

МАТЕМАТИЧКЕ И ИНФОРМАЦИОНЕ ТЕХНОЛОГИЈЕ
МАТЕМАТИЧЕСКИЕ И ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ
MATHEMATICAL AND INFORMATIONAL TECHNOLOGIES

MIT 2016

ВОДИЧ КОНФЕРЕНЦИЈЕ
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Водич конференције Справочник конференцији Conference Information



MIT 2016

Mathematical and Informational Technologies

Математичке и информационе технологије
Математические и информационные технологии
Mathematical and Informational Technologies

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Conference Information**

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.rs Научни програм:

Главни научни правац конференције је „Математичко моделовање и комбиноване информационе технологије“. Правац је посвећен дискусији о недавном развоју и примени нумеричких метода на решавање практичних проблема. Такође, неки комбиновани информациони проблеми попут обраде података су предмет дискусије. Области интересовања варирају од математичких, рачунарских и информационих метода до моделовања и симулације захтевних апликација. Главне теме интересовања укључују, али нису ограничене следећим:

- Информационе и рачунарске технологије
- Коначне разике и метод коначних елемената
- Метод коначних елемената
- Методе честица
- Рачунарске методе вишег реда
- Рачунарска механика флуида
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- Рачунарска механика лома и оштећења
- Рачунарска физика и рачунарске инжењерске науке
- Моделовање и анализа композитних материјала
- Математичко моделовање и технике предвиђања
- Безбедност и заштита информација
- Обрада, анализа и складиштење информација.

.ru Научная программа:

Основным научным направлением конференции является “Математическое моделирование и информационные технологии”. В рамках данного направления предлагается обсудить последние достижения в области разработки и применения численных методов к практическим задачам, а также некоторые вопросы из области информационных технологий. Круг проблем, представляемый на конференции, включает, но не ограничен следующими направлениями:

- Информационные и вычислительные технологии
- Методы конечных разностей и конечных объемов
- Методы конечных элементов
- Методы частиц
- Вычислительные методы высокого порядка
- Вычислительная гидродинамика
- Вычислительная механика твердого тела
- Вычислительная механика разрушения твёрдых тел
- Вычислительная инженерия и физика
- Моделирование и анализ композитных материалов
- Математическое моделирование и методы прогнозирования
- Информационная безопасность и защита информации
- Обработка, анализ и хранение информации

Scientific program:**.uk**

The main scientific direction of the Conference is “Mathematical modeling and combining information technologies”. The direction is dedicated to the discussion of recent developments and applications of numerical methods applied to practice problems. Also some combined information problems like data processing is discussed. The areas of interested topics vary from the mathematical, computational and information methods to the modeling and simulation of challenging applications. The main interested topics includes but not limited to:

- Information and computing technologies
- Finite differences and finite volume methods
- Finite elements methods
- Particle methods
- High order computational methods
- Computational fluid mechanics
- Computational solid and structural mechanics
- Computational damage and fracture mechanics
- Computational engineering sciences and physics
- Modeling and analysis of composite materials
- Mathematical models and forecasting techniques
- Information security and information protection
- Processing, analysis and storage of information



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Herzegovina, Sarajevo, Bosnia and Herzegovina

Duska Yovovich, professor, University of Pristina temporarily settled in Kosovska
Mitrovica, Kosovska Mitrovica, Serbia

Ziyavidin Yuldashev, professor, National University of Uzbekistan named by after
Mirza Ulugbek, Tashkent, Uzbekistan

Andrei Yurchenko, doctor, Institute of Computational Technologies SB RAS,
Novosibirsk, Russia

Aleksandar Zoric, professor, University of Pristina temporarily settled in Kosovska
Mitrovica, Kosovska Mitrovica, Serbia

Organizing committee:

Hranislav Milosevic, Serbia, chairman

Denis Esipov, Russia, deputy chairman

Dojcin Petkovic, Serbia, deputy chairman

Ivan Arandelovic, Serbia

Alexey Redyuk, Russia, academic secretary

Dragan Acimovic, Serbia, academic secretary

Gullazzat Dairbayeva, Kazakhstan

Sergei Rylov, Russia

Igor Chehovskoy, Russia

Natasha Kontrec, Serbia

Anja Jokic, Serbia

Slavica Dasic, Serbia

Tatyana Djekic, Serbia

Dragan Radovanovic, Serbia

Stefan Panic, Serbia

Vladica Stojanovic, Serbia

Milena Petrovic, Serbia

Jelena Vujakovic, Serbia

Danijel Djosic, Serbia

Aleksandar Valjarevic, Serbia

Zoran Dragovic, Serbia

Dragan Doric, Serbia

Eugen Ljajko, Serbia

Tanja Jovanovic, Serbia

Dejan Stosovic, Serbia

Andjela Lekic, Serbia

.rs План рада конференције МИТ 2016 - Врњачка Бања

Недеља, 28.08.2016.	16:00 - 21:00	Долазак и регистрација учесника
Понедељак, 29.08.2016.	08:00	Регистрација учесника
	09:00	Отварање конференције
	09:45	Пленарна седница
	10:30	Коктел
	11:30	Пленарна седница
	13:30	Ручак
	15:00	Рад по секцијама
	16:20	Кафе пауза
	16:40	Рад по секцијама
	18:00	Постер презентације
	19:00	Вечера
	21:00	Округли сто: Дигитализација културног блага, МИ САНУ, Београд и ИАИЕ, Новосибирск
Уторак, 30.08.2016.	09:00	Пленарна седница
	11:00	Кафе пауза
	11:30	Пленарна седница
	13:30	Ручак
	15:00	Рад по секцијама
	16:20	Кафе пауза
	16:40	Рад по секцијама
	18:00	Постер презентације
	19:00	Свечана вечера - банкет
Среда, 31.08.2016.	09:00	Пленарна седница
	11:00	Кафе пауза
	11:30	Пленарна седница
	13:30	Ручак
	15:00	Рад по секцијама
	16:20	Кафе пауза
	16:40	Рад по секцијама
	18:00	Постер презентације
	19:00	Вечера
	21:00	Округли сто: Advanced optics and Laser technologies, МИ САНУ, Београд и ИАИЕ, Новосибирск
Четвртак, 01.09.2016.	09:00	Одлазак учесника Конференције
	09:00	Део учесника Конференције, путује за Бечиће, Црна Гора, где наставља са даљим радом.

План рада конференције МИТ 2016 - Будва**.rs**

Петак, 02.09.2016.	14:30	Пленарна седница
	16:15	Рад по секцијама
	17:00	Слободне дискусије
	18:00	Завршетак рада
Субота, 03.09.2016.	14:30	Пленарна седница
	16:15	Рад по секцијама
	17:00	Слободне дискусије
	18:00	Завршетак рада
Недеља, 04.09.2016.	14:30	Пленарна седница
	16:15	Рад по секцијама
	17:00	Слободне дискусије
	18:00	Завршетак рада
Понедељак, 05.09.2016.	14:30	Округли сто
	17:00	Затварање конференције
Уторак, 06.09.2016.	09:00	Одлазак учесника Конференције



.ru Расписание работы конференции МИТ 2016 - Врњачка Бања

Воскресенье, 28.08.2016.	16:00 - 21:00	Приезд и регистрация участников
Понедельник, 29.08.2016.	08:00	Регистрация участников
	09:00	Открытие конференции
	09:45	Пленарное заседание
	10:30	Коктель
	11:30	Пленарное заседание
	13:30	Обед
	15:00	Секционные заседания
	16:20	Перерыв
	16:40	Секционные заседания
	18:00	Стендовые доклады
	19:00	Ужин
	21:00	Круглый стол
Вторник, 30.08.2016.	09:00	Пленарное заседание
	11:00	Перерыв
	11:30	Пленарное заседание
	13:30	Обед
	15:00	Секционные заседания
	16:20	Перерыв
	16:40	Секционные заседания
	18:00	Стендовые доклады
	19:00	Торжественный ужин - банкет
Среда, 31.08.2016.	09:00	Пленарное заседание
	11:00	Перерыв
	11:30	Пленарное заседание
	13:30	Обед
	15:00	Секционные заседания
	16:20	Перерыв
	16:40	Секционные заседания
	18:00	Стендовые доклады
	19:00	Ужин
	21:00	Круглый стол
Четверг, 01.09.2016.	09:00	Отъезд участников, завершивших работу на конференции
	09:00	Отъезд участников, продолжающих работу в Бечиче.

Расписание работы конференции МИТ 2016 - Будва**.ru**

Пятница, 02.09.2016.	14:30	Пленарное заседание
	16:15	Секционные заседания
	17:00	Свободные дискуссии
	18:00	Окончание работы
Суббота, 03.09.2016.	14:30	Пленарное заседание
	16:15	Секционные заседания
	17:00	Свободные дискуссии
	18:00	Окончание работы
Воскресенье, 04.09.2016.	14:30	Пленарное заседание
	16:15	Секционные заседания
	17:00	Свободные дискуссии
	18:00	Окончание работы
Понедельник, 05.09.2016.	14:30	Круглый стол
	17:00	Закрытие конференции
Вторник, 06.09.2016.	09:00	Отъезд из Будвы



.uk MIT 2016 Timetable - Vrnjacka Banja

Sunday, 28.08.2016.	16:00 - 21:00	Arrival and registration of participants
Monday, 29.08.2016.	08:00	Registration of participants
	09:00	Conference opening
	09:45	Plenary session
	10:30	Cocktail
	11:30	Plenary session
	13:30	Lunch
	15:00	Oral sessions
	16:20	Coffee break
	16:40	Oral sessions
	18:00	Poster session
	19:00	Dinner
	21:00	Round table
Tuesday, 30.08.2016.	09:00	Plenary session
	11:00	Coffee break
	11:30	Plenary session
	13:30	Lunch
	15:00	Oral sessions
	16:20	Coffee Break
	16:40	Oral sessions
	18:00	Poster session
	19:00	Banquet
Wednesday, 31.08.2016.	09:00	Plenary session
	11:00	Coffee break
	11:30	Plenary session
	13:30	Lunch
	15:00	Oral sessions
	16:20	Coffee break
	16:40	Oral sessions
	18:00	Poster session
	19:00	Dinner
	21:00	Round table
Thursday, 01.09.2016.	09:00	Departure
	09:00	Departure of participants who continue to work in Bechich.

MIT 2016 Timetable - Budva

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Friday, 02.09.2016.	14:30	Plenary session
	16:15	Oral sessions
	17:00	Free debate
	18:00	End of day
Saturday, 03.09.2016.	14:30	Plenary session
	16:15	Oral sessions
	17:00	Free debate
	18:00	End of day
Sunday, 04.09.2016.	14:30	Plenary session
	16:15	Oral sessions
	17:00	Free debate
	18:00	End of day
Monday, 05.09.2016.	14:30	Round table
	17:00	Conference closing
Tuesday, 06.09.2016.	09:00	Departure



PLENARY SESSION

August, 29 (first day), Vrnjacka Banja			
Session 1:			
Chairmen: Yuriy Zaharov, Hranislav Milosevic			
09:45 1-1	Serbia	Milovanovic G.	Gradimir V. Milovanovic
		Nonstandard Quadratures and Applications in the Fractional Calculus	
10:30	Cocktail reception		
Session 2			
Chairmen: Sergey Smagin, Zarko Pavicevic			
11:30 1-2	Russia	Samgin S. I., Lupyan E. A., Sorokin A. A., Burcev M. A., Korolev S. P., Proshin A. A., Kramareva L. S.	Smagin Sergey
		Analysis of possibilities of cloud technologies for distributed storage and processing of remote sensing data for environmental monitoring	
12:15 1-3	Serbia	Ognjanovic Z., Raskovic M., Perovic A., Doder D.	Zoran Ognjanovic (Aleksandar Perovic)
		Probability Logics	
August, 30 (second day), Vrnjacka Banja			
Session 3			
Chairmen: Amanbek Zhainakov, Stefan R. Panic			
09:00 2-1	France	Guessab A.	Allal Guessab
		On the enrichment of finite-element approximations	
09:45 2-2	Kyrgyzstan	Zhainakov A.	Amanbek Zhainakov
		About selecting the computational domain when critical modes of plasma arc flow	
10:30	Coffee Break		

Session 4				Chairmen: Ryabko Boris, Nebojsa Arsic	
11:00 2-3	Russia	Barakhnin V., Kozhemyakina O.Yu., Zabaykin A.V.	Vladimir Barakhnin	The automation of the process of creation of the metrical handbooks and concordances with the usage of the computer algorithms of the analysis of Russian poetic texts	
11:45 2-4	Serbia	Arsic N., Spalevic Z., Ilic M.	Nebojsa Arsic	Usage of E-government in the Republic of Serbia	
August, 31 (trith day), Vrnjacka Banja					
Session 5				Chairmen: Zarko Mijajlovic, Guessab Allal	
09:00 3-1	Montenegro	Pavicevic Z.	Zarko Pavicevic	On P-sequences of analytic functions and their applications	
09:45 3-2	Russia	Chernyi S.	Sergey Chernyi	Methods for optimal control of hydraulic fracturing process	
10:30	Coffee Break				
Session 6				Chairmen: Vladimir Barakhnin, Sergey Chernyi	
11:00 3-3	Serbia	Stefan R. Panić	Stefan R. Panić	Algorithms for signal drawbacks mitigation in fading environment	
11:45 3-4	Serbia	Žarko Mijajlović	Žarko Mijajlović	Applications of regularly varying functions in the study of cosmological parameters	

September, 02 (fifth day), Budva			
Session 7		Chairmen: Viktor Kasyanov, Amanbek Zhainakov	
15:30 5-1	Russia	Lepikhin A., Chernyakova N.	Anatoliy Lepikhin A risk assessment methodology for critical infrastructure
September, 03 (sixth day), Budva			
Session 8		Chairmen: Vladimir Barakhnin, Anatoliy Lepikhin	
15:30 6-1	Russia	Ryabko B., Rakitskiy A.	Boris Ryabko An information-theoretic approach to estimation of the capacity of computers and supercomputers
September, 04 (seventh day), Budva			
Session 9		Chairmen: Hranislav Milosevic, Yuriy Zaharov	
15:30 7-1	Russia	Zakharov Y. N., Miloshevich H., Shokin Y. I., Dolgov D. A.	Yuriy Zakharov Mathematical modeling of artificial aortic heart valve

SECTION 1

MATHEMATICAL MODELING IN HYDRODYNAMICS

August, 29 (first day)				
Conference room "Gruzha" hotel "Zvezda"				
Chairmen: Stefan Panic, Anton Zimin				
15:30	Russia	Andreev V.K.	Andreev Viktor Konstantinovich	On the direct and inverse problems of a creeping motions in a thin layers
	Russia	Arkhipov D.G., Khabakhpashev G.A.	Arkhipov Dmitriy Grigorevich	Mathematical modeling of gravitational waves at two-layer flow interface in a flat horizontal channel
	Russia	Zimin A., Zakharov Y.	Zimin Anton	Numerical simulation of surface waves arising from underwater landslide movement
	Russia	Bodiakin E.V., Peretokin S.A., Simonov K.V.	Bodiakin Evgeniy Vladimirovich	Evaluation of Seismic Hazard Using Seismic Microzonation Methods
16:50				Coffee break
Chairmen: Zakharaov Y. N., Taseiko Olga				
17:10	Russia	Grigorieva I., Zakharov Y.N., Dolgov D.	Zakharov Yuriy Nikolaevich	Mathematical Modeling of Large Blood Vessel Aneurysm Development and Growth
	Russia	Churuksaeva V., Starchenko A.	Churuksaeva Vladislava	Numerical modeling of pollution transport in a river flow
	Russia	Taseiko O., Spitsyna T.P., Radovanovic D., Milosevic H.	Taseiko Olga	Biochemical Processes Of Self-Purification Model In Small Rivers
	Russia	Polishchuk V.Y., Polishchuk Y.M.	Polishchuk Yuriy Mikhailovich	Forecast of dynamics of thermokarst lakes in permafrost based on geo-simulation modeling and remote sensing data
18:30				End of day

August, 30 (second day)				
Conference room “Gruzha” hotel “Zvezda”				
Chairmen: Zhainakov A., Yeltsov I.				
15:30	Russia	Yeltsov I.N., Eltsov T., Makarov A., Nikitenko M.	Yeltsov Igor Nikolaevich	Effect of Dielectric Permittivity Distribution in Invaded Zone on Induction Log Data
	Russia	Esipov D.V., Popenov A. Y.	Popenov Alexander	The simulation of viscous flows with disperse particles in the flat channel
	Kyrgyzstan	Zhainakov A., Sultangazieva R.T., Medralieva B.N.	Zhainakov Amanbek	Computational modeling of metal vapour influence on the electric arc welding
	Russia	Perepechko Y., Sorokin K.	Perepechko Yuriy	Two-phase convection in acoustic field
16:50	Coffee break			
Chairmen: Ivanov Konstantin, Voronina Tatyana				
17:10	Russia	Zakharov Y.N., Botvenko D.V., Filatov Y.M., Li A.A., Perminov V.A.	Zakharov Yuriy Nikolaevich	Mathematical Model of Ignition of Gas-Air Mixture and Fine Coal Dust Laminar Flow
	Russia	Zakharov Y.N., Nudner I.S., Geidarov N.A., Ivanov K., Semenov K.K., Stukolov S., Yushkov A.	Ivanov Konstantin	Computational Investigation of Turbulent Flow Impact on Noncohesive Soil Erosion near Foundations of Gravity Type Oil Platforms
	Russia	Dekterev A.A., Dekterev A.A., Minakov A.V.	Minakov Andrey Victorovich	Numerical simulation of industrial flames
	Russia	Gachenko A.S., Bychkov I., Rugnikov G.M., Hmelnov A.E.	Hmelnov Alexei Evgenievich	3-D modeling of Angara river bed
18:30	End of day			

SECTION 2

MATHEMATICAL MODELING IN MECHANICS OF CONTINUA

August, 29 (first day)				
Conference room "Morava" hotel "Zvezda"				
Chairmen: Ramazanov Gaukhar, Orlov Maxim				
15:30	Russia	Khisamutdinov A.	Khisamutdinov Alfred	On approach "Successive approximations by characteristic interactions" for inverse problems of nuclear-geophysical technologies
	Kazakhstan	Ramazanov G., Assilbekov B., Zhabbasbayev U., Sattinova Z.	Ramazanov Gaukhar	Modeling of Beryllia Ceramics Formation Process
	Russia	Gerasimov A.V., Pashkov S.V., Khristenko Y.F.	Gerasimov Alexander Vladimirovich	Single and group strikes of high-velocity elements in a spacecrafts
	Russia	Orlov M.Y., Bogomolov G.N., Orlova Y.N.	Orlov Maxim Yurevich	Studies of the behavior of ice under shock and explosive loading
16:50	Coffee break			
Chairmen: Stojanovic Vladica, Gerasimov Aleksandar				
17:10	Serbia	Milovanović G.V., Stojanović V., Kevkić T.	Stojanović Vladica	Application of the homotopy perturbations in the surface-potential-based MOSFET modeling
	Serbia	Pecić L., Miodragović G., Bulatović R., Ivanović S., Aleksandrov S.	Pecić Ljiljana	Loop Bat Family Algorithm (Loop BFA) Application for Problem Solving in Numerical Optimization
	Russia	Gerasimov A.V., Cherepanov R.O.	Gerasimov Alexander Vladimirovich	Tensor smooth length for SPH modelling of high speed impact
18:10	End of day			

August, 30 (second day)				
Conference room "Morava" hotel "Zvezda"				
Chairmen: Golusko Sergey, Semisalav Boris				
15:30	Russia	Golushko S.K.	Golushko Sergey	Composite Structures: Mathematical Modeling, Calculation and Optimization
	Russia	Amelina E.V., Golushko S.K., Yurchenko A.	Amelina Evgeniya Valerevna	The problems of analysis and design of hybrid pressure vessels
	Russia	Semisalov B.V., Golushko S.K.	Semisalov Boris Vladimirovich	On the Modelling and Simulation of Anisogrid Shells of Zero Gaussian Curvature with Error Control
	Russia	Dimitrienko Y.I., Zakharova Y.V., Sborschikov S.V.	Zakharova Yulia Vladimirovna	Multiscale modeling of strength properties of dispersion-reinforced composite materials produced by additive technologies
16:50	Coffee break			
Chairmen: Idimeshev Semyon, Varigina Maria				
17:10	Russia	Semisalov B.V. Kuzmin G.A.	Semisalov Boris Vladimirovich	Modification of Fourier Approximation for Solving Boundary Value Problems Having Singularities of Boundary Layer Type
	Russia	Varygina M.	Varygina Maria	Numerical Algorithm for the Solution of Dynamic Problems in Micropolar Theory of Rods and Thin Plates
	Russia	Idimeshev S., Golushko S.K., Shapeev V.P.	Idimeshev Semyon	hp-Version of Collocation and Least Residuals Method in Mechanics of Laminated Composite Plates
18:10	End of day			

SECTION 3

MATHEMATICAL MODELING

August, 29 (first day)			
Conference room "Goch" hotel "Zvezda"			
Chairmen: Kazakov A., Shornikov Y.			
15:30	Russia	Shornikov Y.V., Dostovalov D.N., Nasyrova M.S.	Shornikov Yuri Vladimirovich
	Russia	Sidelnikov O.S., Redyuk A., Fedoruk M.P., Turitsyn S.K.	Sidelnikov Oleg Sergeevich
	Russia	Kazakov A., Orlov S.	Kazakov Alexander
	Russia	Kamenshchikov L.P., Krasnov I.V.	Kamenshchikov Leonid P.
16:50			
Coffee break			
Chairmen: Bartsev Sergey, Ivan Arandjelovic			
17:10	Russia	Bartsev S.I., Belolipetskii P., Degermendzhi A., Saltykov M.	Bartsev Sergey Igorevich
	Russia	Bolodurina I., Golovatskaia E., Khanzhina N.	Bolodurina Irina
	Kazakhstan	Muradov A.D., Seidakhmet A.Z.	Muradov Abyl Darhanovich
18:10			
End of day			

August, 30 (second day)				
Conference room "Goch" hotel "Zvezda"				
Chairmen: Mankhanova Azhar, Shestakovskaya Elena				
15:30	Russia	Smolekho I.V., Sadovskaya O.V., Sadovskii V.M.	Smolekho Irina Vladimirovna	Numerical Analysis of Acoustic Waves in a Liquid Crystal Taking into Account Couple-Stress Interaction
	Russia	Kuropatenko V. Shestakovskaya E.	Shestakovskaya Elena	About verification of calculation methods of the shock waves
	Russia	Muksimova R., Zhitnikov V.	Muksimova Roza	Approximation and Identification Errors Investigation
	Kazakhstan	Mankhanova A.Y., Turegeldiyeva K.A., Sadykov R.M., Zhabbasbayev U.K., Zolotukhin A.B., Yazynina I.V., Shelyago E.V.	Mankhanova Azhar Yerlanovna	EOR Screening Using Fuzzy Logic and Comparing with the Results of Filtration Experiments (on the Example of One Kazakhstani Oil Field)
16:50	Coffee break			

SECTION 4

INFORMATION TECHNOLOGIES

August, 29 (first day)			
Conference room "Kopaonik" Hotel "Zvezda"			
Chairmen: Barakhnin V., Knyazeva A.			
15:30	Russia	Barakhnin V.B., Kozhemyakina O.Y., Zabaykin A.V., Pastushkov I.S.	Barakhnin Vladimir Borisovich
	Russia	Zelenchuk A., Molorodov Y.I.	Molorodov Yurii I.
	Russia	Knyazeva A.A., Kolobov O.S., Turchanovsky I.Y., Ilmayurov V.O., Trubinov V.V.	Knyazeva Anna Anatolievna
	Russia	Kosyakov D.V., Guskov A., Bykhovtsev E.S.	Kosyakov Denis Viktorovich
16:50			Webometric Analysis of Russian Academic and Education Web
Coffee break			
Chairmen: Milic Petar, Zaikin Oleg			
17:10	Russia	Ryabko B.Y.	Ryabko Boris Yakovlevich
	Serbia	Milić P.	Milić Petar
	Russia	Gribanova I.A., Zaikin O.S., Kochemazov S.E., Otpuschennikov I.V., Semenov A.A.	Zaikin Oleg Sergeevich
	Serbia	Bjelica M.	Bjelica Momcilo
18:30			Asymptotic equidistance of averages H, G, A and Q for approximately equal statistical data and moments
End of day			

August, 31 (third day)				
Conference room “Kopaonik” Hotel “Zvezda”				
Chairmen: Ryabko B., Kasyanov V.				
15:30	Russia	Guskov A., Ryabko B., Selivanova I.	Ryabko B.	Information-Theoretic Approach to Classification of Scientific Documents
	Russia	Hmel'nov A.E., Bychkov I., Rugnikov G.M., Gachenko A.S., Fereferov E.S.	Hmel'nov Alexei Evgenievich	Methods for automation of development of information systems using specifications of database applications
	Russia	Kasyanov V.N., Kasyanova E.V.	Kasyanov Victor Nikolaevich	Methods and Tools of Parallel Programming
	Russia	Gruzenkin D., Chernigovskiy A.S., Tsarev R.Y.	Gruzenkin Denis	Requirements for N-version Software Modules Design and Development
16:50	Coffee break			
Chairmen: Barakhnin V., Nugumanova A.				
17:10	Russia	Mansurova M., Barakhnin V.B., Khibatkhanuly E., Aubakirov S., Musina A.	Barakhnin Vladimir Borisovich	Parallel Text Document Clustering based on Genetic Algorithm
	Russia	Savina N., Ryabko B., Nechta I.	Ryabko Boris	Applications of Information Theory and Psychology Laws to Optimization of Internet Search
	Kazakhstan	Nugumanova A., Mansurova M.E., Alimzhanov Y., Baiburin Y.	Nugumanova Aliya	Using Non-Negative Matrix Factorization for Text Segmentation
18:10	End of day			

SECTION 5

APPLIED MATHEMATICS

August, 30 (second day)				
Conference room "Goch" Hotel "Zvezda"				
Chairmen: Zekovic B., Arandjelovic I.				
17:10	Montenegro	B. Zekovich	B. Zekovich	Initial consideration about tensor product of irreducible modules over n-bialgebras
	Serbia	Babić R.V.	Babic Ranko V	Infinity and infinitesimal in interpretation of Fourier Transform nature
	Serbia	Dmitrovic M., Draskovic D., Obradovic Cuk J.	Dmitrovic Mirjana	Different Types of Regression through examples
	Serbia	Arandelovic I.D.	Arandelovic Ivan D.	On the Weak Admissibility on Topological Vector Spaces and its Applications in Nonlinear Analysis and Infinite Dimensional Topology
18:30	End of day			
August, 31 (third day)				
Conference room "Goch" Hotel "Zvezda"				
Chairmen: Jela Susic, Valjarevic Dragana				
15:30	Montenegro	Jela Susic	Jela Susic	New space of distributions with applications to photon distribution equation in tne space with an infinite absorption point
	Serbia	Draskovic D., Dmitrovic M.	Draskovic Dragana	Finite difference method for solving general linear differential equations

	Serbia	Kolarević M., Radičević B., Rajović M., Grković V., Đorđević V.	Kolarević Milan	Development of the Algorithm for the Formation of Empirical Model for the Ternary Mixture Experiments
	Serbia	Valjarevic D., Ljajko E., Jovanovic T.	Valjarevic Dragana	Theory of Statistical Causality and Quasimartingales
16:50	Coffee break			
Chairmen: Ranko Babic, Anna Lempert				
17:10	Serbia	Babic R.V., Babic L.	Babic Ranko V	A new approach to representation of contours in images
	Russia	Lempert A., Kazakov A.	Lempert Anna	Congruent Circles Packing into a Multi-connected Domain with Non-Euclidean Metric and its Applications in Logistics
	Serbia	Dejan Stosovic	Dejan Stosovic	Application of actuarial mathematics in banking
18-10	End of day			

SECTION 5

INFORMATION TECHNOLOGIES IN MANAGEMENT

August, 30 (second day)		
Conference room "Kopaonik" Hotel "Zvezda"		
Chairmen: Sergey Smagin, Nebojsa Arsic		
17:10	Russia	Grecheneva A.V., Konstantinov I.S., Kuzichkin O.R.
		Grecheneva Anastasia Vladimirovna
	Russia	Kamaev A.N., Karmanov D.A., Sukhenko V.A., Smagin S.I.
		Smagin Sergey Ivanovich
	Russia	Rubtsov K.A., Lazarev S., Maslakov Y.N.
		Rubtsov Konstantin Anatol'evich
	Russia	Kuklin E.Y., Ushenin K.S., Byordov D.A., Sozykin A.
		Sozykin Andrey
	Russia	Dorofeev N.V., Kuzichkin O.R., Podmaster'ev K.V.
		Dorofeev Nikolai Victorovich
18:50		End of day
August, 31 (third day)		
Conference room "Gruzha" Hotel "Zvezda"		
Chairmen: Natasa Kontrec, Aleksandar Valjarevic		
15:30	Serbia	Kontrec N., Petrovic M., Vujakovic J., Milosevic H.
		Kontrec Nataša
		Implementation of Weibull's model for determination of aircraft's parts reliability and spare parts forecast

	Montenegro	Kordić S.	Kordić Stevan	Application of Sedimentation Algorithm for Solving SAT and Max-SAT Problems
	Serbia	Lazić L., Alashhb M.	Lazić Ljubomir	Software Test Case Optimization Applying Design of Experiments Methods
	Serbia	Valjarevic A., Radovanovic D., Djekic T., Taseiko O., Milosevic H.	Valjarevic Aleksandar	GIS analysis of health objects and public transport in the city Belgrade
16:50	Coffee break			
Chairmen: Ivan Arandjelovic, Konstantyn Polishchikov				
17:10	Serbia	Panic S., Jaksic B., Spalevic P., Smilic M., Markovic A.	Smilic Marko	Analisis of the influence of communication parameters of FSO channels on the reception quality
	Russia	Grecheneva A.V., Eremenko V.T., Kuzichkin O.R.	Grecheneva Anastasia Vladimirovna	The method of selection of key geodynamic objects
	Russia	Polshchykova O., Lazarev S., Polshchikov K., Konstantinov I.S.	Polshchikov Konstantyn	Model of neuro-fuzzy prediction of confirmation timeout in a mobile ad hoc network
	Russia	Moskvichev V.V., Taseiko O.	Taseiko Olga	Risks Assessment Of Industrial Region Development As Social-Natural-Technogenic System
18:30	End of day			

SECTION 7

INFORMATION TECHNOLOGY IN COMMUNICATIONS

August, 30 (second day)				
Conference room "Kopaonik" Hotel "Zvezda"				
Chairmen: Stefanovic Hana, Stefan Panic				
15:30	Serbia	Stefan P., Jaksic B., Spalevic P.	Stefan Panic	Analysis of communication parameters FSO channels on reception quality
	Serbia	Djosic D., Radenkovic D., Milenkovic V., Jovkovic S.	Djosic Danijel	Ratio of Weibull random variable and α - μ random variable
	Serbia	Stefanovic H., Milic D.	Stefanovic Hana	Implementing Simulink Low Bitrate Codec Model for VoIP
	Serbia	Stefanovic M., Djasic D., Doljak V., Radenkovic D.	Stefanovic Mihajlo	Wireless communication system in the presence of Rician and Nakagami-m short term fading
16:50			Coffee break	

August, 31 (third day)				
Conference room "Morava" Hotel "Zvezda"				
Chairmen: Andreeva Nadezda, Gavrilovic Snezana				
15:30	Serbia	Gavrilovic S., Denic N., Korac V., Petrovic V.	Gavrilovic Snezana	Application of e-learning tools in different ways of implementation
	Russia	Andreeva N.M., Pak N.I.	Andreeva Nadezhda Michailovna	Organization of Computer Science Education Process Under the Control of Road Maps in the Conditions of Information Subject Environment
	Serbia	Gavrilovic S., Denic N., Korac V., Petrovic V.	Gavrilovic Snezana	Application of video conference in education and possible ways of its implementation

