

IMAGE PROCESSING FOR MEDICAL AND INDUSTRIAL APPLICATIONS

Laurent Babout, Marcin Janaszewski: **Analysis of Bridge Ligaments in 3D Volumetric Images Using Discrete Topology** • Automatyka 2009, t. 13, z. 3

The paper presents a new algorithm that aims to fragment volumetric features that are connected via thin junctions such as isthmus. The method is based on the calculation of local topological numbers and decision making about the volume of the features following junction deletion. The algorithm is applied on a real 3D dataset from X-ray tomography imaging which represents crack and bridge ligaments in stainless steel during intergranular stress corrosion cracking. Bridge ligaments, which can be identified as holes in a 3D object – the crack – are segmented using so-called hole closing algorithm.

Keywords: *topology numbers, X-ray tomography, image processing*

Wojciech Bieniecki, Victor Manuel Martínez González, Szymon Grabowski: **Fine-Tuned Spot Detection on ELISPOT Images** • Automatyka 2009, t. 13, z. 3

Enzyme linked immunospot assay (ELISPOT) is a powerful technique used for detection and quantification of antigen specific immunological responses at the single cell level, which could have a prognostic value to diagnose the long-term graft outcome (i.e., kidney) and to evaluate the level of immunosuppression therapy needed. Basically, ELISPOT image contains round spots of different color, intensity and size. The image analysis should include accurate measurements of spot properties, like area and color. We propose a new approach to spot detection and measurement on ELISPOT microscope images, combining the Canny operator and a circle-fitting routine that we previously used (in somewhat different context) for that class of images. Good edge detection algorithms, like the Canny one, yield locally accurate spot contour arcs but their drawback is that the found arcs are not connected, i.e., do not constitute full contours. We solved the problem, fitting arcs belonging to the same spot contour. For each arc, a circle to each it

belongs was approximated and then circle clustering was performed not to produce too many (false) contours.

Keywords: *ELISPOT, Canny's operator, color images*

Zbigniew Bibliński: **Use of SSE Instructions in Image Processing**
• Automatyka 2009, t. 13, z. 3

The paper presents an attempt to utilize the SIMD extensions, available in modern processor architectures, in order to minimize image processing time. In particular, the effect of MMX and SSE instructions on the digital image thresholding algorithm was investigated in detail. The results, i.e. processing times, were compared with those obtained from an algorithm written in plain C and in x86 assembly language.

Keywords: *SIMD extensions, MMX and SSE instructions, time optimization of image processing algorithms, digital image processing, assembly language programming*

Sławomir Cichoń: **Concept Design of Implementation FPGA-Based VLC 3-Stage Decoding System Compliant with DV Standard** • Automatyka 2009, t. 13, z. 3

VLC coding (*Variable Length Coding*) is one of entropy type of coding. With different modifications it is used in many of video compression standards, both moving, and still images, e.g. JPEG, MPEG-2, DV (IEC 61834). In this paper VLC coding algorithm used in DV will be described in details. Concept design of VLC decoder implementation, exercising all three stages in reprogrammable chip, will be presented, with consideration of reusing it in hardware DV decoder, as processing element in the pipeline architecture.

Keywords: *video decompression, entropy coding, reprogrammable system, DV coding*

Anna Fabijańska: **Two-Pass Median Filter for Impulse Noise Removal** • Automatyka 2009, t. 13, z. 3

In this paper the new approach to impulse noise removal is introduced. Described algorithm involves modification of median filtration mechanism. However, in opposition to traditional approach only pixels corrupted by noise are filtered. Results of applying in-

roduced method to exemplary images are presented and compared with results achieved with traditional approaches. Moreover, the performance of the method is analyzed. Factors influencing efficiency of noise removal using proposed algorithm are deliberated.

Keywords: *image enhancement, impulse noise, median filter*

Anna Fabijańska, Michał Postolski, Marcin Janaszewski, Laurent Babout: **Comparative Analysis of Bronchal Tree Segmentation Algorithms** • Automatyka 2009, t. 13, z. 3

In this paper problem of airway tree segmentation from 3D CT chest scans was considered. Especially comparison of two authors' algorithms was provided. The algorithms are 3D region growing approaches. The first method uses hole closing algorithm in order to avoid leakages into the lungs. The second approach guides and constrains region growing by morphological gradient. Results of both considered methods for exemplary data are presented and discussed.

