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FLEX TANDEM WITH SENTINEL-3

Abstract

The FLuorescence EXplorer (FLEX) is an Earth observation mission developed by ESA, whose main objective is to perform quantitative measurements of the solar induced vegetation fluorescence.

FLEX will orbit in tandem with one of the Copernicus Sentinel-3 satellites. This will allow to benefit from the optical and thermal instruments of Sentinel-3 (OLCI and SLSTR) and provide an integrated package of measurements.

The swath of the FLEX instrument needs to be contained within the swath of the OLCI camera 4 on board of Sentinel-3. This derives in the requirement that both satellites shall overfly the same location within 6 to 15 seconds, keeping the selected distance as stable as possible.

When defining the orbit control strategy safety is the highest priority, while disturbances in Sentinel-3 operations shall be avoided and FLEX operations shall be kept to the minimum. Plan to be launched in 2023, FLEX mission is currently in phase B2. At this stage of the mission there are still many uncertainties, for example the ballistic coefficient, therefore any proposed orbit control shall demonstrate compliance with the above stated requirements under a wide range of design and environment boundaries.

The most straightforward approach is a hybrid control box strategy. This strategy allows an independent control of the in plane maneuvers to correct for the air drag, whereas the out-of-plane maneuvers of both satellites are coordinated. Aiming at improving the performances of the control-box approach, a master-slave strategy in which FLEX mimicked all Sentinel-3 maneuvers was envisaged. The analysis showed some improvement with respect to the control box strategy, but for the cases in which the ratio between the ballistic coefficients is low a more advanced orbit control concept was needed. Intermediate FLEX maneuvers were introduced, reducing significantly the variation in the along-track distance and defining a safer scenario for the mission.

Due to the passive safety constraints, Sentinel-3 maneuvers cannot be replicated immediately. A time margin needs to be allocated for confirmation of maneuver execution and calibration. During this interval a high drift in the relative along-track distance is induced. Reducing this along-track shift and therefore tightening the formation control in this direction, while maintaining a safe constellation has been the key objective in the final proposed strategy. The paper provides a detailed explanation of the tandem concept with an analysis of the dynamics of the tandem formation showing how the proposed control algorithm adapts to the different encountered environments.