Paper ID: 64582
student

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry & Landing Systems (3)

Author: Ms. Shayna Hume
University of Colorado Boulder, United States

NOVEL ORBITAL ENERGY TARGETING IN MARTIAN ENTRY, DESCENT, AND LANDING

Abstract

Despite the fact that Entry, Descent, and Landing (EDL) serves as one of NASA's 16 official technology road maps, many of NASA's developments in atmospheric flight from as distant as the 1960's remain the basis of their capabilities. One of the goals of both the public and private industry is to update these heritage methods and implement new knowledge in the area of on-board autonomous descent, in order to use them for upcoming missions such as the Sample Return Lander (SRL) and Earth Return Orbiter (ERL) that may follow the recent success of Mars 2020. SRL, in particular, would represent a 20-25% increase in mass capabilities and include the new goal of pinpoint landings, with a landing ellipse of only 20 meters. The goal of this study was to develop and test a closed-loop Mars EDL simulation code that propagates the controlled dynamics of an entry vehicle from an entry interface (EI) until landing. Existing guidance algorithms reduce uncertainty through high-frequency course-correction during descent, however, do not produce optimal solutions under perturbations. This research suggests a modification in the Fully Numerical Predictor-Corrector Entry Guidance (FNPEG) method, which decouples the longitudinal and lateral control dynamics under an assumption of small angular deviations, of the closed-loop simulation. FNPEG relies on an orbital energy targeting mechanism throughout EDL. However, it is posited that by changing the targeting mechanism in the *entry phase*, from EI to the start of powered descent initiation (PDI), that it would be possible to target a volume dictated by position and velocity coordinates at the PDI interface - which would improve the accuracy of the *descent phase* to the surface. The targeted volume is defined by varying position and velocity for a constant orbital energy: $E(r, v)$. This research will give an overview of the method implemented, the relationship between this method and other decoupling targeting solutions between the entry and descent phases, and a performance comparison between this and traditional FNPEG orbital energy targeting. The outcome of this effort will demonstrate whether this targeting solution has potential for improving the precision of on-board Martian landing systems on the scale of other technologies such as pinpoint landing.