

Scientific and Research Center for
Information in Physics and Technique



Institute of theoretical and
experimental biophysics



Pushchino State Institute of Natural
Science



CPT2021

9th International Conference
«Computing for Physics and Technology - CPT2021»

November 08-12, 2021

**Institute of theoretical and experimental biophysics,
Russian Academy of Sciences, Pushchino, Moscow region,
Russia**

**Pushchino State Institute of Natural Science, Pushchino,
Moscow region, Russia**

**ANO «Scientific and Research Center for Information in
Physics and Technique», Nizhny Novgorod, Russia**

Conference Program

Organizing committee

Rotkov Sergey I. - Chairman of the Organizing Committee, Doctor of Technical Sciences, Professor, Head of the Department of NNGASU, Director of ANO «SRCIPT»

Berberova Maria A. - Deputy Chairman of the Organizing Committee, Candidate of Technical Sciences, Associate Professor of the Department of RTU MIREA, Researcher of ANO INSC, Deputy Director of ANO «SRCIPT»

Tiras Kharlampy P. - Deputy Chairman of the Organizing Committee, Candidate of Biological Sciences, Head of the ITEB RAS Training Center.

Organizing committee members:

Bugaev Alexander S. - Doctor of Physical and Mathematical Sciences, Professor, Academician of the RAS, Member of the Presidium of the RAS, Head of the Department of the - Honorary Chairman of the Conference;

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Galaktionov Vladimir A. - Doctor of Physics and Mathematics, Professor, Chief Researcher of the Keldysh Institute of Applied Mathematics RAS;

Massel Ludmila V. - Doctor of Technical Sciences, Professor, Head of the Laboratory of the Melentiev Energy Systems Institute of the Siberian Branch of the RAS, Professor of the Department of the Irkutsk National Research Technical University;

Mikhailuk Mikhail V. - Doctor of Physical and Mathematical Sciences, Professor, Head of the Department of the Federal State Institution «Federal Scientific Center Scientific Research Institute for System Research of the Russian Academy of Sciences», Professor of the Department of the Russian Technological University MIREA;

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Podvesovskiy Alexander G. - Candidate of Technical Sciences, Associate Professor of the Bryansk State Technical University,

Raikov Alexander N. - Doctor of Technical Sciences, Professor, Leading Researcher at V.A. Trapeznikov Institute of Control Sciences RAS, Professor of the Department of the Russian Technological University MIREA;

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Zakharova Alena A. - Doctor of Technical Sciences, Professor, Chief Researcher of the V.A. Trapeznikov Institute of Control Sciences RAS.

Program committee

Tolok Aleksey V. - Chairman of the Program Committee, Doctor of Technical Sciences, Professor, Chief Researcher of the V.A. Trapeznikov Institute of Control Sciences RAS, Head of the Department of MSUT «STANKIN»

Orlov Yuri N. - Deputy Chairman of the Program Committee, Doctor of Physical and Mathematical Sciences, Associate Professor, Associate Professor of the Department of the Moscow Institute of Physics and Technology (NRU), Head of the Department of the Peoples' Friendship University of Russia, Chief Researcher of the Keldysh Institute of Applied Mathematics of Russian Academy of Sciences.

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Galaktionov Vladimir A. - Doctor of Physics and Mathematics, Professor, Chief Researcher of the Keldysh Institute of Applied Mathematics RAS;

Govorunov Igor G. - Candidate of Biological Sciences, Head of the Department of the «State Scientific Center for Applied Microbiology and Biotechnology» Rospotrebnadzor;

Debelov Viktor A. - Doctor of Technical Sciences, Associate Professor, Head of the Laboratory, Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of RAS, Laureate of the USSR State Prize in Science and Technology;

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Mikhailuk Mikhail V. - Doctor of Physical and Mathematical Sciences, Professor, Head of the Department of the Federal State Institution «Federal Scientific Center, Scientific Research Institute for System Research of the Russian Academy of Sciences», Professor of the Department of the Russian Technological University MIREA;

Moiseev Vyacheslav I. - Doctor of Philosophy, Professor, Head of the Department of Philosophy of the A.I. Evdokimov Moscow State University of Medicine and

Dentistry;

Podvesovskiy Alexander G. - Candidate of Technical Sciences, Associate Professor of the Bryansk State Technical University;

Raikov Alexander N. - Doctor of Technical Sciences, Professor, Leading Researcher at V.A. Trapeznikov Institute of Control Sciences RAS, Professor of the Department of the Russian Technological University MIREA;

Rotkov Sergey I. - Doctor of Technical Sciences, Professor, Head of the Department of NNGASU, Director of ANO «SRCIPT»;

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Sigov Alexander S. - Doctor of Physical and Mathematical Sciences, Professor, Academician of the RAS, President of the RTU MIREA, Laureate of the State Prize, Prize of the Government of the Russian Federation in the field of science and technology, Honored Scientist of the RF;

Slobodyuk Evgeny A. - Candidate of Physical and Mathematical Sciences, Associate Professor of the Department of MIPT (NRU), Assistant Director of ANO «SRCIPT»;

Tiras Kharlampy P. - Candidate of Biological Sciences, Head of the ITEB RAS Training Center;

Vasin Dmitry Yu. - Candidate of Technical Sciences, Nizhny Novgorod State University n.a. N.I. Lobachevsky;

Zakharova Alena A. - Doctor of Technical Sciences, Professor, Chief Researcher of V.A. Trapeznikov Institute of Control Sciences RAS.

Internationa Program committee members:

Coquillart Sabine (France) - research director at INRIA (the French National Institute for Research in Computer Science and Control) and LIG (the Laboratory of Informatics of Grenoble);

Gavrilova Marina (Canada) - Ph.D, Full Professor, Department of Computer Science, University of Calgary, Editor-in-Chief, Transactions on Computational Science Journal, Springer;

Heiden Wolfgang (Germany) – Professor, Doctor, Computer Science, Dean of the Department Hypermedia- and Multimedia-Systems, Bonn-Rhein-Sieg;

Hui-Huang Hsu (Taiwan) - Professor in the Department of Computer Science and Information Engineering at Tamkang University;

Jehn-Ruey Jiang (Taiwan) - Professor, Department of Computer Science and Information Engineering, National Central University;

Magenat-Thalmann Nadia (Switzerland) - Founder and Director of MIRALab, University of Geneva;

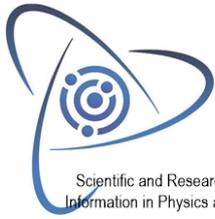
Nielson Gregory M. (USA) - Arizona State University, School of Computing, Informatics, and Decision Systems Engineering, Doctor of Philosophy, Mathematics;

Shih Timothy K. (Taiwan) - Distinguished Professor and the Vice Dean of College of EECS at the National Central University;

Suleimenov Ibragim E. (Kazakhstan) – Doctor of Chemistry, Candidate of Physical and Mathematical Sciences, Professor of NPP Department, Almaty Energy and Communications University;

Thalmann Daniel (Switzerland) - Honorary Professor at EPFL, Senior Principal Scientist at DEX-LAB Ltd in Singapore and Director of Research Development at MIRALab Sarl in Geneva.

Organizers



Scientific and Research Center for
Information in Physics and Technique

(organizer)



Institute of theoretical
and experimental
biophysics
(organizer)



Pushchino State Institute of Natural
Science

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Bryansk State Technical Univer
sity (BSTU)
(co-organizer)



Keldysh Institute of Applied
Mathematics
(co-organizer)



MIREA - Russian
Technological University
(co-organizer)



(co-organizer)



ANO INSC
(co-organizer)



Dear friends! Dear Colleagues!

For the third year, our traditional conference has been held without our Friend and Teacher Stanislav Vladimirovich Klimenko! Every year, the scale of his personality, the horizon of understanding the problems and the incredible positive energy of his existence, the scientific and simply human pleasure that we all experienced while in the magnetic field of his personality, are becoming clearer. The second year of the pandemic especially highlighted the enduring importance of direct human communication, the need for which everyone appreciated, because we have something to remember about our meetings in Drakino, Larnaca or TsarGrad. For this special thanks to Stanislav Vladimirovich! We remember that he always spoke and advocated for the preservation and development of the scientific community, as a special corporation of right-thinking people, true patriots of their Motherland and, at the same time, the scientific world of the entire planet.

However, even in these conditions of forced isolation, our collective mind continues to support its carriers, and we hold our conferences online, increasingly adapting to its peculiarities and using all the positive aspects of this communication format. For once, all the declared participants have the opportunity to speak at the conference, and no one rushes on other reasons to the train, plane or subway. Everyone can and do speak to colleagues, and not in parallel in various symposia, but sequentially, which is very useful for our common goal of jointly discussing the work of colleagues, even if not in our own area of expertise.

However, this is not surprising, since various aspects of distance education have been the subject of discussion at our conferences for a long time. And now, it has become clear that when holding conferences in an online format, it makes sense to revive the genre of panel discussions (for example, after the end of the working day with a discussion of a single but important idea that colleagues put forward during their keynote speeches). Then the potential of our team will be fully realized, one of the main features of which is real, not formal, interdisciplinarity.

It is quite obvious that one of the defining trends in the development of science in general today is the synthesis of ideas, models and approaches developed not only within the natural sciences, but also within the humanities. We see that the personal nature of the knowledge obtained is increasingly coming to the fore, the role and position of the scientist as a person decides the value of the knowledge obtained for the entire scientific community. In the context of a pandemic, in fact, a world “war” waged by all of humanity, the ethical and moral qualities of scientists come to the fore, who "according to their position" are obliged to look ahead and give correct human guidelines to their community and society as a whole.

In this regard, it is especially important to observe the constant participation of young scientists in the conference, it is nice to see progress in their reports as they grow and develop internally. There are all kinds of conferences at which reports are presented by leading scientists in different fields of science. But the peculiarity of our conference is precisely in the fact that it is not only a platform for the statements of mature specialists, but, to a large extent, the place of perhaps the first serious speech for students and undergraduates of our universities, who receive invaluable practice of a scientific report and a serious, albeit friendly, discussion.

This trend has received a new impetus in the last two years: schoolchildren who have fallen into the orbit of scientific research, are speaking at our conferences. For two years in a row, the pupils perform both in separate and general sections, on a par with the "adult" participants. The first were the students of the PushGENI-ITEB School of Digital Biology, created more than three years ago. It should be noted that from the very beginning of the school's work, the task was to engage in science, and not play it. Schoolchildren Pushchino, Protvino and Serpukhov together carry out projects that have pronounced socially significant goals - environmental monitoring. It is interesting that this work is directly related to the task of the ANO ICPT, and then of the ANO SRCIPT: obtaining scientific information, forming databases of biological images and developing methods for its analysis. Members of our team from Pushchino, Protvino and Moscow participate in this work, which characterizes our common understanding of the importance of working with young people, including high school students.

As the school continues to work, a whole range of scientific and pedagogical problems are solved in parallel, which allow the children to understand what science is doing and how it is actually done. They learn to work, make mistakes, analyze and correct them, work in a team and develop personally.

It should be noted here that this was, perhaps, one of the last initiatives that received direct support and parting words from S.V. Klimenko. The creation and operation of this school is a direct continuation of his ideas on combining the potential of the science cities of Protvino and Pushchino to form a common scientific environment in the south of the Moscow region. It is important that we see how these children grow up and understand that such kind of initiative projects really contribute to the development of our science.

Now children from other schools are taking part in the conference and we hope that this initiative will be supported and expanded.

In recent years, our conference has received great support from well-known organizations as Bryansk State Technical University, Keldysh Institute of Applied Mathematics of the RAS, MIREA - Russian Technological University, Nizhny Novgorod State University of Architecture and Civil Engineering, Nizhny Novgorod State University n.a. N.I. Lobachevsky, ANO International nuclear safety Center, National Research University «Moscow Power Engineering Institute», Perm National Research Polytechnic University, Ufa State Aviation Technical University, etc. Our conference became known in countries such as Kazakhstan and Belarus. It is also attended by colleagues from the Donetsk and Lugansk People's Republics.