	Russia	Markov P.V., Rodionov S.P.	Markov Pavel Vladimirovich	The Method of Fast Numerical Solutions Calculations for Seepage Equations Using Continuous Groups of Symmetries
16:50				Coffee break
Chairmen: Djosic Danijel , Stefanovic Caslav				
17:10	Serbia	Stefan P., Spalevic P., Princevic B., Stamenkovic N.	Stefan Panic	Performance analysis of FSO transmission over H-K atmospheric channel
	Serbia	Jovkovic S., Milenkovic V., Djosic D., Popovic Z.	Djosic Danijel	Ratio of product of two Nakagami-m random variables and Rician random variable
	Serbia	Stefanovic C., Djosic D., Milic D., Stefanovic M.	Djosic Danijel	Level crossing rate of macrodiversity system in the presence of k- μ multipath fading, Nakagami-m multipath fading and Gamma shadowing
	Serbia	Miletic A., Stefanovic H., Cirovic Z.	Miletic Ana	The development of interactive, multimedia content using a multi-platform environment
18:30				End of day

SECTION 2

MATHEMATICAL MODELING IN MECHANICS OF CONTINUA

September, 2 (fifth day)			
Hotel Mediteran, Kongress center			
Chairman: Ramazanov Gaukhar, Zakharov Andrey			
16:15	Russia	Zakharov A., Dimitrienko Y.I.	Zakharov Andrey Development of Preprocessor of SIGMA Software Package for Generating Adaptive Grids
	Russia	Khislamutdinov A., Velker N.	Khislamutdinov Alfred Comparison of Imitation splitting Monte Carlo methods with DSMC ones on the problem "on flow over a flat plate"
17:00	End of day		

SECTION 3

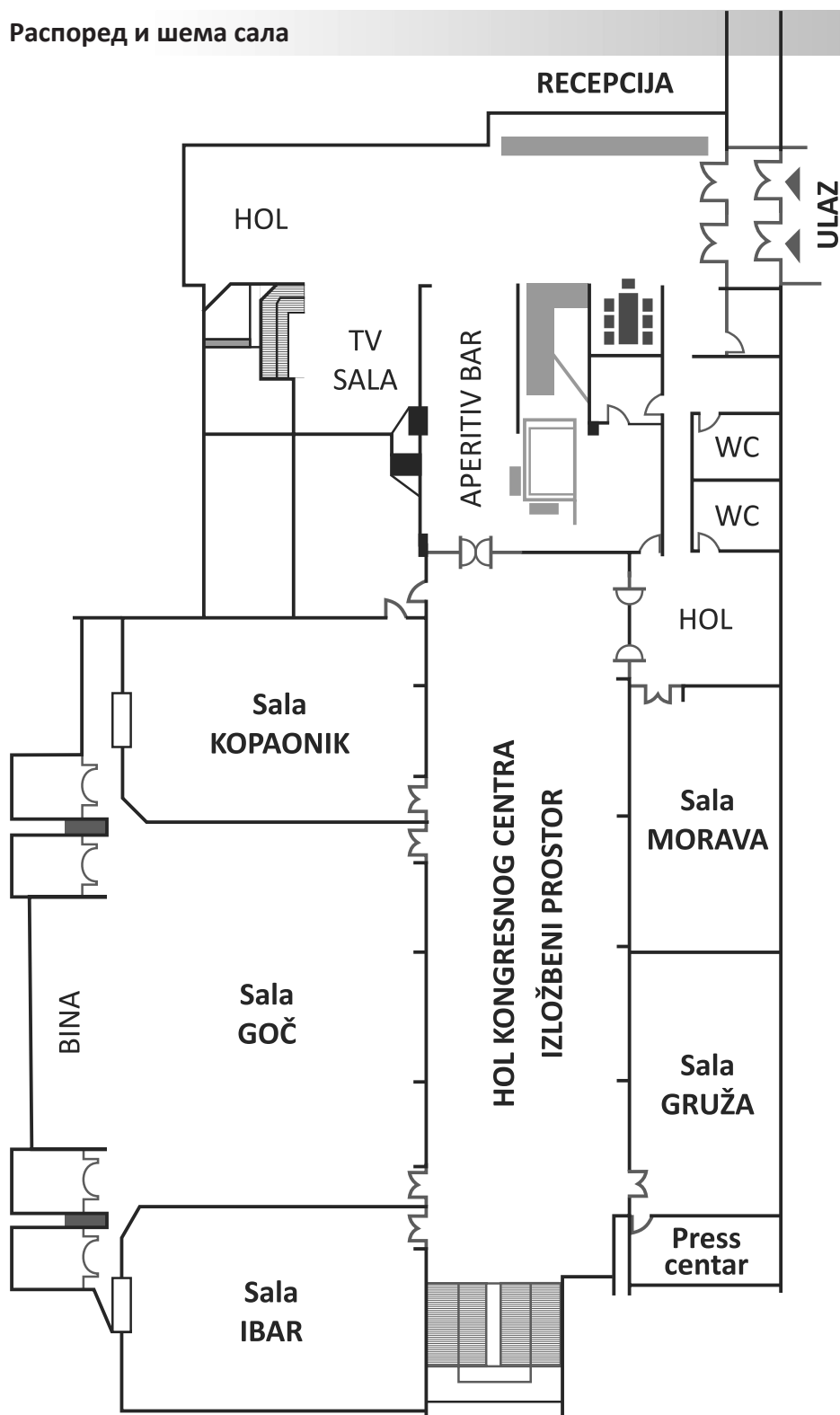
MATHEMATICAL MODELING

September 3 (sixth day)			
Hotel Mediteran, Kongress center			
Chairman: Seydahmet A., Shornikov Y.			
16:15	Russia	Sozykin A., Epanchintsev T., Zverev V., Bersenev A.	Sozykin Andrey Using the FEniCS Framework for Heart Simulation on Parallel Computing Systems
	Kazakhstan	Gritsenko I.S., Seidakhmet A.Z., Bekbagambetov A., Gritsenko P.S.	Seydahmet Askar Dynamical model of humanoid robot biolod type A
17:00	End of day		

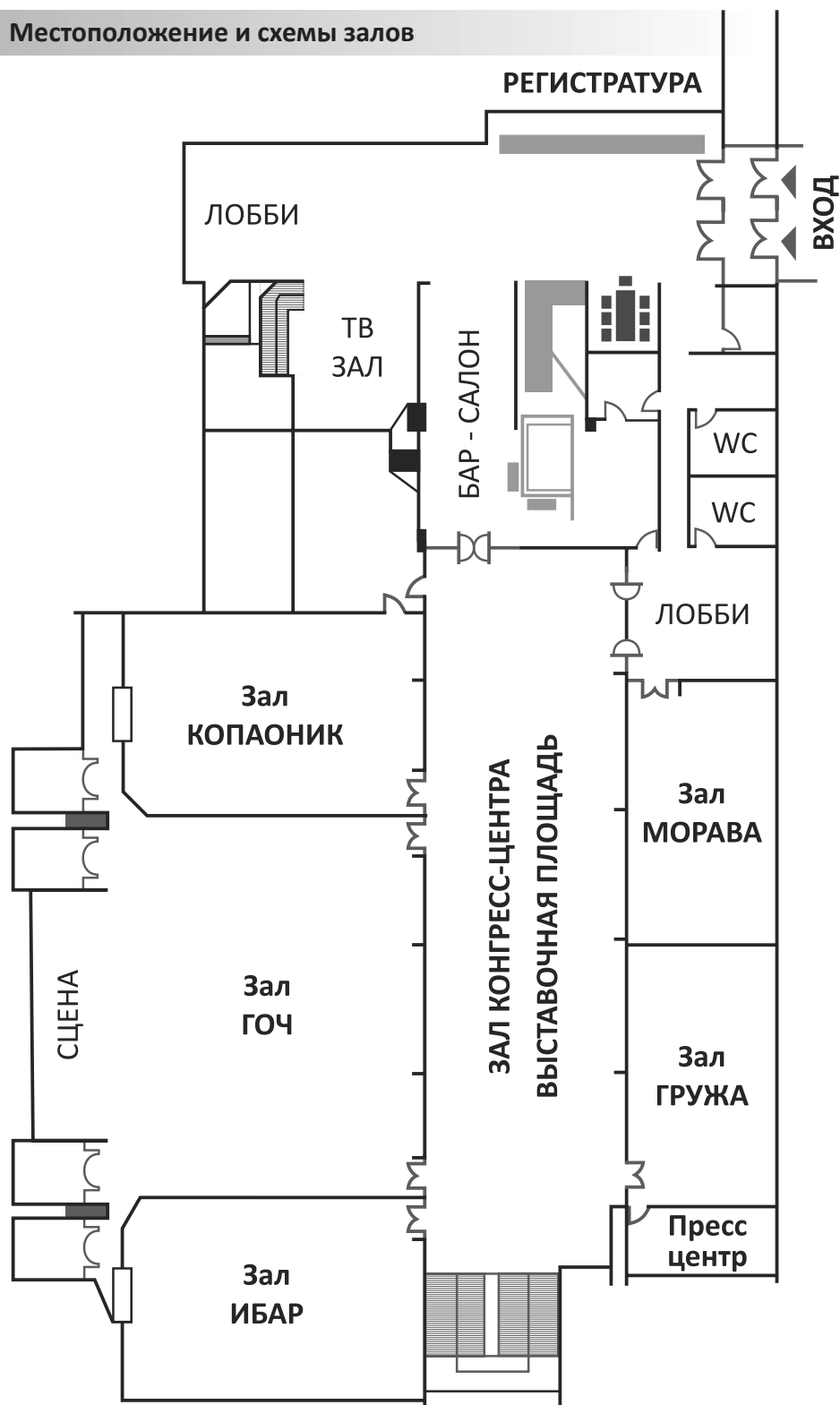
SECTION 4			
APPLIED MATHEMATICS			
September, 4 (seventh day)			
Hotel Mediteran, Kongress center			
Chairman: Zaikin O., Zakharov Y.N.			
16:15	Russia	Kochemazov S.E., Zaikin O.S., Semenov A.A.	Zaikin Oleg Sergeevich The comparison of different SAT encodings for the problem of search for systems of orthogonal Latin squares
	Russia	Chernskutov M.A.	Chernskutov Mikhail Alexandrovich Methods for High Performance Graph Processing
17:00	Conference Summary		

Распоред и шема сала

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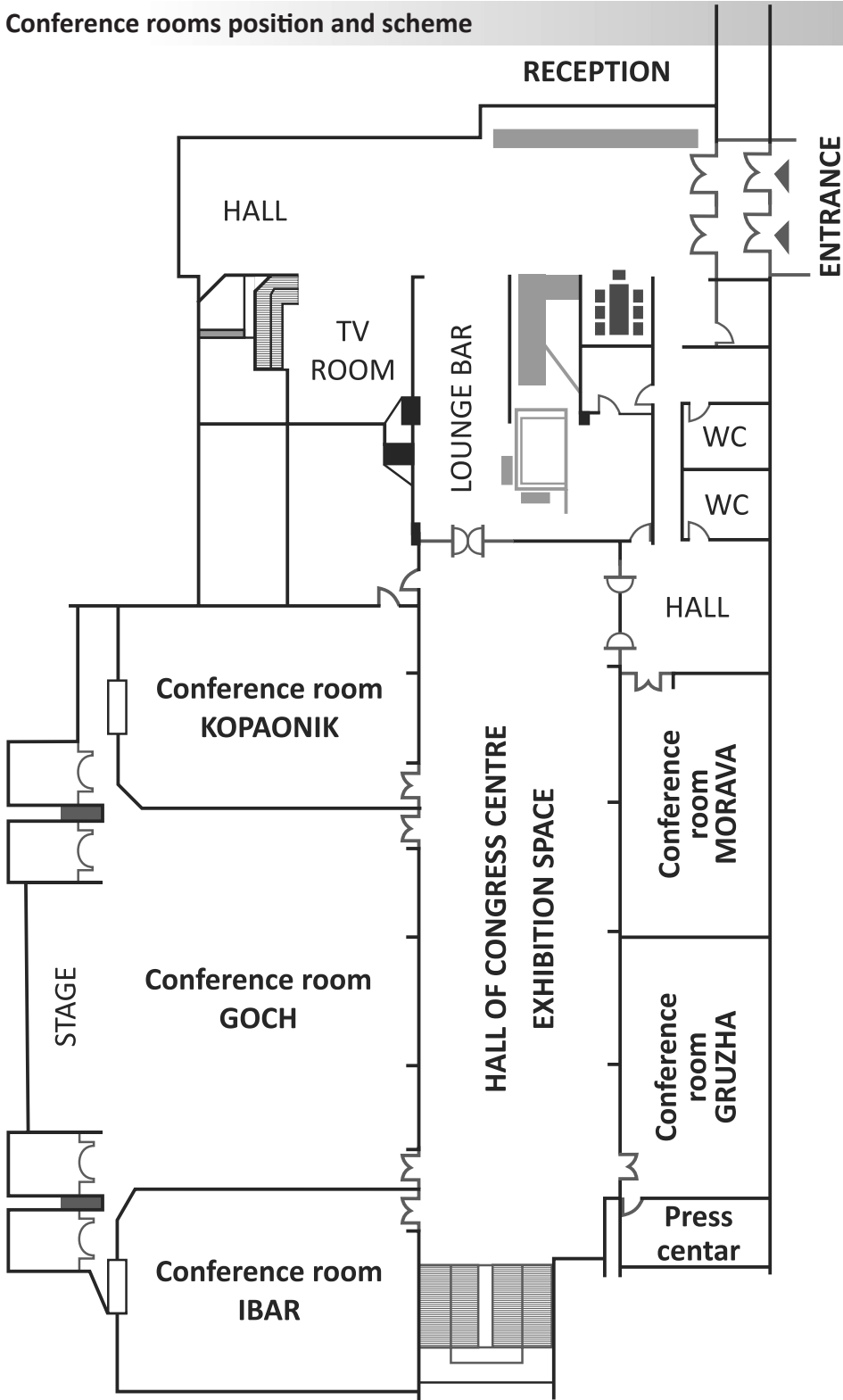


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Conference rooms position and scheme

.uk



**АПСТРАКТИ
ТЕЗИСЫ
ABSTRACTS**

USAGE OF E-GOVERNMENT IN THE REPUBLIC OF SERBIA

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²*Singidunum University, Belgrade, Serbia*

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Different electronic governance services are being introduced by State authorities in order to facilitate business, accelerate the process of information exchange and reduce the potential costs. The concept of e-governance predicts interactive electronic services tailored to the needs of citizens and businesses, and integrated at all levels of the public sector. In this way e-governance can provide more efficient, transparent and accountable public services. Application of these services requires adoption of appropriate legal regulations by state authorities. These legal acts regulate every aspect of application as well as sanctions for possible abuse. This paper outlines the current situation of electronic administration in the Republic of Serbia, and the strategy for further development. Paper provides a comparison with similar services in the neighboring countries from the aspect of implemented services, and applied security mechanisms. In addition, the paper covers the legal regulations applied when these services are in use.

MIT 2016

METHODS FOR OPTIMAL CONTROL OF HYDRAULIC FRACTURING PROCESS

S. Cherny, V. N. Lapin, D. S. Kurankov, A. S. Astakova,
Yu. I. Shokin, and D. V. Esipov

Institute of Computational Technologies SB RAS, Novosibirsk, Russia

The model of fracture initiation and propagation from the cavity in elastic media caused by viscous fluid pumping is proposed. Based on this model the method for optimal control of fracture initiation and propagation processes is developed. Input parameters of fracture initiation and propagation model are: the surface of the cavity in infinite elastic media; pumping pressure of fluid that causes fracture initiation and propagation (or pumping schedule for fluid of given rheology); elastic media parameters. Output characteristics of the model are: the fracture surface; fracture width distribution; speed of fracture front propagation. Determination of output characteristics using the input parameters is the direct problem of fracture propagation. By solving it one can predict the geometry of forming fracture, volume of oil produced from the fracture, calculate costs of this process, etc. Inverse problem considers finding the input parameters of fracture initiation and propagation model with which the solution of direct problem satisfies the given objective functions of fracture initiation and propagation processes. Optimal control of hydraulic fracturing process consists in the solution of inverse problem. It requires choosing the parameters of rheological laws for fluid, pumping schedule, conditions of fracture initiation (shape of the cavity, its orientation against in-situ stresses of elastic media) that satisfy the needed location of incipient fracture, linearity of fracture propagation trajectory, uniformity of fracture width distribution along the trajectory, no profile twisting along the fracture trajectory, minimal costs for hydraulic

fracturing, maximal volume of produced oil, etc. To solve the inverse problem the method of optimization design is used. This method consists choosing the input parameters of direct problem that do provide the best fulfillment of one or several objectives. Strategy of input parameters adjustment is based on the genetic algorithm.

MIT 2016

THE AUTOMATION OF THE PROCESS OF CREATION OF THE METRICAL HANDBOOKS AND CONCORDANCES WITH THE USAGE OF THE COMPUTER ALGORITHMS OF THE ANALYSIS OF RUSSIAN POETIC TEXTS

V. B. Barakhnin

Institute of Computational Technologies SB RAS, Novosibirsk, Russia

In this paper we outline the main approaches to automation of the process of statistical analysis of the lower structural levels (meter, rhythm, phonetics, vocabulary, grammar) of Russian poetic texts, and we present the algorithm of the complex analysis of Russian poetic texts in order to automate the process of metric reference books and concordances. The results of this analysis will significantly expand the opportunities of the philologists, examining as the indicated above levels of poetry, as well their semantic and pragmatic features; in addition the philologists can be spared from routine work, the range of analyzed works can be widened by reducing the dependence of the quality of the comparative analysis on the personal knowledge of the researcher.

MIT 2016

ALGORITHMS FOR SIGNAL DRAWBACKS MITIGATION IN FADING ENVIRONMENT

Stefan R. Panić

Faculty of Natural Science and Mathematics, University of Pristina, Kosovska Mitrovica, Serbia

Signal propagation in the wireless medium is accompanied by various side effects and drawbacks such as multipath fading and shadowing. Mathematical characterization of these complex phenomena, which describes various types of propagation environments, will be presented. First, various models, already known in the literature, such as: Rayleigh, Ricean, Hoyt, Nakagami-m, Weibull, α - μ , η - μ , and κ - μ fading model, used for the statistical modeling of multipath influence, will be introduced. Then, some of models for statistical modeling of shadowing influence, such as: long-normal and Gamma shadowing model, will be mentioned. Finally, some respect will be paid to composite models, which correspond to the scenario when multipath fading is superimposed on shadowing. Suzuki, Ricean-shadowing and Generalized K composite fading models have been discussed. Further analysis

will be extended by introducing correlative fading models, considering exponential, constant and general type of correlation between random processes. Several performance measures related to the wireless communication system design, such are: average signal-to-noise ratio, outage probability, average symbol error probability, amount of fading, level crossing rate and average fade duration, will be defined and mathematically modeled. Basic concepts of several space diversity reception algorithms, such are: maximal ratio combining, equal gain combining, selection combining and switch-and stay combining, will be portrayed also, with emphases put to the reception performance measures evaluation. Necessity and the validity of space diversity reception algorithms usage, from the point of view of multipath fading and CCI influence mitigation, will be shown by first evaluating single-channel receiver performances for few general propagation models and then by presenting performance improvement at the receiver, achieved by appliance of diversity reception algorithms through the standard performance criterions. Also, necessity and validity of the macrodiversity algorithm reception usage, from the point of view of multipath fading and shadowing mitigation through the second order statistical measures at the output of the macrodiversity algorithm receiver, will be considered.

MIT 2016

NONSTANDARD QUADRATURES AND APPLICATIONS IN THE FRACTIONAL CALCULUS

Gradimir V. Milovanović

Mathematical Institute of the SASA, Belgrade, Serbia

Nonstandard Gaussian and Gauss-Lobatto quadrature formulas are considered, including their numerical construction. Applications of this kind of quadratures in fractional calculus to approximation of fractional derivatives are presented. Several numerical experiments are given in order to illustrate and test the behaviour of these quadratures.

MIT 2016

PROBABILITY LOGICS

Zoran Ognjanovic

Mathematical Institute of the SASA, Belgrade, Serbia

The paper summarizes the results of the authors in formalization of uncertain reasoning. A number of probability logics is considered. Their axiomatizations, completeness, compactness and decidability are addressed. Some possible applications of probability logics are analyzed, e.g., nonmonotonic reasoning, measuring of inconsistent knowledge bases, heuristic approaches to satisfiability etc.

ON THE ENRICHMENT OF FINITE-ELEMENT APPROXIMATIONS

Allal Guessab

Université de Pau et des Pays de l'Adour, Pau, France

In this talk we present a general method for enriching (conforming or nonconforming) finite element approximations, via the use of additional enrichment functions (not necessary polynomials). To this end, we will first give, under certain conditions on enrichment functions, an abstract general theorem characterizing the existence of any enriched finite element approximation. We then establish four key lemmas in order to prove under an unsolvence condition a more practical characterization result. As illustrative applications, using a general class of trapezoidal, midpoint and Simpson type cubature formulas or their perturbed versions, which employ integrals over facets, we will describe how our method may be applied to build new enriched nonconforming finite elements. There are respectively obtained as an enrichment of the Han rectangular element and the well known Wilson's element.

MIT 2016

ON P -SEQUENCES OF ANALYTIC FUNCTIONS AND THEIR APPLICATIONS

Zarko Pavicevic

Faculty of Natural Sciences and Mathematics, University of Montenegro, Podgorica, Montenegro

Problems in Theory of boundary properties of functions occupy one of the central places in theory of functions and theory of cluster sets. They find application in theory of functions of a real variable, theory of functions of a complex variable, potential theory, Fourier analysis, functional analysis, measure theory, theory of dynamical systems, theory of fractals etc.

In this paper we deal with local boundary properties of analytic functions. Here the analytic functions will include holomorphic functions and meromorphic functions of one complex variable. The domain of investigated functions is the open unit disk of the complex plane. Such a domain does not restrict the generality of obtained results, which is guaranteed by the Riemann theorem on conformal mappings from a domain onto the open unit disk.

This announcement consists of the following four parts: P -series and the normality of functions, Jordan curve and P -series, Plesner and Mayer - type theorems and Applications.

In this resume we announce our results.

Let $\gamma \subseteq \mathbf{D}$ be a curve which terminates at a point $e^{i\theta} \in \Gamma$ and let $f : D \rightarrow \mathbf{C}$ be an analytic function.

Then for every $r \in (0,1)$ the following conditions are equivalent:

- (1) f is normal along the curve γ on $D(r) = \{z \mid |z| < r\}$, $0 < r < 1$;
- (2) f does not have a P -sequences in $\Delta_r \gamma$, $\Delta_r \gamma$ is called a curvilinear angle.

Let $f : D \rightarrow \mathbf{C}$ be an analytic function. A simple curve γ contains a P -sequence of a function f if and only if every curvilinear angle $\Delta_r \gamma$ contains a P -sequence.

Let $f : D \rightarrow \mathbf{C}$ be an analytic function. A simple curve γ does not contain a P -sequence of a function f if and only if there exists a curvilinear angle $\Delta_r \gamma$ which does not contain a P -sequence of a function f .

The above results may be used to obtain a better characterization of sets of points are certain rules in Plesner and Meier [4].

The normality of functions, and thus P -sequences of functions, are very important objects in theory of boundary properties of because of they give necessary and conditions for a description of “good” boundary properties of functions.

The set

$$C(f, A, e^{i\theta}) = \{w \in \mathbb{C} : \text{there exists a sequence } \{z_n\} \subseteq A, \lim_{n \rightarrow \infty} z_n = e^{i\theta} \in \Gamma \\ \text{such that } \lim_{n \rightarrow \infty} f(z_n) = w\}$$

is the cluster set of the function $f : D \rightarrow \bar{\mathbb{C}}$ at the point $e^{i\theta}$ along the set A whose closure in $D \cup \Gamma$ contains $e^{i\theta}$.

It may be checked that $C(f, A, e^{i\theta})$ is closed.

THEOREM: Let $f : D \rightarrow \mathbb{C}$ be an analytic function, let $\gamma \subseteq D$ be a curve which terminates at $e^{i\theta} \in \Gamma$, and let $c \in \mathbb{C}$. Then the following conditions are equivalent:

- (1) f is normal along γ on D and $\lim_{\gamma \ni z \rightarrow e^{i\theta}} f(z) = c$;
- (2) c is the Δ_γ -boundary value of f .

Notice that Theorem is a generalization of Theorem 1 in Lehto and Virtanen's paper [5] for an analytic function in the disc D and for the Δ_γ -boundary behavior.

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MIT 2016

A RISK ASSESSMENT METHODOLOGY FOR CRITICAL INFRASTRUCTURE

A. Lepikhin and N. Cherniakova

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Infrastructure protection typifies a problem of risk assessment in a large-scale system. The study offers a methodological framework to identify, prioritize and assess risk. It includes the following major consideration: system approach to risk identification, prioritization of large number of risks or risk scenarios, structured solicitation and effective integration of expert judgment into qualitative and quantitative analysis to supplement limited data availability, extreme and catastrophic event analysis and use of multi objective framework to evaluate management option.

The methodology was illustrated using case studies of selected critical infrastructures of Syberia.

APPLICATIONS OF REGULARLY VARYING FUNCTIONS IN STUDY OF COSMOLOGICAL PARAMETERS

Žarko Mijajlović

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State University of Novi Pazar, Novi Pazar, Serbia*

Most of the cosmological parameters, such as the scale factor $a(t)$, the energy density $\rho(t)$ and the pressure of the material in the universe $p(t)$, under usual circumstances satisfy asymptotically the power law. On the other hand the quantities that satisfy the power law are best modeled by regularly varying functions. The aim of this paper is to apply the theory of regularly varying functions to study Friedmann equations and their solutions which are in fact the mentioned cosmological parameters. In particular we shall consider the possible formulas for cosmological parameters of the dual universe.

MIT 2016

AN INFORMATION-THEORETIC APPROACH TO ESTIMATION OF THE CAPACITY OF COMPUTERS AND SUPERCOMPUTERS

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² *Novosibirsk State University, Novosibirsk, Russia*

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Currently, there are many approaches to evaluate the performance of computer systems. Basically most of the methods are the use of benchmarks, i.e., a test set of tasks, which helps to determine execution time required to solve them. Comparison of computers is performed on the analysis of these execution times. A disadvantage of benchmarks is the need to have a working model of tested system. This imposes restrictions on the usage and increases the cost of the evaluation and comparison of computers. Besides, it is impossible to use benchmarks in order to evaluate computer during the development phase, when there is no working model. Moreover, the objectiveness of benchmarks is reduced by the fact that they are focused on specific tasks.

A concept of computer capacity was suggested and then it was applied to analysis of computers of different kinds. The computer capacity characterizes the performance of real computers with different CPU clock speed, number of processor cores, memory organization and instruction set of processors, etc. It is important to note that the computer capacity is estimated theoretically based on instruction set of processors and their execution times, including latencies of accessing to different types of memory (cache-memory, RAM, etc.), as well as delays associated to restarting the pipeline, to changing of processor context and with exceptions that occur during the execution of instructions. Note that the basis of the developed approach is the concept of Shannon entropy, capacity of the discrete channel and some other ideas, which included in Informational Theory.

In this report we apply the computer capacity for analysis of modern supercomputers. More precisely, we estimate the computer capacity for three following CRAY supercomputers from the top 500 list (November, 2015): Trinity - Cray XC40, Hazel Hen - Cray XC40, and Shaheen II - Cray XC40, which are the sixth, eighth and ninth in the list. It turned out that our theoretical estimations are close to ones derived from benchmarks. Also we consider how the supercomputer parameters have an influence on the capacity and make some recommendations how to increase the performance.

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MIT 2016

ANALYSIS OF POSSIBILITIES OF CLOUD TECHNOLOGIES FOR DISTRIBUTED STORAGE AND PROCESSING OF REMOTE SENSING DATA FOR ENVIRONMENTAL MONITORING

S. I. Smagin¹, E. A. Loupian², A. A. Sorokin¹, M. A. Burtsev²,
S. P. Korolev¹, A. A. Proshin², and L. S. Kramareva³

¹ *Computing Center of FEB RAS, Khabarovsk, Russia*

² *Space Research Institute of RAS, Moscow, Russia*

³ *Far Eastern Center FGBI "SRC" Planeta ", Khabarovsk, Russia*

Currently, remote sensing data systems are a major source of objective information for evaluation and monitoring of the environment and environmental management in various regions of the planet. The growing number of specialized satellites and their features favours almost explosive growth of the amounts of received instrumental data.

Technology and methods of remote sensing data analysis and processing have been rapidly developing in recent years aimed to solve large-scale scientific problems (e.g., studies of volcanic activity, the study of changes in vegetation cover, etc.) [1-5]. For example, a geographically distributed system FGBI SRC "Planeta" daily receives over 1 terabyte of instrumental data from 16 foreign and Russian Earth observation satellites, producing about 350 types of information products and using the IKI technologies and application systems. The total volume of operational and long-term data archives is currently exceeding 0.6 petabytes.

For efficient use of such information, it is necessary to have a specialized system that addresses technological problems related to the data collection and unification, the formation of structured data archives and very large-scale data sets and provides researchers with the instruments implemented in the form of software tools for data analysis.

In solving such a problem, it is impossible to follow the traditional path implying that for each scientific task a separate set of data archives is individually formed and filled with all

available data sources, and specific tools are designed to work with them. This approach has a number of significant drawbacks, because it is necessary to develop and maintain large-scale technological services for every, even a small research project. In addition, it requires significant computational resources allocated for data storage and processing, and for the operation of a large variety of software. Therefore, more and more designers are turning to cloud computing [6-8], translating the solution of these laborious tasks into virtual computing environment and implementing its interaction with their applications and information systems through flexible RESTful web-services.

This trend exists in present-day Russia, where a modern unified geographically distributed system for work with remote sensing data (ERS ETRIS) began to be established a few years ago with the support of the Russian Space Agency. The system should particularly solve the problems of efficient access to distributed archives of satellite data, but now the work is still far from complete.

Under the support of RFBR, the authors are conducting research and developing modern methods and algorithms for storage, processing and analysis of extra large volumes of remote sensing data using the capabilities of cloud computing environments. The work involves the creation of software tools to build and maintain distributed data archives for remote sensing data and their processing results, as well as provides users (including a variety of specialized information systems) with convenient services for distributed data access and analysis.

As part of the research, the efficiency of application of modern information technologies is evaluated for secure data storage and access for the project tasks. These technologies include a distributed parallel file system (Lustre, GlusterFS, Ceph, etc.), distributed databases (RasDaMan, Apache HBase, Apache Cassandra, etc.), and cloud storage system (OpenStack, etc.).

The developed algorithms and technologies will be implemented for existing, constantly updated distributed archives of CC FEB RAS, IKI, and SRC "Planeta", the total volume of which already exceeds one PB, growing daily by over 1 Tbyte. This project will allow the following:

- facilitating interdisciplinary integration and ensuring a scalable and secure storage of scientific data with a common data model and query language;
- data recording and reading speed up;
- conducting distributed search of metadata and traceability data (data provenance);
- facilitating the interactive analysis and visual search of regularity and data reuse.

In addition, the derived results will be used to organize the work with extra-large distributed archives of satellite data obtained by SRI RAS and SRC "Planeta" in the information system "Vega - Far East" [2]. This system is designed to provide access to the distributed data information system for collective use of space-based remote sensing data (ERS CLAIMS) for scientific, education and innovation activities in the field of research and monitoring the environment in the Russian Far East regions. This will expand the list of information resources available to users of the system for more than 0.5 petabytes of data and provide the possibilities of remote sensing data processing and analysis based on the cloud-computing environment, formed by the resources available at CC FEB RAS, Space Research Institute and the regional centers of SRC "Planeta".

The studies were supported by the Program of Fundamental Studies of the Far Eastern Branch of the RAS "The Far East" (No. 15-I-4-071, 15-I-4-072) and by the Russian Foundation for Basic Research (No. 15-29-07953).

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MATHEMATICAL MODELING OF ARTIFICIAL AORTIC HEART VALVE

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In this paper we propose a mathematical model for describing the viscous inhomogeneous fluid flow in canal with flexible walls and valve. We present the results of the modeling of the valve leaflets dynamics, and the fluid flow inside valve "Yunilain".

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ABOUT SELECTING THE COMPUTATIONAL DOMAIN WHEN CRITICAL MODES OF PLASMA ARC FLOW

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Mathematical modeling of physical processes in arc plasma flows devices is conducted on the basis of a system of Magnetohydrodynamic (MHD) equations, which include the Navier-Stokes equations, Maxwell and energy equations. The system is supplemented by State equation coefficients transfer Wednesday and the relevant boundary conditions.

