Individual Lab Report 5

By Clare Cui

Team B: Arcus

Clare Cui

Maitreya Naik

Angad Sidhu

Logan Wan

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Individual Progress

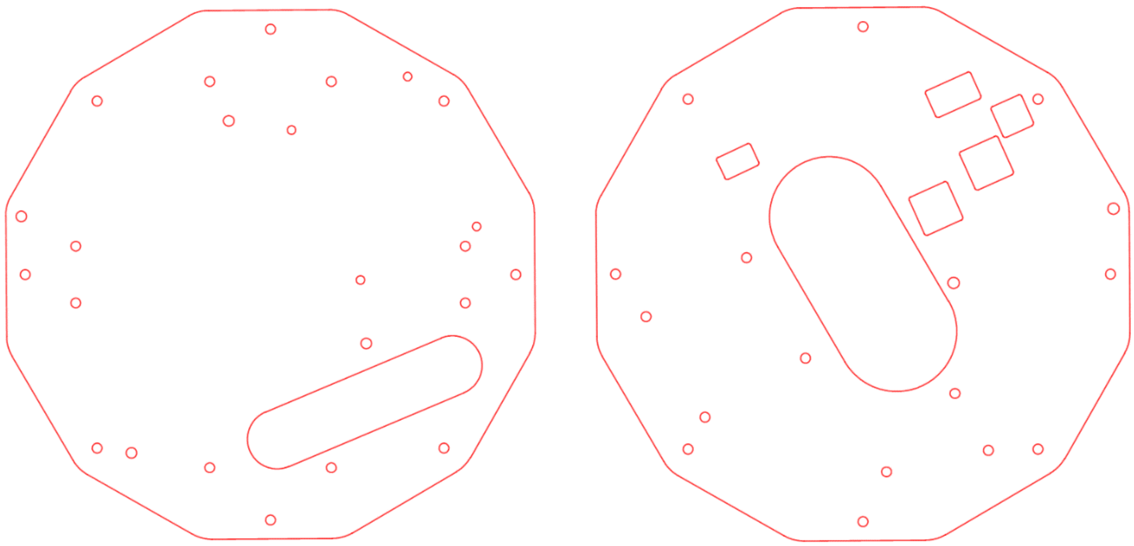
This week, I was largely responsible for the hardware mounting on top of the chassis, materials ordering, making the dummy payload for a preliminary flight test, and integrating the hardware onto the UAV chassis.

For hardware mounting, I decided to make two plates that would sit on top of standoffs on the off-the-shelf carbon fiber base plate. The material would be laser-cut 1/16" Delrin, and it was decided that M3 standoffs and screws would be used throughout the assembly to keep everything consistent. A breakdown of the layers is seen in Table 1 below.

Table 1: *Breakdown of hardware components on each platform*

Platform 1	Pixhawk flight controller
	RC receiver
	FPV telemetry radio
	Switch
	Buzzer
Platform 2	Gigabyte Brix
	Power Distribution Board (PDB)
Platform 3	Piksi GPS
	Piksi GPS antenna
	Piksi telemetry radio
	3DR GPS antenna
	19 V voltage regulator

Because the Pixhawk materials were encased in plastic, they could be directly mounted on to the base plate which also served as a grounding plane for the ESCs. The Brix, PDB, 19V regulator, and Piksi components all needed mounting holes along, and, in most cases, standoffs to account for protruding wires, connectors, and other components underneath the PCB. Spacing was extremely important; we wanted to have a tight system and only provided 30 mm of height between each level. Previously CAD-modeled cabling proved useful in determining clearances, and I used "skeleton" sketch models for multiple parts to create consistent hole patterns. For the third platform, I had to include several cutouts for the PDB which sat on the 2nd level. Some of its components extended past the 30 mm height limit – we had abnormally large fuse holders – and the female connectors were easier to reach from above given the male connector size on the cable. The vector images of the two laser cut platforms can be seen below in Figure 1a and 1b. They are lined in red because laser cutters recognize red lines as places to cut whereas black lines are rastering lines.



(a) *(b)*

Figure 1: *Vector images for (a) Platform 2 (b) Platform 3 of the UAV chassis.*

In addition to hardware integration, we wanted to conduct a dummy payload flight test, to make sure our system was able to handle its full payload before mounting our expensive sensors.. I weighed all the components that we had on hand that would not be mounted onto the platform, and lump-summed them into weights that would go underneath and on top of the chasses base plates. The Velodyne had most weight of the lower platform at 840.8/929.8 g, so the bottom weight was affixed to the location the Velodyne normally occupied. The top assembly came to a total weight of 749.5 g with all of the small components summed together. Everything except the chassis, motors, propellers, undercarriage sensor mount, and the hardware on first platform of the UAV was lumped into these two weights. The total weight came to 5.35 kg. The test system which resulted in a successful flight can be seen below in Figure 2.

