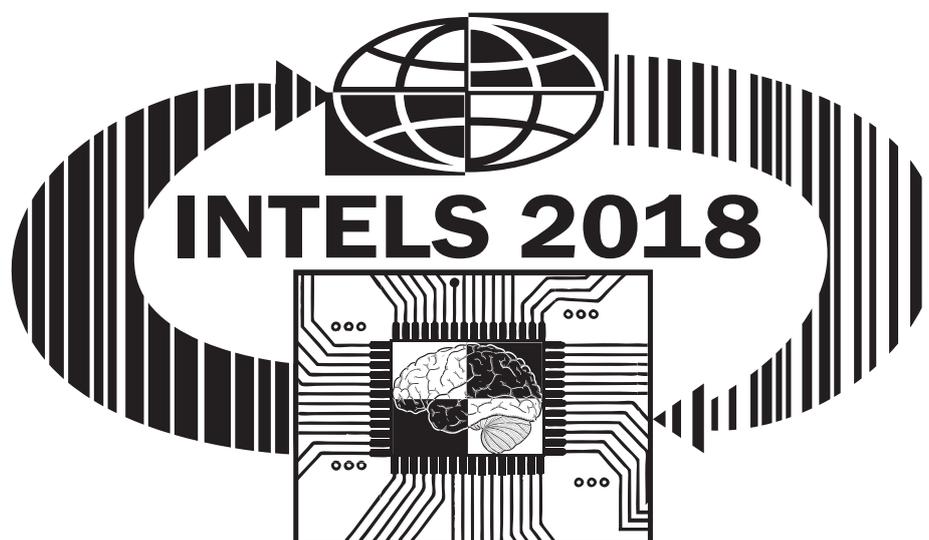


XIII International Symposium

Intelligent Systems 2018

**October 22-24, 2018
Saint Petersburg, Russia**

PROGRAM AND ABSTRACTS



Editors:

D.Sc., Prof. K.A. Pupkov

D.Sc., Prof. A.I. Diveev

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WELCOME MESSAGE FROM HONORARY CHAIR



D.Sc., Prof. Pupkov K.A.
Honorary Chair
Symposium Founder

Today we begin the work of the XIII International Symposium «Intelligent Systems» (INTELS'18). It is held in the great Russian city of St. Petersburg at ETU «LETI», one of the world's largest education centers specializing in radio engineering, electrical engineering, electronics and computer science. I welcome the participants and guests of this Symposium and congratulate you on this important event for science.

An intelligent system is an integrated information system, a set of hardware and software that works in conjunction with a person (a group of people) or autonomously, capable of synthesizing a goal based on information and knowledge, if motivated, and making decisions for action and finding rational ways.

Research and development of intelligent systems is a complex problem. It can be solved by the interaction of various fields of science, such as neurophysiology, physiology, biology and the application of nanotechnology, biotechnology, information technology, knowledge technology, control theory and other basic sciences.

Unfortunately, we still know a little about the mechanism of the latent period of information passing through the human brain, that greatly affects the stability of the system and the quality of the decision making process, and, consequently, the quality of control.

Nature carefully hides from us the mechanism of transition from living contemplation (physico-chemical processes occurring in the brain) to the formation of concepts and decision-making at an abstract level of thinking. Some of the problems were also mentioned in my report at the previous Symposium.

I hope that we will discuss these and other problems at our sessions and try to find ways to overcome them, assessing, of course, the results achieved.

The statement of the Russian physiologist, a Nobel prize laureate, I.P. Pavlov, in my opinion, could be an epigraph to all of our research: «The whole life from the simplest organisms to the most complex, including, of course, human beings, is a long series of environment balances that become more complex to the highest degree. A time will come, albeit remote, when mathematical analysis, relying on the natural sciences, will illuminate with majestic equations all these balances, including itself in them».

This time has come.

I wish you success in the field of intelligent systems development.

D.Sc., Prof. Konstantin PUPKOV
INTELS'18 Honorary Chair
Symposium Founder

WELCOME MESSAGE FROM GENERAL CHAIR

On behalf of the Program committee, I would like to express a warm welcome to all the participants of the XIII International Symposium «Intelligent Systems – 2018», (INTELS'18), 22-24 October 2018, St. Petersburg, Russia.

Established in 1994, the INTELS series of biannual symposia have served as an excellent forum for scientists, researchers, engineers and industrial practitioners from around the world to network and to share the latest advancements and future trends in intelligent systems, control, optimization, computer science and information technologies.

INTELS'18 is organized by RUDN University, St. Petersburg Electrotechnical University «LETI» and Bauman Moscow State Technical University. We have received more than 200 submissions from more than 15 countries worldwide and could accept nearly 100 papers. The acceptance rate for this Symposium was around 51%. In addition to the regular papers, INTELS'18 includes exciting plenary keynotes by internationally renowned professors and researches. I thank all delegates for submitting their works to our Symposium, for long-lasting and strong support.



D.Sc., Prof. Diveev A.I.
General Chair

In addition to the regular papers, INTELS'18 includes exciting plenary keynotes. We have received around 200 papers from more than 15 countries worldwide and could accept nearly 100 papers. The acceptance rate for this Symposium was around 51%. Authors honored us by reporting their original works in all areas of Intelligent Systems: Control, Optimization, Decision, Engineering, Computer Science and Information Technologies. We thank them for submitting their works to our Symposium.

I would like to thank the rector of LETI Victor Sheludko, professor Mikhail Kupriyanov, and all the staff of LETI, our host, for their extraordinary efforts to ensure that this Symposium will be fruitful, successful, enjoyable and memorable one.

I would like to express our gratitude to the Ministry of Education and Science of the Russian Federation for the financial support on the program to improve the competitiveness of RUDN University, among the world's leading research and educational centers in the 2016-2020, and to Russian Fund of Basic Research, project №18-08-20119.

D.Sc., Prof. Askhat DIVEEV
INTELS'18 General Chair

WELCOME MESSAGE FROM THE RECTOR OF ST. PETERSBURG ELECTROTECHNICAL UNIVERSITY «LETI»



D.Sc., Prof. Sheludko V.N.
Rector of «LETI»

St. Petersburg Electrotechnical University «LETI» (ETU «LETI») appeared to be the first higher education institution in Europe to major in electrical engineering. For more than 130 years since its establishment, ETU «LETI» has been a leader in education and research. Today it is a research-driven university with a global outlook and a leading Russian university of technology. ETU «LETI» is committed to achieving academic excellence, providing students and faculty members with research opportunities and engaging in sustainable development which is illustrated by our motto – Professionalism, Sociability, Availability.

ETU «LETI» generates new knowledge and applies it in a dynamically developing education process. ETU «LETI» provides students not only with fundamental high quality education but all practical skills, necessary for maintaining a successful career after graduation. ETU «LETI» promotes conditions for harmonious personal growth and creative development of students to improve the lives of young people.

Many generations of teachers and scientists who worked for ETU «LETI» contributed to our success. We are proud of our history, respect our traditions and think about the future. We look forward to positive changes and pioneering ideas that are going to emerge.

We are very glad to contribute to a successful series of the International Symposium «Intelligent Systems» by hosting the XIIIth Symposium INTELS'18 at ETU «LETI». We wish the Symposium participants a fruitful work and a pleasant stay in St. Petersburg. Welcome to INTELS'18. Welcome to St. Petersburg Electrotechnical University «LETI».

D.Sc., Prof. Viktor SHELUDKO

Rector of St. Petersburg Electrotechnical University «LETI»

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ST. PETERSBURG ELECTROTECHNICAL UNIVERSITY «LETI» AT A GLANCE



Established in 1886, St. Petersburg Electrotechnical University «LETI» (ETU «LETI») has been the oldest higher educational institution of electrical engineering in Europe. It has strong roots and an excellent heritage, and has achieved an outstanding reputation. Achievements of ETU gained national and worldwide priority and have been widely recognized.

The first elected director was the inventor of radio communication, Professor Alexander S. Popov (1905). The Institute of Electrical and Electronic Engineers (IEEE) mounted a Milestone Plaque at ETU «LETI» (2005) as recognition of Popov's contribution to the development of wireless communication.

Most of the Russian scientific schools in Electric Communication, Electrical Engineering, Electroenergetics, Electrochemistry, High-voltage Technology and Electric Power Transmission were founded at ETU. The first chair of Radio Engineering in Russia was established by the alumni Professor Imant G. Freiman (1917). It appeared to be the basis for the successful development of the Russian scientific school in the field. The director of ETU «LETI» and the founder of the national hydropower engineering school, Member of the Academy of Sciences, Professor Genrikh O. Graftio, supervised the State plan for electrification of Russia – «GOELRO» (1920s). The following chairs were established at ETU for the first time in the world: Electric Drive by Professor Sergey A. Rinkevich (1922); Electroacoustics and Ultrasonic Testing by Professor Sergey Ya. Sokolov (1931); High-frequency Electrothermy by Professor Valentin P. Vologdin (1935).

Pioneer works in the area of electrotechnical materials investigation were carried out at ETU «LETI» under the supervision of Professor Nikolai P. Bogoroditsky (1940s-50s). A prototype of a phased-array antenna for radar applications was elaborated by the team of Professor Yury Ya. Yurov for the first time in the world (1955). The foundations of nuclear spectrometry were developed (early 1960s). A unique test complex for spacemen to work in the state of weightlessness was designed (early 1960s). A method of sublimation growth, which is nowadays widely used all

over the world for manufacturing SiC boules and became known as the LETI method, was elaborated (1976). The first University Center for Innovations Commercialization in the former USSR was established (1991).

Professor Zhores I. Alferov, a graduate and the former Chair of the Optoelectronics Department of ETU «LETI», was awarded the Nobel Prize in Physics jointly with Herbert Kroemer «for basic work on information and communication technology», especially «for developing semiconductor heterostructures used in high-speed- and opto-electronics» (2000).

Today, ETU «LETI» is a leading Russian educational and research center whose mission is to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence. As such, ETU «LETI» tries to sustain, strengthen, and increase its competitiveness, and to ensure a continuously high level of education and research. Since 2013, ETU «LETI» is ranked among 21 top Russian universities which are the members of the Russian Academic Excellence Project 5-100 that is to maximize the competitive position of a group of leading Russian universities in the global research and education market.

ETU «LETI» consists of seven schools: Radio Engineering and Telecommunications; Electronics; Computer Science and Technology; Electrical Engineering and Automatics; Information, Measurement, and Biotechnical Systems; Economics and Management; Humanities.

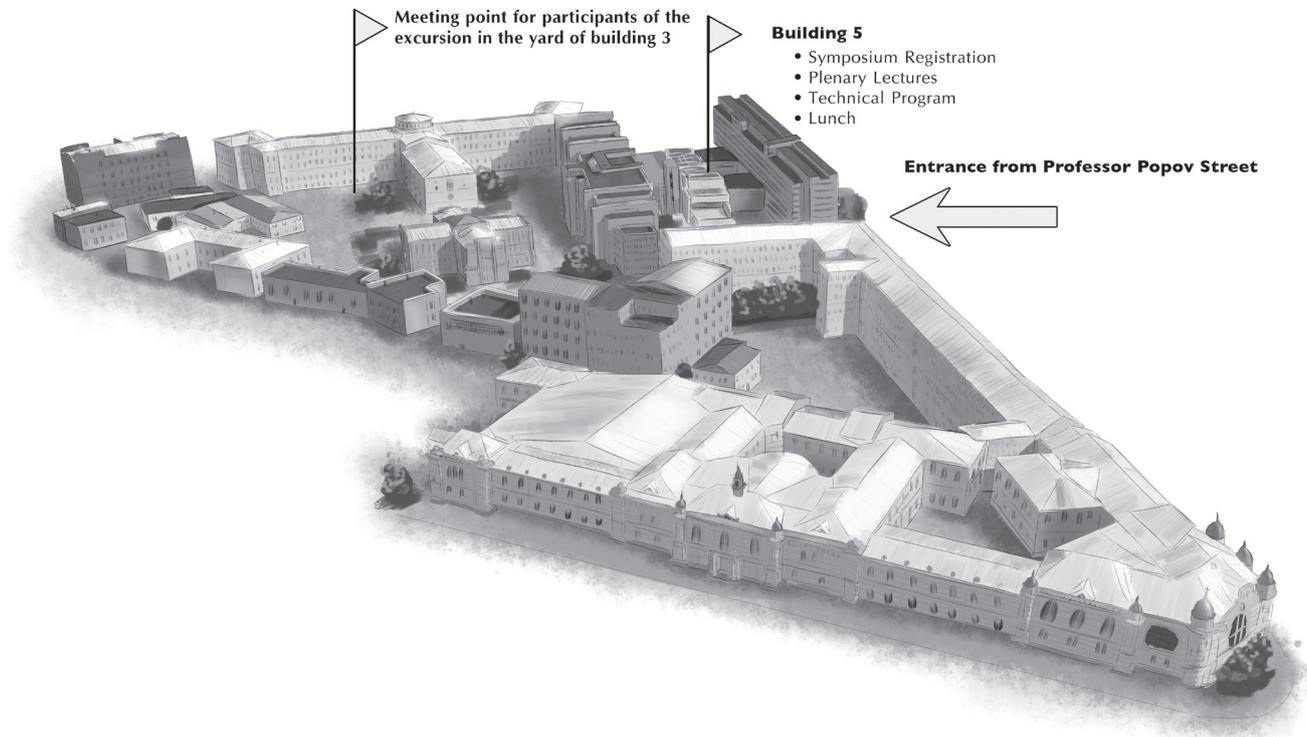
ETU «LETI» offers about 100 major educational programs and over 40 Ph.D. courses. The following Master Degree programs are offered in English: «Automation / Mechatronics»; «Bioengineering Systems and Technologies for Prosthetics and Rehabilitation»; «Computer Science and Knowledge Discovery»; «Laser Measurement Technology»; «Photovoltaics and Solar Energy Technology»; «RF, Microwave and Terahertz Engineering of Wireless Systems». Around 40% of the academic curricula are devoted to fundamental disciplines. Near 8500 students attend study programs at ETU «LETI» annually. Over 18% of them come from abroad, representing 62 countries. About 800 academic staff members work for ETU «LETI».

Over 50 research teams and state-of-the-art laboratories carry out breakthrough fundamental and applied research in Radio Electronics, Radio Physics, Information Technology, Telecommunications, Solid State Physics, Nanotechnology, Optoelectronics and Quantum Electronics, Vacuum and Plasma Technology, Microwave and Millimeter-wave Technology, Biomedical Engineering etc. ETU «LETI» hosts laboratories of such world-wide companies as Altium, Infineon, Intel, Microsoft, National Instruments, Siemens, Texas Instruments et al. Among the foreign partners of ETU «LETI» are 170 universities, many research centers and industrial companies from all over the world.

