Development of a Fully Reusable and Autonomously Landing Suborbital Launch Vehicle

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Throughout the past decade, significant aerospace research has been focused on bending the cost curve of space exploration through the development of reusable boosters. However, the investments in reusable technology have been primarily directed towards developing cost savings for large, orbital class boosters. This has left the smaller, lower-powered launch market without reusable technology which has resulted in relatively high launch prices. The development of technology capable of returning and landing smaller rockets could dramatically reduce launch costs. To achieve this goal, I worked towards developing hardware and software that enables a small booster to propulsively land, ready to be reused. The propulsion system that I engineered utilizes four solid rocket motors, each of which can be gimbaled on one axis. This configuration enables yaw, pitch, roll, and throttle control of the vehicle. I also developed software that utilizes proportional-integral-derivative (PID), sensor fusion, and data filtering algorithms. PID coefficients were determined by developing a mathematical model which simulated the rocket landing. The flight computer I developed runs on a 180 MHz ARM Cortex-M4 processor and contains all necessary sensors and control interfaces. Additional hardware was also designed and built to support the landing and reusability of the rocket. My project analysis indicates that the successful development of this system shows significant potential to save costs for smaller launch vehicles by enabling them to propulsively land and be reused.

Awards Won:

First Award of $3,000

Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category

National Aeronautics and Space Administration: Second Award of $750

China Association for Science and Technology (CAST): Award of $1,200

International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention