Control for the confinement of swarms in an spherical domine around the Earth

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Abstract

The spacecraft swarm concept considers a large number of small spacecraft that are confined in a region, but without strict requirements in terms of distances and geometry between the agents. The main applications of this concept aims to interferometry and communications.

As the distance does not need to be maintained constant between spacecraft, the cost of maintenance is smaller, but cannot be neglected. There are two main controls that must be applied to the swarm: First, the natural motion of spacecraft tends to separate their orbits, losing the configuration of the swarm, and a control to confine them in a region is needed. Second, the large number of spacecraft in a small space, can lead to collision hazards, that must be avoided.

This work focuses on the strategies and costs for the maintenance of a swarm of a large number of spacecraft in a close neighborhood (in our case represented by an sphere but any other confining geometry could be considered) for long periods of time. One of the main issues that one encounters when optimizing the sequence of control maneuvers for a large group of spacecraft is the huge number of variables and constraints. Our methodology considers a hierarchical structure that accounts both for collision avoidance and degradation of the confinement region of the spacecraft swarm. In an strobe way, usually counted in one or few orbital periods, a few spacecraft of the set are selected and a suitable and efficient control procedure is applied to them, assuring this way computational efficiency.

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