The ETU «LETI» campus is located in the historical downtown of St. Petersburg that is the second largest city of the Russian Federation, its cultural capital and a UNESCO World Heritage Site.

LOCATION AND PROGRAM

St. Petersburg is one of the world's most beautiful cities. The historic center of St. Petersburg is on the UNESCO World Heritage List. The Symposium Program will be held in the campus of St. Petersburg Electrotechnical University. Registration, Plenary Lectures and Technical Program will take place at building #5 (**St. Petersburg, 5 bld. 5, Professora Popova str.**).



Program

Date	Time	Event	Place
22 October 2018, (Mon)	8:30-10:00	Registration / Coffee break	<i>Conference Hall</i>
	10:00-10:15	Opening Ceremony	<i>Conference Hall</i>
	10:15-11:05	Plenary Session 1	<i>Conference Hall</i>
		Keynote 1: F.L. Pereira Advanced Optimization-based Approaches for the Control Synthesis for Autonomous Underwater Vehicles	Info on page 16
	11:10-12:00	Keynote 2: I. Zelinka Evolutionary Algorithms In Modern Engineering Problems and Solutions. Recent Advances and Progress	Info on page 17
	12:00-12:10	Collective photo	<i>Conference Hall</i>
12:10-13:00	Lunch	<i>Canteen</i>	

Location and Program

Date	Time	Event	Place
22 October 2018, (Mon)	13:00-15:00	Technical Sections: TS1.1 TS2.1 TS3.1	<i>Conference Hall</i> <i>Room 5234</i> <i>Room 5156</i>
	15:00-15:20	Coffee break	<i>Conference Hall</i>
	15:20-17.50	Technical Sections: TS1.2 TS2.2 TS3.2	<i>Conference Hall</i> <i>Room 5234</i> <i>Room 5156</i>
	8:30-9:30	Coffee break	<i>Conference Hall</i>
23 October 2018, (Tue)	9:30-10:15	Plenary Session 2 Keynote 3: S.N. Vassilyev Intelligent Control of Autonomous and Anthropocentric Onboard Systems	<i>Conference Hall</i> Info on page 18
	10:15-11:00	Keynote 4: A.I. Diveev Comparison of Artificial Neural Networks and Symbolic Regression for Synthesis of Intelligent Control Systems	Info on page 19
	11:00-11:45	Keynote 5: S.P. Shiva Prakash Methods and Models in Energy Aware Routing for Wireless Networks	Info on page 20
	11:45-12:00	Keynote 6: A.T. Nguyen The Concept of AI-Government, AI World Society	Info on page 21
	12:00-13:00	Lunch	<i>Canteen</i>
	13:00-15:00	Technical Sections: TS1.3 TS2.3 TS3.3	<i>Conference Hall</i> <i>Room 5234</i> <i>Room 5326</i>
	13:10	Excursions to Museums / Free time	
	19:00	Gala Dinner	<i>Golitsyn Hall*</i>
24 October 2018, (Wed)	10:00-12:00	Technical Sections: TS1.4 TS2.4 TS3.4	<i>Room 2115</i> <i>Room 5234</i> <i>Room 2122</i>
	12:00-13:00	Lunch	<i>Canteen</i>
	13:10	Excursions to Museums	

* *Gala Dinner will take place at Golitsyn Hall. Address: Fontanka river embankment, 20.*

TECHNICAL PROGRAM

*The duration of each presentation is up to 10 minutes plus 5-10 minutes for questions.
Accepted file formats for all presentations are PDF and PPT.*

Technical Session 1. Intelligent Control Systems

Session Chairs: *Evgeny Kovshov*

JSC «Research and Development Institute of Construction Technology - Atomstroy»

Oleg Korsun

Federal State Unitary Enterprise State Research Institute of Aviation Systems

Studies on the development and application of intelligent control systems are presented. A distinctive feature of intelligent control systems is the use of conditional operators and logical functions in the control. Control systems of complex objects or objects operating in difficult conditions always have signs of intelligent control systems. Intelligent control systems include smart systems and systems that replace the human operator in the control loop.

Session ID	Date / Time	Place	Papers	Abstract page
<i>TS1.1</i>	October 22, 2018 13:00-15:00	<i>Conference Hall</i>	156, 162, 163, 164, 170, 180, 198, 200	p.22–24
<i>TS1.2</i>	October 22, 2018 15:20-17:20	<i>Conference Hall</i>	202, 205, 214, 216, 222, 224, 227, 250	p.24–27
<i>TS1.3</i>	October 23, 2018 13:00-15:00	<i>Conference Hall</i>	252, 268, 280, 290, 293, 294, 302, 307	p.28–31
<i>TS1.4</i>	October 24, 2018 10:00-12:00	<i>Room 2115</i>	174, 258, 318, 327, 334, 347	p.32–34

Technical Session 2. Numerical Methods for Intelligent Control Systems

Session Chairs: *Askhat Diveev*

*Federal Research Centre «Computer Science and Control» of RAS
RUDN University*

Liliya Demidova

Ryazan State Radio Engineering University

Yuri Skobtsov

Saint Petersburg State University of Aerospace Instrumentation

Studies on the development of new and application of well-known numerical methods for creating intelligent control systems are presented. Computational methods of intelligent control systems include evolutionary algorithms, neural networks, symbolic regression methods, fuzzy sets,

Technical Program

multivalued logic, big data analysis algorithms and other computational methods that provide the structure and parameters of intelligent control systems.

Session ID	Date / Time	Place	Papers	Abstract page
<i>TS2.1</i>	October 22, 2018 13:00-15:00	<i>Room 5234</i>	157, 160, 165, 175, 188, 193, 194, 197	p.35–38
<i>TS2.2</i>	October 22, 2018 15:20-17:50	<i>Room 5234</i>	232, 233, 237, 239, 251, 265, 270, 350, 348, 351	p.38–43
<i>TS2.3</i>	October 23, 2018 13:00-15:00	<i>Room 5234</i>	272, 275, 277, 282, 284, 289, 291, 301	p.43–46
<i>TS2.4</i>	October 24, 2018 10:00-12:30	<i>Room 5234</i>	316, 319, 338, 339, 340, 341, 342, 343, 344	p.46–50

Technical Session 3. Elements of Intelligent Control Systems

Session Chairs: *Alexey Paznikov*

Saint Petersburg Electrotechnical University «LETI»

Studies on the development and research of elements and subsystems included in intelligent control systems are presented. The elements of intelligent control systems are image, sounds, texts, signals recognition systems, forecasting systems, systems of decision making under uncertainty, access control systems and others. Also the creation of elements of artificial intelligence, automatic translation systems, automatic training, automatic assistance, etc. are discussed.

Session ID	Date / Time	Place	Papers	Abstract page
<i>TS3.1</i>	October 22, 2018 13:00-15:00	<i>Room 5156</i>	159, 167, 173, 177, 196, 209, 211, 212	p.51–54
<i>TS3.2</i>	October 22, 2018 15:20-17:50	<i>Room 5156</i>	158, 217, 235, 242, 246, 254, 255, 256, 262, 271	p.54–58
<i>TS3.3</i>	October 23, 2018 13:00-15:00	<i>Room 5326</i>	281, 286, 295, 313, 324, 326, 331, 333	p.58–61
<i>TS3.4</i>	October 24, 2018 10:00-12:00	<i>Room 2122</i>	195, 345, 240, 245, 259, 296, 306, 346	p.61–65

«Advanced Optimization-based Approaches for the Control Synthesis for Autonomous Underwater Vehicles»

Fernando Manuel Ferreira Lobo Pereira

Systems of autonomous – air, surface, and underwater – robotic vehicles are increasingly regarded as an option of choice to gather data to respond to an increasingly wider range of societal needs in science, environment, exploitation of natural resources (geologic and biomass), surveillance, security, defense, and leisure. LSTS – The Laboratory of Underwater Systems and Technologies (<https://lsts.fe.up.pt/>) of Faculty of Engineering of Porto University has, over the years, been devoting a very significant R&D effort to the advancement of theoretical research in systems and control, as well as technologies to design and build such systems. The notorious achievements that gained worldwide visibility makes LSTS a reference institution with a consolidated leadership in many key niches of the pertinent very interdisciplinary contexts.



In this talk, I will focus on issues specific to the control of Autonomous Underwater Vehicles (AUVs) in either stand alone or formation modes. More specifically, a computationally efficient architecture to control formations of AUVs is presented and discussed. The proposed control structure enables the articulation of resources optimization with state feedback control while keeping the onboard computational burden very low. These features are critical for AUV systems as they operate in contexts of scarce resources and high uncertainty or environmental variability. The hybrid nature of the controller enables different modes of operation, notably, in dealing with unanticipated obstacles. Optimization and feedback control are brought together in a novel Model Control Predictive (MPC) scheme constructed with pre-computed Attainable Sets and Value Functions by taking advantage of the time-invariance subsystems and leaving to the real-time context, adaptivity operations requiring relatively low computational burden.

Speaker's biography

Fernando Manuel Ferreira Lobo Pereira (<http://paginas.fe.up.pt/~flp/>) is a Full Professor at Porto University, Faculty of Engineering, Electrical and Computer Engineering Department, Director of the Institute for Systems and Robotic Porto, Scientific Coordinator of FCT R&D unit SYSTEC. Academic degrees, fields of study, awarding institutions, dates in reverse chronological order: Received the Habilitation («Agregação») title from Porto University in 1997; Received the PhD in Control Theory from Imperial College of Science and Technology, London University, in 1986; Graduated in Electrical Engineering, Automation and Control at the Faculty of Engineering of Porto University in 1981. Main scientific and technical area of research: Control and Optimization Theories (Non-smooth Analysis, Dynamic Optimization, and Impulsive Control), Hybrid Systems, and Coordinated Control, and their application in the control of autonomous and/or networked systems arising mainly in multiple robotic vehicle systems. The main application areas are: oceanography, and environment monitoring and surveillance, as well as data gathering for scientific marine research. Society and Technical Committees membership: IEEE, SIAM, APCA, AMS, INFORMS, SPM, and OE, IFAC Technical Committee on Optimal Control. Published more than 300 publications in peer-reviewed journals and conferences.

«Evolutionary Algorithms In Modern Engineering Problems and Solutions Recent Advances and Progress»

Ivan Zelinka

This keynote is focused on recent progress in design and use of evolutionary algorithms. Based on our research and research of various scientists worldwide it has been shown and experimentally demonstrated on many evolutionary algorithms, that it is possible to use them in wide spectra of practical applications as well as the solution of hard theoretical research problems.

The lecture will be focused on selected evolutionary algorithms, its basic principles, and its classification. After the introduction of basic principles of evolutionary algorithms will be discussed some physical limits of computing and algorithms. In the second part will be briefly described selected applications as the swarm robot control, plasma reactor control, chaos synthesis, control and identification, the evolutionary design of control law for a robot, evolutionary structure synthesis (math formulas, electronic circuits, logical functions,...), Darwinian evolution of computer viruses and swarm malware, amongst the others.



■ Speaker's biography

Ivan Zelinka (born in 1965, <http://www.ivanzelinka.eu>) is currently associated with the Technical University of Ostrava (VSB-TU), Faculty of Electrical Engineering and Computer Science. He graduated consequently at the Technical University in Brno (1995 – MSc.), UTB in Zlín (2001 – Ph.D.) and again at Technical University in Brno (2004 – Assoc. Prof.) and VSB-TU (2010 – Professor).

Prof. Zelinka is responsible supervisor of several grant researches of Czech grant agency GAČR as for example Unconventional Control of Complex Systems, Security of Mobile Devices and Communication (bilateral project between Czech and Vietnam) and co-supervisor of grant FRVŠ – Laboratory of parallel computing amongst the others. He was also working on numerous grants and two EU projects as member of team (FP5 – RESTORM) and supervisor (FP7 – PROMOEVO) of the Czech team. He is also head of research team NAVY <http://navy.cs.vsb.cz/>.

Prof. Zelinka was awarded by Siemens Award for his Ph.D. thesis, as well as by journal Software news for his book about artificial intelligence. He is a member of the British Computer Society, Machine Intelligence Research Labs (MIR Labs – <http://www.mirlabs.org/czech.php>), IEEE (committee of Czech section of Computational Intelligence), a few international program committees of various conferences.

«Intelligent Control of Autonomous and Anthropocentric Onboard Systems»

S.N. Vassilyev

A hybrid technology of intelligent control of autonomous and anthropocentric onboard systems is proposed. It is based on non-clausal prover for automated reasoning and combines a symbolic knowledge representation, a processing with neural network pattern recognition, a numerical predictive modeling of physical processes in control object and its threat environment as well as with analytical methods of optimal control. If a control task is not provided with all necessary means of its solving, then the prover is able to deduce conditions for the task solvability and to ask another intelligent agents for the missing means to continue the control task solving (e.g., some digital means from the operator of onboard system). Applications to motion control problems in threat environments are examined.



Speaker's biography

Vassilyev Stanislav Nikolayevich (born in 1946 in Thorez of Donetsk region, USSR), Doctor of Sciences in Physics and Mathematics, Member of the Russian Academy of Sciences, Chief researcher of the Institute of Control Sciences of RAS, Head of department of the Lomonosov Moscow State University.

S.N. Vassilyev is an author and co-author of more than 400 scientific works, including 14 monographs. Research directions developed by him are artificial intelligence and intelligent control, mathematical system theory, digital economy technologies. He has prepared more than 20 Candidates and Doctors of Sciences. In 2005-2015 years he was the Member of the Expert Council of the Higher Attestation Commission. He is the Chairman of the Dissertation Councils at the Institute of Control Sciences of RAS, the chairman of the Scientific Council of the Russian Academy of Sciences on the theory of control processes and automation, co-chairman of the Scientific Council of the Russian Academy of Sciences on the methodology of artificial intelligence, a member of RAS Council for Defense Studies, the Scientific Publishing Council of RAS, Expert commissions of the Russian Academy of Sciences on the gold medal of the RAS named after S.P. Korolev and the Prize of the Russian Academy of Sciences after B.N. Petrov et al.

S.N. Vassilyev is an Editor-in-chief of the journal «Automation and Remote Control» of RAS, deputy editor-in-Chief of the journal «Reports of the Academy of Sciences», member of the editorial board of «Proceedings of RAS. Theory and Control Systems», «Information and Computer Technologies Bulletin», «Control Problems», «Underwater Research and Robotics», «Nonlinear Studies», «Mathematics in Science, Engineering and Aerospace», «Nonlinear Dynamics and Systems Theory», «Journal of Automation and Information Science», «Numerical Analysis and Applications», etc.

