A B S T R A C T
of the cycle of works

entitled «Control under information constraints with applications to networked, robotic, and physico-technical systems», coathored by associate professor, PhD Gusev Sergei Vladimirovich, professor, Doctor of Sciences Matveev Alexey Serafimovich, and professor, Doctor of Science Fradkov Alexander L'vovich, and nominated for the award of the Saint-Petersburg state University «For Scientific Contribution» in the category «For Fundamental Achievements in Science»

The Saint-Petersburg (Leningrad) scientific school of cybernetics, created by the scholar with worldwide reputation, corresponding member of RAN, professor emeritus of SPbGU V.A. Yakubovich, is traditionally targeted at solution of fundamental mathematical problems motivated by current technological challenges. Nowadays, there is a layer of such problems that lies at the crossroads of various traditional branches of pure and applied mathematics, which calls for interdisciplinary research to integrate and complement knowledge from multiple traditional disciplines. Following the traditions of the school, the research of the nominees deals with practically important problems concerned with discretely controlled continuous-time systems and physical processes, along with distributed architecture of control elements, synchronization in networked systems, control of networked multi-component dynamical ensembles, including information issues, networked systems of various nature, navigation problems in mobile robotics, as well as control of systems with complex nonlinear dynamics. The research is based and focused on key problems both in classic settings and settings recently forged in the mainstream of modern research.

The cycle of works deals with a new fundamental chapter of the control theory in which the control, communication, and computation issues are integrated. The papers [1-3,9,15] present a series of relevant novel results, including those concerned with fundamental communication data rate limitations imposed by the control objective. Based on the original research of the authors, the monograph "A.S.Matveev and A.V.Savkin, Estimation and Control over Communication Networks, Birkhauzer, 2009, Boston" is among the world's first volumes on this topic. The methodologically homogeneous series of works [2-8] is devoted to solution of the fundamental problem in mobile robotics, i.e., design of mathematically rigorous algorithms of mobile robots navigation in complex environments with guaranteed achievement of the navigation objective, as well as to research on relatively new and promising problems concerned with multiagent cooperative robotics and interactions of mobile robots with natural fields.

The applications motivated substantial generalization of the fundamental result of mathematical control theory the Kalman-Yakubovich-Popov lemma is obtained and its relation to celebrated Hilbert's 17^{th} problem is revealed [10, 11, 14]. The Hilbert's 17^{th} problem is one of the 23 cardinal mathematical problems that were formulated by D.Hilbert on the secondInternational Congress of Mathematicians in 1900 and to a large extent shaped the progress of pure mathematics in 20^{th} century and in the beginning of 21th century. The obtained result made it possible to solve the problem of periodic motions orbital stabilization for nonlinear physical–technical systems in difficult for solution and important in application case of systems that have more generalized coordinates then the controlled inputs [12, 13]. The proposed method is especially fruitful in robots motion control problems.

New design methods for simple robust and adaptive controllers for coordination in nonlinear dynamical networks are proposed: implicit reference model based method, passification method and others [18,19,21]. Besides, qualitative properties of the systems under communication constraints are investigated [9,15]. The results are applied to control problems of robotic networks, adaptive control of nonlinear oscillator networks. They allow one to evaluate limit possibilities of control under lack of information [16,17,20].

The presented works make a substantial contribution into a new fundamental area of control theory where the issues of control, communication and computations are studied in their interaction. The works of the authors have received an appreciation of the international experts: the total number of their citations exceeds 3500 while average Hirsch index is equal to 16 in Scopus.