Constructing a Reusable Solid-Fuel Rocket Capable of Propulsive Landing

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By 2025, more than 1,100 satellites will be deployed annually. These satellites will provide GPS, weather tracking, and communications, along with countless other services to humanity. Currently, most satellites are deployed using reusable orbital-class rockets. Because space travel will eventually replace air travel, a recovery method with a short turnaround time, such as propulsive landing, is necessary. The liquid rocket engines (LREs) used are incredibly complex, requiring extensive refurbishment prior to reuse, resulting in long turnaround times. Solid rocket boosters (SRBs) are significantly simpler than LREs and can be refurbished faster. However, because their fuel and oxidizer are premixed, they cannot be throttled, making propulsive landing impossible. The goal of this research is to develop a novel method of artificial throttling that can be achieved with SRBs by utilizing control systems that are already present on the rocket. By vectoring the SRB away from the ground, the vertical component of thrust will decrease, providing artificial throttle control. The horizontal thrust component created by this maneuver can be countered by vectoring the thrust circularly, tightening the radius as the rocket approaches the ground. This theory was tested using a custom simulation that models the dynamics of a thrust-vectoring SRB on the model scale. The simulated launch and landing procedure has a success rate of 97.4% after a genetic algorithm was created to determine ideal control coefficients. Additionally, a physical model rocket was created to test the interaction between the control logic and the system hardware. The results show that it is possible to propulsively land an SRB, and a future physical landing test will verify the findings.

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