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MULTIOBJECTIVE OPTIMIZATION OF SKIP TRAJECTORY FOR SMV WITH THRUST ENGINE

Abstract

With expansion of space operations over the past few decades, the risk of space debris has considerably increased such as collision with asset in space or survival from re-entry which threats human and property on ground and even aviation. Many active debris removal methods have been investigated and in this paper, a debris remediation method is first proposed based on reusable Space Manoeuvre Vehicles (SMV) with skip trajectory. The focus is to perform controlled re-entry.

These vehicles are expected to achieve a transatmospheric maneuver with thrust engine. If debris are released at altitude below 80 km, debris could be captured by the atmosphere drag force and this method improves landing precision. Moreover if the debris are released in a cargo at a much lower altitude, this method protects high value space asset from break up by the atmosphere.

This paper presents the simulation results of SMV skip trajectory optimization problem for specified mission. The mission profile includes: 1) descent to predetermined altitude (For example, descent from 120 km to 60 km); 2) ascent back to orbit with thrust (For example, exit out of atmosphere from 60 km to 120 km).

Considering the global optimality and high-accuracy, the Evolutionary Collocation based on NSGA-II and collocation method is presented which is actually a two-step optimization approach. State variable and control variable are discreted on collocation point. Then NSGA-II is used to give the multi-objective optimization result.

Simulation is conducted and different scenarios are compared. The Evolutionary collocation method gives a truthful re-entry trajectory satisfying path constraints and boundary constraints.