

Post Flight report for MBARI Flight - 19-005 for Flightwave Edge Reg#FA33FHTPNC

UAV test flights – 4/16/2019

Pilots Present: Ben Erwin, Rob McEwen, Steve Haddock

Description:

Flight testing conducted around further testing of FW Edge features, including a new critical firmware update, and an HD Camera nose cone. Over the course of several hours we had completed 9 flights, which unfortunately ended in a catastrophic crash during an autonomous mission. Logs are still being examined by personnel at both Flightwave and MBARI. Initial conclusions seem to suggest that the vehicle is inherently unstable in winds between 10-15 knots (well below advertised wind maximums). The leading theory is that this instability caused an emergency transition to 'hover mode' after the Edge was hit by a gust of air and it was unable to right itself. A further theory suggests that after the vehicle performed its emergency transition, a conflicting autonomous flight mode might have counteracted its own ability to right itself. We will append this post flight with more details when they become available. Pilot error does not seem to have played a role in this crash as the plane was completing an autonomous mission and no one was actively manipulating the sticks (confirmed in the logs). The payload on the crash was a simple weighted nose cone. No sensors, people, or property were damaged in the crash, but the FW Edge appears to be a total loss (see pictures).

Update from Flightwave regarding the crash:

"Right now we've narrowed the cause of the issue to the tilt pods, most likely due to a hardware malfunction.

We are beginning to make plans to repair your vehicle."

The MBARI UAV team is looking for further clarification into the failing tilt pods. We performed pre-flight checks to the tilt pods specifically prior to the flight, and viewed no hardware failures.

Individual Flight Details:

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Weather: 6.6 Knots from the West.

Batt 1 @ Start: 16.88 VDC

Batt 2 @ Start: 16.77 VDC

Flight 1: Take off, mode transitions Alt mode, Position, Alt, fixed wing, land.

https://review.px4.io/plot_app?log=cfc4ca5a-0984-4abb-93ec-6aeed82bff69

Pilot: Ben

Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 10:19
Logging Duration: 0:07:34
Dropouts: 23 (4.16 s)
Vehicle Life
Flight Time: 5 hours 11 minutes 56 seconds
Vehicle UUID: 003900333336511136313734
Distance: 3.39 km
Max Altitude Difference: 105 m
Average Speed MC: 8.0 km/h
Average Speed FW: 49.3 km/h
Max Speed: 76.9 km/h
Max Speed Horizontal: 76.9 km/h
Max Speed Up: 20.7 km/h
Max Speed Down: 12.8 km/h
Max Tilt Angle: 43.3 deg
Max Rotation Speed: 238.1 deg/s
Average Current MC: 12.1 A
Average Current FW: 3.6 A
Max Current: 23.1 Aot: Ben

Flight 2: Repeat flight 1

https://review.px4.io/plot_app?log=e92d6a5b-2296-4559-9e10-bb5ededb1519

Pilot: Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 10:40
Logging Duration: 0:08:51
Dropouts: 26 (6 s)
Vehicle Life
Flight Time: 5 hours 19 minutes 22 seconds
Vehicle UUID: 003900333336511136313734
Distance: 4.47 km

Max Altitude Difference: 228 m
Average Speed MC: 15.1 km/h
Average Speed FW: 48.1 km/h
Max Speed: 84.0 km/h
Max Speed Horizontal: 83.7 km/h
Max Speed Up: 24.2 km/h
Max Speed Down: 19.7 km/h
Max Tilt Angle: 66.2 deg
Max Rotation Speed: 294.3 deg/s
Average Current MC: 9.3 A
Average Current FW: 5.4 A
Max Current: 33.3 A

Pilot complained that the aircraft seemed momentarily unresponsive to controls, but was unsure at time. The UAV had no other issues, but we returned home to assess and verify controls. UAV appeared to be responsive after this, though later, the logs confirm that commands were being issued, and drone was not responding in desired fashion.

