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Ministry of Science, ICT and Future Planning

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Science. Innovation. Production

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3RD BELARUS-KOREA FORUM

"Science. Innovation. Production"

Session:

Biomedicine

SENSITIVITY OF CLONOGENIC HUMAN MEDULLOBLASTOMA TUMOR CELLS TO INFLUENCE OF ANTITUMORAL PREPARATION "ARGLABIN": INNOVATIVE APPROACH

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Introduction. One of breakthrough directions in the field of modern antitumor therapy of malignant human brain tumors is isolation and proliferation characteristic of clonogenic tumor cells and development of new antitumor preparations, influencing selectively on these cells. Research results of influence on clonogenic human medulloblastoma cells *in vitro* by antitumor preparation "Arglabin" prove that clonogenic cells can be a target for antitumor therapy.

Material and research methods. We developed technology of isolation and proliferation characteristic of clonogenic and nonclonogenic human medulloblastoma cells by cell cloning method *in vitro* (fig. 1). Experiment designs: 1) isolation of primary culture of medulloblastoma tumor cells from bioptic tumor material; 2) influence of arglabin on heterogeneous population of medulloblastoma cells in monolayer *in vitro*. After 24 hour cell cloning; 3) influence of arglabin on clonogenic medulloblastoma tumor cells in clones *in vitro*. Arglabin was injected into clonogenic medulloblastoma cells population for 2 days of cloning when colonies contained individual cells. Fixation and analysis of clones were carried out for 10 days of cloning.

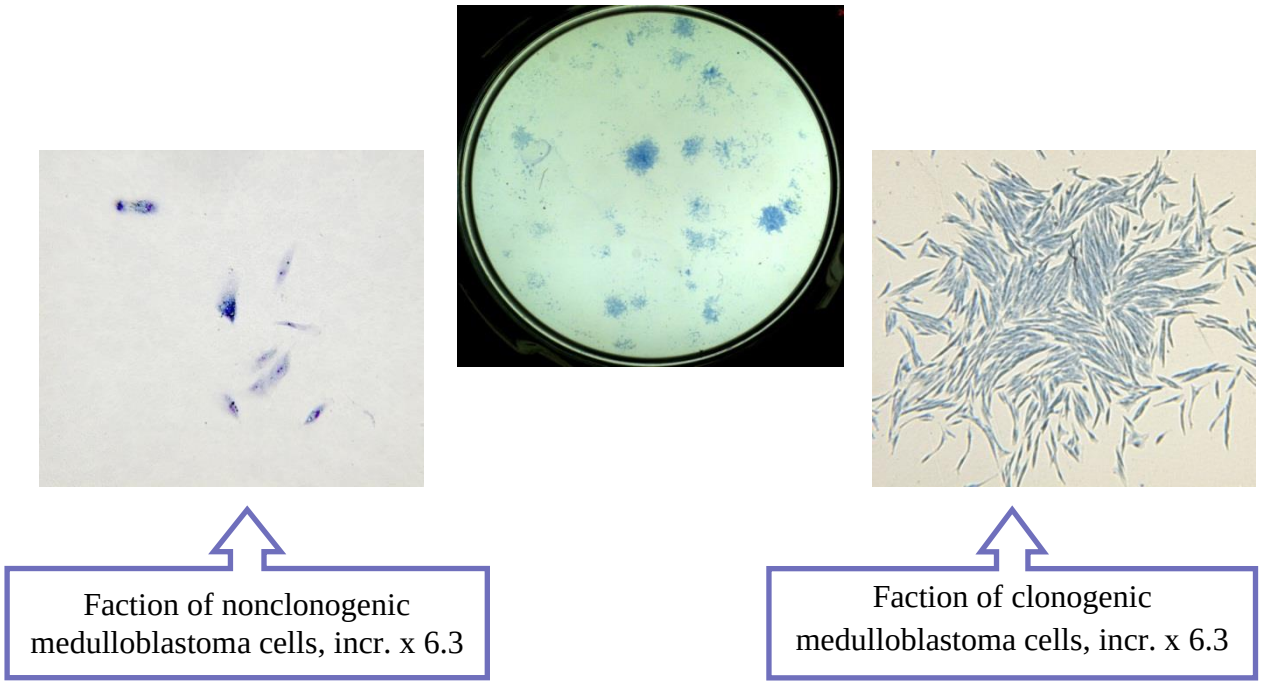
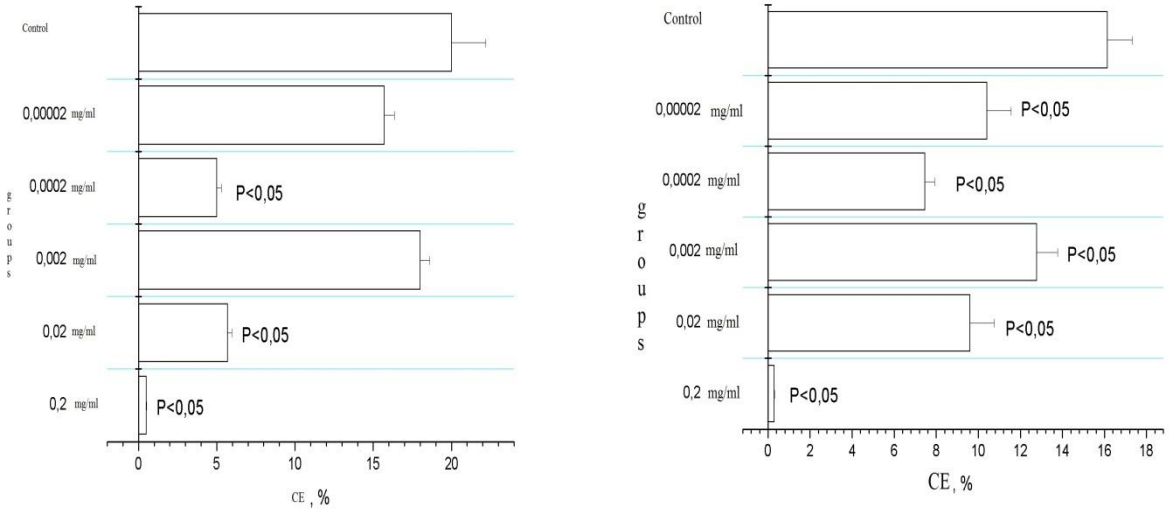


Fig. 1. Method of cloning in vitro human medulloblastoma cells

In terms on model *in vitro* the therapeutic dose of arglabin made 0.2 mg/ml (250 mg/m^2), which reduced by serial dilution method in 10 times. Final doses of arglabin made 0.2; 0.02; 0.002; 0.0002 and 0.00002 mg/ml. Indexes of proliferation and survival of clonogenic cells were defined: 1) proliferation (cloning efficiency, CE) of clonogenic cells was estimated on ability of clonogenic tumor cells to form multicellular colonies (not less than 50 cells). Cloning efficiency (CE, %) was counted as ratio of full-rate (> 50 cells) colonies on Petri dishes to count of cell seeding; 2) survival (LD, %) - as ration of CE in dose to CE in control.

Research results. Influence of preparation "Arglabin" on clonogenic human medulloblastoma cells was first researched. The obtained data testified the perspective application of preparation "Arglabin" as effective antitumor agent to inhibit proliferation of clonogenic medulloblastoma cells (fig. 2).



A *B*

Fig. 2. Cloning efficiency of clonogenic tumor cells after influence of preparation "Arglabin" on heterogeneous population of human medulloblastoma cells in monolayer in vitro (A) and on clonogenic cells in clones in vitro (B)

Selective influence of arglabin on clonogenic medulloblastoma cells, which expressed in death of clonogenic cells in clones' center was shown and testified to possibility of their use as target for antitumor therapy.

Colonies of nonclonogenic cells (abortive clones), which probably more sensitive to influence of arglabin in therapeutic dose were isolated among multicellular colonies of clonogenic medulloblastoma cells, and their death is caused by apoptosis mechanisms. Their share among clones of clonogenic cells increases in process of dose reduction of arglabin.

Conclusion. The further studying properties of clonogenic tumor cells will allow passing to qualitatively new level of search of pharmacological targets and development of new antitumor preparations.

BIOLOGICAL NEURAL NETWORKS IN THE NEW TECHNIQUES FOR PHARMACOLOGY AND BIOMEDICINE

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Modern advances in field of investigation of biological neural networks functioning together with achievements in new biophysical techniques for electronic interfaces with neural cells, computer modeling and stem cell technologies open new tremendous possibilities for practical applications of cultured neural tissue in biomedicine, neurophysiology, and neuropharmacology [1, 2].

One of the aims of our work is to create an automated system for analysis of information processing state in the neural network in conditions of external informational and chemical (including pharmacological) influences. Modern systems of *in vitro* drug testing and screening usually relay on the data about state of single cells. However, we should monitor specific functional properties of neural network in order to estimate adequately drug or toxin action in case of neural tissue. The approach that we propose is based on the neural network cultured on the surface of planar microelectrode sensor. Specific patterns of stimulating electrical pulses sent via electrodes will formulate specific learning tasks for the network and recording electrodes will monitor task execution. In this case it will be possible to monitor influence of drugs on speed of neural network learning. The system will contain also the module of computer simulation of the neural network to provide new techniques of high-throughput drug screening.

Normal state of the network can be shifted by pharmacological or toxic modulation into pathological one, for example, epileptic. Such a pathological state can be investigated and appropriate drugs can be tested for their therapeutic action.

The field of applications of techniques proposed can be extended to stem cells derived neural networks. This kind of neural networks can be useful in prospective methods for transplantology in order to cure diseases such as stroke. Neural networks created artificially from human stem cells than can be tested by the system proposed for the ability to solve functional tasks. Stem cells deriver neural network will have varying synaptic connectivity at the different stages of development. This will lead to different activity patterns and functional properties. Such a biotechnologically formed neural network can be tested for ability to substitute neural tissue on the basis of estimation of its information processing capabilities.

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LONG-TERM EFFECTS OF THE IMPLANTATION OF DIFFERENT TYPES OF SUTURES IN THE SUBCUTANEOUS ADIPOSE TISSUE OF RATS

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Traditionally, manufacturers of suture materials claim that their maximum thread safe, inert and absorbable ligature even absorbed in tissues with no side effects. However, the scientific evidence relating to long-term effects and possible complications developing after the use of various types of ligatures in the literature is not enough.

By light microscopy, studied the reaction of the surrounding tissue to the implantation of absorbable sutures (threads simple catgut, polydioxanone (Surgikrol)) and non-absorbable (ligatures prolene 3/0) in the subcutaneous fat of male rats at 12 months. Each group had at least six animals.

The results obtained. 1 year after implantation, the implantation of a place managed with difficulty to detect macroscopically in four animals of 6 implanted catgut, one animal with an implanted Surgikrolom and all animals implanted with prolenom.

Microscopically, in the case of catgut one animal was found non-resorbed fragment ligation (Figure 1). The rest was determined perifocal sclerosis with foci of scarring, sclerosis of the vascular walls, sclerosis and degeneration of peripheral nerves (Figure 1).

An animal with an implanted thread Surgikrol zone implantation residues ligatures were found, around determined thickening due to the expressed sclerosis vascular walls, sclerosis of the peripheral nerves and soft tissues (Figure 2).

In animals with implanted Prolene ligature preserved. Around determined pronounced sclerosis, until soft tissue scarring, nerve trunks sclerosis and vascular walls (Figure 3-4).

Thus, none of the modern suture can not be absolutely inert and safe. Catgut filaments may persist for a long time in the body, causing chronic inflammation and sclerosis. Their biodegradation almost always incomplete regeneration of the surrounding tissues. Surgikrol considered to be fully biodegradable ligature, but the experimental data indicate that its use can lead to incomplete regeneration of the surrounding tissues with the development of sclerotic changes (substitution). Long-term presence in the body shed leads to the development of gross scarring of the surrounding tissues. In turn, incomplete regeneration of tissue may cause malfunction of organs and tissues [1, 2]. We believe that clinicians desirable to consider the above evidence, and not just promotional offers firms.

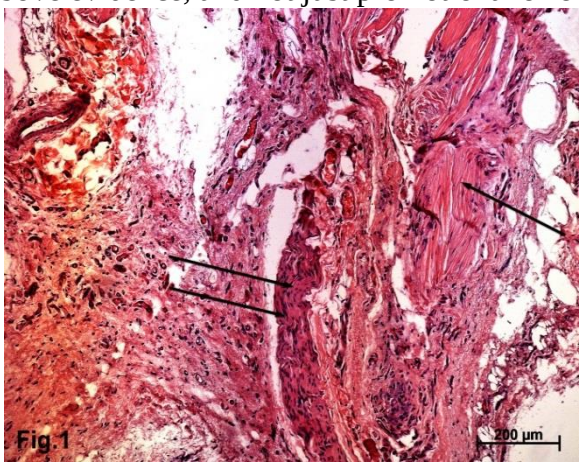

Fig. 1: One arrow Set surviving fragment of catgut, two - a nerve with signs of multiple sclerosis

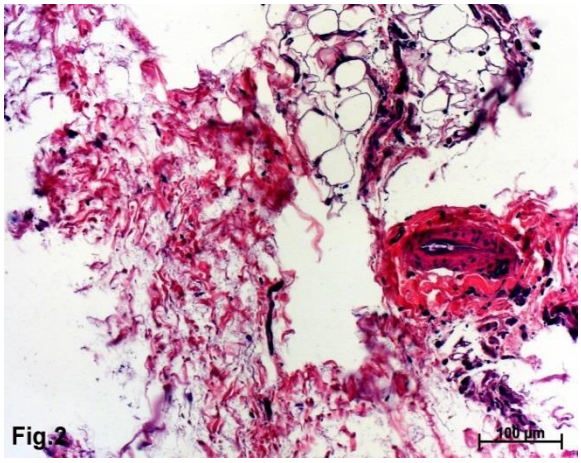

Fig. 2: Area Surgikrol implantation. Sclerosis vessel wall and soft tissues

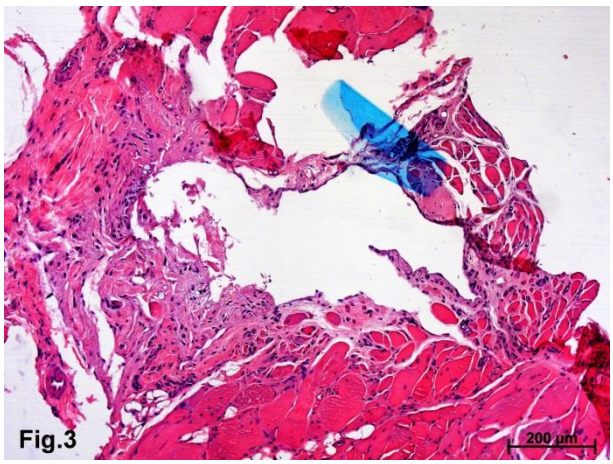

Fig. 3: Zone Prolene implantation. Rough sclerosis surrounding tissues

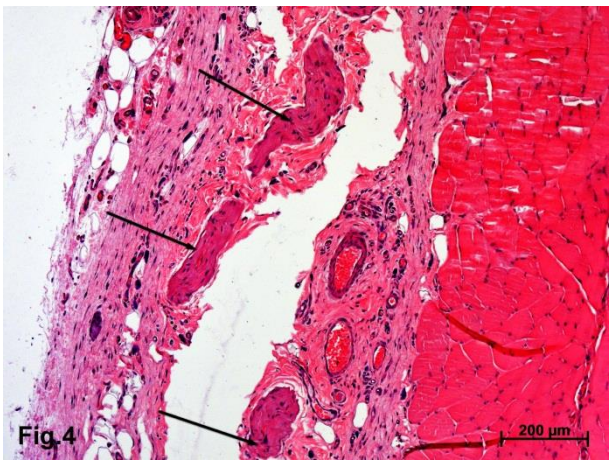

Fig. 4: Zone Prolene implantation. Arrows indicate the peripheral nerves with signs of multiple sclerosis

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MORPHOLOGICAL MARKERS TO ASSESS THE EFFECTS OF CHRONIC HYPOPERFUSION IN THE RAT BRAIN

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Existing criteria for evaluating of key attributes and consequences of hypoxia are diverse and contradictory. Therefore, the searching of structural and/or functional manifestations of hypoxia in the body tissues and primarily in the brain is the actual direction for investigation. The morphological changes in the brain tissue of out bred male rats with diabetes mellitus, obesity and there combinations and SHR line male rats with obesity and arterial hypertension were estimated with light microscopy method. It is well known that all diseases are accompanied by blood stream lesions and following up of different forms of cerebrovascular pathology. According to the international epidemiological studies, acute forms of brain disorders in human are the second or the third place in the mortality structure. There is increasing evidence to support the idea that chronic hypoperfusion of the brain is responsible for the Alzheimer's disease pathogenesis and other cognitive disorders. [1] Key relationships between these states are not fully identified and require further research.

The obtain results. All studied pathological processes were accompanied by signs of varying severity of encephalopathy. The neurons degeneration, gliosis (hyperplasia astrocytes), edema (perivascular and/or pericellular) were found in all cases (see Fig. 1, 2). But the most pronounced pathological changes, which are the manifestation of chronic hypoperfusion and hypoxia of the brain, consequently, have been identified in the modeling comorbidity (hypertension and obesity, diabetes mellitus and obesity), as well as in the modeling of obesity. Morphologically, these changes were expressed as edema, irregular arrangement of cellular elements with local spongiosis, astrocyte gliosis, oligodenrocyte satellitosis, aggregation of microglial, neuron dystrophy and necrobiosis (cell bodies were wrinkled and had the triangular form, Nissl's granules had disappeared, eosinophilia of the cytoplasm, pyknotic nucleus of triangular form) (see Fig. 3-6) [2].

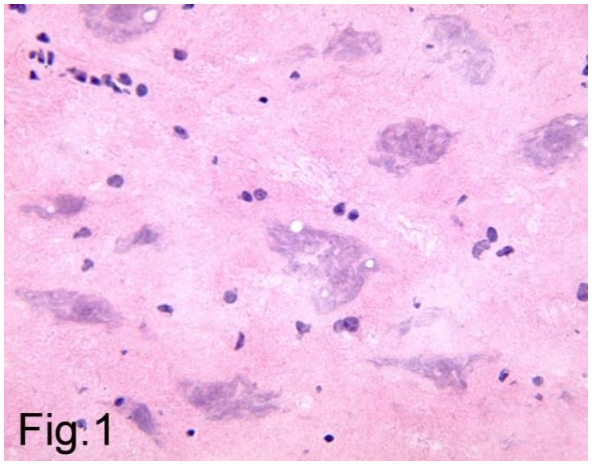

Fig. 1. Edema and degeneration of neurons in hypertension. Hematoxylin and eosin

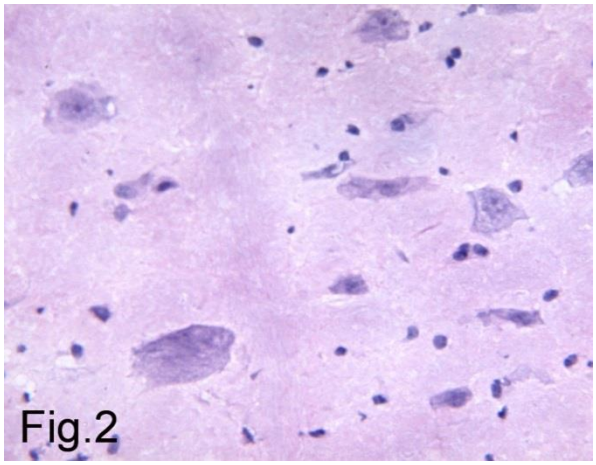

Fig. 2. Degeneration neurons in diabetes mellitus. Hematoxylin and eosin

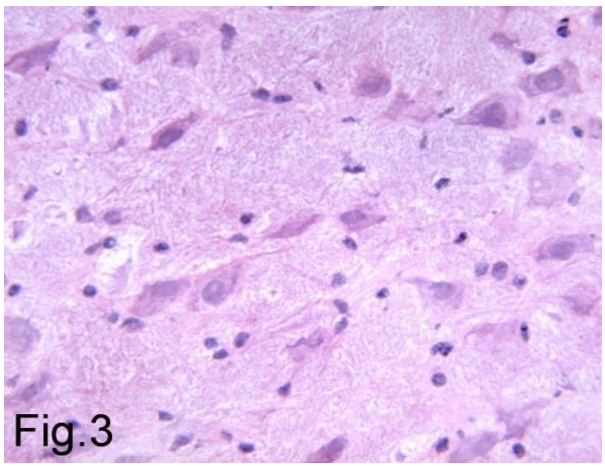

Fig. 3. Edema, degeneration of neurons, gliosis, satellitosis of oligodenrocytes in obesity. Hematoxylin and eosin

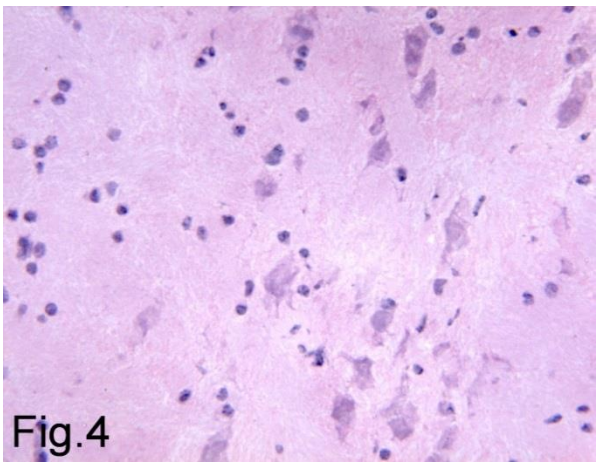

Fig. 4. Edema, degeneration of neurons, gliosis, satellitosis of oligodenrocytes in obesity. Hematoxylin and eosin

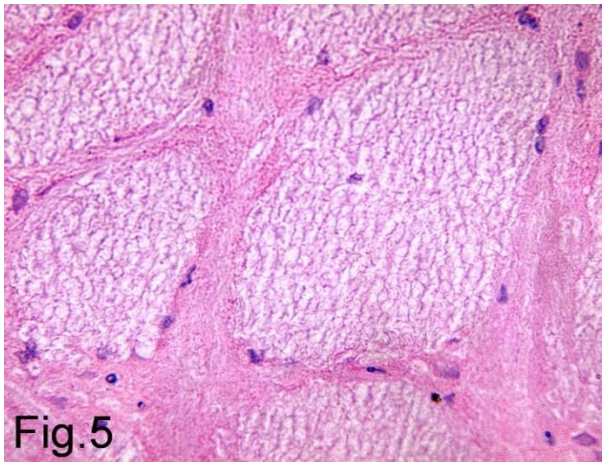

Fig. 5. Severe spongiosis stroma with hypertension combined with obesity. Hematoxylin and eosin

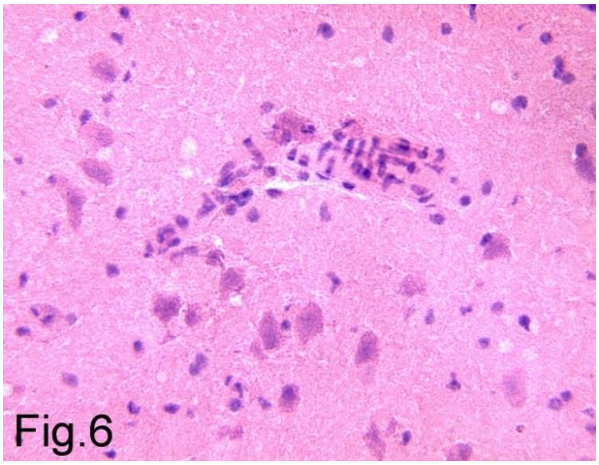

Fig. 6. Hypoxic degeneration of neurons, satellitosis of oligodenrocytes, gliosis in diabetes combined with obesity. Hematoxylin and eosin

Thus, the brain is one of the main targets for all kinds of pathology. With obesity and its combination with arterial hypertension and diabetes mellitus the brain changes are most significant. The ischemic encephalopathy, which is caused by severe vascular lesions, was formed. Vascular lesions are morphological markers for assessing the effects of chronic hypoperfusion in the brain.

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VITALITY OF TUMOR CELLS AND FIBROBLASTS BY MICROGRAVITY MODELING

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Problem microgravity attracted the attention of scientists and physicians from the time of training for space flight. The first human flight to space revealed a number of health issues, the solution of which depended on the prospect of space exploration. Researchers have begun to investigate the influence of simulated microgravity on living organisms [1, 2]. The results of one such study are shown below.

Methods. C6 rat glioma cells and FLv human fibroblasts were cultivated (concentration 2×10^5 cells/ml) in 25 ml flasks in F10 medium with 10% fetal bovine serum and 10^{-4} g/ml gentamycin sulfates. Flasks were placed in CO_2 incubator at 5% CO_2 and 37°C. Flasks position was changed to ∠60º from the horizontal during experiments with C6 rat glioma cells and human fibroblasts cultures. Rotation was carried out in 40-48 hours after reaching 70% confluence. The change in full strength direction was made for 24 hours. One flask stayed in horizontal position during the experiment (No 1) and the other one was tilted ∠60º relative to the horizon (No 2). The results of observations were compared. The monitoring of analogue events was carried over 24 hours using inverted microscope Opton ISM-405 with an increase in lens 16x and Leica DC 300F camcorder, and then the events were accumulated in digital form on the computer every 10 minutes. The 24-hour monitoring was carried out to determine the features of proliferative activity of cultured cells. The research was made on tumor and non-tumor cell cultures. Passaged culture of rat glioma C6 was chosen as tumor cells, passaged culture of FLv line fibroblasts – as non-tumor cells. The calculation of the number of cells in the visual field was made considering the area the calculation took place in. The area of the field was 900 x 700 μm.

