ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimisation (1) (6)

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OPTIMIZATION OF OPERATIVE PLANNING AND EFFICIENCY FOR MULTI-SATELLITE OBSERVATION AND COMMUNICATION CONSTELLATIONS

Abstract

The control of target operations is one of the important phases of modern satellite observation and communication systems functioning. Their constellations can consist from any number of spacecrafts (SC), located in different altitudes of planes as well as at several orbital segments, and they are multi-satellite. Efficiency of systems' target functioning, for example, film-making information, productivity of SC on-board equipment, operationability of data transmission or another indicator (criterion) should meet the requirements of customers. Optimization of systems' constellations is necessary for increasing of their efficiency mentioned above. Generally, such optimization is a fundamental problem of the modern control theory which is characterized by polynomial complexity. Universal approach for its solving is not offered till present time. That is why such problem is very actually now especially for perspective multi-satellite observation and communication constellations. The purpose of the paper is to present the problem formalization and methodical approach for its solving. The statements of general problem and applied tasks for observation and communication on the basic of systems' target functioning operative planning, taking into account the restrictions on technical resource and flight operations of their SC, are considered in the paper. The efficiency of the system functioning during given time interval is characterized by two main indicators - constellation indicator and control of SC on-board equipment indicator. Both of them should be optimized simultaneously. The approach for optimization realizes several computing stages which are based on the repeated optimization of operative plans with feedback that allows to vary parameters and to optimize SC constellation structure. Such approach is the result of authors' practical research which has been spent during last 15 years by the operative planning as for different single SC as for satellite systems with different constellations. Statements of such problem, observation and communication applied tasks and methodical approach for solving of them differ from earlier considered, including authors' publications and papers, and present here for the first time. Several examples of model optimization tasks in frameworks of general problem are considered: for constellations of observation SC with project parameters of "RapidEye", "CBERS", "NigeriaSat", "KompSat" and other systems; for constellations of "Iridium" (66 SC), "Teledesic" (288 SC) and "Odyssey" (12 SC) global communication systems projects. The results are illustrated and discussed in the paper too. The paper was supported by The Russian Foundation for Basic Research (projects positions are 11-08-01278-a, 12-08-00175-a, 13-08-01381-a).