DOI: http://doi.org/10.25728/cs.2022.4.5

16TH INTERNATIONAL CONFERENCE ON STABILITY AND OSCILLATIONS OF NONLINEAR CONTROL SYSTEMS (PYATNITSKIY'S CONFERENCE)

The 16th International Conference on Stability and Oscillations of Nonlinear Control Systems (Pyatnitskiy's Conference) took place on June 1–3, 2022, at Trapeznikov Institute of Control Sciences, Russian Academy of Sciences (ICS RAS). The conference was organized by ICS RAS with the technical co-sponsorship of IEEE Russia Section. Chairman of the Organizing Committee was *V.N. Tkhai*, Chief Researcher of Laboratory No. 16 (Dynamics of Nonlinear Control Processes) named after E.S. Pyatnitskiy (ICS RAS).

The conference was devoted to presenting and discussing new results obtained by Russian and foreign researchers in the following areas:

- General problems of stability and stabilization;
- Nonlinear oscillations: general problems and methods;
- Lyapunov functions methods;
- Smooth and nonsmooth dynamics;
- Problems of controllability and observability;
- Robust control problems;
- Control in mechanical and electromechanical systems;
- Control in mechatronic systems and robotic control;
- Oscillations, stability, and stabilization in the network and coupled systems;
- Stability and control of hybrid and switched systems.

The event was held online using Russian video conferencing software. During the three days, there were 14 sessions, including 2 plenary ones. In total, 4 plenary talks and 137 section talks were delivered at the conference. The event was attended by researchers from Armenia, France, Germany, Kazakhstan, Kyrgyzstan, Russia, and Uzbekistan. Russian participants represented scientific organizations and universities from 19 cities.

At the first plenary session (June 1, 2022), two talks were presented. The first talk by *S. Dashkovskiy* (the Institute of Mathematics, the University of Wuerzburg, Germany) was devoted to the paradigm of input-to-state stability. Its origin as a natural extension of classical Lyapunov stability to systems with input was considered. Different applications of the paradigm were described, within which the theory of small-gain systems was developed. As noted by the author, the theory of input-to-state stability for finite-dimensional systems has now acquired a complete form. Recent results of this theory were surveyed, in particular, extensions to delayed systems, hybrid and switched systems, and infinite-dimensional systems. Finally, some open problems of the theory were outlined.

The second talk of that plenary session, entitled "Use of Feedback in Control Problems as an Optimization Problem," was presented by *B.T. Polyak* and *M.V. Khlebnikov* (ICS RAS and Moscow Institute of Physics and Technology). The talk dealt with an approach to linear control systems from an optimization point of view. In the classical linear-quadratic control problem, one can consider the linear feedback matrix as a variable and reduce the problem to minimizing a performance index by this variable. This approach goes back to the works of R. Kalman in the 1950s. In addition to the linear-quadratic control problem, the authors studied other problems from the same positions: the suppression of nonrandom bounded external disturbances by constructing a static linear output-feedback law and using a dynamic output-feedback law with an observer. For each of the three problems mentioned, a gradient method for finding the feedback law was described and justified. Several illustrative examples with simple and double pendulums were provided.

The second plenary session, held on June 2, 2022, also included two talks. The first one, entitled "Theory of Homogeneous Dynamical Systems and Their Application," was presented by *D. Efimov* from the National Institute for Research in Digital Science and Technology (INRIA, Lille, France). The author overviewed the theory of homogeneous dynamical systems and briefly described new results and applications for different classes of models, including those given by delayed or partial differential equations, and discrete-time systems. Also, connections of homogeneity with

finite- or fixed-time convergence and input-to-state stability were explained.

In the second talk, "Attracting Cycle in a Controlled Mechanical System," *V.N. Tkhai* (ICS RAS) described the stabilization of oscillations of a controlled mechanical system by constructing an orbitally asymptotically stable cycle. He presented a general principle to stabilize arbitrary conservative systems through control actions based on self-oscillator signals. The control system is treated as a coupled system, and a Van der Pol oscillator is used as a generator. It acts on the mechanical system admitting a family of nondegenerate oscillations by one-way coupling control. The control system consists of electrical and mechanical parts with a mechatronic scheme to stabilize oscillations: the cycle is attracted in large.

The program of section sessions was made according to the scientific topics of the conference.

Sessions devoted to general problems of stability and stabilization concerned both theoretical problems and problems related to control, stability, and stabilization of particular objects, e.g., control problems in cerebral blood flow autoregulation modeling (*A.E. Golubev*, Ishlinsky Institute for Problems in Mechanics RAS), HIV infection models (*A.N. Kanatnikov*, Bauman Moscow State Technical University, and *O.S. Tkacheva*, ICS RAS), models of markets (*A.M. Kotyukov*, ICS RAS, and *N.G. Pavlova*, RUDN University), etc. Among theoretical problems, note the application of the theory of matrix inequalities to stability analysis (*V.A. Kamenetskiy*, ICS RAS), stability of periodic differential inclusions (*M.V. Morozov*, ICS RAS), stability and stabilization of systems with delay (*A.Yu. Aleksandrov*, St. Petersburg State University), state estimation of a continuous system by output discrete measurements (*A.I. Malikov*, Kazan National Research Technical University-Kazan Aviation Institute), and others.