Results and Discussion. Figure 1 plots the curves showing the changes in C6 glioma cells number in horizontal position and in ∠60° flasks rotation. Flasks were standing in horizontal position *(control)* and in ∠60° flasks rotation *(exp)*.

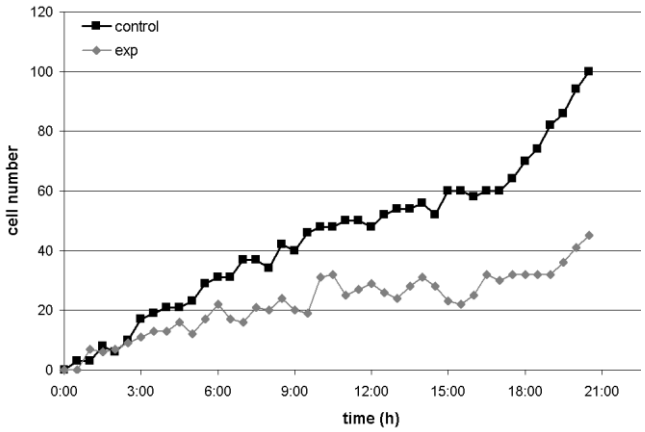

Fig. 1. Explanations in the text

Figure 2 plots the curves showing the changes in the number of human FLv-line fibroblasts. Flasks were standing in horizontal position *(control)* and in ∠60° flasks rotation *(exp)*.

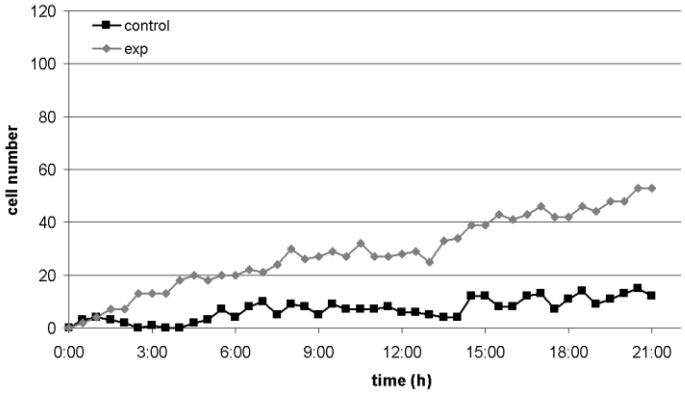

Fig. 2. Explanations in the text

The data on the structural and functional shifts in cell cultures when changing their position in space were obtained in conducted experiments. **It was found that the change in full strength direction provides an inhibitory effect on tumor glial cells (Fig. 1). Fibroblasts' proliferative activity enhances at the same situation (Fig. 2).** Namely the shift of full strength direction, which is one of the factors of wildlife development under gravity, comes out the cause of transformations in living cells in changing both the body position in space and the flask with culture position. The modeling of full strength direction shift in conducted experiments was accompanied with multidirectional changes in proliferative processes in fibroblasts (FLv) and C6 glioma cultures (Figures 1 and 2). The obtained data raised new questions about the effects of the factors of microgravity on living organisms.

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LASER OPTICAL DIFFERENTIAL DIAGNOSTIC BRAIN STRUCTURES AND TUMORS

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Objective: to develop the parameters of laser-optical structures and differential diagnosis of tumors of the brain for non-recognition of their histological structures.

Materials and methods. The study used the device for express optical diagnosis of cancer (Institute of Physics, National Academy of Sciences of Belarus), which includes recording unit spectral and temporal characteristics of the fluorescence (temporal resolution of 50 ps, the spectral range 330-850 nm) and recording unit spectra diffusely scattered light (wavelength range 350 to 1100 nm).

The studies were conducted on samples of human pituitary adenomas, taken immediately after surgery and normal pituitary tissue taken from the corpse. Excitation and detection of fluorescence and diffusely scattered light via fiber optic probe, which is at a distance of 2-5 mm from the surface of the sample immersed in two-thirds of normal saline. By means of this device were measured intrinsic fluorescence decay kinetics adenoma and normal pituitary tissue when excited by ultraviolet radiation having a wavelength of 342 nm, and registration in the wavelength range of 380-600 nm in steps of 20 nm, and the diffusely scattered light spectra

Results. We studied 23 samples, including 12 samples of pituitary adenomas and 11 samples of healthy pituitary tissue. The average duration of autofluorescence patterns of pituitary adenomas during registration in the blue region of the spectrum is 5.2 ns, and as we move to the red region of the spectrum gradually decreases to a value of 3.5 ns. At the same time, the average length of sample autofluorescence healthy pituitary tissue in the blue region of the spectrum is 4.6 ns, and with the transition to the green region of the spectrum gradually increases to 5.5 ns and then decreases in the red region of the spectrum to a value of 4.9 ns.

Thus, it was found that the average lifetime of fluorescence of the samples of normal and tumor tissue are significantly different at check-kinetics in the wavelength range 500-600 nm. Characteristics of diffusely scattered light samples of normal tissue and pituitary adenomas have distinct differences in shape and intensity of the spectrum in the wavelength range 650-900 nm. The intensity of the diffusely scattered light samples of healthy tissue is much less than samples pituitary adenoma. Spectrum of diffusely scattered light patterns of pituitary adenoma has a pronounced maximum near 690 nm, which is not observed in the spectra of healthy samples.

Discussion. Using parameters such as the average duration of tissue autofluorescence in the wavelength range 500-600 nm and the intensity of diffusely reflected light in the wavelength range of 650-900 nm will allow for laser-optical structures and differential diagnosis of tumors of the brain. Application of the technology being developed contactless laser-optical differential diagnosis of tumors express and its subsequent introduction into medical practice will greatly reduce the time and economic costs of postmortem diagnosis, increase the complete resection of brain tumors and reduce the damaged area of normal brain tissue.

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THE MODERN APPROACHES TO DIAGNOSIS AND TREATMENT OF CAVERNOUS ANGIOMAS OF THE BRAIN

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Cavernoma (cavernous malformity, angioma and hemangioma) congenital, usually not hereditary vascular anomaly. Hemangioma is one of the most rare encounter of vascular tumors of the brain, which can occur at any age as the result of accident or be the cause of serious neurological disorders.

It should be noted that recently there has been a significant increase in the number of patients with cavernomas in the brain; it can be associated with the improvement and expansion of diagnostic possibilities. Has also increased the number of detectable asymptomatic of caverna, malformations, manifested minimal non-specific symptoms, and a small caverna (up to 1 cm). Considering the fact that cavernoma are inherently benign tumors, determination of the indications for surgery is quite a difficult task. Surgical removal of cavernoma has established itself as an effective treatment method that eliminates the risk of hemorrhage and, in many cases, significantly improve the course of epilepsy. However, the experience of the various clinics showed that the operation, especially when cavernoma located in functionally important regions that may be associated with serious complications. Currently no clear indications for surgical treatment of caverna brain. Relation to the need and possibilities of surgical treatment of caverna largely determined by the experience of the particular clinic. In this regard, the analysis of results of surgical treatment of caverna brain and the role of different factors [1, 2] affecting treatment outcomes are a prerequisite for improving the quality of treatment of patients and define tasks for further research.

A special place in the study of this disease is diagnosis, as this malformation is a very "hidden". Cavernous angioma could be diagnosed only in rare cases, and often remained invisible during angiographic studies. The introduction into clinical practice of computed tomography (CT) significantly improved the detection of caverna. But it should also be noted that the diagnosis of this pathology on the basis of CT is often unreliable, the sensitivity of the method was quite low, and the specificity was only about 40%. An enormous breakthrough in the diagnosis of caverna was the advent of magnetic resonance imaging (MRI) in the arsenal of neurologists and neurosurgeons. Due to this, the number of patients with this pathology has grown rapidly, and has a high probability to identify cavernoma. In addition to studies of CT and MRI in some cases, the radiological diagnosis of caverna may be supplemented by positron emission tomography. Among the variety of clinical manifestations of cavernoma should be identified 4 main patterns: convulsions, focal neurological deficits, hemorrhages and headaches.

When we talk about the treatment of caverna, you must understand that there cannot be a single strategy that applies to all patients. Each case must be assessed on an individual plan, taking into account all the many factors. Convulsive syndrome is the most frequent indication for microsurgical removal of supratentorial caverna. The goal of surgical treatment is not only the relief of seizures, but also the prevention of hemorrhage. Treatment of drug-resistant epilepsy is not always accompanied by only removing cavernoma, but should be considered in the context of epilepsy surgery, that is, given the possibility of additional resection of epileptogenic areas of the brain.

The ultimate goal of surgical treatment of caverna is their total removal. Partial resection increases the risk of bleeding in the postoperative period. Cavernoma should be removed only under the control of the operating microscope and microsurgical instrumentation and microsurgical techniques. Preoperative planning and mapping of functional significant

zones located near the hearth, is the most important part of surgical treatment, as even the slightest error in the direction of entry and angle of attack can lead to disorientation and failure when trying to find a small hearth in the matter of the brain. The most effective method is a combination of the orientation of the available anatomical landmarks and according to the neuronavigation (frame or frameless). It should also be noted that if cavernoma has no exophytic component acting on the surface of the cortex of the brain, problems with the testimony of neuronavigation of the displacement of the cord, you can use intraoperative ultrasonography, as most cavernous angioma well visualized in this type of research.

The use of intraoperative neurophysiological monitoring in surgery of caverna hard to reach locations or functionally important areas helps to minimize the risk of surgical complications and improve outcome. Stem evoked potentials, somatosensory evoked potentials, mapping nuclei of cranial nerves, electromyography and muscle evoked potentials should be in the Arsenal of any neurosurgical clinic and each neurosurgeon, occupying the problem.

Thus it should be noted that the rapid development of neuroimaging techniques and microsurgical techniques have led to increasing interest in vascular diseases of the brain, in particular to the cavernous angioma. Despite the relative rarity of the disease, the number of patients with this disease everywhere increased and the incidence of this disease is increasing every year. Treatment strategy of caverna diverse and depends on many factors, both objective and subjective, so a single algorithm for the management of these patients is still not there.

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THE MODERN TECHNOLOGY IN RECONSTRUCTIVE NEUROSURGERY

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Aim: To enhance surgical treatment of patients with complex cranial defects after traumatic injury or after removing lesions of roof and base of the scull using emerging computer simulation and prototyping technologies.

Materials: Clinical part of the study included 15 patients suffered traumatic brain injury and requiring complex reconstructive surgery and 7 patients undergoing surgical removal of pathologically affected bone and single-step reconstruction of roof and base of the scull defects. Individual titanium implants created by three-dimensional computer simulation and full-sized laser prototyping techniques were used as a graft.

Methods: Study group consisted of 6 (40%) men and 9 (60%) women aged from 14 to 64 years. Patients with large cranial bone lesions reasons for surgical treatment were: functional impairment – 6 (40%); pain syndrome – 5 (32,3%); esthetics considerations – 13 (86,6 %); prevention of possible functional impairment – 3 (20,5%).

Results: Results of surgical treatment were estimated using following criteria: correction of anatomical defect, reversal of functional impairment and achievement of good esthetics. Also were taken into consideration feasibility of proposed technique and length of hospital stay of patients. The photos taken before and after surgery allowed estimating the severity of cosmetic defect and improvements in appearance of the patient.

Conclusions: Computer simulation and prototyping helps to achieve better esthetic and functional results of surgical treatment, including single-step resection of scull roof and base bone lesions and reconstruction. Proposed technology significantly reduces duration of surgery and risk of surgical infection, enhances esthetic and functional outcomes, which was impossible to achieve using other technologies and materials.

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NEW BIOACTIVE DERIVATIVES OF ISOXAZOLES AND ISOTHIAZOLES WITH AMINO ACID MOIETIES

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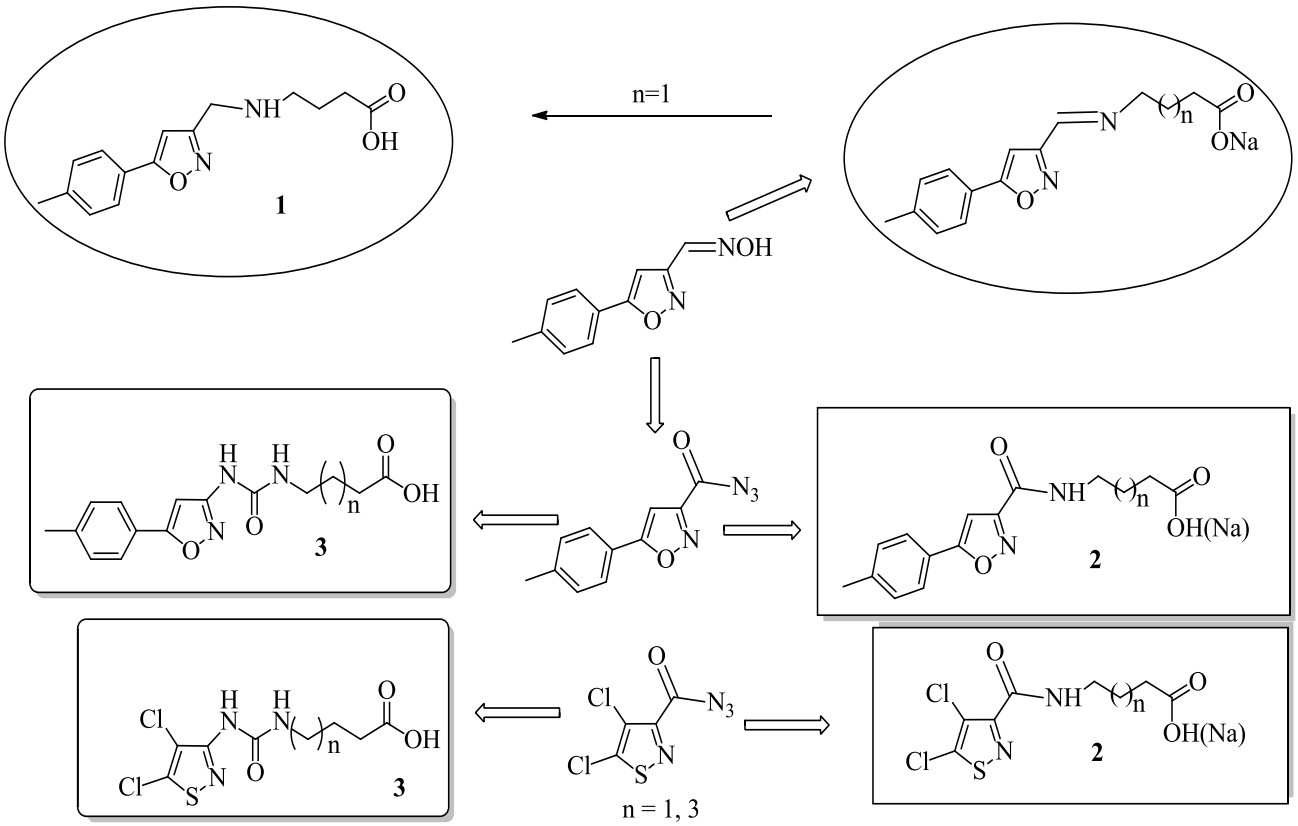
Isothiazole and isoxazole are known to be fragments of wide range of biologically active compounds. For example, 2-amino-3-(3-hydroxy-5-methylisothiazol-4-yl)propionic acid as well as its isoxazole analogue (AMPA) blocks the activation of glutamate receptors which are crucial for different neurodegenerative diseases. Efficiency of the biological action of isothiazoles and isoxazoles is heavily regulated by functional ambience of 1,2-azole scaffold. In this regard, isoxazolyl(isothiazolyl) amines, carboxamides and ureas are very promising for the development of new targeted drugs. Some of the substituted isoxazole carboxamides are FAAH inhibitors and protect against experimental colitis, other are growth hormone secretagogue receptor (GHS-R) antagonists. One representative of (3-benzyloxy-4-carboxamidoisothiazol-3-yl)ureas is an effective inhibitor of tyrosine kinases and it is studied as a promising anticancer agent (CP-547.632).5 Among (isoxazol-3-yl)ureas a perspective Raf kinase inhibitor was spotted [1,2].

We developed the convenient approaches for the synthes of isoxazol-3-yl(isothiazol-3-yl) amines **1**, carboxamides **2** and ureas **3** with amino acid residues. It was expected that the presence of amino acid residue in the molecule would increase the efficiency and selectivity of biological action of the conjugate. Moreover, the amino acid moiety allows to obtain water soluble salt forms, which is important for biological activity and bioassay.



The antitumor activity of some synthesized compounds was studied. The experiments were carried out on primary and linear cultures of neuroepithelial tumors. It was found out that antitumor activity of isoxazoles and isothiazoles conjugates with 4-aminobutanoic acid (carboxamides and ureas) significantly exceeded the effect of the corresponding 1,2-azolyl carboxylic acids. In addition, death of over 40% of cells and decrease in proliferation index ($p \leq 0.05$) were recorded in 24 h of observation after the application of 1M solution of conjugate on glioma cells C6 culture in the experiments in vitro.

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EXPERIMENTAL JUSTIFICATION AND APPLICATION OF PHOTOMAGNETOTHERAPY IN TREATMENT OF DERMATITIS

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Recently, physiotherapy acquired great social significance and became an important part of specialized medical care. Rational use of physical factors improves the efficiency of treatment, reduces its time and decreases the dose of drugs consumed, as well as the number of side effects [1, 2].

The aim of the work was a comparative study of the efficacy of low-frequency pulsed magnetic field and monochromatic light of various ranges in experimental dermatitis. The assesment of the parameters of surface microcirculation as well as complex morphological (histological and histochemical) study of rat skin were made.

Comparative studies have shown that photomagnetotherapy with green (wavelength of 510-550 nm) and blue (460-480 nm) monochromatic light in combination with low frequency pulsed magnetic field (induction 25 mT ± 5) has a pronounced therapeutic effect on the morphofunctional state of the skin and microhemodynamics in experimental dermatitis. Photomagnetotherapy provided a favorable effect on metabolic processes in keratinocytes of the epidermis basal layer, which was confirmed by histochemical studies of redox enzymes. Aerobic energy production in the Krebs cycle was increased, indicating an increase in the functional activity of cells. Decrease in the activity of lactate dehydrogenase, a key enzyme of glycolysis, demonstrates a pronounced anti-inflammatory effect. Reduction of leukocyte infiltration in the papillary and reticular dermis in the histological preparations was also observed.

The studies were used as the basis for the development of a technique of combined use of low-frequency pulsed magnetic field and visible light (blue and green range) in the complex therapy of patients with dermatitis and its introduction into clinical practice.

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HETEROGENEOUS CONTROL OF RESPIRATORY REACTIONS BY VENTRAL MEDULLA STRUCTURES IN APNEA MODELING

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The problem of sleep disordered breathing accompanied with snoring and breathing arrest always includes the analysis of central and peripheral pathological mechanisms [1, 2]. The sequential analysis of the problem will be carried out. Peripheral mechanisms provide air circulation in airways during respiratory cycle. The development of obstructive events in airways conditionally leads to apnea (for example after food aspiration). Such apnea always initiates protective reactions of the organism including forced expiration and cough being the signs of central mechanisms' switch. In most cases the initiation of these protective (central) mechanisms during wakefulness or sleep is sufficient for obstructive event elimination. Unfortunately, clinical practice shows that in certain cases, particularly in patients with obstructive sleep apnea syndrome, these protective (central) reactions are ineffective. An irreversible breathing arrest occurs. Given the complexity of central and peripheral breathing control organization, special attention was paid to the modeling of central mechanisms of ventilation embarrassment by blocking superficial structures of ventral medulla in the experimental study. These regions of brain stem include chemosensitive structures, which mainly react to hypercapnic stimulus, and neuron populations, which transmit signals from medullary chemoreceptors to respiratory centre [3].

Lidocaine (50-100µl, 0.01-1.0%) was applied on ventral medulla surface through polyethylene catheter introduced under dura mater by ventral access between first and second cervical vertebrae in acute experiments on anesthetized with nembutal and urethan (30 and 500 mg/kg) rats. The acceleration of diaphragm electrical activity was established in first tens of seconds after the application of lidocaine in small doses (0.01%) (Figure).

Fig. 1. The electrical activity of anesthetized rat diaphragm before (1) and in 10 seconds after the application of 0.01 % lidocaine on caudal regions of ventral medulla surface (2)

This experimental effect conflicted with the data obtained by other researchers [1, 2]. It was proved that the application of anesthetics (for example lidocaine) on ventral medulla surface of anesthetized animals leads to ventilation embarrassment up to apnea development. What is the reason for increased frequency and amplitude of diaphragm activity? The literature data [3-5] on the heterogeneous organization of neural networks in the ventral medulla may be the answer to this. Cell populations located in caudal regions of ventrolateral medulla tonically inhibit the activity of rostral cell groups which are responsible for the formation of signals' pattern to respiratory centre. Therefore, the injection of anesthetic in small volumes into caudal parts of brain stem is accompanied with lidocaine action primarily on the neurons of "caudal group". The blockade of "caudal group" cell functions is accompanied with disinhibition of

neurons in rostral regions of ventral medulla, leading to increase in frequency and amplitude of diaphragm electrical activity (Figure).

The fact established in acute experiments allows explaining the multidirectional changes of ventilation in patients with obstructive sleep apnea syndrome. The neurochemical interaction between cell populations in ventral medulla is presumably a reason for this phenomenon.

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DENDRIMER-DRIVEN ANTICANCER SIRNA DELIVERY

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The rapid development of nanotechnology led to the appearance of the new perspective engineered nanomaterials for cancer imaging and gene therapy including fullerenes, carbon nanotubes, nanoparticles of metals, quantum dots and dendrimers. Dendrimers are branching polymers which structure is formed by monomeric branches diverging to all sides from a central core. Dendrimers have found their place in medicine as new synthetic vectors for gene therapy [1].

We are studying the dendrimer-based delivery of anticancer small interfering RNAs into cancer cells. It was found that the dendrimer-based siRNA transfection depended both on type of a dendrimer and on its generation. Also, it was found that siRNA cocktails were more effective than the single siRNAs to treat cancer cells. Thus, nanomaterial-driven gene therapy is the perspective way to treat cancer.

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THE PREPARATION OF OAK SILKWORM PUPAE (ANTHERAEA PERNYI G.-M.), WHICH PREVENTS THE DEVELOPMENT OF INSULIN RESISTANCE IN THE EXPERIMENT

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Actual problems of biology and medicine is growing in sync with the technical progress and to identify the incidence of insulin resistance in the form of metabolic syndrome, diabetes, obesity. The aim of this study was to find a biological object in nature, in the life cycle is in the process of evolution has shaped the mechanisms that prevent the development of insulin resistance. Thus the biological object was elected oak silkworm, acclimatized to the conditions of breeding in the Vitebsk region of Belarus. Pupae of this insect was obtained by triple drug extraction and boiling 0.9% sodium chloride solution and standardized content of free amino acids [1].

Modeling insulin resistance was carried out by the content of rats on high-fat diet by Lieber-De Carli for 3 months. The drug was administered intragastrically by gavage daily for the third month of the playback and insulin resistance in a dose of 7 μg of free aminoacids/100 g body weight.

Established that the high-fat diets cause the development of insulin resistance: have increased body weight of rats in the 2-fold, the concentration of glucose by 25.8%, insulin by 87%, the coefficient of Homa at 210%, the concentration of TNF-α by 7.2 times, corticosterone 1,5 times and reduced adiponectin concentration by 1.2 times. It was established that during the development of insulin resistance were activated glycogenolysis, inhibited glycolysis and oxidative branch of the pentose phosphate pathway. Pyruvate dehydrogenase activity was increased 1.8-fold, and the activity of α-ketoglutarate dehydrogenase was reduced by 1.6 times, that signaled a more intensive transformations at the level of isocitrate, the physiological role of which is the regulation of glycolysis by changing the level of citrate and participation in the NADPH-dependent processes (lipid synthesis, neutralization of xenobiotics). With the development of insulin resistance were activated gluconeogenesis and non-oxidative branch of the pentose phosphate reaction path. In the simulation of insulin resistance have been identified biochemical signs of steatogepatosis: hepatic triglyceride content was increased by 3.0 times and the cholesterol content of 3.2 times. It has been established that feeding rats high-fat food for three months resulted in increased levels of malondialdehyde 96% and caused a decrease in the level of reduced glutathione to 77.5%.

The introduction of the drug from the oak silkworm pupae on the background of feeding rats high-fat food had a positive effect: body weight decreased by 33.2%, hyperglycemia - 12%, coefficient of Homa - by 34.6%, the concentration of insulin - 26.9% corticosterone level - 35.7%. Was identified normalizing effect of the drug from oak moth pupae on the activity of glycogen phosphorylase, phosphoglucomutase, fructose-1,6-bisphosphatase, glucose-6-phosphatase, transketolase, hexokinase, phosphofructokinase and other enzymes of carbohydrate metabolism. The preparation of oak silkworm pupae warned development steatogepatosis liver, probably due to the suppression of oxidative stress in rat liver cells.

Conclusion: The result of the research obtained by the preparation of oak silkworm pupae, which is low, close to the homeopathic dilutions, hindered the development of the metabolic syndrome in the experiment [2].