S.N. Vassilyev was awarded the title of laureate of the USSR State Prize in Science and Technology (1984), the Prize of the Government of the Russian Federation in the field of education (2010), the Government Prize in Science and Technology (2012) and the Prizes of RAS in Basic Research, the Orders of Honor, Friendship and other state and scientific awards, letters of recognition and gratitude.

«Comparison of Artificial Neural Networks and Symbolic Regression for Synthesis of Intelligent Control Systems»

A.I. Diveev

Specific aspects of the numerical solution of the control synthesis problem by the artificial neural networks and symbolic regression are considered. It is shown that artificial neural networks can be seen as one of the methods of symbolic regression with a given structure when symbolic regression comprises parametric optimization. To effectively solve the synthesis problem by the artificial neural networks, it is necessary to have a training sample. It is proposed to use as a training sample the results of multiple numerical solution of the optimal control problem for various initial conditions. Examples of control synthesis for a group of robots by the methods of artificial neural networks and symbolic regression are given.



■ Speaker's biography

Askhat Diveev (born in 1954) is currently the head of cybernetic problems sector at the Federal Research Center «Computer Science and Control» of Russian Academy of Sciences and head of Cybernetics and mechatronics Department at RUDN University. He graduated Bauman Moscow State Technical University in 1980, candidate of technical sciences in 1989, doctor of technical sciences in 2001, Professor in 2009.

Prof. Diveev is the author of 4 books and more than 250 papers. Prof. Diveev is an inventor of the network operator method (2006). The method allows to find the structure and parameters of mathematical expression by the means of computational techniques for a number of problems in systems control and identification. At present Prof. Diveev uses this network operator method and other symbolic regression methods for solving the control synthesis problem for group of robots.

«Methods and Models in Energy Aware Routing for Wireless Networks»

S.P. Shiva Prakash

Wireless networks use radio waves to attach devices like laptops to the net, the business network and applications. once laptops area unit connected to Wi-Fi hot spots publically places, the affiliation is established to it business's wireless network. Routing enables transparent frame forwarding in arbitrary multi-hop. Routing protocol is responsible for multi-hop path discovery and maintenance, Apart from basic multi-hop path discovery and forwarding functions, it includes a number of advanced features such as internetworking, security, power save, and channel assignment etc.. Design issues in modelling includes energy constraints, node mobility, network topology, type of protocol, type of control and optimality criteria. Wireless devices have limited battery life. Each node consumes power depending on whether it is Asleep (i.e. no transmission), Idle (i.e. listening but not sending), transmitting (i.e. sending but blocking its channel), transmitting packets is considered more expensive than receiving or processing packets: switching from asleep mode to idle mode is expensive and Protocol architecture impacts the energy requirements. Energy constraints restricts the topology of a network (i.e. hop count, degree of a node). The goal is to design a model for an energy aware cost function that satisfies the energy constraints and node mobility.



Speaker's biography

Dr. S.P. Shiva Prakash is working as an Assistant Professor in the department of Information Science & Engineering, JSS Science and Technology University (Formerly known as SJCE), Mysuru, Karnataka, India. He has been awarded Ph.D in Computer Science degree in the area of Wireless Mesh Networks in 2017 from University of Mysore, Mysuru and M.Tech in Software Engineering degree in the year 2010 from Vishweshwaraiah Technological University, Belgaum. He has obtained his bachelors degree B.E. in Information Science and Engineering from Vishweshwaraiah Technological University, Belgaum. His research interest includes Energy aware routing in WMN, Body Area Networks, Internet of Things and Health care applications. He has published more than 25 research papers in various national, international conferences and journals. He has developed many applications for Nokia N900 devices such as Virtual Kannada Keyboard, Crop Management System, Health Monitoring System etc using Qt. He has conducted several workshops and FDP along with Professors from Delhi, Russia and Finland. He is one of the Jury for Qt-Competition, conducted by Finnish-Russian University Cooperation in Telecommunications (FRUCT), Russia, 2010, 2011. He secured "Excellent Team Work award" in the short term course on "Creativity and Innovation" conducted by IIT Delhi. He also received appreciation letter from Nokia for coordinating and developing applications for Nokia devices. Recently he received appreciation letter from FRUCT, Finland for contributing in translation of medical data from English to Hindi and Kannada languages. Currently he is guiding two research scholars of JSS Science and Technology University in the area of 5G, IOT networks and WBAN.

«The Concept of AI-Government, AI World Society»

Nguyen Anh Tuan

E-Government is the use of communication and information technology for improving the performance of public sector agencies. AI-Government transcends E-Government by applying AI to assist decision making for all critical public sector functions – notably provision of public services, performance of civic functions, and evaluation of public officials. At the core of AI-Government is the National Decision making and Data Center (NDMD). NDMD collects, stores, analyzes, and applies massive amounts of data relevant to the provision of public services and the evaluation of public programs and officials. It does not replace governance by humans or human decisional processes but guides and informs them, while providing an objective basis for service provision and evaluation.



Speaker's biography

Nguyen Anh Tuan is the Director of The Michael Dukakis Institute for Leadership and Innovation (MDI), the Co-founder and Chief Executive Officer of The Boston Global Forum (BGF). Tuan is also the Founder and Chairman of the VietNamNet Media Group and the Founder and Editor-in-Chief of VietNamNet, Vietnam's preeminent online newspaper. Additionally, Tuan was the Founder and CEO of VASC Software and Media Company and VietNet, the first Internet service provider in Vietnam. For his contributions to his native land, the Government of Vietnam named Tuan one of the nation's 10 most outstanding young talents in 1996. In 2009, Tuan conceived of an annual global initiative making September 9th World Compassion and Reconciliation Day. As a Shorenstein Fellow at Harvard Kennedy School in 2007, Tuan researched major trends in the development of electronic media in Vietnam. In 2011, he became a Pacific Leadership Fellow at the School of International Relations and Pacific Studies at the University of California San Diego. From February 2011 to July 2014 Tuan was an Associate of the Shorenstein Center on Media, Politics and Public Policy, John F. Kennedy School of Government, Harvard University. In April 2012, Tuan founded the Tran Nhan Tong Academy, which is dedicated to encouraging reconciliation to avoid conflict among nations. In December of 2012, Tuan cofounded the Boston Global Forum with the Honorable Michael Dukakis, former governor of Massachusetts and U.S. Presidential candidate, who serves as Chairman of the Board of Directors for this think tank dedicated to developing peaceful solutions to global tensions. Three years later, Tuan and Governor Dukakis, cofounded The Michael Dukakis Institute for Leadership and Innovation (MDI), where Tuan serves as Director of the Institute. Tuan served on the Harvard Business School Global Advisory Board from 2008 to 2016. Since July of 2015 to November of 2017 he served as Chair of the International Advisory Committee of UCLA – UNESCO Chair on Global Learning and Global Citizenship Education at the University of California Los Angeles. Tuan is cofounder, and Chief Executive Officer of the Global Citizenship Education Network (GCEN), a collaboration between the Boston Global Forum and the UNESCO-UCLA Chair on Global Learning and Global Citizenship Education as well as being cofounder and Former Associate Editor of UCLA's Global Commons Review. In an effort to enhance cybersecurity worldwide, Tuan created Global Cybersecurity Day, produced the recent BGF-G7 Summit Initiative, and coauthored the Ethics Code of Conduct for Cyber Peace and Security (ECCC). In November of 2017, Tuan and Governor Michael Dukakis founded AI World Society Initiative.

INTELLIGENT CONTROL SYSTEMS

Session ID: TS1.1

October 22, 2018 / 13:00-15:00

PAPER 156

Synthesis of Fuzzy Controller Based on Simple PID Controller

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This article will present the nonlinear mathematical model of quadrotor, then this model will be linearized around more than one operational point to cover all nonlinear system dynamics while fulfilling different movements. PID controller was developed with considering of control signals constraints. The data of closed loops PID of quadrotor including error and control signals will be analyzed to derive the most appropriate input and output linguistic variables and rule base that describe the behavior, more precisely the dynamics of the system. The proposed method of analysis will define the main parameters of fuzzy controller and help avoiding the complexity of contributing experts' knowledge which is either difficult to give full description neither readily exists in reach of the designer. This will lead to design a fuzzy controller that is supposed to maintain the performance of basic PID controller and to be immune to uncertainty of the model coefficients.

Keywords: quadrotor; PID controller; Rule base derivation; fuzzy controller.

PAPER 162

Control of the Motion Orientation of Autonomous Underwater Vehicle

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In this paper we present an application of the hedge algebras controller and a direct adaptive fuzzy-neural output-feedback controller (DAF-NOC) and Hedge algebras (HA) in control of the orientation of underwater vehicles. The experiments simulated on computers are done to prove the effectiveness, the feasibility of the proposed algorithm of the neural controller under different actions such as the noise in the measuring devices, the influence of the flow to the motion of underwater vehicles

Keywords: neural controller; hedge algebras; underwater vehicles.

PAPER 163

Sliding Mode Based Lateral Control of Unmanned Aerial Vehicles

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The article describes the application of sliding mode in lateral control of a UAVs. Thanks to establishment of outer loop based on non-linear sliding mode, the system has a good performance in path following. The existence of sliding mode

with limits of control signal, as well as the stability in sliding mode have been verified using Lyapunov function. The results of the simulation have proven the effectiveness of the selected control method in comparison to other common control methods.

Keywords: UAV control; sliding control.

PAPER 164

Fuzzy Description Hemispherical Resonator Gyro Error

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This paper addresses models of errors caused by irregularity of density, radius defect, different Q-factor and irregular resonator thickness of a hemispherical resonator gyro based on fuzzy description. A fuzzy algorithm has been proposed for processing error and its simulation results are given.

Keywords: hemispherical resonator gyro; model of error; fuzzy description; fuzzy algorithm

PAPER 170

Cascade Non-linear Filters for Image Recovery

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Non-linear filtering is considered as a problem of cancelling non-Gaussian noise from the additive

mixture of this noise and the initial signal. This task is formulated within the framework of the «black box» principle, when the non-linear filter operator is approximated by a behavioural model that establishes a relationship between the sets of input and output signals of a device. The case, when image signals distorted by the impulse noise excite a filter, is in highlight. Non-linear filtering results in the recovery of initial images with a assigned error estimated in the mean-square norm. A non-linear filter is synthesized as the cascade connection of the median filter, the cellular neural network and the Volterra filter. Under different impulse noise densities, the cascade non-linear filter is shown to ensure the higher accuracy of the image restoration in comparison with its singled out parts.

Keywords: non-linear filter; neural network; mathematical model; impulse noise.

PAPER 180

Software and Hardware Complex for the Management of Small-sized Underwater Vehicle

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The report deals with the design and implementation of a control system for a small underwater vehicle designed for search and monitoring. The structures of algorithmic and software support of the remote control system are proposed. Private algorithms for the management and processing of navigation information have been developed. The application screens with the results of full-scale tests of the small underwater vehicle (SUV) are given.

Keywords: underwater vehicle; remote control system; processing.

PAPER 198

The Analytical Approach to the Parameterized Fuzzy Operators Design

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In this paper we discussed the problem of generation and efficient software- and hardware-based implementation of branches of fuzzy logic parametric operations that can be used as basic operations of reconfigurable fuzzy systems (embedded fuzzy controllers). The ways of design of strict t -norms and t -conorms on fuzzy systems in presented paper based on the mathematical theory of geometrical aggregation operations from the Rvatchev constructive geometry. Presented theoretical results may be implemented for a new branches of membership functions design and in the hardware-based units of analytical fuzzy inference systems.

Keywords: fuzzy set; fuzzy controller; membership function; triangular norm; fuzzy inference.

PAPER 200

Methods of Visual Navigation in the Task of Moon Landing

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This paper describes development of image registration method based on Generalized Hough Transform for the task of visual navigation on automatic moon landing. A hybrid algorithm is de-

scribed which allows to compare observed image with a vector map in a form of crater parameters list without additional feature detection. Performance of algorithm is estimated. Measures to increase algorithm stability to noise and camera orientation changing are described.

Keywords: pattern recognition; visual navigation; GHT.

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PAPER 202

On Development of Module for Neural Tuner to Adjust D-part of PID-controller Online

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Nowadays nonlinear industrial plants are controlled by linear P, PI and PID-controllers with constant parameters. This results in both transients quality and energy efficiency decrease. An adaptive neural tuner to adjust P and PI controllers parameters has been proposed to solve these problems and tested both for heating furnaces and DC drives. But it is not able to adjust a D-part of the controller, which is widely used for the heating furnaces. So the aim of this research is to extend the functionality of the tuner with a new software module to adjust K_D parameter online. In order to achieve this, a new structure

of the neural network for the tuner is chosen, its rule base is enhanced with the developed rules for K_D , and the sustainability criterion for the system with the tuner and the PID-controller is developed. The new version of the tuner is applied to control a heating furnace to keep the required transients quality under the condition of the furnace parameters non-stationarity. Comparing to the PID-controller, it allows to reduce transients time averagely by 11.6% and the furnace energy consumption by 8.4%.

Keywords: nonlinear plants; neural tuner; PID-controller; sustainability; rule base.

PAPER 205

Collective Opinion Formation as a Set of Intelligent Agents to Achieve the Goal

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The connection between the decision-making process and the opinion of community participating in the voting, which is given in the form of analytical expressions that are close to description of the voting process, as well as public opinion assessment are described in this paper. Analytical expressions that can be used in order to describe the voting process have been obtained. An approximate equation based on mathematical principles, in which a more detailed study of reality can be developed from a mathematical point of view is developed. Moreover, the significant influence of minor initial conditions on the voting process has been shown. The reliability of the results has been verified by computer simulation.

Keywords: voting; collective opinion; a set of intelligent agents; binomial distribution.

PAPER 214

Advanced Iterative Action Planning or Intelligent Real-Time Agents

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Action planning by intelligent agents in open dynamic multi-agent worlds is a challenging problem when creating autonomous robots, UAVs and other autonomous systems. A method for planning actions in an ever-changing multi-agent world is proposed, that ensures the effective use of the deliberation time by planning mental actions. Knowledge representation models necessary for the agent to implement advanced iterative planning are considered. The proposed approach is illustrated by examples of planning an agent's actions in virtual soccer.

Keywords: intelligent agent; multi-agent systems; real-time; action planning; knowledge representation models.

