ILR05: Progress Review 4

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Team B: Arcus

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ILR03

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1. Individual Progress

Since the last progress review, I was responsible for the electrical testing and verification of the power distribution board, making a PixHawk [1] integration cable, flight controller recalibration, and full electrical system test.
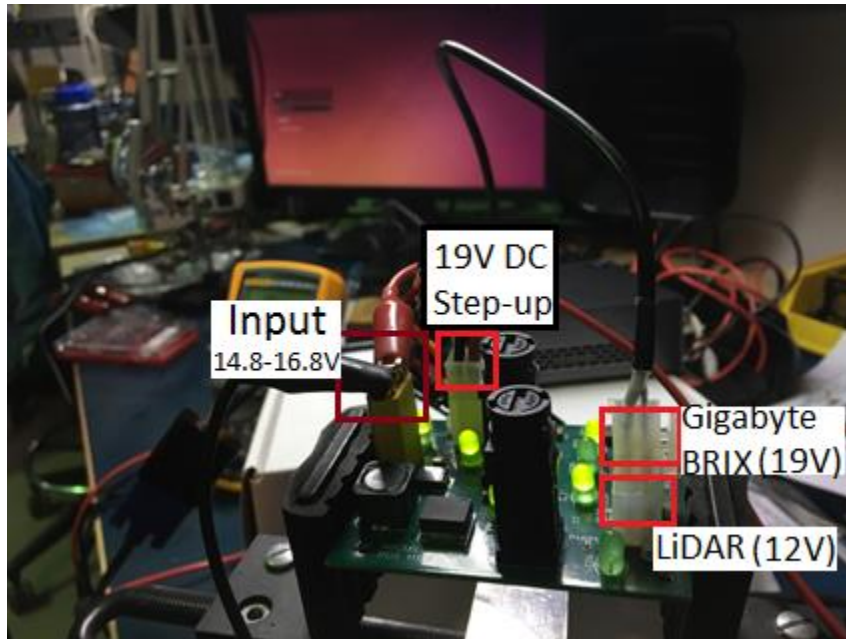
1.1. Electrical Testing and Verification

Figure 1: Power Distribution Board

This process involved the following steps:

1) Verify traces with Eagle [2] layout file.
2) Clean board and check connectivity across traces by referencing Eagle [2] schematic circuit.
3) Verify SMD component values.
4) Clean board, apply solder paste to SMD pads and solder components by heating on griddle.
5) Check connectivity across traces and resistances across resistors.
6) Verify through-hole component values
7) Solder through-hole components.
8) Our 19V DC step-up converter is detachable from the board. Hence, before connecting it, energize the board with a wall power supply and check intermediate voltages.
9) After successful check, attach 19V converter, and verify end voltages.
10) Detach 19V converter, and attach LiDAR [3] to verified 12V output of the board.
11) Energize board and wait for 10 seconds for LiDAR [3] to start up and reach a nominal speed.
12) Wait 1 minute and track power supply input voltage and current.

13) Connect LiDAR [3] to a computer and verify point cloud acquisition on the computer using RViz.

14) Switch off power, disconnect the LiDAR [3] and connect the 19V converter.

15) Energize the PDB and check again for correct voltage outputs.

16) Switch off power, connect the GIGABYTE BRIX [4] to the 19V output of the PDB and connect a monitor the the BRIX's HDMi port. Switch on power.

17) The Brix [4] has been programmed to start-up as soon as it receives power. Hence, it should boot up into Ubuntu (verified by monitor output) as soon as the PDB power is turned on.

18) Wait 10 seconds after you login to observe fluctuations in power supply voltage or current.

19) If all good, compile a program like OpenCV [5] on the Brix [4] and monitor the current draw from the power supply.

20) Switch off the power, connect the Gigabyte Brix [4] to the 19V power supply, the LiDAR [3] to the 12V power supply, and connect the LiDAR [3] data Ethernet cable to the Gigabyte Brix [4].

