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COLLISION RISK MANAGEMENT FOR AUTONOMOUS SPACECRAFT

Abstract

Autonomous on-board orbit control makes satellite maneuver management easier but makes collisions risk evaluation and resolution difficult.

The first natural approach to solve this problem is to think about collision surveillance in a box around the target orbit, the orbit which is targeted by the autonomous orbit control. This approach seems to be pleasant as this target orbit never changes. But it leads to too many false collision detections.

A second possible approach would be try to guess the real orbit which will be chosen by the autonomous orbit control of the satellite and to evaluate the collision risk on this orbit. However, the dates of the maneuver are hardly predictable : a very little error on the real position of the satellite could lead to an error of one or two orbits on the date of the next maneuver. And the problem is that the incertitude around this "real orbit" is not Gaussian, and not even progressive. So this orbit is unusable for the evaluation of collision risk.

The method we propose in this paper enables to identify risk situations with a reasonable increase in the rate of generated alerts and enables also to solve some of these alerts automatically, without stopping the autonomous orbit control mode. In the end, the number of evasive maneuvers that remains to be done is of the same order of magnitude as for a satellite without autonomous orbit control.

The principle of the risk evaluation is based on a multiple extrapolation of the orbit by discretization of the incertitude on the position, on the drag force and on the size of executed maneuvers. A suitable method, based on analytic extrapolation, is used to assess interest of each extrapolation, otherwise the computation time explodes and the number of trajectories to be evaluated becomes prohibitive.

The principle of alert solving is based on the removal of the slots which would lead the satellite toward the collision trajectory.

The paper will explain in details this operational method, the results of the simulations on several years and its future implementation for a real satellite.