Keywords: *bronchial tree, image segmentation, region growing, hole closing, morphological gradient*

Jarosław Gocławski, Joanna Sekulska-Nalewajko, Ewa Gajewska, Marzena Wielanek: **An Automatic Root Length Measurement of Wheat Seedlings from Hydroponic Culture Using the Methods of Image Processing and Analysis** • Automatyka 2009, t. 13, z. 3

In the paper an automatic method of length measurement has been presented for the roots of wheat from hydroponic culture, based on image processing and analysis. Evaluation of this feature of root systems is important for the estimation of plant tolerance to environmental factors influencing their productivity. In the proposed method simplified procedure of root preparation is applied and low-cost equipment is assumed consisting of typical scanner device and personal computer. The method includes root image segmentation in colour space, binary image skeletonization and then 3D trees topology reconstruction from 2D skeletons of all individual fibrous roots defined as 1. order roots. The analysis of tree data structures enables the reconstruction of axes of 1. order roots and their lateral branches in the image raster. Root lengths are calculated along these axes following cubic splines smoothing of their routes. The measu-

rements of 1. order roots, carried out for the series of 10 images (about 50 roots) revealed only small differences from the results obtained with manual method – 1,94% in average.

Keywords: *root system, wheat, length measurement, image segmentation, chroma image, skeletonization, root tree, spline curve*

Mirosław Jabłoński, Zbigniew Bublński: **Acceleration of Image Processing Algorithms Using Graphics Card Resources** • Automatyka 2009, t. 13, z. 3

The paper presents an attempt to utilize the graphics card resources for acceleration of selected image processing operations. The use of tools obtained from NVIDIA for GeForce graphics cards series makes it possible to distribute a computational task on threads executed by GPU floating-point cores. Execution times of parallelized operations were measured and compared with execution time of single-threaded program run on CPU. Also, the speed-up factors (acceleration factors) were calculated.

Keywords: *GPU, image processing, parallel computing*

Marcin Janaszewski, Laurent Babout, Michał Postolski, Łukasz Jopek: **Hole Segmentation in Volumetric Objects** • Automatyka 2009, t. 13, z. 3

The article presents the new conception of a hole in 3D volumetric objects. The authors have built, implemented and tested a new algorithm of hole segmentation (filling) based on the conception. The algorithm has been tested on artificially generated objects and very complicated 3D objects which represent stress-corrosion crack to be propagated in stainless steel. The article includes also results of the algorithm tests, discussion of its properties and possible applications.

Keywords: *3D hole, hole segmentation, hole closing, discrete topology*

Marcin Janaszewski, Laurent Babout, Michał Postolski, Łukasz Jopek: **Hole Closing in 3D Volumetric Objects** • Automatyka 2009, t. 13, z. 3

Hole closing in 3D volumetric objects is a challenge in computer science because from a topological point of view a hole is not

a subset of 3D space. Therefore it is impossible to close a hole by the use of classical methods based on connected component labeling or suppressing filters. The article presents the new algorithm of hole closing based on the algorithm presented by Aktouf e.g. in 2002 year. Algorithm presented in the paper has several advantages in comparison with the Aktouf's approach: only holes are closed but not cavities - bounded by an object disconnected fragments of background. Moreover generated patch which closes a hole corresponds to its "geometry" and geometry of the patch is not influenced by branches of the object which are situated close to the hole. The algorithm has been tested on artificially generated objects and very complicated 3D objects which represent stress-corrosion crack to be propagated in stainless steel. The article includes also results of the algorithm tests, discussion of its properties and possible applications.

