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MAGNETORQUERS ATTITUDE CONTROL FOR FORMATION FLYING IN LEO

Abstract

Nowadays people from both the scientific community and space industry are paying more and more attention to formation flying missions. This type of mission is quite challenging for realization but also it opens up new perspectives on space exploration. If we consider the near-Earth space missions, then a formation flying can be used for remote sensing, studying the effects occurring in the atmosphere or radiation coming from space, etc.

The accessibility, unification and low cost of the Cubesats makes them attractive for consideration in formation flying missions. For the success of mission, it should be possible to control both orbital and angular motion of the CubeSats. Usually reaction wheels, magnetorquers and thrusters can be used as actuators. Although reaction wheels have obvious advantages in attitude control systems, they might be unsuitable due to the vibrations they create or the lack of space at the platform for installation. As a result magnetorquers are often considered as attitude actuators for CubeSats. As for orbital control, small size of the satellite might not allow us to install thrusters, thus requiring propellantless control approaches. In this case, the atmospheric drag control is the most suitable one.

In our work we consider a mission consisting of several 3U CubeSats with attitude control system based on magnetorquers in near-polar low Earth orbit. The atmospheric drag control is used to maintain the formation. In this case, it is needed to change the attitude of the satellite relative to the incoming airflow to provide necessary aerodynamic drag. There are two modes of angular motion considered: stable and unstable gravity-gradient equilibria stabilization. The control algorithm is obtained in the same way as proportional-differential controller, however six control coefficients are used instead of two. The Floquet theory and numerical optimization are used for the selection of these coefficients to maximize the stability index of the system. Obtained analytical results are verified numerically in realistic mission scenario.