Coordinated Orbital Control for Satellite Constellations and Formations

Giovanni B. Palmerini[1]

[1]*Scuola di Ingegneria Aerospaziale, Universita' di Roma "la Sapienza"*
via Eudossiana 18, 00184 Roma, Italy. E-mail: g.palmerini@caspur.it

Satellite constellations and formations pose strict requirements to the orbital control design. Relative positioning among the satellites, with quite limited tolerances, is instrumental to satisfy mission goals. The amount of data to be considered to compute a control action is quite high, as the system state vector has to include all platforms belonging to the constellation. An autonomous, on board control capability is the correct target in order to reduce downlink requirements and ground segment tasks. Therefore, computation tasks has to be limited to a resonable level in terms of time and memory allocation. Due to the autonomy, robustness is mandatory.

Previous experiences at the Universita' di Roma indicated several possible solutions. This paper aims to cover the most interesting of these approaches, directly related to the work performed in the 90s by Colin McInnes. His introduction in the orbital control field of a classical dynamical system tool, as the Lyapunov method, should be helpful to identify convenient strategies.

This method is here applied to a numerical model in which all satellites are linked by a virtual spring network. Orbital perturbations acting on the constellation/formation move the satellites from the desired configuration. The distance between the current, perturbed orbital distribution of the platforms and the desired one is represented by means of the elongation of the virtual spring. Stretching of the springs define the amount of the control action to be performed, and, as support points for virtual springs are not fixed but connected to the satellites, distribute this action among all the platforms.

The results presented are mainly focussed on the convergence of the state vector to the desired configuration and on the amount of control action (i.e. on the propellant consumption) needed.