This once again convinces us of the correctness of the chosen direction of work of ANO NICFTI and the guarantee of our further progress. Good luck and health to all colleagues and see you at future conferences!

*On behalf of the committees:
Doctor of Technical Sciences S.I. Rotkov
Doctor of Technical Sciences A.V. Tolok
Candidate of Biologically Sciences Kh.P. Tiras*

All the accepted as a result of peer reviews will be published in the proceedings of the CPT2021 conference.

CPT2021 conference includes 5 sections:

1. Biobanks and modern information resources in biology (Session chair, Candidate of Biologically Sciences Kh.P. Tiras)

- The problem of information biobanks: the ecological aspect
- Monitoring of the ecological state of Serpukhov
- Monitoring the state of the urban environment using digital biology methods
- Comparative analysis of the state of the ecology of the city using UAVs
- Characterization of cultures isolated from soil of the anthrax old cattle burial ground
- Compliance with biological safety requirements in diagnostic laboratories during the pandemic caused by SARS-COV-2 virus (COVID-19)

2. To R-geometry of plants (Session chair, Doctor of Physico-Mathematical Sciences, Professor V.I. Moiseev)

- On two types of R-functions in the research of V. L. Rvachev
- Arithmetic in functional voxel modeling
- Idea paradigms and their human-sign interfaces
- Anthropocentric properties of the landscape and their significance in the prevention of a pandemic
- Comparison and assessment of paradigms and models of tourism development at the municipal level
- Application of EDA-system to find the shortest path on an electronic GIS map
- Application of a functional voxel model to simulate the flocking motion of a multiagent system in a limited space
- The Ascent of Artificial Intelligence: From Weak to Strong Artificial Intelligence
- Ways to overcome the supposed artificial intelligence crisis
- The problems of human embryos genome editing from the position of Islam denominations
- Estimates of the State of Distributed Systems by Mathematical and Mapping Simulation Methods on the Example of HFRS Disease Data in the Territory of the Republic Bashkortostan
- A mobile application for predicting relapses of myocardial infarction
- Development of a system for helping people with vision disabilities when moving around the city based on machine learning algorithms
- Development and research of machine learning algorithms for analyzing the video stream of vehicle traffic

3. Nuclear and radiation safety (Session chair, Candidate of Engineering Sciences M.A. Berberova)

- Comparison of the capabilities of neural networks and Shepard's method for predicting floods based on processing statistical data
- Development of technical systems for the safe work of personnel at nuclear power plants
- Control over measurements of risk indicators at NPPs using a mobile application

- Development of robotic systems for work in the hazardous zone of nuclear power plants
- Dependent Events Accounting in Organizational Risk Management and Resilience Cost Planning Tasks Using Matrix Equations
- Management tools to determine the economic and technological risks associated with the use of innovative technologies in industrial enterprises
- Optimizing the cost / effectiveness ratio in risk management in software development
- Modeling energy transitions in a stress-deformed geological environment
- Resource potential of oil and gas deposits in the Laptev Sea basin
- Assessment of the stressed-deformed geological environment in the process of construction
- On the methodology for ensuring specified availability factors of NPP power units
- Optimization of the design of the experimental stand «Neutron Converter»
- Usage of visualization methods to determine the genuine flow rate
- On the destruction of the value of Russian energy organizations
- The capabilities of the RELAP5 program code for reproducing experiments on the study of heat transfer in tubes with supercritical pressure water
- Visualization of Research Trending Topic Prediction to Determine Promising Directions in the Field of Nuclear Power Plant Safety
- The theory of percolation in the third stage of generation and development of cracks modeling on the surface of a steel microcut
- Influence of the gas phase injected into the coolant on the heat transfer process
- The value of predicting deviations in the operation of NPP secondary equipment

4. Digital technologies (Session chair, Candidate of Engineering Sciences, Docent D.Yu.Vasin)

- Combinatorial-geometric approach in problems of automatic processing of documents with a weakly formalized description of objects
- Polyline smoothing with compound Bezier splines
- Digital technologies in education during the pandemic
- Development and research of computer vision algorithms for image analysis of deformed erythrocytes
- Construction of the "Patient" agent model for an agent-oriented model of the functioning of a medical center
- Influence of Informational Content on Film Frame Perception
- Decision support system for managing the quality of production of complex hardware and software systems
- Digitalization of tax administration and its analytical potential
- Mathematical model development for a digital twin of the cutting process
- Converting an analytical boundary model of a 3D object to a voxel model
- Restoration of a wireframe model of a 3D object from a paper archive drawing
- Using the language of geometric constructions to create models of some technical surfaces
- Development of visual and mathematical models to support decision-making

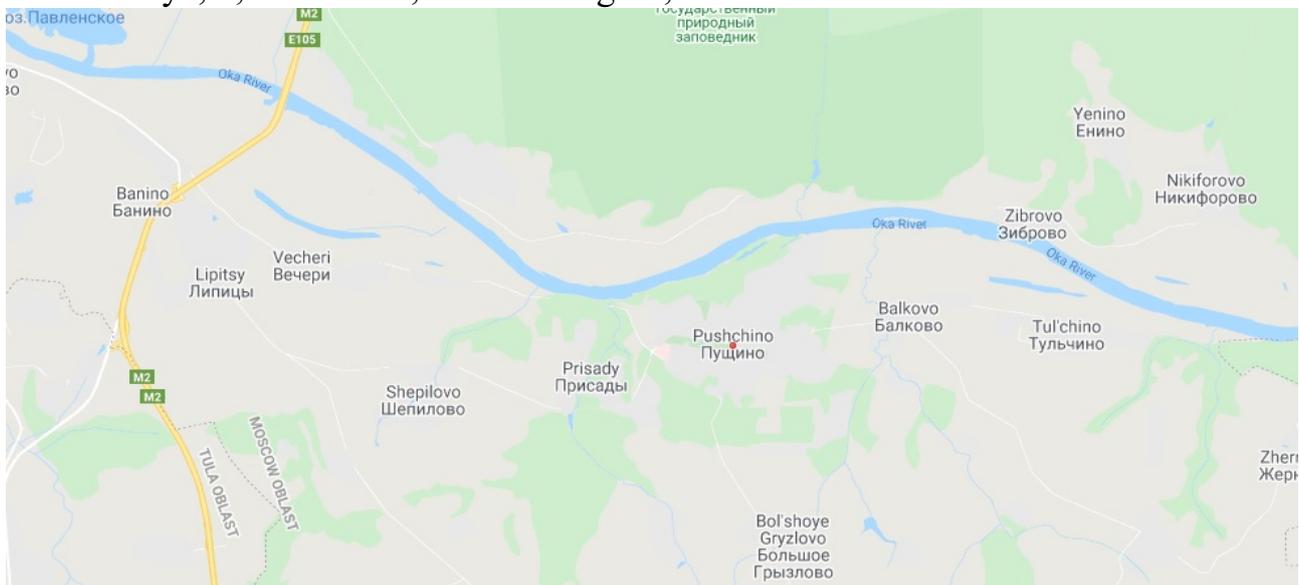
- Some aspects of evaluating the effectiveness of information systems
- Fuzzy cognitive maps, neural networks and conservation laws
- Theoretical foundations of the mathematical apparatus «Point calculus»
- Mathematical modeling of cylindrical shell stress-deformed state of membrane coating with a reinforcing element
- Application of Projection Algorithms for Geometric Modeling and Optimization of Socio-economic Processes
- Simulation of semi-automatic control for bipedal walking robot in virtual environment systems
- An effective ray casting technology to construct accurate terrain shadows in virtual environment system
- Development of a high availability cluster management system in a protected environment of AstraLinux SE 1.6 OS

5. Neutron physics (Session chair, Doctor of Physical and Mathematical Sciences, Professor V.P.Afanas'ev)

- Analytical model of light ions reflection from solids
- Monolayer and submonolayer coatings parameters measurement by X-ray photoelectron spectroscopy
- Electric cars: rescue or collapse?
- Axiomatic generalization of the 4-dimensional space of the Galaxy by timing the pulsar
- Comparative analysis of point processes of different nature
- Strain-stress state control of multidimensional resilient kinematic with indefinite external disturbance
- Classification of the factors of functioning of the individual human thermoregulation system and prediction of its state (local thermophysical aspects)

Location

International Conference CPT2021 will be held at the Institute of Theoretical and Experimental Biophysics RAS (Pushchino, Moscow Region) at the address: st. Institutskaya, 3, Pushchino, Moscow region, 142290





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November 08, 2021

10:00-10:30	Opening of the conference. Greetings from the Chairman of the Organizing Committee and Guests of Honor	
Plenary lectures		
10:30-11:15	A. Raikov	Strong artificial intelligence for fast strategy synthesis
11:15-12:00	V. Medennikov, A. Raikov, A. Zatsarinny	Integration of Agricultural Artificial Intelligence Applications into a Single Digital Platform
<i>12:00-12:20 - Coffee-break</i>		
12:20-13:10	A. Faddeev, R. Stepanov, V. Minaev, M. Berberova, A. Oboimov	Digital model of the earth lithosphere and geodata application analysis
13:10-14:00	A. Bakirov, Ye. Vitulyova, I. Moldakhan, D. Shaltykova, I. Suleimenov	Analysis of the statistics of information processes in telecommunication networks from the point of view of a neural-network model of the noosphere
<i>14:00-15:00 Lunch</i>		
Session 1 «Biobanks and modern information resources in biology». Session chair, Candidate of Biologically Sciences Kh.P. Tiras		
15:00-15:40	Kh. Tiras, S. Nefedova	The problem of information biobanks: the ecological aspect
<i>15:40-16:00 Coffee-break</i>		
16:00-16:20	A. Bolotina, D. Djansaidova	Monitoring of the ecological state of Serpukhov
16:20-16:40	I. Valkov	Monitoring the state of the urban environment using digital biology methods
16:40-17:00	L. Valkov	Comparative analysis of the state of the ecology of the city using UAVs
17:00-17:30	L. Marinin, N. Shishkova, A. Mokrievich, I. Dyatlov	Characterization of cultures isolated from soil of the anthrax old cattle burial ground
17:30-14:00	E. Tyurin, L. Chekan, M. Khramov	Compliance with biological safety requirements in diagnostic laboratories during the pandemic caused by SARS-COV-2 virus (COVID-19)

November 09, 2021

Session 2 «To R-geometry of plants». Session chair, Doctor of Physico-Mathematical Sciences, Professor V.I. Moiseev		
10:00-10:30	V. Moiseev	On two types of R-functions in the research of V. L. Rvachev
10:30-11:00	A. Tolok, N. Tolok	Arithmetic in functional voxel modeling
11:00-11:30	A. Solomonick	Idea paradigms and their human-sign interfaces
11:30-12:00	Yu. Golubchikov	Anthropic properties of the landscape and their significance in the prevention of a pandemic
<i>12:00-12:20 - Coffee-break</i>		
12:20-12:50	V. Minaev, E. Tsyshchuk, G. Tsyshchuk	Comparison and assessment of paradigms and models of tourism development at the municipal level
12:50-13:05	S. Smirnov, L. Sizova	Application of EDA-system to find the shortest path on an electronic GIS map
13:05-13:20	K. Shutova, A. Sycheva	Application of a functional voxel model to simulate the flocking motion of a multiagent system in a limited space
13:20-13:40	V. Voitsekhovich	The Ascent of Artificial Intelligence: From Weak to Strong Artificial Intelligence
13:40-	G. Malinetskiy, V. Smolin, V.	Ways to overcome the supposed artificial intelligence

14:00	Voitsekhovich	crisis
14:00-15:00 Lunch		
15:00-15:40	E.Gribkov, T.Minchenko	The problems of human embryos genome editing from the position of Islam denominations
15:40-16:00 Coffee-break		
16:00-16:30	V. Gvozdev, O. Bezhaeva, G. Gvozdev, T. Prosvirkina, S. Larshutin, E. Barudkina	Estimates of the State of Distributed Systems by Mathematical and Mapping Simulation Methods on the Example of HFRS Disease Data in the Territory of the Republic Bashkortostan
16:30-17:00	A. Brezhneva, R. Tomakova, A. Brezhnev	A mobile application for predicting relapses of myocardial infarction
17:00-17:30	T. Karklin, T. Borodina, M. Bagirov	Development of a system for helping people with vision disabilities when moving around the city based on machine learning algorithms
17:30-18:00	T. Karklin, T. Borodina, M. Bagirov, D. Koblyakov	Development and research of machine learning algorithms for analyzing the video stream of vehicle traffic

