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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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METHODS AND MODELS IN DYNAMICS OF STABILIZATION, ORIENTATION AND NAVIGATION SYSTEMS

Abstract

The subject of this research is related to mathematical modelling, analysis and synthesis problems for the systems of stabilization, orientation and control, with reference to peculiarities of avia-, aerospace systems, using gyroscopic controlling elements. In this work it is considered the fundamental aspects of applications for decomposition problems of original complex model at system level and sub-system level, including complexed navigation systems. It is necessary to note that obtaining exact solution by analytical and analytic-computer methods in designing and control for considered systems of multidisciplinary character is impossible due to nonlinearity, high dimensionality, multi-connectivity of full, good explicated, original model. Therefore it leads to the necessity of the "idealization" of original model elements, with reducing of full model, with the subsequent transition to the decomposed subsystems, to reduced submodels, with possibility of designing from early stages on level of separated subsystems and channels. Interesting non-traditional approach is worked out with reference to complexed navigation system problems for small objects. Here new theoretical and applied problems are revealed, that are considered in the research. 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. The specific principal problems inherent for avia-, aerospace systems were revealed. Among them: the methodology of the reduction-decomposition problems; the development of the approaches, methods both for physical and for mathematical decomposition; the substantiation of legitimacy of decomposed models in dynamics problems; the determination of the qualitative equivalence conditions under constructed decomposition and correctness; ... Here above formulated problems are solved by method, following to the ideology of stability theory. Extended approach, based on A.M.Lyapunov methodology, applied by N.G.Chetayev to mechanics problems, is established 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.

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