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A FEASIBILITY STUDY OF SOLAR RADIATION PRESSURE FEEDBACK CONTROL STRATEGY FOR UNSTABLE PERIODIC ORBITS IN THE RESTRICTED THREE-BODY PROBLEM

Abstract

Previous research performed at the University of Southampton compared Floquet modes and Hamiltonian Structure-Preserving (HSP) feedback control theories for periodic orbits in the restricted three-body problem. This allowed the advantages and disadvantages of these two strategies to be identified. This paper investigates a HSP control strategy that uses solar radiation pressure as control acceleration. This control strategy is based on the work of Scheeres et al. and Xu et al., but it is extended to a general case in which complex and conjugate eigenvalues (stable-unstable foci) occur at higher amplitude orbits which is currently of interest to ESA for future space missions. As already proved by Scheeres et al., the HSP control can also be applied when nonlinearities dominate the system, even if the control law is designed to study the local stability of the linearised dynamics which will affect the orbit stability. This control aims to stabilise the periodic orbit in the sense of Lyapunov (simple stability), and it preserves the natural Hamiltonian dynamics of the controlled system. The controller works by projecting the position error with respect to the target orbit along the stable and unstable manifolds and it aims to create an artificial centre manifold that removes the instabilities by keeping the spacecraft trajectory close to its reference unstable orbit. Based on the design of the feedback control, the purpose of this work is to verify when the use of SRP is feasible. Indeed, the order of magnitude of SRP acceleration depends on the spacecraft's reflective area, the area orientation angle and its reflectivity properties. Therefore, due to constraints in the orientation angle and in the deployable reflective area, it is important to identify when along the spacecraft's trajectory it is possible to apply SRP to stabilise the unstable periodic orbit. The purpose of this study will be then to investigate different concept solutions by using existing on-board deployable satellite structures based on the design of the feedback control law.