PAPER 216

A Model for Decision Making Support for Evaluation of Functional Efficiency of Lower Limb Orthotics

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A problem of decision making in case of multi-criteria instrumental evaluation of orthotics results with foot pathology is considered. Application

appropriateness of decision making process models developed on the basis of the hierarchic process analysis method is grounded. Decision making models are suggested at the stage of the examination plan formation and at the stage of orthotics efficiency evaluation according to the results of this examination. In order to provide modes for decision making support when evaluating functional efficiency of orthotics it is appropriate to use models developed on the basis of hierarchies analysis of corresponding decision making processes. The process model of decision making when choosing evaluation criteria should contain hierarchic levels with alternatives: indications for orthopedic appliance prescription, indicators of orthotics efficiency, evaluation criteria. In order to evaluate orthotics efficiency the model should also contain a level whose alternatives are state types of the system «patient – orthotic». The method efficiency improvement is provided by mapping of decision making models in a matrix form, automation of computations connected with their application, provision of a possibility to correct models directly in the process of patient examination in order to adapt to clinical situation not taken into consideration earlier that require application of computer technologies.

Keywords: model for decision making support; orthotics; decision making; bioengineering system; foot.

PAPER 222

Principles of Constructing of Intellectual Systems for the Diagnostics and the Rehabilitation of the Human Spine

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The article proposes general principles of the build of intelligent systems of the diagnostic and of the rehabilitation of the spine: a general structure scheme of the build, an individual neuro-mechanical model of the spine, and an algorithm for the constructing of the neuro-mechanical model. The neuro-mechanical model described in this work takes into account physiological characteristics (pathology and trauma) of the spine, as well as the pain sensitivity and pain threshold of the patient. The individual neuromechanical model is built on the basis of a basic model with the use of neural networks. The algorithm of adaptation of the individual model allows to identify pathologies in the patient's movement and to correct the model at all stages of the rehabilitation of the spine. The results of MRT, CT, EEG, EMNG and data of goniometric measurements are input data for the construction of the individual model of patient.

Keywords: diagnostics; rehabilitation; spine; neural network; fuzzy logic; accelerometer; goniometry; vertebra.

PAPER 224

Manipulation Robots' Trajectory Motion Adaptive Control

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This paper describes the construction, research and comparative analysis of adaptive control systems of elastic oscillations suppression of electric drive transmissions of joints and the unleashing of the interrelated dynamics of the degrees-of-freedom of manipulation arms robots under conditions of nonlinearity and uncertainty of their mathematical description with the aim of improving the accuracy and speed of spatial trajectory movement of the robot flange. The strat-

egy of solving the two mentioned interrelated problems is based on the decomposition of the nonlinear mathematical model of the manipulation arm onto the rigid and elastic subsystems, which allows to introduce unification of the construction of combined (composite) adaptive electromechanical systems, using the accurate method of the calculated moment (Li-Slotine) and the approximate method of majorizing functions.

Keywords: manipulator; manipulation arm; majorizing functions; adaptive control; control system.

PAPER 227

Development of the Ground Mobile Robot with Adaptive Agility Systems

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The development of unmanned vehicle traffic control systems is a world trend. The development of a market of unmanned vehicles is stimulated by various contests and competitions. This paper presents the prerequisites and the first steps in the development of unmanned vehicle traffic control systems by the NNSTU n.a. R.E. Alekseev with the support of engineers from the United Engineering Center of the GAZ Group and specialists from PJSC GAZ. This system is developed for operation in difficult road-climatic conditions in the territory of the Russian Federation. As a chassis for installation of the system, an electrical platform was chosen. The component composition of the unmanned vehicle traffic control system is proposed, the location and coverage of the equipment are determined. The software modules of the unmanned traffic control system are implemented. Experimental studies of the system were carried out.

Keywords: agility; ground mobile robots; adaptive control systems.

PAPER 250

Optimal Control Design for Maneuverable Aircraft Using Population-based Algorithms

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The report outlines the algorithmic and methodological approaches to solving the problem of the optimal program control design for the maneuverable aircraft. An object model convenient for generating program control is shown. This paper demonstrates possibility of solving considered problem using direct method, involving cubic Hermite splines and a population-based optimization algorithm for generating control signals. This report also compares proposed direct method with classic approaches to optimal control.

Keywords: optimal control; direct optimization; population-based algorithm; aircraft.

Session ID: TS1.3

October 23, 2018 / 13:00-15:00

PAPER 252

Autonomous Unmanned Aerial Vehicles Control System Intellectualization

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Among unmanned aerial vehicles (UAVs) control systems the most interest are the systems capable to provide object control the high level of autonomy due to the maximum use of information awareness based on external environment condition and internal UAV status. Firstly, it is the widest range of external influences, in many cases having character of purposeful impact on the ability of the control system to perform its assigned target function. Secondly, it is about the unforeseen internal situations: equipment element failure(s), information security violation, software failure, etc. Functioning process model of such perspective system can be represented by three components: information (provides information awareness with appropriate quality indicators), manager (decides which way to a target to choose) and executive (realizes the action corresponding to the chosen way of target achievement). Such perspective control systems are identified as a class of intellectual control systems with realization of function of information awareness. Consider the possible control system structure of an autonomous UAV (AUAV) on the terminal phase of his flight executing a complex

of information and administrative tasks with information awareness function implementation while executing main function. The considered system consists of two parts: 1) Ground flight preparation system, making the AUAV flight task (using available and predicted information about external environment); 2) AUAV onboard system, using the current (a posteriori) information about the external environment conditions and a condition of the AUAV, comparison of aprioristic and a posteriori information, making relevant flight management. Basic structural and functional features, such as are inherent in the systems of this class: 1) An aprioristic standard situations set (SSS) preparation and problem subsituations set (PrSS) for each TS; 2) existence of the aprioristic knowledge base (AKB) as the light task (FT) main component; AKB includes base of the allocated interest objects reference descriptions, onboard decision-making algorithms and AUAV flight control for all problem subsituations, processes realization cyclograms of the specified algorithms; 3) Vision system onboard, carrying out algorithms of automatic receiving and processing of a posteriori information, classifying this information to the relevant SSS and PRS / C, priority interest objects automatic recognition, decision-making and AUAV flight control. The perspective control system of AUAV formation technique, realizing an information awareness function is considered on the solution example of interest objects recognition, which are a part of a multi-object stationary land scene; priorities definition and flight trajectory choice.

Keywords: autonomous unmanned aerial vehicles; information awareness; intellectual control system; technical vision system.

PAPER 268

Dynamic Correction Algorithms in Multi-axis Systems Based on Predictive and Invariant Control Methods

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This article considers the issue of controlling a mobile robotic technological complex based on the use of predictive and invariant control methods for compensation of external indeterminate perturbations. Authors carry out the analysis of the perturbations arising in the control system. We propose to introduce three correction contours into the control system structure ensuring parrying of all the perturbation components. A modification of the classical predictive control scheme based on the application of complementary correction algorithms is presented. The algorithms of the complementary correction are based on the statements of the fourth modified form of invariance. We consider the application of cross-correction in the automatic control system of a robot while controlling the motion along specified technological trajectories.

Keywords: external indeterminate perturbation; predictive control; invariance; complementary correction algorithms; multi-coordinate technological robot.

PAPER 280

A Generalized Filippov-like Existence Theorem for Optimal Control Problems with Constraints

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As is known, an optimal control problem may not have a solution. A.F. Filippov in 1 obtained his well-known theorem under the assumption of the convexity of the velocity set. Further, this convexity-based approach was significantly improved in the work of R.V. Gamkrelidze and J. Warga, see in 2,3, while a more general existence theorem was proposed for which, by introducing the so-called generalized controls and the concept of convexification of the problem, the existence of a solution in an extended control problem was asserted. In this paper, such an approach is developed on discontinuous arcs. More precisely, our work combines the two approaches – the one based on the Lebesgue discontinuous time variable change, and the other, based on the convexification of the optimal control problem by virtue of the generalized controls proposed by Gamkrelidze. This leads to a general impulsive extension of the optimal control problem based on the concept of generalized impulsive control. A generalized Filippov-like existence theorem for a solution is obtained. Within the framework of the proposed approach, a few classic examples taken from the calculus of variations are examined, in which discontinuities of optimal arcs inevitably arise.

Keywords: optimal control; existence theorems, generalized controls, discontinuous arcs.

PAPER 290

On Decision Making under Fuzzy Information about an Uncontrolled Factor

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The paper is concerned with the decision-making problem under fuzzy uncertainty. A decision maker selects one alternative focusing on the impact of an uncontrolled factor. In this paper the case when the information about an uncontrolled factor is fuzzy is considered. Three concepts for solving this problem are offered: a weak solution, a strong solution and a solution on the average. The relationship between solutions is investigated. As an example, the problem of treating soil with pesticides is considered, with a strong solution and a solution on the average being found for this problem.

Keywords: decision-making; uncertainty; fuzzy uncontrolled factor.

PAPER 293

Intelligent Systems and Human Being

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Problems discussed are, on the one hand, the participation of a human being in the functioning of the intelligent system as a person who perceives information, forms the notion of the essence of a phenomenon, and makes a control decision, on the other hand, the psychophysical studies aimed at elucidating the connection between mental phenomena and physical processes (i.e. physicochemical processes specific for a living organism). There is an intermediate functional unit, which is usually hidden from strict scientific knowledge, and it significantly complicates the creation of artificial intelligence systems. The essence of problems is considered and some ways of their solution are outlined.

Keywords: intelligent systems; human being; latent period; forms of cognition; quality of control; functional link; brain knowledge; neuron; large pyramidal neuron; goal-oriented activity of the brain.

PAPER 294

Monitoring, Certification and Verification of Autonomous Robots and Intelligent Systems: Technical and Legal Approaches

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In the paper the problems of current legislative system of autonomous robots and intelligent systems are studied. Telemetric data of autonomous robots and intelligent systems are described. The principles of conducting certification and verification tests are formalized. Also, the architecture of the monitoring and testing system for autonomous robots and intelligent systems with cloud-based implementation is described in detail.

Keywords: autonomous robots; intelligent systems; monitoring; certification; verification.

is carried out. The mathematical apparatus is based on special interval matrix algebra transformations, which could not be included in the article because of the volume, and therefore are only stated. As a result, the authors obtain a new class of quasi-relay type controls with system state dependent modulated impact jumps, and therefore combining the properties of both soft smooth and hard forcing types.

Keywords: control system; stability; stabilizer; interval matrix; modular function; cubic form; compensator.

PAPER 302

Interval Quadratic Connected Control Systems in Industrial Robotics and Mechatronics

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Industrial robotic and mechatronic systems in real machinery are quadratically connected dynamical systems with parametric uncertainties, whose mathematical models can be extremely complex. Program motion stabilization of such systems, especially those described in quasi-coordinates, is a topical scientific problem, which does not yet have an acceptable for engineering developments comprehensive solution. The article proposes a possible concept of such a solution, based on the Lyapunov's direct method, extended to the interval dynamic systems domain with time derivatives of state variables written in the interval cubic forms. The authors conceptual approach is based on new concepts introduced in the article: covering form, form compensator, modular variables form. According to this approach, first of all, the transition to new complex system state variables formed with signatures

PAPER 307

Adaptive Wind Turbine PID Controller Tuner Algorithm with Elements of Artificial Intelligence

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The vast majority of automatic control systems (ACS) currently in operation use the PID algorithm. However, there are still many problems in the adjustment of PID regulators parameters that provide the required quality of control. In this connection, it is proposed to use for this task an algorithm with two reference models for self-tuning of automatic control systems, in which continuous processes that accumulate information about the dynamics of the controlled object are implemented, it is used for determining optimal values of tunable parameters, assessing the performance of ACS in the course of mathematical modeling and automatic change of the ACS adjustment factors, in the case of approaching the performance of ACS to the limits of admissible values of the criteria quality, defined in the specifications.

Keywords: control; artificial intelligence; automatic control systems; self-tuning; PID; adaptive.

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PAPER 174

Networked Control for Active Suspension System

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A suspension system is one of the most important subsystems in the car; it acts as a bridge between the occupants of a vehicle and the road. This paper presents a simulation of two cases of control for a full model car active suspension system. The first case is a control system without network, while the second is a networked control system. In the first approach, there is a comparison between two control methods (PID and LQR) for active suspension systems. Results shown that PID is better than LQR when the goal is to control the suspension travel of the car, while controlling other parameter of the system is more available using LQR and depends on the complexity of the reference index used. The second case is a networked control for active suspension system using a proposed model of CAN network in Matlab to transfer the readings values of sensors and actuators to/from a controller; the control method inside the controller is either PID or LQR. The results show that LQR method has better performance than PID when the speed of network is low.

Keywords: active suspension system; CAN; LQR; PID; networked control system.

The Predictive Principle in Control Systems with Standard Lows

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Instead of the standard control principle on current state of controlled output, it offered to pass to the predictive control principle on future output. The realization of this principle in automatic control systems of technological parameters with standard algorithms allows to increase significantly quality of regulation and at the same time more fully using the opportunities given by programmable microprocessor equipment. The given in paper examples are proving that the prediction allows to reduce the range of control output deviation twice – three times. Prediction can use in coherent systems of regulation for the best approach of the real influence compensator to the ideal compensator. Potential opportunities of predictive algorithms can use at regulator's tuning for cases when the object dynamic characteristics are unknown. The method of setup of predictive linear regulators by one parameter – predictive time – offered.

Keywords: principle on current state control; predictive control principle; automatic control systems; standard linear algorithms; setup of predictive regulators.

PAPER 318

Process of the Positioning Complex Modeling Objects with Elements of Intellectual Analysis

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The calculation and results of simulation of the magnetic control system for the spacecraft momentum are presented in the paper. The simulation includes an assessment of the reliability of calculating the Earth's magnetic field parameters, as well as an assessment of the quality of object stabilization by resetting the total momentum with the aid of the system under review. The outcome of a comparative analysis of resource efficiency and energy efficiency are demonstrated in the implementation of the proposed hardware models of controllers on FPGA. The calculate is performed on the mechatronic system parameters of realistic situation.

Keywords: comparative analysis; stabilization; controller; realistic situation.

PAPER 327

A Newton-Type Method for Quadratic Programming Problem and Variational Equilibrium Problem

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The active-set Newton method developed earlier by the author and her supervisor for mixed complementarity problems is applied to solving the quadratic programming problem with a positive definite matrix of the objective function and for variational equilibrium problem. A theoretical justification is given to the fact that the method is guaranteed to find the exact solution in a finite number of steps. Numerical results indicate that this approach is competitive with other available methods as for quadratic programming problems and for variational equilibrium problem.