21) Repeat steps 11 -13 and 18-19 while monitoring the power supply.

22) Table 1 contains the board capacities and actual draw observed upon load

Device	PDB Test Input Voltage (V)	Board Input Current Capacity	Observed Max Input Current	Board Rated Output Voltage	Observed Output Voltage
Gigabyte Brix [4]	15	5A	0.55A (Ideal)	19V	18.8V
			1.7A (Startup)		
			1.7A (OpenCV Compile)		
Velodyne VP-16 [3]	15	2.5A	0.68A	12V	11.65V
Brix + VP16	15	7.5A	2.5A	As above for each device	As above for each device

Table 1: Power Distribution Board Test Results

1.2. PixHawk Integration Cable

The PixHawk has a Serial TTL port which can be used to retrieve PixHawk data like the IMU readings, compass readings, battery voltage readings, and current readings. Upon referring to the Serial 4/5 pinout here: https://pixhawk.org/modules/pixhawk#pinouts, a cable can be made as shown in Figure 2.
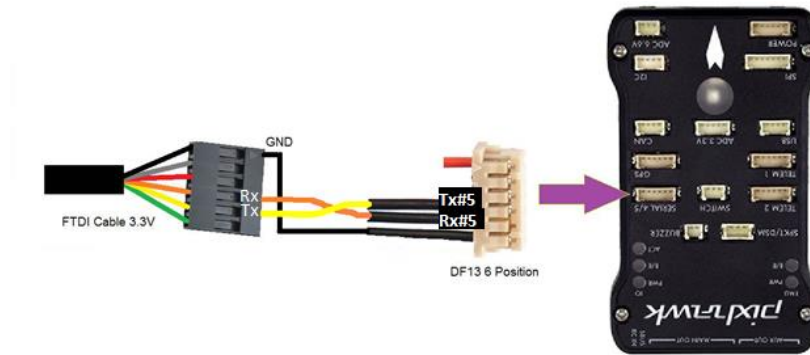
Figure 2: PixHawk USB Integration [6]

However, it was found that using the Micro-USB slot on the PixHawk and the mavros [7] library, we can retrieve the same data using MavLink. Moreover, the Serial4/5 communication will not work when the PixHawk is not armed (safety switch not pressed). Hence, a serial TTL cable may not be needed and most data acquisition may be possible across MAVlink.

1.3.   Flight Controller Recalibration

Dummy weights were loaded onto the ARCUS Hexrotor to simulate the LiDAR and electrical payload. The positioning of the PixHawk and its peripherals were changed, which required recalibration of the PixHawk. This was carried out again using QGroundControl [8] as described in ILR02 by Maitreya Naik [9] on the ARCUS website [10]

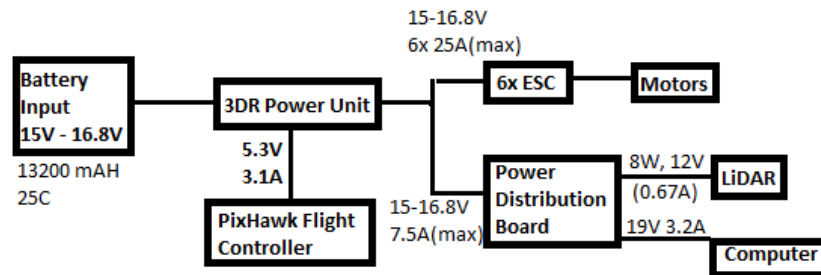## 1.4.   Full Electrical System Test

Figure 3: Power Distribution Diagram. [Refer to [11] for the 3DR Power Unit]

The Power Distribution board was connected to the battery power along with the Hexrotor ESC as shown in Figure 3. Then, a full system electrical test was carried out. First, the ESC was disconnected and the Electrical System Test and Verification was carried out as described in Section 1.1 above. Then the ESC was connected and the drone was armed with minimum throttle, and again, Section 1.1 was followed. Next, the system was re-powered and the throttle was increased gradually, while the Gigabyte BRIX booted up, until the motors were spinning at full throttle. The system was maintained in this state for up to 3 minutes to ensure smooth operation. This was the verification of the electrical system. A video is available here https://youtu.be/QSzQeGIbwk8.