Selection of computational domain is usually determined by the geometry of the technical device, discharge or other such considerations. On the borders of the settlement area, on

the basis of reasonable physical assumptions are justified and are determined by the boundary conditions. In the calculations the calculation and raised them boundary conditions can be verified and adjusted.

As a result of the carried out researches it has been established that there were currents of plasma arc flow modes for which the border settlement area should be checked with insignificant alterations of such external parameters of electric arc like electricity or gas consumption.

As an example, threads are considered arc plasma welding plazmatronom generated in Wednesday carbon dioxide or argon. As the anode is selected polubeskonečnaâ plate on which the natekaet flowing from the nozzle flow plazmatrona channel arc plasma and spreads further in the radial direction.

The first. During close to turbulent plasma flow regime (let's call them critical), defining boundary conditions for radial velocity and temperature distributions at the cut channel plazmatrona have to take into account the geometry and dimensions, as well as plazmatrona channel devices. Otherwise, depending on boundary conditions, you can receive a variety of currents. In fact, this means that the inclusion in the settlement area of the entire turbine site, which includes channel nozzles plazmatrona and a cooled cathode. Selection of borders and conditions on them in this area is a separate task. The initial tasks of small orifice gas costs and a wide range of strength of electric current, radial velocity and temperature distribution at the nozzle correctly enough channel cutoff are put out of joint solution of the equations of motion of Hagen-poiseuille and Èlenbaasa-Geller.

The second. Setting boundary conditions for the temperature at the surface of the anode is often determined by the analysis of experimental data. Speed on flat wall is equal to zero. Critical flow modes determining influence in this area become radial dimensions of anode and radial dimensions anode spots. As a result, there is a need for: concretization of the geometry and size of the anode; inclusion in the calculation of the anode site, taking into account the processes in near the surface of the anode and the anode.

Studies of plasma arc welding genertruemoj flow plazmatronom found for achieving tangible results in the area of calculation must include not only the area burning electric arc, but also associated with it, which include the cathode node and plazmatrona nozzle, tube site. When the mating task with a selection of computational domain boundaries and boundary conditions on them practically no problems arise.

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ON THE DIRECT AND INVERSE PROBLEMS OF A CREEPING MOTIONS IN A THIN LAYERS

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Marangoni effects can play a significant role in the transport of momentum, heat and mass in a number of physico-chemical systems. The effect occurs at the interface between a liquid and a gas, or between two immiscible liquids in a thin layers due to dependence surface tension on temperature. The temperature gradient corresponds to a tangential force acting on the molecules at the interface and can drive a significant fluid motion: the thermocapillary flow. Thermocapillary flows arise in the drying of paint, the spreading of liquid films, and in welding processes, to name only a few areas of application.

The 2D motion of two immiscible incompressible viscous heat conducting liquids in a flat layer is considered. The solution has the velocity, pressure and temperature presentations

$$u_{1j} = u_j(y, t)x, \quad u_{2j} = v_j(y, t), \quad p_j = h_j(y, t) - f_j(t)x^2/2, \quad \theta_j = a_j(y, t)x^2 + b_j(y, t). \quad (1)$$

It is assumed that motion arises under act of thermocapillary forces from state of rest and surface tension linearly depends on temperature, $\sigma = \sigma_0 - \kappa\theta$. Under these assumptions the equations of motion and heat transfer can be reduced to the coupled initial boundary value problem for unknowns $u_j(y, t)$, $a_j(y, t)$. This problem is inverse one since the functions $f_j(t)$ must be determined together with functions $u_j(y, t)$ and $a_j(y, t)$. As concerning to the functions $b_j(y, t)$, then the problem of its finding is separated. The following results are obtained for creeping motion when Marangoni and capillary numbers are small:

1) exact stationary solution $u_j^s(y)$, $a_j^s(y)$ and f_j^s are found;

2) obtained a priori estimates of solution prove the convergence to stationary one. More exactly, the following estimates are valid:

$$|u_j(y, t) - u_j^s(y)| \leq U_j e^{-\gamma t}, \quad |a_j(y, t) - a_j^s(y)| \leq A_j e^{-\gamma t}, \quad |f_j(t) - f_j^s| \leq F_j e^{-\gamma t}$$

with positive constants U_j , A_j , F_j , γ depending physical liquids properties and thickness of layer;

3) solution of the non-stationary problem in the form of final analytical formulas in the transforms of Laplace representation was found and some numerical results of velocities and temperatures behaviour in layers are presented.

Some results were obtained for non-linear problem by using asymptotical methods. In that case the more general energy condition on interface $\Gamma = \{y = 0\}$ was used

$$\left[k \frac{\partial \theta}{\partial y} \right]_{\Gamma} = \kappa \theta_1 \operatorname{div}_{\Gamma} \mathbf{u}_1 \quad (2)$$

where symbol $[f]$ denotes the difference between f_1 and f_2 on interface. It means the jump of the heat flux into direction of the normal to Γ is compensated by the change in the internal energy of interface. This change is related both to the change in temperature and to the change in the interface area: this circumstance is responsible for the emergence of term in the right-hand side of equation (2).

If the functions $f_j(t)$ in formulae (1) are equal to zero, then the problem becomes the direct one. Some previous results devoted this problem should be observed.

MATHEMATICAL MODELING OF GRAVITATIONAL WAVES AT TWO-LAYER FLOW INTERFACE IN A FLAT HORIZONTAL CHANNEL

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To date, there are a large number of papers devoted to linear stability of two-layer shear flows in rectangular channels (see for example reviews in monographs [1,2]). An important feature of the two-layer system is the existence of interfacial perturbation mode (in addition to the usual shear modes), which may be unstable in a wide range of problem parameters. In deep layers, when the viscous dissipation may be neglected, the interfacial mode corresponds to internal gravity waves, and the instability is caused by the occurrence of a critical layer. In the two-layer fluid the gravitational waves with a small difference in densities run with small velocity, comparable to the velocity of the steady-state flow. The amplitude of the unstable interfacial perturbations increases rapidly, causing a need to take into account nonlinear effects. The article [3] proposed the weakly nonlinear evolution equation to simulate waves at the interface of the two-layer laminar flow. However, the final equation was derived under the assumption of small ratio of the main flow rate to the wave propagation velocity. The aim of this work is to expand the applicability of the integral-differential equation for larger values of the steady-state flow velocities.

To model the propagation of nonlinear internal waves in a horizontal channel we used the following assumptions: 1) fluids are incompressible and immiscible; 2) moderately long perturbations of small but finite amplitude are to be considered; 3) thicknesses of the viscous boundary layers in a disturbed flow remain thin, i.e. much thinner than the depths of layers; 4) capillary effects are not large; and 5) the perturbation growth rate is small. With these assumptions, using the multiscale method for time, it became possible to build a regular series of perturbation theory to account for the effects of dispersion and nonlinearity of waves, weak dissipation in the viscous boundary layers, as well as perturbation energy excitation by the stationary flow.

The solution in the first order of perturbation theory is a wave moving with constant speed and retaining its initial form. Solving the problem we determine not only the speed of wave propagation, but also the profiles of vertical and horizontal components of perturbed liquid velocity. These data are used in the second order of perturbation theory. On a slow time scale, the initial system of hydrodynamic equations is reduced to a single inhomogeneous differential equation for second order corrections to the vertical velocity perturbation. The right-hand side of this equation includes the previously found velocity profiles. The condition of this equation consistency was found using the adjoint operator method. This condition results in the following integro-differential equation for the interfacial perturbation:

$$\frac{\partial \eta}{\partial t} + \text{Re}(c) \frac{\partial \eta}{\partial x} + C_d \frac{\partial^3 \eta}{\partial x^3} + C_n \eta \frac{\partial \eta}{\partial x} - C_b \int_0^x \frac{\partial \eta}{\partial x'} \frac{dx'}{\sqrt{x-x'}} = \int_{-\infty}^{+\infty} \text{Im}(c) \hat{\eta}(k, t) e^{ikx} dk,$$

where η is the interfacial perturbation, t is the time, x is the coordinate, c is the phase velocity, and k is the wave number. Constants C_d , C_n , C_b are determined both by main parameters of the problem (ratios of depths, viscosities and densities of liquids) and by vertical profiles of the perturbed flow. The integral in the left-hand side of this equation determines dissipation in unsteady boundary layers, and the right-hand side determines the energy transfer from the main flow into the wave.

The numerical solution of this equation was based on the spectral method with expansion of the function η in spatial Fourier series. Calculations of the evolution of small initial

perturbations have shown that the increase of the solitary waves amplitude is accompanied by the corresponding decrease in their length. Eventually, the wave parameters overstep the scope of applicability of the model evolution equations that is looks like a collapse phenomenon.

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NUMERICAL SIMULATION OF SURFACE WAVES ARISING FROM UNDERWATER LANDSLIDE MOVEMENT

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The underwater landslide can generate sufficiently large surface waves. If it happens near the coastline, the splash of the waves can lead to the destruction of buildings located on the shore.

The main aim of this paper is to construct a model of simultaneous movement of the landslide, internal currents and surface waves that can come ashore. In [1] we considered the cohesive soil erosion process as a motion of a two-component viscous incompressible fluid, the soil being more viscous and dense component. The same approach was used to model the process of the surface wave propagation ([2]). The idea of a multicomponent fluid movement is also used in this paper. We consider soil, liquid and gas as components of non-homogeneous fluid. Movement of such fluid is described by the Navier–Stokes equations with variable density and viscosity and the convection-diffusion equations. Special ratios are used to calculate the density and the viscosity of the medium.

$$\left\{ \begin{array}{l} \frac{\partial v_i}{\partial t} + \sum_j v_j \frac{\partial v_i}{\partial x_j} = \frac{1}{\rho} \left(-v_i D \Delta \rho - \frac{\partial p}{\partial x_i} + \sum_j \frac{\partial}{\partial x_j} \left(\mu \left(\frac{\partial v_i}{\partial x_j} + \frac{\partial v_j}{\partial x_i} \right) \right) \right) + f_i, \quad i = 1, 2, 3, \\ \sum_j \frac{\partial v_j}{\partial x_j} = 0, \\ \frac{\partial C_1}{\partial t} + \sum_j v_j \frac{\partial C_1}{\partial x_j} = D_1 \Delta C_1, \quad \frac{\partial C_2}{\partial t} + \sum_j v_j \frac{\partial C_2}{\partial x_j} = D_2 \Delta C_2, \\ \rho = \rho_1 C_1 + \rho_2 C_2 + \rho_3 (1 - C_1 - C_2), \quad \mu = \mu_1 C_1 + \mu_2 C_2 + \mu_3 (1 - C_1 - C_2), \end{array} \right.$$

where (v_1, v_2, v_3) - vector of velocity projections on the spatial axes (x_1, x_2, x_3) , μ - dynamic viscosity, ρ - density, p - pressure, (f_1, f_2, f_3) - vector of mass forces, C_1, C_2 - concentrations of the first and second components, D_1, D_2 - diffusion coefficients, $\mu_1, \mu_2, \mu_3, \rho_1, \rho_2, \rho_3$ - viscosities and densities of the components.

The results of test calculations for two- and three-dimensional problems of the wave generation and run-up ashore are presented.

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EVALUATION OF SEISMIC HAZARD USING SEISMIC MICROZONATION METHODS

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It was shown the technique of seismic hazard assessment based on comprehensive use of methods of seismic microzonation [1].

This technique consists of four steps. The first step is to collect geological, seismological, geophysical and topographic information. Each layer according to geological engineering survey and geophysical work are assigned physical and mechanical properties (density, limit shear stress) and the P- and S- wave velocity. Next (step 2) after visualization and examination input data using GIS technologies 3D modelling of the geological environment is performed (it is created a grid each point of which is referred to coordinates of the site). The number and depth of soil are set in each point based on geological drilling data. Then (step 3) at each point seismic intensity are calculated using the method of acoustic impedance [2, 3] and computer simulation (programs SHAKE91 and GRUNT [4, 5]). At the last stage according to the analysis of the results of theoretical and instrumental methods seismic microzonation map are created using GIS technologies (Fig. 1). The procedure of constructing maps uses different methods of selection areas with the same seismic hazard (kriging, spline interpolation).

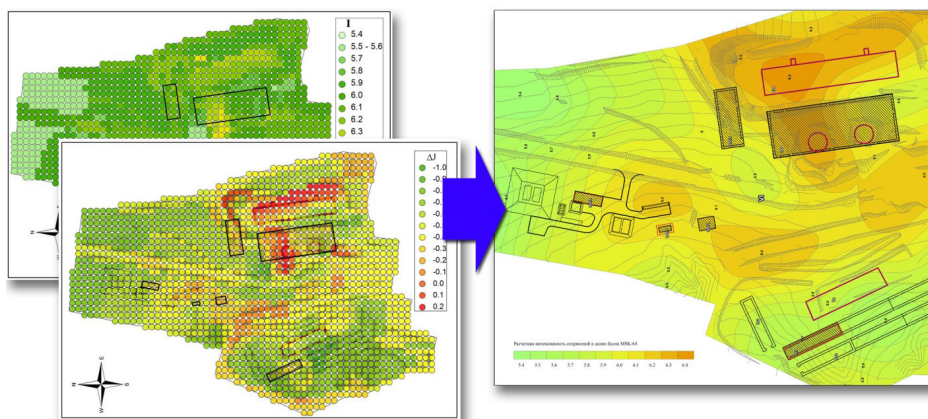


Fig. 1: Creation of seismic microzonation map using GIS technologies

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DEPTH AVERAGED MODELING OF TURBULENT RIVER FLOW

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Problems connected with wastewater discharge into rivers as well as flood control problems are issues of current importance. Extensive scientific knowledge about the structure of a river stream is the essential basis for minimizing damage and making predictions about the behavior of the river.

The purpose of this work is to construct a mathematical model and a computational method for simulating the river stream and to apply them to investigating the problems connected with transport of pollutants and local flooding on the Tom River (Siberia, Russia).

The river flow turbulence has a great influence on bed formation and on transport of pollutants by a stream. In spite of the fact that the performance of modern computational systems has increased significantly in recent decades, the computational cost of solving the full system of 3D Reynolds equations (RANS) for large-scale natural flows is too high because it usually requires very fine computational mesh and accurate approximation of the wet-dry boundary [1]. One-dimensional computational models are widely used to get approximate data about flows on a very large scale (about 1000 km) [2, 3] but inapplicable to situations when the precise characteristics of the flow in smaller areas are needed. The model proposed is based on depth-integrated RANS equations. This approach is preferable because it combines acceptable computational cost and precision of obtaining results [4-6]. Averaged turbulent stresses appearing in the model were defined from Boussinesq's hypothesis. Turbulent characteristics of the flow were computed from the depth averaged high-Reynolds modification of the k-epsilon turbulence model proposed by Launder and Spalding [7] that had been successfully applied to large-scale flow modeling. The model also includes wind stresses on water surface, bottom share stresses depending on roughness, and terms to account for the Coriolis force that are significant for the flow in a river.

A finite volume method on the staggered structured grid was used to discretize the equations. Convective fluxes were discretized with the third order MUSCLE scheme [8]. Solution of the discrete system was obtained with a SIMPLE iterative algorithm based on coupled correction of the depth and velocity fields on each time step. The principal innovation of the

algorithm proposed is accounting for the variability of the water depth in the source term in the momentum equations.

Steady turbulent flow in a small shallow river that had been accurately investigated both experimentally and computationally was modeled to validate the model and method proposed.

The main object of the research is the 50 km section of the Tom River near the city of Tomsk. Two problems that could be solved using the method proposed are the analysis of transport of pollutants from wastewater discharge into the river and the prediction of the areas that could be affected by local flooding from spring snow melt and ice flow. The results of the calculations for two test cases for the problems described show agreement with general concepts and represent flow patterns observed in field studies of the river.

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MATHEMATICAL MODELING OF LARGE BLOOD VESSEL ANEURYSM DEVELOPMENT AND GROWTH

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The paper is devoted to mathematical modeling of large blood vessel aneurysm development and growth. Aneurysm rupture can cause massive hemorrhage and most probably death. Aneurysm (an aorta area enlargement or a bulging area in its wall) size and possibly its geometrical pattern are considered to be its rupture risk factors.

Age, vascular walls erosion, as well as high blood pressure are supposed to be aneurysm risk factors. Some researchers consider vascular wall material fatigue to be somehow associated with the risk factors, though the reasons and mechanisms of aneurysm development are insufficiently studied.

We consider the blood to be incompressible, heterogeneous, two-component fluid with variable viscosity. Vascular wall material is considered to be homogeneous fluid-tight material with variable rigidity.

The paper shows the process of aneurysm development in blood vessels with different vessel geometry in the context of the elasticity reduction of particular vessel wall areas. Inclination of vascular wall muscle fibers and type of weakness zone impact on aneurysm development is under consideration. The range of biomaterial fatigue models is shown. Fatigue impact on vascular wall tensile stress resistance due to fluid motion is estimated. Immersed boundary method is used for numerical calculation of differential problem. Numerical experiment results are shown.

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BIOCHEMICAL PROCESSES OF SELF-PURIFICATION MODEL IN SMALL RIVERS

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The studying of water self-purification ability is a part of the problem of the regional limits developing of water quality that has the important role for the water quality management. The self-purification of natural water systems is a complex process that often involves physical, chemical, and biological processes working simultaneously. The complexity of this problem depends on heterogeneity of biotic and abiotic factors along a stream for every river. Natural process of self-purification for small river in sharp continental climate of Central Siberia is inhibited by low temperatures, rapid currents and poor development of plankton cenosis. The additional complexity for self-purification modeling in small river is diffusion sources as a results of agricultural practices.

This work shows that a simple model structure can be set up to describe the water quality in small river basins in terms of carbon and nitrogen compounds, when it is unfeasible to use complex models. The physical part of the model includes hydrodynamical components derived from Saint Venant's equations, coupled to a transport model based on a convection-dispersion equation under non-uniform and unsteady flow conditions. Biological part of the model includes principle factors such as chemical and biological oxidation, concentration of biogenic elements (nitrogen, phosphorus etc.). The main control parameters of this model are reaeration and biochemical oxidation rates. Nowadays, there is no method available to determine these rates that fit precisely to the reality of a given water body. It was found that the inclusion of non-point sources as piecewise constant parameters affects the identifiability to a considerable extent. In this article we used both mathematical modeling and natural sampling of surface water in some small rivers of Central Siberia for the control parameter assessment.

The methods of numerical modelling were used to estimate the principal parameters of developing model. These results have allowed to analyze the annual dynamics of the nitrification and denitrification rates, the mineralization rate of total phosphorus and organic nitrogen. The data of state monitoring network has allowed to verify the results of numerical

calculations. The biochemical oxidation and reaeration rates have been specified under the impacts of natural-climatic conditions. The contribution of the main biochemical processes in the purification processes in the small rivers in the conditions of Central Siberia climate is estimated numerically. These estimations will use to develop purification model by adding new parameters.

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FORECAST OF DYNAMICS OF THERMOKARST LAKES IN PERMAFROST BASED ON GEO-SIMULATION MODELING AND REMOTE SENSING DATA

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The global warming leads to an increase of accidents on pipelines and other oil and gas facilities due to lower strength of permafrost. Moreover permafrost, as a repository of carbon conserved in the vast frozen peat bogs of northern Eurasia and America may cause even more warming if greenhouse gas release. The development of measures to reduce the damage of oil and gas companies require the use of forward-looking assessments of the dynamics of thermokarst processes. Due to considerable bogging and inaccessibility of the territory of Western Siberia, where is located the main oil and gas complex of Russia the research of these processes is impossible without the use of remote sensing data. The information technology of modeling and forecasting of the dynamics of thermokarst lakes fields was developed using satellite images for the period 1973-2010 years. An important issue is the creation of a mathematical model. The complexity of modeling the field of thermokarst lakes has led to the need to use geo-simulation approach to modeling of natural objects with a spatial structure developed in [1].

To predict the dynamics of thermokarst processes simulation model of the fields of thermokarst lakes was developed, which allows to take into account the changes in climatic characteristics. The main elements of the description of the model introduced options that take into account the shape of the borders of the coastal lakes, the characteristics of their random arrangement on the plane and the random distribution of the size of the lakes, as well as their temporal dependence. The adequacy of the developed model is tested on the basis of the analysis of conformity of model and experimental laws of size-distribution in the test sites selected on satellite images of different areas of permafrost [2].

A new forecast assessments of changes of thermokarst processes on the territory of West-Siberian permafrost were obtained using computer experiments with the model. It is shown that the gradual increase in temperature to 2 - 3 °C by 2100 will cause a reduction in the area of thermokarst lakes, what is an indicator of the continuing degradation of permafrost by the end of the century.

The information technology of modeling and forecasting of the dynamics of thermokarst lakes fields can be used for solving problems of reducing the accident rate on the infrastruc-

ture facilities in the territory of permafrost, and to predict the dynamics of greenhouse gas emissions from thermokarst ponds in Western Siberia under the impact of global warming.

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COMPUTATIONAL MODELING OF METAL VAPOUR INFLUENCE ON THE ELECTRIC ARC WELDING

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Tungsten inert gas welding is a widespread technology for joining of metals. The physical phenomenon in the arc and workpiece are unique to each welding process and depends from the nature of the material, the type of the heat source, and the parameters of the welding process. The weld pool surface temperatures could be greater than the melting temperature and pronounced vaporization of alloying elements could takes place, consequently, it result in a change in the composition of the weld metal, affect weld properties, and are a serious problem in the welding of many important engineering alloys.

The mathematical model, which takes into account the effects of the Fe vapour in the arc welding of stainless steel workpieces in closed volume are proposed. Metal vapour is formed in gas arc welding processes by the evaporation of molten metal in the weld pool and affects on the thermodynamic, transport and radiative properties of plasma as well as on the size and shape of the weld pool.

The physical phenomena in arc plasma and molten pool are considered in one unified MHD model. Basic assumptions for the developed two-dimensional numerical modeling are as follows: The arc is in the local thermodynamic equilibrium and optically thin, the gas flow is laminar, the system is a steady state and axisymmetric.

Governing equation consists of the mass continuity, momentum, energy, current and metal vapour conservation [1]. Plasma properties are dependent from temperature and concentration of iron vapor. A viscosity approximation is used to express the diffusion coefficient in terms of the viscosities of the ambient gas and the metal vapour [2].

The system is solved in the variables vorticity-stream function for five variables: stream function, vorticity, current function, enthalpy and metal vapour concentration [3]. The system of equations solved by the finite difference method on a rectangular non-uniform orthogonal grid using the five-point difference scheme.

We set the boundary conditions for all of the computational domain. At the top surface of molten pool with higher temperatures and non-uniform melt temperature distribution, the effects on melt flow and heat transfer of Marangoni convection, caused by the surface tension gradient, the radiation heat loss and evaporation phenomena from top surface are considered.

Calculations were made for design of real plasma torch, for various welding currents ($I=150A, 200A, 250A$) and for both helium and argon welding gases. The effect of metal vapour from weld pool on the characteristics of the arc column was numerically investigated. Distribution of electric field, current density and temperature field in the arc column and weld pool with and without consideration of the Fe vapour are shown. Velocities of plasma, flow and iron vapour concentration were predicted, together with the weld penetration. Influence of surface tension gradient on the temperature of the weld pool surface studied, i.e. metal evaporation process have been investigated. The changes of heat input to the work-piece due to the presence of iron vapour have been studied. Electric arc penetrating power with and without consideration of the Fe vapour have been investigated.

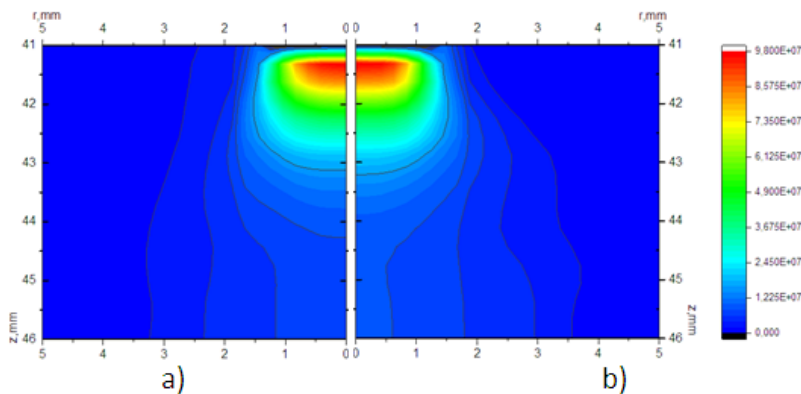


Fig. 1: The current density in the arc column a) with Fe vapour b) without Fe vapour, $I=200A$

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MIT 2016

EFFECT OF DIELECTRIC PERMITTIVITY DISTRIBUTION IN INVASED ZONE ON INDUCTION LOG DATA

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The mud invasion process causes formation fluid displacement that results in changing of resistivity and dielectric permittivity distribution (electro-physical properties) of the near wellbore zone. To do a correct interpretation of electromagnetic logging data, it is necessary to take changing resistivity and dielectric permittivity parameters in the invaded area into account. The goal of this investigation is to show how near wellbore dielectric permittivity and resistivity distribution affects induction logging measurements.

We simulate the process of mud invasion to obtain water saturation and salinity distributions that we use to compute distribution of electro-physical parameters in the near wellbore area. Then we estimate the influence of resistivity and dielectric permittivity on induction logging signals using induction logging data modeling. Buckley–Leverett equations for two-phase flow in porous media are used to carry out mud invasion simulation. Resistivity distributions are calculated using Archie's equation. Dielectric permittivity distributions are calculated using the Complex Refractive Index Method (CRIM). Signals of an induction logging tool are computed using axisymmetric cylindrically layered earth model.

Analysis of the computed induction tool signals shows that dielectric permittivity influence on magnetic field attenuation is higher than on magnetic field phase difference. High frequency (>1 MHz) measurements are significantly influenced by dielectric permittivity distribution of the invaded zone. The highest influence of dielectric permittivity on induction logging signals is observed in the case of low water saturation and high resistivity of drilling mud.

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TWO-PHASE CONVECTION IN ACOUSTIC FIELD

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Convective heat and mass transfer plays an important role in the evolution of geological fluid systems and determines hydrodynamic processes in the lithosphere, associated with igneous volcanism, mineralization, etc. The interest to the study of heat and mass transfer in fluid / fluid-magmatic systems in the presence of internal acoustic sources is caused by the seismic activity in the lithosphere. In applied works concerned with the study of convection in liquids under acoustic or vibratory exposure, usually anacoustic approximation of incompressibility of the medium is employed. The study of thermoacoustic convection has been conducted for single-phase liquids [1, 2]. The influence of acoustic effects on convection in complex media is poorly studied. In this paper we investigate the influence of the compressibility of heterophase media on convective flows under the influence of acoustic vibrations of different frequencies as well the stability of convective flows. We consider the dynamics of two-velocity compressible media such as a saturated granular medium. The equations of thermodynamically consistent two-velocity model of compressible two-phase medium [3] are obtained through the conservation laws method [4, 5]. Computational implementation of the model is based on the control volume method [6], which ensures the integral conservation of basic quantities at digitalization of differential equations. For an adequate description of acoustic processes, the correct consideration of the compressibility of the medium was carried out in the framework of the proposed model and numerical simulation. The SIMPLE iterative procedure was modified to account for nonequilibrium nature of the medium in terms of pressure in the phases [7]. The paper presents the results of numerical simulation of Rayleigh-Benard thermal convection in a flat layer of two-phase medium, heated from below. The perturbations behavior near the stability threshold of thermoacous-

tic flow of two-phase media was investigated to obtain the conditions for the transition from stationary regime of diffusion heat transfer to the convective heat and mass transfer initiated by high frequency acoustic impact, which was generated by the internal final small source.

This work was supported by Russian Foundation for Basic Research, grant #16-01-00729a, and the Ministry of Education and Science of the Russian Federation, agreement #14.607.21.0106 (the unique identifier of the project RFMEFI60714X0106).

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MATHEMATICAL MODEL OF IGNITION OF GAS-AIR MIXTURE AND FINE COAL DUST LAMINAR FLOW

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Protection from methane and coal dust explosions is the key problem of mine worker safety ensuring. Modern degassing systems can extract not more than 40% of methane out of coal bed. It means that there is a high chance of methane explosive limit development in mine face areas of stope ores and development workings. Suspended particles of fine coal dust contained in airstream increase explosion power and reduce induction period. Intensity of mining activities and high performance equipment enhance the chances of frictional sparking.

Experimental study of gas suspensions which can generate heat due to chemical reactions is rather challenging. Accordingly, mathematical modeling is the main way to study oxidizing explosive atmosphere macrokinetics. Its main goal is to analyze ignition process patterns due to different conditions and estimate prevention methods and combustion containment methods as well as combustion effects.

The article considers the problem of gas suspension laminar flow ignition in the context of exothermal oxidizing reactions regarding both vapor phase and particle surface. It is based on the heat-diffusion gas combustion model [1,2,3]. For the sake of simplicity the flow of gas mixture (methane, oxygen, unreactive part and combustion products) with uniform suspended particles of coal is supposed to be parallel flow in a semi-infinite domain. Flow velocity is considered to be constant. Dispersed phase particles like in [3] have equal size and spherical shape. Velocity of particles and gas flow velocity are equal. Oxidation process is tak-

ing part on a particle surface. Heat exchange between particles and gas follows the Newton's law. Chemical reaction rate depends on the temperature according to the Arrhenius law. Quantity of the molecules involved into oxidation and reaction products depend on stoichiometry proportion. Thermal expansion and flow compressibility are deliberately neglected. Gas flow ignition is modelled by heat source at the boundary of solution domain $x=x_j$.

The dynamics of temperature distribution and reacting agents and resultants of reaction depending on time, initial concentrations and flow velocity is found as a result of solving the equation system

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COMPUTATIONAL INVESTIGATION OF TURBULENT FLOW IMPACT ON NONCOHESIVE SOIL EROSION NEAR FOUNDATIONS OF GRAVITY TYPE OIL PLATFORMS

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Gravity type oil platforms at shallow marine coastal areas are currently used for oil extraction. Processes of bottom soil erosion near foundations of those platforms and analyses of their stability problems are of great interest. Laboratory-based experiments, seminatural physics experiments and mathematical model approaches have been recently used to study those problems. Papers [1-3] show the results of many experimental investigations and computational investigations of noncohesive soil erosion near foundation of the platform "Prirazlomnaya", comparative tables of laboratory experiments and computational experiments, analysis of different wave modes of fluid flow impact on bottom material particle transportation. Fluid flow mode is supposed to be laminar. The paper studies flow developed turbulence impact on erosions and soil load development near foundations of gravity type oil platform by using experimental and computational investigations.

To calculate turbulent fluid flow LES method is used due to the significant flow unsteadiness. Both algebraic and differential models are used to model subgrid viscosity. Morphological model [6] based on balance of forces which effect soil particles is used together with the model described in [4,5] to calculate soil erosion.

The results of experimental and computational investigations of soil erosion in the context of flow developed turbulence with variable input parameters are shown. Qualitative erosion patterns and its quantitative characteristics are compared to laminar fluid flow modes.

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ON APPROACH “SUCCESSIVE APPROXIMATIONS BY CHARACTERISTIC INTERACTIONS” FOR INVERSE PROBLEMS OF NUCLEAR-GEOPHYSICAL TECHNOLOGIES

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The Transport equation for describing physical and kinetic processes of the particles propagation in different media and methods of its solutions are used in various fields of science, technology and industry; including, in the nuclear-geophysical technologies (NGT) to study rocks and oil-and-gas-bearing strata, as well as in the study of planetary surfaces. It should be noted that modern numerical solutions of forward problems of NGT focused on supercomputers. But the development of many techniques and methods of the interpretation of data measurements was carried out before “the era of supercomputing”, in conditions of shortage of computer time, and so they are often based on approximations to the Transport equation (TE), on empirical and experimental curves and on a different kind approximate approaches (see, e.g., [1-2]). In this paper, the problem of interpretation of NGT measurement data is considered on the basis of the precise TE.

In this approach, the inverse problem of evaluating the coefficients of the TE from the measurement data is reduced to the problem of evaluating a set of parameters on which the equations of connections and constraints are imposed [3-5]. Macroscopic differential and total cross sections of particle interactions with the media, as is known, are formed as linear combinations of the corresponding partial cross-sections, i.e. sections on the elements and components of the medium, which are assumed to be known. In this approach, the coefficients of this linear combination are included in the set of unknown parameters. If the parameters are evaluated, the coefficients of the equation will also be determined. Characteristic interactions and characteristic parameters are the major contributors to the measurement data.