Keywords: Newton-type method; quadratic programming problem; variational equilibrium problem; error bound; semistability.

PAPER 334

Evaluation of the Influence of Cross-connections Accounting in the Simplified Mathematical Model of the Quadrotor Motion in Three-dimensional Space

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Nowadays unmanned aerial vehicles are in active development and are used in many areas of human activity. One of the main problems in their application is the description of their motion with a given level of accuracy. The use of nonlinear systems of high-order differential equations is associated with the complexity, and often the inability to obtain an analytical solution of the problem of transferring the drone to a given state. Many authors work in the direction of simplifying the mathematical model of the quadrotor

motion, discarding the influence of cross-connections caused by the presence of gyroscopic momentums during the rotation of the quadrotor. In this paper we evaluate the accuracy of the description of such a model in comparison with a system of nonlinear differential equations, taking into account the presence of cross-connections and perturbations in the motion of the quadrotor. Conclusions about the need to take into account these factors in the modeling process due to the significant values of the resulting mismatches while using a simplified model are made.

Keywords: mathematical model; quadrotor; UAV; control; cross-connection; mismatch.

PAPER 347

**Analysis of Control System Models
with Conventional LQR and Fuzzy
LQR Controller**

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Linear quadratic LQR and fuzzy FLC+LQR controllers are analyzed. It is shown that under the same conditions, the fuzzy FLC+LQR controller has a much higher speed than the LQR controller.

Keywords: linear quadratic LQR; fuzzy FLC+LQR; controller; analysis.

NUMERICAL METHODS FOR INTELLIGENT CONTROL SYSTEMS

Session ID: TS2.1

October 22, 2018 / 13:00-15:00

PAPER 157

The Approach to Managing a Group of UAVs as a System with Distributed Parameters

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The research is devoted to one of the promising directions in the field of group control of unmanned aerial vehicles (UAVs), which function jointly within dense groups in solving specific problems. A large group of densely located UAVs is considered as a system with distributed parameters that are functions of time and spatial coordinates. The state of such a system is described by partial differential equations. A method for describing and managing such systems is proposed, based on the provisions of mathematical physics and the theory of systems with distributed parameters. The relevance of the proposed study is due to the need to solve complex tasks of trajectory control, taking into account the provision of controllability and prevention of collisions in the group of numerous UAVs.

Keywords: unmanned aerial vehicle; system with distributed parameters; complex system; complicated system; trajectory control; group control; group robotics; group management system; system topology; simulation modeling.

PAPER 160

The Design Principles of Intelligent Load Balancing for Scalable WebSocket Services Used with Grid Computing

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Large-scale grid compute projects may use computational capabilities of web browser sessions on numerous client devices to run distributed data processing algorithms. WebSocket protocol is the basis of duplex communications between browser worker nodes. Publish/Subscribe pattern defines communication scheme for client-server messaging. The downside of WebSocket-based Publish/Subscribe implementations is the stateful nature of long-living network connections. This aspect makes WebSocket scaling and load balancing a challenging task. In present work, we state that the intelligent balancer needs to consider different behavior types of client connections. We propose the negotiation-like mechanism between client and the load balancing system about the target server to set the client on. Our construction principles of scalable multi-server infrastructure with effective inter-server communications intensively use Redis instances, because Redis is a mature, well-tested, high performance system, rich of functions.

Keywords: browser-based grid computing; WebSocket protocol; horizontal scaling; load balancing; Publish/Subscribe; Redis applications.

PAPER 165

Advanced Cat Swarm Optimization Algorithm in Group Robotics Problem

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Localization of plots of land which have the highest level of radiation, chemical or alternative contamination is one of the typical group robotics objectives. The research aim lies in development, software implementation and performance study of the original robotic group control algorithm based on nature-inspired Cat Swarm Optimization algorithm. This paper proposes Cat Swarm Optimization algorithm description, features of software realization and a vast computational experiment results. The practical value of this work lies in applicability of proposed algorithm for decentralized robotic group control systems synthesis.

Keywords: robot; group robotics; SEMS; decentralized robotic group control; nature-inspired algorithms of global optimization; contaminated plts of land localization.

PAPER 175

Approaches to Speed up Data Processing in Relational Databases

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The increasing of data volumes and the tightening of requirements by the time of data processing actualize the problem of finding methods for optimizing data structures and queries in data-

bases. This article presents a set of methods that can help speed up the processing of data. These include the method of restructuring a completed database, a method for obtaining a parallel query plan, and methods for optimizing queries. The presented methods can be used both in a complex and independently of each other. At the end of the article, are shown the results of the experiments, which were carried out on a test database for approbation of optimization methods for a parallel query plan.

Keywords: database; query; parallel computing; information graph; optimization.

PAPER 188

Development of a Knowledge Base in the «Smart Farming» System for Agricultural Enterprise Management

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Increasing the efficiency of agricultural production is a very important task. To solve this problem, it is proposed to use the «Smart Farming» cloud system for precision farming management. The novelty of the proposed approach lies in using the knowledge base and multi-agent technology to develop coordinated decisions on management of agricultural enterprises. The paper focuses on development of the knowledge base in the «Smart Farming» system on precision ag-

riculture. Information storage is organized in the form of a semantic network of concepts and relations on the «All about the concept» principle in a single repository, which facilitates the work of farmers with this resource. The paper covers storage, editing, verification, and visualization of knowledge representation about the domain of crop production, production resources, agricultural machinery, equipment and other material resources, as well as peculiarities of the tasks of precision farming. The knowledge base of plant production, built on ontological principles, will be useful to enterprise managers, agronomists, machine operators, planning services and other specialists of large, medium and small farms, as well as to individual farmers.

Keywords: knowledge base; Aristotle metaontology; ontology of plant growing; semantic network; multi-agent technology; smart decision support system.

PAPER 193

Open Source Robotic Simulators Platforms for Teaching Deep Reinforcement Learning Algorithms

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One of the primary goals of the artificial intelligence field is to produce fully autonomous agents that interact with their environments to learn optimal behaviors, improving over time through trial and error. A mathematical principled framework for experience-driven autonomous learning is reinforcement learning, but they are inherently limited to low-dimensional problems, but the deep learning boom has provided new tools to overcome these problems. For deep reinforce-

ment learning teaching, we do not have an appropriate platform for making optimal labs. In the article, after studying the theoretical foundations and the requirements of the main platforms, we selected two open source platforms, according to their characteristics: robotic simulators platforms for teaching and benchmarking deep reinforcement learning algorithms. The first platform was Gym and V-REP and the second one, KNIME DeepLearning4J Integration supports and Teaching-Box.

Keywords: deep reinforcement learning; open source platforms; robotic simulator; teaching.

PAPER 194

Multi-agent Algorithm for Re-allocating Grid-resources and Improving Fault-tolerance of Problem-solving Processes

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Nowadays, a provision of the computational process fault-tolerance in Grid is a relevant issue. In the paper, we address a fault-tolerance improvement in solving large-scale scientific and applied problems that are implemented through modular programming in heterogeneous distributed computing environments. We describe a computational process by an abstract program (problem-solving scheme) that correlates to a workflow. The problem-solving scheme specifies modules (applied software) and their relations with each other. This paper proposes a new multi-agent algorithm for re-allocating Grid-resources when the computational process fails. The algorithm execution involves forming a residual problem-solving scheme using methods of the abstract pro-

gram specialization and reallocating its modules between agents that represent computational resources. In comparison to the known algorithms for the same purpose, the proposed algorithm implements an adaptive multi-scenario solving this issue and therefore increases a degree of computational process fault-tolerance. Extensive modeling and practical experiments demonstrate the practicability of the proposed algorithm.

Keywords: large-scale problems; workflow; Grid; multi-agent management; fault-tolerance.

PAPER 197

All convolutional neural networks for radar-based precipitation nowcasting

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Today deep learning is taking its rise in hydro-meteorological applications, and it is critical to extensively evaluate its prediction performance and robustness. In our study, we use deep all convolutional neural networks for radar-based precipitation nowcasting, which has a crucial role for early warning of hazardous events at small spatiotemporal scales. Our trial and error study focuses the particular importance of selecting and adopting suitable data preprocessing routine, network structure, and loss function regarding input data features, and, as a result, highlights limited transferability of methods in existing studies. Results show that parsimonious deep learning models can forecast a complex nature of a short-term precipitation field evolution and compete for the state-of-the-art performance with well-established nowcasting models based on optical flow

techniques.

Keywords: precipitation; nowcasting; convolutional networks; deep learning.

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PAPER 232

Unmanned Flying Vehicle Trajectory Guaranteeing Control at Approach to the Maneuvering Air Target

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An algorithm of unmanned flying vehicle-interceptor trajectory guaranteeing control at the stage of maneuvering target approach as a result of game problem solution was developed. Conditions of a saddle point existence for a mode of differential game under consideration have been examined. The results of modeling, confirming the fact that our guaranteeing control algorithm provides the tactical advantage for the unmanned interceptor vehicle, have been presented.

Keywords: unmanned flying vehicle-interceptor; game problem; optimal control criterion; guaranteeing control law; modeling.

PAPER 233

Optimal Control for Traffic Flows in the Urban Road Networks and Its Solution by Variational Genetic Algorithm

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A study is aimed at development and research of mathematical models and algorithms for traffic flows control in urban road networks. An optimal control problem statement for traffic flows in urban networks is given. A feature of the problem is that the model of control object is presented in finite-difference equations. A control is constrained by the durations of active phases of traffic lights at intersections. The solution is a control program that determines the moments for phase switching. A variational genetic algorithm is used to solve the problem.

Keywords: traffic flow control; controlled networks; optimal control; evolutionary algorithms.

PAPER 237

A Method of Monitoring and Detecting APT Attacks Based on Unknown Domains

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The increasing coverage of Internet has created opportunities and advantages for different aspects of society. However, there come new threats and challenges to information security. One of the typical types of attacks that has increasingly occurred is the APT attack (Advanced Persistent Threat). APT is dangerous with clear purposes. APT attacks employ different sophisticated methods and techniques attacking targets in order to steal confidential and sensitive information. In the past, hackers attacked information systems with personal and financial motives. However, there are nowadays other motives such as political ones and they are potentially backed by governments or nations. Nations that own advanced technologies such as United States, India, Russia, UK are also suffering from special purpose attacks. APT is an advanced type of attacks that consists of many stages and concrete strategies. Besides, techniques and technologies employed in APT attack are usually new and developed by hackers in order to break through the monitoring of security softwares. However, APT is normally implemented through concrete steps and stages. If one of the steps or stages fails, the entire APT attack will fail. This paper presents a method of detecting APT attacks based on monitoring accesses to unknown domains. This detection method results into high effectiveness in the initial stage of APT attacks.

Keywords: Information Security; APT; unknown domain; attack detection; attack monitoring.

PAPER 239

**Theoretical and Experimental
Evaluation of Hybrid ACO-k-means
Image Segmentation Algorithm for
MRI Images Using Drift-analysis**

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The hybrid Ant Colony Optimization (ACO) – k-means image segmentation algorithm for MRI images segmentation is considered. The proposed algorithm and sub-system for the medical image segmentation have been implemented. The time complexity of proposed algorithm is investigated using consequences from Drift theorem. It is established that the proposed algorithm has a polynomial estimation of complexity. Images from the Ossirix image dataset and real medical images were used for testing. Comparison of segmentation accuracy have been performed between proposed algorithm and competing algorithms C-means and Magic Wand.

Keywords: MRI images segmentation; Ant colony optimization; k-means algorithm; swarm intelligence; drift-analysis.

PAPER 251

**The Use of a Convolutional Neural
Network for Detecting Snow According
to the Data of the Multichannel
Satellite Device of Meteor-M No.2
Spacecraft**

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The paper presents a method for detecting snow using a machine learning algorithm based on a convolutional neural network. As the input data, the satellite images obtained from a multispectral low-resolution scanning device (MSU-MR) installed on the Meteor-M No. 2 spacecraft are used. This unit provides images in six visible and infrared channels at 1 km spatial resolution. The developed algorithm can be an alternative to the traditional methods of snow detection, based on calculation the normalized difference snow index (NDSI), the normalized difference vegetation index (NDVI) and threshold values. Evaluation of the algorithm using the f-measure showed a high level of quality of its work. Calculated using the algorithm, the snow mask allows for the construction of maps that can be successfully applied for snow cover monitoring.

Keywords: MSU-MR; snow mask; CNN; convolutional neural network; Decision Tree; cloud mask; satellite.

PAPER 265

Obstacle Avoidance for Swarm Robot Based on Self-Organizing Migrating Algorithm

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This paper presents an obstacle avoidance algorithm for swarm robot in unknown environment based on self-organizing migrating algorithm in which the trajectory is divided into a set of points created by the SOMA that robot must pass through. During the move, obstacles will be detected by sensors on the robot, it only knows the target position without knowing the obstacles location until detecting them. The fitness function is based on the principle of attraction from the target and the repulsion of the obstacles, which helps robot find the trajectory for moving, and the ways leaving it to move safely away from the trapped area. Simulation results are also presented to show the feasibility of the algorithm.

Keywords: Self-organizing migrating algorithm; obstacle avoidance; swarm robot; trajectory planning.

PAPER 270

Hierarchical model of parallel metaheuristic optimization algorithms

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The paper introduces a novel model of parallel metaheuristic optimization algorithms. The hier-

archical graph model of a parallel optimization algorithm is proposed. It consists of the model for a parallel optimization algorithm at the top level of the hierarchy and the model for a sequential optimization algorithm at the bottom level. The unified representation of a metaheuristic optimization algorithm, which allows representing a class of metaheuristic algorithms, is used. The extension of the proposed model to the parametric hierarchical model is proposed. Graph model transformations for a parallel algorithm analysis and synthesis are introduced. The representation of several metaheuristic algorithms with the proposed model is discussed.

Keywords: evolutionary algorithms; metaheuristic; optimization; parametric optimization; parallel algorithms; particle swarm optimization.

PAPER 350

From Malware Testing to Virtualization

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Viruses are everywhere around us. Not only in our environment but also in virtual environment we are now using on daily basis. To be able to predict their growth it is necessary to understand them or even to develop them.

The main problem was how to get rid of any harm in computer or even infrastructure and still be possible to simulate infiltration. Of course it is not an infiltration from real deep point of view. This paper describes how this problem was handled, which type of malware1 was used, briefly introduces its implementation and also virtual environment this threat was tested. As preferred virtualization tool docker was chosen. Images created in docker and after then run as a containers fit to this work. Alpine was chosen as mini virtual

docker image for our purposes. For implementation part c++ and a Qt5 framework was utilized to reduce the time with implementation which are already done. Frameworks or OS-es do not provide all important tools and this happened also in this case. Because of that some additional tools has been installed. Most of them are network based tools which are important for this work because this worm implementation communicates over the LAN and communication is on udp based packets. Result of this investigation is fully virtual platform which can be used for testing and improved also for other types of features related to viral usage.

