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COLLISION RISK ESTIMATION IN MULTI-EVENT SCENARIOS

Abstract

Multi-event scenarios occur when two or more conjunctions are detected between the same primary object (i.e. the operational satellite) and different secondary objects (i.e. fragments of space debris or rogue satellites that cannot be controlled) in a conjunction screening analysis. As part of its CA service, the EUSST partnership has observed an increasing concern among satellite operators around this kind of scenario. Ideally, a collision risk mitigation measure (e.g. collision avoidance maneuvers or drag augmentation methods) shall consider all the conjunctions of the multi-event at once. This approach allows, for example, to minimize the propellant consumption and the impact on the satellite's mission. Moreover, if the conjunctions of a multi-event are studied separately, the mitigation measures devoted to reduce the collision risk of some of them may increase that of others, and the global collision risk may end up becoming higher. Therefore, it is necessary to define a global collision metric for an accurate and operationally feasible evaluation of the collision risk and an adequate consideration and design of collision risk mitigation measures in multi-event scenarios.

The EUSST partnership is working on analysis and the development of algorithms to improve the reliability and quality of its CA service. The collision metric proposed to estimate the collision risk of multi-events is a global probability of collision. This metric can be defined as the probability of having at least one collision out of the different conjunctions forming the multi-event. Assuming uncorrelated or independent events and small probabilities of collision of the individual conjunctions, the global probability of collision can be approximated as the addition of the probabilities of collision of the individual events. The computation of the individual probabilities of collision can be performed with any short- or long-term encounter method available in the literature. However, the assumption of uncorrelated events might lead to a wrong estimation the real risk. This work analyzes the correctness of this assumption and tries to provide with an estimate of the error committed in the global probability of collision estimation. Finally, statistics and a review on historical data generated by the EUSST is presented to highlight how some real cases could have benefited from an approach to reduce the risk level globally.

Keywords: Collision Risk estimation, Multi-event, Global Risk, Risk Mitigation