Progress Review 8

Cole Gulino

Team C / Column Robotics

Teammates: Job Bedford, Erik Sjoberg, Rohan Thakker

ILR # 7

February 11, 2016

Individual Progress

This week of the project I worked again with Rohan Thakker in order to get the Iris+ autonomously hovering. My individual contribution to this part of the project was to develop the software framework in order to get the Iris+ up and running with the PXFLOW hardware. The setup for the Iris+ hardware is shown in Figure 1.

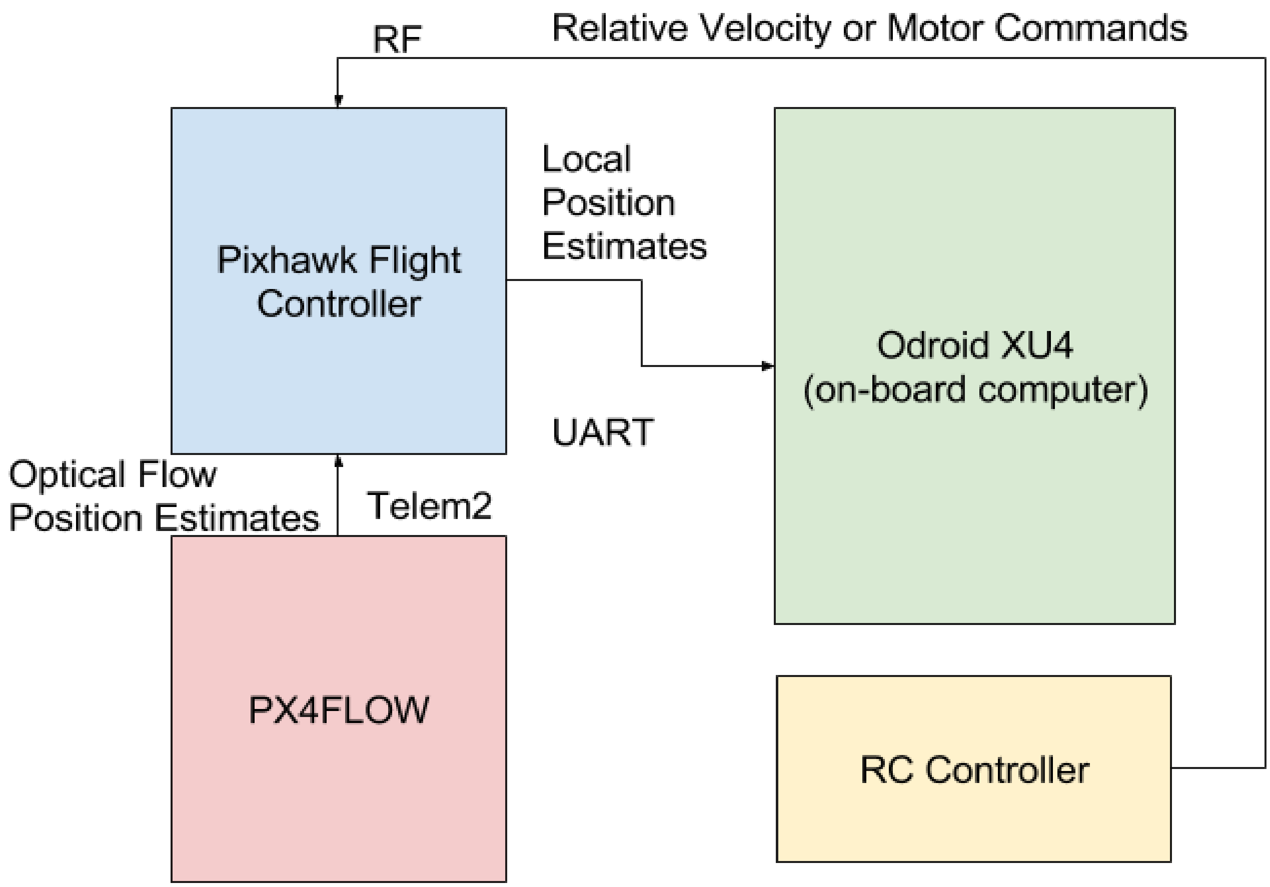

Figure 1) Hardware Setup on the Iris+

The hardware is connected in order to facilitate communication between the main parts. The PX4FLOW is an optical flow camera that runs the algorithms on board. It is designed to work directly with the Pixhawk hardware with the PX4 firmware. We set it up so that it directly sends the optical flow position estimates to the Pixhawk. The Pixhawk then uses this information along with its IMU to get local position estimates.

We then setup the Odroid XU4 in order to get the local position estimates from UART using the mavros package to get and parse the packets [1]. We also use the RC Controller in order to manually control the Iris+.

In order to get the information from the Pixhawk, we used rosbags in order to get the information from the mavros topics. I developed a protocol in order to gather the information from the topics.

We used a router in order to communicate wirelessly. We then used SSH in order to get into the Odroid XU4.

The protocol used to get the information while the Iris+ was flying is shown below in Figure 2:

```
$ roslaunch mavros px4.launch
$ roslaunch mavros_extras px4flow.launch
$ rosbags record -a
```

Figure 2) Commands for Gathering Mavros Topics

This protocol was then used in order to gather valuable information about the flight.

I also developed tests for the testing plan. My responsibility for that section was to develop the tests for:

- Cone Search with Iris+
- Integrate the Subsystems

These test plans are shown in Figure 3:

7. Cone Search with Iris+

a. Objective: The purpose of this test is to showcase the system integration for two of the major functional elements of the project: “Search for and Approach Wellhead” and “Align Self with Wellhead”. The integration of these two functional areas is highly critical for the success of the project. By showcasing the integration of the subsystems involved with these two functional elements, we will showcase that two-thirds of the major system functionality has been fully implemented and integrated.
b. Elements: This test will feature the following elements:
    i. Vision subsystem - In order to recognize and lock on dock position, we must showcase that the vision system is able to recognize tages and get position estimates from them.
    ii. Control subsystem - In order to send waypoint information for the predefined cone-search path, we must have accurate position control in order to have waypoint following.
    iii. Navigation system - The entire navigation system will be tested for integration effectiveness. The subsystems involved: vision, sensor fusion, position control, localization, etc.
    iv. Autonomous position locking - The system must be able to lock around a position in order to hover over the dock in preparation for landing. This integration test covers the same subsystems of the navigation system.
c. Location: NSH B-Level Basement
d. Equipment:
    i. Iris+ Drone
    ii. Wellhead infrastructure with identifying tag
e. Personnel:
    i. Cole Gulino - will be the operator who is required to run the commands for the drone.
    ii. Erik Sjoberg - will be the backup operator for manual control of the Iris+ in case of emergency.
f. Procedure:
    i. Cordone off the area in the B-Level basement for safety.
    ii. Under manual control, take off with the drone and move into desired initial position and orientation.
    iii. Run the command to commence the cone-search.
    iv. Observe as the Iris+ autonomously navigates the predefined cone-search trajectory until it has located the wellhead and locked on the position of the dock next to it.
    v. Verify that the Iris+ has position lock with the dock within the tolerance specified in the Verification Criteria.
g. Verification Criteria:
    i. Iris+ has completed its cone-search maneuver.
    ii. Iris+ is hovering over around the center of the tag on the wellhead with a tolerance of 0.5m in any direction.