Keywords: alpine; image; container; Qt5 framework; C++; nmap; ssh; udp; LAN; worm.

PAPER 348

Analysis of the AnyWalker Software Architecture Using the UML Refactoring Tool

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Refactoring (restructuring of a system, which keeps its functionality invariant) of the software can be aimed at the optimization of such characteristics as modifiability, maintainability and understandability. Model refactoring can be conducted not only at the code level, but also at the model level. According to the MDA approach models are described using the Unified Modeling Language (UML). UML class diagrams are

used to specify software architecture. UML Refactoring is a software tool, which provides UML class diagram analysis and refactoring. This article proposes results of AnyWalker project UML class diagram refactoring using the UML Refactoring tool.

Keywords: UML Refactoring; AnyWalker; refactoring; software architecture; clas diagram; model refactoring; MDA.

PAPER 351

Convolutional Neural Network in the Recognition of Spatial Images of Sugarcane Crops in the Troncal Region of the Coast of Ecuador

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This article deals with the agriculture, as part of the primary sector of the economy, includes the transformation of the natural environment through a set of actions and human intervention that allows satisfying the production mainly of food and derived raw materials. Therefore, with the high demand for products required for agricultural activity, it is necessary to implement new technologies to guarantee the quality and performance of production techniques and reduce environmental impact. In this context, precision agriculture has emerged to improve, evaluate, estimate and understand, based on the information obtained, the needs of crops. Taking into account the evolution of the methodology for processing of satellite images and the obtaining of indirect data, a classification of the characteristics of crop yield can be made. Definitely, different techniques have been applied to the processing of satellite images, but recently a current approach, both in effectiveness and speed in obtaining excellent re-

sults is the use of deep learning of the convolution of neural networks. The deep convolution of neural networks is used both in the recognition as well as in the classification of the satellite images of the sugarcane plantation in the Troncal region of the Coast of Ecuador. The experiment showed affirmative results of approximately 95% probability of recognition of crop status.

Keywords: Convolutional Neural Network; Machine Learning; classification; image analysis; precision agriculture.

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PAPER 272

Hybrid Approach to Improving the Results of the SVM Classification Using the Random Forest Algorithm

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The aim of this work is to improve the results of the SVM classification (Support Vector Machine) by hybridizing the SVM classifier with the random forest classifier (Random Forest, RF) used as the auxiliary. Specification of the classification decisions obtained on the basis of the SVM classifier is performed for the objects located in the experimentally determined subareas near the hyperplane separating the classes and including both correctly and erroneously classified objects. In the case of

improving the quality of the objects classification from the initial dataset, the proposed hybrid approach to the objects classification can be recommended for classification of new objects. When developing the SVM classifier, the fixed default parameters values are used. A comparative analysis of the classification results obtained during the computational experiments in the hybridization of the SVM classifier with two auxiliary classifiers – the random forest classifier (RF classifier) and the k nearest neighbor classifier (kNN classifier), for which the parameters values are determined randomly, confirms the expediency of using of these classifiers to increase the SVM classification quality. It was found that in most cases, the random forest classifier works better in terms of improving the SVM classification quality in comparison with the kNN classifier.

Keywords: intelligent classification algorithm; SVM algorithm; k-nearest neighbors algorithm; random forest algorithm; support vector; kernel function; kernel function parameter; regularization parameter; hybridization.

PAPER 275

Comparative Research of Random Search Algorithms and Evolutionary Algorithms for the Optimal Control Problem of the Mobile Robot

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An experimental comparison of evolutionary algorithms and random search algorithms for the optimal control problem is carried out. The problem is solved separately by several representatives of each type of algorithms. The simulation is performed on a mobile robot model. The

results of each algorithm performance are compared according to the best found value of the fitness function, the mean value and the standard deviation.

Keywords: evolutionary algorithms; random search algorithms; optimal control.

PAPER 277

A Novel Hybrid Method of Global Optimization Based on the Grey Wolf Optimizer and the Bees Algorithm

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A new hybrid evolutionary algorithm based on the Grey wolf optimizer and the Bees algorithm is proposed. Embedded hybridization allows combining the strengths of original methods. A comparative analysis of the new hybrid method is performed on benchmark functions.

Keywords: evolutionary algorithms; hybrid algorithms; Bees algorithm; Grey wolf optimizer.

PAPER 282

A Genetic Approach for Auto-Tuning of Adaptive Fuzzy PID Control of a Telescope's Tracking System

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This paper devotes to design of Fuzzy Adaptive PID position Controller of servo drive of telescope's axis to tracking space objects with high accuracy. Suggested method automatically adjusts membership functions and control rules of fuzzy controller using an evolutionary algorithm. Finally, simulation and experimental results demonstrate that presented controller is effective in high-precision control due to elimination of stepping mode that may be occur in multi-mass system with nonlinear friction torque at very low tracking speed for space objects.

Keywords: fuzzy control; motion control; genetic algorithm; PMSM; angular speed control; telescopes.

PAPER 284

A Self-tuning Multiobjective Genetic Algorithm with Application in the SVM Classification

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In this paper we suggest the self-tuning multi-objective genetic algorithm (STMGA) based on the NSGA-II. This new algorithm is aimed to im-

prove the SVM classification quality. The quality classification indicators such as overall accuracy, specificity, sensitivity and a number of support vectors represent the objective functions in the STMGA. The ways for realizing the self-tuning of the such STMGA parameters as the crossover probability, the crossover distribution index and the mutation distribution index have been proposed and investigated. The considered STMGA is more flexible in the context of selecting its parameters' values and allows to refuse from the use of the parameters' values which are set manually. In the case of the radial basis kernel function used for the SVM classifier development, the STMGA finds the Pareto-front of such parameters values as the regularization parameter value and the Gaussian kernel parameter value which give the best values in the chosen set of the classification quality indicators. The experimental results obtained on the basis of the model and real datasets of loan scoring, medical and technical diagnostics, etc. confirm the efficiency of the proposed STMGA.

Keywords: classification; SVM algorithm; genetic algorithm; NSGA-II; self-tuning algorithm

PAPER 289

Distribution of Roles in Groups of Robots with Limited Communications Based on the Swarm Interaction

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The paper is aimed at the problem of the distribution of roles in groups of robots with limited communications and based on the principles of the swarm intelligence. The iteration approach to the distribution of roles in a group of robots is proposed. There are results of the study and computer simulation of the proposed approach.

Keywords: swarm intelligence; distribution of tasks; distribution of roles; group of robots.

PAPER 291

Using the Ensemble of Deep Neural Networks for Normal and Abnormal Situations Detection and Recognition in the Continuous Video Stream of the Security System

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It is suggested to use the ensemble of deep neural networks to design an intellectual situation classifier that solves the problem of normal and abnormal situations detection and recognition in a continuous video stream of the security system. The testing of its work was made on the basis of modern hardware and software and computer vision methods, the result of which is the classification probabilities for each video fragment. A software module in Python was created for normal and abnormal situations detection and recognition.

Keywords: recognition; classification; normal and abnormal situation; deep neural network; video stream.

PAPER 301

An Online Priority Configuration Algorithm for the UAV Swarm in Complex Context

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Collision avoidance problems of a swarm of unmanned air vehicles (UAVs) flying in an obstacle-laden environment are investigated in this paper. Given that the UAV swarm needs to adapt to the obstacle distribution in dynamic operation, a priority configuration is designed to guide the UAVs to pass through the obstacles in turn. Based on the collision cone approach and the prediction of the collision time, a collision evaluation model is established to judge the urgency of the imminent collision of each UAV, and the evaluation result is used to assign the priority of each UAV to further instruct them going through the obstacles in descending order. At last, the simulation results provide the promising validation in terms of the efficiency and scalability of the proposed approach.

Keywords: UAV swarm; collision avoidance; complex environment; online priority; collision cone.

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PAPER 316

The Crossover Operator of a Genetic Algorithm as Applied to the Task of a Production Planning

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In this paper we propose using a genetic crossover operator for the task of detecting the optimal queue of a product parts. We performed a literature review on the problem and defined the goal of this work. An offered crossover operator is presented in a formalized way. Based on this operator was developed the optimizing software. Comparative analysis of the developed software and the existed solution was performed.

Keywords: planning; genetic algorithms; crossover.

PAPER 319

Construction a Neural-net Model of Network Traffic Using the Topologic Analysis of Its Time Series Complexity

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The dynamics of data traffic intensity is examined using traffic measurements at the interface switch input. The wish to prevent failures of trunk line equipment and take the full advantage of network resources makes it necessary to be able to predict the network usage. The research tackles the problem of building a predicting neural-net model of the time sequence of network traffic. Topological data analysis methods are used for data preprocessing. Nonlinear dynamics algorithms are used to choose the neural net architecture. Topological data analysis methods allow the computation of time sequence invariants. The probability function for random field maxima cannot be described analytically. However, computational topology algorithms make it possible to approximate this function using the expected value of Euler's characteristic defined over a set of peaks. The expected values of Euler's characteristic are found by constructing persistence diagrams and computing barcode lengths. A solution of the problem with the help of R-based libraries is given. The computation of Euler's characteristics allows us to divide the whole data set into several uniform subsets. Predicting neural-net models are built for each of such subsets. Whitney and Takens theorems are used for determining the architecture of the sought-for neural net model. According to these theorems, the associative properties of a mathematical model depend on how accurate the dimensionality of the dynamic system is defined. The sub-problem is solved using nonlinear dynamics algorithms and calculating the correlation integral. The goal of the research is to provide ways to secure the effective transmission of data packets.

Keywords: computational topology; persistence; stability; neural network.

PAPER 338

Modified Recognition Algorithms Based on the Construction of Models of Elementary Transformations

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This paper deals with the issues of building a model of recognition algorithms targeted at classifying objects in conditions of high dimensionality of the feature space. A model of recognition algorithms based on the estimate calculation has been considered as the source one. The distinctive features of the approach under consideration are as follows: 1) forming subsets of correlated features; 2) selecting a set of representative features when developing recognition algorithms; 3) building models of elementary transformations in the subspace of representative features. The main advantage of the proposed algorithms is the selection of the preferred models of elementary threshold rules with the subsequent calculation of the object membership estimate and ensuring a significant reduction in the number of computational operations when recognizing unknown objects. This characteristic is very important for real-time recognition systems. To test the operability of the proposed model, experimental studies have been carried out in solving a number of problems; in particular, model problems have been generated in the space of correlated features; as well as facial recognition tasks. These experimental studies considered: a model of recognition algorithms based on the estimate calculation; a model of recognition algorithms based

on the potential function; the proposed model of recognition algorithms. A comparative analysis of the above models of recognition algorithms shows that the proposed model allows increasing the recognition accuracy by an average of 7-10%. The developed recognition algorithms can be used in medical and technical diagnostic, geological forecasting, biometric identification and other areas, in which solving problems of classification of objects specified in the high dimension feature space.

Keywords: pattern recognition; features' correlation; subsets of strongly correlated features; representative feature, elementary transformation model.

PAPER 339

Python Package for the Network Operator Implementation and its Application for Group Control System Synthesis Problem

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One of the main problems of symbolic regression methods is how to encode mathematical expressions to make the structure concise and readable. Here we address to the problem of network operator's matrix scarcity, which we resolve using python's standard types. Our approach allows to get rid of zero elements bellow the main diagonal. Moreover, we introduce new parametric variation, which helps us to tune parameters during structural evolving.

We provide a description of the network operator and algorithms for finding the optimal solution using the principle of small variations of the basis

solution. Our new encoding scheme and the complex functional for the group control task then described.

In the experimental part we introduce a new way to apply network operator with a variable number of arguments to the group control system synthesis problem. Along with this we use for the first time individual network operators for each robot. From the experiment we can see that provided tricks lead to results that are not inferior in the case of usual network operator shared by all robots.

Keywords: control synthesis; python library; symbolic regression; optimal control; mobile robot.

PAPER 340

Methods of a Heterogeneous Multi-agent Robotic System Group Control

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The paper presents the implementation of the high-level decentralized control system for a group of mobile robots (MR), which provides a common information space in a group, and performs decomposition of the main task (task from operator) and generates subgroups on the basis of agents' functional purpose.

Keywords: robotics; robot group; distributed control system; neural network; cloud technology; common information space.

PAPER 341

Problem of Cost Function Synthesis for Mobile Robot's Trajectory and the Network Operator Method for its Solution

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In mobile robotic systems are designed for patrolling and protecting large areas, in difficult conditions, when environmental constraints severely limit the space of acceptable motions preferences, a state space sampling strategy is more effective, than sampling in the space of controls. Although this has been evident for some time, the practical question is how to achieve it while also satisfying the severe constraints of vehicle dynamic feasibility. The paper presents a new the network operator method for state space sampling utilizing a model-based trajectory generation approach

Keywords: synthesis; trajectory generation; mobile robots.

PAPER 342

Robotic Solutions for Arctic Transit Corridor Cargo Autonomous Undersea Vehicles

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The development of regular navigation through the Arctic Ocean transit transport corridor from Southeast Asia to Western Europe can provide economic advantages comparable in importance with the construction and operation of the main canals between the oceans – the Suez and Panama. Cost-effective year-round navigation on the northern transport corridor is possible with an undersea (under-ice) scheme of cargo delivery. The construction of reinforced concrete Cargo Autonomous Undersea Vehicles (CAUVs) and the lighter transportation scheme allow solving technical and economic problems. The complicated scheme of undersea transportation gives birth to a new class of ships and raises a number of unsolved technical tasks. Among them are the loading of lighters on CAUVs, the formation of CAUVs trains and the locomotion control tasks. All these tasks require control of a large number of parameters and are complex for humans. Robotic CAUVs are regarded as an option of choice to deal with these control tasks.

Keywords: The Arctic Ocean; transit corridor; CAUVs; reinforced concrete; DNN; RL.

PAPER 343

Evolutional Methods for Creating Artificial Intelligence of Robotic Technical Systems

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This paper considers evolutionary methods of symbolic regression for the creation of artificial intelligence of robotic systems. Methods of symbolic regression are reviewed and the features of

their application to the solution of the problem of synthesis of control of robotic systems are indicated. The measure of the complexity of artificial intelligence is determined and the advantage of using the principle of small variations of the basic solution is shown, while creating intelligent control systems. A method of variational analytic programming is described and an example of its use for the synthesis of intellectual control is given.

