27-May-2016

Post Flight Analysis

University of Wisconsin – River Falls

High Powered Rocketry: ORCA

UNIVERSITY OF WISCONSIN–RIVER FALLS

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1. Executive Summary

On 16-May-2016, the University of Wisconsin – River Falls High Powered Rocket Team launched their rocket three times in the 2016 Space Grant Midwest High-Powered Rocket Competition. The goal of the competition was to conduct a minimum of two launches within one hour, the first having a goal of a minimum apogee of 3,000 feet and the second to reach exactly 75% of the first through the application of an active drag system. Additionally, coefficient of drag was to be characterized on all launches. The airframe of the rocket had a length of 175cm, diameter of 10cm and weighed in at 5.7kg with motor. The active drag system design was based on a cam system that converted rotational motion to linear motion, powered by one servo controlled by an Arduino based microcontroller. Data was logged by this system to an on-board SD card. Unfortunately, there was an excessive amount of noise with our data collection that not only made the drag system calculate the wrong expected apogee and pull in, but made calculating a coefficient of drag nearly impossible. The team opted for a third flight where the drag system would be completely time based. I rough estimate of four seconds of fully extending added drag was used and there was a significant reduction in apogee yet not nearly the 25% wanted. The camera system also did not work on the last flight so the only drag visual we have to is on the second flight where the system engaged and disengaged immediately. The rocket, however, was successfully recovered after each flight and is still in flyable condition which seen as a tremendous success by team since it was our first dealing with rockets.

2. Rocket Operation Assessment

a. Motor Performance

- The J295-16A motor selected worked perfectly as expected. We were trying to achieve just over 5000 feet in altitude for maximum points without going overboard making recovery more difficult and stresses to the rocket to excessive. The motor we selected ended up bringing us to 5097 feet. This was very consistence with our two practice flights which were 5101 and 5243 feet and much more precise than the +/- 10% tolerance of the motors.

b. Flight Path

- Each of three flights flew almost perfectly horizontal with the smallest amount of wobble in the first 100 meters. The static margin of 2 helped direct the rocket slightly into the wind.

c. Recovery System

- The Altus Metrum Telemetrum performed as expected on all launches. This is a commercially available dual deployment package that provides remote continuity testing of the main and drogue parachutes. The package also enables the remote arming/disarming of the ejection charges.

d. Ground Recovery

- The drogue parachute selected for these flights was about twice the size needed. Larger than expected drift was experienced as a result of this decision. The team

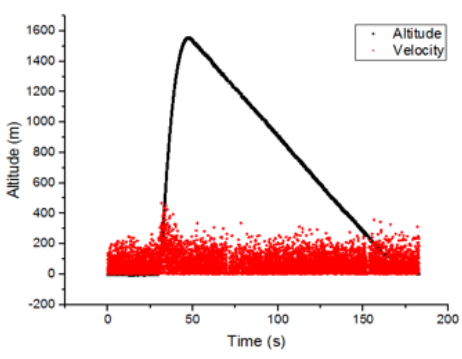
settled on a larger than required drogue for safety, but resulted in an extremely inconvenient recovery.

e. **Operational Procedures**
- All flight procedures were completely overhauled after the 09-April-2016 test launch. The original version of the checklists were the step-by-step instructions on preparing the rocket for launch.

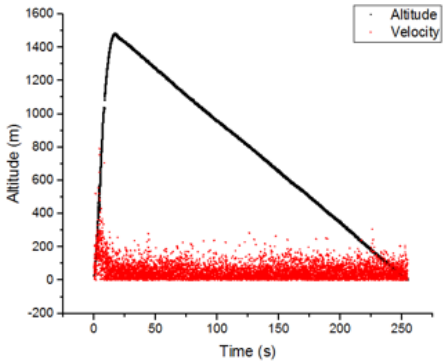
3. Actual vs Predicted Performance

a. Peak Altitude & Velocity
- Velocity data collected was erratic on all flights. After the 9-Apr test launch, oversampling on the data acquisition through the altimeter was disabled. This was a decision made in order to increase the amount of data points collected during the launch. With oversampling enabled, the sampling rate was roughly 2 samples per second. This resulted in about 40 data points in a 20 second launch. Disabling over sampling increased the sampling rate to 50 per second, but also resulted in extreme noise. Oversampling smooths out that noise, which is seen in the velocity over time illustrations below.

