DEDICATED TO THE 90TH BIRTH ANNIVERSARY OF ACADEMICIAN V.M. GLUSHKOV

On 24 August 2013 ninety years passed since Victor Glushkov's birthday, who was an outstanding scientist, author of fundamental works in the field of cybernetics, computer engineering and applied mathematics. Academician V.M. Glushkov lived to be 58, and 35 years of his creative development brought hundreds of works which contributed to forming cybernetics as a science.

V.M. Glushkov joined such important courses of scientific-technical progress as the cybernetics fundamentals development and practical methods of developing computer engineering forming. He was one of the founders of the interdepartmental collection of scientific papers "Cybernetics and Computer Engineering". Thoughtful scientist and unsurpassed pedagogue V.M. Glushkov is a founder of a world-known school.

UNESCO ANNOUNCED 2013 AS THE YEAR OF N.M. AMOSOV IN MEDICINE

On 6 December 2013 we will celebrate Nikolai Amosov's 100th birthday anniversary who was an outstanding scientist and genius surgeon, founder of cardiosurgery in Ukraine, medical and biological cybernetics, writer and public figure.

The interdepartmental collection of scientific papers "Cybernetics and Computer Engineering" is presenting a series of articles devoted to the development of scientific schools initiated by N.M. Amosov. The basic results of the articles were discussed and recommended to be published at the seminar "Biological and Medical Informatics and Cybernetics" (18-21 July 2013, Zhukin) dedicated to the anniversary.

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NEURAL DISTRIBUTED REPRESENTATION FOR INTELLIGENT INFORMATION TECHNOLOGIES AND MODELING OF THINKING

Introduction: The state-of-the-art arsenal of artificial intelligence and machine learning includes well developed methods for vector data. However, traditional vector representations of high-dimensionsioanl data lead to slow. On the other hand, processing of complex structured data represented in a symbolic form requires sequential and often computationally complex algorithms (e.g., graph similarity is often determined by the sub-graph isomorphism, which is NP-complete problem). So, such methods hardly applicable to large-scale applications.

The purpose of the paper is to review our approach to creation of intelligent information technologies based on modeling human thinking and a special kind of vector representations that use the idea of distributed representations in the brain. This approach is the development of the ideas of Nikolai Mikhailovich Amosov and his scientific school.

Results: It is shown that distributed representations allow an efficient estimation of numeric vector similarity as well as efficient solving of discrete ill-posed problems. The formation of distributed representations of complex structured relational information used in declarative knowledge bases is considered, that allows an efficient search for analogs in analogical reasoning.

Possible implementation of N.M. Amosov's functional acts for modeling of intelligent behavior based on distributed representations is also proposed.

Conclusions: Thus, distributed representations, when used in information technologies, can improve computational efficiency by converting various data types (both unstructured information in the form of vectors arrays and relational structures of knowledge bases) to a special format of binary vectors. In addition, distributed representations can naturally combine information about the structure and semantics, opening the possibility of creating computationally efficient and qualitatively new methods for processing relational structures of data and knowledge bases by similarity of their representations. Neurobiological relevance of distributed representations opens the possibility of using them as the basis of intelligent information technologies that function similarly to the human brain.

Keywords: distributed representations, similarity-based, retrieval, analogical reasoning, discrete ill-posed problem.

A.D. Goltsev, V.I. Gritsenko

ALGORITHM OF SEQUENTIAL FINDING THE TEXTURAL FEATURES CHARACTERIZING HOMOGENEOUS TEXTURE SEGMENTS FOR THE IMAGE SEGMENTATION TASK

Introduction: The paper describes a part of the model for texture segmentation of visual images. The model is designed to solve the problem of segmentation of arbitrary images into homogeneous texture segments under condition of absence of any information about the image. A computer program simulating the texture segmentation model is created. The program has been tested on black and white natural images of a landscape type. The experiments demonstrate the effectiveness of the model for texture segmentation of natural images.

Purpose: The texture segmentation procedure is performed basing on textural features extracted from the image. The segmentation process is sequential and iterative, one homogeneous texture segment is delineated in each iteration. At the beginning of every iteration, a set of textural features characterizing the currently extracted segment is found by means of some computations in a multi-dimensional feature space. Thus, it is development of the algorithm for finding a representative feature set that is the goal of this work.

Results: The algorithm for finding a representative feature set that characterizes homogeneous texture segments has been designed; this algorithm is a part of the model for segmentation of arbitrary image into homogeneous texture regions under condition of absence of any information about the image.

