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A "WORN-OUT NET" MODEL FOR ANALYSIS OF CONFLICTS IN A MULTITUDE OF ORBITAL OBJECTS

Abstract

Growing number of orbital objects causes appearance of groups of trajectories, on which simultaneous close approach of several objects is possible. We divide such groups into two classes. For the first class, dangerous approaches are possible on relatively short segments. We will call sets of such segments polyconflict nodes. The second class will include groups of trajectories, which remain close along the entire trajectory. Now methods of analysis of closing-in based on simulating of shifting of orbits with a large step by time and reviewing current geometry of their composition are widely used. In addition to this approach, this work proposes a complex of mathematical models and methods for identification of these classes of groups in the multitude of trajectories without substantial computing time and for monitoring the current composition of the groups and their evolution. We shall explain it for the second class. A method for determining dangerous closeness of two points along the trajectories of two osculating orbits with the use of several analytical expressions was developed. An algorithm for quick processing of information on pairs of close ("tied") trajectories was developed for finding groups of different tie-ups (each trajectory in a group of k tie-up is close at least to k trajectories of the group). For the groups of tie-up k=2, a model of "embracing" the group – osculating tube of trajectories – is proposed. The median line of the tube is an abstract orbit, parameters of which at the moment of modeling are determined as the average of corresponding parameters of objects in this group (parameters are determined only basing on the secular variations). The radius of the tube is sufficient for embracing all trajectories of the group. Location of orbits in it is determined by the indicator of "catching and holding within the tube". The same algorithm that is used for determining pairs of close trajectories checks closeness of the trajectory to the median line of the tube (if its distance is less than the radius of the tube). Trajectories outside the tube satisfying this condition get included into the group. Trajectories that cease to satisfy it leave the tube. The tube model works like a "worn-out net" – catches and releases trajectories, and eventually loses its properties (and then, determination of a group is repeated). A similar approach was developed for determining the current composition of a polyconflict node.