Project 1

Executive Summary

ENGR 130

Problem Statement:

This project involves designing a descent control system for a Landing Recovery Vehicle (LRV) on a zipline. The system must regulate speed to ensure a controlled descent while meeting specific time and acceleration constraints. This challenge reflects real-world applications such as spacecraft landings and re-entry vehicles, where minimizing speed impact is critical.

The LRV must:

- Have a descent time that is **60-70% slower** compared to the baseline.
- Limit peak acceleration to **1.5 m/s^2** or less.
- Allow easy installation of the telemetry device.
- Operate autonomously after release.
- Use only approved materials within a **$10 budget** without permanent modifications.

Unique Features of the Device:

Our LRV descent system combines **stability, controlled drag, and impact absorption** for a smooth, low-impact landing while staying within budget.

- **Triangle Shaped Wings –** These wings, made out of light weight material such as paper, tape and popsicle sticks, located on the right and left sides of the LRV, are used to enhance stability by reducing unwanted rotation and keeping the LRV aligned along the descent path, improving aerodynamic control.
- **Parachute** – A parachute made from a plastic bag, with a short string length of 4-5 inches, ensures quick deployment and maximizes air resistance, effectively slowing the LRV without excessive swinging.
- **String Compression System –** The front of the LRV features a cushioning system made from pipe cleaners, tape and balloons, which absorbs impact forces and reduces acceleration upon landing.

Performance Analysis:

Our LRV landing system performed subideally during the glide phase of the descent, with vertical acceleration magnitudes reaching their maximum at 4.265 m/s^2 near the beginning of the descent. (See Appendix A) This may have been due in part to strong reverberations in the zipline immediately after release that caused the LRV to bounce up and down. However, the descent time was within specifications, with a 61% increase over the benchmark time (See Appendix B), and the LRV remained stable and oriented throughout its flight, experiencing only minimal rotation.

In contrast, our LRV performed adequately upon landing, with the deceleration being fairly gradual during the initial phases of the catch. Unfortunately, our readings were impacted by human error when the LRV did not come to a full stop, causing it to tumble over the catcher's hand and impact the ground upside-down. We chose not to reflect this in the metrics of the LRV's performance, as it was beyond the initial parameters of the project.

Overall, our LRV performed adequately during the demonstration, achieving all but one of the performance metrics. Our design has proven to be reliable, ensuring that these results can be consistently replicated in future projects. We believe that, given another attempt, we could enhance our acceleration metric by implementing a more controlled release, reducing the bouncing for a smoother descent.

Appendices:

Appendix A: Acceleration Data During the Descent

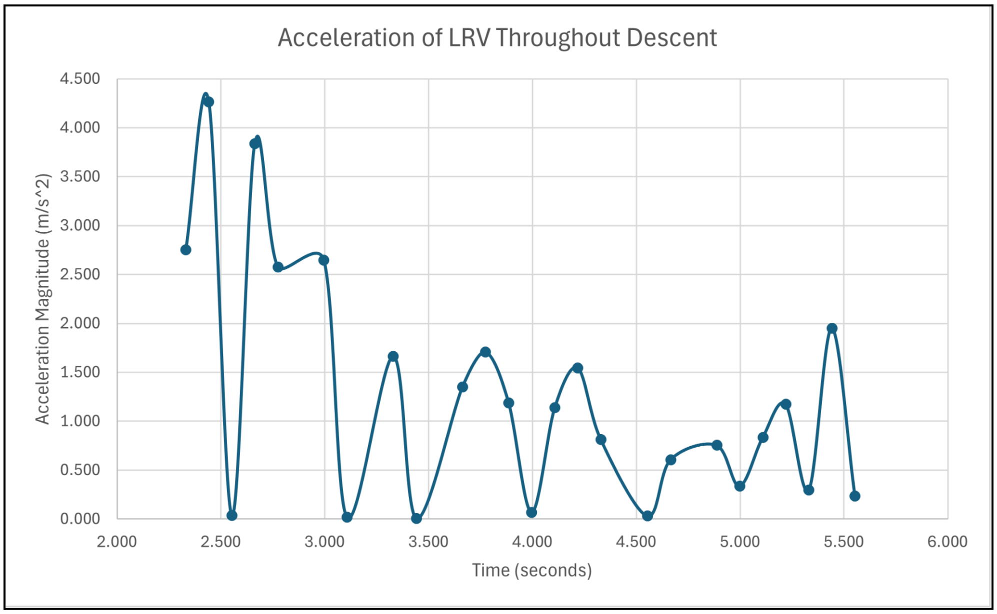

Figure 1: A graph of the acceleration experienced by the LRV during its descent. The cyclical shape of the graph suggests that oscillations in the zipline may be responsible for significant amounts of vertical acceleration.

Appendix B: Performance Metrics

Table 1: Performance Results	
Metric	**Value**
Descent Time (sec):	3.55
Benchmark Descent Time (sec):	2.20
Descent Time % Increase:	61.6%
Maximum Acceleration (m/s^2):	4.27
Minimum Acceleration (m/s^2):	0.006
Average Acceleration (m/s^2):	1.273
Material Cost:	$ 0.97
Total Score:	46285.39

Table 1: A summary of the performance results of our LRV.