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DYNAMICAL RESHAPING STATION-KEEPING APPROACH FOR NEAR RECTILINEAR HALO ORBITS USING SOLAR RADIATION PRESSURE

Abstract

Near Rectilinear Halo Orbits (NRHOs), a subset of the Earth–Moon L_1 and L_2 halo orbit families with stable or nearly stable properties,are considered as strong candidates for the Gateway mission. However, because of unmodeled perturbations and orbit determination errors, an effective station-keeping strategy is necessary for long-term maintenance in this dynamically sensitive region. This paper investigates the solar radiation pressure (SRP) assisted station keeping of NRHOs based on the dynamical reshaping method in the coherent Quasi-Bicircular Problem (QBCP), which includes the Sun's gravity into the Earth–Moon system. Although the control acceleration provided by the SRP is small, it is unlimited, therefore, the SRP acceleration is a good option for long-term station-keeping missions. The idea behind the proposed method is to reshape the dynamical structure about the reference orbits and cancel the unstable Floquet modes using the SRP acceleration. In particular, the two sail attitude angles, i.e in-plan angle and out-of-plane angle, are taken as control variables. Moreover, the Jet Transport technique is used in the algorithms implementation to derive the control laws explicitly as high-order Taylor polynomials in terms of the deviation between the state of the spacecraft and the one of a nominal point on the reference orbits. In this way the control laws are feasible to be implemented onboard, which fits well for solar-sail missions. In the simulation performed, some resonance NHROs in the QBCP are taken as the reference orbits due to their favorable eclipse properties. The aim of this paper is show the stability and robustness in front of errors in the orbit determination and sail orientation, of the proposed approaches, as well as the feasibility of the use of SRP in the station keeping of NRHOs.