Individual Lab Report 7

By Clare Cui

Team B: Arcus

Clare Cui

Maitreya Naik

Angad Sidhu

Logan Wan

16 February 2017

Individual Progress

My progress over the past two weeks has been split between mechanical and software-related topics. I have helped Maitreya install the new Pixracer and remount various modules that connect to the Pixracer. To do this, we deconstructed the hardware stack of layers and carefully aligned the ends of the X-shaped mount's legs with the sides of the base plate. The mount was attached with thin, double-sided foam tape that has worked well consistently for the Pixhawk. We added all the cables onto the Pixracer before we installed the rest of the layers because, due to its smaller form factor, the Pixracer, which sits in the middle of the base plate, is much harder to reach than the Pixhawk. In addition to the Pixracer, we received the new, shorter cables that we had ordered, and these were also installed. While this was fairly simple and straightforward, the IMU cable installation was not so trivial. Because the sensor mount design did not have enough clearance for the IMU end of the cable, the LiDAR, batteries, and front half of the undercarriage mount had to be removed for the removal of the old cable and installation of the new. Once this was completed and we had rebuilt our drone, it looked much cleaner. The final product can be seen in Figure 1.

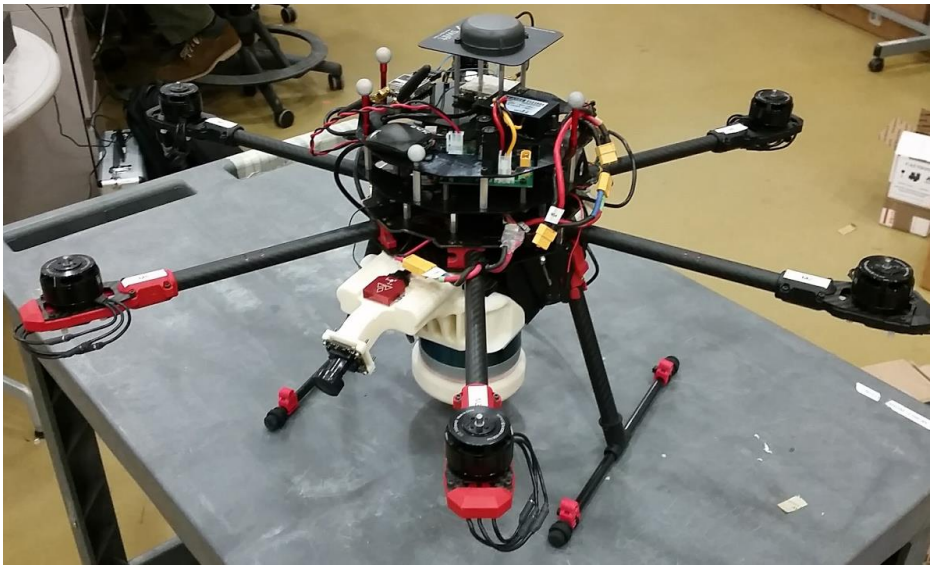

Figure 1: *Completed UAV*

For the software part, I have been working on understanding the mapping framework and finding transforms between sensor and body frames for it. Specifically, I have started getting into data fusion and synchronization, where, eventually, the expected output will be to have a colorized dense voxel grid. The reason synchronization is a necessity is because the RGB and point cloud data update at different frequencies, where the LiDAR scans at 20 Hz and the RGB camera takes images at 30 frames per second. Because the motion capture in the Vicon arena updates at 100 Hz, the colored map could be updated at a maximum rate of 20 Hz. In order to do this, it will be necessary to take the latest Velodyne point cloud and the state estimate at that point and then transform the point cloud back into a previous state that

corresponds with the camera data. Some interpolation between state estimates will also likely be needed here. Work had already been done getting transforms between the IMU and other sensors, but I needed to retrieve transforms between the center of the UAV body to the IMU and the Vicon bead center of mass as well as the RGB camera to IMU transform. To do this, I used coordinate frames created in Solidworks and overlaid them on top of one another as well as found the distances using the measurement tool. An example of the latter can be seen in Figure 2. Finally, Angad has been reviewing over the map_server and map_utils packages with me and going over the complex C++ code that is used. I began learning about how the measurement_synchronizer package worked in particular, as it will be necessary in the initial stages to sort the sensor messages in the correct order.

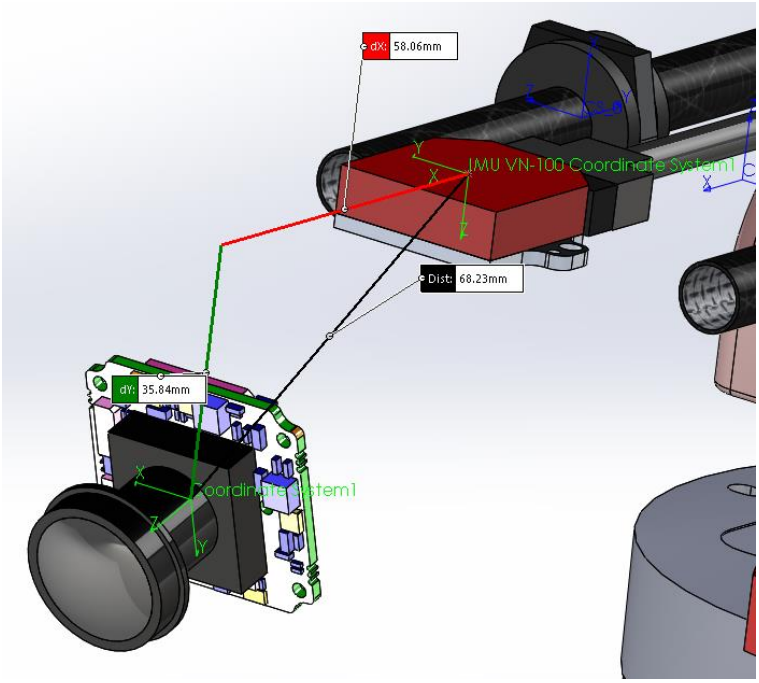

Figure 2: *Measurement tool used in finding the translation vector for the transformation matrix for RGB camera and IMU.*

Challenges

My biggest challenge this week was working with Angad to understand the C++ code. I learned about constructs such as templating of classes, shared pointers and why they were useful, and how to use typedefs as shorthand. I also walked through a little bit of the package organization, although this was fairly difficult to comprehend because there are references to many different libraries, classes, and member functions. While it will take some time to internalize this material, I will be working through this challenge by asking my teammate and PhD advisor plenty of questions (as she wrote the mapping framework) and likely turning to Google for C++ syntax comprehension.

Teamwork

Logan Wan: Logan worked on getting the mapping framework prepared. This involved deleting the references to classes that used the thermal imaging and time-of-flight packages, since we will not be using these sensors onboard our UAV.

Angad Sidhu: Angad successfully got the IMU pre-integration working, both for the initial ICP scan matching and in GTSAM. The transform is used as an initial guess in ICP for the odometry calculations and has made the mapped trajectory much smoother in BLAM.

Maitreya Naik: Maitreya made new cables for the Pixracer, added MAVLink and MAVROS to our software stack, calibrated the Pixracer sensors, and wrote some demo code for the offboard control of the UAV. The computer is now capable of

Future Plans

For the next progress review, I will continue to work on the mapping framework. My goal is to be able to read in bagged data from flight tests inside the PRL, sort the RGB and LiDAR data into a chronological queue, and find the state estimate transforms between the points of data capture. Once this is done, it can be integrated with Logan's work on the mapping framework, where we will ideally be able to see a colorized map.