Keywords: *hole closing, skeletonization, 3D hole, discrete topology*

Aleksander Jasiński, Marek Gorgoń: **Initialization and Testing of Petalinux Operating System Properties in Environment of Re-Programmable FPGA Device** • Automatyka 2009, t. 13, z. 3

The paper describes the steps needed to start up and test of computing system based on Petalinux operating system and Xilinx Spartan 3E reconfigurable device. The article concerns on creating of hardware and software part of the system and their cooperation. Steps for creating of the solution, which can be base of embedded system and its potential improvements have been described. The document also presents applications used for image processing and control peripheral devices of the board.

Keywords: *embedded system, petalinux, uclinux, microblaze, re-programmable devices, software-hardware solutions*

Sławomir Jeżewski, Piotr Duch: **Color Images Segmentation Algorithms for Object Detection on Sattelite and Aerial Images** • Automatyka 2009, t. 13, z. 3

This paper describes influence of color space to the results of image segmentation by watershed and quadtree algorithms. The most popular color space like RGB, HSV and CIEL*a*b was analy-

zed. The mathematical measure of segmentation quality was presented and contrasted with the subjective human feelings. Sets of images from COREL collection and aerial images from Google were used in experiments.

Keywords: *segmentation, color space, color measurement*

Tomasz Koszmider, Marcin Bąkała: **New Drop Shape Analysis Algorithms for Measurements of Surface Tension and Wetting Angle of Metals at High Temperatures** • Automatyka 2009, t. 13, z. 3

New metal's drop shape analysis algorithms are presented in this paper. They concerns utilization of digital image processing and analysis methods in process of wetting tension and contact angle measurements at high temperatures.

Keywords: *high temperature measurements, image processing, shape analysis, surface tension, contact angle*

Leszek Kotulski, Adam Sędziwy: **DPO Graph Grammars Application in GRADIS Framework** • Automatyka 2009, t. 13, z. 3

Parallel graph computations improve a system effectiveness. GRADIS multiagent framework is offered to support this idea. In the paper we evaluate an overhead generated by a cooperation in a set of the agents in the distributed environment, for the case of the one of most popular graph grammars – double pushout grammar.

Keywords: *parallel graph transformations, double pushout graph grammar, multiagent systems*

Łukasz Mik, Marek Gorgoń: **FPGA-Based Digital Camera with Image Processing System** • Automatyka 2009, t. 13, z. 3

In the paper an architecture of digital camera based on Spartan-3 FPGA device is presented. Acquisition and image processing systems have been integrated in a compact case. The camera is able to process 5 frames per second. Image processing algorithms are effectively executed in FPGA resources.

Keywords: *Digital Camera, FPGA, Image Processing*

Grzegorz Nowak, Włodzimierz Mosorow: **Method of Metallic Colour Matching Based on Spectral Data Analysis and Image Processing** • Automatyka 2009, t. 13, z. 3

The article presents a method of metallic colour matching to obtain the corresponding formula. The method is based on spectral data analysis of a colour sample and on image-processing procedures, used to determine a size and number of metal particles.

The proposed method can be applied in different areas such as car painting, cosmetic or plastic industry etc., where metallic colours are widely used. The proposed solution will allow to optimize costs of necessary colour formula, taking into account prices and accessibility of basic colours.

Keywords: metallic colour matching, image processing

Piotr Pawlik, Zbigniew Bublński, Mariusz Duplaga: **ROI Tracking on Sequences of Bronchoscopy Images** • Automatyka 2009, t. 13, z. 3

The paper presents an attempt to utilize the modified SIFT method for ROI (region of interest) tracking on sequences of bronchoscopy images. The method was tested on several movies recorded during medical treatment and very promising results were obtained. Also, the areas of possible improvements were pointed out.

Keywords: SIFT, bronchoscopy

Michał Postolski, Marcin Janaszewski, Anna Fabijańska, Laurent Babout, Mariusz Jędrzejczyk, Ludomir Stefańczyk: **Airway Tree Segmentation Based on Holes Closing Algorithm** • Automatyka 2009, t. 13, z. 3

Reliable segmentation of a human airway tree from volumetric computer tomography (CT) data sets is the most important step for further analysis in many clinical applications. In this paper the original airway segmentation algorithm based on discrete topology and geometry is presented. The proposed method is fully automated and takes advantage of well defined mathematical notions. Holes occur in bronchial walls due to many reasons, for example they are results of noise. Holes are common problem in previously proposed methods because in some areas they can cause the segmentation al-

gorithms to leak into surrounding parenchyma parts of a lung. The novelty of the approach consist in the application of a dedicated hole closing algorithm which closes all disturbing holes in a bronchial tree. The experimental results showed that the method is reliable and generate good quality and accurate results.

