SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FAR FUTURE (D4)
Novel Concepts and Technologies (1)

Author: Dr. Min Hu
Academy of Equipment, China

Prof. Li Fan
Academy of Equipment, China
Dr. Xuerong Yang
Academy of Equipment, China

CONTROL FORCE SHARING APPROACH FOR FRACTIONATED SPACECRAFT BASED ON ELECTROMAGNETIC FORCE

Abstract

Fractionated spacecraft distribute the functionalities of a traditional monolithic satellite through wireless communication, the on-orbit resources are shared and the cluster flight configuration can be easily reconfigurated. Fractionated spacecraft are different from formation flying satellites on many levels: 1) Fractionated spacecraftare heterogeneous by nature; 2) The number of modules in fractionated spacecraft is usually large; 3) Most of the modules in fractionated spacecraft may not contain propulsion systems; 4) The relative configuration are not strictly restricted as long as the relative distance are within the communication and power transfer range, and the modules will not collide with each other. Therefore, the long-term cluster flight is one of the key techniques for fractionated spacecraft.

This paper proposes a novel control force sharing approach for fractionated spacecraft based on electromagnetic force. The electromagnetic control is propellantless, each module is equipped with three orthogonal magnetic coils and three orthogonal reaction wheels,by controlling currents running through magnetic coils, any force and torque can be easily generated. Thus, the propulsion systems are not required for all the modules, and the cluster flight configuration can be easily controlled, such as collision avoidance and scatter-regather maneuvers.

Firstly, the far-field dipole model is introduced and the relative dynamics equationsare presented. Secondly, the overall design of the control force sharing system is proposed, all the modules are equipped with magnetic coils, and some of them are equipped with thrusters, then, the push-and-pull concept can be realized. Thirdly, a robust finite-time control approach which combines the advantages of linear and terminal sliding mode controls is presented, and the theoretical proof of stability and convergence is given subsequently. Then, the scatter-regather and collision avoidance maneuvers of 8 modules are carried out, and analyses and comparisons of results are conducted. Finally, we present our conclusions.