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DECOMPOSITION PROBLEMS IN DYNAMICS OF GYROSTABILIZATION SYSTEMS FOR SMALL SATELLITES

Abstract

This research is devoted to the specific problems of aerospace systems dynamics, with reference to problems of the mathematical modelling, analysis and synthesis for the systems of stabilization, orientation and control, with gyroscopic controlling elements, including applications for decomposition problems at system level and sub-system level, for complex stabilization/orientation and navigation systems. Nonlinearity, high dimensionality, multi-connectivity of initial model are causing the difficulties in obtaining exact solution by analytical and analytic-computer methods in designing and control. It leads to the necessity of the reducing for original model, with the subsequent transition to the decomposed subsystems, to reduced submodels, with designing of separated subsystems. Interesting approach is worked out with reference to complex stabilization/orientation system for small satellites. Here new theoretical and applied problems are revealed, that are considered in this investigation. In regard to the stabilization and orientation systems with the gyroscopic controlling elements, it leads to the singularly perturbed problems with the different singularities types, with critical cases, with the nonlinear singular generating systems. From theoretical points the principal questions are discussed: -the methodology of the reduction-decomposition problems;-the development of the manners, of methods for both physical and mathematical decomposition;-the substantiation of legitimacy of decomposed models in dynamics and control problems; -the determination of the qualitative equivalence conditions and correctness... Here above formulated problems are solved by method, following to the ideology of stability theory. General approach, based by A.M.Lyapunov and N.G.Chetayev , is extended here. The understanding these problems via singularly perturbed systems approach gives the perspective results both for theory and for applications, with revealing a constructiveness of Lyapunov stability methods as effective unified mathematical tool. As illustration there is considered the family of the stabilization and orientation systems models with gyroscopic controlling elements (including the models for small satellites, for big stabilized objects, ...). The cases of full mathematical decomposition for original model are examined.