November 10, 2021

Session 3 «Nuclear and radiation safety». Session chair, Candidate of Engineering Sciences M.A.Berberova		
10:00-10:15	A. Karandeev, V. Osipov	Comparison of the capabilities of neural networks and Shepard's method for predicting floods based on processing statistical data
10:15-10:30	A. Baimurzaev	Development of technical systems for the safe work of personnel at nuclear power plants
10:30-10:45	A. Zaporozhskikh	Control over measurements of risk indicators at NPPs using a mobile application
10:45-11:00	M. Holatov	Development of robotic systems for work in the hazardous zone of nuclear power plants
11:00-11:20	L. Sachenko, A. Kondrashin	Dependent Events Accounting in Organizational Risk Management and Resilience Cost Planning Tasks Using Matrix Equations
11:20-11:40	D. Seleznev, A. Ozdoeva	Management tools to determine the economic and technological risks associated with the use of innovative technologies in industrial enterprises
11:40-12:00	D.Kuznecova, M.Plaksin	Optimizing the cost / effectiveness ratio in risk management in software development
12:00-12:20 - Coffee-break		
12:20-12:40	V. Minaev, R. Stepanov, A. Faddeev, M. Berberova, A. Koryachko	Modeling energy transitions in a stress-deformed geological environment
12:40-13:00	V. Minaev, R. Stepanov, A. Faddeev, M. Berberova, K. Bondar	Resource potential of oil and gas deposits in the Laptev Sea basin
13:00-13:30	V. Minaev, R. Stepanov, A. Faddeev, M. Berberova, K. Bondar	Assessment of the stressed-deformed geological environment in the process of construction
13:30-14:00	Alexander Arzhaev, Alexey Arzhaev, A. Kalyutik, V. Makhanev, V. Modestov	On the methodology for ensuring specified availability factors of NPP power units
14:00-15:00 Lunch		
15:00-15:20	M. Borisov	Optimization of the design of the experimental stand «Neutron Converter»
15:20-15:40	A. Samoilov, A. Sataev, A. Blokhin, P. Blinokhvatov, V. Andreev	Usage of visualization methods to determine the genuine flow rate
15:40-16:00 Coffee-break		
16:00-	O. Dranko, Ye. Blagodarnyy	On the destruction of the value of Russian energy

16:20		organizations
16:20-16:40	A. Sujyan, A. Osipov	The capabilities of the RELAP5 program code for reproducing experiments on the study of heat transfer in tubes with supercritical pressure water
16:40-17:00	M. Charnine, A. Tishchenko	Visualization of Research Trending Topic Prediction to Determine Promising Directions in the Field of Nuclear Power Plant Safety
17:00-17:20	V. Andreev, O. Andreeva, V. Gai	The theory of percolation in the third stage of generation and development of cracks modeling on the surface of a steel microcut
17:20-17:40	E. Ermolenko, V. Andreev, N. Tarasova, N. Herman	Influence of the gas phase injected into the coolant on the heat transfer process
17:40-18:00	N. Paulouskaya	The value of predicting deviations in the operation of NPP secondary equipment

November 11, 2021

Session 4 «Digital technologies». Session chair, Candidate of Engineering Sciences, Docent D.Yu.Vasin		
10:00-10:20	D. Vasin	Combinatorial-geometric approach in problems of automatic processing of documents with a weakly formalized description of objects
10:20-10:35	V. Romakin	Polyline smoothing with compound Bezier splines
10:35-10:50	L. Reingold, O. Klychikhina, A. Soloviev	Digital technologies in education during the pandemic
10:50-11:05	P. Shagalova, A. Savkin, E. Sokolova	Development and research of computer vision algorithms for image analysis of deformed erythrocytes
11:05-11:25	V. Baluta, Yu. Titov	Construction of the "Patient" agent model for an agent-oriented model of the functioning of a medical center
11:25-11:40	E. Borevich, S. Mescheryakov, V. Yanchus	Influence of Informational Content on Film Frame Perception
11:40-12:00	L. Chernyakhovskaya	Decision support system for managing the quality of production of complex hardware and software systems
12:00-12:20 - Coffee-break		
12:20-12:45	V. Tyutyuryukov, N. Tyutyuryukov, N. Guseva	Digitalization of tax administration and its analytical potential
12:45-13:00	E. Kashirskaya, V. Kholopov	Mathematical model development for a digital twin of the cutting process
13:00-13:10	A. Shirokov	Converting an analytical boundary model of a 3D object to a voxel model
13:10-13:25	S. Romensky, S. Rotkov, Yu. Burcev, V. Provorov, V. Tyurina, M. Smychek, A. Nazarovskaya	Restoration of a wireframe model of a 3D object from a paper archive drawing
13:25-13:40	A. Boykov	Using the language of geometric constructions to create models of some technical surfaces
13:40-14:00	A. Boykov, A. Zaporozhskikh	Development of visual and mathematical models to support decision-making
14:00-15:00 Lunch		
15:00-15:20	A. Zatsarinnyy, Yu. Ionenkov	Some aspects of evaluating the effectiveness of information systems
15:20-15:40	Yu. Rykov	Fuzzy cognitive maps, neural networks and conservation laws

15:40-16:00 - Coffee-break		
16:00-16:20	I. Balyuba, A. Naidysh, E. Konopatskiy, S. Rotkov, A. Bezditnyi	Theoretical foundations of the mathematical apparatus «Point calculus»
16:20-16:40	E. Konopatskiy, V. Shpinkov, A. Bezditnyi	Mathematical modeling of cylindrical shell stress-deformed state of membrane coating with a reinforcing element
16:40-17:00	E. Konopatskiy, O. Veretennikova, A. Bezditnyi, S. Rotkov, M. Lagunova	Application of Projection Algorithms for Geometric Modeling and Optimization of Socio-economic Processes
17:00-17:20	E. Strashnov, L. Finagin	Simulation of semi-automatic control for bipedal walking robot in virtual environment systems
17:20-17:40	P. Timokhin, M. Mikhaylyuk	An effective ray casting technology to construct accurate terrain shadows in virtual environment system
17:40-18:00	T. Karusevich, A. Stavtsev, K. Popov	Development of a high availability cluster management system in a protected environment of AstraLinux SE 1.6 OS

November 12, 2021

Session 5 «Neutron physics». Session chair, Doctor of Physical and Mathematical Sciences, Professor V.P.Afanas'ev		
10:00-10:30	V.Afanas'ev, L.Lobanova, D.Selyakov, M.Semenov-Shefov	Analytical model of light ions reflection from solids
10:30-11:00	V.Afanas'ev, L.Lobanova, D.Selyakov, M.Semenov-Shefov	Monolayer and submonolayer coatings parameters measurement by X-ray photoelectron spectroscopy
11:00-11:15	V. Sachenko, A. Kruchmalev	Electric cars: rescue or collapse?
11:15-12:00	A. Avramenko	Axiomatic generalization of the 4-dimensional space of the Galaxy by timing the pulsar
12:00-12:20 - Coffee-break		
12:20-13:00	E. Kashirskaya	Comparative analysis of point processes of different nature
13:00-13:30	V. Chizhikov, E. Kurnasov	Strain-stress state control of multidimensional resilient kinematic with indefinite external disturbance
13:30-14:00	D. Simankov	Classification of the factors of functioning of the individual human thermoregulation system and prediction of its state (local thermophysical aspects)

14:00 – Summing up. Closure of the conference

Abstracts of reports

Plenary lectures

Integration of Agricultural Artificial Intelligence Applications into a Single Digital Platform

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The paper addresses digital transformation trends in agriculture towards precision production embodied in precision agricultural technologies, which require combining a huge amount of inconsistent, multidimensional, and multi-industry data with appropriate processing technologies. Methods of artificial intelligence (AI) are of particular importance among these technologies. A sufficient amount of structured and reliable data is a prerequisite for using those methods. The paper provides a list of the most significant AI developments in agriculture offered by the market, accompanied by an analysis of their application prospects. Since AI applications are currently used in almost all known precision technologies in agriculture, which are evolving from the digitalization of individual operations to the digitalization of an interconnected system, based on the integration of all operations, including those of related industries, the AI applications should undergo integration transformations into the standards of the proposed unified digital platform for managing the agricultural economics, which is powered by mathematical and ontological modelling. The transition of the industry to this single platform is challenged by a patchwork and discontinuous informatization that dominates in our country. An effective solution is proposed in the form of elaborating the most advanced AI technologies in combination with precision agriculture and precision cattle breeding methods in several reference facilities.

Keywords: Agriculture, artificial intelligence, digital platform, mathematical modelling

Digital model of the earth lithosphere and geodata application analysis

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The lithosphere is defined as the solid Earth crust that covers the entire planet thus protecting it from the temperature of the incandescent Earth core reaching 60,000°C. The lithosphere is located in between the atmosphere and hydrosphere at the top and the asthenosphere at the bottom. The thickness of the Earth's crust is not the same everywhere as it may range from dozens to several hundred kilometers in different locations.

This article presents and explains a digital model of the Earth's lithosphere as a structured "big data" technology including system wide information on the geodynamic properties and specific features of the lithosphere at various depth

levels. The model is designed to deal with a variety of challenging tasks related to geodata application study. The following topical problems are under review: geodynamic risks assessment, migration of seismic deformation energy, and preliminary prospecting for hydrocarbon deposits. Solution of these problems relies on information support provided by database (DB) "Digital Model of the Earth's Lithosphere" and the program called "Lithosphere" which are used as special-purpose tools for accessing and processing the database information. The article also describes the findings resulting from practical application of a digital model of the Earth's lithosphere in the context of geodata application analysis accompanied by relevant visualized representation. The authors have demonstrated that modeling the migration of seismic deformation energy and substantiating a new geodynamic risk indicator opens up new opportunities for predictive assessment of seismic and volcanic activity. It is also revealed that a new method of preliminary exploration of hydrocarbon deposits implemented on the basis of computerized geodynamic modeling offers the most cost-effective solution as compared to any existing methods of prospecting operations in oil and gas fields.

Keywords: Digital model, geodata analysis, geodynamic risk, the Earth's lithosphere, Big Data, mathematical model, visualization of results

Analysis of the statistics of information processes in telecommunication networks from the point of view of a neural-network model of the noosphere

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It was found that the distribution of users of social networks by the number of contacts, as well as the statistics of telephone conversations by duration, obtained for different cities on the basis of experimental data, obey the same laws, expressed through a differential equation of the first order. This differential equation contains two phenomenological parameters, one of which is interpreted as the fractal dimension of the communication space, and the second is directly expressed through the Dunbar number or its analogue. Essentially, for all cities, the statistics for which were studied in this work, the numerical value of the parameter, interpreted as the fractal dimension of the communication space, remains constant with high accuracy. At the same time, the analogue of the Dunbar number, which describes the distribution of users of social online networks by the number of contacts, correlates with the population of the city. The results obtained are discussed from the point of view of the formation of a global communication network - the noosphere, which, due to the development of telecommunication technologies, is already de facto man-machine system. It is shown that the results obtained confirm the conclusion about the existence of objective laws describing the behavior of human-machine systems, made earlier on the basis of general philosophical considerations.

Keywords: social networks, teletraffic statistics, noosphere, neural networks, Dunbar number.

