Individual Lab Report 8

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Team A / The Avengers

Teammates: Tushar Agrawal & Pratik Chatrat

ILR08

February 25, 2016

1. Individual Progress

Over the past two weeks, I've (a) mounted all sensors to the drone (b) successfully controlled the NicaDrone Electro-Permanent Magnet via the Pixhawk and (c) revised the mounting hardware for the drone's sensors.

a. Drone Modifications

First big item I tackled was to modify the 3DR X-8+. On top of the drone, I attached the Odroid and Hokuyo. Additionally, the Underbelly infrastructure straddled the battery on the bottom.

Attaching the Underbelly was the biggest challenge and the most important modification. I've been continually tweaking the original design since we changed UAV's, and I identified further improvements as I was mounting the current generation.

Figure 1 shows the Underbelly attached to the drone. The entirety of the Underbelly is held in place by four screws that lineup with four holes on the drone's frame. These proved to be in a tight space that were difficult to align. This is an issue because the entire Underbelly needs to be taken off to remove the sensors or NicaDrone. I have a plan to improve upon this design. However, the current design meets our needs even if it requires more effort.

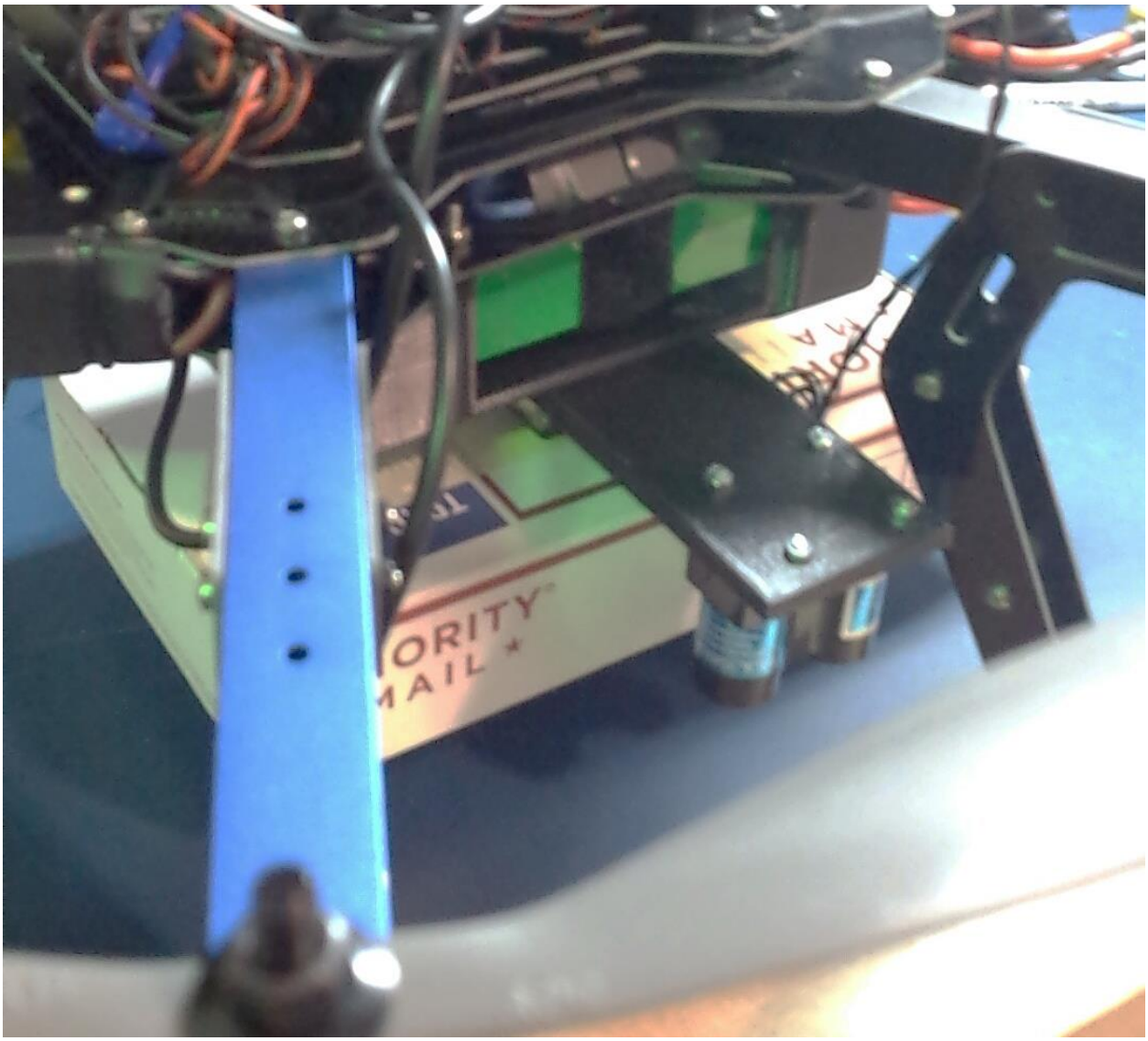


Figure 1: Underbelly Infrastructure Mounted

Finishing the Underbelly, left the Odroid and Hokuyo left to be mounted. The Odroid needed to be protected, rigidly attached, but leaving access to ports on the board. A simple solution was to modify an extra case for the Odroid that Tushar had purchased. I cut away excess material on the case to expose the ports we needed. I then 3d printed 4mm spacers to ensure the case cleared the drone surface (this is important for both cooling and a strong attachement.