This report examines two themes. First, we analyze application of a well-known formula “small perturbations” of transport theory to the problem on relations between the two closest sets of parameters. It is assumed that as the first set is defined; the second, a more complete set of parameters, is considered as bringing small perturbations in the measurement data. The other theme is the use of the approach and the method “Successive approximations by the Characteristic interaction” to a problem on evaluating a coefficient of water-oil saturation of a formation from data of the Pulse neutron capture Log. Previously, the problem was considered on the basis of the diffusion approximations to the TE.

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3-D MODELING OF ANGARA RIVER BED

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This work is devoted to development of hybrid geoinformation system for making forecasts for areas of possible flooding in the downstream of the of the Irkutsk hydroelectric station with damages assessment in extreme water content conditions for lake Baikal and effluents of the Angara river.

For 3D model construction of the Angara's bed they used Atlas “Map of the Angara River in Irkutsk hydroelectric power station till 142 km on scale of 1: 10000” General plan of “Waterways of the East Siberian basin”, Irkutsk, 1994. Due to lack of a digital model (map), a paper-based map was digitized using vectorizer program Easy Trace 7.99. Depth contours, marks and bank lines were also digitized.

To combine the data about land and underwater relief a specific software was developed using Delaunay triangulation method. For data layers their role in the construction of triangulation is specified. The layers contain information about: land relief, standing water levels, shore lines, underwater topography. To work with the underwater relief information about standing water levels is used. Auxiliary triangulation is made according to the data whereof further information is revealed regarding heights levels to which shore lines contours are attached and in reference to which depths are measured.

As a result of the works execution according to evaluation of extreme floods under various cases of extreme water content in the basin of the Angara river and Lake Baikal hybrid geographic information system is made, which allows to simulate different scenarios of flooding and to determine the flood zones with account for underwater and land relief.

MODELING OF BERILLYA CERAMICS FORMATION PROCESS

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The technology of hot pressure molding [1] remains the basic for obtaining long-length, multi-channel, and complex shaped ceramics from non-plastic powders, in spite of using the isostatic pressing.

Obtaining ceramic fabrications by hot molding from dispersion materials with anomalous physical properties, such as beryllium oxide (BeO), is particularly complicated. In this case, the difficulties of obtaining the high quality products are caused firstly by thermo-physical properties of BeO, in particular, by its unique thermal conductivity [2].

It stands to reason that it is impossible to eliminate technological limitations and problems without the development based on all experience and knowledge of theoretical representations about regularities and regulation mechanisms of the thermal conditions on the forming process of cast.

The slurry is a structured system where the mineral phase is a beryllium oxide powder and the liquid phase is an organic binder (paraffin, oleic acid and beeswax).

Experiments were carried out in the die for molding a circular tube with an outer diameter of 0.02 m and the inner diameter of 0.012 m. The experiment modes that depending on the molding speed are presented in Table 1.

Table 1: Regimes of experiments as a function of the molding velocity

Number of the diagram		1	2	3	4	5
Molding regime	Hot water flow rate, l/hour	500	500	500	500	500
	Cold water flow rate, l/hour	1500	1500	1500	1500	1500
	Molding speed, mm/min	20	40	60	80	100
	Hot water temperature, °C	80	80	80	80	80
	Cold water temperature °C	20	20	20	20	20

Temperature distribution in the form-building cavity of bushing depending on the molding speed and heat extraction conditions on the walls of form-building annular cavity estimated during the experiments lets us determine the transition from liquid (viscous–plastic) state to solid–plastic one.

The experiment results have been analyzed and generalized using the mathematical model of the thermoplastic slurry molding process. The latent heat of the phase change has been accounted by the apparent heat capacity [3].

The mathematical model includes the equations of mass, momentum and energy conservation laws of non-Newtonian fluid with the Shvedov-Bingham's rheological model. Rheological and thermo-physical properties of the slurry were found on the basis of experimental data and express the dependence on the temperature.

The coefficients of heat exchange and heat transfer on the walls of the annular cavity were determined by the comparison of experimental and calculation data.

Fig. 1 shows the calculated data of temperature field of the slurry mass in the liquid (viscous–plastic) and the solid–plastic state.

Positions of AB “solidus” (54°C) and CD “solidus” (40°C) which correspond to the upper bound and to the lower bound of the solidification zone are in agreement with the experimental data.

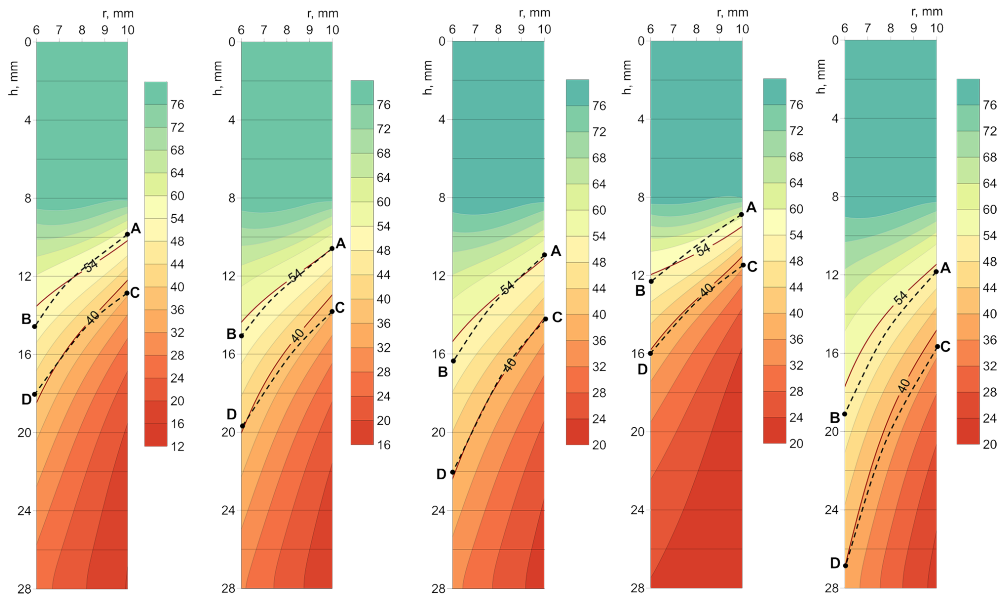


Fig. 1: Comparison of the calculated and experimental data of temperature distribution depending on the slurry molding speed

The results of calculation are in agreement with the experimental data, and they show physical validity of the proposed mathematical model of the solidification process of the BeO thermoplastic slurry.

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МИТ 2016

SINGLE AND GROUP STRIKES OF HIGH-VELOCITY ELEMENTS IN A SPACECRAFTS

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The presence in a near-earth layer (a width of 300 to 2,000 kilometers), a huge number of man-made fragments of various sizes and shapes, which were formed in the process of destroying the satellites, the last stages of carrier rockets, boosters and other vehicles and equipment, represents a serious threat to the security of automatic and manned space objects. The problem of high-speed interaction of designs with projectiles now acquires particular importance due to the increasing speed of the collision, which increases the likelihood of penetration, destruction and disruption of the normal functioning of the protected objects.

In recent years, particularly acute problem of reliable protection of elements of manned and automatic machines to study of near-Earth and deep space due to the increasing duration of flight of these objects, which increases the likelihood of collisions with man-made fragments that emerged as a result of the destruction of the orbital structures. Creating a reliable spacecraft protection from space debris fragments determines the necessity of studying the interaction of a high-speed elongated strikers with securable objects.

Numerical simulation of high-speed interaction of solids with protective systems able to reproduce the characteristics of the physical processes occurring in the collision, to consider and select the optimum screens of protection. Application to the study of the problems of modern computers and numerical methods to solve the problems of high-speed collisions in a three-dimensional setting, taking into account the fragmentation of projectiles and protective elements of spacecraft design, it is theoretically and practically important task. Accounting fragmentation and interaction of fragments with each other and with the spacecraft shell allows a better understanding of the processes taking place at high speed interaction of space debris with a shell of the space object. To solve this problem it is necessary to have a reliable and sufficiently universal method to enable adequate reproduction of the processes occurring in solids under high-velocity collision.

In this paper we consider the interaction of single projectile and groups of projectiles with systems layered spaced plates. It should be noted that for practical problems of great interest are spaced obstacles and hit at an angle. For the numerical solution of these problems we need a reliable and sufficiently universal method to adequately reproduce the processes of destruction and fragmentation occurring in solids at high speed interaction.

A probabilistic approach to fragmentation of solids under shock loading and proposed numerical technique to the fullest three-dimensional formulation allows with sufficient accuracy to reproduce of the processes of penetration of high-speed elements into multi-layer barriers and spaced barriers. Accounting fragmentation of solids at intensive dynamic loading allows you to use the approach Lagrangian to the problems of high-speed impact in a fairly wide range of speeds interaction. This approach is especially useful when considering the multi-contact interaction of colliding bodies, especially for the three-dimensional problems. Primary heterogeneity heterogeneity of structure of real materials affects the character of the distribution of physical and mechanical characteristics of the material and is an important factor in determining the nature of the fracture.

One way to account for this fact is the introduction into the equations of solid mechanics random distribution of deviations of the initial strength properties from the nominal value, that is, simulation, thus the structural features of the initial material, namely, the presence of pores, inclusions, dislocations, etc.

The probabilistic approach proposed and numerical technique developed on its basis enable us to simulate the processes of barrier breaking in a wide range of angles of impact. The calculations fully have simulated of the field of fragmentation and have taken into account the interaction of fragments with each other and with the elements of multi-layer barrier, which is extremely important in the calculations for the protection of spacecraft, since the stream of high-velocity particles may penetrate the main body of the apparatus and this can damage equipment. Therefore, the kinetic energy of the fragments is necessary to evaluate and calculate the process of collision with the main body. The proposed approach allows us to investigate the entire process of the interaction of projectiles and targets, taking into account the formation of fragment flow and the impact of the latter on the protected object.

The paper compares the effectiveness of the impact of the group of projectiles and we made an assessment of their impact on the degree of damage obstacles. The calculation

results showed greater risk of exposure to the group of rods for the protecting shell of the spacecraft relative to the impact of a single projectile with a mass equal mass of seven per-cussionists, and the same rate.

The developed numerical method allows to simulate the interactions of shells spacecraft with high-speed long rods in a wide range of speeds and angles of impact, and also to investigate the processes of fragmentation barriers and a nature of fields of fragmentation . These results allow us to optimize protection of objects .

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STUDIES OF THE BEHAVIOR OF ICE UNDER SHOCK AND EXPLOSIVE LOADING

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Nowadays, researches of the behavior of certain natural materials are relevant. This is due to the development of the northern territories, the extraction of natural resources in the Far North, etc. Now, ice is a little known natural material. The modern concept of failure the ice is just beginning to develop. For the development of a numerical method requires reliable experimental data on the processes of destruction the ice with explosive conditions. The present research a comprehensive theoretical and experimental study of the behavior of the ice during a shock and explosive loading were investigated. Research work consists of two parts. Firstly full-scale experiments on the explosive loading of river ice average thickness of emulsion explosive have been conducted. Next, with the help of numerical simulation of the developed numerical methods were modeled some experiments and solved practically important problem of ice failure. Organized in Tomsk State University mobile laboratory "Explosive destruction of the natural and geological materials" is capable of conducting express-analysis process of explosive loading. The main purpose is a rapid analysis of the behavior of ice under explosive loading. The mobile laboratory was organized three years ago, and developing as an alternative to "SCICEX" American resumed program. Numerical investigations conducted by numerical lagrangian method for calculating the dynamic multi-contact problems Mechanics solid body. It developed a database of the same name

Numerical studies carried out by a multifunctional package software multiway dynamic problems of solid mechanics (SM). Model ice is described from the point of macroscopic phenomenological theory of continuum mechanics based on fundamental conservation laws. The simulated environment is isotropic, elastic-plastic, porous, taking into account the properties of strength and shock-wave phenomena, as well as joint formation vouchers and shear damage. The solution of these tasks carried out by means of numerical Lagrangian method, design of which is supplemented by the mechanism of destruction of calculated elements and splitting settlement nodes in two-dimensional statment. The originality of the method lies in a new algorithm of allocating surfaces, which imposes severe restrictions on the solution of these problems SM. The calculation results are compared with experimental data and analytical solutions. The result of the investigations obtained in the form of pictures, graphs, tables and calculated configuration "impactor - ice".

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APPLICATION OF THE HOMOTOPY PERTURBATIONS IN THE SURFACE-POTENTIAL-BASED MOSFET MODELLING

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The paper describes a novel approach in approximate solving the implicit relation between the surface potential and terminal voltage in n-type MOS transistor. Using the homotopy perturbation (HP) method, an approximative solution, which at the same time has a relative simple mathematical form, and a high degree of accuracy was obtained. It is shown that HP approximations, in comparison to a previously used approximate methods, have a many advantages: they can be calculated recursively to arbitrary numerical precision, and the whole procedure can be implemented by using the appropriate software.

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TENSOR SMOOTH LENGTH FOR SPH MODELLING OF HIGH SPEED IMPACT

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We propose a variant of the method of smooth particles [1-2], which uses a tensor representation of the smoothing parameter. This view allows you to switch from spherical particles to particles of ellipsoidal shape, oriented according to the main directions of the strain tensor. Calculations with the representation of particle shape allows better control the amount of adjacent particles involved in the calculation of derivatives, resulting in easier to provide the conditions necessary to calculate approximations of spatial derivatives of maintaining order accuracy. Also, this approach avoids the numerical distortion, which is often observed in the simulation of high-speed collision with smooth particle. To integrate the equations of motion using a weak variational formulation [3], the Lagrangian for this system is recorded using the SPH-approximation of at least first order accuracy [2], and time derivatives are approximated by finite difference with the first order of accuracy. The resulting explicit numerical scheme conserved energy and momentum, and tested on the solution of a number of model problems of collision and propagation of elastic waves. Main differences between constant smoothing length and tensor smooth parameter are shown at Fig.1.

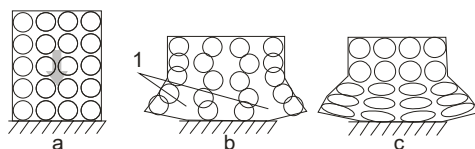


Fig. 1: Simple Taylor test for small particle count: initial configuration (a), final configuration with constant smoothing length (b) and final configuration with variable tensor smoothing parameter (c). Numerical fracture areas are marked with "1".

As it shown at Fig. 1., constatn smoothing length lead to numerical fracture, and SPH with tensor smooth shows no numerical fracture and gives more accurate results.

Evolution of smoothing parameter is defined via evolution of strain tensor, and main axes of smoothing are rotated with rotation of material. It allows to avoid neighbour loosing during calculation, and therefore a matrix of approximations of test functions are always well defined. This matrix is used to restore particle inconsistency [2] at each point. If neighbour count of particle becomes small, correction matrix can't be found, and we loose order of accuracy. Variable tensor smoothing parameter allow us to avoid such situation and to pre-serve order of accuracy.

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DEVELOPMENT OF PREPROCESSOR OF SIGMA SOFTWARE PACKAGE FOR GENERATING ADAPTIVE GRIDS

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Software package SIGMA is used for numerical solution of a wide range of problems in continuum mechanics (e.g. see [1]). It is developed by Computational Mathematics and Mathematical Physics Department of Bauman Moscow State Technical University. It includes a full set of modules that are required for the numerical simulation. SIGMA preprocessor includes a three-dimensional geometric simulation module, which allows to generate a wide range of geometric shapes; a module, which allows to set properties, parameters and initial conditions and an adaptive mesh generator.

The preprocessor module has a graphical interface that allows to create a solution domain visually. The domain is constructed from a set of initial hexahedral blocks (primitives) by their combining and subsequent deformation. The deformation is performed by changing of coordinates of control points of the domain by entering them or reading from a file. The control points of the domain are located on the boundary surfaces of the primitives, form a regular surface mesh and are the basis for the construction of the linear or cubic spline surfaces. It is possible to generate the curvilinear blocks which are based on the equidistant transformations of the surfaces, imported from solid simulation software. The functions for generation of points in given sections and along lines between the two specified points on a surface are implemented for the construction of the regular mesh of control points of a spline on the imported surfaces. The first four pictures of fig.1 illustrate the process of importing the geometry from STL format, view of the surface spline, curvilinear blocks construction and generated hexahedron mesh.

The mesh generator creates block-structured quasi-regular adaptive grids (see the last three pictures of fig.1) and uses the explicit form of the algebraic transformation, which refers to the lagrangian coordinate transformations of transfinite interpolation methods [2].

The generated grids can be two-dimensional, two-dimensional axisymmetric (the fifth pictures of fig.1) or three-dimensional (the fourth and the sixth pictures of fig.1). The additional transformations of the grids are introduced to concentrate the nodes near the boundaries (the fifth pictures of fig.1). The preprocessor is able to construct the O-grid blocks for the certain types of curved domains (the forth and the last pictures of fig.1) like in ANSYS ICEM CFD.

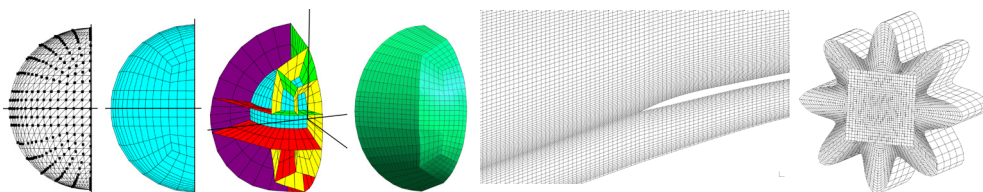


Fig. 1: The domain construction and the mesh generation examples.

The resulting adaptive regular mesh of hexahedrons could be divided into tetrahedrons for applying the finite-element or finite-volume method. Generally each hexahedron is divided into five tetrahedrons and in some cases or if the option is checked into six tetrahedrons.

The preprocessor can generate finite-volume adaptive meshes based on elements centered on the grid point. The vertex-centered control volumes are built around the generated mesh nodes [3].

Such meshes retain adaptation grid lines to geometry borders and allow to obtain solutions of better quality than with meshes generated by ordinary finite-element mesh generators with an arbitrary orientation of boundary surfaces and edges.

Each SIGMA module is the detached cross-platform software, implemented using C++ with the ability to create extensions. Most of the iterative procedures for the mesh generation are implemented using OpenMP 2.0 and MPI libraries by means of the geometric decomposition.

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LOOP BAT FAMILY ALGORITHM (LOOP BFA) APPLICATION FOR PROBLEM SOLVING IN NUMERICAL OPTIMIZATION

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In this paper, the standard Bat Algorithm (BA) is extended by introducing a bat family for the purpose of continuous repetition of the procedure for searching for an optimal solution. The standard BA is modified by including the loop search in the zone of solutions. For

each bat, in each family, fine search according to the Lévy-flight step is used for looking for an improved solution until the given constraints are satisfied. Such solutions are compared for each bat family and the best one is selected. In this paper, the Loop Bat Family Algorithm (Loop BFA) is tested on five standard benchmark functions known in the literature. The correctness and efficiency of the proposed algorithm are verified by good results in these examples.

Keywords: Bat Algorithm, Global optimization, Metaheuristic, Lévy-flight, Loop Bat Family Algorithm

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COMPARISON OF IMITATION SPLITTING MONTE CARLO METHODS WITH DSMC ONES ON THE PROBLEM “ON FLOW OVER A FLAT PLATE”.

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Multi-dimensional stationary flows of a rarefied gas with small values of the Knudsen number is an important area of application of statistical modeling techniques. In this paper, one of the well-known problems of this area, namely, “on longitudinal hypersonic flow over a flat plate”, is regarded as a test for numerical comparison between the “Imitation Splitting Monte Carlo method” (ISMC) (see [1-4] and others) and the famous DSMC methods (see [5], [6]). Compared methods differ not only in their inherent mathematical transformations typical in such comparisons. But they differ in their embedded physical models of the pair interaction as well.

Selection of an optimal simulation method of rarefied gas dynamics depends on parameters of the gas flow and, in particular, the spatial size of its domain. DSMC methods are widely used in this area and are considered as a good enough modeling technique. The characteristic property of large systems is the weak dependence of its sub-parts on each other at a sufficiently small time intervals. We applied this property, using an approximate method based on the splitting of a master-equation-system operator “over groups of particles” ([3,4]). The essence of the method is that the system of particles is divided into spatial subparts which are modeled “quasi”-independently for small intervals of time, using the precise imitation methods [1,2,3], that themselves are quite adequate for problems with the large Knudsen number.

Imitation splitting method and DSMC one have two main differences. The first one is the type of splitting of the master-equation-system operator: DSMC method uses well-known type “over collisions and displacements”, while suggested one is based on the already mentioned splitting “over groups of particles”. Another difference is the model of pair interaction. DSMC method utilizes so called “cell model” where physical scattering of a pair occurs only in the case when the spatial coordinates of both particles lay in the same “interaction cell”. As a result DSMC method requires preconstruction of the grid of such cells for each particular model. Imitation method, in the same time, uses models in which physical scattering of a pair of particles depends only on the relative differences of their spatial coordinates.

The considered ISMC method was compared vs. the DSMC based application, called DS2V, on a spatially 2D problem “on longitudinal hypersonic flow over a flat plate”. DS2V can

be free downloaded from the site <http://www.gab.com.au/>. Our talk contains comparisons of spatial distributions: of numerical density, temperature and average velocity components. The results of computations are in a good agreement for all listed parameters and all relative differences are approximately within 5%. In the same time, the statistical errors of all parameters ISMC does not exceed 1%. Also both algorithms are compared by the time of computation and demonstrated approximately equal performance.

Theoretical estimate of computation cost of suggested algorithm has been already represented in [7]. In this paper we will demonstrate how the numerical estimate of the algorithm computation cost coincides with the theoretical one on example of the given problem.

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COMPOSITE STRUCTURES: MATHEMATICAL MODELING, CALCULATION AND OPTIMIZATION

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The first part of the report is dedicated to modeling the properties of composite materials. Two major approaches are discussed: phenomenological and structural [1]. Within the framework of the first approach reinforced materials are modeled as homogeneous anisotropic medium with efficient physical and mechanical properties. In this case mechanical parameters of the material are determined basing on experimental data. In a structural approach, physical and mechanical parameters of the composite are expressed in terms of the parameters of its components and design of reinforcement that open up opportunities for improvement of the properties of composite structures.

The second part of the report is devoted to methods of solving boundary value problems for the mechanics of elastic composite plates and shells [2-4]. The systems of differential equations have a high order, variable coefficients and small parameters that result into edge effects. Various aspects of the application of discrete orthogonalization, spline collocation, collocation and least residuals methods for problems of classical and non-classical theories for plates and shells have been studied.

The third part of the report discusses the problem of rational and optimal design of composite plates and shells. The conditions of solvability, analytical and numerical solutions

of rational design problems for cylindrical, conical, spherical, ellipsoidal shells, pressure vessels have been obtained.

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THE PROBLEMS OF ANALYSIS AND DESIGN OF HYBRID PRESSURE VESSELS

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Rocket and Space industry makes extensive use of high-pressure vessels for transport and storage of different kinds of gas. High strength and reliability along with lightweight are critical properties for such structures. The main load applied to such vessels is a high internal pressure amounting for tens and hundreds of atmospheres. A promising solution is to make hybrid composite overwrapped pressure vessels (COPV) of a metal (titanium) liner and reinforced multilayer fibrous composite (CFRP). Such hybrid structures have significantly greater capabilities to manage their stress-strain state and thus durability and weight.

Producing reliable COPV requires developing and testing the technology for forecasting and analyzing the deformation and strength of vessels under typical and high load. It is useful to explore possibilities to control characteristics of deformation and strength by changing the geometry of the vessels and the mechanical and structural parameters of the composite. It is also important to develop and test a technology for optimization of the characteristics of vessels, primarily how to reduce the weight of the tank while maintaining its usable capacity.

Applying methods of mathematical modeling and numerical optimization can significantly reduce the duration of research aimed at finding the best parameters of the hybrid structure and cut down the cost of the research. However, a number of serious problems can occur along this way. They include the lack of reliable methods of solving problems of optimal design of such complexity, the problems of numerical modeling of such hybrid structures associated with the choice of models that describe adequately the behavior of such structures, and which are not too demanding on computational resources.

In this report, we propose approaches to the solution of direct problems with the use of a number of shell theories [1–3] and of several structural models of composite material [4]. The opportunities for controlling stress-strain state of COPV were shown. Regularities in the behavior of the vessels were found for all studied versions of shell theories and their combinations with different models of composite materials, which allows identifying the

ways of making best reinforcement by using simpler theories and models, saving computing resources significantly.

The second part of the study is dedicated to the solution of problems of optimum design of pressure vessels with minimum weight under given constraints on volume and strength. Basing on the results of the first part of research the classical shell theory and structural theory of fibrous composite material with one-dimensional fibres [4] were chosen as the basic theories. To solve these tasks we used the methods of global numerical optimization [5]. The results were verified by solving the direct problem with the obtained parameters.

The research resulted in development of the technological sequence from the analysis of stress and strain to optimal design of vessels with given constraints on the load and the internal volume. To design vessels with capacity V^* litres and a permissible pressure P^* , a parametric analysis was conducted with account of the strength characteristics depending on the parameters of the composite. The numerical optimizations were performed at different constraints on control functions: the form of a vessel, wall thickness, and reinforcement angles. It was shown that the variable control functions could significantly reduce the weight of the optimal design in comparison with the design with constant characteristics.

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MULTISCALE MODELING OF STRENGTH PROPERTIES OF DISPERSION-REINFORCED COMPOSITE MATERIALS PRODUCED BY ADDITIVE TECHNOLOGIES

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Additive technology is one of the most promising research areas in the production of composite structures. Methods based on this technology can improve the mechanical properties of products, but only at a certain optimization of the manufacturing process. Otherwise, significant residual stresses in the manufactured product may occur during solidification due to the shrinkage; which can lead to strain and even bundles in the final product. This work is devoted to the modeling of strength properties of the dispersion-reinforced ceramic composite material, taking into account the technological features of its manufacture by the additive technology.

We represent the ceramic composite, which is based on a matrix of reaction-bonded silicon carbide in the form of a three-level structure [1,2] (Fig 1).

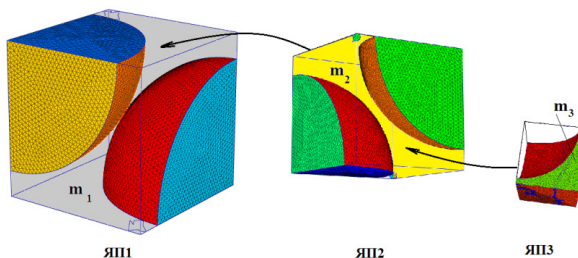


Fig. 1: The three-level structure of silicon carbide ceramics.

The level 1 is formed by the cells of periodicity 1, consisting of a filler of a coarse fraction and a matrix m_1 . On the 2nd level the matrix m_1 forms the cells of periodicity 2, each of them consists of a filler of a fine fraction and a reaction-sintered silicon carbide matrix m_2 . The matrix m_2 has defects, so we introduce the third structural level formed by the cells of periodicity 3. Each cell of periodicity 3 is formed by a defect-free silicon carbide matrix and a defect. All structural levels may be considered as independent according to the method of multiscale homogenization. At first we compute the effective elastic and strength characteristics of the lower level 3, then we calculate the effective characteristics of the second level, considering the composite matrix as a homogeneous material with effective characteristics of the level 3, and then we calculate the characteristics of the first top level. We formulate a set of local problems of elasticity theory over a $1/8$ cell of periodicity to calculate the microstrain:

$$\begin{cases} \sigma_{ij(pq)l} = 0, \quad \tilde{V}_\xi, \\ \sigma_{ij(pq)} = C_{ijkl}(\xi_s, z)(\varepsilon_{kl(pq)} - \alpha_{kl}(\theta - \theta^*)), \quad \tilde{V}_\xi \cup \Sigma'_s \cup \Sigma_s, \\ \varepsilon_{ij(pq)} = \frac{1}{2}(U_{i(pq)l} + U_{j(pq)l}), \quad \tilde{V}_\xi, \\ [U_{i(pq)}] = 0, \quad [\sigma_{ij(pq)}]n_j = 0, \quad \tilde{\Sigma}_{\xi\alpha N}. \end{cases} \quad (1)$$

The solution of the local problems (1) with special boundary conditions is implemented by the finite element method in the MicroYes software package, developed in the scientific and educational center "Supercomputer Engineering Simulation and Development of Software Packages" of the Bauman Moscow State Technical University. The effective elastic and strength characteristics are calculated in the result of solutions [3]. The influence of technological parameters on the strength characteristics of the composite is taken into account by the presence of residual stresses in the composite. The stresses arise due to the thermal strain $\varepsilon_{kl}^0 = \alpha_{kl}(\theta - \theta^*)$ of the ceramic composite $\varepsilon_{kl}^0 = \alpha_{kl}(\theta - \theta^*)$ during cooling after the laser sintering. It was found that the presence of residual stress reduces the total limiting strength characteristics of the composite under the load. The dependencies of tensile strength ceramic composites on the concentration of coarse ceramics fractions were investigated.

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ON THE MODELLING AND SIMULATION OF ANISOGRID SHELLS OF ZERO GAUSSIAN CURVATURE WITH ERROR CONTROL

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Anosogrid structures are grid shells manufactured of unidirectional carbon fibre reinforced plastics (CFRP) by automated method of continuous filament winding. They demonstrate enhanced properties of strength and stiffness and have significant potential in the field of construction of rockets and spacecrafts, aircrafts and deep-diving vehicles, buildings and high-duty structures [1].

The prospective technological solution of space industry is manufacturing of anisogrid shells of zero Gaussian curvature including conical payload adapters of launch vehicles and cylindrical elements of their airframes. The tendency to minimization of weight of such elements leads to decrease of safety factors during its design that results in significant increase of requirements of reliability, precision and stability regarding applied mathematical models and methods.

In this work for satisfaction of these requirements, the relations of three-dimensional theory of elasticity are used. In accordance with continuous approach and the so-called "smearing" concept [2], the averaged characteristics of stiffness of grid shell were derived. As a result, a cumbersome resolving system for displacement was obtained. It describes the stress-strain state of continuous equivalent of anisogrid shells [3].

Our further aim is to apply state-of-the-art computational systems to solve numerically these cumbersome equations taking into account nonlinear kinematical properties of structures and nonlinear physical behavior of CFRPs including its different resistance to tension and compression loads. To this end in this work, a new computational technology is proposed. It includes symbolic derivation of resolving systems in Wolfram Mathematica, syntactic analysis (parsing) of the obtained equations and transforming them into Java code for performing computations in ANISOGRID software package [4].

To provide and control high accuracy and computation stability ANISOGRID software package uses a nonlocal algorithm without saturation [5] based on the original way of discretization of resolving systems – approximations without saturation [6]. The properties of such approximations significantly depend on the smoothness of approximating function and for each class of smoothness its accuracy asymptotically coincides with the accuracy of best polynomial approximations. For obtained resolving systems, it means the exponential decrease of error with grows of nodes of numerical algorithm.

The application of nonlocal algorithm without saturation based on Fourier series and Chebyshev polynomials allows one not only to minimize memory requirements and computational efforts (that is most important for 3D problems) but also to control the error. In this work the numerical solutions to the problem of axial compression of anisogrid structures having zero Gaussian curvature are obtained. The error of method of approximation was estimated applying the nonlocal algorithm on a sequence of meshes. The numerical (truncation) error connected with truncation of digits in floating point computations was estimated through the residual of iterative process of algorithm and through the values of norms and condition numbers of its matrix operators. A good property of algorithm is a slow grows of these norms and condition numbers with the grows of number of basis function used for approximation.

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NUMERICAL ALGORITHM FOR THE SOLUTION OF DYNAMIC PROBLEMS IN MICROPOLAR THEORY OF RODS AND THIN PLATES

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The micropolar (Cosserat) model is used to describe materials with microstructure like composite, granulate, powdery and porous media [1, 2]. In this model independent small rotations of particles described by the angular velocity vector are taken into consideration. In addition to asymmetric stress tensor an asymmetric couple stress tensor is introduced. The issues of numerical solution of dynamic problems in the framework of three-dimensional Cosserat elasticity theory are presented in [3, 4]. In this paper the numerical algorithms for the solution of dynamic problems in micropolar rods and thin plates are proposed.