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THE PREVALENCE OF THE GENES RESPONSIBLE FOR BOVINE LEUKOCYTE ADHESION DEFICIENCY IN DAIRY CATTLE

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According to the assignment of President of the Republic of Kazakhstan, 80% of dairy products in markets should consist of domestic products. Therefore, it is important to increase livestock production and productivity.

Today, there are more than 6000 American Holstein cattle in Kostanay region. When they reach 16-17 months and 380-400 kg in weight intensive technology method is used in order to breed them. This technology allows to fertilize the young breeders and to increase the production of well-bred cattle and thus gives profitable economic opportunity [1].

Since the second half of XX-th century, Holstein cattle breed has been used widely across the world. The breed is used not only for meat production but also for the improvement of milk quality. In order to increase the selective breeding the use of the breed resources is important. In many countries, there are wide gene resources of breed to increase breeders for milk.

The use of increased the production of cattle in Kazakhstan. In Russia, more than 5000 kg of milk products of well-bred cattle are obtained only from Holstein cattle. Therefore, in the case of Kazakhstan Holstein breeders also increases the milk products.

Black and Wight Holstein Friesians are known the world's highest-production dairy animals. The increase of breeders by new reproduction methods will lead to widely spread of genetic defects.

DNA-markers give opportunity to detect the productivity and genetic disorder genes. The screening of well-bred products is very important today. This allows to identify the hereditary diseases in cattle [3].

Bovine leukocyte adhesion deficiency (*BLAD)* is a hereditary disease in *Holstein* dairy cattle. The gene which is responsible for this disease has a recessive inheritance. This monogenic disease is found only in homozygotes. The symptoms of disease include wounds around mouth, gingivitis, long catarrh of the lungs, and deficiency of wound recovery mechanisms, anorexia, prolonged dermatitis, and diarrhea.

The disease is caused by a missense point mutation, where adenine substitutes guanine at position 383 in the CD18 gene, resulting in a substitution of aspartic acid by glycine at position 128 (D128G)[4].

This kind of genetic mutation may lead to physiological disorders statedabove. So, bovine leukocyte adhesion deficiency in black cattle reduces the productivity and fitness. Therefore, it is important for producers to find the genetic methods that detect BLAD (Bovine Leucocyte Adhesion Deficency) mutation transporters.

According to above information, it is clear that well-bread cattle in the territory of the Republic of Kazakhstan should be tested genetically for BLAD by polymerase chain reaction.

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PRECISION MICROMOTOR TECHNOLOGY FOR BIOMEDICAL APPLICATION

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Microelectromechanical system (MEMS) is a miniature system composed of electronic and mechanical components with average size from 1 to 100 microns. Typically MEMS consists of an electronic module (microprocessor or microcontroller) and a set of microscopic electromechanical sensors and actuators.

The main advantages of microelectromechanical systems are: small size, high functionality and reliability, low power consumption and repeatability.

Currently, one of the most promising MEMS applications are biomedical technologies (Fig. 1). The use of modern micro- and nanomotors allows people to solve such problems as isolation and transport, bio recognition, bio sensing, nano-surgery, imaging, neural implants, drug delivery and many others. According to the Yole Development bioMEMS market will grow from $ 3.5 billion in 2015 to $ 6.6 billion in 2018 [1-3].

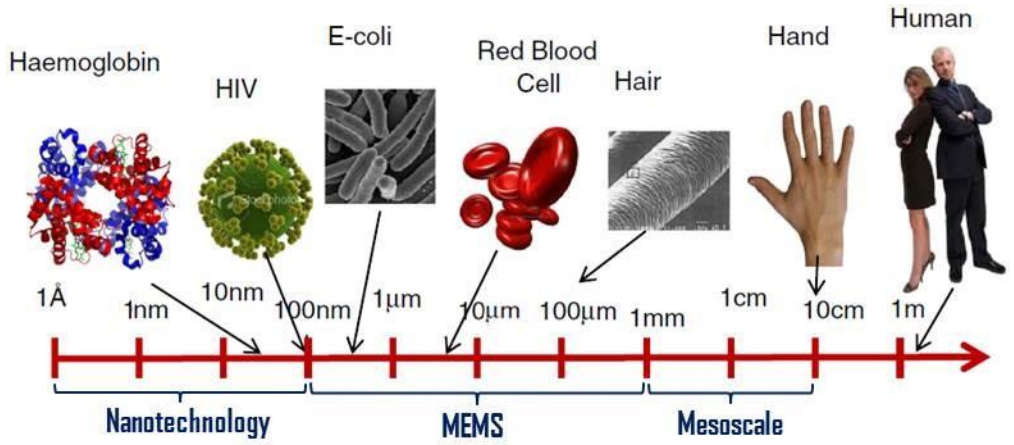

Fig. 1 - Dimensional scale of MEMS and Nanotechnology (Adapted from Nguyen et al. [4])

Nowadays different materials are used for MEMS components manufacturing such as silicon, various metals and alloys, as well as polymers. Especially, polymers are attractive for biomedical applications due to their bio-compatibility, low cost, and suitability for rapid prototyping.

We have used the SU-8 photoresists to obtain ultra-thick MEMS components with parallel side walls. SU-8 is a high contrast, epoxy based negative photoresist developed and patented by IBM. It has been used extensively in LIGA-like technologies for MEMS applications due to its excellent thermal and chemical properties. Feature height is varied from tens of micrometers to several millimeters, high aspect ratios are on the order of 100:1.

We have used UV lithography, which utilizes an inexpensive ultraviolet light source to expose a SU-8 photoresist. As heating and transmittance are not an issue in optical masks, a simple chromium mask can be substituted for the technically sophisticated X-ray mask.

Different components of micromotor with thickness from 50 to 230 µm with the minimum feature size of 10 µm were obtained (Fig. 2, 3) on the different substrates (glass, ITO, pyroceramics, copper, etc.).

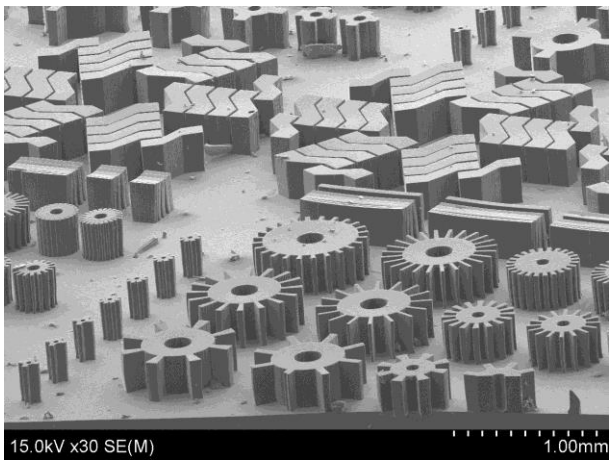

Fig. 2 - SEM photo of 230 µm thick microstructures based on the SU-8 2150 photoresist

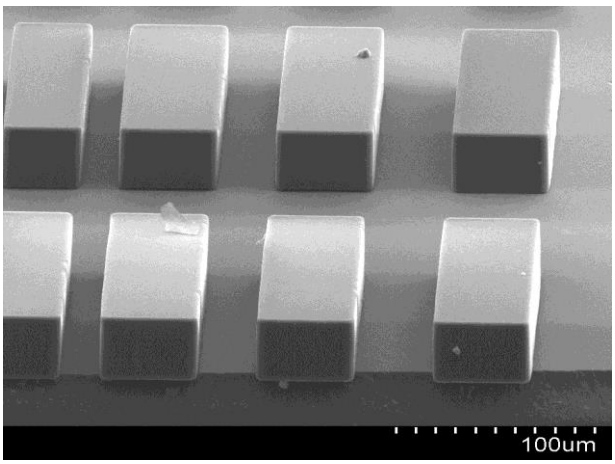

Fig. 3 - SEM photo of 40 µm thick test micropattern with 5 µm minimum feature size based on the SU-8 3050 photoresist

Photo Surface Processor PL16-110D was used to prepare the substrate surfaces by UV cleaning. The cleaning process consists of three main processing steps: generating ozone from atmospheric oxygen (with a wavelength of 184.9 nm), ozonolysis (formation of singlet oxygen at a wavelength of 253.7 nm), and decomposition of organic pollutants (strong oxidative activity of atomic oxygen permits it to react with contaminants materials to form reaction products such as water, carbon dioxide, etc., which are then simply evaporate). Next the photoresist have been spin-coated over the substrate for uniform distribution. Then soft baking step has followed to evaporate remaining solvent in SU-8. A proper soft bake time is one of the most important control factors for a thick photoresist process. Photoresist have been exposed with UV light of i-line (365 nm) through a photomask. Lightningcure LC-L2 manufactured by Hamamatsu was used as a light source. Exposure energy was 250-300 mJ/cm^2. Further, the samples have had post exposure bake on the plate at 65-95°C. This leads local photochemical reactions to provide photoresist crosslinking. Cross-linked areas are insoluble during the next development stage, which removes the uncured resin [4].

Thereby as evident from the market trend, there are vast possibilities for MEMS in the biomedical technology. The proposed technology of MEMS components manufacturing is promising due to the use of unique materials, the possibility to obtain microstructures with vertical sidewalls of large thickness and a high aspect ratio, manufacturability, the possibility of integration with a variety of complex systems, as well as its simplicity and low-cost equipment.

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PREDICTION THE PROBABILITY OF RETROMBOSIS IN PATIENTS WITH ACUTE CORONARY SYNDROME AND ST-SEGMENT ELEVATION DURING MEDICAL REPERFUSION THERAPY AND PERCUTANEOUS INTERVENTION

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Myocardial infarction with ST-segment elevation is about a third of all acute coronary events. Hospital mortality from myocardial infarction with ST-segment elevation according to national registries of the European Society of Cardiology is from 6 to 14%. Reduction in short-term and long-term mortality from myocardial infarction with ST-segment elevation is directly related to a wide reperfusion therapy or primary percutaneous intervention. Percutaneous intervention is preferable regardless of the time from the beginning infarction in patients with shock and those who thrombolysis is contraindicated. If percutaneous intervention cannot be performed in the recommended time frame, pharmacological reperfusion is performed (in the absence of contraindications). As close as possible to the patient is thrombolytic therapy. Effect of thrombolytic therapy is associated with the restoration of patency of the affected artery, limiting areas of necrosis, the viability and electrical stability of the myocardium, left ventricular function and decrease complications of acute coronary syndrome with the rise interval ST.

Existing evaluation scale cardiovascular risk in patients with acute coronary syndrome segment elevation ST, as a rule, take into account clinical and some laboratory parameters and don't allow to fully characterize the risk of complications of the disease. Since the methods of reperfusion therapy are being actively implemented in clinical practice, of particular interest is the study of the causes of adverse coronary events in patients with acute coronary syndrome and ST-segment elevation after reperfusion of the infarct-related artery with the use of thrombolytic therapy and percutaneous interventions, as well as their prediction in step reperfusion.

The aim is to determine the predictors of recurrent coronary events in patients with acute coronary syndrome with ST-segment elevation after reperfusion therapy in the form of systemic thrombolysis and percutaneous coronary intervention, as well as the development of computer programs predict the likelihood retrombosis in patients with acute coronary syndrome with ST segment elevation on the step of performing medical reperfusion therapy or percutaneous coronary intervention. The objects of study became the patients with acute coronary syndrome segment elevation ST.

The distribution of patients in the group carried out depending upon the type of reperfusion therapy. Group 1 consisted of patients who underwent thrombolytic therapy; group 2 - those who underwent primary percutaneous intervention. Surveyed patients of each group divided into two subgroups: with and without coronary artery retrombosis. The database is formed on the basis of clinical signs, results of laboratory tests and echocardiography. To determine the probability of recurrent coronary events was used logistic regression (logit model). In this approach, the probability is defined as follows:

$$p = \frac{\exp\left(b_0 + b_1 X_1 + ... + b_n X_n\right)}{1 + \exp\left(b_0 + b_1 X_1 + ... + b_n X_n\right)},$$

where the variables (predictors) X_i correspond to grounds of discrimination of the concerned groups . The model parameters b_i are estimated using maximum likelihood method. The most significant predictors are found on basis of the method of successive elimination of variables. As a criterion for the comparison of models was used the Akaike information criterion (AIC).

Group of patients with acute coronary syndrome segment elevation ST, which was carried out effective thrombolytic therapy consisted of 115 people aged 35 to 78 years. Patients in this group were divided into two groups: with rethrombosis of coronary arteries (40) and without rethrombosis (sub-group comparison, 75). After exclusion the less significant features, the ratio for the probability retrombosis in patients with acute coronary syndrome and ST-segment elevation after reperfusion therapy takes the form

$$p = \frac{\exp\left(1.303 - 0.065X_1 + 0.394X_2 + 0.248X_3 + 0.171X_4 + 0.155X_5\right)}{1 + \exp\left(1.303 - 0.065X_1 + 0.394X_2 + 0.248X_3 + 0.171X_4 + 0.155X_5\right)},$$

where X_1 is the systolic blood pressure (mm. Hg. art.); X_2 is the maximum segment elevation ST (mm); X_3 is the level of leukocyte Gl^{-1}; X_4 is the total contractility affected segments; X_5 is the concentration of troponin (ng / ml).

A group of patients with acute coronary syndrome and segment elevation ST after percutaneous coronary intervention was consisted of 112 people aged 35 to 78 years. Patients in this group were divided into two groups: with rethrombosis of coronary arteries (32) and without rethrombosis (sub-group comparison, 80). In this case, the probability of retrombosis is defined as follows

$$\begin{aligned} p = \exp\big(&-10.071 + 4.24001X_1 + 3.46229X_2 + 6.04796X_3 - 0.04664X_4 + \\ &+0.07953X_5 + 0.50134X_6 + 0.1608X_7 + 0.20728X_8\big)\times \\ \times\big(1 + \exp\big(&-10.071 + 4.24001X_1 + 3.46229X_2 + 6.04796X_3 - 0.04664X_4 + \\ &+0.07953X_5 + 0.50134X_6 + 0.1608X_7 + 0.20728X_8\big)\big)^{-1}, \end{aligned}$$

where X_1 is the localization of the defeat of the infarct-related artery (matching the affected area of the infarct-related artery the first segment of the left anterior descending branch of the left coronary artery); X_2 – «Killip» (class of acute heart failure patients on admission Killip1, Killip2 or Killip3 / Killip4); X_3 is the systolic blood pressure (mm. Hg. art.); X_4 is the heart rate X_5 is the maximum segment elevation ST (mm); X_6 is the troponin (ng / ml); X_7 is the overall contractility of affected segments.

On the basis of the logit-models are developed computer programs to predict the likelihood of retrombosis in patients with acute coronary syndrome and ST-segment elevation on the step of the medical reperfusion therapy or percutaneous coronary intervention. Computer programs are in place in the institutions of the Ministry of Health of the Republic of Belarus, specializing in treatment of the internal diseases (9th Clinical Hospital, National Clinical Medical Center and other).

ENDO G TRANSLOCATION AND CARDIOMYOCYTE MITOCHONDRIAL POTENTIAL DECREASE AFTER MYOCARDIUM ISCHEMIA

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Apoptosis − a programmed cell death – a process, where it's main purpose is to eliminate any damaged cells or serves as a fundamental function during tissue development.

Most common apoptosis specificities are: cell dehydration compression, loss of transcellular links, blebbing , cytoskeleton destruction, chromatin condensation, nucleus fragmentation and DNA degradation (Häcker, 2000; Bortner, Cidlowski, 2002).

Apoptosis can be caused by external and internal signals, most important of which is DNA damage (Reed, 2000; Roy, Nicholson, 2000; Ghobrial et al., 2005).

EndoG is a nuclear-encoded mitochondrial enzyme that is known to be released from its original location, translocate to nucleus, and degrade nuclear DNA during caspase-independent apoptosis.

EndoG is a nuclease that has a unique site selectivity, initially attacking poly(dG). poly(dC) sequences in double-stranded DNA, as a result of which the enzyme got its name.

The discovery of EndoG inhibitor in drosophila (EndoGI) has been an important discovery, and was conducted his complex crystal structure with EndoG. EndoGI renounces in nucleus as a defender from chromosome damage caused by EndoG.

EndoG crystal structure has not been investigated in mammals, even with detailed research of biochemical qualities and cell function.

The main objective of our research is to analyze cardiomyocyte EndoG cell expression with intervenient ischemic postconditioning, while using immunehystochemical methods of research, because it has been seen that at the ischemia site after short-term occlusion as of the nucleus EndoG translocation.

Methods.

Research was conducted on isolated heart tissue of 16 outbred male rat's. Rat's heats were isolated by Langendorff. We established a value of WHSV coronary flow in rat's heart tissue and review of myocardial contractile activity and perfusion intensity. Into left ventricle, which was connected with blood pressure detector, was injected latex balloon. The heart of small laboratory animals were isolated for heart perfusion. We monitored functional hearts and vessels parameters.

All measuring equipment through analog-to-digital converter was connected with computer, with which we started registration and processing of measured indicators, while using specialized programs.

Heart in the control group was perfusioned with Krebs-Henseleit. Were modulated myocardium heart attacks with coming up series of occlusions/reperfusion to coronary artery in experimental group.

For modeling myocardial infarction animals isolated posterior interventricular branch of the right coronary artery, it is brought under vascular clamp for 5-10 minutes to form an acute ischemia area of myocardium perfused by this artery, after − reduced blood flow (control group). In the main group after removing the wire clip from one to five consecutive short cycles occlusion/reperfusion (10-15 seconds) of the lumen of the coronary artery. After the period of reperfusion in the control and study group received histology and cytological analysis of the heart muscle.

Structural features (semifine sections) ventricular myocardium were studied in transmitted light and fluorescence method. For histological and cytological analysis of half

slices exposed as standard histological staining with hematoxylin-eosin, azure-eosin, azure-2 pikrofuksinom and *gallotsianin-chrome* alum by *Einarsson* and 5,5 ', 1,1 6,6'- tetrahloro-' , 3,3' tetraetilbenzimidazolil-karbotsianin iodide (JC-1), which is able to detect ΔΨm.

For cytochemic analysis were used half-thin slices for Anti-EndoG fluorescence (Anti-Endo G antibody -ab64668, Abcam, UK).

Myocardial slices were fixed with 100% methanol, was carried unmasking antigen permeabilization. Sections were then incubated in 1% solution of bovine serum albumin for 1 h; Incubation with Anti-EndoG antibodies for 12 hours in the dark at 4 ° C. Phycoerythrin-conjugated secondary antibody anti-rabbit IgG were used at a dilution of 1/1000 for 1 hour.

Result.

It has been conducted that rat's myocardium ischemia and reperfusion follows the increase of JC-1 cardiomyocyte cytoplasm. Described changes are an indication of ΔΨm decrease as it could be an evidence of early apoptosis. Cardiomyocytic chromatin at the ischemia/reperfusion models had tendency to compact and optical density increase.

With models of postconditioning in rat's cardiomyocytes the red JC-1 fluorescence was dominant (70% of cell volume), which is a mark of penetration probe in intact mitochondria Chromatin status was similar pre-operation period. Postconditioning, which is used in experimental conditions, causes a decrease of reperfusion damage in myocardium of rat's.

Conclusion.

Research in EndoG translocation of rat's cardiomyocytes conducted that ischemia that was modeled at more intensity in reperfusion and less in acute myocardial infarction as it can start a translocation of Endocnuclease G to cardiomyocyte nucleus. With the model of acute myocardial infarction postconditioning disabled reperfusion EndoG translocation which can be sorted as positive development in acute myocardial infarction. With this said, myocardium of rat's ischemia and reperfusion is bind with cardiomyocytes apoptosis activation.

CRITERIA FOR ABNORMALITIES IN THE VISCERAL ORGANS AS A RESULT OF ISCHEMIA-REPERFUSION INJURY OF THE SPINAL CORD TISSUE

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Termination or reduction in the volume of aorta's blood flow at various levels (chest, abdomen) is accompanied by serious consequences for the organism. Circulatory disorders of the spinal cord tissue are the result of posttraumatic aortic pseudoaneurysms, tumor growth, surgery for removal of thoracic aneurysm or abdominal aorta. More than 25% of the patients have impaired motion function as a result of the spinal cord ischemia [1, 2].

In addition to damaging effects on the central nervous system, temporary cessation of blood flow in the aorta is a damaging factor to the underlying organs and organ systems. In addition, it is logical to assume that the consequences of disturbances in the central nervous system alter the functioning of the motion and sensory fibers in the peripheral nerves that innervate various organs. Such changes trigger a number of pathophysiological processes: pain, inflammation, release of free radicals, apoptosis, structural and functional changes of innervation of target organs [1, 2].

Based on the above, the main objective of our study was to investigate the changes of the internal organs functioning in animals exposed to short-term (15 min) occlusion of the thoracic aorta, followed by (1 hour) reperfusion period (n=6). Irregularities in the visceral organs were examined by recording changes in impulse activity of abdominal-aortic plexus' nerve. As a result, the frequency of depression identified sympathetic efferent impulses by 63% to 12.5±4.1 p/s ($p<0.05$) compared to the background level (33.6±2.4 p/s) by the end of the ischemia period. During reperfusion, the complete restoration of the values of impulse activity was not registered. Frequency electrical discharges remained at 27.6±4.8 p/s (Figure). Thus, occlusion of the thoracic aorta leads to ischemic damage of ganglia tissue, localized at the periphery, in particular abdominal-aortic plexus.

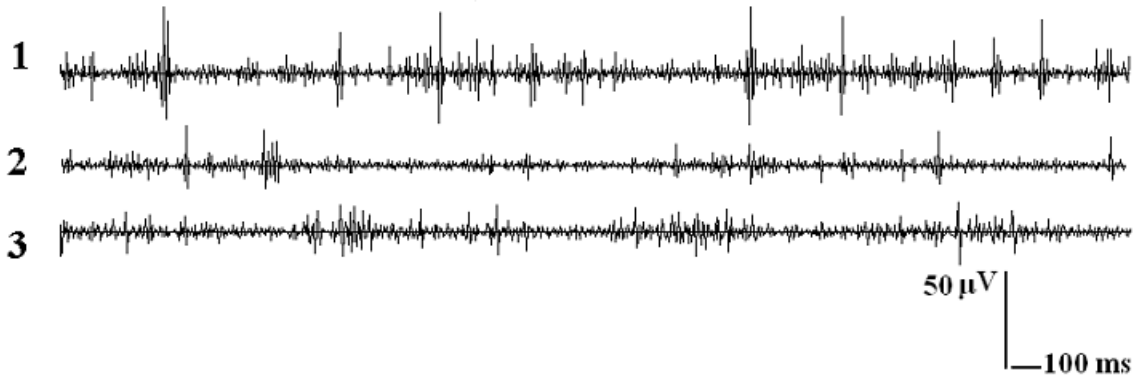

Fig. 1. Impulse activity of abdominal aortic nerve in the normal conditions (1), the end of the period of ischemia (2) and 5 minutes after recovering of blood flow in the aorta (3)

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PROTEO-METABOLOMICS STUDIES FOR AUTOIMMUNE DISORDER AND BIOLOGICAL FUNCTIONS

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Proteo-metabolomics technologies are not so well used in autoimmune disorder studies. Global pharmaceutical companies are recognized already its importance and have been used for several years in drug development. This technology beginning its application in all over the biological research fields, and barrier between leading and developing countries is not so big.

We have been used proteo-metabolmics techniques in autoimmune disorder for the unraveling its mysterious mechanisms and seeking medical bio-markers. Rheumatoid arthritis is fatal and painful but hardly curing disease. We studied and revealing its progress mechanism and useful markers by comparing with osteoarthritis.

And also we used same technologies in cancer metastasis study and signaling cascades in biological functions with several diseases. I'll show you several findings after these studies.

CHANGE OF HIGH-DENSITY LIPOPROTEIN (HDL) IN AGING-RELATED DISEASE AS RELIABLE BIOMARKER

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Abstract

It has been reported that the glycation could also occurred in high-density lipoproteins (HDL) in blood. High-density lipoprotein-cholesterol (HDL-C) is inversely associated with incidence of cardiovascular disease and is directly related to longevity. In type 2 diabetes patients, blood infusion of rHDL caused reduction of plasma glucose levels by increasing plasma insulin in pancreatic beta cells, which raised the feasibility of a wider clinical application of rHDL from cardiovascular disease to diabetes. The glycation resulted in severe loss of beneficial functions of HDL regarding anti-senescence and anti-diabetic, and anti-atherosclerosis activity due to functional and structural modification with increased protein degradation.

To compare the change in lipoprotein metabolism with aging, we analyzed the lipid and protein compositions of individual lipoprotein fractions. Healthy and non-obese elderly subjects (elderly group, n=26) had a serum lipid profile within the normal range, although slightly higher than in young subjects (control group, n=18). However, the elderly group had a 2-fold higher serum uric acid level and triglyceride (TG)/high-density lipoprotein (HDL)-cholesterol ratio. The elderly group had less antioxidant ability and elevated TG content in HDL with enhanced cholesteryl ester transfer activity. An elevated level of advanced glycated end products in lipoproteins and fragmentation of apoA-I were present in the elderly group, with detected lower apoA-I level and more multimerized apoA-I in HDL. The protein levels of apoA-I, apoC-III, and serum amyloid A in lipoprotein-deficient serum were increased in the elderly group.

Keywords: aging, apolipoprotein, lipoprotein, cholesteryl ester transfer protein, advanced glycated end products, apoA-I.

