MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

Author: Prof. Lyudmila Kuzmina
Kazan National Research Technical University, Russian Federation, Lyudmila.Kuzmina@ksu.ru

DECOMPOSITION METHODS IN MULTISCALE DYNAMICS OF SPACECRAFTS WITH SGS

Abstract

Main aims of the research are general problems of mathematical modelling and analysis for complex technical objects, that are related to aviation and aerospace systems. Special attention in this is attracted to the conceptual points and methodology for solving decomposition problem in dynamics of small spacecrafts(small stabilized objects). The proposed methodology is based on developing classical statements of A.M.Lyapunov, N.G.Chetayev in stability theory for decomposition-idealization problems of original complex multidisciplinary model of singularly perturbed class object. Besides the constructing approximate models is realized by strong mathematical manners. It is conforming the original thesis of I.M.Gradstein about close connection between A.M.Lyapunov stability theory theorems and the results of the differential equations theory with small parameters, that are the direct consequence of stability theory theorems. Such points are allowing to construct the effective algorithm for reduction-decomposition of original complex model. Special interest in this is the decomposition of dynamic properties including fast - operating, optimality ones. Established unified approach gives the possibility to obtain the reduced motion equations and shortened models as asymptotic nonlinear s-approximations that will be acceptable in analysis , synthesis, control. From stability theory point it is some generalization of A.M.Lyapunov linearization method and reduction principle. Elaborated method has the brilliant applied results in general theory of gyroscopic systems, multiscale systems of gyrostabilization (SGS), orientation, navigation (K.Magnus, D.R.Merkin, A.Yu.Ishlinskiy, P.A.Kuzmin, B.V.Raushenbakh). In case of fast gyroscopes (mathematical model with big parameter) it leads to the decomposed equations of motion (to approximate theories, including elementary gyroscopes theory) as s- asymptotic models. In dynamics of small spacecrafts it is revealing new acceptable asymptotic models, with original model decomposition, with separation of stabilization channels in nonlinear statement. But in dynamics of big stabilized objects (spacecrafts) it is revealed another decomposition, with other asymptotic models and conditions of acceptability. Such approach is giving powerful multidisciplinary tools, allowing to provide the required analysis by analytical and computer-analytical manners from first stages of designing with lesser times. Here the modelling of engineering systems is carried out as Art of Professional Specialists. This study is implemented with support of Russian Foundation of Fundamental Investigations.