Problems of control and stability of oscillations were considered at two section sessions, namely, (1) Nonlinear oscillations: general problems and (2) Oscillations, stability, and stabilization in the network and coupled systems. Among the objects of research were Hamiltonian systems at different resonances (*O.V. Kholostova*, Moscow Aviation Institute), self-oscillations of an aerodynamic pendulum (*D.V. Belyakov*, Moscow Aviation Institute), chaotic and periodic attractors (*I.M. Burkin*, Tula State University, and *N.V. Kuznetsov* and *T.N. Mokaev*, St. Petersburg State University), coupled conservative systems (*I.N. Barabanov* and *V.N. Tkhai*, ICS RAS), and multi-agent systems (*R.P. Agaev* and *D.K. Khomutov*, ICS RAS).

A large group of talks was devoted to control problems in mechanical, electromechanical, and mechatronic systems. The problems considered include control of string vibrations (*V.R. Barseghyan*, Yerevan State University, and *S.V. Solodusha*, Melentiev Energy Systems Institute SB RAS), stabilization of artificial Earth satellite rotations (*A.Yu. Aleksandrov* and *A.A. Tikhonov*, St. Petersburg State University), control of different manipulator robots (*Yu.F. Dolgui* and *I.A. Chupin*, Ural Federal University; *V.A.* Sobolev and *E.A. Shchepakina*, Federal Research Center "Computer Science and Control" RAS and Samara State University; *A.S. Andreev* and *O.A. Peregudova*, Ulyanovsk State University; and others). Also, optimal control problems for mechanical systems were considered, in particular, optimal damping of flexible rotor vibrations in electromagnetic bearings (*D.V. Balandin* and *R.S. Biryukov*, Lobachevsky State University of Nizhny Novgorod, and *M.M. Kogan*, Nizhny Novgorod State University of Architecture and Civil Engineering), the time-optimal movement of a platform with oscillators (*O.R. Kayumov*, Omsk State Pedagogical University), and others.

A separate session united talks on different control aspects for spacecraft and unmanned aerial vehicles. In particular, the following problems were discussed: control of a space robot-manipulator (*Ye.I. Somov*, *S.A. Butyrin*, and *S.E. Somov*, Samara State Technical University), attitude control of a geostationary satellite (*Ye.I. Somov*, *S.A. Butyrin*, and *T.E. Somova*, Samara State Technical University), control of space flight with a solar sail (*E.N. Polyakhova* and *V.S. Korolev*, St. Petersburg State University; *A.V. Rodnikov*, Moscow Aviation Institute; *D.V. Shimanchuk*, *A.S. Shmyrov*, and *V.A. Shmyrov*, St. Petersburg State University), and trajectory planning, stabilization, and attitude control for unmanned quadcopters (*V.A. Alexandrov* and *I.G. Rezkov*, ICS RAS; *A.I. Glushchenko* and *K.A. Lastochkin*, ICS RAS; *I.S. Trenev*, ICS RAS), etc.

The conference program and proceedings can be found on the conference website: https://stab22.ipu.ru/.

Note the high level of scientific discussion at the sessions as well as the high level of interest of the conference participants.

With the online format chosen by the Organizing Committee due to the epidemic situation, many organizational issues for the organizers and participants of the event were simplified. It was easier for researchers from far Russian cities (Blagoveshchensk, Khabarovsk, Irkutsk, Novosibirsk, etc.) and foreign countries to take part in the sessions. At the same time, in the final general discussion, it was declared that the improving epidemic situation would, hopefully, soon allow the traditional format of the conference to over-

come the deficit of live communication between researchers.

The conference talks recommended by the Program Committee were published as extended papers in English; see Proceedings of 2022 16th International Conference on Stability and Oscillations of Nonlinear Control Systems (Pyatnitskiy's Conference) in the IEEE Xplore electronic library: https://ieeexplore.ieee.org/xpl/conhome/9807427/proceeding.

All conference proceedings were electronically published in Russian and are freely available on the conference website: https://stab22.ipu.ru/sites/default/files/news/Stab_2022_Rus%20%281%29.pdf.

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Cite this paper
Barabanov, I.N. 16th International Conference on Stability and Oscillations of Nonlinear Control Systems (Pyatnitskiy's Conference). *Control Sciences* **4**, 31–33 (2022). http://doi.org/10.25728/cs.2022.4.5

Original Russian Text © Barabanov, I.N., 2022, published in *Problemy Upravleniya*, 2022, no. 4, pp. 38–40.

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