Keywords: segmentation, airway tree, hole closing, region growing

Zbigniew Rudnicki: Investigation of Some Discrimination Features of Texture Images • Automatyka 2009, t. 13, z. 3

The paper presents the results of investigation of many image features commonly used in discrimination of texture image classes. The features calculated from: histogram, gradient matrix, co-occurrence matrix, run-length matrix and autoregression model were taken into consideration. The sensivity of these features on the changes of brightness, contrast, blurring and structure arrangement were investigated and the best discriminators were selected.

Keywords: image analysis, texture image, image features, contrast, blurring, arrangement

Joanna Sekulska-Nalewajko, Jarosław Goćławski: The Segmentation Algorithm of Microscopic Images of Diatoms from Slides with Sedimental Pollutions • Automatyka 2009, t. 13, z. 3

In the paper a new, robust to artefacts, method of microscopic diatom image segmentation has been presented. Images are acquired in grey-levels using bright field microscopy from specimens with impurities such as dust specks, debris or sand crystals. The method assumes superposition of images from different focal planes including diatom surface ornamentation and boundaries. Diatom object contours are detected using Canny filtering and their background regions are extracted independently applying bottom hat filtering and morphological reconstruction. Contour gaps are filled by linking of all contour ends inside of individual diatom background regions. To distinguish regularly shaped objects of diatoms from artefacts, contour curvatures, symmetry axes and centres are verified for each segmented object. Directional ornamentation of diatom frustules (if present) is detected by histogram analysis of phase images inside of individual region masks.

Keywords: diatoms, segmentation, region boundaries, morphological reconstruction, boundary curvature, ornamentation

Adam Sędziwy: **Collective Agent Strategies in the GRADIS Environment** • Automatyka 2009, t. 13, z. 3

The common obstacle in using a graph representation of the problems, used successfully in many areas (e.g. pattern recognition) is time complexity of related computations. In some cases only using the parallel computations applied to the graph grammars with quadratic parsing time make the graph approach applicable in practical use. The paper focuses on the multiagent methods of obtaining the graph partitions in the GRADIS framework, that are optimal for further effective parallel computations (decomposing of a graph representation). Various criteria of optimum are discussed. Also the results of performed tests are presented.

Keywords: *distributed graph transformations, multiagent systems, GRADIS framework*

Artur Sierszeń: **Cascade Algorithm for the Reference Set Size Reduction** • Automatyka 2009, t. 13, z. 3

Two algorithms of the reference set condensation, one of which is based on finding the mutually furthest points and the other is the modification of the Chang's algorithm, are respectively of the incremental and eliminative type, i.e. the size of the condensed set increases or is reduced as a result of a subsequent iteration. The combination of both aforementioned types of condensation, i.e. the cascade algorithm of condensation, is more effective than each of these algorithms executed separately.

Keywords: *pattern recognition, nearest neighbor rule, reference set condensation, reference set reduction, Chang's algorithm, modified Chang's algorithm, method of cutting hyperplanes, cascade algorithm*

Artur Sierszeń: **Reduction of Large Reference Sets with Modified Chang's Algorithm** • Automatyka 2009, t. 13, z. 3

The advantage of the Chang's algorithm is a considerable reduction of the reference set. Its drawback is relatively small speed. The modification proposed by the author of this article aims at accelerating computations by replacing a larger number of objects, not only a pair of them, with one object. For any object in the reference set, it is possible to determine all objects from the same class which

are located at a shorter distance to it than any other object from a different class. This group of objects can be replaced by a single artificial object.

