Paper ID: 33931
oral
student

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1) (6)

Author: Mr. Andrea Colagrossi
Politecnico di Milano, Italy, andrea.colagrossi@polimi.it

Prof. Michèle Lavagna
Politecnico di Milano, Italy, michelle.lavagna@polimi.it

PRELIMINARY RESULTS ON THE DYNAMICS OF LARGE AND FLEXIBLE SPACE STRUCTURES IN HALO ORBITS

Abstract

The global exploration roadmap suggests, among other ambitious future space programmes, a possible manned outpost in lunar vicinity, to support surface operations and further astronaut training for longer and deeper space missions and transfers. In particular, a Lagrangian point orbit location - in the Earth-Moon system - is suggested for a manned cis-lunar infrastructure; proposal which opens an interesting field of study from the astrodynamics perspective. Literature offers a wide set of scientific research done on orbital dynamics under the Three-Body Problem modelling approach, while less of it includes the attitude dynamics modelling as well. However, whenever a large space structure (ISS-like) is considered, not only the coupled orbit-attitude dynamics should be modelled to run more accurate analyses, but the structural flexibility should be included too.

The paper, starting from the well-known Circular Restricted Three-Body Problem formulation, presents some preliminary results obtained by adding a coupled orbit-attitude dynamical model and the effects due to the large structure flexibility. In addition, the most relevant perturbing phenomena, such as the Solar Radiation Pressure and the fourth-body (Sun) gravity, are included in the model as well.

A multi-body approach has been preferred to represent possible configurations of the large cis-lunar infrastructure: interconnected simple structural elements - such as beams, rods or lumped masses linked by springs and dampers - build up the space segment. To better investigate the relevance of the flexibility effects, the lumped parameters approach is compared with a distributed parameters semi-analytical technique.

A sensitivity analysis of system dynamics, with respect to different configurations and mechanical properties of the extended structure, is also presented, in order to highlight drivers for the lunar outpost design and station-keeping manoeuvres minimisation. Furthermore, a case study for a large and flexible space structure on Halo orbits around one of the Earth-Moon collinear Lagrangian points, L1 or L2, is discussed to point out some relevant outcomes for the potential implementation of such a mission.