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ENABLING ATTITUDE-BASED APPLICATIONS IN THE DEBRIS MITIGATION FACILITY (DMF)

Abstract

Nowadays, it has become commonplace to have many daily-live services provided from space: communications, weather forecasts, television, remote sensing of the environment and navigation. Since the era of space exploration started, the number of Earth-orbiting objects has steadily increased due to high frequency of space activities, on-orbit fragmentation and collisions between existing objects, resulting in many small fragments. The increasing number of space debris led to the creation of reference models by different agencies, with the European reference being the Meteoroid And Space debris Terrestrial Environment Reference (MASTER) model.

This crowded space environment makes it necessary, when designing a mission, to take into account how the mission interacts with the environment as well as the impact on other missions. For this purpose, ESA Space Debris Mitigation Requirements were introduced, which describe current mitigation measures that represent best practices to preserve the orbital environment and protect current space assets. The above-mentioned space debris mitigation requirements turned into mission requirements that have become applicable for any ESA mission since 2014. The Debris Risk Assessment and Mitigation Analysis (DRAMA) software tool is used to enable ESA programs to assess their compliance with the ESA's mitigation requirements. The regulatory regime in place, however, makes it necessary to align the current set of tools related to space debris mitigation in a way that accommodates state-of-the-art engineering

techniques from the early design phases of a space mission onwards. To achieve this objective, the Debris Mitigation Facility (DMF) Framework has been developed to integrate the existing tools, such as DRAMA and MASTER, to support the requirements verification activities.

In the DMF03 project, the individual analysis modules belonging to DRAMA that are currently used in debris mitigation and risk analyses are updated and integrated in the DMF framework. Such upgrades intend to analyse spacecraft attitude-related dynamics in the space debris mitigation context. Main goals of the activity include:

- Develop and integrate a 6-Degree-of-Freedom (DOF) simulator that covers the main attitude motions;
- Augment the model from DMF-01 to account for movable parts (like solar panels) and combine it with user-defined attitude laws.
- Improve disposal analyses based on attitude modes for different disposal techniques and exploitation of force model resonance conditions.
- Include attitude-related effects in the evaluation of collision risk, avoidance manoeuvres and potential collision damage.

The developed features are assessed in a complete-mission scenario, where different disposal and collision avoidance strategies are simulated.