Keywords: pattern recognition, nearest neighbor rule, reference set condensation, reference set reduction, Chang's algorithm, modified Chang's algorithm

Sebastian Stoliński, Szymon Grabowski, Wojciech Bieniecki: **On Efficient Implementations of Median Filters in Theory and in Practice** • Automatyka 2009, t. 13, z. 3

The median filter, in its scalar and vector form, is a classic tool for suppressing impulse noise from images. In this paper we present a theoretical algorithm for worst-case optimized scalar median finding and an efficient implementation of the vector median filter (VMF). The former has not better complexity than two existing algorithms, but matches them for some relation between L and r , and is obtained using means which are novel in this context. The latter achievement is a simple practical idea which, for large enough masks, speeds up the standard (naive) implementation of VMF several times. We also presented results of a multi-threaded implementation, run on multicore machines.

Keywords: image processing, median filters, data structures

Roman Vorobel, Magdalena Stobińska, Krzysztof Przybyszewski: **On the Applications of Local Contrast Method for Edges Detection in Images** • Automatyka 2009, t. 13, z. 3

A simple method of edges detection have been described. It is based on the method of local contrast enhancement and it is distinguished by increased sensitivity of the brightness difference. It enables the edges detection even for a minimal brightness difference because of a more sensitivity method of the derivative calculations based on the relative differences between brightness levels. It is possible to use that method instead another ones, as Stobel's one for example, in more complicated calculations, as Canny's method, for example. These create a new possibility to increase a sensitivity of the edges detection methods.

Keywords: image, image transformation, contrast enhancement, edges detection

Maciej Wielgosz, Ernest Jamro, Kazimierz Wiatr: **FPGA Implementation of the Orbital Function Calculation Module** • Automatyka 2009, t. 13, z. 3

This paper presents an FPGA implementation of a finite sum of the exponential products (orbital function) calculation module. The module is composed of several units. All of them are specially designed, fully pipelined floating-point modules optimized for high speed performance, up to 200 MHz. Execution results revealed speed-up of 5× for the finite sum of the exponential products comparing to Intel Itanium 2 1.6 processor. Orbital function is a computationally critical part of the Hartree-Fock algorithm. Therefore an approach presented here aims to increase the performance of the whole quantum chemistry computational system by extending it with FPGA-based accelerator which is composed of two Xilinx Virtex-4 LX200 chips. It is worth underlining that achieved speed-up is limited by an external memory width constrain. Thus it can be expected that in foreseeable future introduction of next generation of FPGA-based accelerators will allow to increase the speed-up by just porting a project to them without adoption of any changes in the module's architecture.

Keywords: HRC (High Performance Computing), FPGA, elementary functions, exponential function

SIGNAL PROCESSING FOR IDENTIFICATION AND CONTROL SYSTEMS

Marcin Bąkała, Dominik Sankowski, Andrzej Albrecht, Rafał Wojciechowski: **Determination of Surface Tension Using the Maximum Gas Bubble Pressure Implemented in Brazeability Analyzing System** • Automatyka 2009, t. 13, z. 3

In this paper the original surface tension determination method based on maximum gas pressure in a bubble released in melted braze material is presented. This method is alternative solution to the laying drop method. The concept and realization of the measurement experiment is presented in the aspects of device construction and application operation. Proposed solution as original concept

which allows to conduct fully automated, repeatable experiments and accurate analysis.

Keywords: *surface tension, bubble method, brazeability analyzing system*

Anna Broniec, Jacek Chodak: **Application of EEG-Signal to Control Simple Electric Device** • Automatyka 2009, t. 13, z. 3

Detailed knowledge of changes in electroencephalography signal (EEG) which occur during various human activities gives enormous possibilities to create brain-computer interfaces (BCI). The BCI research is progressively expanding and extremely important field in biomedical engineering. These brain-computer interfaces give hope to people with severe disabilities for improving their quality of life. There is also a wide range of BCI applications in the field of virtual reality and mind-controlled games. The aim of our project was to create a simple game using a railway toy, which is able to move by conscious changes in brain activity of players. The EEG signal is acquired using a set of electrodes placed on the heads of the players and it is processed in real time by dedicated algorithms. This project has been performed for the educational and cognitive purposes.

