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EXPANSION OF THE NOTION OF A MECHANICAL CONFLICT OF ORBITAL OBJECTS: A SERIAL CONFLICT AND A POLYCONFLICT, FAST METHODS OF FORECASTING THEM

Abstract

The near-Earth space ever becomes more saturated with moving objects, which increases probability of their collisions (mechanical conflicts). In a number of problems. There is no need to model the collisions as such and their consequences, and it is enough to forecast the situation of objects approaching dangerously from the point of view of their possible collision (approaching at a dangerous distance). We shall call such approaches conflict situations (or simply conflicts).

In forecasting conflict situations one has to take into account that, for a pair of orbital objects during a particular period of time, conflict approaches are periodically repeated on a number of orbits. We shall call this situation a serial conflict. The growing number of orbital objects in the near-Earth space makes it possible not only a conflict approach of a pair of objects, but also polyconflict approaches. Let us assume that m orbital objects are in the state of a polyconflict, if each of them has dangerous closing in with two or more other orbital objects of this set.

Let us consider three objects, A, B and C. If pairs A, B and A, C are at a dangerous distance from each other, while there is no a dangerous closeness of the pair B,C, we shall call this a coherent polyconflict. If in all three pairs, A,B, A,C and B,C, objects are dangerously close, then conflicts of these objects "superimpose" (a superimposed conflict). A big number of orbital objects form a conflict, which may include a multitude of multiple coherent and multiple superimposed conflicts, as well as combinations of possible variants.

Association of serial conflicts and polyconflicts forms a complex conflict situation.

A complex of characteristics has been developed for description of a single conflict situation and a polyconflict, and also a number of characteristics for describing a complex conflict situation have been proposed. In this work, a number of methods are presented, which allow one to determine these characteristics without using the traditional approach to forecasting conflicts based on modeling of the motion of orbital objects and monitoring of the current distances between them. In comparison with this approach, the proposed methods reduce the time necessary for forecasting by several orders of magnitude. Also, in the work an adaptation of these methods is proposed to the problem of planning of maneuvers of a spacecraft for avoiding a collision.