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Entry, Descent and Landing System Design and Analysis of a Small Platform in Mars Environment

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Abstract : Thanks to the latest Mars mission, the planetary exploration has made enormous strides over the past ten years increasing the interest of the scientific community and beyond. These missions aim to fulfill 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 general objective of the system is to safely bring the spacecraft from orbital conditions to rest on the planet surface, following the designed mission profile. For this reason, this work aims to develop a simulation tool integrating the re-entry trajectory algorithm in order to support the EDL design during the preliminary phase of the mission. This tool was used on a reference unmanned mission, whose objective is finding bio-evidence and bio-hazards on Martian (sub)surface in order to support the future manned mission. Regarding the concept of operations (CONOPS) of the mission, it concerns the use of Space Penetrator Systems (SPS) that will descend on Mars surface following a ballistic fall and will penetrate the ground after the impact with the surface (around 50 and 300 cm of depth). Each SPS shall contain all the instrumentation required to sample and make the required analyses. Respecting the low-cost and low-mass requirements, as result of the tool, an Entry Descent and Impact (EDI) system based on inflatable structure has been designed. Hence, a solution could be the one chosen by Finnish Meteorological Institute in the Mars Met-Net mission, 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: at altitude of 125 km the IBU is inflated at speed 5.5 km/s; at altitude of 16 km the IBU is jettisoned and an Additional Inflatable Braking Unit (AIBU) is inflated; Lastly at about 13 km, the SPS is ejected from AIBU and it impacts on the Martian surface. Since all parameters are evaluated, it is possible to confirm that the chosen EDI system and strategy verify the requirements of the mission.

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