ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (1) (7)

Author: Prof. Mikhail Ovchinnikov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation

Mr. Maksim Shirobokov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation
Mr. Sergey Trofimov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation

RECOVERY OF LUNAR LIBRATION POINT MISSIONS IN CASE OF CONTINGENCY CORRECTION MANEUVER DELAY

Abstract

The recovery strategy previously developed by the authors for the Sun-Earth libration point missions is now applied to halo orbit missions around L1/L2 points in the Earth-Moon system. The strategy is aimed to be used in the case of contingency correction maneuver delay which is temporarily caused by thruster failure or by loss of communication with a spacecraft. It is supposed that a thruster does not produce thrust during the delay and that the spacecraft control becomes available after the delay. Due to the inherent instability in the dynamics around collinear libration points, maneuver delays can substantially deviate a spacecraft from the reference halo orbit. Making a spacecraft to follow the reference orbit after the correction maneuver delay is often not critical whereas it is much more important to save enough fuel for station-keeping during the planned mission term. For that purpose, transfers to the "cheapest-to-get" halo orbit are examined and then compared with transfers to the reference halo orbit for different correction maneuver delay values. The case of families of halo orbits around the Earth-Moon L1/L2 points is considered. Northern halo orbits with z-amplitude of 35000 km are chosen as the reference orbits about L1 and L2. The position and velocity standard deviations (nominal navigation uncertainties) are selected to be 5 km and 5 cm/s, respectively. To evaluate the proposed strategy, an optimization problem is stated and solved in optimal two-impulse transfer formulation. The gain in delta-v is examined for the delays up to 1.5 reference orbit periods. The results show that for delays less than one orbit period, the delta-v of the optimal transfer to the reference orbit grows exponentially from 5 m/s to 18.2 m/s for L2 point and from 1.5 m/s to 75 m/s for L1 point while the gain in delta-v for a transfer to the "cheapest-to-get" halo orbit varies over the range from 1 m/s to 3 m/s for L2 point and from 0 m/s to 7 m/s for L1 point. Thus, the strategy makes it possible to reduce the characteristic velocity spent for the mission recovery up to 60% for L2 point and up to 35% for L1 point. The equivalent gain in spacecraft's lifetime exceeds half a year.