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# LUNAR SOFT-LANDING TRAJECTORY OPTIMIZATION IN A 6DOF DYNAMICAL MODEL

**Abstract**

An algorithm for the optimization of a lunar soft-landing trajectory is presented. A 6DOF modeling of the dynamics is adopted together with an accurate description of the Moon gravity field. The problem is faced as a direct optimization problem with the goal of obtaining a vertical landing whilst minimizing the overall fuel consumption. The descent trajectory is supposed to start from the periselenium of a low Moon orbit. Four optimization phases are considered. Each phase is characterized by a different set of optimization variables, constraints, and increasing level of complexity. In the first phase the thrust direction is optimized considering the translational motion of the lander only. Furthermore, no throttle capability is considered. In the second phase the thrust direction is fixed in the spacecraft body reference frame. The proper thrust orientation is obtained by optimizing the control torques supplied to the lander by the attitude sub-system. In the third phase the thrust magnitude is optimized too, and the constraint of landing on specific site is added. Furthermore, more restrictive constraints on the final velocities (linear and angular) are set. Finally, in the fourth phase a more accurate gravitational model of Moon that includes the main harmonics is considered. The algorithm is tested on two different landing scenarios. One considers a landing in an area close to the Moon's equator, and it is inspired by Google Lunar X-prize. The second one describes a landing near the north pole area for a mission whose goal is to visit the craters where recently the presence of water has been discovered.