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UNCERTAINTY PROPAGATION IN ASTEROIDS SYSTEMS

Abstract

Uncertainty propagation has been addressed extensively in space situation awareness. Nevertheless, compared with missions around Earth, new challenges come forth for asteroid missions, mainly due to larger uncertainties of system parameters, e.g. gravity field, density and rotation rate etc. Moreover, the gravity field of the asteroid is generally irregular and weak, and the rotation rate of the small body ranges from extremely slow to extremely fast, both of which generate highly nonlinear dynamics.

To keep the accuracy and also address the efficiency, this study applies the dynamics-based differential algebra method to propagate uncertainties from the initial state of the spacecraft, the gravity field and rotation rate of the asteroid, separately. For this preliminary work, the correlations among them are not considered. Firstly, the random samples are generated given the Gaussian distributions of the initial uncertainties. Then, each sample is transformed through the selected order expansion of the flow (or the nonlinear dynamics), and the transformed distributions are obtained. With the same initial distributions, the sensitivities of the orbital motion on the uncertainties of the initial state, the gravity field of the rotation rate of are analyzed and compared. The outcome of this research can help mission designers assessing the posed risks and designing appropriate mission strategies.