Master thesis

Proposal of energy absorbing solutions for manned spacecraft landers during contact with the surface

Damian Grabowski

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Supervisor: dr hab. inż. Cezary Rzymkowski, prof. PW

1. Introduction

The subject of presented thesis is developing mechanism capable of safely landing manned space-craft on the Lunar surface, with possible adaptation for landing on the Mars. Spacecraft touchdown is supposed to be controllable, with maintaining the stability and absorbing the majority of lander kinetic energy so the emerging g-loads would be in acceptable range.

The thesis includes vast review of existing energy absorbing solutions, future moon landers, and acceptable landing parameters (such as g-shocks)

2. Proposed mechanism

The amortization mechanism includes symmetrically distributed around lander construction, 4 legged design. Each of them contained 2 spring-damper elements.

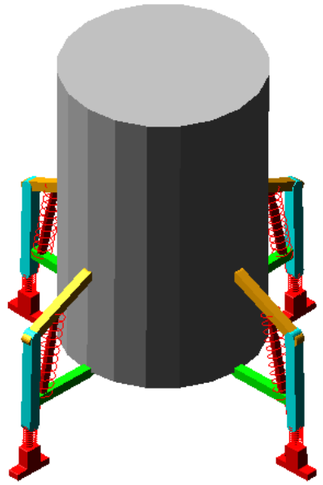
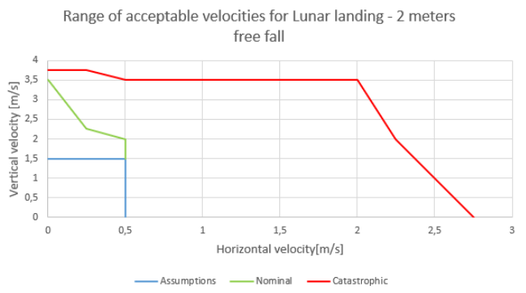
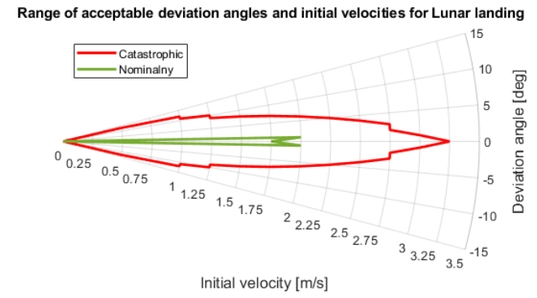


Figure: Lander model visualization

3. Analyses results

Most important results from the model analyses were the acceptable landing (both horizontal and vertical) velocities profiles, with taking into account free-fall height and deviation angle from ideal perpendicular approach. Three landing types were distinguished: nominal, emergency (without threat for the crew health) and catastrophic (involving mission termination).





4. Conclusions

- Proposed mechanism is capable of safe Lunar landing with relatively wide range of initial velocities.
- Direct adaptation for Martian landing is impossible.
- Mechanism has tendency to oscillate
- Additional mechanism used for stowing and deploying lander legs was introduced and examined as well.

5. Modification and further research propositions

- For the analyses the planar mechanism was used, next step in developing system would be creating and testing three dimensional mechanism.
- System modification in order to minimize the transverse oscillations.
- Mechanism adaptation for Martian landing (changing the elasticity and damping parame-ters).
- Including the elastic susceptibility of the mechanism elements.