Session reports

Session 1 «Biobanks and modern information resources in biology» (Session chair, Candidate of Biologically Sciences Kh.P. Tiras)

Characterization of cultures isolated from soil of the anthrax old cattle burial ground

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In modern conditions, there is a risk of infection of people with Bacillus anthracis soil spores (the causative agent of anthrax) due to the human economic professional activity. In Russia there is a large number of soil foci, which have manifested themselves as periodic outbreaks of anthrax among people and farm animals for many years. Of the greatest threat are anthrax animal burial grounds ("anthrax burial grounds" - ABG). An animal burial ground is a place for the long-term burial of the corpses of farm and domestic animals that died or were slaughtered because of anthrax infection. After having entered the soil, the pathogen can retain not only its viability, but also its virulence for a long time of its persistence.

We have studied soil specimens taken at the site of an old cattle burial ground that has existed for more than 75 years on the shore of the Ivankovsky water reservoir in the Konakovo district of Tver region. Three types of Bacillus anthracis cultures were isolated from the specimens. Some of them had properties typical for B. anthracis, while others differed in some characteristics. The possibility of using a complex technique for typing of anthrax strains, as well as for their differentiation from closely related microorganisms, was shown.

Keywords: anthrax, Bacillus anthracis spore, soil, animal burial grounds

Compliance with biological safety requirements in diagnostic laboratories during the pandemic caused by SARS-COV-2 virus (COVID-19)

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Laboratory diagnostics of biomaterials of bacterial and viral origin requires strict compliance with the requirements of biological safety. This is also true for research conducted by safety-varying laboratories where polymerase chain reaction express methods are used. Conditions of handling biomaterials suspected of containing pathogens of Groups I-IV of pathogenicity are discussed. Research is carried out in the laboratories of organizations licensed for activities related to pathogens of human infectious diseases of a bacterial and / or viral nature. Laboratories in which diagnostic tests are carried out must have sanitary and epidemiological conclusions of the conditions with state sanitary and epidemiological rules and regulations issued in accordance with the established procedure for a period of no more than five years on the compliance. The laboratory premises should be equipped with boxes and pre-

boxes. The box rooms are need to be equipped with supply and exhaust ventilation with highly efficient air purification filters of safety class not lower than H14, a water supply system not connected to the centralized network, a sewage system with a waste water disinfection system, electricity and heating, fire extinguishing equipment, natural and artificial lighting. The admission of employees to carry out diagnostic work on material based on genetic constructions is carried out under the same conditions as the admission of personnel to work with microorganisms after passing the medical examination, primary training in specialized courses on the basics of biological safety and on certification special courses on carrying out amplification reactions, passing the test on knowledge of the requirements and provisions of biosafety. The choice of the level of biological safety with the necessary set of equipment, the type of protective clothing and personal protective equipment for the respiratory organs is carried out in strict accordance with the regulatory documents, which is determined by the type of pathogen, the working area, equipped by microbiological safety boxes. A conclusion about the need for strict compliance with the requirements of biological safety when conducting genetic research is made.

Keywords: biological safety, pathogens of infectious diseases, laboratory diagnostics, genetic material, polymerase chain reaction

Session 2 «To R-geometry of plants» (Session chair, Doctor of Physico-Mathematical Sciences, Professor V.I. Moiseev)

On two types of R-functions in the research of V. L. Rvachev

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The article considers the idea of the presence of two types of R-functions in the research of academician V. L. Rvachev. It is proposed to call them "R-functions of the first type" ("R1-functions") and "R-functions of the second type" ("R2-functions"). The R1-functions are widely known and correspond to the usual definition of the R-function in the Rvachev approach. R2-functions are in the one-dimensional case isomorphic maps of a set of real numbers into a finite real interval, which allows us to talk about the moment of non-Archimedeaness of such a set and the prospects for constructing a non-Archimedean version of mathematical analysis. The task is to find the grounds for the possible unity of two types of R-functions, possible solutions for their interaction are proposed, including the example of organic shaping-modeling of the hierarchical R-structure of a maple leaf.

The article aims to clarify the issues of possible coordination of two types of R-functions within the framework of a unified system of V. L. Rvachev's research.

Keywords: V. L. Rvachev, R-function, R-function of the first type, R-function of the second type, non-Archimedean analysis, organic form, R-space

Arithmetic in functional voxel modeling

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The paper considers the claim that the function-voxel model allows arithmetic operations over the space of values of two different functions given by a single domain. At the same time, there are three possible approaches to solving the problem, leading to a similar result: functional approach - when the analytical representation of functions is involved in the calculations; functional voxel approach - when voxel data representing local geometric characteristics are used in the construction of local functions for further use in the calculation; voxel approach - when exclusively voxel data is used for sequential recalculation of local geometric characteristics of the model. The basic arithmetic operations on functional voxel models are considered, including such procedures as: addition, subtraction, modulo, exponentiation, taking root expressions, multiplication and division of functional voxel models. It is shown that the obtained applicability of arithmetic operations to functional voxel models leads to obtaining new complex functional voxel models.

Keywords: *Functional voxel modeling method, arithmetic operations, R-functions.*

Idea paradigms and their human-sign interfaces

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By idea, I mean a thought generated by an individual human consciousness. It arises spontaneously under the influence of any impulses and gradually settles in the brain of the individual. At first, it appears in vague outlines, then, as it is processed, it acquires an ever more distinct sign design (we cannot think otherwise than in signs - words, numbers, images, etc.). A thought formed in the brain becomes an idea that allows a person to realize a given thought to its logical conclusion and express it orally or in writing in a verbal or other symbolic presentation. If an idea touches the imagination of a mass of people or solves some practical problem, it becomes the property of many and begins to develop systematically in the form of science or an ideologically charged movement of many. At the stage of familiarizing people with mastering and applying an idea in practice, it becomes necessary to create a paradigm for it. The paradigm allows the idea to exist in more or less the same embodiment in the minds of different people, which contributes to its further development in different, but similar incarnations. Without a common paradigm, the joint development of an idea in many countries and in different languages would not be possible. This vision of the paradigm, at least for scientific research, was first expressed in its entirety by Thomas Kuhn in his book "The Structure of Scientific Revolutions" in 1962 and has since become entrenched in the scientific consciousness of scientists around the world.

Keywords: *Paradigms, ideas, human-sign interfaces*

Anthropic properties of the landscape and their significance in the prevention of a pandemic

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The exhaustion of chemical and drug medicine in the prevention of coronavirus has been analyzed. The intercivilizational results of the manifestation of the coronavirus are considered. which can be taken as indicators of the viability of states. The coronavirus pandemic increases the importance of secluded walks, local history, and rural tourism. The prophylactic value of landscape therapy is established. The importance of the accelerated development of the digital economy in enhancing rural tourism and dacha de-urbanization is considered.

Keywords: COVID-19 pandemic, healing, landscape, dacha deurbanization.

Comparison and assessment of paradigms and models of tourism development at the municipal level

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The article examines the factors and principles of building models of tourism development at the municipal level of management. The concepts are introduced: "paradigm of tourism development", "model of tourism development". As a basis for modeling the tourist and recreational system, the current paradigms of tourism development are considered: their structure, essential (substantive) basis and paradoxes. It is concluded that paradigms are evolving, making the transition from autonomous-private principles to budgetary and distributional and further to value-oriented ones. Two types of models have been identified: by the depth of changes in relation to tourism (diversification, situational (trend) model) and the type of interaction (localization, cooperation). Their comparative characteristics are carried out, highlighting their strengths and weaknesses. The network-centric model, which synthesized the considered features, is considered separately. On the example of municipalities of two types: with a high industrial potential and a pronounced agrarian specialization, the prospects of using network-centric principles for constructing models of tourism development at the municipal level are shown. A comparative expert assessment of the potentials of various models of tourism development was carried out in the context of three characteristics: resource provision, quality of management and the severity of priorities in relation to the tourism industry. It is concluded that the network-centric model, which has the maximum potential according to the above characteristics, reflects the value-oriented paradigm in the best way in its content, essential basis and principles of construction. The information base of the study is the results of scientific and applied research carried out in the territory of municipalities of the North-West, Central and South of Russia in the period from 2015 to 2019. The applied value of the study is to provide feedback of the methodology for designing tourist and recreational systems of various

levels and ranks with management decisions made by authorities and business entities.

Keywords: *Tourism and recreation system, tourism development paradigm, tourism development model, network-centric model.*

Application of EDA-system to find the shortest path on an electronic GIS map

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The history of the development of CAD (CAD), CAM and PDM systems in our country and abroad is briefly described. The main disadvantages of using foreign CAD systems in Russia are presented. The capabilities of the domestic software package "Graphics - TR", which belongs to the category of EDA-systems and is developed in Russia (ICS RAS), have been investigated. Complex "Graphics - TR" is considered as a tool intended for the design of electronic devices for communication, the creation of schematic documentation in accordance with USDD, the development of drawings, drawing diagrams of algorithms, tables, search and visualization of the shortest path between objects.

The main algorithms that can be used to find the shortest path (their disadvantages and advantages for solving the problem) are considered. The substantiation of the choice of an algorithm for solving the problem of finding the shortest path is given.

The solution to the problem in the field of cartography was presented: the design of the optimal route for the social and educational sphere. Finding the shortest path was presented as a task of tracing connections between objects on a GIS (Geographic Information System) map. The algorithm for tracing connections between objects using "Graphics-TR" is analyzed in detail, indicating all the operations included in the construction process.

Keywords: *computer-aided design (CAD) systems, EDA-systems, "Graphics-TR" software package, electrical circuits, printed circuit boards, shortest path, connection routing, placement of elements, geographic information systems (GIS), network analysis, Ford-Fulkerson algorithm, routing algorithm, wave algorithm.*

Application of a functional voxel model to simulate the flocking motion of a multiagent system in a limited space

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The paper considers the implementation of a multiagent system that moves toward a common goal in unbounded space by swarming algorithms based on Reynolds rules. Three approaches to modeling flocking motion are presented, together implementing a final algorithm that provides collision avoidance with all available types of obstacles. To ensure avoidance of collisions with dynamically occurring obstacles, a joint application of the investigated swarming algorithm and the predator avoidance model based on reinforcement learning is proposed. Thus, it is possible to temporarily evade the target to ensure the safety of the movement of agents. The algorithm is organized on Q-learning, the result of which is an action function. We consider the behavior of the multiagent system modeled by the proposed

approaches in a limited space - a polygon or range. In this case, in addition to the described interactions, the movement of a group of agents is influenced by repulsive forces from the walls. The problem of compensation of repulsive and attractive potentials with the consequent inhibition of the agent or ignoring the walls when moving toward the target is revealed. This task is proposed to be solved by applying functional-voxel models. The principle of movement of agents according to local geometric characteristics stored in the represented graphical M-images of a simulated polygon is described. The advantages of using these models and the necessity of applying to them the algorithm of escaping from a predator are emphasized.

Keywords: *Flocking motion, ML, reinforced learning, functional-voxel modelling, FLOZ-function*

Ways to overcome the supposed artificial intelligence crisis

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Artificial intelligence (AI) is called the XXI century main technology. Great scientific forces are involved in its development. In addition to the algorithmic and neural network AI creating directions, developing since the last century, many other approaches have appeared. Such as quantum and cognitive semantics of AI models, neuromorphic approaches, hybrid AI and many other methods and technologies. Now it's difficult to say which direction will give the greatest impetus to AI development, it can be any of them. But some fundamental issues of creating AI can be considered using any example, and now it is natural to take the neural network area, which is still the most commercially successful. The growth over the past decade in the number of tunable parameters in "neural network" computing schemes by 9-10 decimal orders of magnitude to hundreds of billions and trillions has made it possible to achieve outstanding results in solving a wide "intelligent" problems class. According to Ashby's theorem on the required complexity of control systems, an increase in complexity is potentially required to solve increasing large-scale problems. The use of a wide range of mathematical ideas, algorithms optimization, information collection automation, and electronics improvement have reduced the costs growth rate. As we approach the reasonable costs limits for solving "smart" problems, the focus of development is increasingly moving from the backpropagation error (BPE) algorithmic and hardware implementation to other mathematical approaches. The success of self-organization ideas such simple as memory localization, decomposition, and transformations linearization can give a new impetus to the development of AI, possibly comparable to the introduction of the idea of gradient descent in training "deep" neural networks, which has already led to a revolution in machine learning.

