Paper ID: 15449
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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Near Term Strategies for Lunar Surface Infrastructure (1)

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DESIGN AND EXPERIMENTAL CHARACTERIZATION OF ELECTROMAGNETIC SHOCK ABSORBERS FOR LANDING GEARS

Abstract

A fundamental step on planet explorations is to achieve the capability to perform a safe landing on planet surface to perform the activities that are impossible to perform from orbit, including human settlement. In this frame, has been identified an Active Shock Absorber (ASA) technology as key issue enabling future on-soil explorations. The ASA could lead to an efficiency increasing for *Lander* (e.g. reusable landing gear, hopping mobility exploitation, etc.), but could be also used into *Rover* suspensions (e.g. the advantage of utilization of ASA into Rover suspension is the capability to harvest energy in the process of vibration reduction). Among different possible active shock absorbers technologies, electromagnetic actuators have been selected for the relatively simple control architecture and for the absence of freezable fluid inside the mechanisms. One improvement of ASA w.r.t. traditional dampers is given by the capability to work in a bidirectional way; this means that:

- during landing ASA act as a damper, assuring a safe landing and energy dissipation,
- after landing, ASA could be utilized to adjust the lander attitude and even, to actuate the entire leg.

The walking capability is not a target of the study, but is considered in the definition of leg kinematics scenario. The Moon South Pole is considered as reference scenario for its challenging morphology, due to its rough surface. The investigation of the most adequate landing configuration (tripod landing gear) and the multibody analyses of landing scenarios, to extract the load and energy requirements, have driven the ASA design. A design methodology based on a Simulink model of ASA has been developed and utilised in co-simulation with the multibody software to optimize the design and verify the initial assumption.

The prototype has been validated experimentally in active and passive configuration both at steady state and in vibration conditions. A dedicated test rig was developed for the purposes of the project. The good correlation between the experimental and the numerical results is a proof of the model robustness and the actual performance of the system. The last part of the paper is devoted to an investigation on ASA mass saving strategy.