The systems of equations describing rods and thin plates are constructed with the help of reduction of three-dimensional equations of the micropolar media by integration over the thickness. These systems can be written in matrix form convenient for numerical realisation. Under some restrictions on material parameters the systems of equations are hyperbolic in the sense of Friedrichs. For these systems the energy balance equation is fulfilled.

The algorithms of the solution of dynamic problems in micropolar thin-walled structures are based on the two-cyclic decomposition method with respect to the spatial variables and time. For two-dimensional case the two-cyclic decomposition method on time interval $(t; t + \tau)$ consists of five stages: the solution of one-dimensional problem in the x_1 direction on the interval $(t; t + \tau / 2)$; similar stage in the x_2 direction, the stage of solution of a system of linear ordinary differential equations; and two stages of repeated recalculation of the problem in the x_2 and x_1 directions on time interval $(t + \tau / 2; t + \tau)$. At all stages except the third one for the solution of one-dimensional systems in spatial directions the explicit monotone finite-difference scheme of the "predictor-corrector" type is used. At third stage Crank-Nicholson finite-difference scheme with full time step is used. This scheme has good computational properties: it is conservative in the sense of consistency with the corresponding energy balance equation.

A series of numerical computations of elastic wave propagation induced by the action of instant concentrated loads and periodic distributed loads is performed. A verification of a problem is made by comparing the results of computations with the exact solutions describing elastic wave propagation in special cases.

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MODIFICATION OF FOURIER APPROXIMATION FOR SOLVING BOUNDARY VALUE PROBLEMS HAVING SINGULARITIES OF BOUNDARY LAYER TYPE

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By now, a huge amount of urgent scientific and technological problems is reduced to boundary value problems for differential equations having pronounced singularities of boundary layer type. The most popular approaches to solving them are based on construction of computational grids with piecewise linear/polynomial approximation of the unknown function in each cell of grid [1]. Such approaches provide relatively low rate of convergence and lead to essential refinement of grid in the vicinity of boundary layer and consequently to grows of computation costs and errors. In [2,3] methods of coordinate transformations were developed that allows to decrease the influence of mentioned effect due to application of special coordinate mappings eliminating the singularity. Nevertheless, the analysis of key issue concerning the smoothness of such transformations and its influence on the quality of approximation method is absent. Frequently authors restrict their self by transforming uniform or more special grid and performing numerical experiments using finite difference or spectral methods [2–5].

In this work a step aside from the traditional grid approaches is made and the approximations based on mapping of Fourier series domain to the segment $[-1,1]$ are used to approximate functions having singularities of boundary layer type. One of such mappings that allows one to eliminate (in mentioned sense) the singularity of function in the vicinity on boundary leads to the expansion

$$f(x) = P_N(x) \approx \sum_{k=0}^N a_k \cos \left(k \arccos \left(\tan \left[\frac{x \arctan(b)}{b} \right] \right) \right) = \sum_{k=0}^N a_k B(k, x),$$

where $b > 0$ is parameter, N is number of basis functions of the expansion. For smooth functions, the basis $B(k, x)$ provides exponential decrease of approximation error with moderate value of factor of exponent and ensures high computational stability inherent to Fourier series.

In this work the high rate of convergence and stability of the proposed method is justified theoretically for four types of coordinate mappings, the dependences of approximation

error on the values of derivatives of approximated function are obtained, the algorithms of expansion of functions into the series with basis consists of Chebyshev polynomials $T(m, x)$ and proposed functions $B(k, x)$ are developed and implemented. It was shown that for functions having high order of smoothness and extremely steep gradients in the vicinity of boundary the accuracy of proposed method cardinally exceeds the accuracy of Chebyshev's approximation. Moreover for such functions method allows to reach an acceptable accuracy using only $N=10$ basis elements (relative error does not exceed 1%).

Having analyzed the data from Table 1 one can compare the errors of two types of approximations of solution to the following boundary value problem with small parameter $0 < \varepsilon \ll 1$

$$\varepsilon f''(x) - f(x) = -\sin \pi x (\varepsilon \pi^2 + 1), \quad f(-1) = 1, f(1) = -1. \quad (1)$$

This data was obtained using single-type basis function $T(m, x)$ (see first row) and the coupled basis $B(k, x)$ with $T(m, x)$ (see second row). One should also take into account that the convergence of expansions in the Chebyshev's basis $T(m, x)$ asymptotically coincides with convergence of the best polynomial approximation (see for example [6]). This means that use of polynomial basis is really not the best way to approximate a smooth function having singularities. A good solution in such case is application of coupled basis.

Table 1: Values of approximation error in supremum norm obtained for the solution of problem (1) with $\varepsilon = 10^{-10}$

N	10	40	70	100
$T(m, x)$	1.0000	1.0000	1.0000	0.9973
$B(k, x)$ and $T(m, x)$	0.0529	$9.2 * (10)^{-8}$	$2.3 * (10)^{-11}$	$2.1 * (10)^{-11}$

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DYNAMICAL MODEL OF HUMANOID ROBOT BIOLOD TYPE A

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The goal of this work was to get precise model of kinematic and dynamic characteristics of small humanoid robot bioloid type A. Obtained data was used for computer model development. Created model can be used for robot locomotion dynamics and load analysis, also for motion planning and control research. It should be mentioned that obtained data and model can be used for analysis of various types of robots with different kinematic structure.

Our results are:

- Robot kinematics data is obtained and this data used for robot kinematics model development. Every robot limb is described as serial manipulator. Robot model is described as 4 connected serial manipulators. This data and model can be easily reused for analysis of locomotion of other robots with different kinematic scheme.
- Dynamic characteristics – mass, centers of masses and inertia tensors are obtained. For plastic parts with uniform mass distribution dynamic characteristics are obtained with computer computations based on parts 3d models. This data was verified with dynamics measures of real parts. Servo motors could not be analyzed as uniform mass distribution objects and dynamics data of motors ax-12A is obtained with measures.
- Obtained data is verified with number ax-12a motors loads measures. Robot Dynamics model is developed on basis of robotics toolbox MATLAB instruments. Model can connect and get data from Real robot online with help of our robot interface class which is based on USB2Dynamixel hardware and data transfer library. This solutions can be used for robot motion analysis and control strategies investigations and developments. Model provides ability to test control algorithms with virtual and real robot using same interface.

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SOME EXACT SOLUTIONS OF A HEAT WAVE TYPE OF A NONLINEAR HEAT EQUATION

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The nonlinear second-order parabolic equation with two variables is considered. Under the additional conditions, this equation can be interpreted as the porous medium equation in case of dependence of the unknown function on two variables: time and distance from the origin. The equation has a wide variety of applications in continuum mechanics, for example, it is applicable for mathematical modeling of filtration of ideal polytropic gas in porous media or heat conduction. The authors deal with a special solutions which are usually called a heat waves. The special feature of such solution is that it consists of two continuously joined solutions. First of them is trivial and second one is nonnegative. The heat wave solution can have a discontinuity derivatives on the line of joint which is called the front of heat wave, i.e. smoothness of the solution, generally speaking, is broken. The most natural problem which has such solutions is so-called "the Sakharov problem of the initiation of a heat wave". New solutions of considering problem in the form of multiple power series for physical variables are constructed. The coefficients of the series are obtained from tridiagonal

nal systems of linear algebraic equations. Herewith, the elements of matrixes of this systems depend on the matrixes order and the condition of the diagonal dominance is not executed. The recurrent formulas for the coefficients are suggested.

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ABOUT VERIFICATION OF CALCULATION METHODS OF THE SHOCK WAVES

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Mathematical modelling of dynamic processes in mechanics of continuous mediums is one of the most important instruments of researches now. Already existing or new created models and numerical methods are used for the solution of specific problems. Their properties are defined using a priori research of stability, approximation, monotonicity, etc. in the linear approximating. Comparing of results of calculations with "reference" solutions is the main control method of accuracy of the difference schemes. While the exact solutions of problems of stationary shock waves are considered as "reference", then their derivatives accept great values only at the front of the "spread" shock wave. In case of a non-stationary shock wave derivatives are large also out of the front, and, therefore, approximation errors are large everywhere.

It is proposed the exact solution of the problem of a convergent shock wave and gas dynamic compression in a spherical vessel with an impermeable wall in Lagrangian coordinates. At the initial time the speed of cold ideal gas is equal to zero, and the negative speed is set on boundary of the sphere. When $t > t_0$ the shock wave spreads from this point into the gas. The boundary of the sphere will move under the certain law correlated with the motion of the shock wave. The trajectories of the gas particles in Lagrangian coordinates are straight lines. The equations determining the structure of the gas flow between the shock front and gas border have been found as a function of time and the Lagrangian coordinate. The dependence of the entropy on the speed of the shock wave has been found too. For Lagrangian coordinates the problem is first solved. It is fundamentally different from previously known formulations of the problem of the self-convergence of the self-similar shock wave to the center of symmetry and its reflection from the center, which was built up for the infinite area in Euler coordinates [1-5].

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SUPERCOMPUTER MODELING OF STOCHASTIC DYNAMICS OF THE MERCURY ION ARRAY IN AN OPTICAL LATTICE

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Study of ions trapped in electromagnetic traps are very important for spectroscopy, metrology, quantum informatics, physics of cold collisions and many-body physics [1,2]. The recent perspective trend in this field of research is the so-called all-optical confinement of ions, i.e. ion trapping without applying radiofrequency or electrostatic and magneto static fields [3-6]. In particular, it is assumed, that with development of all-optical methods, an ion clock can be created with better characteristics [7].

In our previous papers [4-6] the solution of all-optical ion trapping problem was proposed, based on using the 3D polychromatic optical super-lattice (OSL). We demonstrated, by the numerical simulations of stochastic ion motion, the long-term all-optical trapping of two- and three-ion ytterbium clusters in OSL.

In the present work, we carried out numerical simulations of dynamics of nine mercury ions in OSL and showed the long-term all-optical trapping of ordered ion array (nine-particle planar Coulomb cluster) in OSL.

The mathematical model is a system of stochastic differential equations for positions and velocities of each ionic particle. Four forces are considered in the model: the trapping, friction, Coulomb, and stochastic force. The last force arises due to quantum fluctuations of the optical forces. For the numerical solution of basic equations, we employ the generalization (in view of presence of random force) of the well-known Störmer-Verlet scheme. The Monte Carlo method is used to evaluate different average characteristics of this physical problem. Due to slow convergence of the Monte Carlo method, the volume of independent samples may be very large (from 2^{13} to 2^{18}). Use was made of 128-512 processing cores and the run time reached 24 hours. The number of time steps could reach 10^8 . The calculations were carried out using the MVS-100K supercomputer at the Joint Supercomputer Center of RAS.

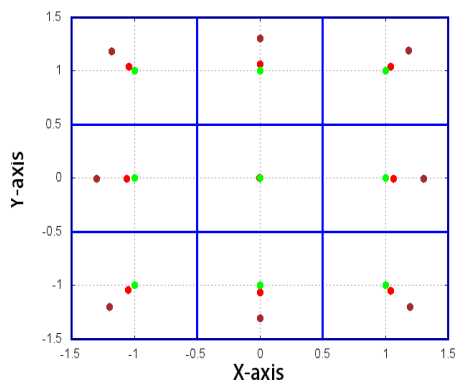


Fig. 1: Formation of the nine-ion planar clusters (red points for $L=0.6$ mm; brown points for $L=0.5$ mm): projections of the ion positions (averaged over 2^{13} independent samples) on the plane XOY . The green points are the initial positions.

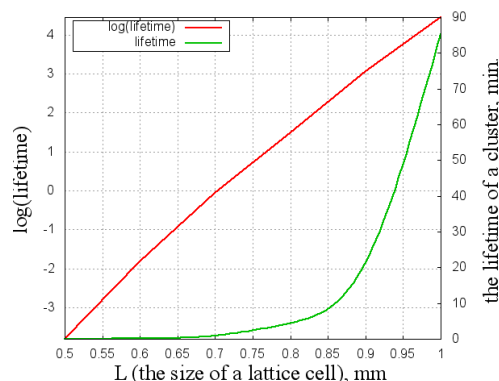


Fig. 2: The lifetime (green line) of the nine-ion planar cluster and natural logarithm (red line) of the lifetime depending on the lattice cell size L .

An example of numerical modeling is shown in Figs. 1-2, demonstrating the formation of nine-ion planar Coulomb clusters in the 3D OSL cells. The time of clusters formation is of

order 10^{-3} seconds and the lifetime of a cluster can exceed 60 minutes (Fig. 2). Such generalization of results [4-6] is very important for practical applications of the new all-optical ion trapping method.

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HP-VERSION OF COLLOCATION AND LEAST RESIDUALS METHOD IN MECHANICS OF LAMINATED COMPOSITE PLATES

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Collocation and least residuals (CLR) method is projection numerical method for solving boundary value problems for partial differential equation. The authors suggest hp-version of CLR method that based on the use of polynomials of higher degrees [1, 2]. The developed hp-version has three major advantages. The method is based on the use of polynomials of higher degrees, written as a direct product of Chebyshev polynomials that helps to minimize the accumulation of rounding errors. Special choice of collocation points, using the roots of Chebyshev polynomials, provides fast convergence and high accuracy of numerical solutions for a wide class of functions. In the CLR method the solution of a corresponding linear algebra problem is defined as the minimum of the functional of residual norm. This brings linear algebra problem well-conditioned. These advantages of hp-version of CLR method allows to carry out calculations at a lower computational cost.

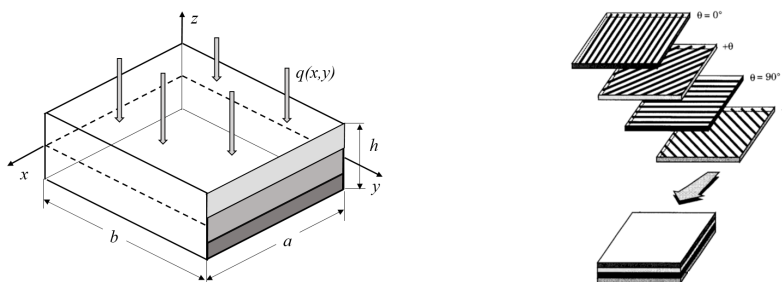


Fig. 1: The bending of laminated plate with transversely isotropic layers. The main directions of elasticity of the layers can be disposed arbitraty in plates's plane.

The developed numerical method was used to calculation of laminated composite plates. Mathematical modeling and the calculation of strength and stiffness characteristics of laminated constructions lead to difficult problems of computational mathematics [3]. Anisotropy and layered (heterogeneous) structure (Fig. 1) lead to a complex stress-strain state distribution in plates. Calculation of stress-strain state of laminated plates leads to ill-conditioned problems due to presence of small parameters arising from the small relative thickness and anisotropy of layers. The hp-version of CLR method does not requires special technics for solving differential equations of high order, that characterize the considered problem statements. And it is easy to implement the boundary conditions that contain linear combinations of derivatives of a higher order.

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NUMERICAL ANALYSIS OF ACOUSTIC WAVES IN A LIQUID CRYSTAL TAKING INTO ACCOUNT COUPLE-STRESS INTERACTION

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Liquid crystals are unique materials because of unusual combination of the properties of elastic anisotropy, inherent to crystals, and fluidity, typical for liquids. A material transforms into the state of a liquid crystal in a certain temperature range under weak external perturbations. The mobility of the liquid crystal molecules allow external forces to change the orientation of crystals and, thus, to control their properties.

One of the approaches to the construction of a mathematical model to describe the behavior of liquid crystals is based on the representation of a liquid crystal medium as a fine-dispersed continuum. At each point of this continuum, the domains of a liquid crystal can move in accordance with laws of the dynamics of viscous or inviscid liquid and can rotate relative to a liquid, encountering resistance to rotation.

In the framework of acoustic approximation, the model of a liquid crystal without taking into account the couple stresses is described in [1, 2]. The system of equations of this model includes the equations of translational and rotational motion, the equation for the angle of rotation, the constitutive equations for pressure and tangential stress, as well as the equation of anisotropic heat conduction with variable coefficients. Parallel computational algorithm for the solution of this system is represented in [3, 4].

The present work is devoted to numerical solution of the second-order differential equations for tangential stress and angular velocity. These equations are derived from the system of equations describing the thermomechanical behavior of a liquid crystal taking into account the couple-stress interactions in two-dimensional case. Computational algorithm for numerical solution of the system of equations of the second order under given initial data

and boundary conditions is worked out. The explicit finite-difference scheme “cross” of the second-order approximation is used. The stability condition for this scheme is obtained. The algorithm is implemented as a parallel program in the C language using the CUDA technology for computer systems with graphic accelerators. Computations are performed on the GPU, which is a coprocessor to the CPU. Graphical device consists of a large number of threads, each of which is associated with a mesh of the difference grid. In parallel mode, the threads of a graphic device perform operations of the same type in the meshes of grid on the calculation of solution at each time step.

A series of numerical calculations was carried out on the high-performance computational server Flagman with eight graphic solvers Tesla C2050 (448 CUDA cores on each GPU) of the Institute of Computational Modeling SB RAS to demonstrate the efficiency of proposed parallel program. In Fig. 1 one can see the results of computations for the problem on the action of three P-shaped impulses of tangential stress on the parts of lateral boundaries of computational domain. Computations were performed for a liquid crystal 5CB. The size of domain is 100 mm × 40 mm, the dimension of a finite-difference grid is 2560 × 1024 meshes.

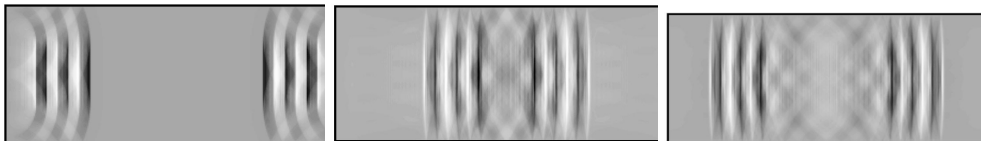


Fig. 1 The action of three P-shaped impulses of tangential stress on the lateral boundaries of computational domain: level curves of tangential stress at different instants of time.

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SPECIFICATION AND ANALYSIS OF TRANSIENTS IN ELECTRICAL POWER SYSTEMS USING THE METHODOLOGY OF HYBRID SYSTEMS

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This paper discusses discrete-continuous (hybrid) systems [1, 2] and corresponding simulation tools. Hybrid system (HS) is characterized by set of instantly changing continuous modes. In this case, the use of analytical methods is often impossible and computer experiment becomes the only universal way of studying the event-continuous behavior. Typically regime change caused by one-sided events when the phase trajectory of the system is dis-

continuous when the event occurred. Modern computer simulation tools (MATLAB/Stateflow, Rand Model Designer, AnyLogic, etc.) support HS class, but not take into account the one-sided events [2, 3]. Therefore, the development of original tools for computer research of HS is an important task.

Modern HS formalism can be effectively used by application specialists in problem-oriented environments of computer analysis. One of the many HS applications is the study of transients in electrical power systems (EPS). The electromagnetic and electromechanical processes in electrical machines are of particular importance. They are simulated to determine the synchronism of the power station units, evaluate the reliability and stability of EPS.

To solve this problem a special module was developed in ISMA simulation environment. Fig. 1 is a schematic diagram of six-machine power system [4] specified in ISMA by designed LISMA_EPS language. Park-Gorev's ordinary differential equations are used for the research of transient processes. Discrete behavior of EPS associated with nonlinear characteristics of generator speed regulators. Also, the EPS operating mode can be changed upon the occurrence of certain events: switching, short circuit, breakage of power lines, etc. Therefore HS methodology is adequate for description and study of transient processes in EPS.

The central object of study in ISMA is a hybrid model obtained by interpretation of graphical programming model (Fig. 1). The solver of simulation environment uses the library of classical and original numerical methods intended for solving systems of differential-algebraic equations with discontinuities. The original algorithm of correct event detection was developed for processing gaps, which is an integral part of numerical analysis. The correctness of the algorithm is theoretically proved in [2]. The efficiency of the proposed methodology is in general constructively proved on a set of test problems.

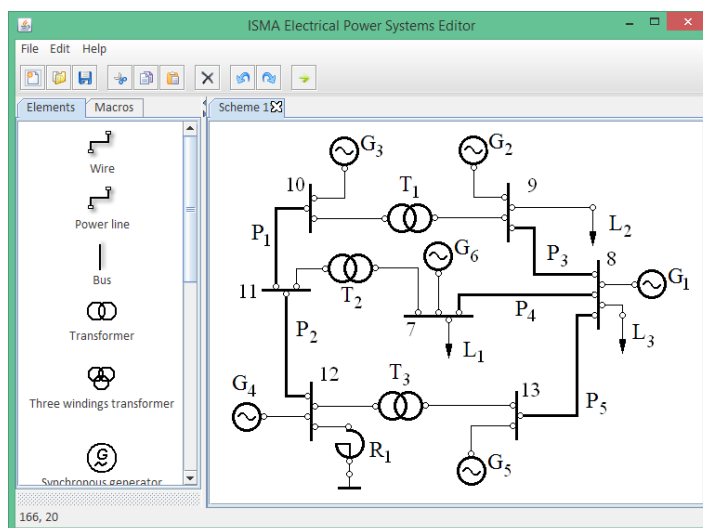


Fig. 1: The EPS circuit in the substantive interface.

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NUMERICAL SIMULATION OF MULTI-MODE FIBER-OPTIC COMMUNICATION LINES

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The annual traffic growth already exceeds the growth of the transmission capacity, and in the nearest years, we may face the problem of the traffic volume exceeding the capabilities of data transmission technologies, if no new technology, providing a significant increase in the transmission capacity of communication lines, will be offered. The development of communication systems based on multi-mode fibers is considered as a promising way for solving the above problem. Multi-mode fibers allow an increase in the transmission capacity of optical networks at the expense of simultaneous transmission of signals through multiple modes of the fibre.

In the present work we consider two important cases of signal propagation through multi-mode fibers (MMF) that are of practical interest, the weak- and strong-coupling regimes. In the present work, we study the process of propagation of electromagnetic radiation in multi-mode fibers. As the basis model, we consider the model based on the Manakov equations and describing the nonlinear propagation of the signal in multi-mode fibers in the case of weak [1] and strong coupling [2]. The aim of the present work is to find the configuration of a digital communication system, optimal with respect to minimising the bit-error rate (BER), depending on the number of propagating modes and the mode coupling regime. To solve propagation equations we used the symmetric version of the split-step Fourier method (SSFM). To transmit the data we used polarisation-division with the quadrature phase-shift keying (QPSK). To shape the pulse we used the filter with the raised cosine characteristic and the smoothing coefficient 0.2. Each signal consisted of 2^{15} symbols with 32 counts per symbol and was transmitted with the symbol rate $R_s = 28.5$ Gbaud.

In the present work we compared weak- and strong-coupling regimes. It was shown that with the growth of the number of modes the strong coupling regime provides a lower level of BER than the weak coupling one [3]. We also investigated the dependence of BER on differential group delay (DGD) between the modes. It was shown that performance increases with increasing DGD.

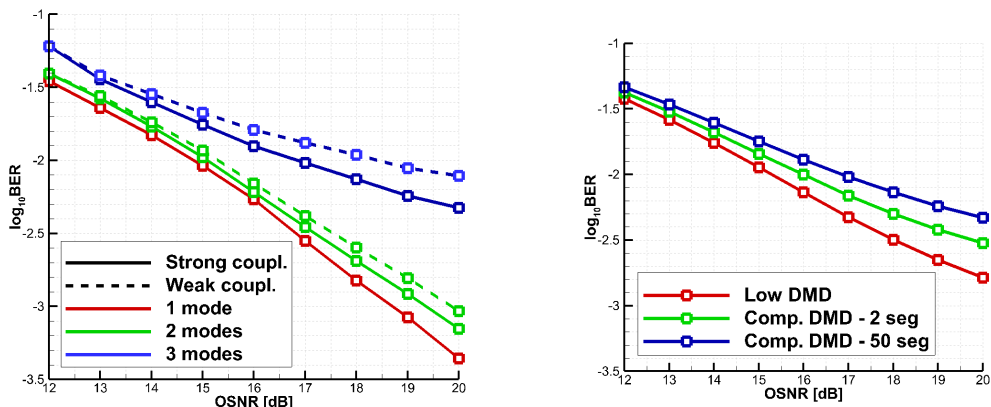


Fig. 1: The comparison of weak and strong coupling regimes (left) and MMF with low and compensated DMD (right).

One of the main challenges of long-distance propagation in multi-mode fibers in weak-coupling regime is the complexity of MIMO receivers that used to equalize for mode coupling. We compared two types of multi-mode fibers to meet this challenge: MMF with low DGD and with compensated DGD (combining fiber sections with DGD of opposite sign). MMF with low DGD demonstrate better performance than fibers with DGD management for long-distance transmission.

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CONCEPTUAL MODELS OF SWITCHING BETWEEN MULTISTABLE STATES IN THE "BIOSPHERE-CLIMATE" SYSTEM

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Time series analysis of global temperature [1] (Fig.1.) and ~70 other global and local parameters [2] indicates the presence of abrupt transitions between stationary states. The concept of non-linear systems, which undoubtedly include the "biosphere-climate" system (BCS), makes the threshold response to gradually increasing influence factor (the increase in greenhouse gas concentrations) quite expectable.

Identification of the switching mechanisms using general circulation models of the atmosphere and the ocean [3] is associated with the obvious difficulties due to their complexity. Understanding the nature of such switches at qualitative concepts can be achieved by using a conceptual small-scale models [4].

Since quasi-periodic natural oscillations and especially El Niño give significant contribution to the global temperature dynamics the conceptual model has to take into account these phenomena. Since the origin of these oscillations is not finally determined there are two possible variants of the relationship between the natural quasi-periodic oscillations and a mechanism of abrupt transitions.

According to the first variant these oscillations are the result of joint influence of external factors (Chandler wobble of the poles, the lunar-solar nutation, solar activity) [5] that overlap the switching of some natural thermostat the existence of which is indicated by some observations [6].

According to the second variant quasi-periodic oscillations are the manifestation of the intrinsic properties of the BCS and the observed abrupt switches of this system are due to changes of the attractor of a nonlinear oscillator or some system of coupled oscillators.

In the paper on the example of the series of small conceptual BCS models conditions for the occurrence of multiple switches (Fig.2) for these variants were studied and qualitative estimates of these variants feasibility were obtained.

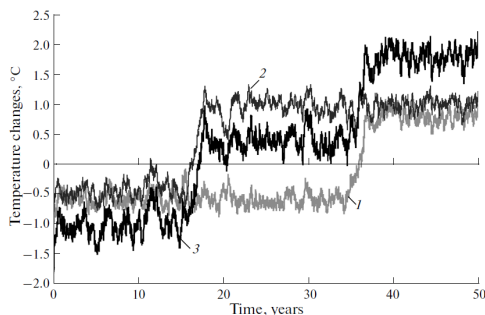


Fig.1: Residual annual average temperature variations. (1) Average annual global temperature anomaly, (2) approximation by the model step function.

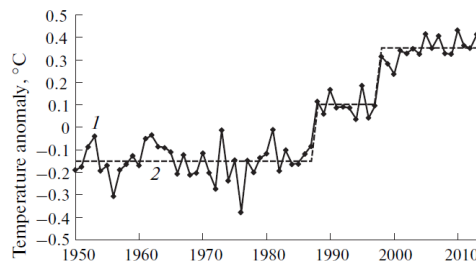


Fig.2: Temperature jumps in the model in the presence of forcing buildup. (1) First climatic domain, (2) second climatic domain, (3) total temperature change.

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МИТ 2016

OPTIMAL CONTROL OF HUMAN CAPITAL ALLOCATION FOR PIECEWISE SMOOTH DYNAMIC MODEL

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The article presents optimal control of human capital allocation under the condition of smoothness abnormality in the right-hand member of the dynamic system. It describes an individual's behavior who strives to leave to his/her heirs the maximum of cash and tries to get the maximum utility through controlling expenditures and time consumption for work and studies. The objective function of the model maximizes the human life utility. The latter is formed by the human capital development and financial savings for heirs. The authors developed special methods how to find optimal control and take into account smoothness abnormality in the right-hand member of the dynamic system. They defined the optimality conditions and designed algorithmic support and software to find optimal control and interpret its content.

Keywords. optimal control, human capital, maximum principle, piecewise smooth dynamic system.

USING FENICS FRAMEWORK FOR HEART SIMULATION ON PARALLEL COMPUTING SYSTEMS

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The purpose of this paper is to evaluate how the automated scientific computing frameworks could be used for heart simulation on parallel computing systems. Heart simulation is a complex task that requires multiscale modelling on the cell, tissue, and organ levels [1]. Such problems are computationally intensive and need parallel computing, including the use of modern computational accelerators such as GPU and Xeon Phi. However, porting complicated multilevel simulation code to a new architecture requires a long time (often 3–5 years) during which the architecture may become obsolete. In addition, adaptation for parallel computing architectures often leads to significant changes of code. Consequently, it is very hard to determine which mathematical models and numerical methods are used in the optimized code. Hence, reflecting the changes in a mathematical model in the optimized code can be very complicated. As a result, complex multiscale simulation software is rarely adapted to modern parallel computing architectures.

An alternative approach is based on the usage of frameworks for automated scientific computing. Such frameworks allow the development of simulation software using programming languages with near-mathematical notation. Traditionally, a significant disadvantage of such frameworks was their low simulation performance. However, some modern implementations use advanced tools such as highly efficient libraries, just-in-time compilers, parallel execution, and so on, which improve their performance. Still, it is not clear if modern automated scientific computing frameworks are efficient enough for real multiscale simulation tasks such as heart simulation.

We present an overview of existing frameworks for automated scientific computing, including OpenFOAM, OpenCMISS, FEniCS, and Chaste. The FEniCS framework [2] was chosen for our purpose, because it provides the automated solution of differential equations by finite element methods and supports automatic parallel execution using MPI. In addition, FEniCS framework is widely used and well documented.

To evaluate the performance of the FEniCS framework for heart simulation tasks, we use the electrophysiological model of cardiac left ventricle and the cell model that were developed in our group [3]. The model incorporates a description of approximately 20 ionic currents and elements of the intracellular signalling. We focus on the implementation of the largest component of the model that is responsible for the simulation of transmembrane potential. This component is a system of nonlinear differential equations that cannot be solved analytically and is very computationally intensive due to the large amount of variables in the 3D domain. The model was implemented using the FEniCS framework in the Python language. The Python code was converted to C/C++ by the Instant dynamic compiler, which is a part of FEniCS. The parallel execution using MPI was automatically provided by FEniCS with the help of the PETSc library. The computational experiments were executed on the “URAN” supercomputer of the Institute of Mathematics and Mechanics of UrB RAS.

During the computational experiments, we investigated the space propagation of membrane potential alternation over left ventricle of human heart. The simulation of one cardiac cycle (one second of physical time) was performed. We used the symmetric anatomical model of left ventricle [4], which was represented by a tetrahedral mesh with 50000 elements.

Performance and scalability of the FEniCS-based solution was compared with the manual implementation of the same model in the LeVen system [5], which uses the C language

and OpenMP for parallelization. The performance of the two implementations was roughly the same, but the FEniCS-based solution provides better scalability: it is scaled up to 64 CPU cores, while LeVen only scaled up to 8 cores.

The FEniCS framework is an efficient tool for heart simulation on parallel computing systems because it provides convenient near-mathematical notation, high simulation performance, and scales well.

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APPROXIMATION AND IDENTIFICATION ERRORS INVESTIGATION

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The problem of approximation of polynomial and non-polynomial functions by the method of least squares is considered. Polynomials of n -th degree have been used for approximation ($n = 1 - 15$). The simulated distortion of free terms of equation system and filtration of results [1,2] were applied. Approximation and identification errors have been compared with the values obtained without distortion. It found that the rounding error has systematic character when the simulated error dominates, so it can be filtered. Rounding error decreases rapidly from baseline as a result of filtration (suppression) of systematic part. Although approximation error is determined by using the polynomial coefficients having a large error $\Delta = 10^{-17} \cdot 10^{1.5n}$, but the result has essentially smaller error $\Delta = 10^{-16.5} \cdot 10^{0.8n}$.

