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ABOUT ORBIT SELECTION FOR LUNAR ORBITAL STATION

Abstract

Following research of approaches, proposed in [1], as a part of ISS Exploration Capabilities Study Team (IECST) research in prospective lunar orbits for international cis-lunar station position. The difference of this paper is in consideration trajectory class characterized by starting earth orbit inclination as 56.

The next types of lunar orbits are considered: low round polar orbit, highly elliptical polar orbit and halo-orbit, belonging to the Lagrange point L2 of Earth-Moon system within the context of limited round three-body problem. Subclass of these orbits in cis-lunar space is called Near Rectilinear Halo Orbit (NRHO) due to the paper [1].

The orbits are compared by cost criterion of the velocity impulse for their formation and maneuvering in the cis-lunar space.

According to this criterion, NRHO is preferred for cis-lunar station intended for launching a manned spacecraft into the near-solar space. For cis-lunar station designed to interact with surface infrastructure, a highly elliptical lunar orbit is considered.

The study of the orbits is conducted taking into account the eccentricity of the Moon's orbit. It is shown that under these conditions NRHO is subject to disturbances that lead to its destruction in a 5-7 turn. Near-moon orbits react weakly to this disturbance. Disadvantages of lunar orbits include the immobility of the orbital plane in absolute space, while NRHO rotates after the Earth-Moon line, remaining in the frontal plane all the time.

This paper shows that to maintain NRHO parameters it is required to choose a strategy for correcting the parameters of its orbit. There are significant deviations of the velocity vector in periseleneum from "unperturbed" orbit, and variances of deviations of the radius vector module in aposeleneum. As for the high-elliptical orbit, to impart to it angular rate of precession in synchronism with the Earth-Moon line, the cost of velocity pulse, directed along the X axis, is required in aposeleneum. There is a tendency to reduce these costs with aposeleneum increase. It becomes a pressing issue to search parameters for elliptical lunar orbits that minimize these costs.

Choice decision of orbit for cis-lunar station position is proposed to take into account cost of correcting NRHO parameters to maintain the stability of it during long-term operation, as well as the cost of velocity pulse to rotate plane of the elliptical orbit following the Earth-Moon line.

Source: 1. R. Whitley and R. Martinez, "Options for Staging Orbits in Cislunar Space," IEEE Aerospace 2015, Mar. 2015.