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GLOBAL LOW-THRUST GUIDANCE SCHEME FOR DISAGGREGATED SPACECRAFT ARCHITECTURES

Abstract

The concept of disaggregated spacecraft reshapes the classic monolithic satellite into a network of multiple free-flying wireless-communicating modules. Compared to a traditional spacecraft, the subsystems may no longer be connected; therefore they can be developed, manufactured and launched separately. Individual modules can be added, removed or exchanged independently, offering a flexible space architecture. Disaggregated satellites offer more flexibility, maintainability and responsiveness compared to traditional designs.

This papers is concerned with the problem of keeping the modules within prescribed bounded distances (typically less than 100 km) for the entire mission lifetime (at least 1 year). Guidance and control techniques are developed to enable cluster flight, assuming a disaggregated spacecraft architecture. Moreover, the possibility that during the overall mission at least one of the modules tracks a given reference orbit is also addressed. It is assumed that each module is equipped with a low-thrust chemical (cold-gas) propulsion system. With the need of establishing the cluster after launch and maintaining it for the entire mission lifetime, dedicated algorithms are proposed considering continuous bang-off-bang thrust profiles.

In detail, once the disaggregated satellites are launched and deployed, they start to drift apart because of differential external disturbing forces. Thus, control strategies are developed in order to balance the perturbations while minimizing the fuel consumption for a long-term mission.

The work is organized as follows: First, a *local* continuous low-thrust maneuver is implemented in order to configure the cluster, starting from the deployment conditions: the modules are taken – within few orbital periods – to ideal initial relative conditions, which yield low-drift inter-module distances. Second, a *global* cooperative guidance strategy is derived to render the cluster operational for long-term time intervals. Two different thruster configurations are investigated: A single gimballed thruster and six body-fixed thrusters. A general approach is proposed that enables optimizing both thruster architectures under the same mathematical formulation.