AN INTEGRATIVE NATURAL PRODUCT RESEARCH PLATFORM- FLORA GENESIS

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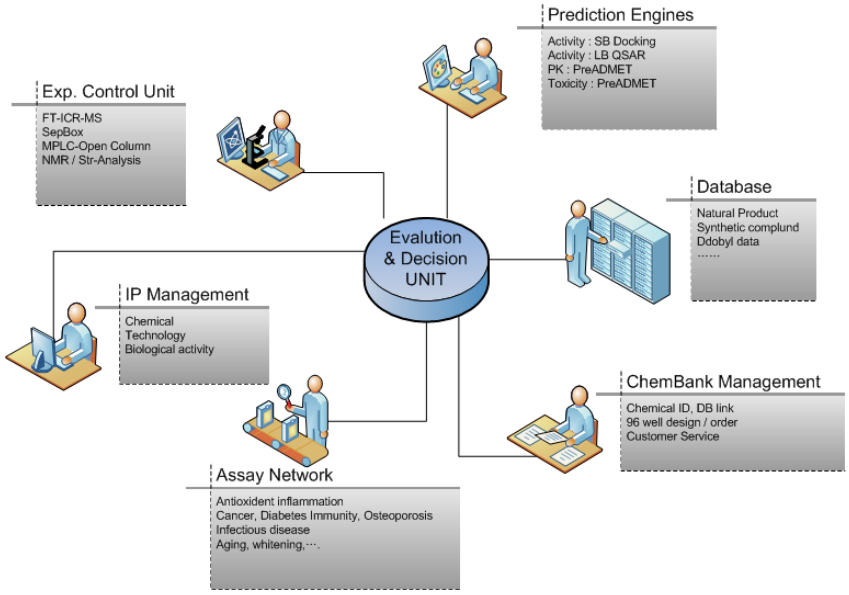
The market of drugs from natural products, functional food, and cosmetics industry glow fast worldwide. From technological point of view, the identification and separation of plant metabolites in short time and with low cost is the most crucial for high competitiveness in natural product research and industry. Since present status of the related technologies lack of high performance of identification and separation, the natural product research at individual molecular level cost lot of money and time.

Since 1997, BMDRC have been working on prediction of biological activity and ADMET of chemicals for drug discovery and collaborated with several drug discovery groups in Korea. BMDRC also working on data base construction of both synthesizes and natural product molecules and developed S/W for the prediction of the toxicity and activity of the chemicals. During last decade for the purpose of fast identification, prediction, and separation of natural product., BMDRC have developing "Flora Genesis system (FG system)" by integrating i) the molecular design technologies that developed by BMDRC, ii) experimental data from collaborators, and iii) recent developed analytical instruments (for example, FT-ICR-Mass spectrometer, LC-SPE-NMR-Mass system)

The following figure shows the structure of the Flora Genesis System.



In the presentation I will briefly introduce the Flora Genesis System described some results of the Flora Genesis application to drug discovery, cosmetic research, systems biology approaches, and oriental medicine.

For the purpose of sharing resources and technologies (analysis and application), BMDRC started to construct international network with African countries, Australia, China, South-East Asian countries. At the same time BMDRC preparing grand national project with Flora Genesia which include 5 national institutes, local governments, companies from pharmaceutical, food, and cosmetic industries, and universities.

3RD BELARUS-KOREA FORUM

"Science. Innovation. Production"

Session:

Energetics

RESEARCH HEAT EXCHANGERS OF THE GAS TURBINE WITH AN EXTERNAL SUPPLY OF HEAT IN THE UTILIZATION SCHEME OF SEWAGE SLUDGE

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Biomass as a low-calorie solid fuel has a number of negative characteristics that hinder its use: low energy density; high humidity, which reduces the calorific value; heterogeneity on the fractional and chemical composition makes it difficult to automate and fuel. Also, due to the use of low-calorie fuel the temperature potential flue gas decreases, which impairs the heat transfer in power plants and increases their cost.

Proven and the most common technology for the construction of a small combined heat and power for local fuels is Steam-power technology at organic coolant with direct fuel combustion in the boiler unit and intermediate coolant (high-temperature oil) to transfer heat from the combustion products to the organic working fluid. The maximum temperature of the organic working fluid in the existing plants, as a rule, does not exceed 250 ... 300 ° C. Given that the temperature potential of the combustion products from the combustion of biomass can be 900 ... 1000 ° C, from a thermodynamic point of view to improve the medium-integrated temperature of the heat supply is useful to consider the application of the superstructure of the gas turbine with an external supply of heat.

Analysis schemes of combined cycle power plants with an external supply of heat in the gas turbine parts showed that the important question of the application of the scheme are heat exchangers. And when you consider that steam power plant heat exchangers on the organic coolant already used modularly as standard equipment, the choice of high-temperature heat exchanger for a gas turbine with an external supply of heat is still problematic because world have the small production and use experience of this heat technologies. Highest demands are placed to heat exchangers such as: oxidation resistance, corrosion resistance at high temperatures, erosion resistance, resistance to thermal stress and so on. A view of the fact that both working fluids in the heat exchanger are gaseous, heat exchanger has large dimensions.

For research as the main structural elements for design high temperature heat exchanger was chosen the loop heat exchanger out of stainless steel pipes. Its advantages are high temperature resistance, high gas tightness, the use of pressurized working environments and ease of fabrication, installation and repair; relatively small size.

Was analyses methods of heat transfer enhancement for reducing the size of the heat exchanger. As a result, it was selected fin fins as the most easy to produce, not to clog the soot particles of flue gases, and having a low aerodynamic drag.

After calculations the high-temperature heat exchanger of smooth pipes heat output is 2,2 MW have heat transfer coefficient k = 69,4 W/(m^2•K) and the area of 250 m^2, the heat exchanger with fin had a heat transfer coefficient k = 113,3 W / (m^2 • K) and the area of 153 m^2, it is possible to reduce its size by about 40 percent.

Numerical analysis showed that for the conditions of treatment facilities of Minsk city water utility plant for waste disposal by combined-cycle scheme can have electrical power of 1,75 MW. At the permissive temperature of heating the air in the two heat exchangers up to 840 °C, the degree of compression in the compressor $\beta = 6$ and excess air coefficient $\alpha = 3$, the efficiency reached of 33,5 percent, which is a good indicator for this type of installation.

DEVELOPMENT OF RENEWABLE ENERGETICS IN THE REPUBLIC OF BELARUS

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The Republic of Belarus does not have sufficient primary energy sources and is heavily dependent on oil and gas imports, mainly from the Russian Federation. Imports of fuel and energy are around 85% of the total consumption of primary energy resources [1].

These factors determine the key principles of the state energy policy: ensuring energy security through improving the fuel and energy mix in parallel with the rational use of energy resources, increased use of local fuels and renewable energy sources (RES) and promotion of energy efficient and environmentally friendly clean technologies in all sectors of the economy [2].

During last 15 years GDP of Belarus increases by 158%, with increasing of Gross Consumption of Fuel and Energy Resources (GCFER) by at about 18%. As a result decreasing of and GDP Energy Intensity by 46% [1] was achieved.

From 2000–2012, the share of RES consumption in gross energy consumption and in the boiler and furnace fuel mix equaled 1.8% and 3.8%, respectively (fig.1).

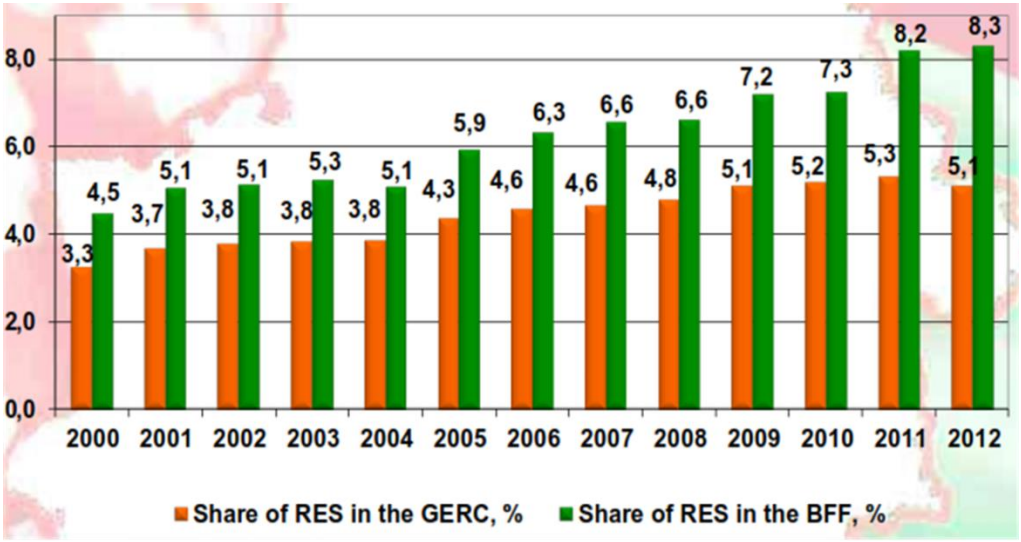

Fig.1. Consumption of RES in gross energy consumption and in the fuel and energy mix for heat and electricity generation [1]

Biomass, biogas, municipal waste, wind and hydro energy are the main RES that are currently economically feasible for use in Belarus. As it can be see from fig.2 main input in renewable energy deployment in Belarus is connected with biomass.

Strategic documents which determine the energy policy of Belarus and the state programmes highlight the importance of RES and local energy sources development for the security of the energy supply. In 2015, due to the increasing use of local fuels and RES, the share of domestic energy resources in the boiler and furnace fuel mix should not be less than 30%, and in 2020 not less than 32%.

The National Programme of Local and Renewable Energy Sources Development for 2011–2015 summarized and specified all programme documents on local fuels and RES use and set forth areas of activities and indicated the specific measures required to achieve the necessary results. The programme will provide for an increase in the use of local energy, including RES, which should reach 7% by 2015 (fig.3).

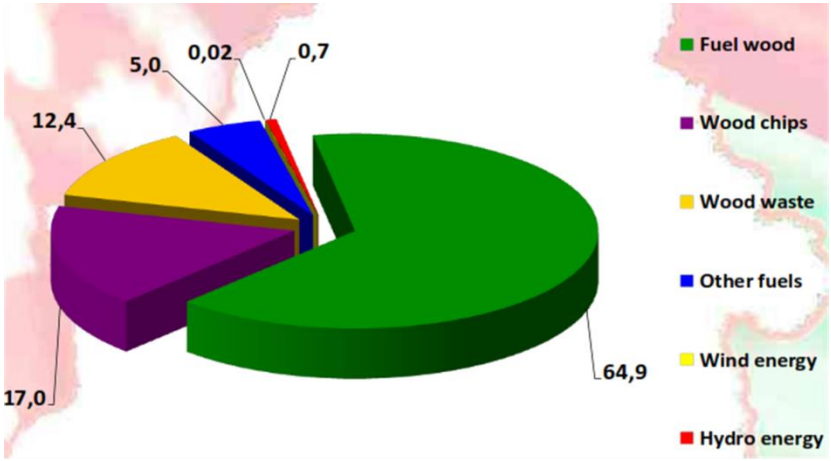

Fig.2. Balance of RES in Belarus, 2012 [1]

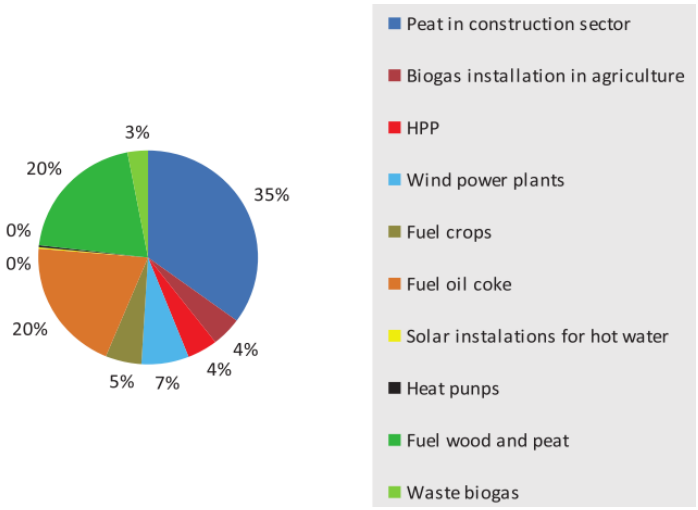

Fig.3: Structure of local fuel and energy sources use, including RES, until 2015 [3]

Belarusian Law on Renewable Energy Sources, dated 27 December 2010, regulates relationships in the sphere of RES use for the generation of electricity, its further consumption and other ways of utilization, as well as the manufacturing of RES-based installations.

- The Law determines the measures of state support for RES;
- Pricing policy aimed at encouraging the use of RES and energy generated from RES;
- Encouragement of investment activities, including providing for favorable conditions for
- national and foreign investors;
- Guaranteed connection to state power grids;
- Tax concessions in accordance with the legislations.

Resolution of the Ministry of Economy of RB on Tariffs for RES Electricity set forth multiplying ratios differentiated by the type of RES (solar energy 2.7, other renewables 1.1 for 10 years. Subsequent 10 years -0.85).

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TRAINING OF SPECIALISTS FOR “GREEN ENERGETICS”

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In accordance with the National program of the development of domestic and renewable energy sources for 2011 – 2015 it was planned to ensure that by 2015 at least 30% (32% by 2020) of the consumption in furnace fuel balance will be constituted by domestic energy resources.

The successful solution to the above mentioned task is associated with the energy security of our country, as well as the main provisions of the Directive №3 "Economy and thrift - the main factors of state economic security," by the President of the Republic of Belarus is largely dependent on the availability of highly qualified specialists in this field.

In Belarus training in the field of energy efficiency and renewable energy is organized at all levels of education:

- in the first stage of higher education: Engineer - energy manager;
- in the second stage of higher education: Master of renewable energy resources;
- specialists of the highest qualification: PhD in "Power installation based on renewable energy";
- retraining in the field of "Renewable Energy. Energy conservation. "

To meet the demands of the economy for specialists in the field of energy efficiency and energy conservation in 1998 curriculum and the standard of the specialty "Energy efficient technologies, energy management" have been developed by Belarusian National Technical University (BNTU) , in 2007 - its new version, currently - a new standard specifically tailored to the 4-year period of training.

According to the State classifier in this specialty were provided the following specializations:

- Energy-efficient technologies in the energy sector;
- Energy-efficient technologies of chemical industry;
- Energy-efficient technologies in industry and housing and communal services;
- Energy-efficient technologies in the agricultural sector;
- Energy-efficient technologies in the forest complex;
- Energy efficiency and energy management in transport;
- Management of renewable energy resources.

Currently, training of the specialists in the field of renewable energy in the Republic of Belarus is carried out by the following universities: BNTU (specialization "Energy efficient technologies in industry and housing and communal services"); Belarusian State Technological University (BSTU) (specialization: "Energy efficient technologies in chemical industry" and "Energy-efficient technologies in housing and communal services"); International Sakharov Environmental University (ISEU) ("Management of renewable energy resources"). Qualification of graduates of the specialty "Energy efficient technologies, energy management" is "Engineer - energy manager."

Disciplines of specialization: "Management of renewable energy resources" includes following: “Bioenergy”; “Wind power”; “Solar and geothermal energy”; “Hydropower”; “Exploitation of renewable energy equipment”; “Management of renewable energy resources”; “Basis of designing of renewable energy equipment”.

To increase the level of knowledge in the field of energy conservation of all university graduates of the Republic of Belarus the subject "Fundamentals of energy efficiency" was introduced to the curriculum, which provides a study in the framework of lectures (16 hrs.), laboratory (practical) classes (16 hrs.) with the following main issues: normative base and policy of the country in the field of energy conservation; application of energy efficient technologies, renewable energy sources; organization of energy efficiency in various sectors of the economy; issues of energy management and auditing.

Training of masters. In 2012, ISEU has developed a program of professional Master's program in "Management of renewable energy resources" (study duration 1.5 - 2 years). Currently, a necessary methodological and technical support for the opening in BNTU this specialization and the professional Master's program are under development.

Training of PhD students. Order of the Higher Attestation Commission of the Republic of Belarus of June 12, 2007 № 111 is approved passport of specialty 05.14.08 "Power plants based on renewable energy". This specialty carried out in the Belarusian State Agro-Technical University (BSATU). In BSATU there is a Specialized council Д 05.31.01 for examination of dissertations in this specialty.

Retraining of specialists. According to the Oder of Ministry of Education of the Republic of Belarus of 09.08.2007 BNTU and ISEU were included in the list of educational institutions for retraining of specialist on energy conservation and renewable energy. For practical realization of this task ISEU developed a training methodical complex in the field of "Renewable Energy. Energy conservation" and organized this work.

Material and technical base. The universities that train specialists of different levels in the field of energy conservation and renewable energy are created the necessary laboratory facilities for the practical training of students and research conducting. In particular, in ISEU was established an educational-research complex "Volma" - the center of renewable energy sources. The teaching and hotel building with classrooms and research laboratories was built in "Volma". Laboratory work is carried out on the real renewable energy equipment (solar photovoltaic panels, solar water collectors, wind turbines, heat pump, micro-hydro power plant, modern wood-fired boilers, biogas equipment) (fig.1).

Fig.1. Renewable energy sources of the Educational-research complex "Volma"

Laboratory for energy conservation have been established also in almost all universities of the country.

Thus, in the Republic of Belarus the necessary methodological support as well as material and technical base have been created, there is qualified teaching staff for the implementation of the training of specialists in the field of renewable energy and energy conservation at all levels of education.

SYNTHESIS OF ZNO FILMS FOR SOLAR SELLS BY SOL-GEL METHOD

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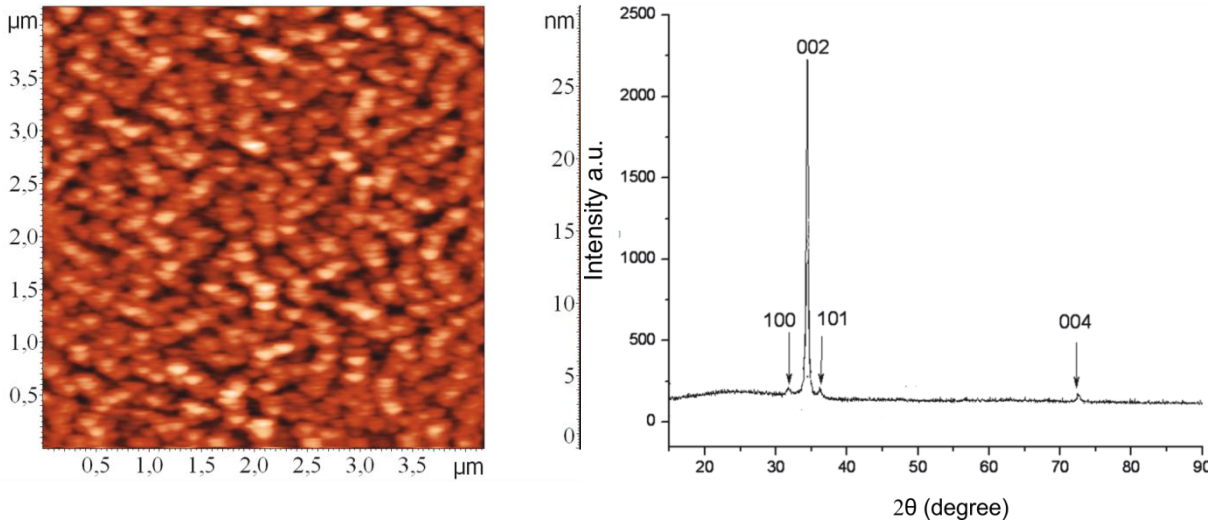
The possibility of functional nanostructured materials for electronic devices synthesis by sol-gel method have been shown. ZnO films were carried out by centrifugation. For manufacturing the precursor (sol), the required amount of zinc acetate filled into absolute isopropyl alcohol (or DMF or 2-methoxyethanol according to the sol type) and stirred. Then sol was stirred for 30 minutes. Sol was kept at the room temperature (22±2) °C for 2-3 days. Monoetalamin was selected as the catalyst because of reducing the exposure time of to two days and ensure their stability during the month. After applying the sol onto the surface of glass, single crystal silicon etc , the samples were placed in the furnace and were heated stepwise at intervals of 20 °C to the temperature of 350 °C for 10 minutes. The process of applying and drying was repeated until the desired thickness of the ZnO layer. AFM and XRD (fig. 1) investigation confirmed the high homogeneity of the films and their suitability for use in solar sells.



a b

Fig. 1 – AFM (a) and XRD spectrum (b) of ZnO:Al sol-gel films

The sol-gel films also can be manufactured with relief film surface for use as holographic concentrator in solar cells. Solar cells using holographic concentrators have such advantages as the lightness and the minimum of thickness. Also the advantage of holographic solar cells is the selection of the light frequencies, leading to high efficiency of photovoltaic cells without overheating ("thermal" part of the spectrum misses photocell). Such type of solar cells do not require turning mechanism. The holographic solar cells compared with solar panels without concentrators require 50-85% less silicon to produce one watt. In this case, the holographic solar sells is much cheaper then large mirrors or lenses.

Organic-inorganic optical layers thicker than 1 mkm with a relief surface were synthesized by sol-gel method on the surface of the glass substrates (Fig. 2). The height of one step is about 5 microns.

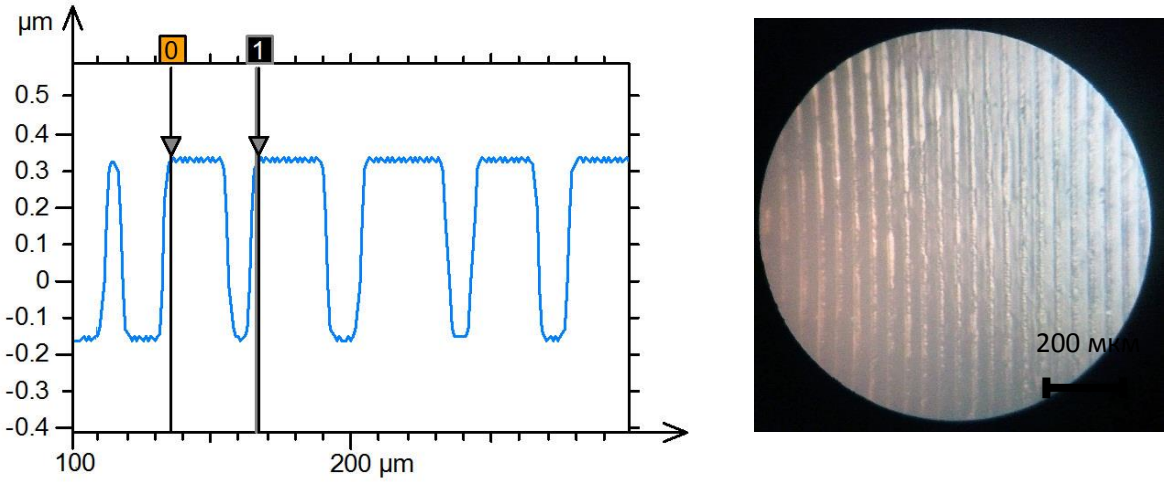


Fig. 2 - The surface topography and the micrograph of the sol-gel film with relief surface

The application of sol-gel method will provide holographic concentrators replacing expensive solar cells by relatively cheap optical systems.

AUTOMATIC VALVE FOR WATER DRAINING

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Automatic valve is designed for installation on units which are cleaning fuel in fuel systems of tractors and cars, fuel tanks and petroleum products storage tanks.

The valve is recommended for implementation in the internal combustion engines and in organizations involved in transportation and storage of petroleum products.

The tasks associated with the timely removal of water from the drainage zone of filter housings, fuel tanks, tanks and reservoirs, are important and topical issue. This is due to the fact that currently in operation the probability of using of watered fuel is very high.

Removal of water from the drainage zone of units of fuel cleaning, fuel tanks and reservoirs is regulated by maintenance operations according to their periodicity.

However, these operations are not always effective, because the periodicity of maintenance service on draining of water is unsubstantiated; in the operating instructions are not included factual geographical and climatic conditions.

Therefore, to ensure the normal functioning of the fuel supply system on watered fuels the water needs to be operatively removed of from the drainage zone of in case of its accumulation.

The automatic valve is designed for the purpose of operational removal of the water from the drainage zone.

Automatic valve consists of a body in which the solenoid valve with a spring and drain connector are fixed. The automatic valve is attached to filter housing by using the connector that is screwed into the drain plug.

The control of solenoid valve is realized by using two electrode sensors, connection wires and a control unit.

The electrical circuit of the control unit of the solenoid valve includes: resistors, transistors, relays, electromagnet reel EM, electrodes toggle Bk and power supply.

Valve eliminates the possibility of water coming into the fuel system when the accumulation of the water to the critical top-level Btl because at this point the valve triggers and the water is drained.

The principle of operation is based on a varying dielectric constant of oil and water. Hydrocarbon fluid is dielectric, and water - conductor. The automatic valve operates as follows. In the initial state, when the water in the settling zone is absent, the coil of the electromagnet EM de-energized, the valve is closed. With the accumulation of water it reaches the lower level Nll, and in this case, an electric circuit "-" – water - R2 - R4 – “+”, so the negative voltage is applied to the base of the transistor and it opens, preparing the switching circuit P. With further accumulation of water, it reaches a critical top-level (Btl), with the formation of an electrical circuit "-" – water – R1 – R3 - «+», and now the transistor V1 is switching on. In this case, the contact of P relay triggers and P1 switches on the coil of the electromagnet, EM-valve opens and the water is drained.

