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Synthesis of a control system for relative motion of closely spaced satellites

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Possible variants for controlling the relative motion of small satellites are considered. The purpose of such control is to create a highly accurate stabilization of an ordered group of satellites operating together on the implementation of the same task. In such groups, control is performed based on measurements of mutual locations of the satellites that are moving at very close orbits. The purpose of formation and rebuilding of a group of satellites is the solution of various practical tasks, such as monitoring the Earth's surface, creation of stereoscopic images, construction of large telescopes in space, and a number of other tasks. The purpose of this work is the synthesis of an optimal control system for the center mass motion of active satellites, with the objective of navigation to a specified point in space relative to the reference satellite. We compare two approaches to the synthesis of a control system. The first approach is based on the Pontryagin maximum principle and it minimizes the fuel consumption in the process of the maneuvering. The second approach is based on the minimization of a quadratic quality functional with a terminal term. This work presents results of a comparative analysis of these two approaches. Utilization of this procedure in sequence to all satellites in a group allows one to create any kind of configuration. The results of the simulation of the relative motion with different initial conditions are given. Operability of the proposed algorithms is proved for all possible initial conditions. A necessary condition for the implementation of the proposed algorithm is the estimation of parameters of the relative orientation and navigation (six parameters). Results of the synthesis of optimal filtering algorithms for primary navigation measurements are obtained. The simulation results are presented and an installation for an actual experiment is described.

Biography

Alexander Nebylov is a famous Scientist in the field of Motion Control with the international reputation. He completed his Graduation with honors as an Engineer in Missile Guidance at Leningrad Institute of Aircraft Instrumentation in 1971. He led many R&D projects in Aerospace Instrumentation, Motion Control Systems and Avionics, and is a Scientific Consultant for various Russian design bureaus and research institutes. For the last three decades, he has been with the State University of Aerospace Instrumentation at St. Petersburg as Professor and Chairman of Aerospace Devices and Measuring Complexes, and Director of the International Institute for Advanced Aerospace Technologies. He is an author of 18 books (seven in English published in Elsevier, Momentum Press and Wiley) and numerous scientific papers and has also been a member of the leadership of the IFAC Aerospace Technical Committee since 2002. He has the title of Honored Scientist of the Russian Federation.

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