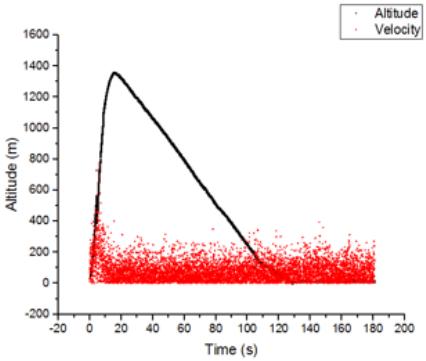
Flight 1



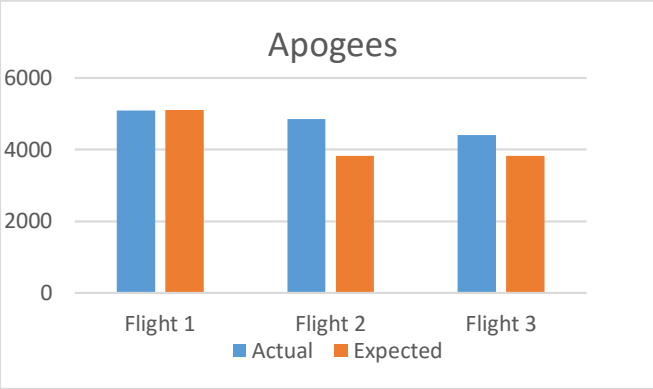
Flight 2

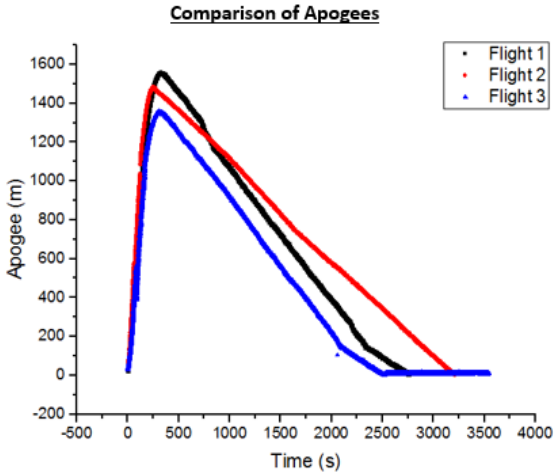


Flight 3



- The clean flight apogee was exactly as expected. Flight two was not close to expected. The drag system deployment apogee failed due to the noise in the velocity calculations illustrated above, which resulted in the algorithm deploying the drag system for less than one second on Flight 2. Flight 3 was programmed to deploy the drag system for four seconds after burnout.





4. Data Collection

a. Unfortunately, the velocity data collected had an extreme amount of noise and was deemed unusable. The altitude data, however, was accurate across all data collection devices.

5. Conclusion

a. The University of Wisconsin – River Falls rocket performed as expected with the exception of the active drag system and in-flight recovery. The first launch, without the active drag system, reached expected apogee. The active drag system algorithm did not perform as expected, due to variations in data collection procedures and sensors. The drogue parachute was about twice the size as needed, as resulted in much larger drift than expected.

b. While the drag system performance was not optimal, the team considers the competition a success. Rocketry was a completely new topic for each member of the team prior to this competition. Everyone gained valuable knowledge, and experience, in rocketry and we all look forward to future competitions. Special thanks go to Gary Stroick and Joe Schneider for the mentorship and guidance during the test phase of development.