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MARS SMALL-SPACECRAFT HUMAN EXPLORATION RESOURCE PROSPECTOR WITH AERO-BRAKING (SHERPA): DEMONSTRATING AN END-TO-END MISSION TO PHOBOS DISTANT RETROGRADE ORBIT

Abstract

This paper summarizes an end-to-end mission design concept exploring the feasibility of using small satellites together with aero-capture technology to achieve Mars orbit insertion, and subsequent injection into a Phobos-stabilized (or distant retrograde) orbit. The science and mission objectives are to carry out a survey of the mineralogy and morphology of Phobos, to answer basic questions concerning its origin and formation, to test the cohesiveness of Phobos regolith, and to search for potential landing sites for future human or robotic spacecraft. The Mars Small-Spacecraft Human Exploration Resource Prospector with Aero-braking (SHERPA) spacecraft is based on a combination flight-tested prototype vehicle and instruments, and first principle sizing of consumables. The resulting system is fitted with an inflatable aerodynamic decelerator to effect aero-capture into a Mars elliptical orbit, on its way to achieving Phobos orbit. A computational fluid dynamics tool is used to analyze the flow-field and identify potential hot spots during aerodynamic flight. This work advocates for the use of small satellites to test out technologies and operational concepts used in sustained human exploration of Mars, and to carry out scientific exploration of the Mars system. Consistent with a systems engineering approach, this work combines elements of the NASA Human Exploration and Operations Mission Directorate, the Space Technology Mission Directorate, and the Science Mission Directorate, and proposes a scenario for science acquisition, technology verification, trajectory validation, and in-situ resource exploration. We believe these type of missions are essential forerunners to human crewed missions to Mars.