Spring Sprint 4: Iris+ Drone Hover Control, April Tag Servoing and Field Testing

Individual Lab Report #9

Job Bedford

Team C: Column Robotics
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ILR9
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Individual Progress

These past 2 week, I worked on precision hover control on the Iris+, servo above a docking April tag, and field testing the drone.

Precision Hover Control

Writing a controller to autonomously hover in place using cmd_vel (command velocities). The drones exist position control mode had gains that were too aggressive and lead to the drone's wide oscillation over a point in air. These oscillations would range from 1meter to 1.5 meters. This was too much error for an precision task we wished to perform. I worked with Rohan on creating our own proportion control on the drone using command velocities to hover in place. This hover was immediately initiated upon entering off-board mode. The proportional control performed wonderfully with a new drift range of 1-4 cm error from desired set position. The gain setting for the controller was unexpectedly simple.
Once we were able to reliably control the drone position in space, we now need it servo over the docking April tag and perform the downward descent demoed from last sprint.

April Tag Servoing :

Autonomous servoing above apriltag is essential for positioning the drone is a proper state to land in our dock. With the April tag detection working, servoing was suspected to be a simple task. Unfortunatly Rohan and I ran into a huge wall with the simple task of re-validating our understanding of the drones frame coordinates. We had spent a good portion of last sprint figuring this reference frame out (which is badly documented online), but for some reason we didn't record our findings in a reliable fashion, and there still existed confusion among the team over the correct coordinates. Over all we desired to verify this once and for all in order to properly servo over the April tag in the correct direction. Due to issue with field testing, which will be later mentioned, and bad communication, much of our time was stalled. The April tag servoing, similar to the precision hovering, simple calculated the error form the drone's frame to the April tag frame, and moved to close the error. The detection need to run a 1 Hz frequency to continually correct itself. Once this servoing was established reliably well, we added the downward descent from last sprint to dock on the April tag, as seen in Figure 1.

