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NEW TECHNOLOGY FOR THE OPTIMIZATION OF LOW-EARTH ORBIT SATELLITE MANEUVERS FOR THE PURPOSES OF VARIOUS SPACE MISSIONS

Abstract

At present there are two principal approaches to solving practical problems of the satellite maneuvers calculation. The first one is to find a simple and intelligible solution, though not an optimal one. Another approach is to apply cumbersome numerical methods in order to obtain an optimal solution. In this paper a new way of solving the basic practical problems is presented. This approach is fundamentally different from the aforementioned ones; it involves software with extended user interface and incorporates the use of geometric elements in search for solution. The solution is obtained by the means of specially developed analytic and numerical analytic methods. Implementation of these methods leads to an optimal solution, like in the case of the second traditional approach, but at the same time, like in the first case, allows vivid interpretation of the results. These methods can be used for solving the problems of coplanar and non-coplanar transfer maneuvers (with flight time not being fixed), the problems of short and medium duration rendezvous, the problem of long duration rendezvous with target orbit having a significant deviation in the longitude of ascending node (this problem is faced during build-up and replenishment of the satellite constellations, space debris disposal etc.) and the problem of absolute and relative keeping of the satellite constellation configuration, including Earth remote sensing systems. The method is applicable for near-impulse maneuvers, as well as for continued maneuvers performed with low-thrust engines. The technology presented allows optimizing separate maneuvers of spacecraft for Various Space Missions (rendezvous problem, orbit keeping problem, etc.), as well as complex maneuvers providing the orbit parameters variation for the case of two or more objectives (for example, joint maneuvers for a specific orbit parameters variation with a simultaneous avoidance of the approaching space object). The technology in review was implemented in the form of a universal software package for the optimization of the LEO spacecraft maneuvers, with eccentricities up to 0.1. It can be easily extended to the cases of geostationary and highly-eccentric orbits.