U-shape

Finally, I also worked with Shivang and Joao to finalize the obstacle avoidance code. Joao made some adjustments to the model parameters and we were able to get a smoother stopping behavior in the DJI PC simulator. The next step for that is to do final live testing so we are prepared for the live demo during SVE.

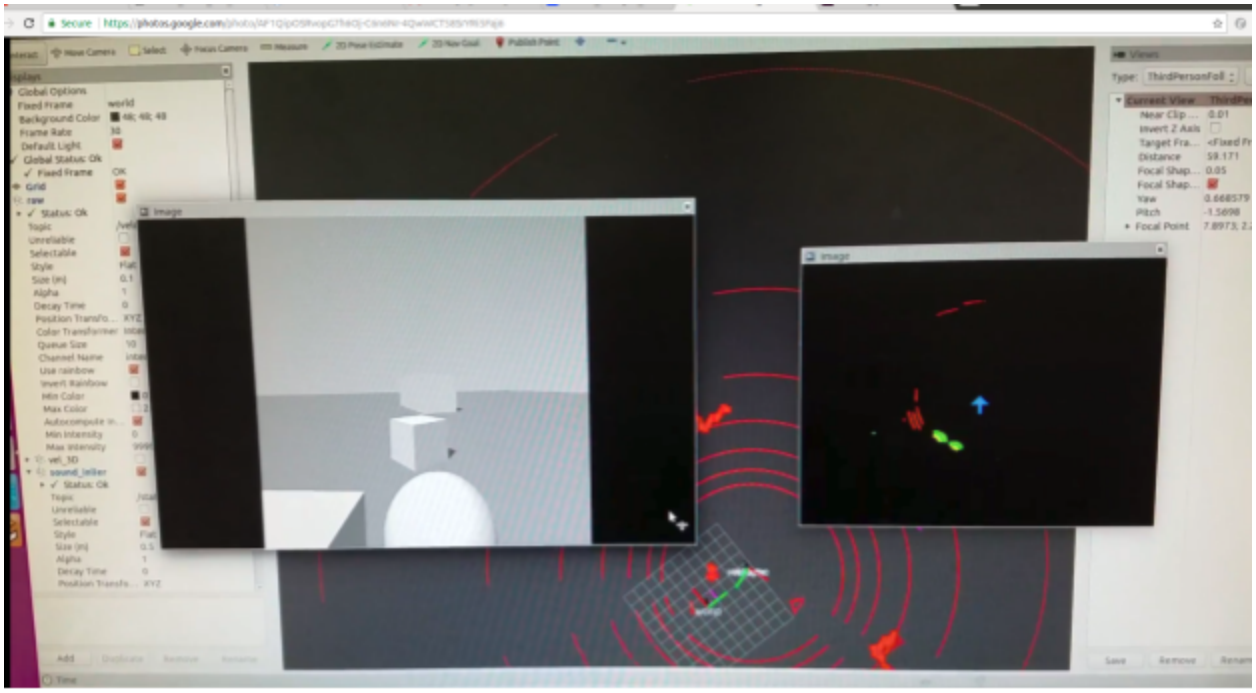

Figure 5: Flying with FlySense in the Gazebo simulator, with background rViz showing the point cloud generated by the virtual LIDAR

Challenges

The big challenges for me came about working through issues I was seeing when trying to integrate my Gazebo code with the DJI PC simulator. Shivang and I encountered an issue where the model would take a very long time to load on the Jetson, and not update properly with any sort of reasonable speed. To resolve this, we combed through the code line by line and stripped out parts that were unnecessary for the core functionality of the simulation, including the complicated DJI drone airframe CAD model. This sped up the process and resulted in the model updating better, but the model would still crash periodically. In order to fix this, we reduced the number of points that the VLP-16 LIDAR was registering as it went around in a full circle, since the Jetson didn't seem to be able to support a denser point cloud when it got a lot of hits near obstacles. This fix resolved the issue, and now the software is much more robust.

As a team, it has been challenging overall to get the final bits of integration tracked down and working. The sound integration took a while to actually happen, but that got resolved recently and has been tested with the full system and is ready for SVE.

Teamwork

Shivang Baveja: Shivang worked on improving the Gazebo model with me and the obstacle avoidance simulator with Joao and me. Shivang was also the technical lead when running the Nardo demo and helped test the final integration for the sound warnings.

Joao Fonseca: Joao worked on the sound warnings with Hari and obstacle avoidance refinements with Shivang and me. He was also a videographer and test engineer for our flight at Nardo.

Hari Suresh: Hari worked on sound warnings and making some improvements to the coloring for the Bird's eye view. He took video during the test and made some great videos after the fact to document the progress.

Nihar Tadichetty: Nihar worked on final improvements to the AR interface and finalize the sound integration on the user interface/AR side of the system. He was a test engineer for the user interface during the Nardo demo.

Future Plans

Right now, it is mostly making some final improvements on the fit and finish of the system in order to be ready for SVE. We need to do a final flight to confirm the obstacle avoidance works, and do a practice test of the live system at Flagstaff Hill. We were anticipating testing at Nardo, so we are making additional plans to practice test at Flagstaff Hill after John alerted us to his scheduling constraints.
For myself specifically, I'll be helping to refine the obstacle avoidance and Gazebo simulator, as well as putting some time into integration testing and planning out how the demo will go.