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MODERN METHODS FOR COLLISION RISK ASSESMENT

Abstract

Over the last few years, the space debris population in orbit has dramatically increased. The risk of collision for satellite missions is an increasing concern for the safe operation of satellites. The growing number of space objects, together with the improvement of the sensors networks' capabilities to detect them have caused a noticeable rise in the workload related to collision assessment tasks, with a great climb in the number of conjunction events considered of high risk for space missions. This has led to an increasing interest for improving the accuracy of the risk predictions and the automation of decision making in the last years.

In this paper, the novel methods for the collision risk estimation to be applied in the CREAM cornerstone of ESA's Space Safety programme, Collision Risk Estimation and Automated Mitigation, are reviewed. First, the analysis of the depth of intrusion is presented together with its use as an estimation of the collision risk dilution and as a decision metric for further mitigation measures. The method aims at detecting situations in which the quality of the data (i. e. the position uncertainty for both objects) is not good enough for a proper estimation of the actual collision risk.

Secondly, the paper presents a method to improve covariance realism with the use of dynamic consider parameters (DCPs). The DCPs are used to improve the covariance realism by estimating the actual DCP to adjust the observed evolution of the covariance to the expected Mahalanobis distribution.

This paper also presents a methodology for the assessment of multiple conjunction events at the same time. The experience in operations show that trying to minimize the risk for the next high risk event might not always be optimum and the need of the estimation and reduction of a combined risk level is required. The proposed method, consists on the computation of a global risk, accounting for all the detected conjunction events for a satellite and the different strategies that can be used to reduce the global risk level with a single collision avoidance manoeuvre.

The paper ends with an overview of the proposed decision tree followed by the Collision Assessment (CA) system from an operational perspective. Presenting in each case, the decision metrics and the possible strategies that can be followed for the risk mitigation and highlighting the integration and impact of the proposed methods in this process.