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ENTRY, DESCENT AND IMPACT SYSTEM DESIGN AND ANALYSIS OF A SMALL PLATFORM IN MARTIAN ENVIRONMENT

Abstract

Thanks to the latest Mars missions, planetary exploration has made enormous strides over the past ten years increasing the interest of the scientific community and beyond. These missions must fulfil many complex operations which are of paramount importance to mission success. Among these, a special mention goes to the Entry, Descent and Landing (EDL) functions which require a dedicated system to overcome all the obstacles of these critical phases. The goal of this study is to describe in detail the design methodology for EDL system during the preliminary phase of the design. The design is supported by a simulation tool integrating the entry trajectory algorithm. The trajectory data computed are used to size the EDL system and strategy in order to have a low aerodynamic acceleration, low dynamic pressure and low convective heat flux incoming to the spacecraft. The reference mission has the goal to find bio-evidence and biohazards on Martian subsurface in order to prepare future manned missions. The mission is based on Space Penetrator Systems (SPS) that can descend on Mars surface following a ballistic fall and penetrate the ground after the impact with the surface (around 50 and 300 cm depth). The SPS contains all the instrumentation required to sample and make the required analyses. As results, an Entry Descent and Impact (EDI) system based on inflatable structure is designed, respecting the low-cost and low-mass constraints. For this mission, a solution, like the one of Finnish Meteorological Institute in the Mars Met-Net mission, is chosen, using an inflatable Thermal Protection System (TPS) called Inflatable Braking Unit (IBU) and an additional inflatable decelerator. Consequently, there are three configurations during the EDI phases: at an altitude of 125 km, the IBU is inflated at speed 5.5 km/s; at an altitude of 16 km, the IBU is jettisoned and an Additional Inflatable Braking Unit (AIBU) is inflated; at last, at about 13 km, the SPS is ejected from AIBU and it impacts on the Martian surface. In this paper, the results obtained by the application of this design methodology are presented and, the obtained system and descent strategy satisfy the requirements of the mission.