Flight 3: Continuance flight from Flight 2.

https://review.px4.io/plot_app?log=66393e57-bb31-483e-853c-50240d6c0978

Pilot: Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 10:56
Logging Duration: 0:08:36
Dropouts: 29 (5 s)
Vehicle Life
Flight Time: 5 hours 28 minutes 10 seconds
Vehicle UUID: 003900333336511136313734
Distance: 4.53 km
Max Altitude Difference: 82 m
Average Speed MC: 13.0 km/h
Average Speed FW: 46.8 km/h
Max Speed: 85.0 km/h
Max Speed Horizontal: 85.0 km/h
Max Speed Up: 14.0 km/h
Max Speed Down: 11.0 km/h
Max Tilt Angle: 39.7 deg
Max Rotation Speed: 117.7 deg/s

Average Current MC: 10.9 A
Average Current FW: 4.1 A
Max Current: 23.8 A

Flight 4:

https://review.px4.io/plot_app?log=ad26336a-2444-4b2e-b4ee-d0edff54d203

Pilot: Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 11:11
Logging Duration: 0:09:46
Dropouts: 29 (5 s)
Vehicle Life
Flight Time: 5 hours 36 minutes 42 seconds
Vehicle UUID: 003900333336511136313734
Distance: 7.12 km
Max Altitude Difference: 88 m
Average Speed MC: 10.6 km/h
Average Speed FW: 50.9 km/h
Max Speed: 74.6 km/h
Max Speed Horizontal: 74.5 km/h
Max Speed Up: 16.8 km/h
Max Speed Down: 16.8 km/h
Max Tilt Angle: 38.9 deg
Max Rotation Speed: 119.1 deg/s
Average Current MC: 13.9 A
Average Current FW: 3.8 A
Max Current: 27.0 A

Flight 5:

https://review.px4.io/plot_app?log=1b88aca6-8b0b-4c23-b56c-d9d5584da12f

Pilot: Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0

Estimator: EKF2
Logging Start : 16-04-2019 11:29
Logging Duration: 0:02:16
Dropouts: 6 (1.03 s)
Vehicle Life
Flight Time: 5 hours 46 minutes 25 seconds
Vehicle UUID: 003900333336511136313734
Distance: 502.3 m
Max Altitude Difference: 74 m
Average Speed MC: 11.2 km/h
Average Speed FW: 34.9 km/h
Max Speed: 40.4 km/h
Max Speed Horizontal: 38.6 km/h
Max Speed Up: 16.8 km/h
Max Speed Down: 9.7 km/h
Max Tilt Angle: 23.7 deg
Max Rotation Speed: 103.1 deg/s
Average Current MC: 12.9 A
Average Current FW: 10.9 A
Max Current: 26.4 A

Flight 6: Tested the new HD Camera nose cone. Noted that the Edge had difficulty maintaining altitude and required constant altitude adjustment by pilot. Camera nose cone weighs in at 320g, a differential weight of +224g from the default baseline nose cone. We did not test autonomous mission features with this nose cone.

https://review.px4.io/plot_app?log=d8226060-2cba-4af1-9fea-fa857218517e

Pilot: Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 12:20
Logging Duration: 0:04:28
Dropouts: 17 (3.19 s)
Vehicle Life
Flight Time: 5 hours 48 minutes 38 seconds
Vehicle UUID: 003900333336511136313734
Distance: 2.64 km
Max Altitude Difference: 78 m
Average Speed MC: 9.8 km/h

Average Speed FW: 63.4 km/h
Max Speed: 117.6 km/h
Max Speed Horizontal: 116.5 km/h
Max Speed Up: 23.5 km/h
Max Speed Down: 26.5 km/h
Max Tilt Angle: 45.6 deg
Max Rotation Speed: 152.7 deg/s
Average Current MC: 14.7 A
Average Current FW: 8.4 A
Max Current: 29.9 A

Flight 7:

https://review.px4.io/plot_app?log=d18044f2-a516-429c-ba38-c4f78fa95977

Pilot: Rob

Power up only, no flight.