2. Challenges

Challenges were faced during the electrical testing and verification. In the fabricated PDB, we needed to solder a male DC barrel jack connector. However, due to wrong dimensioning, the holes for the connector on the PDB are too small. Since it is not a requirement for our FVE, we will be doing a second revision of the PDB board, allowing the connector to be plugged in. Due to limitations of the wall power supply in the MRSD Lab, the voltage displayed on the power supply would drop from 15V to 10.8B when the computer reached a max current of 1.7A. This may be due to the computer pulling power equivalent to the shunt resistance inside the voltmeter, resulting in a different voltmeter reading under load as opposed to when it is open-loop. The same issue occurred while flying the drone, that the flight controller would measure a low battery voltage when in flight since there would be a drop of about 2V (0.5V/cell in a 4S battery) when under load of the motors. This issue was fixed by reprogramming the operational battery range while considering voltage drop under load.

3. Teamwork

Clare Cui and Logan Wan successfully CADed and Clare fabricated the dummy weights to be mounted on the drone. Angad successfully made a custom Ethernet cable for the Velodyne to gain power from the PDB and provide data to the Brix. He also programmed an odometry script to compare and visualize the BLAM odometry performance with the GPS data.
Logan took care of PDB assembly and soldering and finally assisted me in the Electrical verification as described in Section 1.1 above.
Clare also created a Y-splitter cable for supplying battery power to the ESCs and our PDB, as shown in Figure 3.

4. Plan

By the FVE, we plan to have the mounts for the computer and PDB integrated into the system. We also strive to have our test flight conducted with all the hardware integrated, before using the same system to collect flight data at LaFarge Quarry. We then plan to analyze the data and create the respective videos, presentations, and demonstrations.

References

[1] "Pixhawk Flight Controller," Px4 Autopilot, [Online]. Available: https://pixhawk.org/.

[2] E. CAD, "Eagle PCB Design," [Online]. Available: https://cadsoft.io/.

[3] Velodyne, "PUCK," [Online]. Available: http://velodynelidar.com/vlp-16.html.

[4] Gigabyte, "GB-BSi7-6500 (rev. 1.0)," [Online]. Available: http://www.gigabyte.com/products/product-page.aspx?pid=5692#ov.

[5] OpenCV, "OpenCV," [Online]. Available: http://opencv.org/.

[6] A. D. Team, "Interfacing with PixHawk using the NSH," [Online]. Available: http://ardupilot.org/dev/docs/interfacing-with-pixhawk-using-the-nsh.html.

[7] O. S. R. Foundation, "MAVROS," [Online]. Available: http://wiki.ros.org/mavros.

[8] QGroundControl, "QGroundControl," [Online]. Available: http://qgroundcontrol.com/.

[9] M. Naik, "ILR02: Progress Review 1," [Online]. Available: http://mrsdprojects.ri.cmu.edu/2016teamb/wp-content/uploads/sites/13/2016/10/TeamB_mjnaik_ILR02.pdf.

[10] ARCUS, "Documents," [Online]. Available: http://mrsdprojects.ri.cmu.edu/2016teamb/documents/.

[11] Vectornav, "Vectornav VN-100 Rugged Industrial IMU," [Online]. Available: http://www.vectornav.com/products/vn100-rugged.

[12] "MV BlueFox," [Online]. Available: https://www.matrix-vision.com/USB2.0-industrial-camera-mvbluefox.html.

[13] Ardupilot, "3DR Power Module," [Online]. Available: http://ardupilot.org/copter/docs/common-3dr-power-module.html.