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A MULTIDISCIPLINARY APPROACH TO LANDING SITE SELECTION FOR SMALL-BODY MISSIONS

Abstract

Small bodies are fundamental to understand the early stages and evolution of the Solar System as long as they carry records of its original composition. The trend of missions carrying in-situ landers is increasing fast (e.g., Hayabusa, Hayabusa2, Rosetta/Philae). The determination of the landing site from Earth observations is typically unreliable, mostly due to the poor spatial resolution available with telescopes. Thus, the ultimate landing site can only be selected in the phase of close approach to the small body, where accurate information on the target body (shape, kinematics, surface morphology and temperature, etc.) can be retrieved.

The current state of the art for the landing site selection of small body missions is represented by a cascade approach. Once the most relevant sites are selected from a scientific point of view, these are evaluated in terms of: 1) feasibility of the descent trajectory; 2) power/energy produced over a prescribed period; 3) admissibility of temperature ranges; 4) communication with the orbiter. This approach has some limitations; e.g., it requires many iterations, it may prune away good candidate sites, the cooperation of different teams increases the risks associated to the landing site selection.

In this paper an alternative approach for the landing site selection of small-body landers is presented. A multidisciplinary approach is proposed, where all the relevant issues influencing the landing site decision are modeled and simulated in a common framework. A multidisciplinary approach is the key to obtain realistic results on the properties of a landing site, as long as application of constraints deriving from different aspects produce contrasting indications, thus landing site selection becomes a compromise choice between the optimum of the every single constraint.

For what concerns the target small-body, the orbital motion, the spin axis kinematics, the attitude motion, and its shape are modeled. As for the lander, the geometry, the power and thermal subsystems are considered. When these features are considered as a whole, the landing site may be chose by optimizing all the variables simultaneously, provided that the mission requirements are satisfied. These involve (at least) maximization of solar generated power, avoidance of thermal freezing/overheating, total mission duration, etc. This approach has been implemented and specialized to the case of the Rosetta lander Philae, for which landing site options are presented.