Flight 8: This flight tested several mode transitions to check for instability or bugs in the transition routines. An emergency transition to hover mode was encountered, we think due to a wind gust. The Edge transitioned to hover mode safely and stabilized itself. Everything appeared to be functioning so we continued the flight. We measured under 12 knot winds.

https://review.px4.io/plot_app?log=57ae119d-3228-4c5f-8d28-60348feb447c

Pilot: Ben

Airframe: 13300

Hardware: PX4FMU_V2

Software Version: 0a44dde2

branch: feature/qmc5883

OS Version: NuttX, v7.22.0

Estimator: EKF2

Logging Start : 16-04-2019 12:29

Logging Duration: 0:07:55

Dropouts: 22 (4.47 s)

Vehicle Life

Flight Time: 5 hours 52 minutes 58 seconds

Vehicle UUID: 003900333336511136313734

Distance: 5.84 km

Max Altitude Difference: 109 m

Average Speed MC: 10.3 km/h

Average Speed FW: 71.5 km/h

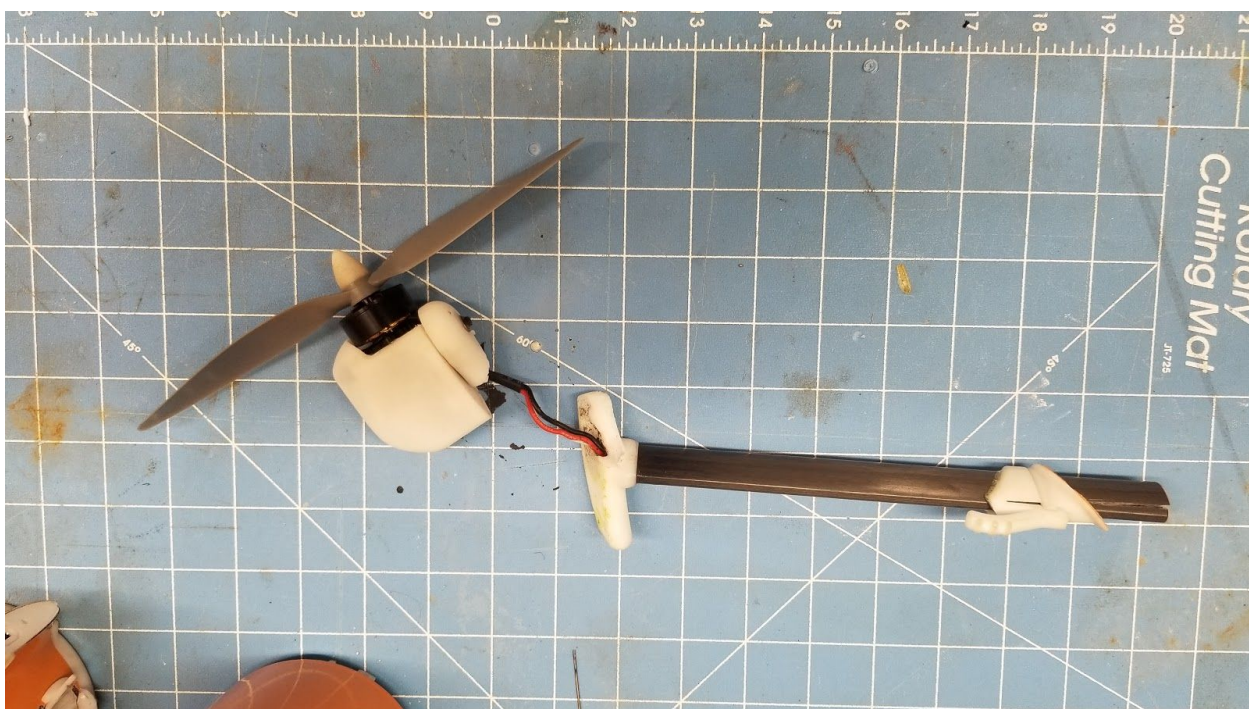
Max Speed: 112.8 km/h

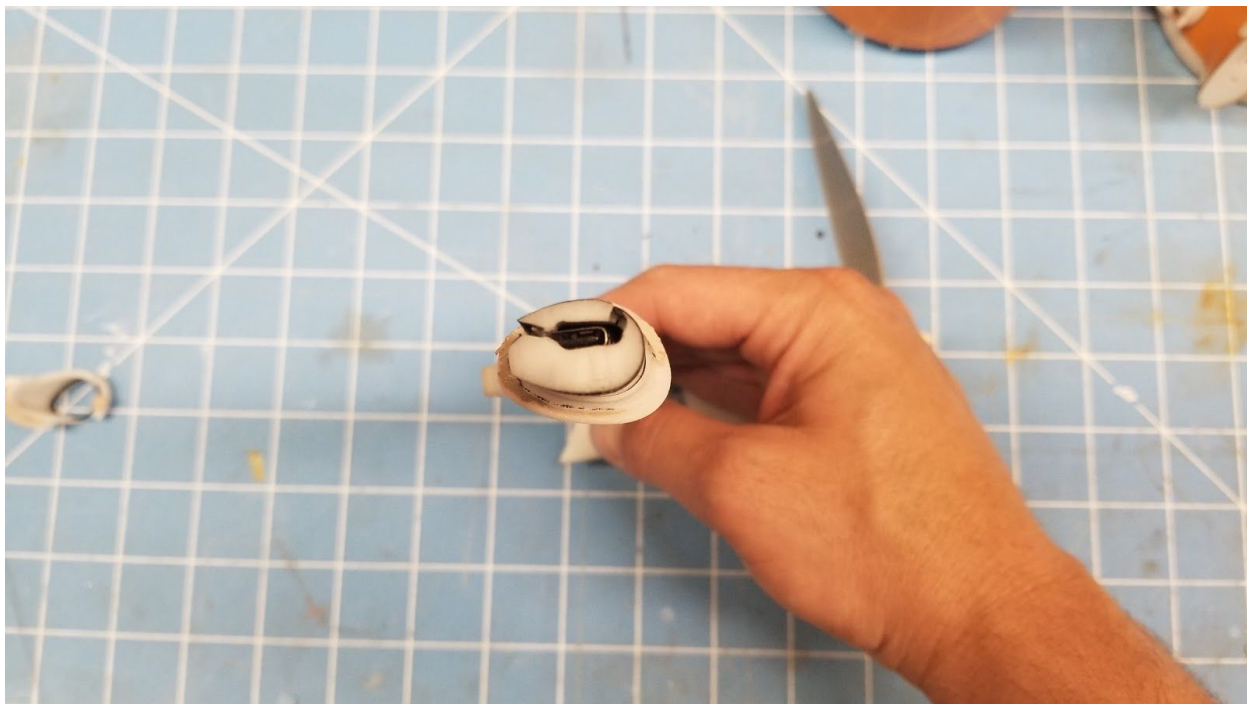
Max Speed Horizontal: 112.5 km/h
Max Speed Up: 19.1 km/h
Max Speed Down: 29.6 km/h
Max Tilt Angle: 60.9 deg
Max Rotation Speed: 149.0 deg/s
Average Current MC: 15.0 A
Average Current FW: 10.1 A
Max Current: 34.0 A

