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LUNAR ORBIT DYNAMICS FOR LUNISAT MISSIONS

Abstract

Low cost and relatively fast design and construction represent the main advantages of microsatellites, which have profited from recent developments in the miniaturization of vital satellite subsystems, such as the onboard computer and the attitude control system. For these reasons, they are currently constructed and operated by a considerable number of subjects, either Universities, space agencies, or private ventures. Lunisat represents a next-generation microsatellite aimed at orbiting the Moon, with the capability of being configured as a launch platform for two or more nanosatellites (such as 3U-cubesats), equipped with their own instrumentation. This work is focused on orbital dynamics of both the main microsatellite and the nanosatellites after release. Due to the masconian character of the lunar mass distribution, low altitude, near-circular lunar orbits are affected by a considerable number of harmonics of the Moon gravitational field. Thus, the nominal Lunisat orbit around the Moon is to be selected accurately, in order to obtain a relatively long lifetime and a predictable dynamical behavior. This task is accomplished through numerical analysis, with the final intent of selecting the appropriate orbit. Nonsingular equinoctial orbit elements are employed in the simulations, because they allow avoiding numerical difficulties even when circular (or near-circular) orbits are encountered. The dynamical model considers the most relevant harmonics of the Moon gravitational field (including some significant tesseral and sectorial terms), as well as the Earth perturbing influence as a third body. Moreover, two or more nanosatellites can be released from Lunisat by means of springs. The orbit of each nanosatellite depends on the release conditions, i.e. the relative velocity magnitude and direction. This work investigates the orbit element time histories as functions of these conditions, adopting a relatively long propagation time. Several relevant quantities, such as lifetime and mean radius, are evaluated as functions of the release conditions, in order to determine the most interesting cases in relation to the mission specifications. Lastly, a possible low-thrust maneuver for reducing the orbit altitude is investigated, for the conclusive phase of the Lunisat mission, which finally terminates with the impact on the Moon surface