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Results of the International Conference on the Control of Dynamical Systems (Moscow, 26–30 January 2009)☆

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Scientific Secretary of the International, Conference on the Control of Dynamical Systems

The A.Yu. Ishlinskii Institute for Problems in Mechanics (IPM RAS) of the Russian Academy of Sciences (RAS) organized and held the International Conference on the Control of Dynamical Systems in Moscow from 26 to 30 January 2009 as part of the International Multi-conference "Control: Theory and Systems" organized jointly by the IPM RAS, the V.A. Trapeznikov Institute of Control Sciences (ICS RAS) of the RAS, and the Institute of System Analysis of the RAS.

The multiconference included three scientific conferences:

- the Fourth International Conference on Control Sciences;
- the Conference on "Mathematical Systems Theory";
- the International Conference on "System Identification and Control Problems".

The programme committee of the International Conference on the Control of Dynamical Systems included Academician F.L. Chernous'ko (chairman), Corresponding Member A.A. Melikyan, Professor I.M. Anan'evskii, Professor N.N. Bolotnik, and G.V. Kostin (scientific secretary). Information, material, and technical resources from the IPM RAS were used to organize the conference. Over 100 applications to take part in the conference were received from Russian and foreign scientists. The programme committee drew up the scientific programme for this forum, which included 85 papers presented over 25 sessions.

Prominent scientists in the field of mathematical, computer, and experimental methods and applied problems of control and dynamics took part in the conference: Academician F.L. Chernous'ko, Corresponding Members G.A. Leonov, A.A. Melikyan, V.N. Ushakov, Corresponding Member of the National Academy of Sciences of Belarus F.M. Kirillova (Belarus), Professors G.H. Bock (Germany), K. Furuta (Japan), A. Lindquist (Sweden), E. Reithmeier (Germany), et al. In all, this event brought together over 80 Russian scientists, representing scientific organizations from Moscow, Ekaterinburg, St Petersburg, Nizhnii Novgorod, Kursk, Samara, and other regions, and about 20 foreign scientists from Azerbaijan, Belarus, Ukraine, Germany, Italy, the USA, Sweden, and Japan. Young scientists, postgraduates, and students took part in the conference.

The subject matter covered by the conference included the following:

- the theory of control for dynamical systems;
- optimal control;
- control and estimating of systems with uncertainties;
- the control of vibrations and stability;
- dynamic games;
- system identification in dynamics;
- control in aerospace engineering;
- control in robotics and mechatronics, including micro- and nanomechanical systems;
- applied control problems.

We will dwell on the principal events of the conference and the most interesting plenary and workshop papers.

The principal sessions of the conference were held on 27, 28 and 30 January 2009 at the IPM RAS. The four conferences of the multiconference shared four plenary workshops which were held on 26 and 29 January 2009 at the IPU RAS.

At the opening of the multiconference on 26 January, the director of the IPU RAS, Academician S.N. Vasil'ev, gave an address. The plenary paper from the Conference on the Control of Dynamical Systems was presented by G.A. Leonov ('Effective methods for the search of periodic solutions of nonlinear dynamical systems', St Petersburg State University). In his paper, the application of new approaches to

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Hilbert's sixteenth problem for quadratic systems and to Eisermann's problem was considered. The synthesis of a method for harmonic linearization with applied bifurcation theory and numerical methods for calculating periodic vibrations was described. Interesting papers were given by F.M. Kirillova (R. Gabasov, F.M. Kirillova, and Ye.I. Poyasok 'Optimal feeds to control dynamical systems under uncertainty conditions', the Belarusian State University and the Institute of Mathematics of the National Academy of Sciences of Belarus, Minsk) and by Professor D.V. Balandin (D.V. Balandin and M.M. Kogan, 'Linear matrix inequalities in synthesis regulators under constraints on the control an phase variables', N.I. Lobachevskii Nizhegorod State University, Nizhnii Novgorod).