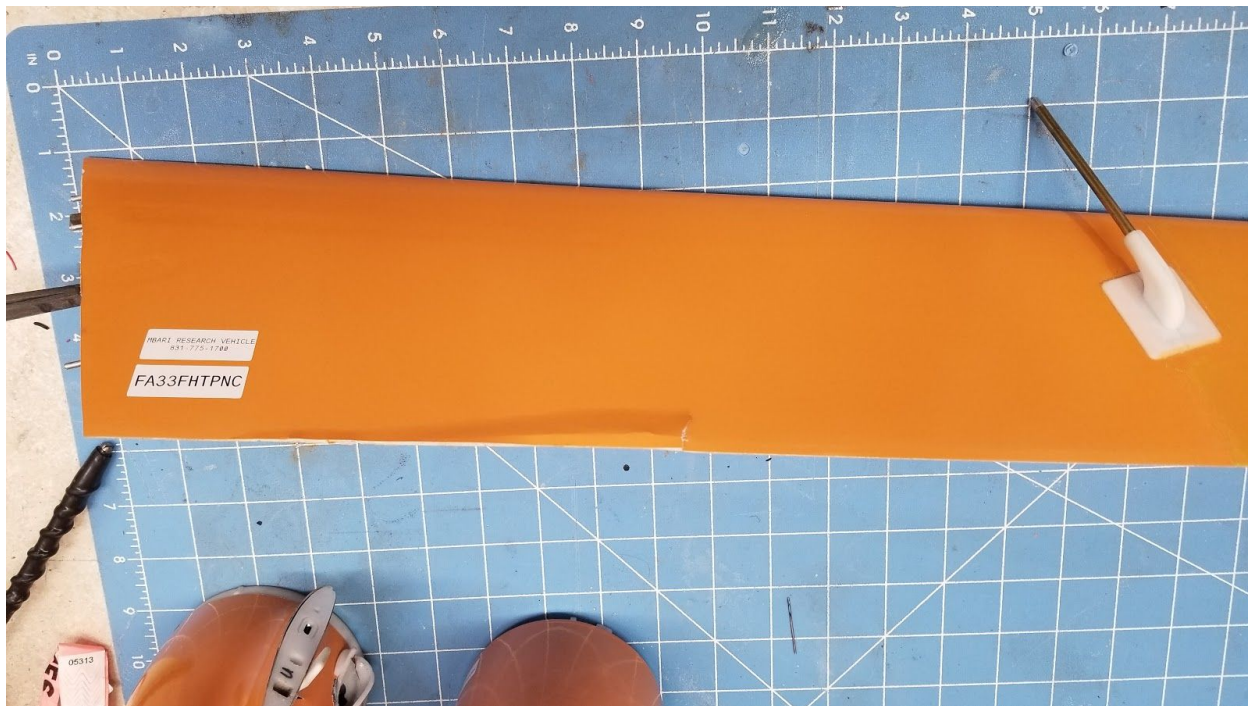
Flight 9: This was the final mission for this Edge, which ended in a crash described in the beginning of this report. The entire log break down can be found at:

https://review.px4.io/plot_app?log=ed45e768-3e5f-4102-8d8a-7adaae8359fb

Pilot: Ben, Rob
Airframe: 13300
Hardware: PX4FMU_V2
Software Version: 0a44dde2
branch: feature/qmc5883
OS Version: NuttX, v7.22.0
Estimator: EKF2
Logging Start : 16-04-2019 13:26
Logging Duration: 0:07:44
Dropouts: 24 (4.42 s)
Vehicle Life
Flight Time: 6 hours 46 seconds
Vehicle UUID: 003900333336511136313734
Feedback: Crash
Distance: 5.78 km
Max Altitude Difference: 90 m
Average Speed MC: 15.6 km/h
Average Speed FW: 51.3 km/h
Max Speed: 83.0 km/h
Max Speed Horizontal: 83.0 km/h
Max Speed Up: 15.8 km/h
Max Speed Down: 45.5 km/h
Max Tilt Angle: 175.6 deg
Max Rotation Speed: 1952.7 deg/s
Average Current MC: 11.7 A
Average Current FW: 4.1 A
Max Current: 42.7 A













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