The water level decreases and is below the upper electrode layer (Btl), in which case V1 is turned off, but does not de-energize relay R, as is blocked by contact P2. When the water level fall below the level Nll, the transistor V2 turns off and de-energizes the relay R and EM valve is closed by the spring. Circuit comes in initial state, then the accumulation of the water cycle is repeated.

The use of automatic valve on diesel engines will improve the reliability of the fuel system and reduce the complexity of fuel cleaning units by 30-40%.

Expected annual savings amount to about 150 th. KZT. per a vehicle with a diesel engine.

FARM BIOGAS FACILITY

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In Kazakhstan, according to the statistics are more than 149,830 farms. In addition, in rural areas private courtyards have individual farms, which are collected a large volume of organic animal waste, poultry, plant growing.

Accumulated organic wastes pollute and degrade the environment: create unfavorable views about the economy and in rural areas; spread an unpleasant smell; pollute underground water, which impairs the health of people, as in rural areas using water mostly from the well; generate methane in the atmosphere and thereby enhances the greenhouse effect.

A promising way to dispose of organic waste is biogas technology and installation. Processing and recycling of organic waste in biogas plants at the same time solve the problem of agricultural chemistry, environment and energy, as biogas plants produce biogas energy fuel and high-quality organic fertilizer.

Today in the world are designed and operate a variety of individual, private and industrial biogas plants.

In Kazakhstan there are several biogas plants. On Lugovoy horse farm in Zhambyl region operates industrial biogas facility, and LLP "Hamburg", located in Zhuvaly area, set the German farm biogas facility with a working volume of the reactor 250m³.

Individual farmers and biogas facilities have not received mass application in Kazakhstan. Therefore, at this time, a huge mass of organic waste farms is not processed, they are scattered in the fields. The main reasons are as follows: no domestic biogas facilities and stably functioning farm biogas facilities; from farms do not require the processing of organic waste, so the easiest way to take them to the fields; shortcomings of the existing (German, Russian and other) farm biogas facilities.

Existing farm biogas plants have the following common faults: the reactor volume is large and therefore the high cost; volume of the reactor is often not match the capabilities of the economy; a large energy consumption for mixing and supporting temperature of the organic matter in the reactor; cleaning of the reactor is difficult and requires interruption of the biogas plant; Overall and integrity of design makes it difficult to transport and change its location.

In this regard, in TarSU M.Kh. Dulati since 2008 in the department of "Mechanics and Engineering" conducted research on the development of farm biogas facility. There are obtained 8 innovative patents of RK on biogas facilities, published more than 15 scientific articles, made 4 biogas plants and laboratory experimental studies. Currently, work is underway to introduce farm biogas facility modular design.

Compared with existing analogues innovativeness of the proposed device is as follows: modular design allows you to create a biogas facility with the capacity of farms and gives you the opportunity to increase the working reactor of volume with increasing power farms; ability to operate a biogas facility at the same time in the discrete and continuous modes; low energy consumption for mixing and supporting temperature of the organic matter in the reactor; cleaning of the reactor unit without stopping the biogas facility; simplicity of design, manufacture, installation and operation; possibility of creating a farm biogas facility for remote and mobile farms.

SOL-GEL TECHNOLOGY PREPARATION OF THIN SOLID FILMS FOR DIFFERENT APPLICATIONS

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In present time of development of new products of micro- and nanoelectronics characterized by change from submicron to nanometer dimensions of topological elements. Vacuum film deposition techniques require expensive processing equipment, for which needs highly qualified personnel. In contrast, chemical methods, the sol - gel method, more accessible and implemented on simpler and cheaper equipment. Universality of technology, applied to chemical methods, allows producing coatings of controlled composition at low temperatures.

Coating must have determined properties in order to provide the normal operation of technological materials during their lifetime. Basic requirements for the coatings follows: the coating should be uniform over the surface without defects, stable in the environment, have high hydrophobicity and a density to protect a gains seepage of water and other substances to the surface, to have good adhesion to the surface, the transparency in the visible region spectrum, as well a protective coating should not affect to the surface characteristics and properties of the surface material.

Precursor solutions for sols will be prepared by hydrolyses of organic compound of silica, titanium, boron, aluminium et. al . Sol-gel films were fabricated by means of spin- or dip- or spray-coating on a substrate at room temperature. Then films will be heated at 200^0 – 1200^0C in air or inert gases.

All known coating to protect or planarize or different application have a different limitations, low transparency in the visible spectrum or a high glass transition temperature or low adhesion to the surface, etc. Therefore, development of sol-gel technology fundamentally new hybrid organic-inorganic coatings is very important and actual task.

We are developed new method of protection and planarization inorganic substances: silica glasses, silicon plates and another specific products (Fig.1).

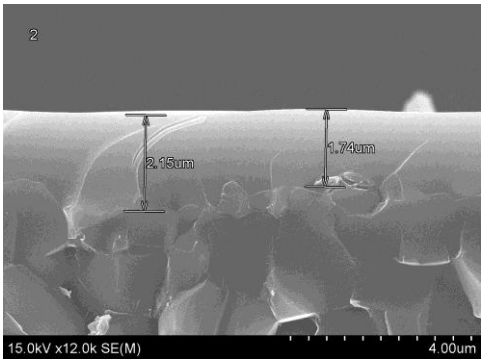

Figure 1. SEM image of ceramic plat with SiO_2 planar films on the surface

The decorative ceramic sol-gel coatings with high hardness (6H), resistant to moisture and heat resistant properties (400 ^{o}C) can be used in the paint industry, production of metal utensils, production of furniture accessories etc. (Fig.2).

As a result we can obtain films on different substrates: glass, silicon, aluminium, steel etc. This technique is resources and energy consuming. The technique of reception of various functional coats developed in our laboratory has are used at the factories of the optical industry (at a factory "Optic" (Lida, Belarus) output is adjusted of lenses with sol-gel decorative coating), electronic industry "Integral" (Minsk, Belarus) (sol-gel dielectric coating materials) and et.al.

Figure 2. Image of the aluminium plates with decorative films base silica dioxide

TO THE QUESTION OF DESIGNING SOLAR SYSTEMS IN RESIDENTIAL BUILDINGS IN THE CLIMATIC CONDITIONS OF BELARUS

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The price increase of non-renewable resources and environmental problems, associated with their use, lead to a change in energy policy in the world. However, with all the urgency of the problem, there are many barriers to widespread implementation of renewable energy sources, including solar systems in residential buildings.

Radiation conditions in Belarus are similar to many Central European countries with well-developed application of solar energy in building construction and solar architecture and in thermal solar systems. In central Europe, the annual amount of direct and diffuse solar energy on a horizontal surface is 1000 ... 1400 kWh / m^2 (in Germany - 1200, Belarus -1100 kWh / m 2), but the climate of Belarus has long periods with a predominance of the diffuse radiation.

Solar collectors are used for heating water. They convert high-frequency solar radiation into thermal energy and thermal energy accumulator, which smooth irregularity of solar energy and irregularity of consumption of heat by heating and hot water system.

Conventionally, modern solar collectors can be divided into solar collectors with high thermal insulation and solar collectors with single glazing. Evacuated tube collectors gained popularity among solar collectors with high insulation. The major component is the "tube", which consists of a glass flask with double glazing and vacuum gap and heat receiving element. Solar collectors with heat receiving element of aluminum alloy have best thermal qualities. There is a U-shaped copper tube circulating heat transfer fluid inside the thermal element. Due to this design there is a direct contact of heat transfer fluid with heat receiving element.

During the analysis of solar collectors some operational features of vacuum tube collectors were taken into account, for example, the real heat receiving surface of evacuated tube collectors is 0.60 ... 0.62 from its geometric surface (fig. 1).

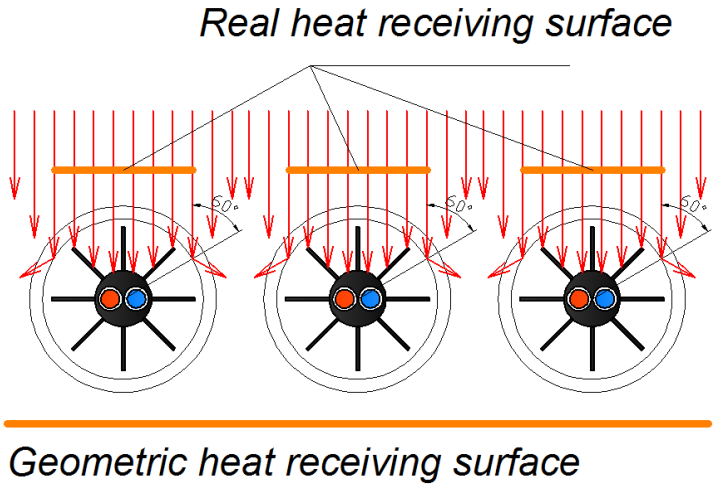

Fig. 1. Evaluation of real heat receiving surface of evacuated tube collectors

For flat-plate collectors, the ratio is 0.9 ... 0.85. Thus, for identical heat receiving geometric surface of tube collectors should be 0.88 / 0.61 = 1.44 times larger. Therefore, when

comparing the cost should also be compared the unit cost per square meter of real surface of the flat and tube collectors.

For climatic and operational conditions of Belarus solar flat-plate collectors with a single translucent coating are more appropriate. They differ in the design of the housing, construction of thermal elements, optical and mechanical characteristics of glazing. Glass usually used in flat solar collectors is ordinary window silicate glass, which withstand the impact of large hail and significant bending loads. This glass can have a special outer surface that eliminates the reflection of sunlight at an incidence angle less than 30 degrees. The highest quality flat-plate solar collectors have a high strength of the housing, including bending, and long-term of its existence, as well as the quality and long-term of the sealant of glazing.

Design capacity of the pump or fan G = const (water flow) is designed, as a rule, on the TDP of solar system at nominal value of intensity of the incident solar radiation in the collector area, W/m^2. In this case, the estimated temperature distribution of while moving L (the length of the collector) heat transfer fluid in the flat-plate collector will be linear. Under the influence of the real intensity (with G = const) the temperature distribution along the direction of while moving L of heat transfer fluid is not linear. In the case of the maximum radiation intensity heat transfer fluid reaches maximum temperature, having only part of the way to the exit of the collector, so to increase the thermal power of collector should increase the water flow (G). At low intensity of radiation heat transfer fluid has a minimum temperature, so to raise the temperature and increase the period of operation of the pump water flow rate should be reduced. These findings were obtained by making a series of experiments. The basic scheme for these experiments of water solar collectors is shown in fig. 2.

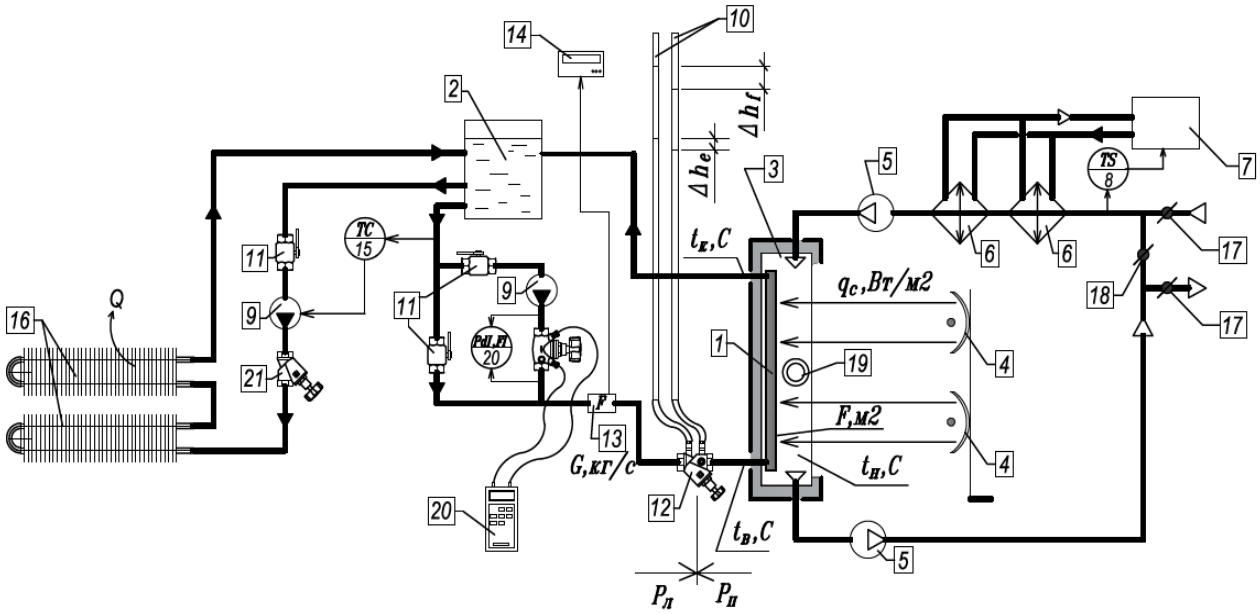

Fig. 2. The scheme of laboratory installation for testing solar collectors
1 – flat-plate solar collector, 2 - storage tank, 3 - thermostatic chamber 4 - halogen lamps, 5 - fans, 6 - air cooler, 7 - refrigerator, 8 - temperature controller in a thermostatic chamber, 9 - circulation pump, 10 - piezometric tube, 11 - ball valve, 12 - balancing valve with measuring nipples, 13 - ultrasonic flow meter, 14 - the electronic block counter of commercial accounting of heat 15 - proportional temperature controller, 16 - water cooler (in the form of two connected convectors), 17 - choke (closed), 18 - choke on bypass (in open position), 19 – pyranometer, 20 - computer to measure differential pressure and flow rate, 21 - balancing valve

FUEL-WATER FILTERS FOR POWER UNITS

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The fuel-water filter (FWF) is designed for installation in the fuel system of power units in order to ensure the purity of the fuels.

It is recommended for implementation in enterprises and organizations operating the vehicles, tractors, fixed installations, as well as construction and agricultural machinery equipped with diesel engines.

Filtrating water separating element has a cylindrical shape and stands along the fuel flow from the inside to the outside of the filter and the coagulation steps.

The filtration step is made of paper BM-120. To increase the filtering surface it is made in the form of corrugated star curtains.

As the coagulating step water separating element consisting of three layers is used: the first two layers of glass fiber materials with a fiber diameter of 1,5-2 and 3-6 microns, arranged in order of increasing the diameter of fibers in the direction of fuel flow, a third layer is polyurethane PPU- EO-130. Filtration and coagulating step are adhered to the covers. The principle of operation of the filter-water separator consists of the following: contaminated fuel enters the element from the inside and moves outward through all partitions. In the filtration stage fuel is cleaned from mechanical impurities, then in the coagulating stage fuel is cleared of water. In the coagulating stage there is an integration of water droplets that linger in the last partition from polyurethane foam.

When the critical pressure drops ejected from this partition and under the action of its own weight, the deposition occurs in a settling zone of the fuel-water filter. This ensures a high degree of purification of fuel from water and mechanical impurities.

Applying a filter-separator significantly improves the quality of cleaning fuel from water and mechanical impurity up to 96-98%, which makes it possible to increase the reliability of power units by 40-60%.

The fuel-water filters are designed for power units in 2014 and passed the performance test at the enterprises of the city and the region.

For the manufacture of thefuel-water filters technical documentation CD No 92-01-154 is available.

Annual production capacity of FWF within 600-800 pieces.

The estimated cost of of FWF is about 500 KZT.

Expected annual savings of up to 100 thousand. KZT to one power unit. The payback period of the filter-separator is 2-3 months.

Organization-developer: M.H.Dulati Taraz State University. Department of "Transport equipment and technologies".

RENEWABLE BIOMASS PRODUCTION ON THE BASE OF INTRODUCTION OF FAST GROWING TREES PLANTATIONS AS A DIRECTION OF GREEN ECONOMY

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Conception of green economy may be used in different branches: industry, agriculture, energy and others. It tightly connected with nature protection because of decreasing of environmental pressure. Environmental benefit may be realized by different way. Introduction of bioenergy enable decreasing of greenhouse gas emission, saving of nature resources as a minimum, but it may also have some not so evidence profit.

The perspective direction of bioenergy is introduction of agroforestry based on short rotation coppice plantations of trees, like willow, poplar and others. Introduction of plantations of fast-growing trees in Belarus provided by National Programme of development local and renewable energy sources for 2011-2015. From economy and ecological point of view special interest has introduction of willow plantations, which require of selection varieties adapted for environmental conditions of country.

For Belarus conditions more interesting is introduction of plantation of willow. The yield of willow biomass crops may achieve 10-15 tons of dried wood or 5-6 toe per hectare. Willow biomass cropping systems simultaneously produce not only power and economic, but also environmental and social benefits. These include reduced SO2 and NOx emission, no extraction of additional CO2 to the atmosphere, reduced soil erosion and pollution from non-point source of agricultural lands, and enhanced agricultural landscape diversity. Willow plants may be successfully grown on different types of lands and also have the potential in reclamation of degraded and polluted soils.

As a result of the Chernobyl disaster the area of radionuclide contaminated agricultural soils in Belarus is about 1.3 million ha, including 0.8 million ha of arable lands. The optimal system of cultivation of this type of soils on contaminated area is a serious problem, because traditional crops such as grass and cereals may accumulate extra radionuclide. Our field study experiments (2007-2010) were conducted at Krichev district of Mogilev region in eastern Belarus, close to the Russian border. This region characterized by high level of Cs-137 contamination as well as high level of heavy metals pollution. The radioactive contamination in the region has been conditioned by precipitating from clouds after the Chernobyl accident. As a result, local cesium “spots” appeared. The level of contamination in the place of our experiment varied from 185 to 370 kBq/m.2 In the first stage of our experiments the concentration of cesium-137 in different parts of willow biomass had been measured and transfer factor calculated. The measuring had been done for leaves, roots and wood. The same experiments fulfilled because of different ways of utilizations these components. The leaves go back to the soil every year, wood is using for energy in every 3 year and roots leave in the soils as far as plantation of willow used. We admitted it for 21 year. To control cesium-137 accumulation in willow biomass we apply different types (nitrogen N, phosphorus P and potassium K) and dose of fertilizer.

The experiments show that potassium mineral fertilizer is the key factor for radionuclide accumulation control. The optimal dose of potassium is 90 kg per hectare. On the base of experimental results the model of cesium-137 accumulation in the wood for a 21 year has been developed. In accordance with calculation to the end of willow cultivation (21 year) concentration of cesium-137 in wood will not be higher than permitted even with the level of cesium-137 contamination in the soil 1480 kBq/m2 (maximum 140 кБк/м2 with permitted level for firewood is 740 Bq/kg.). The concentration of cesium-137 in the roots increases gradually and get maximum in 21 year (3000 кБк/м2).

Our results confirm that in the sum about 0.8 million hectares of radionuclide polluted arable lands partly excluded from agricultural practice in Belarus could be used for willow biomass production.

One more benefit of fast growing willow production is reclamation of post-mining peaty degraded areas. The area of such lands in Belarus is thousands hectares. The problem is absence of adequate technology of willow production for the degraded peaty soils. This type of soils is very heterogenic, poorly drained, with massive structure and poor contents of nutrients. A field study was conducted at Lida region, in western Belarus. The willow clones were planted on peaty soils of post-mining landscape. The degraded peaty soil conditions are not favorable for successful plant cultivation. As the result after completion of peat mining it is impossible to grow any cultural plants for some years. The peaty soils after post-mining activity are very heterogenic. It refers to contents of nutrient, water supplying, and the depth of peaty layer, level of decomposition and so on. Apparently it is necessary to use different method of cultivation for successful growing willow on concrete site.

Our experiments shown, that it is possible to successful cultivation of fast-growing willow on degraded areas. Of course, this approach required the introduction of adequate special adopted technology. The questionable problem is the selection of special forms of willow, more suitable for the degraded post-mining peaty soils. The yield of willow biomass was on 20-30% lower than in mineral soils, but renewable wood production has big environmental benefit.

So, our experiments with willow cultivated in different environmental conditions show, that it is possible to get adequate yield of willow wood on post-mining peat lands, and plants do not accumulate extra quantity of radionuclide 137Cs and some heavy metals. Minimization of environmental impact at the result of willow biomass production may be also realized on the base of erosion and water pollution control and reclamation of contaminated areas. Other issue is economic efficiency. Our experiments let us develop special model to assess the emission of greenhouse gases, cost of willow production in nearest in further perspective, financial benefit at the result biomass using. At the result of calculation the cost of willow wood production from one hectare per year is about 600-800 $. The annual yield of wood consists near 50 ton per hectare. In accordance with metering of calorific value of wood energy equivalent biomass is 4,4 toe or 3850 м3 of natural gas/hectare. The price of gas for Belarus is about 230 $ per 1000 м3. It means that changing of gas for wood may have financial profit as for Belarus so and other countries. Additional profit is utilization of willow wood as a biofuel. It enables to get additionally 3500 – 3700 euro per hectare for all period of plantation existing. It will be possible at the result of saving greenhouse gases in accordance with Kyoto Protocol.

The results of real experiments presented in this publication enable to conclude that fast growing trees production for renewable biomass has multiply environmental so and economic effect. This way totally corresponds to the conception and contents of green economy.

ENERGY RECOVERY FROM NATURAL GAS LETDOWN STATIONS

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Every industrial process creates at least some waste heat or secondary energy sources. A rational solution is to recycle this industrial waste energy in the actual manufacturing process - regenerative usage. Likewise, this waste energy can be used as a secondary energy source, which consists of three main groups: gas overpressure, waste heat and combustible waste.

The main sources of waste heat are technological devices, which are typically energetically inefficient.

One potential secondary energy source is the overpressure that results from lowering natural-gas pressure to meet consumer specifications. In order to be transported through pipelines, natural gas has to have a very high pressure. At this level of pressure, however, it cannot be used by consumers, which means that it has to be forcibly lowered. This creates energy losses. Natural gas pressure is reduced in two steps. First, it is lowered at a gas-regulating station, where the pressure goes from a range of 3,5 – 7,5 MPa to a range of 0,3 – 1,2 MPa. Then, at gas control points, it is reduced to a range of 0,005 – 0,6 MPa. Water steam is treated similarly. Many industrial boilers produce steam with a pressure range of about 1,3 MPa. To make it usable, it needs to be at 0,3 – 0,6 MPa. The pressure has to be reduced through a throttling process.

Secondary energy sources can be recovered by using machines that convert energy streams into a more valuable energy form. Most frequently, the most useful forms are electrical and mechanical energy, due to their widespread use and the need for high exergy value. Low-grade thermal energy does not satisfy modern requirements. Frequently, the secondary energy sources produced by manufacturers significantly exceed their needs for low-temperature heat.

For this purpose, different types of machines can be applied: turbines, piston engines, screw engines, etc. Each year, turbines are getting more popular in small-energy production. This is due to certain advantages, such as the direct transfer of torque to the electric generator, the small number of moving parts, etc.

Turbines with a large capacity (several megawatts) are nowadays applied in industrial systems with large and continuous streams of secondary energy sources. In order to increase the number of possible sources of energy recovery, it is necessary to create low-power machines that can recover small amounts of energy streams with low-potential parameters.

This is made possible by microturbines, which expand the range of objects that allow secondary energy recovery. Existing steam and gas turbines have some disadvantages. It is necessary to improve microturbine designs to make them viable energy recovery machines, while simultaneously increasing the efficiency of the transformations.

The new type of microturbine is developed by the specialists of "Scientific and Technological Park of the BNTU "Polytechnic" is called TurboSphere. It simultaneously combines several units, such as a turbine, a heat exchanger, and a power generator. TurboSphere has only one blade wheel, and its multistage gas-flow expansion is performed by heating gas between stages.

The electrical power of the turbines ranges from 5 kW to 500kW, depending on the characteristics of the energy sources. The TurboSphere is a compact machine, with only one moving part - a blade wheel with a diameter from 300 mm to 700 mm. This blade wheel's rotational velocity can reach 3000 rpm or more. It requires neither a high-velocity electric generator nor a reduction gear. Its dimensions allow for the TurboSphere to be placed indoors or outdoors.

The turbine’s original design and concept allow for earlier implementation of complicated power cycles. Allowing the use of any type of steam or gas as a working fluid, this process creates a wide spectrum of input and output characteristics, including flow rate, pressure, and temperature.

This innovative turbine performs the following tasks:

1 Power generation from waste heat using the Organic Rankine Cycle (ORC);

2 Electricity production from low-potential fuel, such as trash and wood;

3 Recovery of natural gas overpressure at gas stations;

4 Conversion of steam overpressure energy into electricity during steam throttling, minimizing energy loss.

It is possible to integrate the TurboSphere into sources of alternative energy, such as geothermal and solar energy.

The energy market requires small, cheap, and highly efficient micro turbines for the recovery of secondary energy sources. In addition to having these traits, the versatile TurboSphere will be compatible with a wide range of energy sources and their necessary parameters.

WIND POWER INSTALLATION

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At the moment all over the world due to economic and environmental problems has been increased interest in alternative energy sources, in particular, to wind power.

Modern wind energy in many developed countries of the world is part of the energy systems.

Wind energy in Kazakhstan can provide electric energy, capacity 920 billion kW-hr per year. In 2013-2020 years, Kazakhstan has planned to install 13 wind turbines with a total capacity of 793 MW. International exhibition EXPO-2017 is planned to provide electricity through wind power capacity Ereymentau complex.

The main part of the wind power installation is a wind turbine. There are two types of wind turbine: a horizontal rotation axis; with a vertical axis of rotation.