Figure 2: *UAV with dummy payloads attached. Credit to Angad Sidhu for the image and labeling.*

Finally, I contributed largely to hardware integration. I laser cut the platform plates, created a y-splitter cable for powering the PDB and flight system (seen in Figure 3), and assembled most of the system together, from the bottom up. Hardware integration resulted in some issues which are further discussed in the Challenges section.

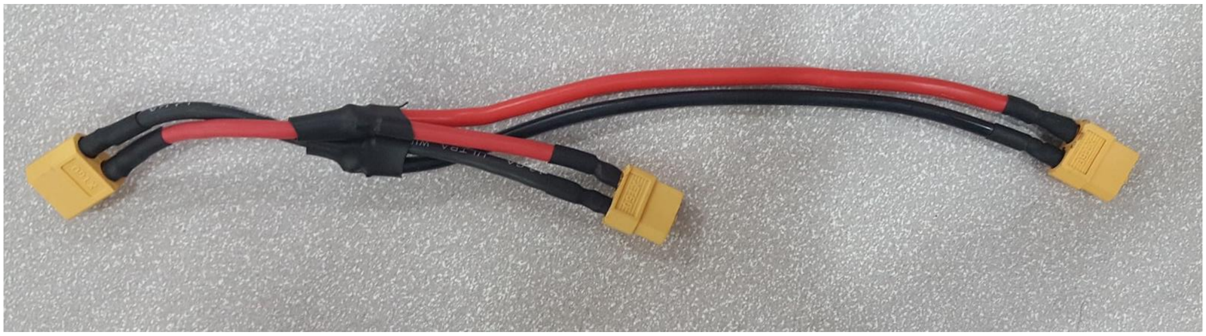


Figure 3: *Y-splitter cable that connects the Pixhawk power module to the flight system (ESCs and motors) and the PDB.*

Figure 4: *UAV with fully integrated mechanical and electrical systems.*

Challenges

I experienced several challenges this week. One of the challenges was in dealing with a broken motor mount on the arm. The mount fractured because I accidentally over-torqued the screw that clamped the mount onto the arm. On the mount was a DC motor and an ESC that had power, ground, and signal cables routed through the hollow arm to the main chassis. The ESC power and ground wires were soldered onto a conductive plane, and, what made this issue challenging was that the ESC was too large to be taken off the mount, so its cables needed to be routed through the arm first. We originally thought we needed to take apart the entire chassis to do this, but, fortunately, we were able to desolder the power and ground cables and separate the one arm from the chassis, allowing us to replace the part.

Some issues cropped up with the 3D printed sensor mount. The heat inserts for the screws were ripped out of the mount when trying to remove the screws. The reason for this was because of low infill for the print, which was 15%. To resolve this issue, we will be experimenting with different infill amounts and ultimately reprinting the mount with higher infill. The battery stop on the mount also fractured for both versions. Version 1 had a through hole that was fastened with a screw and nut while version 2 used a heat insert with a screw for fastening. Both methods results in fractures at the hole. This may be a result of low infill or perhaps the geometry could be designed better to give the stop some relief; regardless, we will be prototyping the stop further. Finally, Velodyne is not mounted reliably given the current hardware. We are using a ¼-20 countersunk screw and two dowel pins epoxied into a 1/16" aluminum plate. Due to the thin plate, the screw wobbles with the velodyne attached, and the dowel pins have been slipping out. We have decided to use dowel pins with a head and screws that have a smaller countersink.

Finally, there were issues in hardware integration. Because there are three layers to the hardware mount, I needed to be very mindful of spacing. Originally, I was trying to fit the Brix, PDB, and 19V voltage regulator onto the same 200 mm diameter plane, which was not working well. There was not enough clearance for a hand to fit in the tight space, and it was difficult to determine locations for the Brix and PDB holes such that they did not interfere with each other or the locations for the standoffs. By moving the 19V regulator to the top, I was able to create enough room, although there is still a very specific bottom-up build order to be able to correctly assemble the UAV. Additionally, upon integrating the hardware, I discovered the hole for the 19V regulator on the 3rd platform is not large enough to fit the cable. While I could file away a larger hole, I have also determined that it may be useful to have holes for the Brix and Velodyne power cables on the 3rd platform as well. Since we have additional Delrin material, I will likely be laser cutting a 2nd version of this plate.

Teamwork

Logan Wan: Logan was responsible for the PDB assembly, PDB power check with Maitreya, and mounting the hardware assembly.

Angad Sidhu: Angad worked on the odometry script, cable splicing, and other odd tasks in system hardware integration. He helped Maitreya with the full electrical load test.

Maitreya Naik: Maitreya conducted the PDB power check with Logan, did the Pixhawk integration cable, did flight controller recalibration and permanent mounting on the UAV, and he conducted a full electrical load test with generation of a LiDAR point cloud on the Brix done simultaneously with the motors at full throttle.

Future Plans

For the fall validation, I will work to fix hardware integration issues and will be making more copies of the mount. I will also be helping to assemble all the necessary hardware and tools for the live demo of pushing a cart with our system mounting on top. Depending on the size of the cart, additional mounting hardware may be necessary.