

SPACE EXPLORATION SYMPOSIUM (A3)  
Interactive Presentations (IP)

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DESIGN AND DEVELOPMENT OF AN ACTIVE LANDING GEAR SYSTEM FOR LOW-GRAVITY  
ENVIRONMENTS

**Abstract**

The spotlight within the space exploration missions being focused on the Rosetta mission of landing a probe on a comet, a first technological consequence implies the shift of the concept of active landing gears from a desired system functionality to a necessity for future planetary exploration missions. The purpose of this paper is to present the design and development of such a system together with the preliminary outputs obtained within REST (Robotically Enhanced Surface Touchdown) project where a consortium formed by GMV-Romania as prime, AVS-UK and CBK-PAN has been tasked with the design and prototype development and testing of the actively compliant landing gear system for Phootprint mission's landing module. ESA's Phootprint mission is now a candidate mission of the ESA MREP programme, with the main objective of acquiring and returning a sample from the Mars moon Phobos. The major requirements for the REST system are to provide safe landing on the surface of Phobos in micro-gravity conditions and ensure the required attitude, stability and dynamic properties to allow surface operations. A state-of-the-art analysis has been so far conducted on similar missions (i.e. Rosetta, Phobos-Grunt) as well on present developments in shock suppression technologies for aviation. During the preliminary design phase two parallel industrial studies have been taken into account in the conceptual design of the REST system, resulting in a four legged landing system selected as baseline. For the design activity the focus falls on electromagnetic actuators due to their relatively simple control architecture and absence of freeze-able fluid. Two possible ways to implement DC actuators are considered: directly as a linear actuator or transforming the rotation of the actuator in a translational movement. The impedance control method applicability to the system's actuators is also studied, as it is widely used in robotics. In support for REST

design multi-body analyses are to be run with the use of a Functional Engineering Simulator (FES). The FES will be implemented on a Matlab/Simulink infrastructure which will allow reproducing the Phobos environmental interactions including all the dynamics and kinematics presented above. In order to validate the REST system design, tests shall be performed on a reduced degree of freedom prototype with the use of an air-bearing table in order to simulate the micro-gravity environment. Obtained tests results will be extrapolated and numerical dynamic model will allow understanding of the behaviour of the REST during the landing and surface activities.