Post-Flight Report

University of Wisconsin - Platteville

Pioneer Rocketry

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Rocket Operation Assessment

In terms of operation as a simple rocket, Mr. Rogers performed without error and was recovered successfully. We only launched the rocket one time due to most of the day being taken up by various electronic issues with the control system. The control system also output undefined control signals in the last moments before launch. For this reason, we decided to completely remove all of the control system and data logging logic, and simply hold the fins level.

Flight Anomalies Analysis

There were a few anomalies during the competition flight of the rocket. The first was excessive spin. All rockets have a spin inherent in the system. The rocket should have had minimal spin because we zeroed the fins and flew in a “dumb” configuration, with how accurately we aligned the fins before launch, the spin on Mr. Rogers should have been minimal. After analysis, excessive spin may have been due one of the collars on a fin’s shaft slipping. This is one of the major problems we have had throughout the project. The grub screw that holds the D-profile shaft into place will become worn down, or break, after repeated use. We believe this may have been the case during launch, and as a result, one of the fins shifted. In Figure 1, the excessive rolling can be seen.

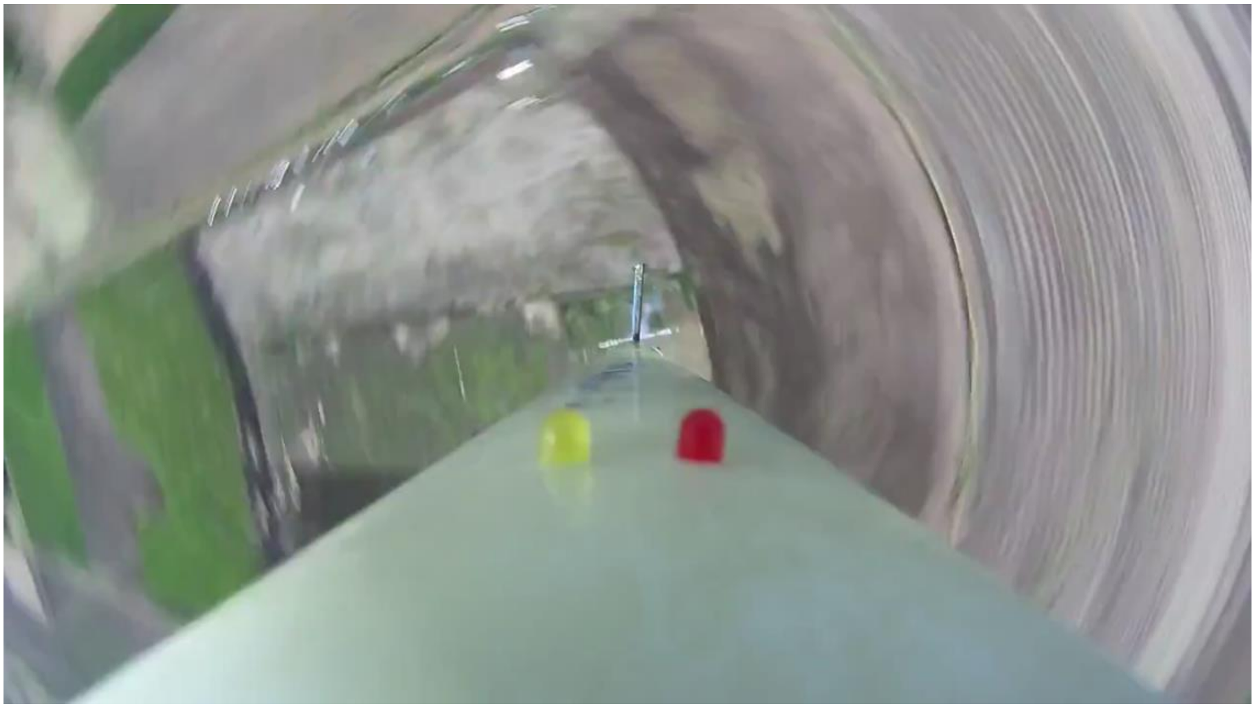

Figure 1 Mr. Rogers rolling quickly during ascent.

Another anomaly was the LEDs being removed from the tube when the parachute ejected. The LEDs are still intact; they simply need to be secured better for subsequent launches.

Propulsion System Assessment

For our propulsion system, we used an Aerotech J800-T. This motor provides a relatively short burn time coupled with high impulse. We planned to use this motor because it allows a lot of control time in accordance to the rules.

