Paper ID: 37564
oral
student

ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations (IP)

Author: Mr. Antonino Campolo
Politecnico di Milano, Italy

Mrs. Sara MANGLAVITI
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France
Mr. Bastien Le Bihan
France
Prof. Stéphanie Lizy-Destrez
SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace, France

SAFETY ANALYSIS FOR NEAR RECTILINEAR ORBIT CLOSE APPROACH RENDEZVOUS IN THE CIRCULAR RESTRICTED THREE-BODY PROBLEM

Abstract

On the road to a human exploration of Mars, several mission scenarios beyond Low Earth Orbit have been identified by the International Space Exploration Coordination Group (ISEGC) as significant landmarks. One fundamental step being considered includes the establishment of a new space station on a Near Rectilinear Orbit (NRO), at one of the libration points of the Earth-Moon system. In this context, the ability to rendezvous in cis-lunar space, necessary for the station deployment and its overall operability, could rely on the combined use of the NASA/ESA Orion Multi-Purpose Crew Vehicle and the Space Launch System (SLS), both currently under development. The Near Rectilinear Orbits (NROs) selected for this work have already been studied in literature but, to the author's knowledge, never considered for a rendezvous analysis. In this paper, a design of Orion's NRO close approach rendezvous strategy is developed using the Circular Restricted Three-Body Problem (CRTBP) as a baseline framework. First, different linear models used to describe cis-lunar relative motion, as the CRTBP linearized relative equations, the Clohessy-Wiltshire equations and the Straight Line equations are discussed and compared. Second, a direct two-impulse transfer is implemented as a tool to compare the results obtained from the linear models and the full non-linear relative model. It is shown that the error introduced by linear models is not generally satisfactory for high-precision maneuvers, especially in orbital regions where the lunar influence is highly predominant, such as the periselene. Third, different close approach strategies are implemented, taking into account Orion's sensor suite, the existing requirements for a LEO rendezvous and the peculiar deep-space conditions. Fourth, a stochastic analysis is performed to validate and compare the results. Finally, a general close approach rendezvous strategy is built so that the safety of the procedure is ensured throughout the whole mission. The requirements deriving from this analysis are then discussed and compared with the ones currently employed for a rendezvous in Low Earth Orbit. The pivotal point of this work is represented by the development of an algorithm to solve a Lambert's Three-Body Problem with the full non-linear relative CRTBP dynamics.