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# EFFICIENTLY DESIGNING ROBUST TRAJECTORIES NEAR ASTEROIDS USING NON-GAUSSIAN POLYNOMIAL CHAOS KRIGING MODEL

## Abstract

The trajectories in space are subject to various uncertainties, especially for asteroids, where their weak gravitational field and irregular shape lead to a complex dynamical environment with high perturbation. Therefore, the optimal trajectories near the asteroid require robustness. In recent studies, convex optimization combined with nonlinear stochastic optimal control has been proposed to develop robust guidance for spacecraft around asteroids. Non-Gaussian uncertainties is an important and challenge factor in robust trajectory optimization. In the previous studies, a large amount of input data is required which leads to the computational burden problem. In this paper, we propose to use the active sampling based Polynomial Chaos Kriging model to improve the computational efficiency without sacrificing or even improving the accuracy. The Polynomial Chaos Kriging model combines Polynomial Chaos model and Kriging model, which represent the global trend of the uncertainty distribution and the local variations to improve accuracy. Active sampling is applied to improve efficiency. Samples and filtered according to the variance information and therefore build the model with fewer sampling points. Specifically, followed by the state-in-art robust trajectory design around asteroid, a design method is developed in this paper. First, a convex optimization problem for trajectory without uncertainty is formulated. Second, a highly nonlinear uncertainty constraint with non-Gaussian distributed is introduced to build a nonlinear programming model. Third, the active sampling based Polynomial Chaos Kriging model is used for uncertainty quantification to improve efficiency while maintaining accuracy. Finally, the quantified uncertainty is used to determine feedback control matrix. The method is validated via numerical simulation of spacecraft flying around asteroids.