On the problem of motion separation in gyrostabilization system dynamics

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The article describes developing concepts and methods of classical stability theory with a generalization of the principle of reduction for the general qualitative analysis applied to problems of modeling the dynamics of stabilization, guidance and control systems. On the basis of developed universal approach the original formulation is proposed combining the ideology of Lyapunov's stability theory and asymptotic perturbation theory methods, which allows reducing solving the problems of simulation and analysis of the multiscale system dynamics to a regular circuit with decomposition of the system. Systematic procedures for constructing simplified equivalent systems are presented as comparison systems. At the same time the shortened system (non-linear on the basis of combination of all input variables) and its solution are assumed as the generating system and generating solution. Unlike traditional approaches the generating system is singularly perturbed, generating solution is not degenerate. With regard to the problems of the dynamics of mechanical and mathematical models for the stabilization, guidance and control systems, taking into account their specific structural features, the algorithm is designed using simplified models as the computational ones. Proprietary methodology based on the development of N.G. Chetaev's and V.V. Rumyantsev's ideas allows, using the developed scheme in the framework of the posed dynamic problem, multirate components in system motion to be separated, parameters and variables in the original system to be distinguished as essential and nonessential, "irrelevant" degrees of freedom to be identified in the framework of the problem being solved, with a subsequent transition to the correct shortened model (idealized in the appropriate sense), elucidating the effect of the discarded "inaccuracy" on the dynamic properties. The problems of constructing an optimal mechanical- mathematical model, minimal model (according to N.N. Moiseyev) are solved. The results brought to the engineering level are obtained. There are examples for the gyrostabilization system computational models with the identification of various subclasses of stabilized objects (small satellites, large space stations), with the possibility of separating motions in the dynamics of the stabilization and control systems in the dynamics of multi-axis systems, for small and large objects being stabilized (satellites and space stations) [1–25].Using the fundamental theoretical results in gyrostabilization system engineering problems will provide new solutions for applications in the stabilization, orientation and control problems with the possibility of separation of stabilization and control channels in a nonlinear formulation.

Keywords: *gyrostabilization systems, multiscale systems, decomposition, Liapunov's methods.*

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