According to the data gathered, the burn time on the J800-T was about 1.5 s. This is assessed by taking the time at which the rocket achieves maximum velocity and subtracting any time that the rocket was sitting still just before launch. Mr. Rogers was sitting still for 0.75 s when data logging started, and maximum velocity was achieved 2.25 s into flight. The J800-T is advertised as having a burn time of about 1.6 s.

Flight Trajectory Assessment

The trajectory of the rocket was nominal. Mr. Rogers did not experience a lot of weather-cocking during the flight, which might be due to the excessive amount of spin experienced by the rocket and the low winds during the launch. In Figure 2 it can be seen that lateral movement of the rocket during flight was minimal. The rocket reached an apogee of 2911 ft, which is under the goal apogee. We believe a considerable amount of energy was transferred into the rocket's spin, which made the fins act as air brakes.

Figure 2 The rocket at near-apogee with the launch site visible.

Recovery System Assessment

Figure 3 The altitude graph of Mr .Rogers's flight.

The flight plan for Mr. Rogers included deployment of a 48 in. drogue at apogee, with a 60” main deploying at 700’. drogue at apogee, with a 60 in. main deploying at 700 ft. The recovery system worked as expected. Figure 3 shows the graph of altitude vs time of the flight. After apogee, the rocket descended at 61 ft/s on the drogue. While on the main parachute, the rocket descended at a safe 21 ft/s.

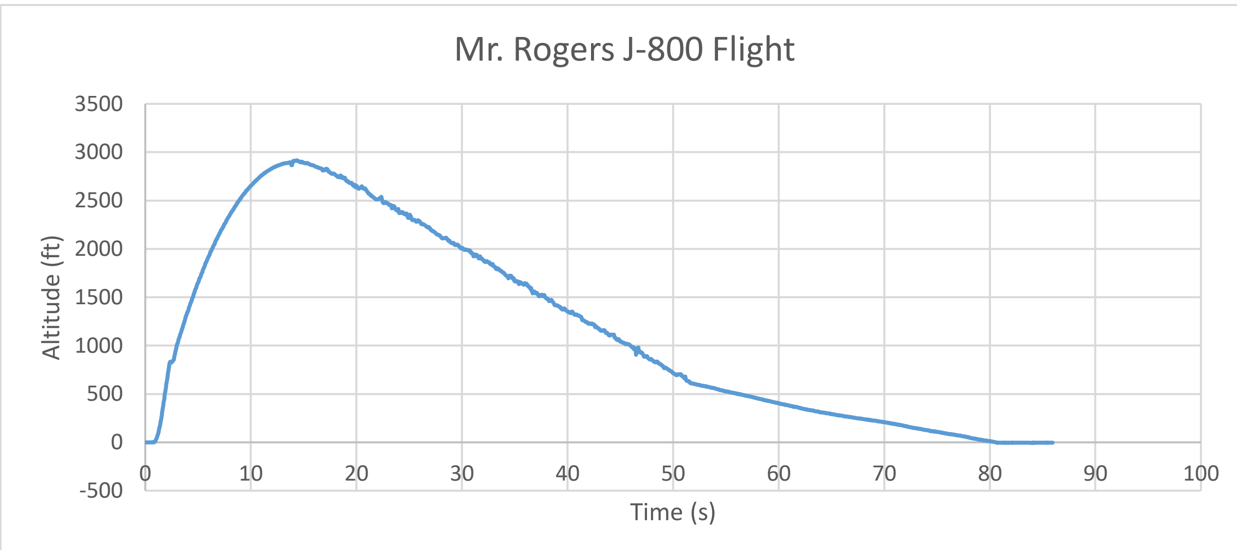

Figure 3 Plot of Mr. Rogers altitude throughout the flight.

Ground Recovery Assessment

The rocket landed only a few meters from the launch site and in good condition. During recovery, the fins appeared to be broken. This was only because they were deactivated. The power to the servos was entirely removed during chute deployment. This behavior can be seen in Figure 4, as the fin was no longer being held in alignment.

Figure 4. The landed rocket before recovery.

The landing site of the rocket was only a few meters from the launch area. The distance between the landing location and the launch rods can be seen in Figure 5. This allowed for a speedy and easy recovery.

Figure 5. The rocket landing spot in relation to the launch rods.