Keywords: *Artificial intelligence (AI), Neural networks, Localization, Decomposition, Linearization, AI crisis, Hierarchy, Applied mathematics, Self-organization, Understanding.*

The problems of human embryos genome editing from the position of Islam denominations

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Biomedical technology is one of the most relevant and rapidly developing branches of science. In response to the major problems of bioethics and bio-law, bioethical dilemmas emerge in society, which constrain the abuse of new technologies. Medical discoveries, on the one hand, can greatly facilitate the life of humankind, but, on the other hand, the problem of interference in human nature actualizes the most fundamental questions concerning his ontology, the boundaries of permissible transformations, the responsibility of a scientist and a specialist applying the latest technologies for remote and unpredictable consequences, due to the integrity and interconnectedness of various aspects of human nature.

This paper presents the experience of generalizing the attitude of the main Islamic confessions to the problem of editing the human embryo genome.

Based on a review of scientific and religious literature, it is concluded that, although the Islamic world is increasingly using Western models of behavior, in matters of the permissibility of editing the human embryo genome from the point of view of Islamic bioethics, it is necessary to rely on the principles of Sharia and multidisciplinary knowledge.

Key words: *Biomedicine, bioethics, human, embryo, genetic manipulation, Islam*

Estimates of the State of Distributed Systems by Mathematical and Mapping Simulation Methods on the Example of HFRS Disease Data in the Territory of the Republic Bashkortostan

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One of the effective technological methods for ensuring the comparability of data, characterizing the state of territorial systems from different position is to convert it to a form of mapping models, known as zoning of territorial systems. This paper discusses the problems of zoning the territory of the Republic Bashkortostan on the example of hemorrhagic fever with renal syndrome (HFRS) disease data. Zoning results provide the basis for solving other information problems. The paper also discusses the issues of identifying similar states of the territorial system for this indicator in different time slices. Analysis of the state of the territory as a whole is reduced in a comparison of the results obtained by means of mathematical and geoinformation models relative to the entire studied territory under various conditions of simulation. Proposed approach, allows to increase the number of particular characteristics, that is, the number of points of view on the state of the territory system.

Keywords: estimates of the state, territory systems, system-forming factors, mapping simulation, HFRS, network-centric control

A mobile application for predicting relapses of myocardial infarction

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The aim of the study is to develop an effective information system that allows predicting the probability of recurrence of myocardial infarction based on the use of fuzzy mathematical models. The soft computing technology based on the methodology of synthesis of hybrid fuzzy decision rules is chosen as the mathematical apparatus. At the expert level, the composition of informative features consisting of four blocks is established. Based on the obtained set of features, a fuzzy predictive model was synthesized for the quality of work, which was tested in the course of expert evaluation, mathematical modeling, and statistical tests on representative control samples. In the course of the conducted studies, it was shown that the confidence in the correct prognosis exceeds the value of 0.85, which is a good result for medical prognostic tasks. In this paper, the space of informative features is formed. The methods chosen in the work and the obtained prognostic model allow us to recommend the results of research in medical practice both in the form of application programs for tablets and smartphones, and as part of decision support systems for cardiologists.

Keywords: prognosis; relapse; myocardial infarction; mathematical model; fuzzy logic; membership function.

Session 3 «Nuclear and radiation safety» (Session chair, Candidate of Engineering Sciences M.A.Berberova)

Comparison of the capabilities of neural networks and Shepard's method for predicting floods based on processing statistical data

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The results of a comparative analysis of the capabilities of neural network modeling, as well as the Shepard method for solving flood forecasting problems are presented. The advantages and disadvantages of each of the approaches are considered. The results of numerical experiments are presented, demonstrating the features of the application of each of the approaches.

Keywords: Neural networks, neural network modeling, Shepard's method, time series, flood

Dependent Events Accounting in Organizational Risk Management and Resilience Cost Planning Tasks Using Matrix Equations

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The maintenance of companies activities in the event of adverse impacts and disruptions of various kinds largely depends on the effectiveness of preventive measures and incident response measures. With limited resources, there arises the task of getting the maximum return from the investments in managing a complex system in a crisis, of finding a balance between the volume of preventive measures and response measures. The article considers approaches to planning the cost of risk and resilience measures for cases with dependent events. Using the model of total cost of risk estimation based on matrix equations the difference between the results obtained by taking into account the event dependency and a similar model without dependency was shown. An increase in the distortion of the estimates obtained without considering the dependencies between the events with increasing uncertainty was revealed to demonstrate the significance of taking into account the dependencies of risk events.

Keywords: Risk management, resilience, cost optimization, dependent events

Management tools to determine the economic and technological risks associated with the use of innovative technologies in industrial enterprises

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In the context of the application of innovative technologies, a detailed study of the project is required, which will allow structuring the project management mechanisms and the possibility of using economic and technological analysis tools. The current article is devoted to the tools for identifying risks for the formation of an optimal strategy for the effective development of a company, taking into account the threats of financial, technological, investment, etc., arising in the process of implementing and preparing projects, when introducing innovative technology in the production of an oil production enterprise. The main area of research in the article is the technical and economic assessment of innovative design solutions. Based on the cross-sectional analysis of the enterprise, the need for an integrated approach and detailed accounting for the choice of technological processes and the definition of methods for economic assessment taking into account risks has been proved. At the same time, it is recommended that project managers / company managers firstly determine for what purposes it is necessary to carry out an integrated approach to assess technical and economic indicators, use tools for risk analysis and determine the effectiveness of a technological solution through an integrated approach to risk assessment using Monte Carlo, Savage methods, Hurwitz, coefficient of variation, etc., to establish the results of a comprehensive assessment and interpret them correctly, form conclusions and build strategies based on the results, allowing to establish a clear algorithm of actions for the development of the company.

Keywords: Risk-management, complex analysis, innovative technologies, technical and economic analysis, variation, sensitivity, sustainability of the project.

Optimizing the cost / effectiveness ratio in risk management in software development

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The paper is devoted to the issues of risk management of software projects.

In risk management, each risk is characterized by "the magnitude of risk." For each risk, two plans can be assigned: a risk prevention plan and a risk response plan. Each of these plans is costly to implement. Several different plans may be proposed for the same risk.

The paper proposes a methodology to simplify the risk management process through the use of simple and effective visual analytics tools. The technique allows: 1. Assess the validity of the plans; identify risks, the costs of which do not correspond to the severity of the threat of this risk for the project (overestimated or underestimated). 2. If there are several plans for one risk, choose the most suitable one.

In both cases, decision making is based on optimizing the cost / effectiveness ratio.

The paper proposes to compare the magnitude of the risk and the cost of plans for its prevention and response. If the risks are insignificant, their plan should be cheap. Only plans designed to deal with significant risks can be expensive.

To visualize the results, it is proposed to use charts of four types.

The plans are designed to reduce the magnitude of the risk. For comparison of several plans, it is proposed to compare the cost of the plan and the reduction in the magnitude of risk that this plan provides. It is logical to choose a plan in which such a decrease will be greatest.

The described methodology can be applied to risk management not only in the field of software development, but also in other subject fields.

Keywords: Cost / effectiveness ratio, risk management, software development

Modeling energy transitions in a stress-deformed geological environment

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This article describes a model with a view to presenting quantitative characteristics of seismic risks calculated on the basis of seismic impacts modeling specified in the Code of Rules titled "Construction in Seismic Areas". The article substantiates certain criteria for selecting test zones, describes the methodology for verifying the adequacy of seismic risk assessment models, characterizes a probabilistic model of energy transitions in a stress-deformed geological environment, and presents a method designed to estimate model parameters relying on indicators of the potential energy transformation in the stress-deformed

geological environment. The territory of Armenia and neighboring states appear to fit well with the criteria of a test region selected for field testing of the model demonstrating high seismicity, availability of the required information base and proven adequacy of seismic risk models application at all depth levels in the location of earthquake epicenters. The article offers a detailed analysis featuring the method of verifying the adequacy of the mathematical model describing the seismic risk assessment based on the Student's criterion. It is shown that in the process of estimating parameters of transitions between the model conditions described by the Kolmogorov equations, it is necessary to take into account both the influence of regional fields (anomalous gravitational field) and local fields (current tectonic movements).

Keywords: *Probabilistic model, seismic risk, stress-deformed geological environment, potential energy, test area, criterion, regional geophysical field, local field*

Resource potential of oil and gas deposits in the Laptev Sea basin

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The article describes a new method of computerized geodynamic modelling (CGM) developed with a view to performing preliminary exploration of oil and gas deposits. This method offers the most cost-effective way of prospecting as compared to any existing techniques and is radically different from the traditional field and analytical methods. CGM is orientated towards poorly developed territories such as the Arctic zone and other underexplored parts of the Earth. The method relies on the use of geodynamic indicators, specifically distribution of vortex structures related to velocity vectors of horizontal shear deformations and normal linear deformations. Potential hydrocarbon deposit locations in the northern part of Yakutia adjacent to the Laptev Sea basin, in direct proximity to the Arctic coastal line, were identified on the basis of the above-specified geodynamic indicators. As a probabilistic model designed to make forecasts of hydrocarbon reserves, it actually reflected changes in the transition between steady, unsteady and quasi-steady states of the geological environment. In addition, the authors of this research designed and subsequently made use of the local and regional models for geodynamic risk assessment. It is noteworthy that other authors, using an alternative methodology in their earlier studies of the southern sector of the Laptev Sea, have identified in approximately the same area a prospective site recommended for appraisal drilling.

Keywords: *The Arctic zone, computerized modelling, geodynamic indicators, oil and gas deposits, forecast.*

Assessment of the stressed-deformed geological environment in the process of construction

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The article presents a description of the regional and local mathematical models created to assess stresses, deformations and displacements in the geological environment as well as model implementation results. Computerized versions of models provided with digital information open up radically new opportunities for the construction sector to address problems related to assessment, analysis and forecasting of the seismic parameters inherent in the geological environment. Mathematical models and calculations obtained as a result of their application appear as a reliable basis in the field of design and construction of buildings and structures in severe geological conditions. Survey activities and construction operations require significant material, technical and financial resources. It is therefore concluded that modern digital technologies that are used for assessing, analyzing and predicting seismic risks reduce unjustified financial losses and facilitate the intellectual component of the applied techniques and methods of design surveys. This article is a follow-up to a series of authors' publications pertaining to modelling of seismic risks in geological environment in the process of design and construction of various projects.

Keywords: *stressed-deformed environment, process, construction.*

On the methodology for ensuring specified availability factors of NPP power units

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Nuclear Power for electricity generation is a valuable component of "green" energy which can help to eliminate use of organic fuel at Power Plants. Safety issues have been successfully solved at "Generation III+" Nuclear Power Plant units developed in Russian Federation. So ensuring of high availability factors for these Power Plants is of the main concern which is discussed in paper.

"Aging management" covers a set of measures – (1) engineering, (2) operation, (3) maintenance - to keep ageing degradation of SSC within acceptable (permissible) borders. Examples of engineering measures include design, technology certification, failure analysis. Examples of operational measures include supervision, implementation of procedures (regulations), environmental measurements.

In this regard, NPP "Life management" or "Lifetime management" strategies should be considered as cooperation of aging management and economic planning for: (1) optimization of performance, maintenance and lifetime of structures, systems and components (SSC); (2) providing an acceptable level of performance and safety;

and (3) maximizing the return on investment during NPP lifetime.

Keywords: Nuclear power plant, life management, safety, availability factor, aging management, structures, systems and components.

Usage of visualization methods to determine the genuine flow rate

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The essential role in thermohydraulic studies is the determination parameters of the objects under study. Since this scientific field is mainly based on empirical regularities, so the importance of accurately determining the studied quantities is a task of paramount importance. The main range of sensors does not allow obtaining the required accuracy when taking small-order quantities. The values in such conditions can be determined by indirect signs or indicators. This work is devoted to a method for determining the genuine flow rate in a channel based on visualization methods, as well as comparison with a theoretical calculation. This method is well applicable in laboratory conditions at relatively low parameters of heat carriers. The actuality of this issue is confirmed by multiple studies and articles on ways to determine low flow rates and their fluctuations. Also, the advantage of the proposed measurement method is the ability to trace all the processes associated with the flow modes of heat carriers. As a result, the typical for the stationary mode of the installation speed-time dependences were obtained. During the work, the deviation of the theoretical calculation from the genuine measurement was an acceptable value. The measurement error by the visualization method was insignificant, which indicates the validity of the theses put forward.