Conclusions: The proposed algorithm is a key part of the texture segmentation model. The algorithm provides automatic finding the texture features that characterize homogeneous texture segments presenting in the analyzed image. It is the algorithm due to which the model can do without specifying the number of segments to which the image should be divided.

Keywords: texture; texture window, textural feature, texture segmentation, pixel.

E.G. Revunova

RANDOMIZATION APPROACH TO THE RECOVERY OF SIGNALS RESULTED FROM INDIRECT MEASUREMENTS

Introduction: A number of applications require solving the problem $\mathbf{Ax} \approx \mathbf{y}$, where the matrix $\mathbf{A}$ and the vector $\mathbf{y}$ (distorted by additive noise) are known. We need to estimate the signal vector $\mathbf{x}$. For example, it may be a linear measuring system with the measurement result $\mathbf{y}$. The matrix $\mathbf{A}$ of the input-output linear transformation describes the interaction of the measured signal with the medium and measuring tool. The columns of $\mathbf{A}$ can be viewed as discrete samples of the basis functions of the measurement system. Another problem appears when we know desired set of basis

functions **C** that would provide improved resolution of the measuring system. The task is to find out the observed output (obtained with **A**) to the output of the system with the given basis **C**.

For some special **A** observed in practice the solution based on matrix inverse is unstable, and regularization is needed. The classic method is Tikhonov regularization. However it suffers from a high computational complexity and the difficulties in selecting the proper regularization parameter. So, **the purpose** is to develop approaches to regularization that provide solution accuracy at the level of Tikhonov regularization, but with less computational complexity.

Results: This paper proposes an approach to stable solution of the output transformation problem based on the use of random projections and QR-decomposition. An experimental study of the solution error, its components, and its dependence on the dimension of the projector matrix is conducted. For a randomized method of solving discrete ill-posed problem, the expressions for error of output signal recovery are obtained, and an experimental study of the error is also conducted.

Conclusions: The proposed approach based on a distributed neural network representations and random projections enables the development of efficient regularization methods both for solving the problem of recovering the signals resulted from indirect measurements and the problem of transforming the observed outputs of a measurement system.

***Keywords*:** projector, random matrix, regularization.

E.M. Kussul, T.N. Baidyk

MICROMECHANICS AS A TESTBED FOR EVALUATION OF ARTIFICIAL INTELLIGENCE METHODS IN MANUFACTURING

Introduction: Artificial intelligence (AI) methods can be used to improve automation systems in manufacturing processes. However, the application of these methods in industry is not widespread, because of the high cost of experiments with AI systems applied to conventional manufacturing systems. To reduce the cost of experiments in this area, we have developed a specific micromechanical equipment, similar to conventional mechanical equipment, but of much smaller size and therefore of lower cost. This equipment can be used for evaluation of different AI methods in an easy and inexpensive way. The methods that show good results can be transferred to the industry through appropriate scaling.

The purpose is to provide a brief description of low cost microequipment prototypes and some AI methods that can be evaluated with such prototypes.

Results: Several neural network algorithms were proposed to improve automation systems in manufacturing processes. These algorithms were tested with specific micromechanical equipment, similar to conventional mechanical equipment, but of much smaller sizes and therefore of lower cost.

Conclusions: We consider this equipment a good testbed for examination of the AI algorithms that can be used to increase the level of automation of manufacturing processes. One of the problems we intend to examine is the prediction of resonant oscillations in the process of turning and avoidance of resonance vibrations using assembly neural networks.

Keywords: artificial intelligence, micromechanics, computer vision, neural networks, neural assemblies.

S.V. Slipchenko

NAMED ENTITY RECOGNITION USING CONTEXT VECTORS

Introduction: Named Entity Recognition is one of the main tasks of natural language processing. Most of the statistical methods are used to detect a huge number

of local features (millions and tens of millions), and rely heavily on secondary characters (mixed case characters, special characters, etc.).

The purpose is to investigate the quality of named entity recognition using Conditional Random Fields with local context features and develop a new approach to taking into account global context features using context vectors.

Results: Our experiments show that recognition precision by Conditional Random Fields is good enough for word only local features. To take global context into account, we propose using context vector of the words represented by localist and distributed vector representations.

Conclusions: The proposed approach that include various combinations of localist and distributed representation of local and global context, as well as informative feature selection, should be investigated to improve the efficiency of learning.

Keywords: distributed representations, named entity recognition.