Keywords: artificial intelligence; evolutionary computations; symbolic regression methods; genetic programming.

model parameters (like push-out and retrial probabilities). Special areas of loads are found, where the model locks itself up for secondary customers or follows linear loss law as well. A detailed comparison is made with the case of preemptive priority, which was studied by the authors earlier.

Keywords: queuing systems; retrial queuing system; randomized push-out mechanism; non-preemptive priority; generating functions; loss probability

PAPER 344

Retrial Queuing System with Randomized Push-Out Mechanism and Non-Preemptive Priority

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A single-server retrial queueing system with finite buffer size, Poisson arrivals, an exponentially distributed service time is considered. If an arriving customer finds the queue completely occupied, it joins a special retrial waiting group (named orbit) in order to seek service over again after some period of time which have exponential distribution. The primary customers take non-preemptive priority over secondary customers. We also introduce so-called randomized push-out buffer management mechanism. It allows you push secondary customers out of the system to free up space that could be taken by primary customers. It is shown that such a queueing system can be reduced to analogous model without retrials. Using generating function technique, the loss probabilities for both types of customers are obtained. Theoretical results allow to investigate the dependency of loss probabilities on the main

ELEMENTS OF INTELLIGENT CONTROL SYSTEMS

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PAPER 159

Generalized Information Content based on Variability Map for Exploratory Landscape Analysis of Global Optimization Problems

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Exploratory Landscape Analysis methods were developed to assess a variety of characteristic features of optimization problems, namely objective function features. These methods are widely used to distinguish and classify problems with respect to calculated vector of features in order to deeply explore optimization algorithm's behavior. Results of the most landscape analysis methods depend on a sample of design points and corresponding objective values representing a discretized landscape of objective function. The Information Content of Fitness Sequences method being relatively stable to sampling methods variations additionally requires sample ordering. The paper introduces a new generalized approach to information content analysis based on aggregated variability map of function's landscape. It gives more accurate and robust results without any ordering algorithm needed based on points generated by a chosen sampling method.

Keywords: optimization algorithm; optimization problem; exploratory landscape analysis; information content of fitness sequences; characteristic features; variability map.

PAPER 167

Intelligent Analysis of Biomedical Signals for Personal Identification and Life Support Systems

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The development of instruments and automatic biomedical signals analysis systems is associated with creation of high-tech software that implements modern methods of pattern recognition and artificial intelligence. In this paper, we considered three problems connected with intellectual analysis of biomedical signals. A developed means of identifying a person using only one standard electrocardiographic lead is presented. New algorithms for recognition of several classes of dangerous arrhythmias have been developed and investigated in order to prevent catastrophic events in the course of continuous monitoring of the patient's state by ECG. This study also describes a method and an algorithm for automatic estimation of the anesthesia depth by the parameters of the approximated entropy of the EEG signal. The results of the work are used in the design of intelligent biomedical systems.

Keywords: intelligent systems; recognition of biomedical signals; biometric identification; electrocardiogram; electroencephalogram; anesthetic depth estimation.

PAPER 173

Algorithm for the Development of a Training Set that Best Describes the Objects of Recognition

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This work is a part of the research aimed at developing an algorithm for classifying a family of partial precedence that allows us to evaluate the generalizing ability of the algorithm in the process of its synthesis from empirical data and to manage this process. One of species of tulip has been chosen as an object of research. This process is carried out via morphological features of tulip. The information about tulip is obtained from Central herbarium of the institute of Botany of Uzbek Academy of sciences.

Keywords: pattern recognition; algorithm of partial precedents; classification; training set; etalon objects; supervised learning; unsupervised learning; TulipaL.

PAPER 177

Class Reconstruction in the Space of Natural System Classification

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The article deals with the method of natural system classification developed within the paradigm of open systems physics. The method reveals the

system ontology of classes by empirical description. Using this method we solved four classification tasks from different knowledge areas: toxicology, semiconductor manufacturing, numbers recognition, biology. For each dataset automatically were obtained: reconstructions of natural system-conditioned features of each class; reconstructions of intensional components; ideal representatives of classes; borders of class areas and referent distribution by class areas.

Keywords: physics of open systems; system ontology; natural classification; big data; archetypes; prototypes.

PAPER 196

Protozoa Behavior Reproduced by the Combination of Genetic Optimization and Learning

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The article is dedicated to the reproduction of behavior of a class of protozoans (ciliates) using computer simulation and genetic optimization. Protozoans have minimal cognitive abilities and no neural system. The only basis of their control system is mRNA and protein systems inside the cell. Ciliates have primitive sensitive receptors which can percept information only from the closest environment. But, nevertheless, unicellular organisms use their cognitive capacities for obstacles avoiding. In this paper, ethology of ciliate *Uronychia transfuga* is reproduced using a simple GasNet neural network and genetic optimization. It is showed that neural network of only 7 neurons combined with simple learning model is enough to achieve robust and natural behavior.

Keywords: genetic algorithm; GasNet; neural networks; unicellular organisms; ciliate; ethology; learning.

PAPER 209

Problems of Design of the Generalized Power Module for Control Systems of Solar Installations

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The work is devoted to the development of solar battery control systems regarding design of the block that is responsible for accumulation in rechargeable batteries and redistribution of the developed electric power. The research of the solar installations applied today was conducted. The solution in the form of the module of the generalized power supply system for realization with use of programmable logical integrated circuits of new generation is proposed. Received decisions are supposed to be used in knowledge base of intelligent solar panels control systems.

Keywords: solar battery; control system; module of power supply of the solar panel.

PAPER 211

An Adaptive Control of the Board Oscillations of Onboard Radio-electronic Equipment in the Resonant Mode

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In the article the features of dynamic plate bending, as a basis of printed board assemblies of on-

board radio-electronic equipment, with its resonance oscillations and various fixing conditions, are analyzed. Application features of the bending mode for solving the problem of radio elements placing on the plate field are considered. Methods for obtaining the eigenmodes of the plate by mathematical and experimental methods are described. An idea of adaptive control of oscillations of the plate in the resonant mode is proposed.

Keywords: vibration; radio-electronic means; printed circuit boards; resonance; plates.

PAPER 212

Multi-project Scheduling: Multicriteria Time-cost Trade-off Problem

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Managers of multiple projects with overly constrained resources face difficult decisions in how to allocate resources to minimize the average delay per project or the time to complete the whole set of projects.

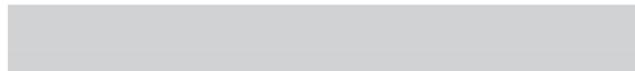
Our offer includes two stages decomposition approach for multi-project scheduling. The first stage of the approach aims to define the projects as aggregations. Each aggregation is determined by solving a resource availability cost problem (RACP) model to complete the project by his critical path. In the second stage, aggregations are used for its resource leveling scheduling to complete the multi-project by a pre-specified project duration. Both stages use priority rule (PR) heuristics. Both stages are based on two parallel schedule generation schemes (SGS) and resource criteria. Each SGS uses two PR. The first SGS, a set of demands must be developed as initial solution. The solutions obtained by the first SGS algorithm with the best resource allocation rule are

used as a baseline to compare those obtained by the latter. The second, the initial solution must be optimized. The visualized results of the offered methodology are given.

Keywords: multi-project management; multi-project scheduling; resource constraints; project aggregation; schedule generation scheme; priority rule; root-mean-square deviation; ranking methods.

learning algorithms for stratigraphy boundaries classification based on geophysics logging data for uranium deposit in Kazakhstan. Correct marking of stratigraphy from geophysics logging data is complex non-linear task. To solve this task we applied several algorithms of machine learning: random forest, logistic regression, gradient boosting, k – nearest neighbour and XGBoost.

Keywords: stratigraphy; classification; machine learning; uranium deposit; geophysics logging data.



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PAPER 158

Machine Learning Algorithms for Stratigraphy Classification on Uranium Deposits

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Machine learning today becomes more and more effective instrument to solve many particular problems, where there are difficulties to apply well known and described math model. In other words - it is a great tool to describe non-linear phenomena. We tried to use this technique to improve existing process of stratigraphy, and reduce costs on site by applying computer leded predictions on the basis of existing on-field collected data. Article describes usage of machine

PAPER 217

Stability-based Hierarchical Clustering of Cases in the Intelligent IT-consulting System Based on Semantic Integration with the Ontology

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Stable clustering is a very desirable property for the dynamical knowledge base consisting of cases indexed through the domain ontology both because the cases are constantly added to the knowledge base, and the ontology structure can be revised from time to time. An approach has been developed for the stable hierarchical clustering of cases based on their semantic integration with the domain ontology. Two variants of dimension reduction are compared: principal component extraction and unsupervised feature selection. As a criterion of stability, it is proposed to use the maximum eigenvalue of the matrix of cophenetic correlations. Studies are carried out on the basis of resampling with continuous weights drawn from lognormal distribution. As a result, it was revealed that the clustering stability decreases with increasing the number of principal components. The optimal number of components

can be chosen on the basis of a trade-off between the stability and the percentage of the explained variance. By unsupervised selection the subset of concepts is significantly reduced. Based on the practice of IT consulting, dendrograms of cases on the initial semantic data matrix and on the principal components were constructed and interpreted.

Keywords: case-based reasoning; ontology; hierarchical cluster analysis; dendrogram; stability; principal component analysis; feature selection.

PAPER 235

The Application of Hardware-in-the-Loop (HIL) Simulation for Evaluation of Active Safety of Vehicles Equipped with Electronic Stability Control (ESC) Systems

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Automated vehicles are one of the most popular trends of modern R&D in the automotive industry. However autonomous driving is impossible without such electronic systems as Anti-Lock Braking System (ABS) and Electronic Stability Control (ESC). Development, adaptation, setup and debugging of mentioned systems require a large amount of field tests. The application of modern real-time simulation technologies based on Hardware-in-the-Loop (HIL) simulation allows to decrease the number of field tests. The paper is dedicated to the development and validation of a HIL test bench for virtual real-time testing of the GAZ Group light commercial vehicles equipped with ESC systems.

Keywords: Hardware-in-the-Loop; HIL; light commercial vehicle; LCV; electronic stability control systems; ESC; simulation; real-time PC; Matlab/Simulink.

PAPER 242

Electrical Energy Consumption Prediction is Based on the Recurrent Neural Network

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The results of forecasting of electric energy consumption based on recurrent neural network model. When developing the model, the following dominant factors were taken into account: data on energy consumption over the forecast period; meteorological factors (air temperature, cloudiness, amount of precipitation, wind speed, length of daylight, etc.); date (day, month); data of production calendars (information on the day of the week: weekday / weekend / holiday / shortened); specificity of the industry in the district under consideration (combining statistical information on major centers of federal districts). The factors were selected on the basis of test runs through the neural network of fixed configuration. The relevance of the study is explained by the practical importance of searching for the most accurate methods for predicting the main parameters of the Russian energy market, when a large error of the forecast subject to more expensive tariffs. The constructed recurrent neural network has yielded more accurate prediction results than the widely used mathematical prediction models based on regression dependencies. The obtained scientific result will help to reduce costs and increase the energy efficiency of the electro-energy subjects in the wholesale electric energy and capacity in Russia.

Keywords: neural network; neural forecast; recurrent neural network; RNN; power industry.

PAPER 246

Heart Rhythm Intelligent Monitoring Algorithm for the Atrial Fibrillation Episodes Detection in the Telemedicine System

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A method and algorithm for intelligent monitoring of heart rhythm for atrial fibrillation episodes detection for the systems of patient's state continuous remote control in real-time mode was developed. For atrial fibrillation episodes detection in the patient's vital activity state the complex of diagnostically significant indexes reflecting the dynamics of patient's atrial rhythm abnormality was formed: heart rhythm frequency, irregularity of heart rhythm, absence of P wave and appearance of f wave in the ECG signal. They are evaluated step by step depending on patient's state changes. The experimental research of suggested algorithm has shown the accuracy of atrial fibrillation episodes detection no less than 94%. The developed method and algorithm provide the high efficiency of continuous remote control of patient's health with heart rate abnormality.

Keywords: heart rhythm; intelligent monitoring; atrial fibrillation episodes; telemedicine system.

PAPER 254

Violation Detection in Heterogeneous Events Streams

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Violation detection at production facilities is a vital task, especially for critical infrastructures. Nowadays, many monitoring sensors of different types are used for the event collection. These sensors often provide a data in different format making thus complex analysis of such data more difficult. This paper suggests an approach for such data analysis, its distinctive feature is grouping events and application of an individual classification method to each group. The suggested approach is demonstrated by its application on real data within continuous time period.

Keywords: violations; violation detection; classifiers; data group; data subsets; attributes.

PAPER 255

Training Normal Bayes Classifier on Distributed Data

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The paper describes an approach to parallelization of Normal Bayes classifier training algorithm for distributed data. In the process of distributed data analysis and the algorithm performance, the results fail to join properly. Due to this, the algo-

rithm is to be performed in a distributed manner. For this purpose, we use representation of the algorithm as a sequential composition of functions. The algorithm is parallelized to work with data distributed horizontally and vertically. This allows placing parallel functions of the algorithm at data nodes. Experiments show that transfer of computations to sources allow to decrease training time and network traffic. We implement the algorithm variants as an extension of the industrial-strength Java-based library Xelopes.

Keywords: data mining; normal bayes classifier; distributed data mining; distributed data; big data.

PAPER 256

The Method of Smart Monitoring and Detection of Sleep Apnea of the Patient out of the Medical Institution

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The work presents a set of significant indicators and a method of detection of sleep apnea episodes based on the cardiovascular and respiratory systems' state analysis by ECG signal, pulse wave signals and respiratory movements signals. The algorithms of biological signal processing based on wavelet analysis for studying the dynamics of indicators important for diagnosis in time and spectral range, an algorithm for detecting apnea episodes, which allows to differentiate sleep apnea of central and obstructive type, are given. The proposed algorithms are based on the method of smart monitoring of sleep apnea, which allows to identify episodes of sleep apnea during the patient's stay outside the hospital.

Keywords: method of intelligent monitoring; sleep apnea; out-of-hospital; wavelet analysis; biomedical signals.

PAPER 262

Visual Explorer of Multivariate Data

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We present a system for visual exploration of multivariate data. The system allows one to choose two sets of two variables, visualise corresponding projections of the data on two panels (left and right) and interactively explore relations between structures revealed on the left pane and corresponding points on the right pane. Case study example related to the complexity of orbits in the free-fall equal-mass three-body problem is given.

Keywords: data analysis; information visualization; data mining.