Pre/Post-Launch Procedure Assessment

Unfortunately, due to electronics problems, we were not able to get the rocket to a flight ready state within the 1-hour time limit. However, the pre-launch procedure did get us to a state where we could launch the rocket. There were no missing steps in the procedure to prepare for launch, and due to this we had a successful launch. The post-launch procedure guided us through the process of retaining flight data, along with taking pictures of the final landing location before touching the rocket. Figure 6 shows the rocket almost entirely prepped for launch.

Figure 6 Mr. Rogers being prepared for launch.

Actual VS Predicted Performance

Peak Altitude Comparison to Expectations

The peak altitude of the rocket came in well below the simulated altitude from OpenRocket. According to simulations, the rocket was to go to 3584 ft.; the rocket only went to 2911 ft.

Peak Velocity and Peak Acceleration Comparison to Expectations

The peak velocity derived from altimeter data shows a maximum velocity of 750 ft/s. The simulations of Mr. Rogers on the J800 predicts a maximum velocity of 566 ft/s. Noise was removed from the raw altimeter data by applying a moving average filter to the data. The rate of the smoothed altimeter data was then found, and the maximum data point is 750 ft/s.

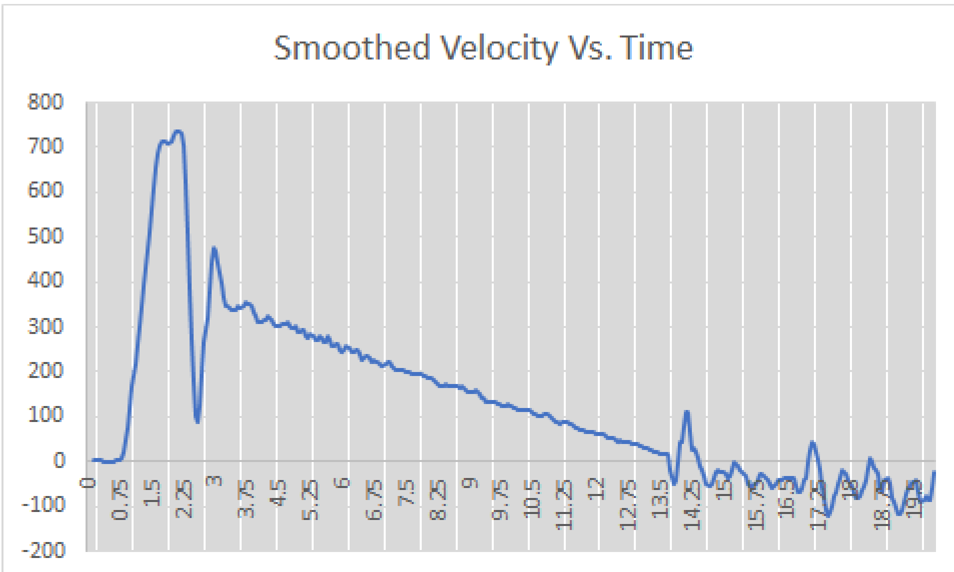

Figure 7. Smoothed velocity derived from smoothed altimeter data using boxcar averaging every three values for the first 20 s of flight. The maximum velocity of 750 ft/s was reached approximately 2 s into the flight.

The open rocket simulation estimated a maximum acceleration of 17.8 G. However, looking over the altimeter data we retrieved, the maximum acceleration was actually 77.8 G. This is assumed to be an error caused by noisy data. The velocity and acceleration can be seen in Figures 7 and 8, respectively.