Key words: Visualization, thermohydraulic, natural circulation, mathematical model, measurement of small expenses, genuine parameters.

On the destruction of the value of Russian energy organizations

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The paper addresses the issue of the development of Russian enterprises from the point of view of increasing or decreasing (destroying) business value. We used a discounted cash flow model to estimate the fundamental value of the business. To study the palpable change in the economic parameters of enterprises, we have developed a modification of the formula for the value of a business based on discounted cash flows in an analytical form, assuming that many parameters remain unchanged. This assumption is confirmed by the dynamics of the development of large organizations. Model calculations were carried out based on information from the official financial statements of the Russian organizations. Methods for processing big data have significantly reduced the processing time of information. For the targeted study, energy-generating industry enterprises were considered. The calculation results show that an increase in the revenue growth rate reduces the value of the business. For this, a particular term is used – destruction. The primary condition for an increase in value with an increase in revenue is the excess of the operating profitability of an organization over its capital-output ratio, taking into

account the discount rate. Model calculations showed that for many Russian organizations in the selected industry, the optimization conditions for maximizing the value are not met, which allows us to speak of the destruction of the value of Russian power generating organizations.

Keywords: *Situational modeling, resilience growth, business valuation, discounted cash flows, big data, express method*

The capabilities of the RELAP5 program code for reproducing experiments on the study of heat transfer in tubes with supercritical pressure water

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Computational studies of thermal-hydraulic processes in the core of nuclear reactors with supercritical water coolant are of high importance. especially at the stage of concept development of such reactors. In this case, the complexity of determining the properties of water in the area of supercritical parameters leads to the need for further development of thermal-hydraulic models and predicting tools. Such studies are necessary in justifying the safety of nuclear reactor concepts with supercritical coolant parameters. As a part of the safety justification for pressurized water reactors, the RELAP5 program code has been widely used. When performing calculations, the correlations used in the program code to describe the heat transfer process between the wall and the liquid are extremely important. In order to assess the correctness of the data on heat transfer in pipes and bundles with supercritical water used in RELAP5 code, a reproduction of an experiment on heat transfer in the vertical pipe was performed. The series of calculations for the wall and the coolant temperatures at the pressures of 23 and 25 MPa and various heat fluxes in the range from 600 kW/m² to 1100 kW/m² have been performed. The results of the experiment are compared with the results of its computational reproduction. The calculated and experimental results are compared with the theoretical characterization of heat transfer mechanism in supercritical pressure water.

Keywords: *Nuclear reactor, supercritical water coolant, heat transfer, RELAP5*

Visualization of Research Trending Topic Prediction to Determine Promising Directions in the Field of Nuclear Power Plant Safety

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This article presents the method of visualization of long-term forecasting of trending research topics and the results of applying this method in the field of nuclear power plant (NPP) safety. Significant topics were identified among the keywords included in the titles of scientific articles. The keywords in the headings, which are encountered several times in the cited articles of the analyzed collection, are considered trending research topics. The duration of the citation trend growth has been a goal for machine learning algorithms. The machine learning method CatBoost was used. The t-SNE and Word2Vec methods were used to visualize the forecast. Long-term forecasting of trending research topics, based on the analysis of

bibliographic collections of millions of scientific articles, helps to determine promising directions, find breakthrough ideas, and focus efforts in the most fruitful direction. Visualizing predicted topics as clusters of trending keywords on a semantic map helps to pinpoint promising directions in NPP safety even more accurately.

Keywords: *NPP safety, visualization, long-term forecasting, trending research topics, decision tree, CatBoost, scientific articles, topic trend dynamics, Big Data*

The theory of percolation in the third stage of generation and development of cracks modeling on the surface of a steel microcut

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The modeling of the process of destruction of structural materials under cyclic loads in the field of high-cycle fatigue was considered. A phenomenological analysis of the main stages of the formation of cracks, mechanisms and schemes of their initiation, formed in the process of destruction of real objects, was carried out. The implementation of these mechanisms using the tools of the percolation theory made it possible to increase the reliability of modeling the processes occurring in real conditions during the destruction of a structure. The parameter of the model of damage accumulation on the images of the microstructure of the surface of metals and alloys was formulated, which makes it possible to detect the moment of completion of the formation of a crack. The fractal dimension of the percolation cluster obtained on the cells belonging to the damage was chosen as a parameter. To calculate the sizes of percolation clusters the Hoshen – Kopelman multiple labeling algorithm was used. The existing algorithm was supplemented with an auxiliary label for open cells belonging to the percolation cluster, which made it possible to get rid of the additional operation of comparing labels and re-marking nodes when combining parts of a single cluster. To confirm the effectiveness of the proposed parameter, simulation the process of damage accumulation on test images of the surface microstructure was made. The magnitude of the error did not exceed 6.6% for calculations using the values of the fractal dimension of percolation clusters built on the cells belonging to the crack.

Keywords: *Modeling of fatigue fractures, percolation cluster, fractal dimension.*

Influence of the gas phase injected into the coolant on the heat transfer process

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The purpose of this work is to study the effect of gas on the heat transfer process and obtain the dependences of the heat transfer coefficient, Reynolds number and boundary layer thickness on the gas content in the coolant. To carry out thermophysical research, a stand was designed and manufactured, which is a simple heat exchanger made in the form of coaxial channels of the "pipe-in-pipe" type. After carrying out the necessary experiments, the following characteristics were obtained: the temperatures of the heating and cooled coolants at the inlet and outlet from the channels, the volumetric flow rates of the coolants and injected gas. To process the

results, the program RaschetTeploobmennika.exe was written, which allows you to obtain the necessary indicators for the analysis of experimental data. The processing of the analysis results showed that gas injection into the coolant intensifies the heat transfer process, which makes it possible to classify the implemented method of supplying the gas phase to the coolant as passive methods for intensifying heat transfer. The result confirms the phenomenology of the phenomenon under study - the intensification of the heat exchange process is realized due to the influence of gas bubbles on the boundary layer, as evidenced by the obtained dependences. Based on the results of the study, an initial assessment of the possible decrease in the weight and size characteristics of a real heat exchanger and, as a consequence, the economic effect was carried out.

Keywords: *Heat transfer intensification, the heat transfer coefficient, gas injection, heat exchanger, boundary layer, turbulization*

The value of predicting deviations in the operation of NPP secondary equipment

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Recent studies on climate change have shown that current levels of carbon dioxide emissions into the Earth's atmosphere are likely to lead to catastrophic scenarios. Against this background, the development of nuclear energy as a source of low-carbon energy is a guarantee of environmental safety. After the accident at the Chernobyl nuclear power plant, new technologies were introduced to improve safety, both at the design stage of new nuclear power plants and during the reconstruction of existing ones.

This article discusses the methodological approaches to ensuring the safety of nuclear power plants: deterministic and probabilistic. The role of technical diagnostics in predicting failures of NPP equipment is outlined, as well as the importance of systems for analyzing the readings of process control sensors in normal operation modes in order to identify abnormal conditions. To improve the overall safety level of nuclear power plants, attention should be paid to timely diagnostics of equipment of not only the first, but also the second circuit.

An assumption is made about the prospects for the application of methods of information entropy, fractal analysis of the phase portrait, vector state diagrams, the "moving average" method and the assessment of the dynamics of disorder to identify anomalous states of equipment in the secondary circuit of nuclear power plants.

Keywords: *Safety, climate, probabilistic safety analysis, deterministic safety analysis, technical diagnostics, cluster analysis, VVER-1200, normal operation*

Session 4 «Digital technologies» (Session chair, Candidate of Engineering Sciences, Docent D.Yu.Vasin)

Combinatorial-geometric approach in problems of automatic processing of documents with a weakly formalized description of objects

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In the article, within the framework of the development of the combinatorial-geometric approach, modern approaches to the creation and use of automatic / automated systems for processing complex-structured raster graphic documents with a weakly formalized description of objects are considered. The features of the specified class of documents influencing the choice of information models of their presentation at both raster and vector levels are determined. The basic tasks of analyzing graphic documents with a weakly formalized description of the depicted objects are formulated as tasks of computational geometry on polygons (contours), broken lines and points. Combinatorial-geometric problems of image input are considered. Estimates of the time complexity of the main combinatorial-geometric algorithms are given. The application of the apparatus of parallel computations to increase the temporal efficiency of the compression algorithm for raster hyperspectral data of remote sensing of the Earth based on local homogeneous "well adapted" basic functions as applied to the processing of various graphic documents with a poorly formalized description of objects is considered the development of the methodological, algorithmic and software base with the aim of further increasing the efficiency of the developed software and hardware systems and automatic processing technologies for the specified class of documents.

Keywords: *Combinatorial-geometric problems and data structures, graphic documents with a poorly formalized description of objects, geometric modeling, models of representation of raster and vector images, estimation of the temporal complexity of the algorithm, hyperspectral raster data of remote sensing of the Earth, compression of hyperspectral data of remote sensing of the Earth, design of parallel algorithms for processing raster data*

Polyline smoothing with compound Bezier splines

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A new iterative method is proposed for constructing a smooth spline consisting of cubic Bezier curves and approximating a given polyline with the required accuracy. At each iteration, the following operations are performed: selection of the number of spline interpolation nodes, their placement on the polyline, construction of a smooth spline passing through them, and estimation of the approximation accuracy. The position of the spline interpolation nodes on the polyline is selected by comparing the proximity measures of the adjacent Bezier curves that make up the spline and the segments of the polyline that they approximate. Results are presented that confirm the effectiveness of the proposed method.

A distinctive feature of the proposed method is that it automatically selects the number of spline nodes and their position on the polyline so that the resulting spline passes as close as possible to the given polyline. Nodes do not snap to the vertices of the polyline, so no preliminary simplification of the polyline is required.

Keywords: *Polyline smoothing, compound splines, Bezier curves*

Digital technologies in education during the pandemic

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Nowadays person’s social and technological environment is changing significantly. Digital technologies are being developed and implemented in all spheres of social life.

These technologies are especially important in the face of emergencies. Thus, they are used during biological threats like the pandemic that was caused among other reasons by the increased mobility. Local infections that emerged at a certain place on the planet rapidly spread all over the world.

Digital technologies allow controlling travels and personal contacts of people but at the same time they create conditions sufficient to perform a lot of activities. One of the examples is education – one of the most sensitive spheres of social life where digitalization turned out to be highly sought-after because full-time education significantly increases the risks of contagion.

This article addresses the challenges emerging due to the accelerated implementation of digital technologies, including in education. We demonstrate examples of solutions allowing to effectively provide education that are being developed and implemented at National Research University Higher School of Economics (HSE University). These include engaging students as digital assistants in helping different types of users with their issues, using gamification methods in educational process and other projects. The application of such approaches results in a positive synergistic effect in implementation of digital technologies at the University, facilitates educational process during the pandemic.

Keywords: *Digitalization, semantic interoperability, the Internet of things, big data, digital assistant, gamification, National Research University Higher School of Economics.*

Development and research of computer vision algorithms for image analysis of deformed erythrocytes

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The deformability of erythrocytes, red blood cells, largely determines the nature of blood microcirculation and therefore is directly related to the diagnosis and treatment of many diseases. At the current moment, the evaluation of blood cells deformations is usually performed visually by medical technicians. Here, we present a new computer vision approach for the rapid and accurate tracking of blood cells and analysis of erythrocytes deformation by a shear flow. The developed algorithms use image binarization and a neural network based on the U-net architecture for

separated erythrocytes and the Stardist architecture for conglomerates. We present the results of the algorithms on real blood microscopy images, compare their effectiveness, and discuss the practical application in medical tests. Automation of image analysis of deformed images will increase the accuracy and simultaneously reduce the time and cost of tests, leading to a better patient treatment. Evaluation of the distribution of erythrocytes by deformability will provide additional diagnostic and scientific information for medical research.