The results of approximation of function $1/(c+x)$ in the interval $[0,1]$ for $c = 2$ and $c = 1$ are shown in Fig. 1a,b. The identification accuracy estimates using a difference of polynomials of degree n and $n - 1$ are marked by number 1, number 2 - approximation accuracy estimates, number 3 - logarithm of maximal difference of the calculated polynomial coefficients and coefficients of Maclaurin series for approximated function. The second case differs from the first because the Maclaurin series does not converge when $x = 1$ in the second case. The results of experiment carried out for approximation of polynomial functions were used to estimate the rounding error (dotted lines).

As it is seen from Fig. 1, a rounding error estimates obtained in independent experiment are adequate for this experiment. The point of accuracy loss and its dependence on n in this experiment are close enough to the dotted line, i.e. matching previous estimates. Identification error estimates by polynomials difference and by comparison with Maclaurin

series coefficients are also in good agreement. Comparison of the graphs in Fig. 1 (a and b) shows that the lack of series convergence has a little impact on the approximation error, but the identification error remains about the same level about 0.1 with increasing n (but still slightly decreases).

Many of those who solve the identification problems use the approximation error as an estimate of the identification error. These examples show that the identification errors can be higher than the approximation ones by several orders.

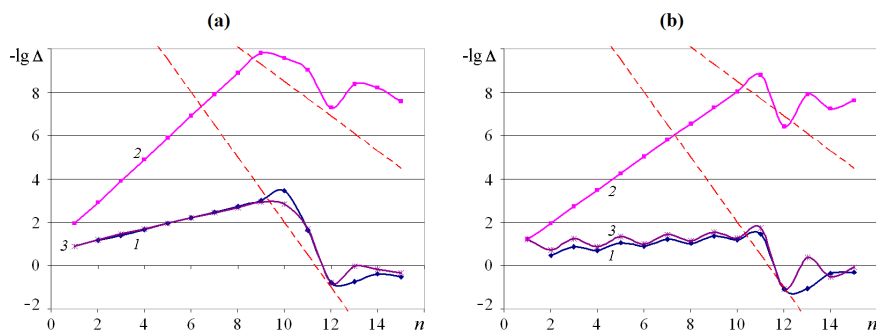


Fig. 1 The results of approximation of the functions: a - function $1/(2+x)$; b - function $1/(1+x)$. Dotted lines $y=16.5-0.8n$ and $y=17.5-1.5n$.

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THE ALGORITHM OF AUTOMATED DEFINITION OF GENRE TYPE AND STYLISTIC COLORING OF THE TEXTS IN RUSSIAN LANGUAGE

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In the process of automated analysis of natural language texts there is the problem of the definition of their genre type and stylistic colouring. The first stage of solving this problem is the development of appropriate classifiers. For the texts in Russian language there is a division of texts (primarily literary) into relevant to high, neutral and low styles, which are originated to the works of M. V. Lomonosov. Historically, each of them is characterized by the ratio of the usage of old Slavonic (Church Slavonic) and Russian words (in this case we consider separately the group of words common to old Slavonic and Russian languages), the part of archaisms, and the usage of certain syntactic constructions. In turn, in the classical theory a genre of a literary text strictly dictates the choice of style. The classic genres of the lyrics (according to the most completed classification given in the works of D. M. Magomedova [1]) include the system of canonical genres: an Ode, an Elegy, an Idyll, an Epistle (a Message), a Ballad, complemented by non-canonical: a Fragment and a Short story in verses.

However, in practice there are frequent cases when in the text, a genre of which is traditionally associated with a particular style, there is a wide range of lexemes of other styles. We made the original two-dimensional classifier of a genre/style that allows to increase the accuracy of determining of the characteristics of a literary text (especially poetry), used in the further process of the automated analysis.

In turn, the process of classifying of a text to one or another section of the constructed two-dimensional classifier can also be automated. For this purpose, we developed an algorithm of the description of semantic fields associated with various genre and stylistic types of texts.

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МИТ 2016

EOR SCREENING USING FUZZY LOGIC AND COMPARING WITH THE RESULTS OF FILTRATION EXPERIMENTS (ON THE EXAMPLE OF ONE KAZAKHSTANI OIL FIELD)

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Most of the active oil fields are in the late stage of production development. In order to increase hydrocarbon production, field life and recovery factor application of enhanced oil recovery (EOR) methods is required. About 3 million barrels per day (3.5% of total world daily oil) is produced through the introduction of EOR [1].

Selection and planning of the EOR methods is a challenging process which requires a complex approach for its implementation, including system studies. It requires deep understanding of geology, geophysics, petrophysics, geological modeling, hydrodynamic simulation etc.

The essence of the EOR screening is analytical and numerical analysis of diverse information. EOR screening aims to describe the behavior of the field and evaluate applicability of the EOR methods to ensure selection of the most effective solutions for oil production.

This paper describes the algorithm for EOR methods selection and evaluation based on the analysis of geological and physical characteristics of the field using fuzzy logic method. Fuzzy logic allows effectively applying the proposed method and mitigating risks when selecting the optimal EOR at uncertainty conditions of input information. The results of study were tested in laboratory filtration experiments on the viscous oil displacement (figure 1).

The aim of the research was to determine the most effective enhanced oil recovery method in terms of displacement efficiency and EOR screening. Laboratory experiments include the base case (water injection); thermal treatment by hot water injection; polymer flooding; polymer flooding at high temperature [2]. This affords to receive results for different reservoir stimulation scenarios. Fuzzy logic method is used to compare and confirm laboratory results.

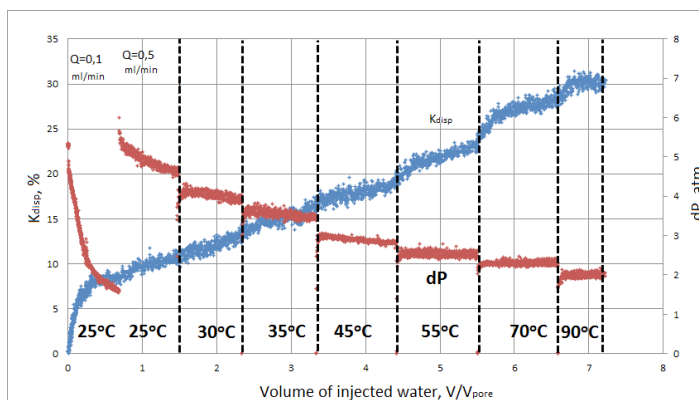


Figure 1. Change of displacement ratio and pressure drop during water injection at a constant rate and different temperature

EOR screening considered more than ten EOR methods including water flooding, hot water injection and polymer flooding which were also tested during laboratory filtration experiments. Both EOR screening and filtration experiments results prove effectiveness of using thermal EOR methods on the studied field.

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FACTUAL INFORMATION SYSTEM FOR INTEGRATION OF THERMOPHYSICAL PROPERTY DATA

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Working with experimental data is central to thermal physics. The goal of this work is to create factual information system for integration (collection, storage, presentation and pre-processing) of data from experimental and theoretical studies on thermophysical properties of materials, particularly chemical substances.

A promising approach is the use of ontology [1]. The ontology term refers to strict description of domain concepts and semantic relations between them in a certain formal format.

One of the main tasks in this work is to create an ontology for working with data on thermophysical properties of materials that adequately describes this subject area and is the basis for an information systems working with the thermophysical property data.

The most popular and suitable for the task family of formal knowledge representation languages, that is ontology description languages, is OWL (Web Ontology Language) [2, 3].

In this work, the terminological component (TBox) claimed the domain ontology is constructed and described by means of OWL [4]. The objects of research in thermal physics are

materials, particularly chemical substances. The base record about thermophysical property data on chemical substance is the following: “A given substance in a given state has a given property with a given value obtained from a given source”.

The next task of this work is to develop an information system that allows to edit a set of statements (ABox) on substances and their thermophysical properties within a given ontology, as well as visualize an information available and pre-process a numerical data.

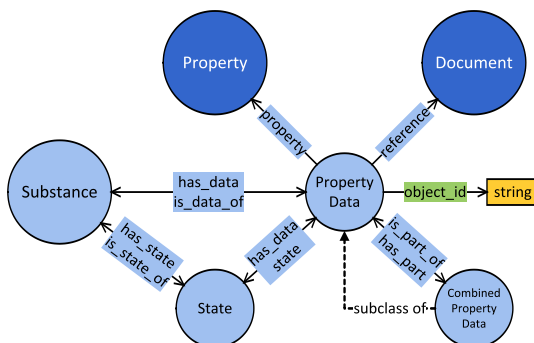


Fig. 1. The part of subject-predicate structure of the ontology.

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COMPARATIVE ANALYSIS OF PERFORMANCE OF OPEN SOURCE DATABASES IN WEB APPLICATION DEVELOPMENT

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One of the dilemmas faced by developers of Web application is whether to use SQL or NoSQL database with the unavoidable fact that application must have a quick response. Often these applications work with large amounts of data. This paper presents a comparative analysis of performance of open source SQL and NoSQL databases used in web application development. We tested behavior of different open source SQL and NoSQL databases by different parameters and give some conclusions about suitability of their application in different cases.

Keywords: database, SQL, NoSQL, performance, web application

RECOMMENDER SYSTEM AS A PART OF THE LIBRARY RESOURCES PROMOTION

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The paper discusses the use of unconventional methods to search the library catalog to solve a more general problem – the promotion of existing information resources to library readers and Internet users. Modern libraries use different mechanisms for promoting: mailing, RSS, social networks, publication of information about resources on the Internet, seminars and advice for readers. In this paper one more promoting method is considered – the recommender system. The use of recommender system can meet the challenges implicit search of resources on the basis of the analysis of user preferences. So recommender system can be an instrument for personalization [1]. At the same time recommender system is not intended to replace traditional methods of searching for documents, but only to supplement them with new instruments. This allows us to get a new search quality, as well as new opportunities for the promotion of information resources. The recommendation system may be seen as a Web 2.0 application, since the user indirectly generates the data used by the system, and the integration into the catalog is being done by means of a mashup – two aspects of Web 2.0 applications [2].

There are a number of existing recommender systems within the library domain such as BibTip, developed in Karlsruhe University [2] or recommender system for WorldCat.org [3]. In this article we describe Library Recommendation System (LRS), designed as a Web service for libraries. This approach allows library not to install special applications [2]. Library could upload an anonymized data to recommender system and then get a list of recommendations for any user. It provides a high level of flexibility and scalability of system.

In our work we implement a variant of recommendation system based on item-item version of collaborative filtering. It means that the main aspect of interest is “which books were viewed together”. So we consider an interaction between users and a library catalog and use “implicit” data. We are going to work with several sources of data: circulation data, information about sharing in social networks, information about catalog’s usage (authorized sessions and unauthorized sessions). All these sources give us a unary data [4]. It means we have no ratings for our resources. We only have user’s history (user has purchased an item or has viewed its description).

The usage of recommendation system has several advantages for the library. First of all it allows users to connect different resources even if they have no common keywords and subjects in description. It’s important because a resource description, which is created by professional librarians, do not always contain all appropriate keywords. And sometimes resources from different fields of science should be viewed together even they have not common features from the point of librarian’s view. In this case an analysis of catalog’s usage can extend the results of user’s search and make them better.

The second advantage is that recommendation system does not require any assistance by librarians after deployment. Once configured, it can make new recommendations without library staff involvement. At the same time one could see how particular resource is popular by counting how often it appears in recommendations.

There are two main challenges in creating recommendation system in any domain. Firstly, we should remember that some resources are purchased together unintentionally. The

main aim of recommender system is to exclude such cases from recommendations and use only resources which were intentionally purchased together. One of variants to solve this problem is using special lower threshold. This solution requires sufficient data collection.

The second challenge is well-known problem of the “cold start”, which means that we cannot create recommendations for resources which were not purchased before. LRS does not to show recommendations for such resources.

The recommender system could improve the quality of library service and involve users to process of resources evaluation. Such systems will allow libraries to meet requirements of modern society and promote their resources.

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WEBOMETRIC ANALYSIS OF RUSSIAN ACADEMIC AND EDUCATION WEB

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In recent years, webometric studies based on web search engine usage [1-3], become a recognized method of measurement of academic institution's websites quality and impact. However, as other infometric studies this method remains quite controversial due to gaps in research base, quality of measurement instrumentation and weight and meaning of measured indicators. We suppose that there is a lack of nationwide recurring measurements and juxtaposition between webometric and other kinds of scientometric assessments.

This research is based on monthly webometric data collection started in January, 2015 for over than 2000 Russian research organizations and higher education institutions websites. For each website, the following indicators are collected: the number of webpages and the number of documents (according to Google, Yandex and Bing), the number of references and referenced domains (according to Ahrefs and Majestic services), the number of documents indexed by Google Scholar, and Yandex Topic Citation Index. Deep analysis of time series of measurements of particular webometric indicators in some cases combined with the parsing of website structure, examining its peculiarities, and correlating with usage statistics [4] allowed us to examine in details the significance of each of indicators, propose some justification methods and to compare different approaches to webometrics rankings calculations.

In this report, we consider the principles and architecture of the webometric data collecting system. It contains a webometric indicators database with monthly data since Janu-

ary, 2015, and web interface (<http://www.webometrix.ru>), that allows anyone to perform an analysis of trends and evolution of the scientific web sites. Institutions can use it to examine the position and dynamics of their website, to compare it with the others and, as a result, to find the ways of its improvement.

In the final part of the report, we made an overview of the Russian Academic and Education Web. We also compared webometric rankings with bibliometric data on institutions' academic output and web site usage statistics.

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INITIAL CONSIDERATION ABOUT TENSOR PRODUCT OF IRREDUCIBLE MODULES OVER n -BIALGEBRAS

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In the paper, we establish some properties of irreducible finite-dimensional modules over n -bialgebra H , which is defined over an algebraically closed field k . We consider semi-simple decomposition of tensor products of irreducible modules. It is supposed that the number of irreducible modules of dimensional > 1 in the tensor products does not exceed 2.

Let E be a one-dimensional H -module with the basis e . If $h_1, \dots, h_{n-1} \in H$, then $h_1 \cdots h_{n-1}e = \lambda(h_1 \cdots h_{n-1})e$, where $\lambda(h_1 \cdots h_{n-1}) \in k$. Then, $\lambda: H^{n-1} \rightarrow k$ is homomorphism of the binary algebras. Conversely, if there is given a homomorphism $\lambda: H^{n-1} \rightarrow k$ of binary algebras, then $h_1 \cdots h_{n-1}e = \lambda(h_1 \cdots h_{n-1})e$ defines the structure of the one-dimensional H -module in the one-dimensional space ke . So, there is the bijective correspondence between one-dimensional H -modules and the algebra homomorphisms $\lambda: H^{n-1} \rightarrow k$ (Prop. 2.1.)

Denote by $E_{\lambda_1}, \dots, E_{\lambda_n}$ the one-dimensional H -modules, associated with a surjective homomorphisms $\lambda_1, \dots, \lambda_n: H^{n-1} \rightarrow k$ which are surjective homomorphisms of the binary algebras, i.e. $E_{\lambda_i} = ke_i$. Then $E_{\lambda_1} \otimes \cdots \otimes E_{\lambda_n} \cong E_{\lambda}$, where $\lambda = \lambda_1 * \cdots * \lambda_n$ is convolution product in the dual algebra $(H^{n-1})^*$ (Prop. 2.2.)

Let $\lambda_1, \dots, \lambda_{n-1}: H^{n-1} \rightarrow k$ be surjective algebra homomorphisms such that the map $\lambda_1 * \cdots * \lambda_i * 1 * \lambda_{i+1} * \cdots * \lambda_{n-1}: H^{n-1} \rightarrow H^{n-1}$ is surjective. Then, the module $E_{\lambda_1} \otimes \cdots \otimes E_{\lambda_i} \otimes M \otimes E_{\lambda_{i+1}} \otimes \cdots \otimes E_{\lambda_{n-1}}$ is irreducible (Prop. 3.1.)

If M_1 is not isomorphic to M_2 , then $M_1 \otimes E_{\lambda_1} \otimes \cdots \otimes M_2 \otimes \cdots \otimes E_{\lambda_{n-2}}$ does not consist one-dimensional H -submodules. If $M_1 \cong M_2$, then each one-dimensional submodule E_{λ} has multiplicity 1. (Corollary of T. 5.1.)

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TWO-FACED PROCESSES AND PSEUDORANDOM NUMBER GENERATORS WITH PROVEN PROPERTIES

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Pseudorandom number generators (PRNG) are used for many purposes including cryptographic [1], modeling and simulation applications [2]. For such applications a generated bit sequence should mimic true random, i.e., by definition, such a sequence could be interpreted as the result of the flips of a “fair” coin with sides that are labelled “0” and “1” (i.e., it is the Bernoulli process with $p(0) = p(1) = 1/2$), see [3].

The RNG and PRNG attract attention of many researchers due to its importance in practice and interest in theory, because, in a certain sense, this problem is close to foundations of probability theory, see, for example, [4,5].

It is known that the Shannon entropy of this process is 1 per letter, whereas for any other stationary process with binary alphabet the Shannon entropy is strictly less than 1. On the other hand, the entropy of the PRNG output should be much less than 1 bit (per letter), but the output sequence should look like truly random [3].

We describe random processes for which these, contradictory at first glance, properties, are valid. More precisely, it is shown that there exist binary-alphabet random processes whose entropy is less than 1 bit (per letter), but the frequency of occurrence of any binary word goes to its probability for the Bernoulli process with $p(0) = p(1) = 1/2$.

In this report we show how the two-faced processes give a possibility to construct PRNG which possess theoretical guarantees. Besides, we describe some experiments where sequences are generated PRNG which are based on the two-faced processes.

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INFINITY AND INFINITESIMAL IN INTERPRETATION OF FOURIER TRANSFORM NATURE

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The Fourier Transform (FT) is a proven powerful tool in signal analysis. Using the concepts of infinity and infinitesimal we attempt to relate the real world of signals with the mathematical world of their representations thereby revealing some aspects of the nature of FT. Firstly, we give interpretation of time domain infinity through formalisation of a signal by respective mathematical function. Then we discuss another case of infinity and infinitesimal given in interrelation between Fourier series and FT. Particular attention we paid to the spectral characteristic of aperiodic function as a mathematical entity which prominently shows how these two concepts stem one from another. The issue of signal i.e. function reconstruction from its spectrum serves to consider infinity from another side where we discuss effects of simple trigonometric functions with infinitesimal frequencies. Further we examine relation between the spectral peak and its limit represented by Dirac's function in order to interpret the notion of spectral line.

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DEVELOPMENT OF THE ALGORITHM FOR THE FORMATION OF EMPIRICAL MODEL FOR THE TERNARY MIXTURE EXPERIMENTS

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In the mechanical and electrical legume properties research process an important role is three-component systems. Regression analysis allows that on the basis of experimental results define mathematical models depending on the size of the mole fraction of the individual components of the mixture. To carry out the process of regression analysis and selection of adequate regression model, it is necessary to implement following stages:

- Input of experimental data
- The summary statistics of possible mathematical models
- Choice of stochastic models
- ANOVA analysis - assessment of the significance of the model
- Assessment of the adequacy of the model
- The interval estimate of model parameters
- Diagnostic models and, if necessary, the transformation model and repeated cycles of selection and assessment of the transformed model
- Interval estimation of regression function
- Graphic interpretation and interpretation of the model.

This paper presents an algorithm for the selection, evaluation and diagnosis of optimal mathematical model for the three-component system.

Keywords: algorithm, ternary mixture experiments, design of experiments, regression models

NEW SPACE OF DISTRIBUTIONS WITH APPLICATIONS TO PHOTON DISTRIBUTION EQUATION IN THE SPACE WITH AN INFINITE ABSORPTION POINT

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We consider the equation for photon distribution as a motivation for the introduction of the new space of distributions and the corresponding weak convergence in the Colombeau algebra. We prove the existence of a solution to the corresponding Cauchy problem. We introduce a new space of distributions defined as a space of continuous linear functionals over discontinuous functions. The discontinuities are chosen so that a linear transform turns them into smooth functions implying that the new space of distributions is isomorphic to the classical Schwartz space of distributions. However, unlike the situation in the case of the Schwartz distributions, multiplication of regularization of e.g. δ -function converges toward a distribution. We use this fact to show existence of a physically reasonable solution to the photon distribution equations.

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THE STUDY OF INVERSION PROBLEMS OF CRYPTOGRAPHIC HASH FUNCTIONS FROM MD FAMILY USING ALGORITHMS FOR SOLVING BOOLEAN SATISFIABILITY PROBLEM

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In this report we present the result of application of state-of-the-art SAT solvers to problems of inversion of cryptographic hash functions from the MD family. In particular we consider the problems of finding preimages and collisions for MD4 and MD5 hash functions. Hash function is a total computable discrete function of the kind $\chi : \{0,1\}^* \rightarrow \{0,1\}^C$, where C is some constant called the hash length. If $n > C$ then in $\{0,1\}^*$ there are such

$x_1, x_2 \in \{0,1\}^n$, $x_1 \neq x_2$, that $\chi(x_1) = \chi(x_2)$. In this case messages x_1, x_2 form a collision. Usually, cryptographic hash functions have to satisfy a number of additional conditions, such as that all problems related to function inversion must be computationally hard. In other words, both finding preimage (i.e. inversion) and finding collisions should be hard.

We consider finding preimages and collisions of the widely known MD4 and MD5 hash functions [1,2]. To solve the problems we apply the approach based on reducing them to Boolean satisfiability problem (SAT) [3], and applying state-of-the-art SAT solvers to corresponding encodings. The SAT encodings of the algorithms specifying the considered functions are constructed using the Transalg system [4]. This system makes it possible to modify the propositional encodings of MD4 and MD5 algorithms by adding to them additional constraints in the form of differential paths by X. Wang for finding collisions [5,6], or the constraints by H. Dobbertin for finding preimages [7]. The effectiveness of proposed algorithms is greater than that of similar algorithms from [8-10]. In addition to that, using the constructed algorithms we managed to find new families of two-block collisions for MD5 and new differential paths for finding single-block collisions for MD4.

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DIFFERENT TYPES OF REGRESSION THROUGH EXAMPLES

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Regression analysis is a widely used tool for modelling and analyzing relationship among variables, as well as for prediction. Examples of regression analysis applications are numerous. For instance, it is difficult to find an economic empirical study without a paying attention to the phenomenon of regression. Each type of regression has its own importance and a specific condition where they are best suited to apply. The aim of this paper is to consider most commonly used regression techniques analyzing scientific papers in the field of economics published in recent years. Also this article deals with the question of whether and when it may be appropriate to use certain type of regression regard to their advantages and limitations through illustrative examples.

FINITE DIFFERENCE METHOD FOR SOLVING GENERAL LINEAR DIFFERENTIAL EQUATIONS

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In this paper, we will present centered finite difference method for solving general linear differential equation with Dirichlet boundary conditions. After approximating derivatives in the Dirichlet boundary value problem we will obtain discretized tridiagonal linear system which we choose to solve by Successive Over Relaxation method. Furthermore, in the theory of the numerical methods of ordinary differential equation it is highly recommended to be familiar with certain aspect of their analytic theory. Since this is the case, before numerical approach we will highlight some of the most important analytical results. A numerical examples are given to illustrate the proposed theoretical results.

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THE COMPARISON OF DIFFERENT SAT ENCODINGS FOR THE PROBLEM OF SEARCH FOR SYSTEMS OF ORTHOGONAL LATIN SQUARES

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In this report we present several different propositional encodings for finding systems of orthogonal Latin squares, evaluate their effectiveness using state-of-the-art parameterized algorithms for solving Boolean satisfiability problem (SAT) and discuss their strengths and weaknesses regarding possible applications for solving several relevant combinatorial problems.

Latin square of order n is a square table $n \times n$ filled with elements from the set $\{1, \dots, n\}$ in such a way that each element appears in each column and each row exactly once [1]. Two Latin squares A and B are called orthogonal if all pairs of the kind (a_{ij}, b_{ij}) , $a_{ij} \in A$, $b_{ij} \in B$, $i, j \in \{1, \dots, n\}$ are different. One of the most widely known currently unsolved combinatorial problems consists in answering the question whether there exist three mutually orthogonal Latin squares of order 10. The fact that this problem is very hard lead to the consideration of several similar but more realistic problems, such as to construct such triples of Latin squares of order 10, in which first square is orthogonal to two others, but the remaining two are orthogonal only over limited set of cells.

Since the problem of constructing pairs of orthogonal Latin squares of order 10 has quite high combinatorial complexity, it is reasonable to apply SAT approach to the construction of systems of such squares [2]. The SAT approach consists in reducing the underlying problem to SAT and applying state-of-the-art sequential and parallel SAT solving algorithms to the considered problem instances. Despite the fact that SAT is NP-complete, many practical problems from various areas of science and industry can be effectively reduced to it and solved relatively fast. Thanks to the remarkable progress seen in the recent years regarding the effectiveness of state-of-the-art SAT solving algorithms, the scope of problems solved via SAT is gradually increasing.

Without the loss of generality let us consider the problem of finding pairs of orthogonal Latin squares. What makes it interesting is that we can reduce it to SAT via several different methods. Thus, we can consider this problem stated for related combinatorial designs. For example, a pair of orthogonal Latin squares can be represented in the form of orthogonal array, or as a set of disjoint transversals. It means that when reducing this problem to SAT we can do it at least in three different ways depending on how we represent Latin squares. Since SAT is considered for Boolean formulas over sets of Boolean variables, we need to represent elements of Latin square or related combinatorial design via Boolean variables. There are two main approaches to this. In the first approach we encode the number from 1 to n with the help of n Boolean variables. In the second approach we encode it as a binary number using $\lceil \log n + 1 \rceil$ Boolean variables. The propositional encoding for the problems of finding systems of orthogonal Latin squares uses many constraints of the kind At-Most-One (AMO) and At-Least-One (ALO). Depending on the chosen way for representing numbers we can apply different methods to encode such constraints [2,3].

As a result we can construct many different variants of SAT encodings for finding various systems of orthogonal Latin squares of order 10. We compare their size in terms of number of literals and clauses in the corresponding Boolean formulas, and evaluate their effectiveness using state-of-the-art parallel parameterized SAT algorithms [4].

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THEORY OF STATISTICAL CAUSALITY AND QUASIMARTINGALES

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Concept of causality is very popular and applicable nowadays. Especially when we consider the cases “what would happen if” and “what would have happened if”. Here we consider the concept of causality based on the Granger’s definition of causality, introduced by P. A. Mykland in [1]. Many of the systems to which it is natural to apply tests of causality take place in continuous time, so we will consider the continuous time processes. The given concept of causality is closely connected to the preservation of the martingale property. Here we consider its connection to the property of being a quasimartingale. Quasimartingales were investigated by D. L. Fisk [2], S.Orey and specially K. M.Rao [3]. Namely we proved an equivalence between the given concept of causality and preservation of the quasimartingale property if the filtration is getting larger.

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ON THE WEAK ADMISSIBILITY ON TOPOLOGICAL VECTOR SPACES AND ITS APPLICATIONS IN NONLINEAR ANALYSIS AND INFINITE DIMENSIONAL TOPOLOGY

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Victor Klee [1,2] introduced the notion of an admissible subset of a topological vector space. The following question is still open: Does exist a convex, nonadmissible subset of topological vector space? Weakly admissible sets were introduced by N. T. Nhu [3] (for metric linear spaces) and I. D. Arandjelović [4] (for arbitrary Hausdorff topological vector spaces). In these papers, fixed point theorems for continuous single-valued functions defined on weakly admissible sets have been given. For more information about weakly admissible sets and spaces see papers [5-9].

Let \mathbf{X} be a Hausdorff topological vector space, \mathbf{U} be the fundamental family of balanced open neighbourhoods of zero in \mathbf{X} and \mathbf{K} nonempty closed convex subset of \mathbf{X} . We say that the set \mathbf{K} is weakly admissible if for every $\mathbf{V} \in \mathbf{U}$ there exists closed convex subsets $\mathbf{K}_1, \dots, \mathbf{K}_n$ of \mathbf{K} , such that \mathbf{K} is convex hull of their union, and continuous mappings $\mathbf{f}_i : \mathbf{K}_i \rightarrow \mathbf{K} \cap \mathbf{E}$, $i = 1, \dots, n$ where \mathbf{E} is a finite dimensional subspace of \mathbf{X} , such that $\sum_{i=1, n} (\mathbf{f}_i(\mathbf{x}_i) - \mathbf{x}_i) \in \mathbf{V}$ for every $\mathbf{x}_i \in \mathbf{K}_i$ and $i = 1, \dots, n$. If for any $\mathbf{V} \in \mathbf{U}$, $n=1$ then \mathbf{K} is admissible set.

In first part of this talk (paper) we discuss current state of research related to weakly admissible sets. Some related problems are also discussed. In second part we give complete proof of following fixed point result, which was presented in [1].

THEOREM. *If \mathbf{E} is a Hausdorff topological vector space, and \mathbf{K} is its compact and convex nonempty weakly admissible subset, then every continuous function $\mathbf{f} : \mathbf{K} \rightarrow \mathbf{K}$ has at least one fixed point.*

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A NEW APPROACH TO REPRESENTATION OF CONTOURS IN IMAGES

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Contour tracing is inevitable the first step in image smart processing. Well known chain code is one-dimensional contour profile. We tend to further reduce the ammount of numeric data which describes a contour. Here we take the problem into loosen domain allowing some degree of approximation. Hence, we get the room for a proposed approach in which a contour is described in fractal-like fashion, i.e. by filling its interior with the system of extremal circles. Therefore, a contour is described by centers and radii of these circles. Outside this system of circles an envelope is circumferenced which spans the gaps between the outer circles. In such way it is defined some kind of two-dimensional contour spectrum. Relying on, we further define another method of contour numerical description by its local curvature, where its segments are replaced by arcs of circles along the contour, after a segmentation procedure along the contour is done. A simple procedure to determine curvature over three points on contour, which allocation depends of their coordinates, is proposed and discussed.

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MODEL OF NEURO-FUZZY PREDICTION OF CONFIRMATION TIMEOUT IN A MOBILE AD HOC NETWORK

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Confirmation timeout (Round Trip Time, RTT) is an important value in data networks. Correct prediction RTT estimates the network load for the adequate selection of packet sending parameters and retransmissions parameters [1]. In the TCP (Transmission Control Protocol) for the estimation of this quantity are used heuristic models. The vauaes of coefficients in these models were obtained experimentally for a fixed topology networks. Therefore, the use of these models in the dynamic network (mobile ad hoc network) is inefficient [2].

The paper presents a prediction model of confirmation timeout, based on the application of fuzzy neural network theory. This model is based on the application of the Sugeno fuzzy inference algorithm zero order [3]. The input values for fuzzy neural network are confirmation timeouts that measured in the current cycle and previous two cycles. The output value is the RTT which expected in the next cycle. The proposed model is set up and studied by simulations. In these experiments is simulated operation of a mobile ad hoc network that used for communication for opposition of emergency on dangerous construction sites.

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IMPLEMENTATION OF WEIBULL'S MODEL FOR DETERMINATION OF AIRCRAFT'S PARTS RELIABILITY AND SPARE PARTS FORECAST.

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Planning of aircraft's maintenance activities, failure occurrences and necessary spare parts are essential for minimizing downtimes, costs and preventing accidents. The aim of this paper is to propose an approach that supports decision making process in planning of aircraft's maintenance activities and required spare parts. Presented mathematical model is based on Weibull's model and calculates aircraft's reliability characteristics by using total unit time parameter provided by aircraft's parts manufacturer. Further, by capitalizing the random nature of total unit time, the number of spare parts and the costs of negative inventory level are determined.

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METHODS FOR HIGH PERFORMANCE GRAPH PROCESSING

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Graph algorithms are common "building blocks" of many complex real-world applications, for instance, network analysis, data enrichment applications, bioinformatics, city planning, etc.

In general, graph algorithms are typical "data intensive" problem [1]. It means that parallel graph processing applications characterized by two important drawbacks [2,3]:

- workload imbalance amongst computational threads;
- large number of data transfers between computational processes.

The object of presented study are two methods which designed to address these drawbacks and to speedup the parallel graph traversal:

- reducing workload imbalance on computational threads (based on the fine-grained parallelization of edge array processing in CSR data structure);
- data transfer optimization (based on fused top-down and bottom-up graph traversal and using of bitmask, which synchronized between computational processes and stores information about vertices in the graph).