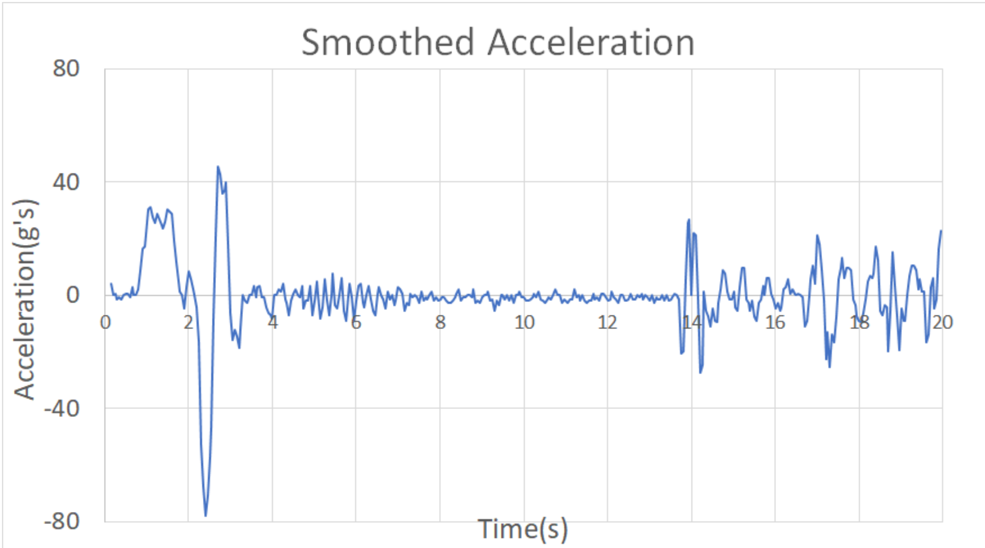

Figure 8. Smoothed acceleration derived from smoothed altimeter data using boxcar averaging every three values for the first 20 s of flight. The maximum acceleration of 77.8 g was reached approximately 2.25 s into the flight.

Recovery System Performance and Decent Velocity Comparison to Expectations

The descent velocities for the rocket derived from the altimeter showed a descent velocity of 20.5 ft/s under the main. The simulation created in OpenRocket predicted a descent velocity of 21.7 ft/s. The descent velocities were derived from the filtered altimeter data used above and taking an average of the section of flight from 700 ft to ground level. Figure 10 below shows the velocity while under the main chute and Figure 9 shows the calculated velocities from OpenRocket. Based on this data the recovery system preformed as expected.

Name	Configuration	Ground hit velocity
0 MPH	[J800T-6]	21.7 ft/s
5 MPH	[J800T-6]	21.7 ft/s
10 MPH	[J800T-6]	21.8 ft/s
15 MPH	[J800T-6]	21.9 ft/s

Figure 9. Predicted ground hit velocities for different light simulations of Mr.Rogers.

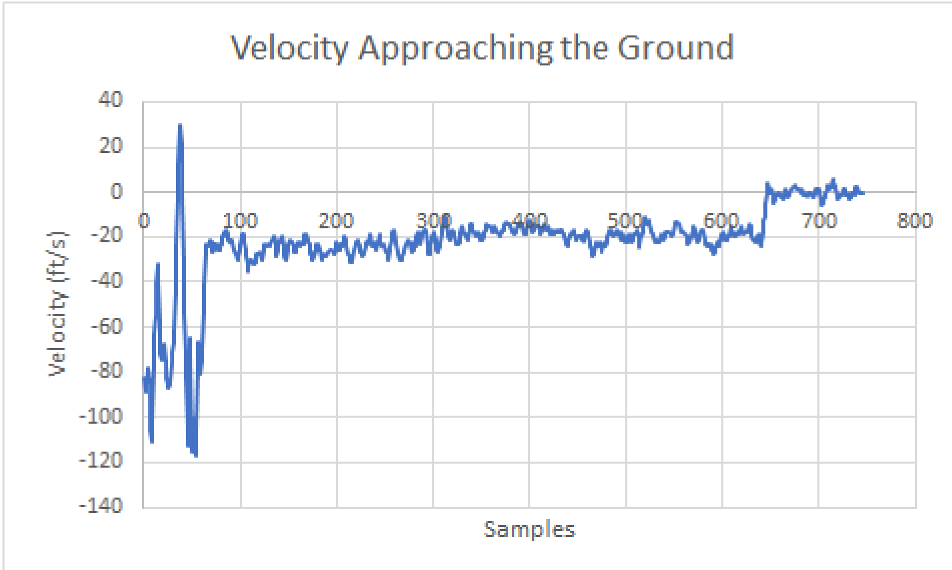

Figure 10. The final moments before Mr. Rogers landed.

The average velocity just before hitting the ground was 20.5 ft/s, which was within 1.2 ft/sec of the predicted value.

Active Roll/Orientation System Data Collection And Analysis

We don't have this data due to a never-encountered-before problem arising from the control system giving undefined outputs to the hardware. Sufficient consideration went into the design and simulation of the control system, and it successfully communicated with hardware preceding the launch. This necessitates further investigation as to what caused the malfunction. The code was reverted to an earlier state before launch to try regaining functionality, and the output was still undefined. This leads us to believe that the problem must be in hardware. Without another day to get the control system ready, and figure out what happened, we decided to use this launch to test our previously untested airframe.