Vane wind turbines include a first group and are currently mainly used in their wind turbines. Power vane wind turbine depends on the length of the impeller. Therefore, for the installation of such wind turbines require high tower. Utilization of wind energy such wind turbines is 0.35-0.45.

Rotary, revolving wind turbines belong to the second group. These wind turbines are low-power, low-speed and large size. Power depends on the area of wind turbine blades. Utilization of wind energy such wind turbines 0.20-0.25.

A common shortcoming of existing wind turbines are low efficiency, large size, the location of a wind turbine required higher off the ground right on the wind currents, exposure to atmospheric agents (rain, snow, frost, heat), the variable speed of the wind wheel.

In this regard, in Taraz State University M.Kh. Dulati the department "Mechanics and Engineering" developed wind power installation for peasant and individual farms with max load capacity of up to 5 kW. It consists of two parts: the convergent-airway system; wind turbine installed on the ground indoors.

Wind turbine installation has a multi-blade wind wheel, most of the blades which simultaneously interact with the flow of the wind, while the existing blade wind wheels blades operate sequentially. Parallel running rotor blade of a wind turbine is reduced dimensions and increases the use of wind power coefficient.

Convergent-airway system picks up the flow of wind, adjusts the speed of the wind (increases, decreases) and submits to the wind turbine.

Wind turbines can be used for the production of electrical energy and wind turbine to drive a variety of working machines, such as pumps, hay and grain crusher, mixer and other machines.

Wind turbine does not require a high-rise tower for mounting and has a simple structure. The proposed wind power installation allows remote management self-powered.

Currently, work is underway to create a prototype of a wind power installation.

On the results of research obtained by two innovative patents, published 6 scientific articles, laboratory made the installation of the convergent wind power installation and experimental studies.

CURRENT STATE AND PROSPECTS OF THE USE OF WOOD FUEL IN BELARUS

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The Republic of Belarus consumes energy, on average a year, in the equivalent to 40 million tons of conventional fuel, and is provided with its own resources only for 15% (including: oil – 40%, wood fuel – 28%, peat – 16%, combustible gas – 6%, windpower and hydropower – 0,2%, other types of fuel – 9,8%). About 8,5 billion US dollars are spent for the purchase of missing energy carriers and the electric power in a year that is about 20% of import volume of the Republic and makes its economy dependent on external factors.

In structure of consumption of fuel and energy resources the share of one energy resource is great – namely natural gas (57,2% in fuel energy balance, 80% in the balance of boiler and furnace fuel and 97,2% in the fuel balance of power supply system) which is generally imported from Russia. In this regard the problem of diversification of the consumed energy resources and their suppliers becomes very actual for ensuring the energy security of the country. In the country the package of measures aimed at increasing the use of local types of fuel is constantly realized which also includes fossils and renewable energy mined in the territory of the Republic. Thanks to the measures taken, the share of own energy resources has increased from 16,8% to 26,4% in the balance of boiler and furnace fuel (BFF) during the last 8 years. Thus the share of renewable energy accounted for 8,3%. Wood fuel dominates in the structure of the used RES. This direction of the use of RES is less capital-intensive and more profitable now. However, Belarus doesn't stop on the reached results. So, the government of Belarus has set up the task to bring the share of local types of fuel in the balance of boiler and furnace fuel to 30% by 2015. In the achievement of these goals, the significant role is assigned to the use of low-quality wood and wood wastes for power purposes.

The forest fund of Belarus is about 45,4% of its territory or 9,43 million hectares. Percentage of forest land of the Republic of Belarus is 39,3% for 1.01.2014 and is the highest for the last 100 years. The general stock of plantings – 1,7 billion m3, including 81,3% for possible operation. According to official statistics, the share of forest complex in gross domestic product (GDP) is 4,2–4,5%. About 110 thousand people are involved in it (3,0% of the volume of employment in the national economy). Each inhabitant of Belarus takes about 0,98 hectares of the woods and 180 m3 of a wood stock that is almost twice higher than the level in Central Europe.

Yearly average, the gain of all forest stands in the Republic is 31,9 million m3. The preparation of wood in Belarus is 13,5-15,5 million m3 in recent years, including on the main consumption – 5-6,5 million m3, on intermediate consumption – 5,5 million m3, other cabins – 3-4,8 million m3. The volume of preparation of firewood is 5,6-5,7 million m3 in recent years. Thus the considerable part (about 3,6 million m3) of the prepared firewood is released to the population, budgetary organizations. Other 2 million m3 of firewood are used by boiler houses of communal services and by mini-combined heat and power plants for the production of thermal and electric energy. The average annual volume of preparation of wood fuel resources in the woods of the Republic of Belarus is 13,6 million m3. An average annual consumption by the population and the organizations as boiler and furnace fuel and for technological needs is about 8,2 million m3.

At this time, the industries based on production of chip are created in 50 state forestry organizations with a total power about 1250 thousand sq. of m3 a year. Thus, they have made 952 thousand sq. of m3 of chip in 2013. Besides, certain capacities for the production of fuel chip have been created at private enterprises. The average price of the fuel chip realized in the Republic is about 27 dollars of the USA / dense m3, and by delivery for export – 30 dollars of the USA / dense m3. The production of wood pellets and briquettes are engaged more than in

30 organizations of the republic. Total power of the operating productions is about 145 thousand tons per year. At the Belarusian State Technological University (BSTU) the complex of technologies and a number of domestic cars was developed for the preparation of the increasing volumes of wood and productionof fuel chip. The family of wheel logging cars for cabins of the main and intermediate consumption was created together with RUP "Minsk Tractor Plant", among which are harvesters, forwarders, hook-on carts with manipulators, various skidders, and also chippers. The release of similar cars was also mastered by JSC "Amkodor". The distinctive feature of these cars is a wide use of import knots and processing equipment. With RUP "Minsk Automobile Plant" the lorry for transportation of chip was created, with the load of the flight about 80 bulk m3, and the dumper with removable containers with the load of the flight about 35-40 bulk m3.

The existence of domestic logging equipment with the foreign cars which are widely presented in the country, allows to realize a number of technological processes of logging with production of fuel chip in the conditions of cutting area, intermediate and interseasonal warehouses. However, the gained national experience shows that the technological process of production and shiping of the fuel chip to the consumer, developed in BSTU with the use of intermediate warehouse, has the greatest prevalence in natural working conditions of the country.

At this time, in the Republic of Belarus more than 3000 coppers with power from 0,012 to 20 MW work at wood fuel. Besides, 12 mini-combined heat and power plants work in the combined cycle of generating thermal and electric energy. In our republic we use local boilers (JSC "Belkotlomash", SOOO "Komkont", etc.), and import boilers. The construction of mini-combined heat and power plant was generally carried out with the use of boilers from "Biysk boiler plant", primary furnace of JSC "AXIS Industries" and steam-turbine installations of JSC "Energotekh" (Russia). Besides, at the number of mini-combined heat and power plants technologies of the Finnish company "Wartsila" and the Austrian company "Polytechnik" were used. A number of projects is realized with use of ORC modules and thermooil coppers. The prime cost of the generated electric power is 20% cheaper than at the development of the electricity from natural gas.

Over the last 10 years the competitiveness of wood fuel has been constantly changing. So, for example, the cost of firewood increased by 3,3 times for the analyzed time period, of sawdust – by 32 times, of fuel chip – by 3,5 times, of wood pellets and briquettes – by 2,2 times. At present time, in the Republic of Belarus firewood and fuel chip are competitive in comparison with fossil types of fuel. So, the cost of fuel chip is lower than the cost of natural gas for 31% in conditional expression.

For now, in the Republic of Belarus the new system of ensuring the power objects with wood fuel demanding resource and financial security is created. Domestic cars, equipment and technologies are developed, the most expedient forms of production organisation are chosen. Today all efforts are aimed at decreasing the cost of production of wood fuel and at increasing its competitiveness in relation to fossil types of fuel by the formation of the most effective systems of cars, optimization of an arrangement of warehouses and the solution of problems of logistics of delivery of fuel. The Belarusian experience shows that the realization of policy based on the increasing of use of wood fuel not only increases the energy security of the country, promotes import substitution, but also creates the considerable quantity of modern, high-efficiency workplaces, and allows to intensify the economy of regions, thereby increasing its competitiveness.

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WIFI-BASED TECHNIQUE FOR INDOOR POSITIONING

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GPS and GLONASS are widely used in all areas of human activity. However, they have a drawback – the inability of positioning inside buildings.

Problem of finding placement in unknown building is one of the possible problems, which can be solved by indoor positioning. This problem is very actual for large shopping centers and airports. If the visitor needs to find a specific room in the building, frequently he has to be guided by a wall map. If the wall card is not present, than human-guide only can help. Electronic program-guide can help to solve this problem with displaying the current location and the shortest path.

This paper proposes a method of positioning an object based on WiFi within the university. The main advantage of the proposed method is working on the basis of an existing WiFi-network.

Figure 1 shows a situation when a device (Z) receives signals from the three access points: W1, W2 and W3. The device has coordinates (X0, Y0), the access point, respectively: (X1, Y1), (X2, Y2) and (X3, Y3). Distances from Z to each access point, respectively: L1, L2 and L3. A weighted centroid algorithm [1] can solve the problem geometrically. However, the positioning accuracy is not good enough when using this solution.

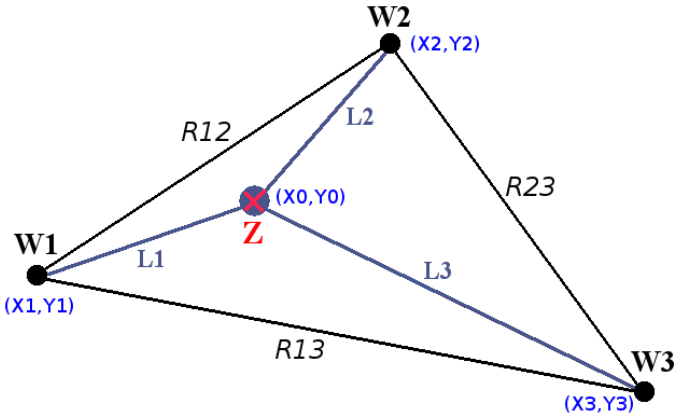

Fig.1. Positioning by three access points

The main provisions of local positioning method are divided into two stages. Preliminary stage is a training phase. After all, you must have a reference set of points with known coordinates for the calculation. It is necessary to obtain reference coordinates for each room. The important thing is that all the rooms were made in the same coordinate system.

It is necessary to obtain reference values of signals WiFi-points for each room during the preparation of the reference coordinates. Also, it must not be forgotten to drop unstable and low-level signals.

Further, it remains only to save information about the room in the database. This info must contain information about five most powerful signals for this concrete room. The number of stored access points may vary depending on the type of room. For example, a classroom can have a lot of visible access points. In this case, the filter must be strict. Gym usually have few access points. So you need to keep all the points in database for accurate positioning.

The main phase of the positioning process is described below.

1) The device eliminates the signal levels to identify the reference points.

2) Points with a low signal level is discarded. Next is verify how many access points have sufficient signal strength. This step is performed 3-5 times in a short time. The results, which are quite different from the others discarded as well. The remaining coordinates are averaged.

3) Coordinates are sent to the server according to the schedule of classes. The data is sent every 15 minutes during class. During the breaks – every 2-3 minutes. Dynamic time intervals are also supported by the system.

4) The server processes the data and determines the position of the object, with single room accuracy. Statistics are kept on the server for later use.

The weak point of the method is necessity to retrain the system in case of equipment reconfiguration. For example, a change in the type or location of access points, adding new points with a high level signal, and the like. Thus, correction information is required after each reconfiguration. In some cases this may be equivalent to the initial training of system. Solution to this problem was proposed in [2]. Author recommends to use system users for its training. Another solution is a so-called dynamic reference. In that case, the stationary device is added to each room. Further, the device sends to the server level of visible points of this particular room in real time.

The experiment was conducted at the Department of "Information Technology" at Pavel Sukhoi State Technical University of Gomel. Five access points have been installed. From 8.00 to 12.00 were carried out 33 measurements. Each measurement was sent to the web server. The resulting graph of time-position dependency can be seen in Figure 2.

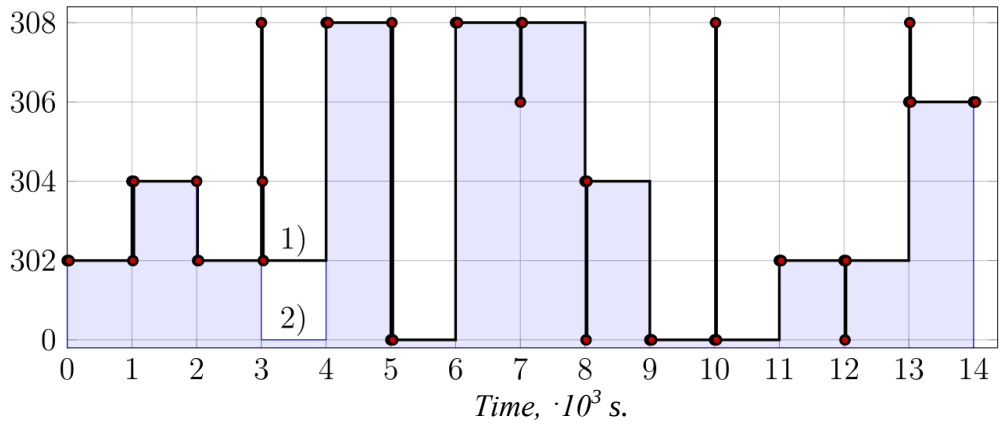

Fig.2. Time-position dependency: 1) Calculated position; 2) Actual Position

Y-axis in Figure 2 is the room in which is currently located positioned device. Code 0 corresponds to the corridor and other rooms, which are unknown. As can be seen, several consecutive measurements can significantly improve picture. At the beginning of the experiment, all three measurements coincide. Measurements on seconds 1000, 1015 and 1030 have the meanings respectively: 304, 302, 304. However, since the two measurements are the same, then the room is accepted value 304.

In this paper we propose a method of indoor positioning based on existing WiFi-network. Applying of this technique allows you to quickly obtain information on the status of a student or a teacher in high school (using the server software that collects statistics), as well as to automated accounting attendance for module-rating system.

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INNOVATIVE TEXTBOOK "HISTORY OF MATERIAL CULTURE AND DESIGN"

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The teaching aid «History of material culture and design» combines consistency of a special training course and quality of scientific research. Despite the fact there are a lot of publications for history of design in Russian schools, there appeared a strong necessity to create a teaching aid for Kazakhstan universities. This is a reason for modernity and design-educational practicality of this book, which explains theoretical and practical problems of the material culture and design history.

Different methods were used to create this teaching aid: historism approach, analytico-synthetic approach on the basis of historism approach; problem-logical method that enabled to distinguish main conceptual ideas in the history of material culture and design; typologic system approach that enables to show specific peculiarities of design development in a certain period; method of comparative analysis that helped to make certain conclusions in the specific nature of Eurasian field of Kazakhstan ethnic design.

The teaching aid consists of introduction, eight chapters, list of references and appendices.

The introduction considers categorial analysis of the concept «material culture», design as a component of culture, different approaches to the design history.

The following issues are stated in natural sequence: material culture of pre-industrial civilizations: ancient Egypt; antiquity; medieval Europe and Eastern countries (Middle East, China and Japan); development of science and technology during Renaissance and Modern Age; material culture of Russia in 10–18 centuries; initiation of design – new cross functional art profession: industrial revolution in the 19th century; industrial exhibitions in the 19th century and their impact on the design development; first theories of design: John Ruskin, Gottfried Semper , Franz Reuleaux, William Morris; modern; functionalism; The Deutscher Werkbund (German Association of Craftsmen); Holland group De Stijl; architectural and artistic creation in Soviet Russia: constructionism, production art.

The range of knowledge includes the following: first design schools: Bauhaus, Vkhutemas and Vkhutein, their contribution to theory and practice of the world design; development of design in the 20th century: design of the industrial society; design of the post-industrial society: post-modernism; Memphis group; New Design in Europe; style direction of high-tech solutions – minimal art, metabolism, high-tech, futurism, Deconstruction. The modern design of the 20th and 21st centuries is under focus.

The chapter «Issues of ethnic design in Kazakhstan», which analyses the main art and cultural traditions of Kazakhstan, architectonical epigraphy, decorative design, design of jewelries, symbolism of Kazakh traditional clothes in modern dress, has a ethnocultural practicality.

In the context of architecture and design the teaching aid is valuable due to availability of the chapter «Interior and decoration»: in architecture of Ancient Greece, Rome, Middle Ages, Middle East, China and Japanese, Renaissance, Art Nouveau, etc.

The most significant fact for the teacher is the study aid for research and instructional methodology: quizzes, tasks for students' self-guided creative work for each chapter of the teaching aid, list of further reading.

Academic value contains in the appendix, which offers topics for abstracts, dictionary of terms, tests, text tables, pictures.

This general in contents teaching aid «History of material culture and design» is recommended for students, graduate students and teachers in the sphere of design education.

ON CLASSIFICATION OF DEGENERATE SINGULAR POINTS OF RICCI FLOWS

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We consider the normalized Ricci flow on generalized Wallach spaces that could be reduced to a system of nonlinear ODEs. As a main result we get the classification of degenerate singular points of the system under consideration in the important partial case $a_i = a_j$, $i, j \in \{1,2,3\}$, $i \neq j$. *In general the problem can also be considered as two-parametric bifurcations of solutions of abstract dynamical systems. Thus the problem under investigation is interesting not only in geometrical sense.*

Key words: Riemannian invariant metric, Einstein metric, generalized Wallach space, Ricci flow, dynamical system, system of nonlinear ordinary differential equations, singular point, degenerate singular point, parametric bifurcations

In the present work we continue investigations started in [1-7]. Consider the autonomous system of nonlinear ODEs obtained in [6]:

$$\frac{dx_1}{dt} = f(x_1,x_2,x_3),\ \frac{dx_2}{dt} = g(x_1,x_2,x_3),\ \frac{dx_3}{dt} = h(x_1,x_2,x_3),\ x_i = x_i(t) > 0, \qquad (1)$$

where $f(x_1,x_2,x_3) = -1 - a_1 x_1\left(\frac{x_1}{x_2x_3} - \frac{x_2}{x_1x_3} - \frac{x_3}{x_1x_2}\right) + x_1 B,$

$$g(x_1,x_2,x_3) = -1 - a_2 x_2\left(\frac{x_2}{x_1x_3} - \frac{x_3}{x_1x_2} - \frac{x_1}{x_2x_3}\right) + x_2 B,$$

$$h(x_1,x_2,x_3) = -1 - a_3 x_3\left(\frac{x_3}{x_1x_2} - \frac{x_1}{x_2x_3} - \frac{x_2}{x_1x_3}\right) + x_3 B,$$

$$B := \left(\frac{1}{a_1x_1} + \frac{1}{a_2x_2} + \frac{1}{a_3x_3} - \frac{x_1}{x_2x_3} - \frac{x_2}{x_1x_3} - \frac{x_3}{x_1x_2}\right)\left(\frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3}\right)^{-1},\ a_i \in (0,1/2],$$

$i = 1,2,3$

Recall that system (1) arises at investigations of Ricci flows ([8], [9]) on generalized Wallach spaces (see details in [3-5]). As it was proved in [6], system (1) could be equivalently reduced to a system of two differential equations of the type

$$\frac{dx_1}{dt} = \tilde{f}(x_1,x_2),\ \frac{dx_2}{dt} = \tilde{g}(x_1,x_2), \qquad (2)$$

where $\tilde{f}(x_1,x_2) = f(x_1,x_2,\varphi(x_1,x_2))$, $\tilde{g}(x_1,x_2) = g(x_1,x_2,\varphi(x_1,x_2))$, $\varphi(x_1,x_2) = x_1^{-\frac{a_3}{a_1}} x_2^{-\frac{a_3}{a_2}}$.

In Theorems 1-3 of [2] we investigated the case $a_1 = a_2 = b$, $a_3 = c$, important from a geometrical point of view, where $b,c \in (0,1/2]$, and determined all possible values of the

parameters b and c ensuring the system (2) degenerate singular points with $x_1 = x_2$ (see [1] for detail). Denote $D := 1-4(1-2c)(b+c)$. In the present work these investigations are continued. More precisely, we offer a qualitative classification of such singular points. Our main results are contained in Theorems 1-3 (see [6,7]).

Theorem 1. Let $D = 0$. Then for the singular point $(x_1^0, x_2^0) = (2(b+c)q, 2(b+c)q)$ of the system (2) only the following types of singularities are possible:

(a) (x_1^0, x_2^0) is a semi-hyperbolic saddle-node only for $b \in [b_2, 1/4)$, $c = c_1$ or $b \in [b_2, 1/4) \cup (1/4, 1/2]$, $c = c_2$;

(b) (x_1^0, x_2^0) is a linear zero saddle only at $b = 1/4$, $c = 1/4$;

(c) There are no values of b, c such that (x_1^0, x_2^0) could be a nilpotent singular point.

Theorem 2. Let $0 < D < 1$, $\mu = 1 - \sqrt{D}$. Then for the singular point (7) of the system (2) only the following types of singularities are possible:

(a) (x_1^0, x_2^0) is a semi-hyperbolic saddle only at $b \in (0, 1/4)$, $c = c_3$;

(b) There are no values of b, c such that (x_1^0, x_2^0) could be nilpotent or linearly zero singular point.

Theorem 3. Let $D > 0$, $\mu = 1 + \sqrt{D}$. Then for the singular point (7) of the system (2) only the following types of singularities are possible:

(a) (x_1^0, x_2^0) is a semi-hyperbolic saddle only at $b \in (1/4, b_3]$, $c = c_3$;

(b) There are no values of b, c such that (x_1^0, x_2^0) could be nilpotent or linearly zero singular point.

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MODELING BENDING TWO-LAYERED AXYSYMMMETRICAL SHELL FINITE ELEMENT

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Currently, more and more applications are multi-layer elements [1]. Consider the stress-strain state of a two-layer rigidly clamped conical shell, zero (internal) layer which is reinforced with fibers of constant cross-section in the meridional direction, the first in the district. The solution to this problem will be sought by the method of finite elements.

As we consider the deflection of the required quantity of a conical shell w = w(s), which we use to simulate the axisymmetric finite element with two nodes with three degrees of freedom in each $\{g_0\}^T = \{u\ w\ \beta\}$, где $\{g_0\}$ – vector of nodal degrees of freedom finite element; β – angle in the radial direction..

Use the principle of virtual displacements [2], which in the case of a two-layer conical shell can be rewritten in the form (1),

$$\left\{\bar{g}\right\}^T\{R\} = \int_{s_i}^{s_{i+1}}\int_0^{2\pi}\int_{-\frac{h_0}{2}}^{\frac{h_0}{2}}\left\{\bar{\varepsilon}^0\right\}^T\{\sigma^0\}dzd\varphi ds + \int_{s_i}^{s_{i+1}}\int_0^{2\pi}\int_{\frac{h_0}{2}}^{\frac{h_0}{2}+h_1}\left\{\bar{\varepsilon}^1\right\}^T\{\sigma^1\}dzd\varphi ds, \quad (1)$$

where the number in the index indicates the number of the shell layer, 0 corresponds to the inner layer,

$\{g\}^T = \{u_i \quad w_i \quad \beta_i \quad u_{i+1} \quad w_{i+1} \quad \beta_{i+1}\}$ – displacement vector;

$\{R\}^T = \{R_{si} \quad R_{\varphi i} \quad M_{\beta i} \quad R_{si+1} \quad R_{\varphi i+1} \quad M_{\beta i+1}\}$ – force vector;

$\{\varepsilon\}^T = \{\varepsilon_s \quad \varepsilon_\varphi \quad \kappa_s \quad \kappa_\varphi\}$ – strain vector;

$\{\sigma\}^T = \{\sigma_s \quad \sigma_\varphi \quad \chi_s \quad \chi_\varphi\}$ – stress vector;

s_i – coordinate of the i-th node; bar over a variable indicates the variation characteristic.

To approximate the displacement we use the following shape functions:

$$u(s) = a_1 + a_2 s;\ w(s) = a_3 + a_4 s + a_5 s^2 + a_6 s^3.$$

Hooke's law [3] in the case of structurally inhomogeneous anisotropic displacement in the meridional and circumferential direction of the shell layers takes the form (respectively)

$$\{\sigma^0\} = \begin{Bmatrix} B_{11} & B_{12} & 0 & 0 \\ B_{12} & B_{22} & 0 & 0 \\ 0 & 0 & -zD_{11} & 0 \\ 0 & 0 & 0 & -zD_{22} \end{Bmatrix}\{\varepsilon^0\};\ \{\sigma^1\} = \begin{Bmatrix} B_{22} & B_{12} & 0 & 0 \\ B_{12} & B_{11} & 0 & 0 \\ 0 & 0 & -zD_{22} & 0 \\ 0 & 0 & 0 & -zD_{11} \end{Bmatrix}\{\varepsilon^1\} \quad (2)$$

$$B_{11} = \frac{(1-\omega_z)E_c}{1-\nu_c^2} + \omega_z E_{11};\ B_{22} = \frac{(1-\omega_z)E_c}{1-\nu_c^2} + \omega_z E_{22};\ B_{12} = \frac{(1-\omega_z)E_c}{1-\nu_c^2}\nu_c + \omega_z E_{12};$$

$$\|D_{11}\| = \|Q_{11}\|^{-1};\ \|D_{22}\| = \|Q_{22}\|^{-1};$$

$$Q_{11} = \frac{2(1-\omega_z)(1+\nu_c)}{E_c} + \omega_z \Gamma_{11};\ Q_{22} = \frac{2(1-\omega_z)(1+\nu_c)}{E_c} + \omega_z \Gamma_{22};$$

where B, D, Q – effective tangential and transverse shear stiffness and compliance reinforced layer.

