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Author: Dr. Francisco Salazar
Universidade Estadual Paulista - Grupo de Dinâmica Orbital, Brazil

Prof. Othon Winter
UNESP - Univ Estadual Paulista, Brazil
Prof. Elbert E.N. Macau
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil
Prof. Josep J. Masdemont
Universitat Politecnica de Catalunya (UPC), Spain
Prof. Gerard Gomez
University of Barcelona, Spain

NATURAL CONFIGURATIONS FOR FORMATION FLYING AROUND TRIANGULAR LIBRATION POINTS FOR THE ELLIPTIC AND THE BICIRCULAR PROBLEM IN THE EARTH-MOON SYSTEM

Abstract

The concept of Satellite Formation Flying (SFF) means to have two or more satellites in orbit such that their relative positions remain constant or obeying a certain dynamical configuration along the trajectory. This concept involves the control over the coordinated motion of a group of satellites, with the goal of maintaining a specific geometric space configuration between the elements of the cluster. Assume a constellation of satellites is flying close a given nominal trajectory around L4 or L5 in the Earth-Moon system in such a way that there is some freedom in the selection of the geometry of the constellation. We are interested in avoiding large variations of the mutual distances between spacecraft. In this case, previous studies about triangular libration points have determined the existence of regions of zero and minimum relative radial acceleration with respect to the nominal trajectory that prevent from the expansion or contraction of the constellation. Similarly, these studies have also shown the existence of regions of maximum relative radial acceleration with respect to the nominal trajectory that produce a larger expansion and contraction of the constellation. However, these studies only considered the gravitational force of the Earth and the Moon using as approximation the Circular Restricted Three Body Problem (CRTBP). Although the CRTBP model is a good approximation for the dynamics of spacecraft in the Earth-Moon system, the stability of constellations flying around L4 and L5 is strongly affected when the primary orbit eccentricity and perturbations from the sun (gravity and light pressure) are considered. As consequence, the previous studies show that, using the CRTBP model, the fuel consumption to maintain the geometry of the constellation computed by the residual acceleration is practically zero. In this manner, the goal of this work is the study and analysis of the best regions to place a constellation that is flying close a given nominal trajectory around L4 or L5, involving a linear approximation of the equations of motion relative to the periodic orbits around triangular libration points and taking into account the Moon's eccentricity and perturbations from the sun. This model is not only more realistic for practical engineering applications but permits to determine more accurately the fuel consumption to maintain the geometry of the constellation