Paper ID: 71577
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (3) (5)

Author: Mr. Iñigo Alforja Ruiz
Politecnico di Milano, Italy, inigo.alforja@polimi.it

Prof. Michèle Lavagna
Politecnico di Milano, Italy, michelle.lavagna@polimi.it
Mr. Juan Carlos Bastante
OHB System AG-Bremen, Germany, juan_carlos.bastante@ohb.de

ANALYSIS OF MULTI-ORBIT MULTI-PAYLOAD INJECTION SCENARIOS FOR AN UPPER STAGE

Abstract

In the recent years, the number of launches has increased dramatically, showing a tendency beyond the current space transport systems. Such a problem, partially provoked by the increased number of space users due to the industry inclusion, as well as by the shift of interest towards smaller satellites and constellation missions, demands of innovative and economical solutions. One of these is the capability of an upper stage to directly inject multiple satellites into their respective differentiated orbits, reducing this way the number of necessary launches while allowing the growth of the space environment usage.

Such multi-payload multi-orbit injection trajectory requires of a control law that can provide the manoeuvres while minimising both the fuel consumption and the overall mission time. Its definition is not straight forward and requires solving a complex optimisation problem composed by the visiting sequence and the individual transfers. The current paper proposes a strategy to define such a trajectory by diving the problem into two: a preliminary bi-level bi-objective optimization algorithm that determines the ideal orbit order and the approximate necessary Lambert transfers; and a Nonlinear Optimal Control solver that uses such result as first guess to obtain the full thrust command sequence.

The result is a flexible algorithm that can provide for the full control law given a set of orbits and satellites to be delivered, regardless of the final injection orbits and mass properties of the payloads. This algorithm is then used to analyse several payload injection scenarios, given realistic mission data from the space industry. The performance of the upper stage in terms of total time and consumed fuel is examined, providing an assessment on the feasibility of such missions. In addition, these analyses allow to derive the necessary requirements towards the design of the full guidance, navigation, and control (GNC) system of an upper stage with multi-payload multi-orbit injection capabilities.

This study lies within the ASCenSIon (Advancing Space Access Capabilities - Reusability and Multiple Satellite Injection) project, an Innovative Training Network (ITN) funded within H2020.