Spring Sprint 5: April Tag Servoing 2.0, Integration and Testing.

Individual Lab Report #10

Job Bedford

Team C: Column Robotics
Eric Sjoberg, Rohan Thakker, Cole Gulino

ILR10
3/31/16

Individual Progress

These past 2 week, I worked on refined apriltag servoing above a docking april tag, integration of our docking phase with our cone search and continuation of field testing of the drone.

Refined April Tag Servoing

Since last week's sprint, apriltag servoing was inaccurate and unreliable, so we decide to refined the algorithm. Before, the downward facing camera's tag detection would simply measure the x and y displacement from the camera center. Even though we wrote a rotational invariant filter to counteract the inaccurate measurements due to the roll and pitch of the quad in flight, the drone still transverses in the wrong direction. Breaking down the elements of the drone state estimation and camera detection, we found that there were two main problems. One, the update rate of the tag detection callback did not take into account the position of the quad at the time the measurement was taken. The local frame estimation runs at 100 Hz while the tag detection runs at 7 Hz. As we set the command velocities of the drone in flight, the drone choose its next set point based on the last tag detection reading and its current state. In between each tag detection the drone continues to set a new set point based on its new local frame update, which causes it to most likely drift. The second issue was revalidating the drone coordinate frame with respects to the apriltag frame.

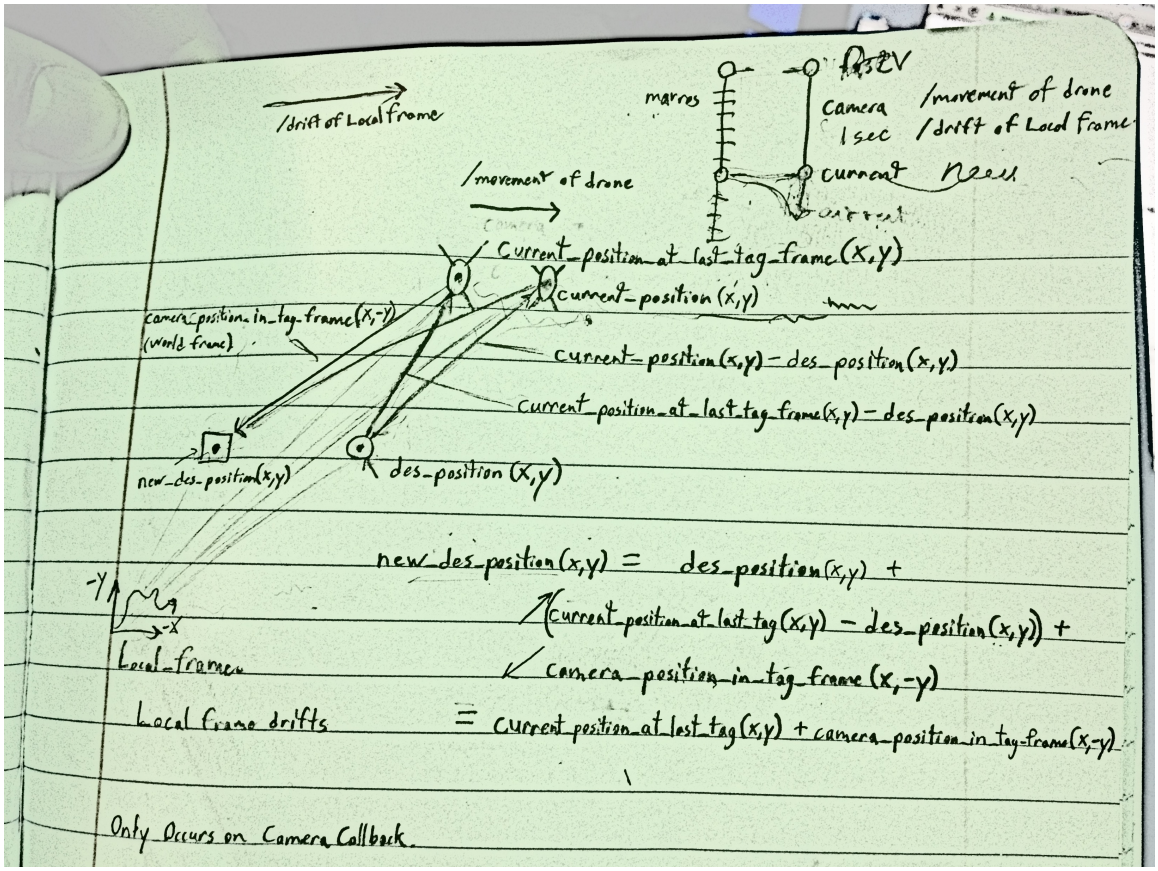

Figure 1: new desired set point scratch notes calculation.

As seen above in Figure 1, I broke the state and tag estimation elements down to determine that the drone simply need to save the its last known position at each tag detection and move to that fixed setpoint in the global frame. While the Drone is servoing over the april tag the new desired set point that motivates its command velocities will be the current local frame position at last tag reading plus inverse of the tag position in the camera frame.

Basic Cone-Search Docking Integration

I also work on basic integration of docking and cone search. Erik wrote a script to perform a simple cone search, where the drone moves forward and strafes laterally in search of the docking April tag. When his cone search was more or less completed, I wrote a python node to immediately enact a trigger to make the drone land upon detection of the April tag.

Challenges

Field Testing:

After implement the algorithm in code, I field-tested the drone to observe and validate its performance. The new testing net along with the scatter plywood to assist with optical flow can be seen below in Figure 2. First issue I noticed was the drone responds sporadically to the 7 Hz update rate of the tag detection. It proceed to twitch violently in flight and then fly off. This detection frequency caused the drone to update its setpoint too abruptly, making it change its cmd_vels before the last desired point was reached. So I drop the update rate down to 1 Hz and it responded better.

The second issue was that the tag measurements were too noisy. After hours of testing, the team decided to implement a RANSAC filter on the detection reading to remove any outliers and reduce noise. Once this filter was completed, the drone successful served over the april tag for a 3 minute stretch of time, and actively respond to physical repositioning of the tag itself.

Teamwork

This sprint the team collaborated on integration and testing. Erik set up the new net in the B-level of NSH. He also added a diffusor sheet to the roof of the net to remove any unwanted drone shadows that would disrupt optical flow. He also added a textured plywood floor to improve the drone's optical flow. Erik worked with me to design the apriltag servoing algorithm. Erik started to initiate a Behavior tree state machine to better improve our drone's software architecture. His main mission this week was establishing the cone search behavior, which was successful for our demo. Rohan and Cole worked as a team to develop a MatLab model of the drone with a simulated EKF for future testing. They also wrote the RANSAC filter mentioned before to remove noise form the drone's tag detection measurements. As

a team we worked with each to integrate all the subsystems for this weeks sprint, as well as testing the drone.

Upcoming Week

This sprint we were minutes away to getting a successful integration between searching and dock. So this upcoming sprint will be polishing up this final integration for our SVE dress rehearsal. Erik will be improving the performance of his cone search, and possibly updating the software to the new behavior tree architecture. Cole, Rohan, and I will be working on precision land into the actual dock. This will require the drone to close loop servo over the april tag while descending. Cole and Rohan will also continue to develop their MatLab EKF model of the drone.