Keywords: *Computer vision, image analysis, binarization, neural networks, completeness and accuracy of recognition, deformability of erythrocytes*

Construction of the "Patient" agent model for an agent-oriented model of the functioning of a medical center

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Pandemics are large-scale outbreaks of diseases, often with serious economic, social, and political consequences. Therefore, the society develops various mechanisms to counteract the spread of infectious diseases. Such mechanisms include the organization of permanent anti-epidemic services, and during outbreaks of diseases-and the restructuring of the functioning of medical institutions as a whole, and the introduction of additional restrictive measures on the lifestyle of the population. When new types of infectious pathogens with initially unclear etiology appear, as happened with SARS-Covid-19, it is difficult to predict the effectiveness of certain measures before studying the consequences of implementing the decisions taken. One of the ways to obtain such an estimate a priori is mathematical modeling. By modeling the development of the situation, it is possible not only to compare the effectiveness of various intervention measures, but also to allocate available and, as a rule, limited resources more rationally. Within the framework of the international grant of the BRICS countries (project No. 20-51-80002), a set of mathematical models, including a multi-agent model, is being developed for conducting model studies of pandemics and obtaining predictive estimates for the spread of infectious diseases. This paper presents a variant of the model for describing the category of agents "patient", that is, persons who have been infected. Modeling their behavior both in the process of normal life activity and when applying to medical institutions will allow reproducing both the effects of the spread of morbidity and the nature of the load on the health care structure. The methods of describing not only its states, but also the rules of transitions and decision-making are proposed. For decision-making, fuzzy sets are used that describe the rules and approaches of the patient's reaction to the appearance of various symptoms. This approach makes it easy to modify the model when the symptoms change. In addition, additional conditions are introduced related to administrative decisions of government bodies, in particular, such as diagnostics and vaccination. Their modeling is necessary for subsequent assessments of the total load on medical institutions, which allows determining the necessary number of medical personnel of various qualifications, identifying the need for retraining, taking into account the number of necessary wards and hospitals, as well as expendable resources and personal protective equipment.

Keywords: *Agent model, Agent-oriented simulation model, Decision-making, Fuzzy sets.*

Influence of Informational Content on Film Frame Perception

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In this paper present an experimental study of the influence of the informational content of a film frame on viewer perception. The authors describe the methodology for preparing stimulus material. Portrait photographs of people with different informational content were chosen as a stimulus material. The experiment was carried out using a hardware-software complex eye-tracking, which records oculomotor activity. The experiment consisted of two stages. In the developed experiment, the observers have the task at the first stage - memorization, at the second stage - identification. When developing the experiment, two focus groups of observers were formed by gender. The experiment involved 20 males and 20 females. The article describes an algorithm for statistical processing of the parametric data obtained as a result of the experiment. The analysis of the results revealed a statistically significant influence of the informational content on the parameters of the viewing template the stimulus material by the observers. A statistically significant influence of gender on the parameters of the examination template was revealed. Male solves the task posed in the experiment more efficiently.

Keywords: *Composition, visual appeal, informational content, film frame, eye-tracker, statistical data analysis, gestalt psychology, art photography*

Digitalization of tax administration and its analytical potential

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State agencies accumulate and publish a significant amount of data, but for administration purposes the public authorities commonly use the official statistical data. At the same time the digitalization of tax administration (the registration of the taxpayers, the receipt of tax reporting, and lately direct access to accounting data) makes possible the usage of tax statistics for public administration purposes. The authors use the reports of Federal Tax Service of Russia to show their analytical potential and more realistic nature in comparison to data of Federal State Statistics Service. Federal Tax Service publishes a statistics on tax revenues, tax expenses and taxpayers for major taxes, with breakdown by regions and municipalities. This makes feasible the detailed analysis of trends in income and property in the economy, welfare in particular regions and municipalities, amount of tax expenditure and other areas of economy. The limitation is, the tax statistics deals only with the items recorded in the tax returns, and therefore a number of issues may go unnoticed.

Key words: *Tax reporting, tax statistics, personal income tax, value added tax, Federal Tax Service of Russia*

Mathematical model development for a digital twin of the cutting process

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The purpose of this work is to develop a mathematical model for calculating the processing accuracy in real-time based on digital twin concept. This paper discusses the mathematical model development of the cutting process based on cone-shaped parts turning process. The influence of varying cutting forces on machining accuracy is considered. The study of forced vibrations of the elastic system of a lathe in the cutting zone is based on the original idea of decomposing the external load into two components: a distributed force running along the workpiece from the longitudinal feed and the increasing load on the part from the lateral feed. Bending vibrations of the part under such a load lead to a significant increase in the cutting force. This has a negative impact on accuracy. Timely compensation for this factor will ensure cutting stability and improve the quality of the resulting part. The model will become the basis for the development of a digital twin and will compensate for the predicted error in real-time.

Keywords: Metal cutting, loading, oscillatory motion, longitudinal feed, deflection, elastic line, vibrations.

Converting an analytical boundary model of a 3D object to a voxel model

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The article deals with voxel representation of 3D models. Here given the concept of the formation of such model, their features in terms of an analytical description. Separately, the article notes that the analytical presentation is not fit voxel models. The description of voxels includes the principles of computation, bit representation and use cases of such models. The transformation of voxel models is carried out by an algorithmic transition from analytical geometry to methods of discrete mathematics. The imperfection of some existing methods for computing the characteristics of products based on a three-dimensional model is considered. A data storage system for a voxel model using a tree-like data structure and an algorithm for parallelizing computational processes for calculating voxel models are proposed.

Keywords: Voxel, octotree, analytical geometry, CAD, voxel-model

Restoration of a wireframe model of a 3D object from a paper archive drawing

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The article describes the practical application of automated information technology for transformation of a paper drawing into an electronic 3D model of a product (wireframe representation). This transformation is relevant for CALS and BIM ideology of design and production of an object in connection with the need to use a paperless presentation of information that accompanies a product during its life cycle. This article describes all the stages of the process required to restore a wireframe model of a "detail" product from a real production paper drawing. The important stages of this difficult formalized process are: scanning of drawing and further vectorization of its raster representation, processing of the resulting vector image and extraction of orthogonal projections of the product from the resulting vector image in the internal parameterization system, analysis of projection views and elimination of errors, transformation of the obtained data to the form of a point 3D model of the object, and, finally, transformation of the point model into a preliminary wireframe model. At the same time, the time spent on automated obtaining of a wireframe model and obtaining the same model interactively was estimated. Drawings of real industrial products of the "detail" type for testing the developed technology were provided by JSC Central Research Institute "Burevestnik", the algorithms of the above stages associated with the processing of vector data representation were developed at the Department of Engineering Geometry, Computer Graphics and Computer-Aided Design of NNGASU.

Keywords: Raster format, vector format, point model, wireframe model, geometric modeling, orthogonal projections, internal parameterization.

Development of visual and mathematical models to support decision-making

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The article discusses the development, analysis and application of a visual model for decision-making, which could take into account a variety of alternative ways to solve a problem and would also have a rigorous mathematical model for evaluating a particular solution. Decision making requires identifying factors, analyzing the associated pros (arguments «for») and cons (arguments «against»), comparing alternative ways to solve the problem, and much more to create formal models that simplify decision-making.

Keywords: Decision making, mathematical model, visual model, hierarchical structure, priority structure.

Some aspects of evaluating the effectiveness of information systems

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The article is devoted to problem of evaluating the effectiveness of information systems (IS). General approaches to IS effectiveness evaluation are presented. There are considered the existing meanings of effectiveness concepts, criteria and performance indicators. The authors present general approaches to the selection of IS performance indicators. The proposals on lists of performance indicators and their calculation methods for different types of IS, considering the systems' specificity and their operation conditions have been developed. The features of the most well-known methods of evaluating the effectiveness of IS are noted. Finally, there are presented the approaches to measure the contribution of IS implementation to effectiveness of relevant organizational systems (ministries, departments, organizations). A general methodological approach to assessing the contribution of IS to the effectiveness of organizational systems is considered, taking into account the features, principles and conditions for building appropriate organizational systems. Presents the list of performance indicators for each of the three groups of generalized indicators of the effectiveness of the IS (the index of rationality of organizational structures, the performance indicators for IS and indicators of organizational and technical level is).

Keywords: *Effectiveness, criterion, indicator, method, information system, organizational system*

Fuzzy cognitive maps, neural networks and conservation laws

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Nowadays, the methodology of Artificial Intelligence (AI) acquires more and more applications. Especially neural networks (NN) gain much of attention. One of the main reasons for this is that NN technology has in a sense a universal character. From the other side certain other technologies, of AI nature or otherwise, also have the properties of universality. In the context of present paper these are the technologies of Fuzzy Cognitive Maps (FCM) and partial differential equations, in particular, systems of Conservation Laws (CL). All just mentioned approaches are used for the modeling of Complex Systems (CS), i.e. the totality of large number of elements with the connections between them of various types. The specific of CL theory, which is capable to model the joint balances of various quantities, is the presence of nonlinear effects such as the formation of singularities in the solutions.

The paper presents an illustration how these technologies can be combined into certain unified methodology for the modeling of CS. In order of such combination to be effective, certain relatively new theoretical approaches should be developed. In particular, it is necessary to elaborate, in a sense, a broader view of the concept of the FCM introduced by B. Kosko, which allows a broader interpretation range, and provides the FCM calculations in a special way that makes it possible to prove rigorous theorems. For the CL technology on the basis of alternative view to the systems of conservation laws it is possible to introduce a form of objective function in order to effective usage of NN strategy for the solution of such systems, which takes

into account the solution singularities. As a result the desired combination of above mentioned technologies implies the creation of NN with rather complex architecture and nonlinear calculation rules.

Keywords: Complex systems, fuzzy cognitive maps, weighted digraph, graph partitioning by cycles, conservation laws, variational representation, neural networks for conservation laws

Theoretical foundations of the mathematical apparatus «Point calculus»

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The purpose of the article is to acquaint the English-speaking reader with the new mathematical apparatus "Point Calculus", which was developed for solving engineering and scientific problems by the leading scientists of the Melitopol School of Applied Geometry and continues its active development in the works of Russian and Ukrainian scientists-geometers. The article presents the fundamental definitions and terms, basic methods, metrics, fundamental theorems of point calculus. Also, this material shows the principles of parametrization of a straight line, plane and 3-dimensional space in point calculus. Possibilities of point calculus include the definition of continuous and discrete geometric models of objects, processes and phenomena in the form of point equations and computational algorithms based on them. The advantage of the new mathematical apparatus is the representation of geometric objects in the form of a set of projections on the axes of the global coordinate system, which makes it possible to determine the geometric models of objects, processes and phenomena in spaces of any dimension.

Keywords: Point calculus, point equation, coordinate-wise calculation, geometric scheme, geometric modeling, geometric object, parameterization

Mathematical modeling of cylindrical shell stress-deformed state of membrane coating with a reinforcing element

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In this work, on the example of modeling the stress-strain state of cylindrical shells of membrane coatings with a reinforcing element, an approach to multidimensional approximation is considered, the prototype of which is the least squares method. A distinctive feature of the proposed approach is the absence of the need to compose and solve a system of linear algebraic equations to determine the polynomial coefficients of the approximating function. Instead, to minimize the sum of squared deviations between the initial data and the calculated ones, high-speed numerical

algorithms for finding extreme values are used, implemented in the MS Excel software package in the form of the "Find solution" function. Proposed approach to the approximation of multidimensional experimental data is a sufficiently flexible and effective tool. But at the same time, it has disadvantages inherent in the classical least square's method in terms of the occurrence of unplanned oscillations between the nodal points of the approximation. Therefore, the paper provides an example of using the geometric theory of multidimensional interpolation to solve the same modeling problems, but using geometric interpolants. As can be seen from the results, in a specific case, the models obtained on the basis of the geometric theory of multidimensional interpolation most accurately reflect the nature of the process. In this regard, they are more preferable in relation to models obtained using two-dimensional approximation. At the same time, approximation models are obtained in the form of explicit functions, and interpolation models are obtained in parametric form.