I.I. Yermakova, J.P. Tadejeva

MODELING COMPLEX FOR PREDICTION HUMAN UNDER EFFECTS OF GENERAL AND REGIONAL ULTRASOUND-FREQUENCY ELECTROMAGNETIC FIELD

Introduction: Ultrasound electromagnetic radiation is commonly used in medicine. Evaluating human exposure to ultrasound monitoring is needed in order to achieve the required temperature in irradiated array at a certain depth, as well as evaluation of the exposure human endurance.

The purpose is to study the result of the general and regional human exposure to ultrasound with the developed mathematical models.

Results: A method for modeling specific absorption rate of an ultrasonic energy by tissues is developed. Mathematical models of energy and heat processes of human for the effect of ultrasonic treatment taking account the characteristics of electromagnetic field in ultrasound ranges are performed.

The developed modeling complex taking into account the responses of nervous system, cardiovascular system, water-salt exchange system, thermoregulatory system and characteristics of ultrasonic exposure makes prognosis of preliminary physiological status and allows to evaluate the result of hyperthermia treatment.

Conclusion: Analysis of the results of computational experiments with the results of other researchers showed that the developed 34-compartments mathematical model for prediction of general and regional human exposure to ultrasound adequately describes the effect of ultrasonic radiation on humans.

Keywords: modeling complex, ultrasound frequency, electromagnetic hyperthermia, specific absorption rate, whole body hyperthermia, regional hyperthermia, prediction of thermophysiological human state, mathematical model.

V.V. Lukovych

SIMPLE ARCHITECTURE OF CONVOLUTION NEURAL NETWORK FOR HANDWRITTEN DIGIT RECOGNITION

Introduction: Convolutional neural network is an example of architecture that is specialized for image recognition. Universal classifier is often used in the last stages of convolutional neural networks. The last feature map of a convolutional neural network contains data whose dimension is usually high. Therefore, it can be assumed that a simple linear classifier could work effectively there.

Purpose: We proposed a simple convolutional neural network with 1-layer classifier in the last stage. The aim of this work was to investigate the performance of such neural network.

Results: A series of experiments was carried out to evaluate proposed network on the MNIST database. An error rate of about 0.38% was achieved.

Conclusions: Experiments have shown that proposed network can yield performance comparable to the state-of-the-art of handwritten digit recognition.

Keywords: convolutional neural network, handwritten digit recognition, MNIST database.

K.G. Lyabakh

MATHEMATICAL MODELS FOR INVESTIGATION OF INFLUENCE OF NITRIC OXIDE ON THE OXYGEN REGIME OF CELL

Introduction: The nitric oxide (NO) plays the key role in many biological functions. NO inhibits mitochondrial O_2 consumption (VO_2) and may act as a citoprotector but it may disturb tissue energy supply in dependence on its concentration[NO]. The existence of NO in tissue is connected with O_2 presence. Scavenging and NO production in tissues by myoglobin Mb vary with the O_2 concentrations and influence oxygen regime parameters: pO_2, NO and VO_2 distribution in tissue.

The purpose of our study was to develop the model of O_2 and NO transport and interaction between NO and Mb in the muscle cell for calculation of main characteristics of oxygen regime in the cell — O_2 parameters.

Results and discussion: Two computer models of O_2 and NO delivery to and O_2 - consumption and NO- elimination in the working muscle cell have been developed:

The model 1 describes convective O_2 delivery by blood and three-dimensional O_2 and NO diffusion-reactions and in the muscle fiber with reversible inhibition of mitochondrial respiration by NO without Mb. Using this model we obtained [NO] and pO_2 values away from capillary in the muscle fiber, taking into consideration the mutual influences [NO] and [O_2] on each other under the parametric changes of [NO] from 0 to 60 nM. We investigated an inhibitory effects of NO on tissue respiration. Model 2 described the influence of myoglobin on [NO] and [O_2] in the cell. Planar radial oxygen, NO and myoglobin diffusion were described. Nitrite reductase and oxidase functions of myoglobine are taken into concideration. Acting as an NO scavenger in normoxia condition, oxygeneted myoglobin locally decreased [NO] and eliminated NO-inhibition of mitochondrial activity. Under hypoxia deoxygenated myoglobin produced NO only in the zone of oxygen lack.

Conclusions: According to calculations intracellular NO gross impacts the oxygen regime of cell, because it increases tissue pO_2 and depresses mitochondrial respiration in the whole cellular volume. Myoglobin modulates the influence of NO on oxygen regime and provides a fine adjustment of oxygen regime in muscle, increasing tissue pO_2 and decreasing a mismatch between oxygen supply and demand.

Keywords: Mathematical model, oxygen mode, oxygen transport, nitric oxide, myoglobin.