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DETAILED DESIGN OF THE PROBA-3 FORMATION FLYING GUIDANCE

Abstract

The PROBA-3 formation flying project has recently entered phase B, and the detailed design of the formation flying system has begun. The space segment consists of two spacecraft in highly elliptic orbit around the Earth.This paper describes the detailed design of the formation flying guidance system, and presents some preliminary results of simulations of the nominal scenario, as well as the formation acquisition. The nominal scenario consists of two main parts. The first part is a forced motion arc during which the formation is continuously controlled to maintain a Sun-pointing orientation. During this phase, the spacecraft performs solar coronagraphy, or formation flying experiments. The forced motion arc is located around apogee, meaning that the influence of perturbations is small, as is the amount of thrust force required to maintain the formation. The second part is the perigee pass manoeuvre, which aims to position the spacecraft such that the formation can be re-acquired at the start of the next forced motion arc, while at the same time maintaining a safe formation. The formation acquisition is based on a safe orbit approach, which ensures a certain minimum separation between the spacecraft even in the presence of drift. All manoeuvres and trajectories have been described in earlier papers, and only a brief summary of these manoeuvres is presented here, to serve as background to the guidance design. The guidance design is based on a finite-state machine, and specific conditions need to be fulfilled to shift from one state to the next. In the case of the nominal scenario, these two states are the forced motion arc around apogee, and the perigee pass manoeuvre around perigee. In the case of the formation acquisition, the different states are defined as safe orbits of different sizes (and with different values of the differential mean anomaly and semi-major axis) around the target, and the transfer manoeuvres between these safe orbits. This paper focuses on the design and testing of the finite state machine. The paper starts with the identification of the different states and the conditions that should be used to identify and switch between them. Next, the implementation of the guidance manoeuvres and of the finite state machine is discussed. Finally, guidance test results are presented, and conclusions are drawn on the behaviour of the guidance system.