These methods allows to accelerate the parallel traversal of big graphs with skewed degree distribution (which have millions of vertices and edges). Thus, it used for development of the custom implementation of Graph500 benchmark (which based on the parallel breadth-first search on large graphs). Testing was carried out on the "Uran" supercomputer located at Institute of Mathematics and Mechanics, Ural Branch Russian Academy of Science (428th place in Top 500, June list, 2013). We conduct experiments on graphs with 2^{23} , 2^{24} , 2^{25} vertices. These graphs are not directed and have average degree 16. In all experiments,

custom implementation significantly (more than two times) outperforms its non-optimized counterpart. These methods also applicable to other types of graph algorithms (for instance, single source shortest path).

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CONGRUENT CIRCLES PACKING INTO A MULTI-CONNECTED DOMAIN WITH NON-EUCLIDEAN METRIC AND ITS APPLICATIONS IN LOGISTICS

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The optimal packing problem of congruent circles in a bounded set in a two-dimensional metric space is considered. The circle packing problem is to find an arrangement in which the circles fill as large a proportion of the space as possible. In the case where the space is Euclidean this problem is well known [1-4], but the case of non-Euclidean metrics is studied much worse [5,6].

However there are some applied problems, which lead us to use other special non-Euclidean metrics [7,8]. For instance such statements appear in the logistics when we need to locate a given number of commercial facilities and to maximize the overall service area.

Let X is a metric space, $C_i, i = 1, \dots, n$ are congruent circles with centers in $s_i = (x_i, y_i)$, P is closed multiply-connected set

$$P = \text{cl} \left(D \setminus \bigcup_{k=1}^m B_k \right) \subset X \subseteq R^2.$$

Here $D \subset X$ is the bounded set, $B_k \subset D, k = 1, \dots, m$ are compact sets with non-empty interior.

It is necessary to find vector $s = (s_1, \dots, s_n) \in R^{2n}$, which provides the packing of the given number of circles with maximum radius R in P .

The distance between the points of the space X is determined as follows:

$$\rho(a, b) = \min_{G \in G(a, b)} \int_G \frac{dG}{f(x, y)},$$

where $G(a, b)$ is the set of all continuous curves, which belong X and connect the points a and b , $0 < \alpha \leq f(x, y) \leq \beta$ is continuous function defined instantaneous speed of movement at every point of P . In other words, the shortest route between two points is a curve, that requires to spend the least time.

Thus, we formulate the following problem:

$$\begin{aligned} R &\rightarrow \max, \\ \rho(s_i, s_j) &\geq 2R, \forall i = \overline{1, n-1}, \forall j = \overline{i+1, n}, \\ \rho(s_i, \partial P) &\geq R, \forall i = \overline{1, n}, \\ s_i &\in P, \forall i = \overline{1, n}. \end{aligned}$$

Here ∂P is the boundary of the set P , $\rho(s, \partial P)$ is the distance from a point to a closed set.

To solve the described problem authors suggest a method based on the physical principles of Fermat and Huygens, which are used in geometric optics. The first principle says that the light in its movement chooses the route that requires to spend a minimum of time. The second one states that each point reached by the light wave, becomes a secondary light source. Thereby if we initiate a light wave from a and fix "photon" which reaches b first, then we can draw the extremal (moved backward at time) curve between these points. This is a basic procedure to solve the problem above. With respect to computational experiment it is clear that proposed method gives acceptable results even for quite complicated metric.

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GIS ANALYSIS OF HEALTH OBJECTS AND PUBLIC TRANSPORT IN THE CITY BELGRADE

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In this paper, we tried to explain for the first time geospatial distribution of health facilities in the city Belgrade. Belgrade is the capital city of the Republic Serbia and the second city in Balkan Peninsula with a total number of citizens 1576124 according to the data from the last census. But, a total number of populations in the urban gravitational area. We also compare health facilities with public: (buses, cars, train, tramway, and with free internet connection). With special kriging method used by GIS and geoinformatics calculation in Google and Javascript code, we derived for the first time interactive Belgrade health objects map. This map we tried to use for users for better recognition and views of health objects.

Keywords: Belgrade, GIS analysis, Google API, Javascript, Health objects

This work supported by the Serbian Ministry of Education and Science projects No. III44006 and by RFBR grant 15-07-06982

**INFORMATION PROCESSING IN THE DIAGNOSTICS SYSTEM
OF THE MUSCULOSKELETAL SYSTEM BASED
ON ACCELEROMETRIC GONIOMETERS**

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A variety of human movement is characterized by a number of parameters of the musculoskeletal system: torque, speed, trajectory complexity, etc. In existing diagnosis systems of musculoskeletal system mainly consider only kinematic parameters of the skeletal system, regardless of the neurophysiological state of the patient [1]. The process of diagnosis and rehabilitation is slower, due to the lack of feedback from the patient's neurophysiological parameters. Thus, the organization of control and diagnosis of human bio kinematiks should be paid to the importance of registration and processing of bioelectric signals of the central nervous system in the implementation of purposeful movements [2,3].

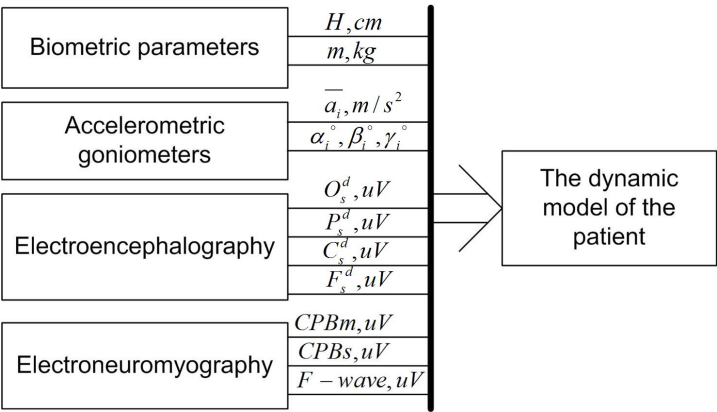


Fig. 1 The dynamic model of the patient's physiological parameters

It is proposed to implement the correction of the dynamic model of the patient with the basis for measurement, and based on the obtained dynamic model of the patient, will be formed an information model. Information model, after the processing of the neural network will be entered in the database of models, thus, will be formed a statistics and selected the optimal operating parameters of the system rehabilitation for patients with a variety of neurophysiological features. According to the physiological parameters model of the patient, will be determined by the maximum pain thresholds and minimum thresholds of sensitivity upon the rehabilitation of the musculoskeletal system. With the help of neural network algorithms and algorithms for systems of decision support (DSS) based on database of the measurements, the database of the evoked potentials and the diseases database, determined an approximate diagnosis of the patient. Neurophysiological criteria are also formed based on statistical clinical studies of patients under normal conditions and in the presence of deviations.

The paper also examines the principle of construction of system of diagnostics and rehabilitation of the musculoskeletal system based on accelerometer method, synchronization algorithms measured patient parameters are considered. The optimum values of the technical

parameters of the accelerometer, goniometer system: sample rate converters accelerometer signal, the required sensitivity of the sensor, and others. The advantages of the proposed approaches to the construction of rehabilitation and diagnostic systems of the musculoskeletal system: adaptability, reliability of the diagnoses.

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USING OF SYNTHETIC DATA FOR TESTING AND DEBUGGING AUV TECHNICAL VISION SYSTEMS

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Complexity of underwater navigation and inability to organize communication with high capacity data exchange between AUV (autonomous underwater vehicle) and operator leads to necessity of onboard technical vision systems development for improving underwater vehicle autonomy. High reliability and quality operation in various conditions is required from such systems. Their development and further usage is impossible without precise debugging and testing. Currently testing process organization and testing data obtaining becomes a serious problem.

At present time, testing areas with markers and targets located on seabed and specifically equipped pools are used for tasks of testing and debugging. Such methods are well suited for testing of AUV's devices and equipment, but they are not capable to provide enough amount and variety of data necessary for technical vision system testing and debugging. Besides, time required for data obtaining is too long, and that is unacceptable especially at the early stages of development.

Virtual water areas, built using computer graphic procedural generation methods, are suggested for solving a problem of AUV's technical vision systems testing and debugging. Proposed system for testing consists of three main parts: virtual water area generator, interface between developing system and virtual AUV and AUV simulator:

1. Virtual water area generator is the most important subsystem. Its task is building and shading of the synthetic seabed model. The process of generation is controlled by the operator through defining a small set of parameters determining seabed appearance. The seabed is built by combining three levels of detail: global low-resolution digital elevation map (built procedurally based on parameters), 3D mesh (built based on digital elevation map and 3D «smart noise» with the help of marching cubes technique) and high-frequency fractal noise (generated and added during

rendering). Testing area is shaded procedurally based on surface roughness and average slope. During generation process the variety of surfaces types and their similarity to real world ones and the absence of repeating texture patterns is provided.

2. Interface between technical vision system and virtual AUV is provided by passing controlling messages (requests on photos from AUV's cameras and control signals) from vision system and by receiving informational messages (photos with debug information and information about real AUV location and orientation) from virtual AUV.
3. AUV simulator provides the simplest physical model of AUV movement and gives possibility of testing area rendering from onboard AUV's cameras points of view

Using of the synthetic testing areas allows us to obtain a lot of advantages in compare with real testing areas:

1. the high speed and low cost of testing data acquisition,
2. the ability to obtain testing data from different surfaces types, starting from sand valleys and ending with rocky canyons,
3. the ability to evaluate technical vision accuracy since the investigated seabed surface is precisely known,
4. the ability to interrupt system working exactly at the moment when error occurs,
5. the testing result repeatability.

It is evident that using of synthetic tests does not allow us to completely abandon the real experiments, but it significantly reduces their amount. As a result, the time required for AUV's technical vision system development is decreasing and reliability is increasing.

MIT 2016

A WORKFLOW AUTOMATION SYSTEM FOR REPRODUCIBLE SIMULATION STUDIES

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Research on living systems requires a large amount of computational resources, which also implies high requirements in such fields as parallel programming and cluster computing to the involved researchers. For bridging the gap between researchers and computer engineers, we have developed LiFlow, a lightweight workflow automation system with a graphical user interface, designed for running a series of computational experiments.

The distinctive feature of our research is conducting a large number of numerical experiments with the same model, but different parameter values. In addition, the calculations generate large amounts of data, and one of the functions of our system is the automatic saving of all results on a dedicated storage system. However, the researchers are often need a database of previously conducted experiments among the essential feature of running an experiment and storing its results.

This paper presents an approach for integrating LiFlow with Sumatra, which is an open source tool to support reproducible computational research [1]. The integrated system captures all the experimental details and creates a database of experiments. The database supports querying, searching and manipulating the experimental data both for retrospective analysis and for conducting the future experiments.

We have evaluated the proposed integrated system by running a series of simulation experiments on the human heart left ventricle [2], and found the present approach functionally operative.

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TECHNIQUE OF FORMATION OF PANORAMIC IMAGE FOR STAND-ALONE PORTABLE DIGITAL DEVICE UHDTV

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Modern systems of panoramic photography and video are being treated, as a rule, on the basis of an array of light-sensitive sensors, with different ways of positioning in space. The authors conducted a study task was to create a high-quality portable system panoramic photo and video shooting using a 12 light-sensitive sensors and the formation of the video standard Ultra HD 4K. According to the simulation results, it was found that the optimal arrangement of 12 the light-sensitive sensors in conjunction with lenses is their location in the center of the dodecahedron faces. In this case, part of the image formed on each photosensitive lens sensor is unique (not repeating other sensors) as part of the panorama of a regular pentagon. This design allows you to create a panorama of 360-degrees.

The problem of projecting high quality panoramic images from 12 cameras of the sphere, in real time, requires large computing resources, which makes difficulties the practical implementation in a compact device. This problem is solved by the authors by means of construction and optimization, by reducing the computational procedures, methods of forming the panoramic image on the basis of a mathematical model of a dodecahedron and obtaining transform coefficients from the information of each light-sensitive sensor. In the investigations it was found that the optimal ratio of the sides of light-sensitive sensor is 4:3. The use of different lenses in the system has shown the need to eliminate the distortion [1], and to compensate for possible deviations from the ideal placement of camera models in the mathematical model are calibration parameters for each light-sensitive sensor. Calibra-

tion parameters take into account the linear displacement cameras from the center of the dodecahedron and turns. Calibration of the system and eliminating distortion of 12 cameras (at this stage of software development) is performed automatically using a specially calibration table. As a result of the calibration coefficients of the matrix are formed to perform fast image sampling correction and formation of spherical panoramas.

Using a mathematical model of a dodecahedron, allows you to perform conversion operation: $\mathbf{P}_n = \mathbf{R}_{z,\Theta} \cdot (\mathbf{R}_{y,\Phi} \cdot \mathbf{p}_n) + \mathbf{P}_{0n}$, where \mathbf{p}_n , \mathbf{P}_{0n} , \mathbf{P}_n – matrix displacement of local coordinates the n -th light-sensitive sensor relative to the center of mass of the dodecahedron, $\mathbf{R}_{y,\Phi}$, $\mathbf{R}_{z,\Theta}$ – massive of 12 rotation matrix. Mathematical model of a dodecahedron made it possible to generate all the transform coefficients without using trigonometric functions. Thus, the set of operations in the formation of the spherical image is limited to addition, subtraction, multiplication, division and square root. For calibration image it was used a mathematical model based on new mathematical operations Zeration and Deltation [2]. These operations have a rank lower than “addition” and “subtraction”, and allow us to describe in a unified mathematical formalism as logical operations and systems of equations, and a number of special functions [3]. The resulting mathematical model of a spherical panoramic images with 12 cameras is optimized for implementation on the PLD.

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WIRELESS COMMUNICATION SYSTEM IN THE PRESENCE OF RICIAN AND NAKAGAMI- m SHORT TERM FADING

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In this paper wireless communication system with maximal ratio combining (MRC) and selection combining (SC) with two branches operating over mixed Nakagami- m and Rician multipath fading channel is considered. In the first branch, desired signal experiences Rician fading and the second branch desired signal is subjected to Nakagami- m fading. Two cases are analysed in this paper. In the first case MRC receiver is used to reduce Rician and Nakagami- m fading effects on system performance and the second case SC receiver is used to mitigate Rician and Nakagami- m fading effects on outage probability. Probability density function, cumulative distribution function and average level crossing rate of wireless communication system receiver output signal are evaluated as expressions closed form. By using these expressions, outage probability, symbol error probability and average fade duration can be calculated. Numerical results are presented graphically to show the influence of Rician factor and Nakagami- m severity parameter on average level crossing rate.

THE IMPROVING THE EFFICIENCY OF THE SYSTEMS OF THE DIAGNOSTICS AND REHABILITATION OF THE HUMAN SPINE

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One important area of medical technology is diagnostic and rehabilitation equipment, special places in which occupy the spinal diagnosis and rehabilitation system [1]. Various deviations in the relative position of the spine segments affect the functioning of the musculoskeletal system, internal organs, eventually triggering a “chain reaction” of disorders of organs and systems of the body as a whole [2, 3].

To carry out timely correction of deviations in the spine, and preventing the formation of irreversible pathological processes, required high accuracy primary diagnosis. It should be noted, that in the period of spinal rehabilitation to assess the effectiveness of the measures and recovery methods, is necessary to analyzing human motion.

Existing automated systems of diagnostics and rehabilitation have certain disadvantages: do not provide an accurate measurement of the mobility in different planes; do not analyze the movement between the vertebrae, spine sections and joints; they are not able to adapt to the anatomical features of the patient, are stationary, have a high cost.

Thus, the development of new methods for automated control and diagnostics of mutual arrangement of the spine segments, and improving the efficiency of diagnostics and spine rehabilitation is an urgent task.

The paper proposes a method of recording and measuring the mutual movement and positioning of the spine segments in space. As a basic method, is proposed to apply the accelerometer measuring method of the rotation angles and acceleration. As research shows, the use of accelerometer sensor significantly increases the flexibility of the system (scalability and easy interfacing the accelerometric diagnostics and rehabilitation system of the spine with other diagnostic systems) and the accuracy of the results (for additional digital processing of recorded signals) due to the small size and high precision sensors. The proposed method is passive (does not use additional exposure, such as in an ultrasound, X-ray method, tomography), and no have negative impact on the person.

To ensure the noise immunity and elimination of severe restrictions on the power supply (as in the compensation methods), and to simplify the design of the device is proposed to apply the phase metric principle formation of supply voltage. To assess the optimal and maximum allowable amount of deviation of the vertebrae provisions are encouraged to apply to apply neural network algorithms for processing of accumulated data, which allow adapting the diagnosis and rehabilitation system for patients with different physiological characteristics and spine disorders and musculoskeletal system as a whole.

The paper also addresses the problem of the origin of errors, upon the work of accelerometer goniometer system, and ways to solve them, and the mathematical and algorithmic models of measurement information processing.

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APPLICATION OF SEDIMENTATION ALGORITHM FOR SOLVING SAT AND MAX-SAT PROBLEMS

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The paper presents further development of the *Sedimentation Algorithm* application for solving Boolean satisfiability problems. Sedimentation Algorithm is original general branch and bound algorithm, for finding exact solutions of a combinatorial optimisation problems, develop by the author and his co-workers. Alternative modelling of the SAT and Max-SAT problems enabled Sedimentation Algorithm to solve Boolean satisfiability more efficiently, compared to the early attempts to solve SAT and Max-SAT problems with Sedimentation Algorithm. Experimental results contain comparison between Sedimentation Algorithm based solver with the *state-of-art* SAT and Max-SAT solvers.

MIT 2016

THE METHOD OF SELECTION OF KEY GEODYNAMIC OBJECTS

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At present, an urgent task is to improve the effectiveness of geodynamic monitoring and forecasting systems, which is especially important for areas with increased activity of surface processes, such as mudslides, landslides and karst-suffusion processes, etc. As a rule, existing systems of geodynamic monitoring and forecasting directly can be located on the protected (observed) territory, and controlled by mostly external manifestations of geodynamic processes (subsidence, the load on the foundation and load-bearing structures, fractures, etc.), in this case are not considered and is not controlled the development of geodynamic processes themselves [1]. Those monitoring systems, which are composed of sub-system control of the near-surface geodynamics, placed in a small area and have a limited set of data about the situation outside the zone of its action, nor does it take into account the mutual influence of neighbouring engineering structures [2]. Thus, the existing system of subsurface geodynamic monitoring and prediction are limited in the scale of the action and have low efficiency, as evidenced by the numerous technological accidents at various levels.

In this paper as an indicator manifestations of geodynamic processes in a large area are invited to select the most sensitive and informative geological structures to the appearance of endogenous and exogenous factors that contribute to the development of geodynamic processes and negative changes in the geological section. Such places are key geodynamic objects that can provide early warning of the beginning of the development of destructive geological processes that have no external signs of existence. Watching the local geodynamic key objects and with the involvement of the hydrology data, geology, meteorology and geo-information technologies, it is possible to form a forward-looking assessment of destructive geological processes over a large area.

The paper proposes a method for detecting the key geodynamic objects, including the distributed processing algorithms informative sections of heterogeneous data, the temperature and the hydrological correction of the measurement results. The proposed approach is based not only on statistical methods and morphological analysis of the territory, but also on the use of mathematical models of the interaction of hydrological, geological and man-made environments.

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MIT 2016

SOFTWARE TEST CASE OPTIMIZATION APPLYING DESIGN OF EXPERIMENTS METHODS

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Software testing is an important activity of the software development process. Software testing is most efforts consuming phase in software development. Nowadays research and investigations on software testing focuses on test coverage criterion design, test-case generation problem, test oracle problem, regression testing problem and fault localization problem. One would like to minimize the effort and maximize the number of faults detected and automate test case generation that contributes to reduce cost and time effort. Hence test case generation may be treated as an optimization problem. Multiple faults in a computer program can interact to form new behaviours in a program that would not be realized if the program were to contain the individual faults. Testing a software system requires the creation of test cases, which contain values for input parameters and the expected results. Exhaustive testing for all of the possible combinations of parameters, in most cases it is not possible, it is not feasible, or the cost is out of the available budget. The main goal of using different methods and techniques of testing is to create a smaller number of combinations of parameters and their values, which will be tested. This paper presents an in-depth study of the effects of the interaction of faults within a program providing extensive mathematical and statistical modelling information. In order to understand how faults interact with each other across real-world programs and how that interaction affects faults detection probability, we conducted the few experiments. The objective of our experiments are to optimize Test case data which are generated automatically using Statistically-Based Test Optimization techniques in order to provide more effective approach in terms of number of detected software errors, number of generated test cases and execution time compared to other existing software test strategies. Considering these issues, this paper explores the issues pertaining to combinatorial t-way software testing from pairwise to variable strength interaction in order to highlight the state-of-the-art as well as the current state-of-practice providing few case studies to prove our optimization approach.

In this work our approach is described with Mathematical and Statistical Modelling, presenting quantitative aspects of the few case studies through: 1. Statistically designed experiments for data collection; 2. The statistical analysis method to determine model parameters, and 3.

A mathematical optimization model to optimize the test case design process. According to inputting different combination of conditions so as to produce different impacts, software testing designs a large number of test cases. If the implementation of an overall test, due to the limit of the combination of conditions, it is difficult to carry out. In order to generate high quality test cases as early as possible to improve the efficiency of software testing, it is designed a generation tool of the automatic software testing case on orthogonal experimental design. For the test data, the use of that tool design test cases. The practice shows that a small number of test cases are generated, the error detection ability is strong, and it greatly improves the efficiency of software testing.

The design of tests for software and other engineered products can be as challenging as the initial design of the product itself. A rich variety of test case design methods have evolved for software.

There are many applications in which the input domain is relatively limited. That is, the number of input parameters is small and the values that each of the parameters may take are clearly bounded. When these numbers are very small, it is possible to consider every input permutation and exhaustively text processing of the input domain. However, as the number of input values grows and the number of discrete values for each data item increases, exhaustive testing becomes impractical or impossible.

Orthogonal experimental design can be applied to problems in which the input domain is relatively small but too large to accommodate exhaustive testing. The orthogonal experimental design is particularly useful in finding errors associated with region faults—an error category associated with faulty logic within a software component. Based on the research of orthogonal experimental design method, it considers that to be applied to design test cases.

Through designing an automatically generated tool to generate test cases, it can be effective in reducing the number of test cases, so as to ensure accomplishing software testing in the lower cost and the lower risk. The ultimate aim is to effectively improve testing results and the efficiency of software testing.

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ANALYSIS OF THE INFLUENCE OF COMMUNICATION PARAMETERS OF FSO CHANNELS ON THE RECEPTION QUALITY

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This paper analyzes the signal transmission in the Free-Space Optics (FSO) communication system. The analysis was conducted using the software package OptiSystem 7.0. The influence of parameters FSO (Free-Space-Optics) channels (Range, Attenuation, Beam Divergence, Transmitter Loss, Receiver Loss, and Additional Losses) on the reception quality. The reception quality will be analyzed according to the values of BER (Bit Error Ratio) and Q factor. Graphics and tables display the changes of BER and Q factor depending on the parameters of FSO. The eye diagrams for the characteristic parameter values are given.

RISKS ASSESSMENT OF INDUSTRIAL REGION DEVELOPMENT AS SOCIAL-NATURAL-TECHNOGENIC SYSTEM

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Two types of strategic risks for social-natural-technogenic systems have the greatest importance in the processes of forecast models both for national and regional development strategy: individual strategic risks of human morbidity and mortality; economic risks of developing of social-natural-technological systems.

The strategic objective of expected development is the decreasing an individual risks to the acceptable levels. There are a lot of approaches for health risk assessment depending on basic risk factors. But common method to connect all factors hadn't developed. The most of existing methods make it possible to estimate mortality and morbidity risks as a result of technogenic or natural emergencies. The paper focuses on selected risk factors which have the greatest influence on human health in Krasnoyarsk region, for which data are available to estimate population exposures or distributions.

This work investigates the cancer inhalation risk caused by the urban air pollution of Krasnoyarsk City because air pollution has great influence on human mortality and morbidity. To estimate an additional mortality caused by climate factors there were calculated some special parameters such as heat and cold waves, extreme temperature changes. Occupational hazards were estimated for employees of the metallurgy, mining and building industries of Krasnoyarsk region. Krasnoyarsk region has a wide range of the natural and technogenic sources leading to emergencies. It was shown that individual risk of death owing to technogenic emergency is greater significantly than risk owing to natural emergency.

In this work it is calculated the main contribution of these risk factors in the decreasing of habitants lifetime which is one of main strategic parameters of region development. This paper shows what kind of risks should be reduced for achievement of the objectives of Krasnoyarsk region development.

Keywords: risk assesment, air polution, social-natural-technogenic systems

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RATIO OF WEIBULL RANDOM VARIABLE AND α - μ RANDOM VARIABLE

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Weibull random process and α - μ random process are evaluated. Weibull distribution can module signal envelope in non linear multipath fading channel with one cluster and α - μ distribution can module co-channel interference envelope in non linear short fading channel with two or more clusters. Probability density function expression can be used for evaluation of symbol error probability of wireless system, the expression for cumulative distribution

function can be used for evaluation of outage probability and the expression for average level crossing rate can be used for calculation average fade duration of wireless system. The influence of Weibull shaping parameter and α - μ shaping parameter on average level crossing rate are analysed and discussed.

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IMPLEMENTING SIMULINK LOW BITRATE CODEC MODEL FOR VOIP

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This paper presents a Simulink model for implementing the Internet Low Bitrate Codec (iLBC) for encoding and decoding speech transmission via Voice over Internet Protocol (VoIP). An input Pulse Code Modulated (PCM) speech signal, sampled at 8 kHz with 16-bit samples, is converted into a stream of iLBC packets, which are sent through a simulated lossy channel, causing random packet loss. Different data transmission rates are supported, while the Packet Loss Correction (PLC) is implemented in order to interpolate the speech for missing packet. The communication model is created in Simulink, a graphical programming environment built inside MATLAB. The comparison of original (transmitted) speech signal and detected (received) speech signal is also presented and discussed.

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LEVEL CROSSING RATE OF MACRODIVERSITY SYSTEM IN THE PRESENCE OF k - μ MULTIPATH FADING, NAKAGAMI- m MULTIPATH FADING AND GAMMA SHADOWING

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Macrodiversity reception with macrodiversity selection combining (SC) receiver and two maximal ratio combining (MRC) receiver operating over shadowed small scale fading channel is considered. Signal at one MRC receiver experiences Gamma long term fading and Nakagami- m short term fading and signal at another MRC receiver experiences Gamma long term fading and k - μ short term fading. Closed form expression for level crossing rate of macrodiversity SC receiver output signal is calculated. This expression can be used for evaluation average fade duration of proposed system. The SC receivers reduces Gamma long term fading effects, the first MRC receiver reduces Nakagami- m short term fading effects and the second MRC receiver reduces k - μ short term fading effects on system performance. The influence of Gamma long term fading severity parameter, Gamma long term fading correlation coefficient, Rician factor of k - μ short term fading and Nakagami- m short term fading severity parameter on system performance is analysed and discussed.

APPLICATION OF ACTUARIAL MATHEMATICS IN BANKING

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In this paper application of actuarial mathematics in banking is shown. The most important term is deposit. Deposit calculation is considered, automation and efficiency using modern technology and program such as Matlab. Furthermore, a new formula is carried out for calculating deposits with regulatory payments with variable amounts. Formula is the generalization and can be reached both by empirical ways, and by using mathematical induction. By introduction of this formula, computing balances in these conditions is notably facilitated and accelerated.

MIT 2016

ORGANIZATION OF COMPUTER SCIENCE EDUCATION PROCESS UNDER THE CONTROL OF ROAD MAPS IN THE CONDITIONS OF INFORMATION SUBJECT ENVIRONMENT

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The paper presents a conceptual model of Computer Science learning under the management of the road maps in the conditions of the mixed form of educating. To realize this model an informative subject environment has been developed in the Learn Management System MOODLE [1].

The teacher lines up the structure of the road map in accordance with general requirements to the results of learning discipline and the plan-chart of the educational process. A student constructs the route of advancement on a travelling map «step by step», taking into account his personal preferences in an educational process and wishful results.

The structural elements of a road map are realized by the MOODLE control elements. The structural elements of a road map are realized by the elements of MOODLE. The control elements of «the task» type realize linear areas of the road map – the teaching tasks, the laboratory works, the tasks of the self-dependent work. The custom control «test» organizes the distance tests of intermediate and final control. The results of the verbal questioning and class work of a student are saved in the «elements of evaluation» of LMS MOODLE.

The results of the learning are a self-weighted sum of all got estimations and the level of development of IC-competence of a student. MOODLE informs a student about the current value of his final estimation and recommends the transit points on every stage of the road map.

Unlike the individual trajectory of teaching the road map of mastering of discipline is more portable. The road map adapts itself to the changing rates of learning, to dynamics of development of IC-competence of a student, to changes of his purposes and personal preferences; allows him to correct the choice of tasks or to go back to a reiteration of the poorly mastered themes. The timeliness of advancement on a road map guarantees the volume

of knowledge and skills, necessary for the further mastering of discipline in every point of the route.

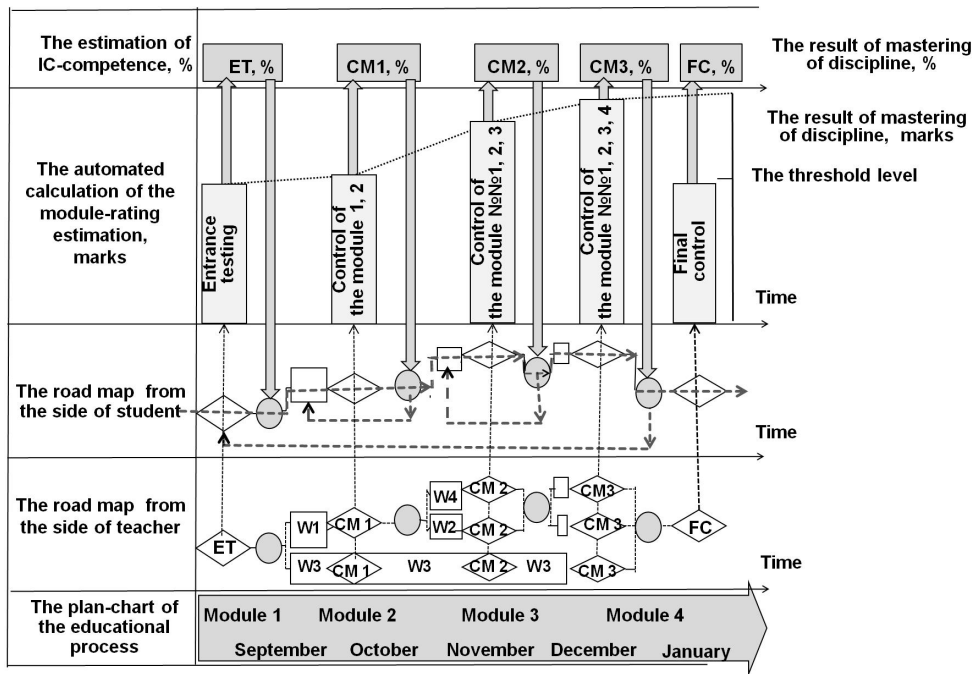


Fig. 1 The training technology to computer science under the control of the road map

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APPLICATION OF E-LEARNING TOOLS IN DIFFERENT WAYS OF IMPLEMENTATION

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In today's stage of development information and communication technologies enable us to display a text, hear a sound material, see a static or dynamic visual material that can be pre-recorded or created on the computer. E-learning, in the form of independent use of the prepared material, often complements the teaching process being implemented in the classroom. The appropriate tools for e-learning are selected depending on the manner of implementation. The ways and possible tools for the implementation of e-learning are presented in the paper.

APPLICATION OF VIDEO CONFERENCE IN EDUCATION AND POSSIBLE WAYS OF ITS IMPLEMENTATION

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Education system reaches a new dimension if video conference is applied. In addition to appropriate technology, the correct selection of the conference tools and implementation methods are of crucial importance for the success of a video conference lecture. Selection of teaching methods, implementation tools, and video conferencing equipment depends primarily on the possibilities and the aim of solving real problems in teaching process. The paper presents all types of video conference communication, as well as tools for the implementation of this kind of teaching method.