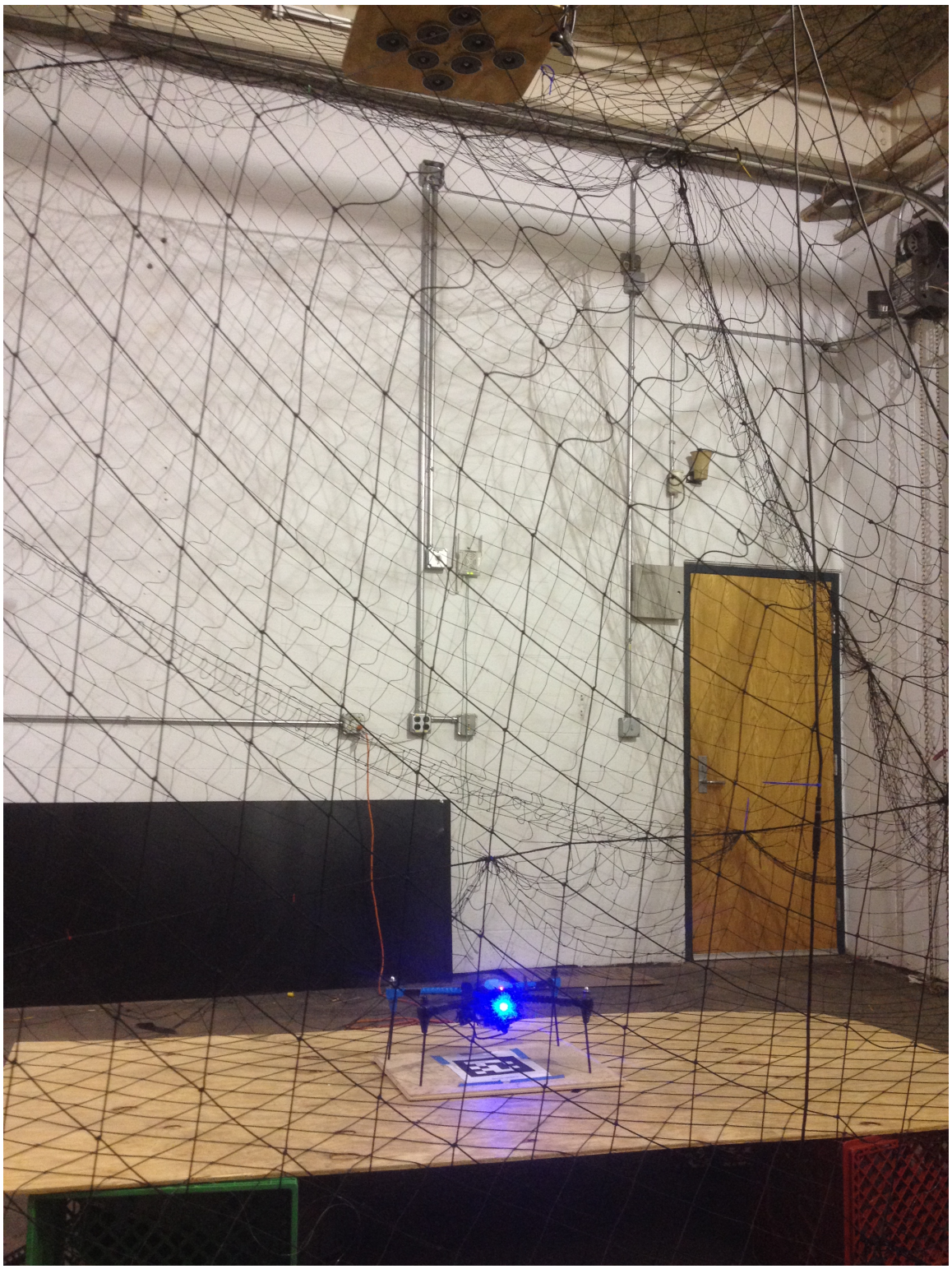

Figure 1: Docking on April tag marker.

Challenges

Field Testing

By far the biggest challenge these past two weeks was field testing the drone. Testing is very tedious. Given small flight room in the MRSD lab, if the drone had an error in flight, it would often hit the net. Resetting of drone after every crash was a must since it messes up its state estimation of it's EKF. Crashes occurred more prevalently with tired pilots mistakes in RC mode. Adjusting the tilt of the drone, when there exist offsets caused issues. Testing off board Iris+ drone autonomy required a switch that if not performed correctly caused the drone to fly off randomly for 2 second. The sluggishness of SSH into drones onboard computer took at least 2-5 minutes every time and often more. We had to recalibrate the Drones ESC (electronic speed controllers) about 3 times between both drones. A good test took 10 minutes. But more often each test took 30 minutes.

Teamwork

This sprint the team was more divided due to spring break travels. All of us collaborated on field testing the drone, but outside of task, Cole and Erik worked independently, and Rohan and I worked as a team on the same task.

Erik started this sprint test the capabilities on the drone ability to move from set point to set point using the built in mavros local_position framing estimation. The control of the drone from the local and global frame estimation proved to be imprecise and unreliable. After Erik deemed this to be an unfruitful pursuit, he switch to working with me and Rohan field testing the drone to properly servo over the April tag. Cole commited his time to writing a roll and pitch invariant pose estimation of the drones position by inversing the April tag pose from the camera's frame. With this, if the drone were to roll or pitch while flying above the April tag and if the tag would move aggressive in the camera view, the drone will not miss read the April tag position but account for the shift from the reorientation of the April tag. Rohan and I worked as a team to establishing precision hovering using command velocities, revalidating the drone coordinate frame, and instituting April tag servoing.

Upcoming Week

Integration is the goal for this upcoming sprint. Erik will be writing a cone search pattern protocol for the drone and then test it in the newly obtain bigger net in the MRSD B-level lab. Cole and Rohan will be modifying the drones internal EKF to grant us better estimation of the drones position with respects to the April tag and other useful markers. This EKF allows the drone to remember a history of its previous measure to better predict a markers location instead us aggressively traversing to the most recent possibly error filled reading. I will be polishing and debugging the April tag servoing and descent into the actual dock. As a team we will all be field test the drone and flight code.