Physical components (2) are defined by:

$$E_{11} = \omega E_a + (1-\omega)E_c + \frac{E_c E_a (\omega\nu_a + (1-\omega)\nu_c)^2}{\omega(1-\nu_a^2)E_c + (1-\omega)(1-\nu_c^2)E_a};$$

$$E_{12} = \frac{E_c E_a (\omega\nu_a + (1-\omega)\nu_c)}{\omega(1-\nu_a^2)E_c + (1-\omega)(1-\nu_c^2)E_a};\ E_{22} = \frac{E_c E_a}{\omega(1-\nu_a^2)E_c + (1-\omega)(1-\nu_c^2)E_a}; \quad (3)$$

$$\Gamma_{11} = \frac{2(1+\nu_c)(1+\nu_a)}{\omega(1+\nu_c)E_a + (1-\omega)(1+\nu_a)E_c};\ \Gamma_{22} = 2\frac{\omega(1+\nu_a)E_c + (1-\omega)(1+\nu_c)E_a}{E_a E_c};$$

where E_a, E_c, ν_a, ν_c – Young's modulus and Poisson's ratio of the reinforcing fibers and the binder. Structural reinforcement parameters - the intensity of the reinforcement in the layer plane (ω) and adjustment layer (ω_z): $\omega = \frac{d}{l}; \omega_z = \frac{\delta}{h}$; where δ, d – dimensions of the reinforcing fibers in height and width; h, l – element size in height and width. Layers of fiber-reinforced shell of constant cross section. Vector of nodal forces {R}, containing the load acting on the shell element

$$\{R\} = \int_0^{2\pi} \int_{s_i}^{s_{i+1}} \{u\}\{p\} ds d\varphi, \qquad \{p\} = \begin{Bmatrix} p_s \\ p_n \\ 0 \end{Bmatrix}, \quad (4)$$

where p_s provides a distributed load in the direction of the coordinate line s, p_n – distributed load perpendicular to the median plane of the shell.

After making the necessary changes is easy to compute $\{R\} = [k]\{g\}$, where κ – stiffness matrix:

$$[k] = \int_{-\frac{h_0}{2}}^{\frac{h_0}{2}} \int_0^{2\pi} \int_{s_i}^{s_{s+1}} \left(\varepsilon_s^0\sigma_s^0 + \varepsilon_\varphi^0\sigma_\varphi^0 + \kappa_s^0\chi_s^0 + \kappa_\varphi^0\chi_\varphi^0\right) dz ds d\varphi + \int_{\frac{h_0}{2}}^{\frac{h_0}{2}+h_1} \int_0^{2\pi} \int_{s_i}^{s_{s+1}} \left(\varepsilon_s^1\sigma_s^1 + \varepsilon_\varphi^1\sigma_\varphi^1 + \kappa_s^1\chi_s^1 + \kappa_\varphi^1\chi_\varphi^1\right) dz ds d\varphi. \quad (5)$$

After determining the displacement components may be calculated strain and stress tensors.

Cone discretized ten and thirty axisymmetric finite elements. The decision by the proposed algorithm was compared with the solution of [3]. The maximum error of solutions did not exceed 9,3 % when the number of elements equal to 10 and 5,4 % when the number of finite elements equal 30.

The advantage of the proposed mathematical model and methods of its use is the use of axisymmetric finite elements allowing for the investigated sample sheath apply fewer nodes than when using other types of elements.

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MODELING OF THERMAL TRANSPORT IN ELECTRONIC NANO-DEVICES USING METHODS OF MOLECULAR DYNAMICS

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1. INTRODUCTION

Numerical modeling of technological processes and devices has become an important economical factor in microelectronics. Now, a very important transition to nano-scaled elements in semiconductor microelectronics is in progress. Extremely high current densities and a high device package density result in a significant heating of separate devices and of the whole integrated circuits. Therefore the problem of the heat management in integrated circuits becomes one of the major challenges for nano-scaled electronics. Conventional methods of the simulation of the thermal transport based on the Fourier equation are insufficient for the description of the thermal transport in device structures that contain small nano-metric features. The reason for this is that the main heat transport mechanism in semiconductors and insulators is the phonon assisted heat transport, and the mean free path of the phonons has a wide spectrum ranging from about 10 nm to millimeters. Therefore for small device features and also for small hot spots that are comparable in size with the mean free path of the phonons participating in thermal transport deviations from the conventional diffusion-like thermal transport is expected.

Here the method of molecular dynamics will be applied for the simulation of the thermal effects typical for nano-scaled electronic devices. The advantage of the method is in its universal applicability. We do not need to know in advance the properties of certain phonon modes. The phonons appear in the simulations in a natural way and all reflections and scattering effects are accounted for without any special measures. It should be mentioned that in the method of molecular dynamics we have to define the atomic structure of the whole simulation sample, and we have to know the interatomic potentials for the materials considered. The interatomic potentials in silicon are well known. There are also models of the interatomic potentials published for silicon dioxide.

There are three principal techniques used to evaluate the thermal conductivity via molecular dynamic simulations [1] (i) the equilibrium approach based on the Green-Kubo method (ii) heat source and sink, also called direct method, non-equilibrium molecular dynamics (NEMD) based on the creation of temperature gradient, (iii) and the homogeneous NEMD, where a heat flux is induced, however, without a temperature gradient thus allowing to use periodic boundary conditions in a similar manner as in the equilibrium approach.

In this paper the direct NEMD method was applied, where a heat flux is induced and the resulting temperature gradient was measured. Specifically, we applied the open-source program LAMMPS [2]. This program allows a parallel computing on several CPUs using the Message Passing Interface paradigm of computing distribution.

2. RESULTS AND DISCUSSION

Let us consider a model sample of a silicon crystal in the form of a rectangular parallelepiped. The parallelepiped is elongated in the direction x, along which an artificially formed thermal gradient will be established. In the area near the right end of parallelepiped an incoming heat flux will be generated (by means of increasing particle velocity in accordance with a desired quantity of flow). Similarly, at the left end the heat sink will be formed. The system is first allowed to reach a steady state at given temperature (300 K). Then, after a relatively long simulations with fixed heat flow a temperature gradient will be formed in the sample. As a result, we can estimate the thermal conductivity based on the Fourier law. The results obtained for the temperature of 300 K, and various combinations of the sample size and boundary conditions are shown in table 1.

Table 1. The calculated values of the thermal conductivity

Potential	Sample size, the number of unit cells	Boundary conditions on *x,y,z*	Sample description	Thermal conductivity, W/m·K
Tersoff	14x8x8	FPP	nanolayer	15.6
Tersoff	28x8x8	FPP	nanolayer	39.2
SW	14x4x4	FFF	nanowire	4.7
SW	20x4x4	PPP	bulk crystal	6.2

Thus, the calculations for the case of a thin silicon layer (7.6 nm and 15.2 nm, respectively) show an increase in thermal conductivity depending on the thickness of the layer. The obtained values are significantly lower than the experimentally measured in solid silicon. The result for the nanowire (sample with free boundary conditions in all three dimentions) is comparable to the result of the paper [3], where the relaxation time for the formation of a temperature gradient was much longer and the obtained value of the thermal conductivity is of the order of 1 W/m·K. Finally, the value of the coefficient for a sample with periodic boundary conditions in all directions corresponds to the result of 5 W / m · K from [4], where the relaxation time was also significantly longer.

Let us note also that LAMMPS package allowed use the acceleration due to parallel execution on multiprocessor systems in all simulations. Moreover, the control commands allow to specify the incoming and outgoing heat fluxes without code modification. However, it is relatively difficult to choose the simulation parameters so as to produce a temperature gradient and without destroying the dynamics of the system.

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TEACHING AND REAL APPLICATION PRACTICE OF IBM COGNOS BI, SPSS MODELER, ILOG CPLEX AND SAP ERP: BELARUSIAN STATE UNIVERSITY EXPERIENCE

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Belarusian State University (BSU) IT Competence Center was organizing training IT courses and seminars for students and professors of natural-science faculties, International Relations and Economical faculties since January 2012. At the beginning of all training activities BSU together with its strategic IT partner and sponsor JV IBA have defined such IBM and SAP solutions as Business Intelligence with Cognos BI, predicative analysis with IBM SPSS Modeler, commerce, marketing, and supply chain with ILOG CPLEX Optimization Studio and SAP ERP as the main directions of their collaborative work. To outpace the modern challenges and overcome 'train the trainer' skill gaps at all levels IBA specialists have prepared for us such courses as "Introduction to IBM Cognos TM1", "Basics of IBM SPSS Modeler and Data Mining", "Working with IBM Cognos BI", "Foundations of SAP ERP", "Programming with SAP ABAP" and so on.

We must outline that all these processes were also really supporting and developing by 3 departments of Belarusian State University:

1. Department of Pedagogic and Education Problems Development (Sirenko Svetlana, associate professor, PhD) [1].
2. Department of Optimal Control Methods (Markov Sergey, associate professor, PhD) [2].
3. Department of Mathematical Modeling and Data Analysis (Malugin Vladimir, associate professor, PhD) [3].

The above mentioned departments are taking the most active part in IBM Academic Initiative and SAP University Alliance Programs and their courses of training BDA / BAO replenish and enrich each other. Our main lecture courses cover such important fields as Statistical Data Analysis, Data Mining, Econometric, Computer Simulation, Optimization and Pedagogic of IT Education.

The new trend in our teaching process is a preparation of specialists in Big Data analysis. The above-mentioned disciplines provide an introduction to the special topics of mathematical and statistical analysis methodology. An algorithmic and programmer's skills of Data Analysts are provided by the training courses "Algorithms and Data Structures", "Data models and database management systems", "Parallel and Distributed Computing", "Intelligent Information Systems" and so on. For example, this year at the BSU Faculty of Applied Mathematics and Computer Science the first set in the master's "Algorithms and systems to handle Big Data" was held.

To prepare our students for real practice in BDA/BAO BSU and its partners - The United Institute of Informatics Problems of the National Academy of Sciences of Belarus, National Bank of Belarus and JV IBA - propose a set of project seminars where they can get a good experience in learning the main concepts of Big Data and Analytics. We'll describe here some of them.

1. The first research project is connected with the application of multivariate statistical analysis and econometric modelling to assess the creditability of non-financial Belarusian companies with SPSS Statistica. On the basis of company's financial reports data obtained within the National Bank's monitoring system it's necessary to propose a system of credit measures called "relative statistical credit ratings", which includes: company ratings, the branch of the economy ratings and the integral indicator of creditworthiness of the national economy [3].

2. The second project is dealing with working out analytical system of efficiency of the main production which helps operative monitoring to be carried out, estimation and the forecast of its efficiency on the basis of all feasible information of the Belarus metal Works (BMW) production – one of the leading enterprises of ferrous metallurgy in Europe. During this project students must work out methodology and tools of monitoring of key indicators of production efficiency and production sales.
3. The third project is the project of Smarter City - "smart trip system" (the automated system of payment and control of trip in Minsk municipal passenger transport). In the future the automated systems of payment and trip control can be integrated on the basis of one iCard. It will allow to optimize a routing network and to correct number of transport vehicles working on a line. And it will be very interesting and useful for the students.
4. The last project objective is to develop algorithms and effective using of IBM and SAP Products such as ILOG CPLEX Optimization Sudio and SAP ERP for solving in real time a complex product delivery problem (Smarter City Problem) Efficient implementation and usage of the proposed intellectual service requires a high educational level, a profound knowledge of contemporary mathematic methods and algorithms, and special IT skills of the students (dispatchers). Furthermore, they should be able to work in an interdisciplinary team and constantly improve their IT competencies, that is, they must be T-shaped.

The students must understand that BDA/BDO have become now a new methodological base for both research and practical activities in various spheres of science, business, education, healthcare and social life, facilitating their convergence, integration and interaction. But they can potentially provide more competitive advantages if they are used together with ERP and Optimization for more profound information processing of modeling, prediction and selection of effective strategies and solutions for the management of complex multi-element systems

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ACCESS CONTROL FOR THE CLOUD STORAGE

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When the organization or enterprise moves to the cloud infrastructure or rather switches to the distributed system paradigm, the problem of information security becomes especially important. One of the biggest challenges in the field of distributed networking is to provide the ultimate protection for the sensitive data. At the moment the security problem requires the fast-working and effective solution in the presence of mobile and wireless devices which are difficult to control.

One of the best ways to restrict the unauthorized access to the shared data is to use the strong cryptographic algorithm. Once the access policy is set and the secret keys are generated and distributed, the security of the system can be guaranteed.

We propose to control the access by means of attribute-based encryption [1] which allows not only to encrypt the data but also to configure the authorized users. In other words, in such encryption system the secret user keys depend on the additional attributes. In the general case, this encryption method requires a complicated implementation.

In our model the large-scale cloud storage has limited number of access user groups so that each user and each shared file belongs to a specific set of groups. This assumption allows us to propose a simplified key generation for the attribute-based access. Also, we introduce the additional key parameters that allow us to enhance the adaptive properties of the system.

In order to initialize the system of attribute-based encryption based on the simple selective principle we need the following:

1) The set of attributes:

$$t_1, t_2, \dots, t_n \in Z_q \text{where } q \text{ is prime}$$

The set of attributes corresponds to the set of the access group identifications:

$$Group1 \rightarrow t_1$$
$$Group2 \rightarrow t_2$$
$$\dots$$
$$Groupn \rightarrow t_n$$

2) The data M, or the hash-value of the open text.

3) The set of user attributes:

$$\{t_i\}_U$$

The set of attributes of the encrypted text

$$\{t_i\}_M$$

The access rule of the selective scheme is as follows:

If at least one attribute in the set $\{t_i\}_U$ is equal to the attribute in the set $\{t_i\}_M$, the corresponding user U can decrypt the text M.

This access rule is enough for the modeling of a large-scale cloud storage security policy based on the group access. So, the general complex structure of the ABE scheme can be simplified with this access control rules. The encryption system can be implemented as follows:

Initialization:

1) G is the group with the generator g;

2) The secret master-key which is stored on server and is accessible only for the administrator

$$MK = (t_1, \dots, t_n, y);$$

3) Public key which is evaluated according to the master-key and used to access the encrypted data:

$PK = (g^{t_1}, \dots, g^{t_n}, Y = e(g,g)^y)$, where e(g,g) is the bilinear pairing.

Key generation

The secret user key D is generation based on the user U attribute set:

$$\{t_i\}_U \to D = \{D_i = g^{yw/t_i}\}.$$

This key is sent to the user by the administrator. It depends on the master-key parameters and additional parameter $w \in Z_q$. This parameter serves for the D_i modification when the public keys need not to be changed.

Encryption

The encrypted text E consists of the encrypted message along with the attributes and the public key set$\{E_i\}$.

The additional parameter $s \in Z_q$ serves for the text re-encryption so that the secret user key set D_i need not to be changed:

$$E = Me(g,g)^{ysw}, \{E_i = g^{t_i s}\}_{\forall i \in \{t_i\}_M}.$$

Decryption

In order to access the value of M one must evaluate $Y^{sw} = e(g,g)^{ysw}$:

$$M = E/Y^{sw}$$

The user evaluates $e(g,g)^{ysw}$ using the secret key D_i which corresponds to the attribute t_i and the public key E_i:

$$e(g,g)^{ysw} = e(E_i, D_i) = e\left(g^{\frac{yw}{t_i}}, g^{t_i s}\right) = e(g,g)^{ysw}.$$

Our encryption system gives a practical solution to the problem of data security in the distributed networks i.e. providing the effective access control to the sensitive data. The algorithm provides additional adaptive parameters: once the user is deleted from the system, his secret key is not only automatically removed but also loses validity. Other properties include re-encryption, access delegation, key expiry period and collaborative access configuration.

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APERIODIC PALINDROMES AND CONNECTED CIRCULANT GRAPHS

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A compositionσ = σ1σ2 . . . σm of n is an ordered word of one or more positive integers whose sum is n. The number of summands m is called the number of parts of the composition σ. A composition of n without order gives a partition of n. A composition of n with k parts is aperiodic if its period is k. In other words, a composition is aperiodic if it is not the concatenation of a proper part of given composition. A composition σ = σ1σ2 . . . σm is called prime if gcd(σ) = gcd{σ1, . . . , σm} = 1. A numeral palindrome (or simply, palindrome) is a composition in which the summands in given order are the same with those in the reverse order (i.e., σ = σ−1 where σ−1 = σm . . . σ2σ1 for σ = σ1σ2 . . . σm). It is known that the number of palindromes of n ≥ 2 is 2⌊ n/2 ⌋. The first 30 palindromes in decimal can be found as the sequence A002113 in OEIS. Several types of palindromes are studied. The number of aperiodic palindromes of n with k parts (1 ≤ k ≤ n) is studied but the numbers are known only for n ≤ 55 (see OEIS). However it is still unknown whether there exist infinitely many palindromic primes or not, where a palindromic prime is a positive integer which is prime and also a palindrome. Although palindromes are often considered in the decimal system, the concept of palindromicity can be generalized to the natural numbers in any numeral system. An integer m>0 is called palindromic in base b≥2 if it is written in standard notation.

A circulant graph is a graph whose automorphism groupincludes a cyclic subgroup which acts transitively on the vertex set of the graph. For a subset S ⊆ Zn satisfying S = -S mod n, a circulant graph of order n denoted by G(n,S) is a graph with vertex set {0, 1, …, n-1} and edge set E, where{i, j}is in E if and only if i is not equals to j and j-i is in S mod n. A circulant digraph is also defined without the condition S=-S. That is, for a subset S ⊆ Zn a circulant digraph G(n,S) is a digraph with vertex set {0, 1, …, n-1} and arc set A, where (i,j) is in A if and only if i is not equals to j and j-i is in S mod n. Isomorphism problem of circulant graphs had been studied by several authorsand it is completely solved by Muzychuk. Recently, Kim, Kwon and Lee found degree distribution polynomials for the equivalence classes of circulant graphs of several types of order. They also found an enumeration formula for the number of equivalence classes of circulant graphs and they listed the degree distribution polynomials and the number of equivalence classes of circulant graphs for 1 ≤n ≤20. We observe that the number of equivalence classes of circulant graphs is equal to the number of aperiodic palindromes of n for 1 ≤n ≤ 20. This leads us to study a coincidence between the set of circulant graphs of order n and the set of aperiodic palindromes of n. In this paper, we study the coincidence and we extend this to circulant digraphs of order n and compositions of n.

We first shows that there is a one-to-one correspondence between the set of compositions of n and the set of circulant digraphs of order n. In particular, we also show that this bijection guarantees a one-to-one correspondence between the set of prime compositions of n and the set of connected circulant digraphs of order n. As an application, we enumerate the number of connected circulant digraphs (i.e., the number of prime compositions), disconnected circulant digraphs and circulant digraphs of outdegree k. Next we first show that there is a one-to-one correspondence between the set of palindromes of n and the set of circulant graphs of order n. In particular, we also show that this bijection in Theorem 3.1 guarantees a one-to-one correspondence between the set of aperiodic palindromes of n and the set of connected circulant graphs of order n. As a corollary, we give an enumeration formula of the number of aperiodic palindromes of n.

ON INTEGRATION OF THE MATHEMATICAL PROGRAMMING, APPLIED STATISTICS AND DECISION MAKING METHODS

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Introduction

The problem of emergency prevention and liquidation is as much practically important as theoretically complicated. By the example of this problem we intend to show how different mathematical and applied theories ([0]) could be used together in order to cope with this problem (and the problems of the same kind).

The problem statement and solution approach

The problem under consideration concerns resources allocation between the emergency liquidation departments (for instance, those dealing with fire prevention). The entire problem consists of the two interrelated subproblems (P_A and P_B).

The first one deals with the resource demands prognosis and uses as inputs the next data:

- the dates when the emergencies occurred (*A*);
- the amounts of the resource(s) used for emergency liquidation (the resource type may be anti-fire equipment, cars, chemical staff and so on) (*B*);
- the probability *P*, estimating that the allocated amount of the resource will be enough to liquidate the next emergency of that type (*C*).

The second subproblem deals with the optimal distribution of the entire amount *R* of the resource between the emergency liquidation departments on the basis of the solutions of the first subproblem and some additional information reflecting emergency complexity and frequencies.

To proceed let us introduce a random variable *x* standing for the resource amount used in emergency liquidation. One can then write

$$P(x \le w) = \int_0^w f(z)dz,$$

for continuous variable *x*, and

$$P(x \le w) = \sum_{i=0}^{i \le w} P(x = i)$$

for a discrete variable. Here *w* denotes the amount of the resource we are interested in; $P(x \le w)$ means the probability value for which *x* won't exceed *w*, that is, the resource amount allocated to emergency department will be enough to liquidate the next emergency consequences by that department alone; $f(z)$ stands for a density function of the unknown probabilistic distribution we need to define. In order to find $f(z)$ we need to build an empirical probabilistic distribution function on the basis of the data (*A*), (*B*). The sequence of the pairs $S = <(t_1, r_1),(t_2, r_2),...,(t_n, r_n)>$ is a priori known, where each pair in *S* contains the time t_k elapsed since the previous emergency case (*k* -1)*th* till the emergency case *k*; and r_k means the resource amount required to liquidate the *k-th* emergency consequences. Introduce a new variable $q = r/t$ showing the «rate» of the resource consumption. Then we shall deal with an integral

$$P(q \le q^{max}) = \int_0^{q^{max}} h(z)dz$$

with $h(z)$ reprezenting empirical density of the «rates» *q* distribution. One can use a polynomial approximation of the empirical distribution function in the form

$H(z) = a_0 + a_1 z + a_2 z^2 + ... + a_m z^m$ with the power value m providing statistically adequate solution (to verify statistical adequacy one can use, for instance, the χ^2-criterion). To find the resulting value of $q_i^{\max}$ (with i standing for a resource index) from the equation above one can use some approximation-based method like the Monte-Carlo one, for instance. Given value $q_i^{\max}$, one can then directly find the amount r of the resource needed to cope with the emergences which are expected to occur within the time period T as $\omega = T \cdot q_i^{\max}$. It should be noted here that one should discriminate between restorable and not restorable type of the resource under consideration. Thus, the above estimations are given for the type of not restorable resource and can be quite easy adopted to the restorable resource type.

Now let us address the second subproblem P_B dealing with resource (re)distribution among emergency liquidation departments. It is supposed that the total amount of the resourse to be allocated may be either known or unknown. Introduce the following goal function

$$L = M \cdot \varepsilon + \sum_{j=1,n} \delta_{kj} / G_j \to \min.$$

Here, $G_j = \lambda_j \cdot \varphi_j$ estimates the tensity of the emergency liquidation department j functioning; λ_j stands for the frequencies of the emergency cases the *j-th* department has been engaged in; φ_j denotes the mean complexity estimation of the emergency case liquidated by the *j-th* department (this estimation requires a multicriteria approach, e.g. based on the Saati's hierarchy analysis). For the *k*th resource and the *j*th department the next inequality should be satisfied: $r_{kj} + \delta_{kj} \geq \omega_{kj}$, where ω_{kj} stands for the amount of the *k*th resource found in the subproblem P_A; r_{kj} denotes the amount of the *k*th resource to be assigned to the *j-th* department (the value of r_{kj} is to be found by solving the optimization problem); δ_{kj} represent extra variable to provide the subproblem P_B consistency. Informally, δ_{kj} means the additional amount of the resource allocated to the *j-th* department if the total amount of the resource *k* is insufficient. We also introduce the next constraint $\sum_{j=1,n} r_{kj} = R_k + \varepsilon$ which means that the sum of the resource of the type *k* assigned to all departments cannot exceed the available total amount R_k. It is clear that in general case one needs to use some extra variable ε to provide the above constraint. Also it should be clear now that this extra amount ε must be as small as possible, so we use a big constant M as a penalty for usage of additional resource amount ε. Finally, we introduce the next constraints

$$R_k \cdot \frac{G_j}{\sum_{k=1,n} G_k} - \delta_{kj} \leq r_{kj} \leq R_k \cdot \frac{G_j}{\sum_{k=1,n} G_k} + \delta_{kj},$$

demanding to provide deviation from the values r_{kj} as low as possible ($k = 1, K; j = 1, n.$). By this we obtained a linear optimization problem with non negative variables.

Conclusion

The described approach was used in a real program for the needs of practical utilization.

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IT-BASED INTERDISCIPLINARY AREAS BETWEEN GIST AND EURASIA: UNDERWATER LOCALIZATION AND IMAGING FOR OFF-SHORE AQUACULTURE MONITORING AND CONTROL

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Last 2 decades, people enjoyed all privileges of wireless TERRESTRIAL communications and computing, not only at the level of scientific interests but also at the personal conveniences. We call this as a benefit of information technology, IT REVOLUTION, or IT-oriented society. Nobody refuses to say that IT is one of the leading technologies, and IT tools are most productive, most fruitful and most effective in many senses. Subsequently, we are now witnessing diverse applications of IT tools to expand the engineering completeness of various so-called classical engineering fields. Those interdisciplinary areas are IT-BT, IT-NT, and IT-xT, where x includes any conventional engineering and technology. Once, mathematics leads all good sciences, and all good sciences have been transformed into practical engineering, now engineering fields undergo a big shaping again with the strong support of IT tools.