The official opening ceremony of the conference was held on the morning of 27 January at the IPM PAS. An introductory speech was given by the chairman of the programme committee, Academician F.L. Chernous'ko, and then a letter of welcome from Professor M. Vukobratović, full member of the Serbian Academy of Sciences and the Arts and a foreign member of the RAS, was read out. Sessions of three plenary and four regular workshops (eight half-hour papers and 16 twenty-minute addresses) were held on the same day.

At the plenary session devoted to control problems in robotics and mechatronics, N.N. Bolotnik presented a paper (N.N. Bolotnik, T.Yu. Figurina, and F.L. Chernous'ko, 'Optimal control of mobile systems with movable internal masses', IPM RAS, Moscow) on problems of the optimal control of mobile systems moving in resistant media without special propelling devices. Such systems consist of a body and moving internal masses. The internal masses interact with the body by means of forces created by drives. The application of a force to an internal mass causes a reactive force that acts on the body, changing its speed, which entails a change in the resistance of the medium to the movement of the body. This principle of motion is suitable for mobile mini- and microrobots. The body of these robots can be made airtight and smooth, with no protruding parts, which enables them to be used for the non-destructive inspection of miniature technical objects such as thin-walled, small-diameter piping, and also in medicine.

The second paper was given by Professor Yu.G. Martynenko ('Stability of steady motions of mobile robots with omnidirectional wheels and shifted centre of mass', Institute of Mechanics, M.V. Lomonosov State University, Moscow). A study was made of the motion of a robot along a horizontal plane on three roller-bearing wheels of the "omnidirectional" type with the centre of mass of the robot not matching the geometric centre of the triangular platform, and with no slip at points of contact of the rollers with the supporting surface. An equation was constructed for determining the steady motions when a constant voltage is supplied to the DC motors driving the wheels. The stability of rectilinear motion of the robot was investigated.

The conference continued with three parallel workshops. We would like to mention papers given by foreign participants at the conference. Professor H. Aschemann (H. Aschemann and H. Schulte, 'Modeling and nonlinear trajectory control of a drive chain with hydrostatic transmission', University of Rostock, Germany) addressed the problem of controlling the motions of the hydraulic drive used in mobile systems such as tractors, diggers, wheel loaders, etc. New approaches to controlling the gear ratio of the hydrostatic transmission with simultaneous suppression of pressure fluctuations in the hydraulic system were proposed. A paper devoted to the active suppression of acoustic fluctuations in compact soundproofing systems was presented by the young scientist J. Graf (J. Graf and E. Reithmeier, 'Computationally efficient active noise reduction in headsets', Hannover University, Germany). The approach developed enabled a portable device to be designed and introduced for industrial soundproofing ear muffs, which has resulted in a considerable improvement in the technical characteristics of these devices in terms of the suppression of harmful external acoustic effects over a wide frequency band.

At the plenary session 'Theory of the Control of Dynamical Systems' on 27 January, presentations were given by A. Rauh (A. Rauh, J. Minisini, and H. Aschemann, 'Interval arithmetic techniques for the design of controllers for nonlinear dynamical systems with applications in mechanics', University of Rostock, Germany), by Professor D.M. Stipanović ('Control of complex dynamical systems with multiple objectives', University of Illinois at Urbana-Champaign, USA), and by Professor A. Lundquist (C.I. Byrnes and A. Lindquist, 'The moment problem for rational measures: convexity in the spirit of Krein', Washington University, St Louis, USA and Royal Institute of Technology, Stockholm, Sweden).

On 28 January, the sessions of seven workshops were held. Three plenary papers were devoted to optimal control in dynamical systems. F.M. Kirillova considered programme and positional types of solution (in the form of feedforward, feedback, and a combination of the two) in problems of optimal control for hybrid (discrete-continuous) control systems in classes of discrete pulse and discrete quasi-pulse control actions (R. Gabasov, F.M. Kirillova, and N.S. Pavlenok, 'Optimal discrete-impulse control of hybrid systems', Minsk, Belarus). Professor N.N. Subbotina reported on sufficient conditions for constructing continuous approximations for the synthesis of optimal control in problems with a terminal objective function on the basis of smooth solutions of the corresponding Hamilton–Jacobi–Bellman equations (V.Yu. Dzhafarov and N.N. Subbotina, 'Sufficient conditions for continuous approximations of optimal feedbacks to control problems with terminal cost', Anadolu University, Eskisehir, Turkey; Institute of Mathematics and Mechanics, Ural Branch of the RAS, Ekaterinburg). The morning plenary workshop was ended by V.N. Nespirnyi (A.M. Kovalev and V.N. Nespirnyi, 'Impulse control in control and stabilization problems for nonlinear dynamical systems', Institute of Applied Mathematics and Mechanics, National Academy of Sciences of Ukraine, Donetsk, Ukraine).