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PERFORMANCE ANALYSIS OF FSO TRANSMISSION OVER H-K ATMOSPHERIC CHANNEL

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In this paper, we derive closed form expressions for standard performance measure criteria of free space optics (FSO) communication systems operating over atmospheric turbulence channels, considering the recently introduced H-K model. Closed-form expressions for bit-error rate (BER) and channel capacity (CC) will be obtained for various transmission scenarios. Capitalizing on obtained expressions BER over given modulation formats and CC values are numerically evaluated and graphically presented and discussed in the function of FSO link parameters, such as number of large-scale cells of the scattering process, amount of fading, amount of scattering power coupled to the line-of-sight (LOS) component and average power of the total scatter components.

MIT 2016

THE DEVELOPMENT OF INTERACTIVE, MULTIMEDIA CONTENT USING A MULTI-PLATFORM ENVIRONMENT

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This paper provides an example of using a multi-platform development environment in the course Digital multimedia 2, at The School of Electrical and Computer Engineering of Applied Studies in Belgrade. The teaching process in developing interactive, multimedia content such as features and elements of making video games is also explained and discussed.

The main steps in developing these interactive contents are described, including an introducing part with the Unity 3D platform with its basic features for interactive multimedia application development, with corresponding graphical editor and the scripting part. The process of making one multimedia, interactive application, from very beginning up to a final project, in order to prepare students for real multimedia project development, using recommended multi-platform environment is also provided.

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RATIO OF PRODUCT OF TWO NAKAGAMI- m RANDOM VARIABLES AND RICIAN RANDOM VARIABLE

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In this paper, ratio of two Nakagami- m random variables and Rician random variable is considered. Probability density function and average level crossing rate of proposed ratio are calculated. Obtained expressions can be used in performance analysis of wireless mobile relay communication system with two sections operating over Nakagami- m multipath fading channel in the presence of co-channel interference subjected to Rician short term fading. The influence Rician factor and Nakagami- m severity parameter on average level crossing rate is analysed and discussed.

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ASYMPTOTIC EQUIDISTANCE OF AVERAGES H , G , A AND Q FOR APPROXIMATELY EQUAL STATISTICAL DATA AND MOMENTS

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Let $\mathbf{x} = (x_1, x_2, \dots, x_N)$, $x_i \geq 0$, $1 \leq i \leq N$, be a sequence of numerical statistical data. Let $H(\mathbf{x}) = M_{-1}(\mathbf{x})$, $G(\mathbf{x}) = M_0(\mathbf{x})$, $A(\mathbf{x}) = M_1(\mathbf{x})$ and $Q(\mathbf{x}) = M_2(\mathbf{x})$ be harmonic, geometric,

arithmetic and quadratic averages respectively, and $M_p(\mathbf{x}) = \left(\frac{\sum_{i=1}^N x_i^p}{N} \right)^{1/p}$ is a power mean value. The power mean value is an increasing function on parameter $H(\mathbf{x}) \leq G(\mathbf{x}) \leq A(\mathbf{x}) \leq Q(\mathbf{x})$, with equality only if $x_1 = x_2 = \dots = x_N$.

These four mean values are asymptotically equidistant

$$\frac{G(\mathbf{x}) - H(\mathbf{x})}{A(\mathbf{x}) - G(\mathbf{x})} \rightarrow 1, \quad \text{and} \quad \frac{A(\mathbf{x}) - G(\mathbf{x})}{Q(\mathbf{x}) - A(\mathbf{x})} \rightarrow 1,$$

if $\mathbf{x} \rightarrow \mathbf{a}$, $\mathbf{x} = (x_1, \dots, x_N)$, $\mathbf{a} = (a, \dots, a)$.

For any power mean value M_p we have

$$M_p(\mathbf{x}) - A(\mathbf{x}) = (p-1)(Q(\mathbf{x}) - A(\mathbf{x}) + o(Q(\mathbf{x}) - \mathbf{x})) = \frac{p-1}{2a} \sigma^2(\mathbf{x}) + o(\sigma^2(\mathbf{x})), \quad \mathbf{x} \rightarrow \mathbf{a},$$

where $\sigma^2(\mathbf{x})$ is a variance of \mathbf{x} . For the moments about the arithmetic mean

$$\mu_n(\mathbf{x}) = \left(\sum_{i=1}^N (x_i - A(\mathbf{x}))^n \right) / N, \text{ for example, obtains}$$

$$\mu_3(\mathbf{x}) = (Q(\mathbf{x}) - A(\mathbf{x}))^2 \cdot O.$$

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MIT 2016

PARALLEL TEXT DOCUMENT CLUSTERING BASED ON GENETIC ALGORITHM

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This work describes parallel implementation of algorithm FRIS-Tax for clustering of a corpus of documents. The algorithm is based on evaluated of the similarity between objects in a competitive situation, which leads to the notion of the competitive similarity function [1, 2, 3]. Similarity measure m on the set of documents D is assigned as follows (1):

$$m: D \times D \rightarrow [0, 1], \tag{1}$$

and the function m in the case of full similarity takes a value 1 and in the case of full differences – 0. Similarity measure can be calculated using the formula (2) :

$$m(d_1, d_2) = \sum a_i m_i(d_1, d_2) \tag{2}$$

where i is number of the attribute of the bibliographic description, a_i is the weight coefficients, $m_i(a_1, a_2)$ is the similarity measure by the i^{th} element.

To determine the similarity measure, the attributes of bibliographic description of documents were chosen. As the attributes the year; the unified code; the keywords; the authors; the series and abstracts have been selected. To choose weight coefficient, which are used in the formula of similarity measure (2), a genetic algorithm has been developed. The genetic algorithm consists of the following stages ([4]): creation of initial population; selection; choice parents; crossing and mutation.

To create the initial population and its further evolution, the ordered chain of genes or genotype has the length equal to 13 representing a set of parameters made up on the basis of attributes of the bibliographic description of documents. In the genetic algorithm, a set

of individuals each with its own genotype presents some solution of clustering task. Let us suppose that we have generated an individual, i.e. a set of weight coefficients for defining the similarity measure is set, specified. Then, clustering FRIS-Tax is executed where the measure of closeness is computed with the given set of weight coefficients. In the algorithm, a fitness-function is set which allows to determine how well the task of clustering is executed. The quality of the obtained clusters in this work is evaluated with the help of an external criterion of clustering quality "Purity" [7]. To decide which of the individuals failed to be chosen and is dying and which one is surviving and will take part in reproduction, a lower boundary (Threshold) for fitness-function is set up.

The time of FRIS-Tax operation increases exponentially with the increase in the amount of articles. In this relation, to speed up the work at two stages of the algorithm, technologies of parallel computations were used. First, when choosing individuals in a genetic algorithm. The parallel genetic algorithm is implemented on high performance platform MPJ Express. Secondly, during direct implementation of the clustering algorithm. The loading test revealed two slowest stages in FRIS-Tax algorithm. They appeared to be finding of the first pillar and finding of the next pillar. To speed up these stages, the technology Streams JAVA 8 was used. For monitoring of the algorithm implementation, we developed a web interface which allows observing the current values of genetic parameters and achieved values of the fitness function. The work presents quantitative values of the process execution time demonstrating the advantage of parallel implementation of the algorithm.

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METHODS AND TOOLS OF PARALLEL PROGRAMMING

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Using traditional methods, it is very difficult to develop high-quality, portable software for parallel computers. In particular, parallel software for supporting of enterprise information systems cannot be developed on low-cost, sequential computers and then moved to high-performance parallel computers without extensive rewriting and debugging. Functional programming [1] is a programming paradigm, which is entirely different from the conventional model: a functional program can be recursively defined as a composition of functions where each function can itself be another composition of functions or a primitive operator (such as arithmetic operators, etc.). The programmer need not be concerned with explicit specification of parallel processes since independent functions are activated by the predecessor functions and the data dependencies of the program. This also means that control can be distributed. Further, no central memory system is inherent to the model since data is

not “written” in by any instruction but is “passed from” one function to the next. However, scientific world is conservative and the FORTRAN programming language is still quite popular in scientific computations for supercomputers.

Functional language Sisal (Streams and Iterations in a Single Assignment Language) is considered as an alternative to FORTRAN language for supercomputers [2, 3]. Compared with imperative languages (like FORTRAN), functional languages, such as Sisal, simplifies programmer’s work. He has only to specify a result of calculations and it is a compiler that is responsible for mapping an algorithm to certain calculator architecture. In contrast with other functional languages (like Lisp, ML and Haskell), Sisal supports data types and operators typical for scientific calculations such as loops and arrays. At present, there are implementations of the Sisal 1.2 language [4] for many supercomputers (e. g., SGI, Sequent, Encore Multimax, Cray X-MP, Cray 2, etc). Sisal 90 [5] language definitions increase the language’s utility for scientific programming and include language level support for complex values, array and vector operations, higher order functions, rectangular arrays, and an explicit interface to other languages like FORTRAN and C. The Sisal 3.2 language [6] integrates features of Sisal 2.0 [7] and Sisal 90 versions and includes language level support for module design, mixed language programming, and preprocessing.

In this paper, a visual cloud system of functional and parallel programming being under development at the Institute of Informatics Systems is considered. The input language of the system is a functional language Cloud Sisal [8] that is based on the Sisal 3.2 and increases the language’s utility for supporting of cloud scientific computations and cloud parallel programming. The Cloud Sisal language supports also so-called annotated programming and concretizing transformations [9]. The system presented uses intermediate languages of hierarchical graphs and provides means to write and debug functional programs regardless target architectures on low-cost devices as well as to translate them into optimized parallel programs, appropriate to the target execution platforms, and then execute them on high performance parallel computers in clouds without extensive rewriting and debugging [10, 11]. So, the system can open the world of parallel and functional programming to all students and scientist without requiring a large investment in new, top-end computer systems.

Our thanks to all colleagues taking part in the project described. This research is supported by the Russian Foundation for Basic Research under grant RFBR № 15-07-02029.

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USING NON-NEGATIVE MATRIX FACTORIZATION FOR TEXT SEGMENTATION

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Segmentation of text documents is one of important and interesting research problems in the sphere of natural language processing (NLP). It comes in many applications of information retrieval the functions of which provide operative and purposeful access to the full text content of digital repositories. As full text documents available in digital repositories are, as a rule, large in volume, the main function of such applications is to provide the user with the possibility of high-accuracy access to the chosen selected fragments of the document containing information relevant to the topics of his request.

The main problems to be solved in the course of the topic segmentation of the document are: 1) to divide the document into initial fragments (for example, paragraph or sentences); 2) to define topics of separated fragments or evaluate topic closely related fragments; 3) to combine closely related fragments into larger, topically homogeneous blocks. Topic blocks obtained due to segmentation are arranged according to the degree of their relevance to the user's request, and the most relevant blocks are chosen for the concluding presentation of the document (for example, in the form of the so-called snippets).

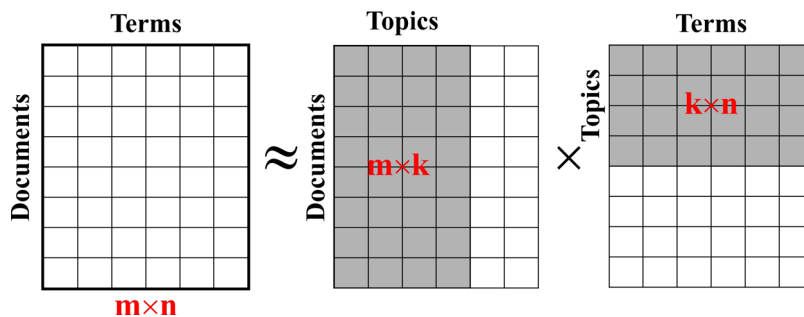


Fig. 1 Non-negative matrix factorization.

The aim of this work is to study the possibility of topic segmentation of document on the basis of non-negative matrix factorization. Non-negative matrix factorization is a method for isolation of significant factors in the data set being analysed [1]. The rows of such matrices correspond to objects (observations) and the columns – to the observed features. The algorithm of non-negative matrix factorization reduces the number of features; as a result, the basis matrix includes observations written down with the help of new larger factors and the features matrix presents weights of initial features in the composition of selected factors. The algorithm iteratively changes the elements of the indicated matrices so that their product would approximate the initial matrix as well as possible but the values of matrix elements would retain their non-negativity.

This work deals with a subject-oriented collection of documents as a data set. To use non-negative matrix factorization, the collection is presented in the form of a special matrix, the line of which corresponds to documents and columns-to term. The matrix elements present frequencies of terms usage in documents. Non-negative matrix factorization allows to execute representation of each document from the space of terms to the space of topics (Fig. 1).

The obtained as a result of factorization basic matrix contains economical representations of documents in the form of topic combinations. The matrix of features represents distribution of terms according to the topics [2]. The main idea of this work is to sort out the weights of each isolated topic according to their decrease and, in this way, determine the most important terms of this topic. It is assumed that these terms can be used as more effective supporting features during topic classification of the document fragments. This work is devoted to the study of this problem.

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INFORMATION-THEORETIC APPROACH TO CLASSIFICATION OF SCIENTIFIC DOCUMENTS

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Nowadays the problem of classification of scientific documents is of a great importance, because a flow of scientific documents is growing in fact exponentially. The development of methods of automatic classification of scientific documents attracts attention of many researchers over the world, see [1-6]. One of the most difficult tasks is the process of automation the thematic classification of documents, the result of which is assigning a document to one or more classes (e.g. mathematics, physics, chemistry, etc.) In spite of many efforts, an efficient automatic method for the thematic classification of scientific documents does not exist yet.

In this report we propose to use data compression methods in order to automatically determine a thematic affiliation of scientific texts. The main idea of the suggested method is quite natural: scientific texts (articles, books, etc.) use similar terminology if they belong to the same area. On the other hand, the data compressor uses frequencies of occurrence of words in the text and "compresses" the data the better, the more repeated words. Based on this observation, we suggest the following classification scheme: for any scientific area we form a set of papers, which represents the area. Then a new text is compressed together with each set of texts representing the thematic areas and refers to that area for which it is compressed to a minimum size.

For an assessment of the possible practical applications of this method, an experiment was conducted. We used data provided on the website arxiv.org to select subject domains and the formation of the texts describing them. This arxiv contains more than a million articles pertaining to various areas of science. When placing the article on the site, an author refers to the work of one of the scientific sections. The first section, pointed by author, we will call "the main category", other - "secondary".

For our experiment, we have chosen thirty research fields, presented in the arxiv (For example, information theory, logic in computer science, artificial Intelligence, cryptography

and security, etc.). For any field we formed a set of 100 documents belonged to this field. Then we randomly chose 20 test files from every category, which did not belong to the sets and use the described method for automatic classification. It turns out that the total numbers of errors is 21 of 600 (3,5 %). In this report we described the experimental results in detail and show that the suggested method is quite efficient.

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REQUIREMENTS FOR N-VERSION SOFTWARE MODULES DESIGN AND DEVELOPMENT

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N-version programming as an approach to provision of fault tolerance in safety-critical systems proved itself positively for a row of various practical tasks [1–4]. Theoretical analysis and practical experiments demonstrate a substantial increase of reliability in case of using N-version software systems in contrast to traditional one-version software [5, 6]. General theoretical approach to N-version software design supposes that potential faults appearing in different versions are completely independent [7]. Independence of potential faults is determined by using different methods and algorithm of the task solving [8]. As for program realization, the problem of potential faults independence lies at the level of source codes. At the stage of software run, fault independence can be lost due to possible interactions disregarded at the stage of execution of the modules versions within the whole software.

This article enunciates requirements imposed for design and development of N-Version software and aimed at solution of this problem. These requirements develop N-version programming methodology, in particular, the task of N-version software deployment in the systems with shared memory is considered in the article. Besides, meeting the suggested requirements during development of N-version software allows to achieve such positive results as elimination of interreaction of the program modules, program faults localization and quick response, usability of deployment and enhancement of N-version program system, enlarging a range of NVP system program module potential developers.

The work describes the developed environment for N-version software runtime, which also allowed to research the functioning reliability of N-version software developed according to the suggested requirements. The stated above environment was developed on the basis of a component approach and besides the components as such it includes interface for program modules execution support, while the modules are realized as independent components.

Reliability and fault-tolerance analysis of N-version software was performed with the use of the developed runtime environment. At the same time, errors of various kind were injected into the N-version software versions. The conducted research confirms expediency of N-version software requirements and verifies theoretical conclusions about ensuring the software fault-tolerance thanks to N-version programming.

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MIT 2016

APPLICATIONS OF INFORMATION THEORY AND PSYCHOLOGY LAWS TO OPTIMIZATION OF INTERNET SEARCH

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The problem of search of the necessary information in Internet and time spent for search becomes very important, because Internet plays important role in all spheres of human life. Especially actuarial this problem is for e-learning and some other human-computer interaction systems where one of the most important problems is design menus, which are used for presenting, organizing, and selecting information, see [1–4].

We consider a particular class of problems for which the objects can be arranged in alphabetical order and a user knows the name of the object in advance (it can be name of a city if one is buying a ticket, the name of a person if one is looking for a telephone number, etc.). For this class of problems a menu could be arranged automatically (i. e. not requiring human participation). We describe a method of menu construction which allows minimization of the average search time. In contrast to the method of the [5], the proposed method of constructing a hierarchical menu is based on a psychological Hick's law [6] and known codes for data compression. It is shown that the Shannon entropy is the lower limit of the average search time for any menu. In this report we describes a general algorithm, that allows to build a menu whose search time is close to the minimum, but the complexity of

the proposed method is high. It makes the discussed problems (first of all, designing more effective general methods for the search and, secondly, for the sub-tasks search, for which fast algorithms could be found) to be very actual. The considered examples have shown that the proposed method allows to build the menu which is close to optimal. Besides, we carried out some experiments which give a possibility to make recommendations for practical applications.

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METHODS FOR AUTOMATION OF DEVELOPMENT OF INFORMATION SYSTEMS USING SPECIFICATIONS OF DATABASE APPLICATIONS

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The automated information systems (AIS) are systems designed for collection, storage, processing, analysis and visualization of information. Besides from some sophisticated specialized algorithms, the main purpose of the major part of AIS is to provide a convenient access to relational database management systems (DBMS) to allow users to perform CRUD (create, read, update, delete) and search operations. So we'll consider the systems, which provide user interface to DBMS, and later on we'll call the systems database applications.

The main disadvantage of the modern software development technologies (like MDA, ORM) is that they force programmer to write a lot of similar code, which differs only in table and field names. Though the technologies may help to generate some part of the code, the programmer will have to perform a lot of similar work anyway, and he will have to rewrite all the code to reflect the changes in the structure of the database which inevitably occur during its lifecycle. The database interaction code parts contain and use some information about database tables, fields and their relations, but this information is intermixed with some typical code patterns, like that for opening tables, retrieving fields and their values and so on.

Our approach is based on the use of specifications of database applications (SDA). The SDA should provide the minimum required information in its pure form about database tables, their fields, the links between them and their usage in the database application. All the other tasks are performed by general algorithms, directed by SDA. We have developed the general SDA-directed algorithms for generation of user interfaces, interactive query building, report generation, GIS interaction, etc, and software, which is based upon the algorithms. The software allows to obtain a full-featured database application by development of SDA,

with the specification being rather small and not containing code duplicates. Some nonstandard tasks can further be solved by plug-in modules, which extend capabilities of the main application.

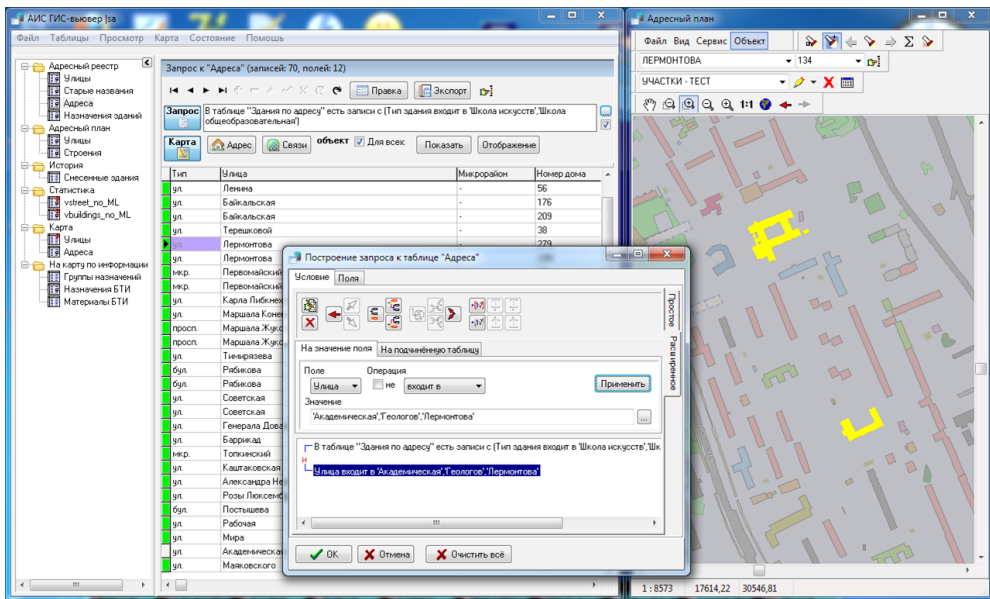


Fig. 1: The query builder and the results of the query shown in the grid and on the map. All the forms have been constructed from the specification of database application.

We can afford to spend much more efforts to develop a general SDA-directed algorithm than when developing a specialized code for solving the same task for a particular table using the traditional technologies. It allows to create more sophisticated user interfaces with richer capabilities (e.g. see the query builder on Fig. 1).

The suggested approach and the SDA-based software were used for development of dozens of custom AIS. It provides consistent user experience for all the applications developed, simplifies software maintenance, redesign and re-engineering. It also allows to integrate some specifications to create complex database applications (say, for a top manager) from the simpler ones.

МИТ 2016

DYNAMICAL MODEL OF HUMANOID ROBOT BIOLOD TYPE A

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The goal of this work was to get precise model of kinematic and dynamic characteristics of small humanoid robot bioloid type A. Obtained data was used for computer model development. Created model can be used for robot locomotion dynamics and load analysis, also for motion planning and control research. It should be mentioned that obtained data and model can be used for analysis of various types of robots with different kinematic structure.

Our results are:

- Robot kinematics data is obtained and this data used for robot kinematics model development. Every robot limb is described as serial manipulator. Robot model is described as 4 connected serial manipulators. This data and model can be easily reused for analysis of locomotion of other robots with different kinematic scheme.
- Dynamic characteristics – mass, centers of masses and inertia tensors are obtained. For plastic parts with uniform mass distribution dynamic characteristics are obtained with computer computations based on parts 3d models. This data was verified with dynamics measures of real parts. Servo motors could not be analyzed as uniform mass distribution objects and dynamics data of motors ax-12A is obtained with measures.
- Obtained data is verified with number ax-12a motors loads measures. Robot Dynamics model is developed on basis of robotics toolbox MATLAB instruments. Model can connect and get data from Real robot online with help of our robot interface class which is based on USB2Dynamixel hardware and data transfer library. This solutions can be used for robot motion analysis and control strategies investigations and developments. Model provides ability to test control algorithms with virtual and real robot using same interface.

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4. Frank L. Lewis "Robot Manipulator Control Theory and Practice" 2004 ISBN: 0-8247-4072-6

MIT 2016

THE SIMULATION OF VISCOUS FLOWS WITH DISPERSE PARTICLES IN THE FLAT CHANNEL

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There is a large class of problems involve the interaction of a viscous incompressible fluid with immersed bodies. One of the challenges is to determine nonstationary influence of dispersed particles on the flow. Some examples of such fluid-particles systems are: the propant transport in hydraulic fractures, slurry pipes systems, nanofluids flow in microchannels, transfer and absorption of medicines in the blood vessels. To avoid difficulties with complicated remeshing procedures, we chose the immersed boundary method as main simulation tool.

In our proposed numerical method, the Navier-Stokes equations are discretized using standard finite difference scheme on a staggered Cartesian grid. Force field is calculated in a feedback way such that the fluid velocity on the boundary satisfy the no-slip boundary condition. The force values are then spread to the Cartesian grid points by a discrete representation of the delta function. The Navier-Stokes equations with the forcing terms are then solved for pressure and velocity using SIMPLE method or MacCormack method. The motion

of the particles is governed by Newton's equations. Evaluating the hydrodynamic forces acting upon a particles we calculate their positions and velocities. Three cases including driven cavity flow, steady and unsteady flows past a circular cylinder are conducted to verificate the method.

A numerical simulation of fluid flow in a flat channel with relatively large number of rigid circular and triangular particles has been performed. The influence of disperse particles on the flow has been investigated.

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THE METHOD OF FAST NUMERICAL SOLUTIONS CALCULATIONS FOR SEEPAGE EQUATIONS USING CONTINUOUS GROUPS OF SYMMETRIES

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Many problems in mathematical modelling have a great degree of uncertainty and different variants of optimal solutions that is why there is a need to conduct multivariate calculations. But this volume of calculations demands fast and effective numerical calculations algorithms. There are two ways of calculation time decreasing for numerical calculations: increasing of hardware resources and using of more advanced methods for theoretical analysis of the algorithms. Improvements of numerical algorithms demand using new unused methods for analysis of them and it is the only way to increase both speed and effectiveness of numerical calculations in many different fields. And one of these new methods of numerical algorithms analysis is theory of continuous symmetries for difference equations.

Knowing of continuous symmetries for an equation (differential or difference) gives an opportunity to obtain a family of solutions if one particular solution (not invariant) is known. This principle lies in the basis of the presented novel method of fast numerical solutions calculations for finite-difference schemes. The method allows to obtain families of numerical solutions for difference schemes of differential equations for different processes. It is made by using of some particular numerical solutions and transformations from continuous symmetry groups of the schemes [1]. This method is base on known results of continuous symmetry analysis of difference schemes and discrete dynamical systems from [2–4]. The main advantage of this method is increasing of numerical calculation speed by orders and an opportunity to analyze all possible solutions.

This method is demonstrated with using of implicit and explicit schemes for some partial differential equation of multiphase flow in porous media, initial and boundary conditions which describe a real problem of development designing of oil and gas fields. Continuous symmetries of difference schemes are obtained using [2] and continuous symmetries for correspondent differential equations are obtained using results of group classification in [5]. The main purpose of this report is to present a novel method of numerical solutions calculations using continuous symmetries of difference schemes for some particular differential equations of multiphase flow in porous media which are generalizations of the Buckley-Leverett problem.

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NUMERICAL SIMULATION OF INDUSTRIAL FLAMES

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Systems of flaming combustion are widely used in industry: a heating and power boilers, flares for heating and melting metal, burners for thermal utilization process gases of metallurgical and petrochemical industries, etc. Various simplifications for physical and chemical processes are used for modeling of flaming combustion systems. Features of various sub-models for the combustion processes depend on the solved problem (fuel efficiency, optimization for integral and local characteristics of heat transfer, emission of environmental pollutants, etc.).

In the recent years, multipurpose software packages, such as ANSYS CFD (Fluent, CFX), Star-CCM+, are widely used for simulation of industrial flames. Combustion is a complex process, determined by the combined action of chemical, heat and mass transfer processes in turbulent flows of multicomponent gas mixtures. For adequate modelling of the fuel combustion requires the careful implementation in a computational model.

The work is devoted to the development of methods for numerical modelling of the gas combustion. Testing of techniques and mathematical models using a commercial package Fluent and in-house CFD code SigmaFlow was carried out. Flow parameters and turbulent characteristics were determined by solving a Reynolds-averaged Navier-Stokes equations and using large eddy simulation (LES) turbulence models as well. Different approaches and models for combustion calculations were used. The simplest one is the hybrid model, in which the reaction rate is calculated on the basis of multi-step reaction mechanism and rate of components turbulent mixing. More complex "eddy dissipation concept model" (EDC) assumes that the combustion reaction proceeds in thin laminar "fine structures" in turbulent eddies. The models were tested on experimental data. on a methane swirling flame in a closed burner of IT SB RAS Fig.1.

Proven method of calculation has been successfully applied for the calculation of burner designs for combustion of wet associated gas at oil-gas production, for the simulation of operating modes of the gas turbine combustion chamber, optimization of the burning process of anode gases from the electrolyzers, to evaluate the heat flow on the ground in the event of self-igniting gas torches in the nature.

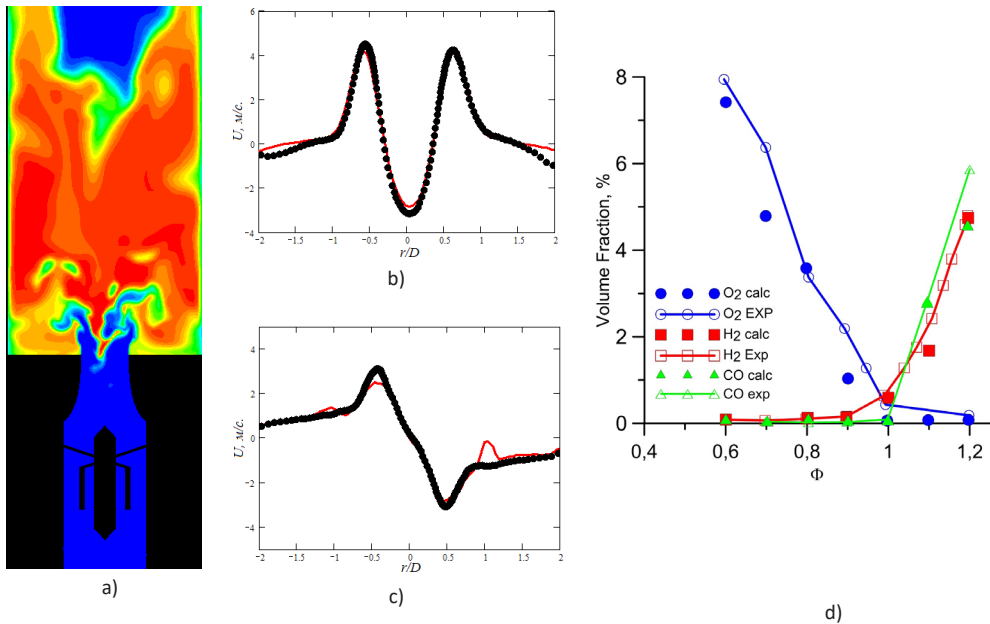


Fig. 1: The simulation results of a swirling flame: a) temperature, b) axial velocity, c) tangential velocity, d) distribution of the volume fraction of the components

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MODELING MECHANICAL DEFORMATION PROCESSES OF METALLIZED POLYMER FILMS IRRADIATED BY ELECTRONS

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Preparations and investigations of the metallized polymeric materials caused by wide use of this materials in the space industry, electronics, etc.

Goal of this materials research is to obtain composite films that have different distribution of the metallic thickness phase and do not affect mechanical properties.

Experimental and theoretical relation between relative extension (ε) and applied stress (σ) to the for non-irradiated and irradiated silver metallized polyimide films were obtained. Research found that the metallization of polyimide film increases its relative elongation to 120% and breaking applied tension reaches ~ 175 MPa. Reason described below effect is related with method of producing these films.

Reaction of the material to mechanical deformation can be described by the following analytical expression:

$$\varepsilon = \exp\left(\frac{\sigma}{E}\right) - 1. \quad (1)$$

expression (1), can be written as:

$$\varepsilon = \frac{\sigma}{E} + \frac{\sigma^2}{2!E^2} + \frac{\sigma^3}{3!E^3} + \dots, \quad (2)$$

where E - average elasticity module of the composite material.

The first and second parts of the series (2) describes behavior of the material in the elastic region. First term of the expansion describes behavior of the material due to deformation as linear law (when $\sigma < 35$ MPa), i.e. Hooke's law, and the second term of the expansion - in a non-linear (if $\sigma \geq 35$ MPa). Third term takes into account the expansion behavior of the material as ductile, when the value of E_n is not a modulus of elasticity, etc.

According to (2) for irradiated metallized polymer films in the elastic region equal average modulus $\varepsilon = f(\sigma)$ was experimentally determined equal to 31,7 MPa.

Experimental and theoretical curves agree very well for the area loads under ~ 140 MPa. Proposed mathematical model describes well the dependence $\varepsilon = f(\sigma)$ for the metallized films and films irradiated with electrons. Elasticity modulus is reducing due to exposure dose. Elasticity modulus is equal to: at $D = 10$ МГр - $E = 31,1$ МПа; $D = 20$ МГр - $E = 31$ МПа; $D = 30$ МГр - $E = 30,1$ МПа; $D = 40$ МГр - $E = 27$ МПа.

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