Figure 3a.) Cone Search with Iris+ Test Plan

8. Integrate the subsystems

a. Objective: By showcasing the integration of the subsystems involved with these three functional elements, we will showcase that the integration for all three functional areas has been completed in the simplest case.

b. Elements: This test will feature the following elements:
   i. Vision subsystem - In order to recognize and lock on dock position, we must showcase that the vision system is able to recognize tages and get position estimates from them.
   ii. Control subsystem - In order to send waypoint information for the predefined cone-search path, we must have accurate position control in order to have waypoint following.
   iii. Navigation system - The entire navigation system will be tested for integration effectiveness. The subsystems involved: vision, sensor fusion, position control, localization, etc.
   iv. Autonomous position locking - The system must be able to lock around a position in order to hover over the dock in preparation for landing. This integration test covers the same subsystems of the navigation system.

c. Location: NSH B-Level Basement

d. Equipment:
   i. Iris+ Drone
   ii. Wellhead infrastructure with identifying tag
   iii. Dock infrastructure with identifying tag

e. Personnel:
   i. Cole Gulino - will be the operator who is required to run the commands for the drone.
   ii. Erik Sjoberg - will be the backup operator for manual control of the Iris+ in case of emergency.

f. Procedure:
   i. Cordone off the area in the B-Level basement for safety.
   ii. Under manual control, take off with the drone and move into desired initial position and orientation.
   iii. Run the command to commence the cone-search.
   iv. Observe as the Iris+ autonomously navigates the predefined cone-search trajectory until it has located the wellhead and locked on the position of the dock next to it.
   v. Verify that the Iris+ has position lock with the dock within the tolerance specified in the Verification Criteria.
   vi. Verify that the Iris+ has successfully landed on the docking infrastructure.

g. Verification Criteria:
   i. Iris+ has completed its cone-search maneuver.
   ii. Iris+ is hovering over around the center of the tag on the wellhead with a tolerance of 0.5m in any direction.
   iii. Iris+ has docked with 5 DOF.

Figure 3b.) Integrate the subsystems test plan

These test plans were part of our Test Plan that we turned into the class. I also did the introduction and the Logistics section.

It was important to do these tests, because they are part of the main integration of the system. We need to ensure that these tests validate that the system can work together as a whole. I focused the testing plan around integration of the system.

Challenges

The main challenge for this PR was that we had trouble flying the Iris+ manually. At the beginning of testing our system, we flew the Iris+ in the net in the MRSD lab. This was very problematic most of the time for a few reasons. The first reason was that neither I nor Rohan (the main team working on flying the Iris+) are able to fly the Iris+ well manually. In order to test the autonomous hovering in place, we needed to manually get the drone to a stable position before it could be set to position control mode where it would autonomously hover.

Because of our lack of skill flying the Iris+ manually, we had trouble getting the Iris+ to this stable position so that we could test the autonomous hovering.

Another problem with flying the Iris+ manually was that the dynamics of the Iris+ seemed to be thrown off in the small room. The ground effects changed the dynamics, which were not accounted for by the Pixhawk position controller. This made the Iris+ drift very far whenever we switched to position control.

This challenge was alleviated by moving to a larger quadrotor net in Ween Hall. By moving to this larger quadrotor net, we were able to successfully manually fly the Iris+ to stable position. From there, we were able to confirm that the Pixhawk's position control mode works for autonomous hovering.

Teamwork

There was a lot of teamwork done this PR as well as last. Me and Rohan worked together most of the time while we worked on the position control of the Iris+. We ran our tests and debugging sessions together. We decided to put two people on these tasks, because it is incredibly essential to our long term goals of getting the Iris+ to dock autonomously.

Job and Erik also provided support by helping us to manually fly the Iris+ whenever me and Rohan could not fly it successfully.

The whole team worked together on the Test Plan as well.

Earlier this week, we came together in order to plan our work for the next PR. We decided that teamwork would be even more important for the next phase of our project as we move from autonomous hovering to autonomous docking.

Future Work

The team will be splitting up into two groups for this next PR, both working on autonomous docking.

One team will be working on open loop docking while the other team will be working on autonomous hovering over a waypoint defined by an April Tag on the floor.

After these two tasks are accomplished, both teams will work on separate implementations of closed loop docking in order to gauge the effectiveness of each.

Resources

[1] mavros