Now, we have interest about how Oceanology or Marine acoustic technologies are turning from a big science into practical and personalized technology. Especially, we will think about whether we can enjoy underwater space similarly like terrestrial open spaces, where electromagnetic wireless communication so-called smartphone is an important IT tool. What are the issues enabling the underwater space to be enjoyable? One simple issue is whether we can localize (LOCATION) and synchronize (TIME). By using these simple measures, we could reconfigure a blind underwater as a new manageable space, and extract and compose a certain complex information enabling the underwater enjoyable.

We need further development, possibly with international collaborations, on the underwater ranging and localization issues, especially near the shore. This coastal underwater localization problem will be technically approached by an IT engineer, a little differently from that of the ocean acoustic scientist, yet fully utilizing known scientific knowledge and tools from the oceanology including a ray tracing model and prediction tools.

EDUCATIONAL PROGRAM FOR "MATHEMATICAL INFORMATICS" SPECIALIZATION IN THE BELARUSIAN STATE UNIVERSITY

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Intellectual data mining goes widespread both in research and commercial areas. A lot of internet-based companies had published their internal data analysis tools as open source software. Thus the barrier to entry to practical intellectual data mining area is rather low right now. There are a lot of outstanding examples of data mining usage in big internet companies. For example, Netflix and Twitter provide recommendation services. IBM is well known by its usage of innovative data mining technologies for question answering problems.

Let specify most popular tools and approaches for data analysis. Namely, different machine learning algorithms are used to generate recommendations. Specific clustering and search algorithms are popular to find out hidden patterns in data. Specialized linguistic analysis and graphs algorithms are used for social and communication data. Domain specific languages (DSL) allows data scientist to operate at a high level with base algorithms and data extraction queries.

There are a lot of specialized software tools nowadays, that implement aforementioned algorithms and approaches. We can use distributed batch and online data processing platforms (e.g. Hadoop, Storm), data classification and query tools (e.g. Mahout, Weka, Scalding), timeframe based event filtering (e.g. Esper), and specialized storage systems (e.g. Cassandra, HDFS).

It is necessary to use additional technologies for data retrieval from third-party services and sources. The list includes search crawlers, message queues, inter-component communication mechanisms and data serialization.

It is important challenge to follow the current trend of hybrid calculation (e.g. IBM Deep QA / Watson approach), when data mining technologies are combined with best semantic and linguistic approaches.

We formalized and propose the following vision on current data analysis trends in a new "Mathematical informatics" specialization program in the mechanic and mathematic faculty of the Belorussian state university. This program may be used as a basis for upcoming education courses and trainings in data mining area.

1. Data modelling:
   - 1.1. Data structures (34h);
   - 1.2. Relational databases and SQL (34h);
   - 1.3. NoSQL databases (with Cassandra, hbase), OLAP / MDX (with Pentaho) (34h);
   - 1.4. Capacity planning, data warehouse technologies, data archiving (34h);
   - 1.5. Semantic and SPARQL (with Virtuoso) (48h);
2. Information technologies
   - 2.1. Python, Matlab and R languages for data scientists (98h)
   - 2.2. Distributed algorithm and tools (with Mahout, Scalding, Mesos) (34h)
   - 2.3. Parallel algorithms (34h);
   - 2.4. Parallel programming languages (Erlang, MPI) (48h)
   - 2.5. Java online data processing (with Storm, Akka, Finagle) (48h)
   - 2.6. High scalable projects and their architectures (on Twitter example) (48h)
   - 2.7. Scala language (68h)
   - 2.8. Machine learning algorithms (34h);
3. Applied data analysis
   - 3.1. System and business – analyses (34h)
   - 3.2. Data mining (34h);

3.3. Crawling, data retrieval and search technologies (34h);
3.4. Computational linguistics (34h);
3.5. Advanced graph algorithms (with Apache Giraph) (34h);
3.6. Financial data analysis(34h)
3.7. Bio informatics (34h);

4. Cloud and specific web /mobile technologies
   4.1. Cloud services, AWS (48h);
   4.2. Web – programming (34h);
   4.3. Mobile application and services (34h);
   4.4. Linux administration (34h)
   4.5. SEO (34h);
   4.6. Data visualization technologies (34h);
   4.7. Recommendation algorithm (on Netflix example) (34h);

RESEARCH INSTITUTE FOR APPLIED PROBLEMS OF MATHEMATICS AND INFORMATICS: MAIN RESULTS

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The Research Institute for Applied Problems of Mathematics and Informatics was founded in 2000 by order of the Council of Ministers of the Republic of Belarus and of the Rector of BSU. The Institute was created in order to develop topical scientific fields of applied mathematics and computer science.

The Institute includes 6 research laboratories: Statistical Analysis and Modeling; Modeling of Physical Processes; Applied Informatics; Analysis and Synthesis of Dynamic Systems; IT security; Mathematical Methods of Information Protection.

Main directions of research are:

- Computer data analysis (multivariate analysis, discriminant analysis, cluster analysis, data mining, time series analysis, forecasting);
- Statistical analysis and computer modeling for Complex Data Structures (robust procedures under outliers, missing values, censoring, spatio-temporal data analysis and forecasting);
- Statistical analysis of genetic sequences;
- Computer methods in medical diagnostics;
- Econometric analysis and forecasting;
- Mathematical modeling of physical processes;
- Mathematical and computer methods of information security;
- Information protection.

The Institute has experience in development of methods and software for computer data analysis:

- European research and academic projects financed by following Programs: INTAS, TEMPUS, REAP.
- International research contracts with computer companies from South Korea, Russian Federation. The objective of these projects was to develop the software and to make related technological research. The developed software includes computer modules for Statistical Analysis, Forecasting, Optimization and Simulation.
- National research contracts with more than 50 private and state enterprises from the Republic of Belarus, e.g., National Bank of the Republic of Belarus, National Unitary Enterprise “Minsk Automobile Plant”, Belarusian Research Institute of Transport "Transtehnika", Research Institute for Oncology and Radiology, United Institute of Informatics Problems of the National Academy of Sciences of Belarus.

In practice, to get more reliable inferences from real data sets we need to use more adequate models for data and construct new statistical procedures. We develop methods and software for statistical analysis (prediction, pattern recognition, discriminant analysis, classification, time series analysis, analysis of discrete data, spatio-temporal analysis) for complex data structures (data with misspecification, distortions, outliers, missing values, censoring, etc.). Theory of our approach is published in many research papers including monographs [1, 2].

We offer solutions to the following topical problems in Medicine, Bioinformatics and Computer Analysis of DNA Sequences:

- Development of methods and algorithms for diagnostics of the coronary ischemic disease based on the parametric discriminant analysis in the different feature spaces:

statistics calculated from the wavelet coefficients, covariance functions and parameters of the Markov chains;

- Development of the robust discriminant analysis methods for diagnostics of malignant neoplasms on the basis of biochemical blood assay tests. Preliminary results show that robust discriminant analysis for diagnostics of malignant neoplasms increases the accuracy of diagnostics by 4-5% with respect to the classical decision rules;
- Development of algorithms and software for spatio-temporal cluster analysis in evaluation of geographical distribution of a rare disease;
- Development of methods and software for multiple precision recognition of coding segments in eukaryotic DNA. The basic weakness of the existed methods for recognition of protein-coding segments of eukaryotic DNA sequences is generated by errors in estimation of the boundaries for the coding segments. We are working on the project that is aimed to solve the following problems:
  - development of new mathematical models for protein-coding segments of eukaryotic DNA sequences based on multivariate probability distributions of nucleotides;
  - development of new mathematical models for protein-coding segments in eukaryotic DNA sequences on the base of new parsimonious high order Markov chains developed by our team;
  - development of methods, algorithms and software for recognition of protein-coding segments in eukaryotic DNA sequences based on the constructed mathematical models.

The Institute is organizer of following International Conferences:

- "Computer Data Analysis and Modeling" *(3-annual International conference)*;
- "Information Systems and Technologies" *(International conference)*;
- "Complex Information protection" (*International conference*).

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CREATING ELECTRONIC EDUCATIONAL RESOURCES FOR COMPUTER GRAPHICS COURSE USING WOLFRAM TECHNOLOGIES

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Introduction

Improving the efficiency of using information and communication technologies is one of the most important trends in the development of modern education. This work covers recommendations for creating and maintaining interactive electronic educational resources using Wolfram technologies. It contains real-world examples from creating training materials for Computer Graphics course for students majoring in applied informatics. This course provides introduction to computer graphics algorithms, software and hardware, demonstrate awareness of the variety of authoring tools and techniques used in the creation and delivery of interactive multimedia (Elements of Mulitmedia Portfolio); communicate effectively with multimedia professionals about the design, development and delivery of interactive multimedia for educational purposes (Criteria for Educational Multimedia, Elements of Multimedia Portfolio); evaluate the suitability of specific examples of multimedia for educational applications (Criteria for Educational Multimedia, Elements); plan, create and deploy simple examples of interactive multimedia in web browser environments (Elements of Multimedia Portfolio, Flash Portfolio). The peculiarity of this discipline is that each theoretical topic requires illustrations. Wolfram Demonstrations Project ([1]) is the solution to this problem provided by Wolfram *Mathematica* ([2]).

Wolfram Demonstrations Project

The Wolfram Demonstrations Project is hosted by Wolfram Research. Its goal is to demonstrate the possibilities of Wolfram *Mathematica*; to increase the number of Wolfram users; to improve programming techniques; to bring computational exploration to the widest possible audience. Demonstrations Project consists of an organized open-source collection of small interactive programs created by Wolfram *Mathematica*. These programs use dynamic computation to illustrate concepts from a number of fields: science, technology, mathematics, art, finance, etc. The collection covers a variety of levels; from elementary school mathematics to much more advanced topics, including quantum mechanics and models of biological organisms.

Most of the demonstration modules have a straightforward user interface that recomputes plot or virtualization dynamically in response to user actions like moving a slider, clicking a button or dragging one of the graphic elements. Each demonstration also includes a brief description about the concept being shown. All demonstrations run freely on any standard Windows, Mac, or Linux computer using the free Wolfram CDF Player (CDF − Computable Document Format) [3]. It is worth noting that users that use Mathematica 8 or higher can save interactive documents they develop in CDF format. Those documents can be shared and run in free to use CDF Player application, including the ability to embed them as web objects that can be run in any popular browser.

The examples of Wolfram demonstrations used in "Computer Graphics" course

In training process of "Computer Graphics" course we recommend using the following interactive modules:

- Color in computer graphics; additive color systems; subtractive color systems; color space; color cube; intuitive color model; color space conversion.
- Mathematical foundations of the computer graphics; point, vector, distance from a point to a line in two and three dimensional space.
- Coordinate transformations; homogeneous coordinates; transformation matrix; translation, scaling, rotation.
- Graphics pipeline and rasterization. Digital image processing: linear and nonlinear filtering, mathematical morphology, image binarization.

- Image-based rendering and lighting. Illumination models in computer graphics.

Colors and color models are important topics of the computer graphics. The Wolfram Demonstrations Project includes interactive modules that visualize color models and allow performing conversions between them (for example, see [4] and modules: Overlapping Light Colors, Colored Lights, Cartesian Color Coordinate Spaces, HSV Loci in the RGB Color Space, CIE Chromaticity Diagram).

Modules [5, 6] show the examples of using transformation matrices in 2D and 3D: applying transformation matrices to lines, points, figures and rotating about an arbitrary axis. Additionally, we advise using following 2D graphics modules: Understanding 2D Translation, Understanding 2D Shearing, Understanding 2D Rotation, Understanding 2D Reflection, Understanding 2D Rescaling; 3D graphics modules: Understanding 3D Rotation, Understanding 3D Scaling, Understanding 3D Reflection, Understanding 3D Shearing, Orthographic Projection of Parallelepipeds, Cutoff Parallelepipeds, Dissection of a Truncated Octahedron into Hexagonal Skew Prisms and Parallelepipeds.

High degree of students' understanding of rendering algorithms and digital image processing is achieved using modules [7, 8]. For example, using [8], students can to choose filter type (median, maximum, minimum, Kuwahara), and change the size of the convolution matrix. Other modules worse mentioning that cover image processing topic are: Adaptive Thresholding of Images, Filtering Images in the Frequency Domain, Sharpening Images, Image Sharpening, Gaussian Filtering for Blurring, Transformations of Gray Levels in an Image, Image Restoration for Degraded Images, Row Profiles in Color Images, Histogram Threshold by Max Contour Contrast.

We recommend using module [9] when studying the topic “Illumination models in computer graphics”. We also recommend: Lighthouses, Gray Color Meditation, Opacity Explorer 3D, Gamma Correction, Optical Model of the Human Eye, Lens Accommodation in the Human Eye.

Conclusion

We reviewed the research carried out in the field of the development of electronic educational resources. A collection of interactive mathematical demonstrations from Wolfram Demonstrations Project covers a big part of the «Computer Graphics» course. Modules from this project allow illustrating the theoretical part of the discipline and give students the opportunity to understand the subject area.

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BASIC PROCESSES OF VEHICLES MONITORING UNDER UNCERTAINTY

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The viability of any country is in many ways dependent on the efficiency of vehicle-aided cargo shifting [1]. The vehicle efficiency depends on the propriety of decision-making under uncertainty typical of modern times. For the reduction of these uncertainties decision support systems are used. Unfortunately, they are characterized by high specificity and complexity of decision-making methods. The report covers the possibility of creating a unified decision synthesis mechanism based on expertise knowledge sources relevant to the current uncertainty level.

Given is a company, which uses vehicles (mgo), equipped with detectors (dt) for cargo shifting project implementation. For the vehicle control a group of actors including a manager (C), dispatcher (D) and executor (P) is formed. The vehicle path goes through places of different levels of uncertainty. Required is a unified monitoring process, which provides for the synthesis of decisions corresponding to the level of uncertainty of a current situation.

The abstract scene (scene) of complicated vehicles control represents under present-day conditions a hierarchy of people, intelligent decision support systems (dss) and data exchange communication systems [1, 2].

On each level the actors make up decisions in accordance with their roles, expertise and resources. A typical decision-making problem is described by the tuple

$$\mathbf{U} = (X, V, U), \quad (1)$$

where: X – object parameters; V – states; U – possible decisions; **U** – the chosen decision.

In this case the actors P, D, C solve the Z_P, Z_D, Z_C decision-making problems depending on the buildup of the uncertainty degree and use three types of communication: local (com1), enterprise-wide (com2) and global (com3):

Scene = (mgo, dt, P, dssP, D, dssD, C, dssC, com1, com2, com3) (2)

Based on the synthesis of (1) and (2) five typical monitoring processes can be distinguished:

1. Set up of a data domain: proj, X,V, U on the levels of dssC, dssD, dssP;
2. Setting of X parameters values;
3. Decision synthesis: dssP → X, V_P, $\mathbf{U_P}$ → P;
4. Decision analysis:
   - if $U_P \in Z_P$ then fulfill the decision $\mathbf{U_P}$ and move to 5;
   - if $U_P \in Z_D$ then by com2 send U_P to the agent D and receive the answer of $\mathbf{U_D}$;
   - if $U_P \in Z_C$ then by com3 send U_P to the agent C and receive the answer of $\mathbf{U_C}$.
5. The fulfillment by the agent P of the decision $\mathbf{U_P}$ or $\mathbf{U_D}$ or $\mathbf{U_C}$.

The unification of decisions allows improving each of the steps without affecting other processes. By representing the processes in software agents, we receive a unified multi-agent architecture aimed at monitoring automation.

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QUANTUM INFORMATION SCIENCE AND TECHNOLOGY

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Quantum information is a field that embraces multiple different scientific and technological disciplines, which include mathematics, physics, electrical engineering, computer science and engineering, etc., and it has huge implications for practical applications, such as cryptographic communications, algorithmic and computational advances, and high-precision measurements and devices. As its title implies, unlike its "classical" counterpart, quantum information fundamentally relies on "quantum" characteristics of nature, for instance, the no-cloning theorem, quantum superposition, quantum entanglement, etc.

The most popular application in quantum information is quantum cryptography. In short, security of a typical quantum cryptographic protocol relies on the no-cloning principle of quantum mechanics; in layman's terms, quantum information cannot be copied, and hence, a secret message between designated parties cannot be compromised. Developing such devices is one of the primary goals of my workplace, Korea Institute of Science and Technology. In the near future, these devices will be available at every site where high-security is a must, and we are aiming to install them as necessary parts of social infrastructure within a decade.

Because quantum nature of the universe is generally observable on a small scale, typically comparable to the nanoscale, quantum mechanics can also be used to enhance the performance of small devices that are traditionally made of electronics only. For example, one can replace an electric current in a circuit with a flow of light that is guided by fabricated nanoscale photonic structures to interact with quantum objects, like atoms or artificial atoms. If we were to replace electronic parts with photonic parts, there are huge advantages in size, power consumptions, precisions, etc. A numerous researchers in the field are working hard to make advancements in such technology, whose applications include chip-scale timepieces that are as accurate as an atomic clock, high-resolution low-noise imaging systems, and small electromagnetic sensors. Those devices are essential for many further applications, and we believe that such advancements in quantum devices will bring benefits to various aspects of humanity.

Finally, the implementation of a quantum computer can be an ultimate goal for quantum information science and technology. There are various physical systems, such as photons, ions, atoms, superconducting circuits, etc, to implement quantum computer. In KIST, we have been studying photonic system that can be utilized in quantum communication including quantum cryptography. The research will be further expanded to other physical systems and by hybriding two or more different physical systems, we will explore the possibilities to realize quantum computation.

STATISTICAL METHODOLOGY AND SOFTWARE TO ASSESS THE CREDITWORTHINESS OF REAL SECTOR OF THE ECONOMY ON THE MICRO AND MACRO LEVELS

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This report presents the system of relative statistical credit ratings to assess the creditworthiness of non-financial companies. It is based on the methods of multivariate statistical analysis, as well as on a set of multivariate econometric models used to assess the creditworthiness on the macro level. On the basis of company's financial reports data it is developed a system of credit measures called "relative statistical credit ratings" (RSCR), which includes: company ratings (CCR), the branch of the economy ratings (BCR) and the integral indicator of creditworthiness of the national economy (ICI). The CCR indicator is used to evaluate the creditworthiness of companies on the micro level. BCR and ICI indicators can be used by the regulators on the macro level. The proposed methodology is applied to evaluate the creditworthiness of Belarusian companies. Using econometric modelling we examine the dependence of the credit measures BCR and ICI on the major macroeconomic factors of the Belarusian economy. We establish also the relations between the integral output indicators of the national economy and the proposed statistical creditworthiness measures. Economic analysis of the obtained statistical and econometric modelling results indicates the informativeness and the economic significance of the proposed indicators.

The software SSCR ("System of Statistical Credit Ratings") developed on the proposed statistical methodology has passed a preliminary approbation on an expanded database in the National Bank of the Republic of Belarus. The approbation results confirm the acceptable effectiveness of this approach in solving some problems the Central bank faces. They include the evaluation of the stability of the national economy as well as the assessment of the system risks of the banking sector.

The presented original methodology and software SSCR have been developed at the Research Institute for Applied Problems of Mathematics and Informatics of the Belarusian State University with the financial support from the National Bank of the Republic of Belarus.

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MODELING OF LOCALIZED ELECTRONIC STATES IN NANOGATE-DONOR SYSTEM

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Recently there has been an enhanced interest to study the manipulation of donor electron wave functions near an interface of two materials by applying external electric field. This problem was investigated earlier in several works using variational methods. However, this approach does not allow to estimate errors for obtained energies and quality of trial functions. In this work main characteristics of such a system with electric field applied by a disc-shaped gate are studied using both the finite element method (FEM) and the variational method. The structure under study can be considered as a basic model for the development of quantum informatics devices.

The aim of this work is to understand effects of different system parameters on electron shuttling between the donor and gate. A joint problem for Laplace and stationary Schroedinger equation has been solved using FEM.

An external parameters controlling the electron state is electric field potential of the gate. The effect of gate potential depends on internal parameters of the problem. These are the gate diameter, the donor position, the thickness of an insulator layer and characteristics of semiconductor and insulator (band gaps, electron effective masses etc.). The last group of parameters on boundary and conjugation conditions for Laplace and Schroedinger equations.

One of the most important characteristics describing the given system is critical potential – the gate potential which corresponds to the electron transferring from the donor to the gate. Another considered characteristic is the minimum gap between ground and first excited state electron energies which allows to estimate the tunneling time.

We calculated ground and first excited state electron energy using FEM and the variational method with trial functions of a simple form, which consisted of two terms: the first one describes the influence of the gate potential, the second one represents electron wave function in the donor field. The results obtained using FEM were compared with the results obtained using the variational method. The variational method allows to determine energies for the gate field near the critical potential with errors less than 1 %. At the same time, the variational method provides convenient way for evaluating the characteristics of the system.

The dependence of ground state energy on the gate potential was defined using FEM. This dependence can be used for evaluating the critical potential in the system and empirical expression for it was obtained, which determines the effect of the gate size on the critical potential.

Similar approximations were obtained for the minimum gap, which appeared to be strongly dependent on the donor position and much less dependent on the gate configuration. Because of this different degree of influence, it is possible to manipulate both critical potential and minimum gap by modifying the donor position and the gate size.

Another way to manipulate the characteristics of the structure is choosing semiconductor material with appropriate electron effective mass. Relevant formulae were derived from the dependences of the critical potential and minimum gap on geometrical parameters. It was also found that the case of materials with anisotrope effective mass can be reduced to isotrope case with certain value of effective mass.

The first numerical computations of wave functions has been performed in 3D axisymmetric geometries. Computational process for a fully 3D setting with finite elements is under development.

STATISTICAL METHODS AND SOFTWARE IN MEDICINE

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Computer data analysis in medical diagnostics

Coronary ischemic disease is characterized by significant changes of the blood flow turbulence and, as a result, by the appearance of high-frequency sounds that are caused by the stenosis of arteries. The acoustic blood flow signal consists of 3 fragments: systole, flap of the mitral valve damper and diastole. The most informative part of this signal, which is used for diagnostics of the coronary ischemic disease, is the diastole. We consider approaches to the diagnostics of the coronary ischemic disease based on the parametric discriminant analysis in the different informative feature spaces: statistics calculated from the wavelet coefficients, covariance functions and parameters of the Markov chains.

Methods of robust discriminant analysis and robust logistic regression were used at the Belarusian Research Institute of Oncology and Medical Radiology for diagnostics of malignant neoplasms in the major sites (lung cancer, gastric cancer, colon cancer) on the basis of biochemical blood assay tests. To construct quadratic discriminant functions, complexes (sets) of informative tests were formed by using several statistical approaches. Since the biochemical blood assay tests have outliers at the terminal stage of malignant neoplasm the robust decision rules, stable for outliers, were used for patients classification. Use of robust discriminant analysis for diagnostics of malignant neoplasms allowed to increase accuracy of diagnostics by 4-5% as against to use of the classical decision rules.

The problem of metastatic appearance risk for melanoma disease classification has been successfully solved with the developed statistical method. The method for each patient gives one of the three decisions: 1) the patient belongs to the class of successfully cured; 2) the patient needs further treatment to prevent high risk of metastatic appearance; 3) the information on the patient is not sufficient, and some more analysis is required. This method is realized in statistical software and showed increase of effectiveness by 20 %.

Spatio-temporal cluster analysis of disease

The methods of spatial and spatio-temporal cluster analysis are widely used in medicine for studying of geographic dissemination of different types of diseases.

Two common types of spatial and spatio-temporal clustering methods are constructed: global clustering methods allow to evaluate the presence of clustering throughout the territory; local clustering methods are used to find out the location and the size of possible clusters. The method based on a statistic which allows to detect clusters with different flexible shapes is considered. In the case of existing outliers among observations so-called robust statistical methods of the spatial cluster analysis were considered. A cluster detection research was held for thyroid carcinoma diagnostical data among children up to 14 years old from 1989 to 2009 in the Republic of Belarus. Spatio-temporal cluster analysis has confirmed that there was a significant increase in the number of thyroid carcinoma cases among children throughout the territory of Gomel region in the 1990s.

The models for the dynamics of clusters in the spatio-temporal cluster analysis of incidence levels were constructed. The methods for the cluster dynamics monitoring based on sequential statistical tests were developed and realized in the algorithmic form. These results are used for the spatio-temporal cluster analysis of malignancies in children and adolescents in Belarus during the post-Chernobyl period. The methodology can be extended to different applications to solve the problems of the quickest detection of spatial changes in clusters or the changes of the characteristics within clusters.

DEVELOPMENT OF MATHEMATICAL MODELS AND METHODS FOR HIGHLY ACCURATE PREDICTION OF CODING SEGMENTS OF EUKARYOTIC DNA

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The identification of coding segments has been one of the most difficult problems in bioinformatics. We propose probability models and methods, allowing to increase accuracy of prediction of protein-coding segments of eukaryotic DNA sequences.

At the present time the large amount of methods proposed and the number of software systems developed for prediction of protein-coding segments of eukaryotic DNA sequences. The basic lacks of the methods proposed and the programs developed are missing and concatenation of coding segments, as well as errors in determining the boundaries of the coding segments.

We propose probability models of protein-coding segments of eukaryotic DNA based on:

1. n-dimensional (n=3, 4, 5, 6) probability distribution of nucleotides.
2. parsimonious high order Markov chains.

We also present mathematical methods for prediction of protein-coding segments in eukaryotic DNA sequences based on our models

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