Pterodactyl: Non-propulsive Control System Designs for Future Planetary Missions

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Advances in deployable entry vehicle (DEV) technology, entry guidance, woven thermal protection systems, and affordable launch services make it possible to conceive of entry vehicles that optimize maneuverability, usable payload mass and volume, and operational costs. NASA's Space Technology Mission Directorate is currently funding the authors on a project, Pterodactyl, that is using on-the-fly trajectory design and integrated software and hardware development to investigate non-propulsive entry control systems for precision targeting of mechanical DEVs. The authors recently reported developments of these control systems for an asymmetric DEV to track bank commands for a lunar return entry.[1, 2, 3, 4, 5, 6, 7]

For this presentation, the authors will highlight key findings from their studies and propose rapid investigations of applications to future Mars missions such as sample return and asset delivery. Pterodactyl entry vehicle designs are suited to handle sensitive payloads and poised to achieve greater payload mass and volume compared to heritage entry vehicles given a particular launch vehicle. Furthermore, these designs could be adapted to launch on less costly launch vehicles as secondary payloads and could enable missions with high-frequency deployment requirements.

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[1] Sarah N. D'Souza, et al. Developing an Entry Guidance and Control Design Capability Using Flaps for the Lifting Nano-ADEPT. AIAA AVIATION 2019 Forum. 2019, AIAA, Dallas, TX.
[2] Bryan C. Yount, et al. Pterodactyl: Mechanical Designs for Integrated Control Design of a Mechanically Deployable Entry Vehicle. AIAA SciTech 2020 Forum. 2020,
AIAA, Orlando, FL.
[3] Ben E. Nikaido, et al. Pterodactyl: Aerodynamic and Aeroheating Database Development for Integrated Control Design of a Mechanically Deployable Entry Vehicle. AIAA SciTech 2020 Forum. 2020, AIAA, Orlando, FL.
[4] Breanna J. Johnson, et al. Pterodactyl: Development and Performance of Guidance Algorithms for a Mechanically Deployed Entry Vehicle. AIAA SciTech 2020 Forum. 2020, AIAA, Orlando, FL.
[5] Wendy A. Okolo, et al. Pterodactyl: Development and Comparison of Control Architectures for a Mechanically Deployed Entry Vehicle. AIAA SciTech 2020 Forum. 2020, AIAA, Orlando, FL.
[6] Zane B. Hays, et al. Pterodactyl: Thermal Protection System for Integrated Control Design of a Mechanically Deployable Entry Vehicle. AIAA SciTech 2020 Forum. 2020 AIAA, Orlando, FL.
[7] Antonella I. Alunni, et al. Pterodactyl: Trade Study for an Integrated Control System Design of a Mechanically Deployable Entry Vehicle. AIAA SciTech 2020 Forum. 2020, AIAA, Orlando, FL.