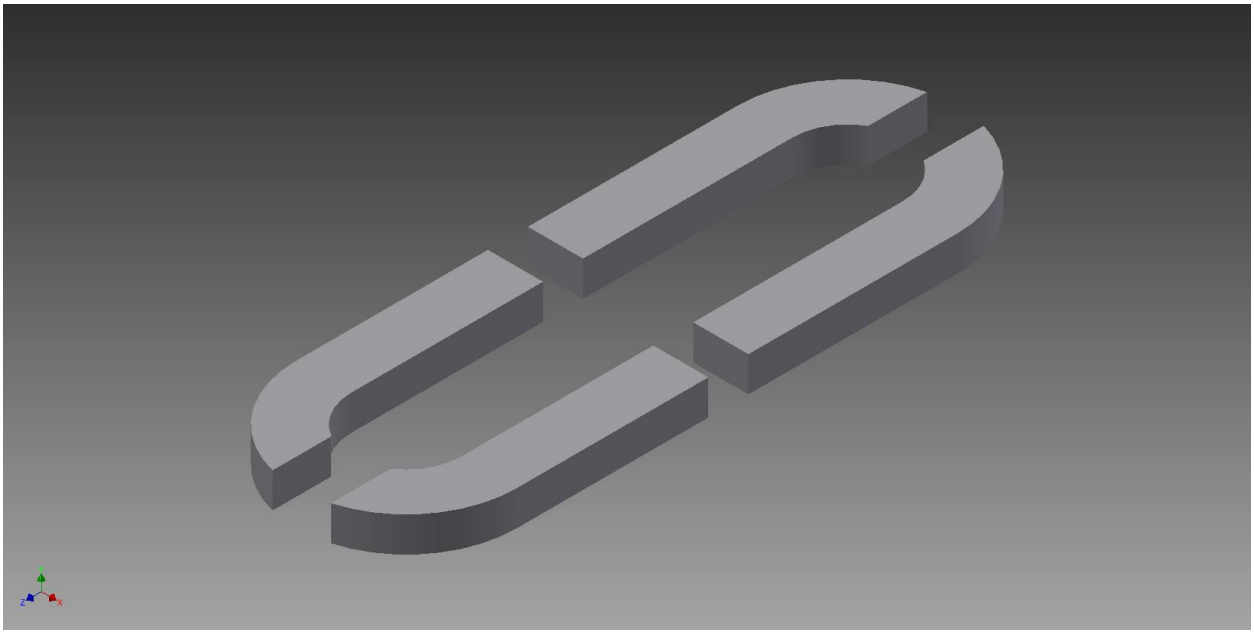


Figure 2: Odroid Spacer

The final component to attach was the Hokuyo LIDAR. After some experimentation, we elected to use a flat portion of the drone's superstructure. The spot is directly above the Pixhawk and centered on the drone so that it wouldn't affect the UAV's center of gravity. The Hokuyo was then fixed using industrial-strength Velcro to ensure that Pratik would have the maximum amount of time to experiment with the sensor and run simulations. This has the added benefit of easy removal once the project is complete.

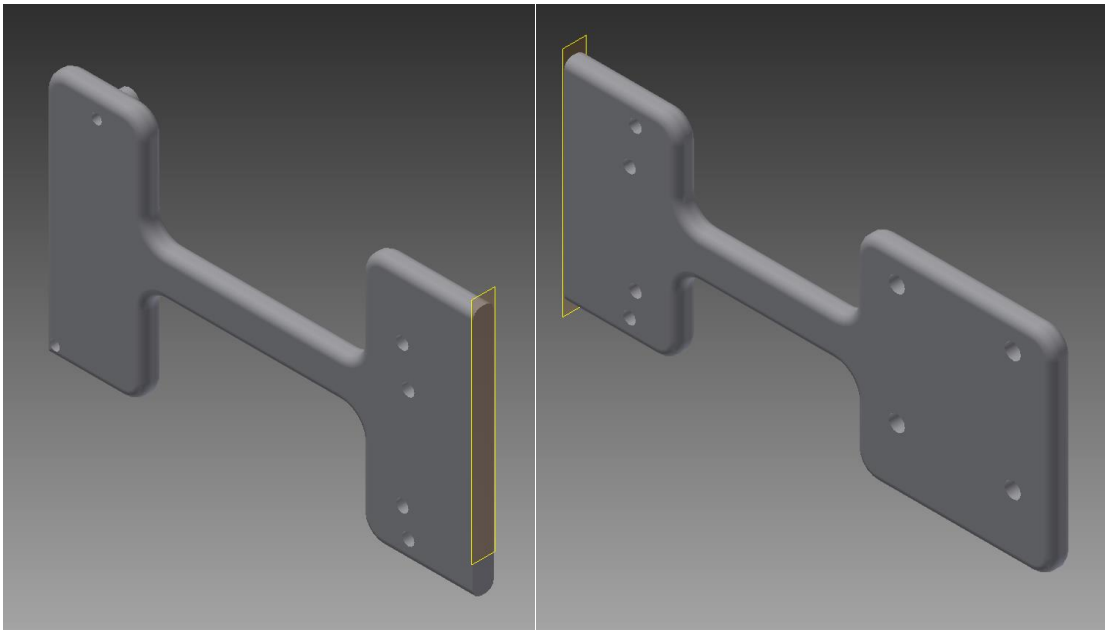
b. NicaDrone controlled by Pixhawk

I moved the project a step closer to completion by connecting and controlling the NicaDrone Electro-Permanent Magnet via the Pixhawk. The original test called for controlling the NicaDrone via the RC transmitter. This was based on the assumption that the RC transmitter would be the easiest interface with the Pixhawk. This assumption proved faulty since the transmitter only supported 8 channels despite allowing you to program up to 16. More details are in the *Challenges* section below. We successfully controlled the NicaDrone by using the Mission Planner application. First, I set RC9_Function to "1" (RC Pass-thru), and PWM low to 1100, PWM mid to 1500, and PWM high to 1900.

The NicaDrone takes about one second to activate or deactivate and there must be at least a one second delay between commands. We will factor this into a 3-second buffer between actions to ensure the system works as intended.

c. Revised Sensor Mounts

Along with reworking the drone Underbelly, weight saving improvements were previously identified on the sensor mounts that attach to the Underbelly. The new design is 40% lighter while still providing adequate structural support. The designs are shown below and will be printed once the design for the second generation Underbelly is complete.



(a) *(b)*

Figure 3: Second Generation (a) Camera Mount & (b) LidarLite Mount

II. Challenges

There were several minor issues dealing with the MakerBot and measuring PCBs to be mounted that continue to be an issue. Additionally, controlling the NicaDrone via RC transmitter proved to be a fruitless endeavor.

a. Drone Modifications

The primary issue with fabricating the Underbelly lay with measuring the mounting holes on PCBs. The first challenge was surrounded the digital calipers issued to teams. These calipers slide along the ruler which results in the calipers being inaccurate due to the rotation sensor not detecting movement.

After moving to traditional calipers, it became a challenge to accurately dimension the PCBs' mounting holes due to the irregularly shaped boards. The camera especially proved difficult. It was easy to measure the distance between the holes,

however, the camera needed to be mounted parallel to the direction the drone moves. This resulted in numerous reprints in order to dial-in the appropriate angle.

b. RC control of NicaDrone

There final challenge was caused by the RC-controller being unable to send signals on an available channel to the Pixhawk for the NicaDrone.

We would have avoided this had we known. However, the RC transmitter allows us to program up to 16 channels and documentation of the device was rather poor. The transmitter is a white-labelled version of a Chinese-manufactured device whose manual contained numerous technical (and grammatical) errors.

Once we identified the issue, Tushar and I researched alternatives. We were able to find documentation on the Mission Planner that allowed for direct control of the Pixhawk channels. Sending “Low,” “High,” and “Toggle” commands, we successfully controlled the NicaDrone via Pixhawk.

III. Teamwork

Team A is on track for the revised schedule that we committed to at the beginning of the semester. Each team member took on different components of the task. This allowed the team to build their individual skillsets while expediting the work.

Tushar Argawal

Tushar has been making good use of the Odroid control of the drone. He successfully tested marker following of the drone. The test was cool to see: Tushar dragged the AprilTag around and the drone followed. One can imagine several scenarios outside the current application where such intuitive control could be useful.

Pratik Chatrat

Pratik successfully integrated the Navigation Stack with the Odroid. With Tushar’s help, he showed integration with the moving drone (handheld for the moment) with the ROS and Hokuyo system.

IV. Plans

Before the next PR, the team has three main goals:

1. Odroid control of NicaDrone controlled by. I will be tackling this goal. The next step in integration of the NicaDrone requires that we control it via the Odroid. This should be a simple project that allows me to get hands-on with the code.

2. Complete Obstacle Avoidance. Pratik will be working on this goal to finalize obstacle avoidance of the drone. He identified a potential issue with the Pixhawk that it only accepts linear velocities and not angular velocities. Pratik and Tushar are doing the necessary research now to overcome this challenge and have reached out to the lead programmer of ArduPilot.

3. Complete Landing Code for Marker. Tushar's next challenge will be to autonomously land on marker. I don't expect any large challenges here provided he gives himself adequate time (which he usually does).