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RECOGNITION, MODELING OF EVOLUTION AND OPERATIONAL ACCOUNTING OF
STRUCTURES OF "SPATIAL WEAVING" FORMED BY DANGEROUS SEGMENTS OF
TRAJECTORIES IN POLYCONFLICT ZONES

Abstract

The growth of objects orbiting the Earth and possible emergence of many relatively compact orbital constellations (clusters) leads to the possibility of appearance, in the path of orbital objects (including spacecraft), of a zone covered by the structure of close segments of trajectories of other objects (zones of potential danger of multi-conflictual approaches). For an operational choice of strategy to avoid mechanical conflicts it will be useful not only to identify a group of close segments of trajectories and determine the shape and location of the zone comprising them, but also to characterize the filling of the zone with these segments and to determine the spatial structure formed by the orbital segments in it. This work represents a study of possible structures formed by groups of close segments of trajectories. Variants of elementary structures listed in the order of "hierarchical nesting" in each other were determined: - "star" (intersection of several trajectories at one point); - "herringbone" (a trajectory segment is intersected at several close points by segments of other trajectories); - star-shaped intersections of the trajectory segments at several points; - a mesh-shaped structure formed by intersecting trajectories on a fragment of a convex surface whose center coincides with the center of Earth (both with relatively regular and irregular location of intersection nodes of the trajectory); - several similar mesh structures described above in different altitudes; - a mesh with nodes of intersection of trajectories arbitrarily scattered in space; - an arbitrary combination of the elements described above. In most cases, a group of trajectory segments forms quasi-structures (these are not intersections, but quasi-intersections of trajectory segments – the location of their closest points at a distance smaller than the given threshold). At determination of a zone trajectories with and without taking into account periodic deviations of the movement from the Keplerian are considered. Methods were proposed for fast determination of a "structural portrait" of the zone and estimation of its dimensions; for forecasting of evolution of the structures formed by segments of trajectories filling a zone; for estimation of probability of conflicts in a zone between objects forming it and probability of conflict situations for an object on the way of which there is a dangerous zone. Conflicts avoidance strategies were proposed for spacecraft having a potentially hazardous zone in their path, with taking into account the structure of filling the zone with the segments of the orbits.