Keywords: *Mathematical model, two-dimensional approximation, two-dimensional interpolation, geometric interpolant, cylindrical shell, stress-strain state, reinforcing element*

Application of Projection Algorithms for Geometric Modeling and Optimization of Socio-economic Processes

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The article proposes an approach to systematization, modeling and optimization of multidimensional statistical data based on the use of projection algorithms for geometric modeling. The proposed approach is presented on the example of geometric modeling and optimization of socio-economic data, but it can also be effectively used to systematize and analyze other experimental statistical data. It consists in the fact that the original multidimensional data are presented in the form of projections on the Radishchev's complex drawing in the form of a system of curved lines. Then, on the indicator curve, the optimal value of the socio-economic indicator is selected (as a rule, this is one of the extrema of the function) and the value of the time at which it was reached is fixed. Here, the indicator curve is understood as the curve corresponding to the response function, and the factor curve is the curves corresponding to the factors influencing the response function. Further, a scientific hypothesis is put forward that the joint interaction of factors recorded at a given moment in time ensures the optimal value of the socio-economic indicator. Thus, we obtain the optimal values of the factors influencing the response function, which in this case is the socio-economic indicator. The interaction between the indicator curve and the factor curves is carried out through the line of interprojection connection. The proposed scientific hypothesis is fully justified, provided that all possible factors affecting the behavior of the socio-economic indicator are taken into account.

The implementation of the proposed approach was carried out using the Radishchev's complex drawing, which displays both the values of the factors and the

socio-economic indicator. At the same time, on the Radishchev's complex drawing, the most favorable conditions for the socio-economic indicator are selected by methods of mathematical analysis. Further, with the help of the line of inter-projection communication, by means of standardization, the desired weight coefficients are determined, corresponding to the most favorable conditions for the socio-economic indicator. This approach is completely independent of the subjective opinion of experts and based solely on the initial statistical information.

Keywords: *Geometric modeling, multidimensional data, socio-economic processes, Radishchev's complex drawing, factors of influence, response function, indicator curve, socio-economic data, decision-making problem, reproductive activity of the population*

Simulation of semi-automatic control for bipedal walking robot in virtual environment systems

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The paper considers methods and approaches for semi-automatic motion control of bipedal walking robots in virtual environment systems. The proposed solution includes walking pattern generation, inverse kinematics and PD controllers with feedback from angle sensors. To ensure static and dynamic stability of bipedal walking robot, the trajectory generation is realized with using the concept of Zero-Moment Point (ZMP) and inverted pendulum model with virtual height. In this case, the walking pattern generation is performed by solving the inverse kinematics problem using Levenberg-Marquardt method for computation of robot's joint angles. To implement the semi-automatic motion control for bipedal walking robot in virtual environment it is proposed an approach that based on the technology of block diagram schemes and virtual control panels. Approbation of proposed methods and approaches was carried out in virtual environment system VirSim and showed their adequacy and effectiveness for simulation of walking robot motion while keeping its balance.

Keywords: *Bipedal walking robot, simulation, walking pattern, stability, zero-moment point, inverse kinematics, virtual control panel, PD controller, virtual environment system*

An effective ray casting technology to construct accurate terrain shadows in virtual environment system

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The paper considers the task of integrating dynamic shadows of the Earth's terrain into the VirSim virtual environment system. Core technology of 3D modeling and visualization of the Earth, implemented in the EarthSim system, the part of the VirSim complex, is described. The paper proposes a technology for expanding the functionality of the stage of light-shadow modeling in a part of constructing dynamic terrain shadows by means of GPU-accelerated ray casting. Proposed technology

includes the stage of creating accelerating local extrema map and the stage of constructing screen map of terrain shadows. Developed solution was tested in simulation of surveilling detailed areas of the Earth's terrain from the International Space Station (ISS). The results obtained can be applied in developing space simulators, virtual environment systems, virtual laboratories, educational applications, etc.

Currently, space industry is one of the advanced human activities where virtual environment systems (VES) are highly demanded. Real-time computer generation of realistic virtual analogue of space environment opens up new opportunities for training cosmonauts, research and development of advanced space systems, planning various missions, etc.

Keywords: *Virtual environment system, terrain, shadows, ray casting, height map, GPU*

Development of a high availability cluster management system in a protected environment of AstraLinux SE 1.6 OS

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In Russian state organizations with increased requirements for information security, in connection with the process of import substitution, foreign-developed OS is replaced by Russian security protected OS, for example, AstraLinux SE. In addition, in order to be able to create fault-tolerant systems in the current versions of the AstraLinux SE OS contain separate elements of outdated versions of clustering tools that do not have tools for diagnostics and condition monitoring. Also, most of the existing popular commercial and free clustering systems do not work due to the mechanisms and information protection tools available in the AstraLinux SE OS. This article describes a software tool for managing a high availability multiservice cluster developed by the authors, as well as a graphical module for configuring and monitoring the state of a cluster.

Keywords: *high availability, cluster, infrastructure, fault-tolerant.*

Session 5 «Neutron physics» (Session chair, Doctor of Physical and Mathematical Sciences, Professor V.P.Afnas'ev)

Analytical model of light ions reflection from solids

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The high efficiency of OKG method to the description of the reflected electrons energy spectra is shown. It was found that the Pass Length Distribution Function for electrons and ions is described by the same formulas. On the basis of the invariant imbedding method analytical formulas are obtained that, using the method of spherical harmonics, describe the differential in energy and angles reflection functions of light ions in a wider energy range than in the case of electron scattering. Satisfactory agreement of the experimental data with the calculation performed on the basis of the model developed in the work is shown. The Strait Line

Approximation, widely used for the interpretation of ion scattering processes, is critically analyzed an approach that completely neglects the processes of multiple elastic scattering in the descending and ascending flows of light ions in the target. It is shown that the main dimensionless parameter that determines the characteristics of the spectrum of reflected ions is $\sigma^ = \frac{E_0}{l_{tr} \cdot \bar{\varepsilon}}$, that depends on the transport path l_{tr} and*

stopping power - $\bar{\varepsilon}$. A high sensitivity of the characteristic parameters of the reflected electrons spectrum to $\bar{\varepsilon}$ is noted. It is recommended to use the fitting procedure of calculated and experimental data to verify $\bar{\varepsilon}$, value, which in some situations is known with an error of up to hundreds of percent.

Keywords: *Electron spectroscopy, invariant imbedding method, spherical harmonics method, light ions spectroscopy, reflection function, analytical solution*

Monolayer and submonolayer coatings parameters measurement by X-ray photoelectron spectroscopy

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The paper considers the application of the traditional X-ray photoelectron spectroscopy (XPS) methodology: the Overlayer Thickness Determination for the analysis of coating parameters. Well-established method is modified for determining the thicknesses of monolayer and submonolayer coatings using XPS. In particular situations considered in this work, it is energetically favorable for the atoms of the coating to form clusters, but not be evenly distributed on the surface of the substrate material. The change in the XPS signal is analyzed in situations when the coating is not a plane-parallel homogeneous layer, but an island (cluster) structure. The mathematical model of the XPS signal formation is considered for the case of the cluster covering in the form of parallelepipeds. Photoelectron path distributions (in the coating material) analysis indicated a strong dependence of the signal on the viewing angle. For the purpose of analysis, experimental spectra were obtained for several samples: gold depositions of various thicknesses on a silicon substrate. The spectra were measured for different viewing angles of photoelectrons and interpreted within the Straight Line Approximation (SLA). It is shown that proposed simplest model of an island coating allows to describe the effect of a decrease in the value of the effective average coating thickness, determined in plane-parallel geometry, with an increase in the viewing angle, observed in XPS experiments with angular resolution.

Keywords: *X-ray photoelectron spectroscopy, Straight Line Approximation, overlayer thickness determination, cluster structure*

Electric cars: rescue or collapse?

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Nowadays, more and more people believe that electric cars will save our planet from global warming, the greenhouse effect and other environmental problems

caused by the large amount of carbon dioxide emissions into the atmosphere. At the same time, few people know that the industrial production of cars can lead to big environmental problems, that the market is not ready for the large-scale introduction of electric cars into mass use, and that cars are not the biggest problem of modern environmentalists. This is what will be discussed in our article.

Keywords: *Electric cars, ecology, recycling, exhaust gases, electric motors, internal combustion engines, automotive market*

Comparative analysis of point processes of different nature

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In complex systems, various catastrophic events can occur associated with failures of the elements of these systems. The processes occurring in the systems lead to the accumulation of changes, for example, to the accumulation of fatigue stresses during the operation of a metalcutting tool. Theoretical models of point random processes allow us to consider the features of the accumulation of such changes. The study of periodic random processes in nature with large sample sets, and, consequently, with reliable statistics, has shown that it is rather difficult to choose a suitable probability distribution. The most acceptable and successful approach to the selection of theoretical distributions is the use of various types of probabilistic papers (normal, lognormal, exponential distribution functions) using the MATLAB computational automation system. The conducted studies create the prerequisites for proving the constancy of the average intensity of events per unit time with a Poisson distribution, which is a consequence of a random Poisson process. This phenomenon will make it possible to predict an increase in the number of random events over time.

Keywords: *Random point processes, Complex systems, Statistical data*

Strain-stress state control of multidimensional resilient kinematic with indefinite external disturbance

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The paper discovers the problem of kinematic structure control whose nodes contain controllable elastic kinematic joints made of closed shells. Besides mechanical elastic characteristics, the mathematical model of an elastic kinematic joint incorporates the thermodynamic gas state. Due to gas throttling, this state leads to a density change, and, as a consequence, to the cavity filling of the elastic element. The shape determination of the main central axis of the elastic element is based on the solution of the brachistochrone problem. Mass and force characteristics acting on the rigid non-deformable node part are reduced to the moving point of the elastic element. When the moving and resisting forces perform the corresponding work on the transferring allowed by the kinematic joint, the ongoing process can be represented by a model of a rolling body, for example, a cylinder rolling on an inclined surface with rolling resistance. The estimation of the deformation time of the kinematic joint was carried out based on the brachistochrone problem. It is advisable to use control by neural network, which allows us to discover additional properties of

the controlled object and significantly simplify the formation of control actions with an undefined pattern of external disturbance.

Keywords: *Elastic kinematic joint, multidimensional kinematic construction, brachistichrone, Bourdon spring, Lagrange multiplier method, neural network*

Classification of the factors of functioning of the individual human thermoregulation system and prediction of its state (local thermophysical aspects)

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A classification of the tasks of human thermoregulation is proposed, which allows combining various scientific studies into one system, which takes into account environmental factors, biological feedback in the body and different properties of the constituent parts of the human thermoregulation system. The proposed multifactorial model of the human thermoregulation system is based on combining the classification of tasks represented by a group of main factors (temperature, time and the characteristic size of the system under consideration), with the classification of tasks in the studied sciences.

Applying an interdisciplinary approach to the study of human thermoregulation (thermogenesis), it is possible to model complex systems that allow predicting the state of the human thermoregulation system. A multifactor model, based on the systematization of knowledge, can be used as the basis for computer modeling of a human thermoregulation system.

Classification of tasks for the study of the human thermoregulation system allows you to systematize scientific knowledge and identify unexplored aspects for future research. Research and modeling of the human thermoregulation system are the scientific basis for the creation of new measuring, diagnostic and therapeutic equipment, new treatment methods and, possibly, a standardized personalized calculation method in the form of a software and hardware complex with an online calculator via the Internet of the influence of external factors (weather) for predicting homeostasis (and the state of the thermoregulation system) of a person.

The article discusses a number of the most significant scientific works for each area of research. Identified and systematized the most important problems for study in each of them from the point of view of heat and mass transfer and energy conversion at different levels of the description of biosystems in the human body.

Keywords: *skin temperature, thermal comfort, human thermal receptors, thermoregulation system, mathematical modeling, skin thermomechanics, bioheat transfer*

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