PAPER 271

Development and Research of Hand Segmentation Algorithms on the Image Based on Convolutional Neural Networks

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In recent years, one of the most important scientific task in robotics is research aimed at developing methods that ensure a safe interaction between a robot and a human. An important aspect of solving this problem is the need to find a solution that allows obtaining maximum recognition accuracy. At the same time, the latest achievements in deep learning open up new possibilities in solving the

task of object recognition. In this regard, the purpose of this work is to investigate the algorithms for recognizing human hands on the image, developed on the basis of deep convolutional neural networks.

Keywords: hand segmentation; convolutional neural networks; conditional random fields.

tions inside complex legal systems, which in turn could undermine their purposes. We consider that contradictions are the fundamental units to take into account when diagnosing a legal system, and we classify them into several kinds according to the system structure they affect. Finally, we point to the direction of research needed for the development of intelligent agents capable of targeting contradictions.

Keywords: multiagent; normative; computational tree logic; computational law; legal contradictions; intelligent agent; logical context

Session ID: TS3.3

October 23, 2018 / 13:00-15:00

PAPER 281

Towards the Formalization of Contradictions in a Legal Multiagent System

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As existing legal systems expand and become more complex, the search of effective ways to model them becomes increasingly important in the area of Computational Law. We chose normative multiagent systems (NMAS) to study the interaction between a legal framework, a set of agents and the fundamental theories that regulate the legal dynamics of a society. Using this approach in conjunction with Computational Tree Logic (CTL), we determined that there is an increasing possibility of encountering contradic-

PAPER 286

Towards automating the creation of OBDA systems

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In the paper, we consider automating the process of constructing and debugging ontology-based data access systems by using the information stored in external ontology resources. In particular, for the constructing stage, we propose to use a tool that suggests concepts from external repositories for those tables from a relational database, which haven't been matched with concepts from a domain ontology by ontology alignment techniques. For the debugging stage, we show how a tool for navigation in a collection of ontologies can be used to simplify SPARQL query writing by generating lacking parts of query thus enhancing ontology engineer's productivity. The proposed approaches have been implemented and used in our system, named Reply, which transforms traditional information systems into intelligent systems with a natural language query interface.

Keywords: ontology-based data access; ontology enrichment; reusable ontologies; sparql; query rewriting.

PAPER 295

Model of a Prospective Digital Platform to Consolidate the Resources of Economic Activity in the Digital Economy

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Within the framework of the development of the national economy is considered the model of a digital platform that ensures interoperability of autonomous control systems of subjects of economic activities – federal, regional, institutional, commercial and other organizational systems. The relevance of such a model is driven by the need to solve economic tasks on the subject of consolidating the productive resources of economic agents. This model underlies the systemic and technical solutions for building and operation of a promising digital platform. These solutions were created by authors with a view to their implementation on the basis of technologies for processing large data, artificial intelligence and machine learning. Their effect is to increase productivity of organizational systems operating using the digital platform.

Keywords: digital platform; organizational systems; control systems; information systems; interoperability; performance.

PAPER 313

Intelligent Decision Supporting System of Rescue Equipment Using in Case of a Threat of a Temporary Inundation of a River Displacement Vessel

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The questions of constructing an intelligent support system for the acceptance by the captain of a river displacement vessel of a decision on the readiness for the use of standard technical means for saving passengers and crew in the event of a threat of a fleet flooding of a ship are considered.

Keywords: displacement vessel; swimming safety; proactive monitoring; fleeting accident; support system for the acceptance.

PAPER 324

Toward High Performance Solutions as Services of Research Digital Platform

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The issues of offering services for providing resources of high-performance hybrid computer systems in applied and fundamental research within the framework of a unified digital platform are considered. Approaches for providing parallel execution of various tasks in a distributed computing cluster are proposed. The problems of organization of the computing process in the joint use of computing resources of a distributed

hybrid cluster and organization of network interaction using software-defined networks are formulated.

Keywords: high performance computing; cluster; digital platform; virtualization; computational process control; distributed computing; parallel computing; software-defined network; graphics accelerator.

PAPER 326

An Ontology-based Approach to Support for Requirements Traceability in Agile Development

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The paper proposes an ontology-based approach to support for requirements traceability in Agile development. The task of supporting the requirements traceability in a software development project is considered as a part of requirements engineering process. A brief overview of the benefits of requirements traceability usage is given. The expediency of using the ontology-based approach to support for requirements engineering, requirements traceability in particular, is shown through the analysis of scientific publications. OWL ontology is chosen to support the requirements engineering process. The ontology is implemented in the Protégé environment. The developed ontology takes into account particular qualities of working with the requirements in Agile projects, accumulates knowledge about the requirements types and requirements artefacts, enables tracing the relations between them.

Keywords: ontology; requirements traceability; agile development.

PAPER 331

Smart City Platform Architecture for Citizens' Mobility Support

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Nowadays cities provide a huge amount of information that can be used not only for city management but also to support citizens. To give proactive and relevant support, services should have access to the gathered information from the corresponding sources. The paper proposes a platform architecture to connect information sources with services through shared knowledge base or directly using the description of the services from the knowledge base. In addition to information and services registry the platform provides facilities to create and manage user profiles – digital identities. Services use these profiles to provide personalized support based on his/her preferences. Also, paper proposes a possible use case of the platform based on driver support. It describes types of information used for support personalization, possible services used as information sources as well as the way of communication between driver and services over the proposed platform.

Keywords: smart city; architecture; Internet of things; digital identity; mobility.

PAPER 333

Implementation and Analysis of Distributed Relaxed Concurrent Queues in Remote Memory Access Model

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Remote memory access (RMA) technique is a very attractive way for improving efficiency of high-performance computations (HPC) and simplifying parallel program development. However, coming up with efficient concurrent data structures for distributed environments with deep hierarchy, such as computer clusters and data centers, is challenging. We propose a novel approach to design distributed concurrent data structures. The core idea behind the approach is relaxation of the order of executed operations. For example, a relaxed priority queues only requires the elements returned by delete-min operation to be sufficiently close to the minimum. Similarly, in a relaxed queue or stack, the removed elements are close to the first or the last one, respectively. There are multiple evidences that, on most workloads, relaxed data structures outperform data structures with strict semantics and ensure acceptable degrees of operation reordering. In this work we approve our approach on the example of a distributed queue, evaluate its efficiency and compare it with the other implementations of distributed lists.

Keywords: relaxed distributed queues; relaxed concurrent data structures; scalability; remote memory access; RMA; MPI.

Session ID: TS3.4
October 24, 2018 / 10:00-12:00

PAPER 195

Selfish General Intelligence

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In this paper, we attempted to formulate a complete minimal list of properties corresponding to human-level intelligent systems.

Intelligence was presented from the algorithmic point of view and considered as the ability to generate fundamentally new compression algorithms. Consciousness was studied as an important property of an intelligent system. The approach to consciousness as a mechanism for integrating information from three components was proposed. Also, emergent generation of fundamentally new algorithms was suggested. It was shown that the intelligent system should consist of separate self-organizing parts. This approach to the evaluation and development of human-level intelligence is called Selfish General Intelligence (SGI). The four proposed postulates of intelligence could help to clarify the understanding of AGI.

Keywords: selfish general intelligence; artificial general intelligence; Kolmogorov complexity; consciousness; self-organization; compression algorithm; autonomy; agent.

PAPER 345

Modeling of Interaction in Command-Information Systems with Dynamic Replicas

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In this paper we introduce an approach to describing the interaction of subscribers – carriers of sensors in information and reconnaissance systems. The approach is based on the use of a special class of graphs – dynamic graphs, defined as a sequence of «classical» static graphs, the transition between which is carried out by various graph operations (deleting / adding an edge, deleting / adding a vertex, replacing the vertex with a seed, priority joining vertices and edges, and etc.). The paper also formulated the task of forming an optimal topology in the network of subscribers – information and reconnaissance systems, taking into account the dynamics of communications between subscribers. Specific cases of the problem and their solutions are described, in which heredity is observed, i.e. the preservation of the solution with specified deviations in conditions of changing communications between subscribers of the network.

Keywords: information and reconnaissance systems; dynamic graphs; networks.

PAPER 240

Non-invasive Method of Intelligent Sensory Control of Hands' Motor Functions for Bionic Systems

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Nowadays actual are the studies that are oriented on discovery and understanding of muscles' motion control mechanisms on the part of motor brain divisions. The appropriate information can be used as the base for the creation and improvement of technical objects, bionic systems including. The authors propose a non-invasive method of intelligent sensory control of hands' motor functions allowing studies of descending integrative activity of the brain's central structures that is directed to moto-neurons and muscles. The paper reviews medical, technical, informational and mathematical foundations of the method and shows the results of its application.

Keywords: non-invasive method; sensory control; time-series analysis; SSA-method; method of principal components; bionic system; limbs prosthetics.

PAPER 245

Applying eye tracking in information security

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In this paper, we are considering the possibility of using eye tracking technology in the context of information security. We expect that this novel technique will have a very effective impact in this field. Eye tracking technology is widely used to investigate user behavior when working with a computer. This technology allows to obtain analysis in the form fixation point (location of a user's eye gaze), scan-path (gaze trajectory), heat maps (areas of interest), salient picture components. Eye tracking research has been widely used to improve the design and usability of web pages, as well as to explore an understanding how users are guided by them. Moreover, this technology is widely used in the protection of information.

Keywords: eye tracking; data security; gaze tracker; identification; electronic documents; security policy.

PAPER 259

Some Methods of Solving the NP-difficult Problem of Optimal Schedule for the University

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The task of an optimal scheduling of training sessions is a combinatorial type problem, and its characteristic feature is a large dimension. In addition, the task is complicated by the presence of a large number of complex shape constraints. At present, there are no universal methods for solving such problems. Classical scheduling theory includes only a narrow circle of well-formalized problems that are usually reduced to the task of a salesman, transportation, etc. Direct application of the methods to the problem of scheduling training sessions is not possible. However, there are a number of heuristic and brute force methods that are quite amenable to programming.

This article presents an analysis of some existing approaches to solve the problem of scheduling such as: replacement method, graph coloring method, intelligent method, genetic algorithm. The advantages and disadvantages of each of them are highlighted. It is concluded that the problem of scheduling refers to the class of discrete optimization with a finite set of alternatives. The task of scheduling is complicated by multi-criteria. It is concluded that it is necessary to apply an integrated approach that takes into account the advantages of the considered methods of this work to solve the problem.

Keywords: method of substitution; method to color the vertices of the graph; intelligent method; genetic algorithm; small variations of the optimal schedule.

PAPER 296

Hold-in, Pull-in and Lock-in Ranges for Phase-locked Loop with Tangential Characteristic of the Phase Detector

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In the present paper the phase-locked loop (PLL), an electric circuit widely used in telecommunications and computer architectures is considered. A new modification of the PLL with tangential phase detector characteristic and active proportionally-integrating (PI) filter is introduced. Hold-in, pull-in and lock-in ranges for given circuit are studied rigorously. It is shown that lock-in range of the new PLL model is infinite, compared to the finite lock-in range of the classical PLL.

Keywords: capture range; hold-in range; pull-in range; lock-in range; nonlinear analysis; phase-locked loop; PLL.

PAPER 306

Computer and Experimental Modelling of Heat Leakage from Porous Substrates of LED Lighting Devices

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In this paper we propose a mathematical and physical model of a porous substrate, evaluate influence of the pores size and quantity on the substrate's specific surface and present experimental results of the heat leakage kinetics by the porous substrate. Performances of the porous aluminium oxide printed circuit board with the record heat conductivity of 120 W/mK are presented.

Keywords: LED lighting device; porous substrate; physical model; printed board; heat conductivity.

Knowledge Company: Approaches to Assessing New Knowledge and Representation it to Society

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The article examines the main approaches and methods for assessing new knowledge, examining by how the corporate value is created. In this regards, the authors investigate into monetary and non-monetary aspects, considerations of valuation models. In the article is also described the analytical approach (scientific theory) that requires preliminary neurocognitive and behavioral analysis, which is connected with the four of human brain centers (reptilian, palaeolimbic, neolimbic and prefrontal), which are used in decision-making process, and in evaluating process of knowledge potential. The role and place of a new tool – integrated reporting in the representation and development of a knowledge-intensive company – is traced as well.

Keywords: new knowledge; knowledgeable company; corporate value; neurocognitive and behavioral analysis; cognitive systems; integrated reporting.

Special Technical Session for Young Researches will be held on October 29-30, 2018.

The duration of each presentation is up to 10 minutes plus 5 minutes for questions.

Accepted file formats for all presentations are PDF and PPT.

Technical Session 1. Methods for Intelligent Control Systems

Date: 29 October 2018, (Mon)

Room: 2115

Time	Author	Title
<i>10:30</i>	Camille Mukeshimana	Processing Data from Industrial Mobile Agent Sensors for Successful Navigation in Space Using a Fuzzy Inference Machine
<i>10:45</i>	Mustafa Ahmed Bador Mahhamed	Algorithmic Support for the Modification of some Design Elements of the Drawings of Design Details with their Parametric Change
<i>11:00</i>	Evgeniy Shklyar, Evgeniy Vorobiev, Maxim Saveliev	Recognition of the Keystroke Dynamics in a Browser
<i>11:15</i>	Vladislav Shevsky	One Approach to Optimizing Database Queries
<i>11:30</i>	Dmitriy Eremenko	Minimal Algebras of Binary Operations of Rank 3
<i>11:45</i>	Almahrouq Muhib Mahmoud Ismael	Image Encoding and Decoding
<i>12:00</i>	Ali Salem	Encoding Image Using Regular Arrays
<i>12:15</i>	Elisey Cherednichenko, Maxim Saveliev, Evgeniy Vorobiev	Multi-agent Systems and their Applications

Technical Session 2. Elements of Intelligent Control Systems

Date: 30 October 2018, (Tue)

Room: 2115

Time	Author	Title
10:30	Maxim Avilov	Network Monitoring System and its Criteria for the Technical Cyber Defence Exercise
10:45	Artyom Filatov	Analysis of the Problem of Sensor Fusion for Autonomous Mobile Platforms
11:00	Anton Filatov	Map Merging in the Context of the Multiagent SLAM Problem
11:15	Danil Bogaevskiy	The Use of Graphics Processors for Image and Video Processing Tasks
11:30	Ivan Abrosimov	Electronic Digital Signature Scheme Based on a New Algebraic Carrier and a Congruence-logarithm Problem
11:45	Artyom Li	Designing Tools for Metaphorical Computing Using Cognitive CAD Systems
12:00	Sergey Moldachev	Content Delivery Network Based on Peer-to-peer Network

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