On 29 January, eight plenary papers were presented at two sessions in the IPU RAS. The morning workshop was opened by the chairman-for-the-day, F.L. Chernous'ko. He presented K. Furuta, the celebrated Japanese scientist, with a RAS honorary doctorate (honoris causa). In his reply speech, the latter thanked the Russian Academy of Sciences, in the person of the chairman and those members of the academy present, for the honour bestowed upon him, and then presented a paper on actual problems of discrete adaptive control of mechanical systems (K. Furuta, A. Ohata, A. Suguki, and M. Saito, 'Discrete-adaptive control of mechanisms', Tokyo Denki University, Japan).

The session was continued by A.A. Melikyan with a paper devoted to methods for constructing and analysing the singular characteristics of the Hamilton–Jacobi equation ('Boundary and internal singular characteristics of Hamilton–Jacobi equation and their applications', IPM RAS, Moscow). The morning workshop concluded with a paper presented by V.N. Ushakov ('Positional procedures for solving game control problems', IMM, Ural Branch of the RAS, Ekaterinburg). He described a method for the approximate construction of the maximum stable bridge in a differential game of convergence-divergence with a fixed termination time.

We would like to mention the contribution of Professor H.G. Bock ('Recent progress in real-time optimal control of dynamic processes', Heidelberg University, Germany).

The plenary workshop on 30 January began with a paper read by Professor A.G. Chentsov ('The route problem of permutations with interior works' IMM, Ural Branch of the RAS, Ekaterinburg). The route problem of visiting finite sets, complicated by conditions of precedence and the need for internal work on the sets characterized by expenditure determined by the point of entry on the set and the point of exit.

This session was continued by Professor E.A. Kostina with a paper devoted to problems of online construction of optimal experiments for estimating the parameters of dynamic models on the basis of given measurements ('Online design of optimal experiments: a challenge for numerical optimal control', Marburg University, Germany).

On this day, the sessions of a further five workshops were held, devoted to the modelling, control, and optimization of dynamical systems and processes.

The results of the work of the International Conference on the Control of Dynamical Systems were collected together and a decision was taken to publish the best papers in the leading reviewed Russian journals. The principal results that were discussed at the conference reflect the current level of world science in terms of the control of dynamical systems.

The scientific programme of the conference included a consideration of the current state, completed developments, and prospects for future development of research at the large scientific centres of the world, including those in Russia. The discussions held in the workshops and in the breaks between the workshops reflect the current state of theory in problems of controlled dynamical systems and are of great importance for determining promising avenues of research and their applications to solve the problems highlighted by the conference. The need to continue collaboration and to develop joint work was noted, and the importance of basic and applied research to world science in the areas touched upon at the conference was emphasized.

It is important to point out that the Russian scientists who took part in the conference are acknowledged as leading specialists, whose scientific results have determined the level of science achieved worldwide in the field of mechanics and control. The justification for staging this event is the fact that the problems discussed and the methods for solving them are pressing matters throughout the world and deserve the attention of the international scientific community. The holding of this scientific forum has helped to raise the status of Russia, as a country that can boast world-class basic scientific achievements in this field, and to strengthen international ties between the leading scientific centres.

The subject matter covered by the International Conference on the Control of Dynamical Systems corresponds to the RAS scientific programme on processes for controlling dynamical systems. The conference was supported financially by the Russian Foundation for Basic Research (09-01-06006-g).

Translated by P.S.C.