Keywords: *brain-computer interface (BCI), neurofeedback, electroencephalography (EEG)*

Marta Chodyka, Włodzimierz Mosorow: **Security Method Preventing Potential Viewers from Viewing Age-Inappropriate TV Programs** • Automatyka 2009, t. 13, z. 3

Usually parents or guardians' supervision over children during television viewing is restricted to selecting programs by the parents, or simply establishing viewing hours for the broadcasted channels. This article consists of an overview of the available solutions, methods and security devices preventing potential viewers from viewing age-inappropriate television programs, as well as the elaborated and designed by the authors method preventing children from viewing inappropriate channels.

Keywords: *parents' supervision, security method, security device*

Andrzej Frączyk, Piotr Urbanek, Jacek Kucharski: **Control Algorithm of Inductor's Movement and Heating Power Providing the Uniform Temperature Distribution in Induction Heated Rotating Steel Cylinder** • Automatyka 2009, t. 13, z. 3

In the paper the influence of the type of inductor's movement and heating power control on the uniformity of temperature distribution along the cylinder axis has been analysed. In two control loops governing movement of the inductor and its heating power the PD algorithms have been used. Obtained results confirm usefulness of proposed method for efficient forming of the temperature profile along cylinder axis.

Keywords: rotating cylinder, induction heating, control algorithms, uniform temperature profile

Maciej Garbacz, Mieczysław Zaczyk: **Path Planning Algorithms in Unknown Environment for Khepera III Mobile Robot** • Automatyka 2009, t. 13, z. 3

In the article some obstacle avoidance algorithms are presented. This application is based on mobile robot Khepera III and Matlab/Simulink system. Proximity sensors and ultrasonic sensors are used to detect obstacles. Presented algorithms control motion of robot using information from proximity and ultrasonic sensors. Some experiments are given to demonstrate the performance of this proposed approach.

Keywords: path planning, mobile robots, obstacle avoidance, proximity sensors, ultrasonic sensors

Sławomir Jeżewski, Maciej Łaski: **Overview and Comparison of Robotic Simulation Environments** • Automatyka 2009, t. 13, z. 3

The paper presents short survey of simulation environments designed to simulate mobile robots. 27 products from the market was evaluated and compared against their capabilities and usability in real design and prototyping tasks. The idea of distributed simulation environment was presented as well as practical issues during simulation of six wheeled robot using Microsoft Robotic Developer Studio.

Keywords: mobile robot, simulation environment, prototyping environment

Sławomir Jeżewski, Dominik Sankowski, Wojciech Dadan: **The Idea of Autonomous Robot Designed for Scouting Tasks and Detection** • Automatyka 2009, t. 13, z. 3

The paper presents the idea of operating system for autonomous mobile robot designed for observation task and mines detection tasks. Authors present overview of the constructions of small military mobile robots (UGV) offered by most advanced enterprises in Poland and worldwide. The review is focused on application of the robots, variety of tasks performed by robots and finally leads authors for the idea competitive military robot. Planned robotic system is a 6 wheeled platform equipped with system of visible range cameras, night vision camera, and directional microphones, optical sensors, lasers sensors, ultrasound sensors and advanced microprocessors systems for data analysis. The system will be capable to autonomously or semi-autonomously navigate in urban or rural environment. The most complex component of the robot is modular and hierarchical controlling system – robot's operating system. Authors propose operating system divided into 7 layers, in which the microprocessors and programming tasks are divided semantically.

Keywords: *mobile robot, autonomous navigation, robot's operating system, mine detection*

Przemysław Korohoda: **Compartmental Model for the GFR Assessment with the Injected Dose of Marker** • Automatyka 2009, t. 13, z. 3

In the paper an updated approach to multicompartment modeling used for the renal efficiency assessment is presented. The technique is based on the injection of a dose of the artificial marker. The vital feature of the proposed solution is that instead of the fixed final formulas, typically presented in the literature, the possible computational formulas are described, suited to match the relevant modern tools. The presented approach makes it possible to conduct multi-aspect investigations based on simulations. The examples of such research are also provided based on the most common two-compartment model. The described modeling technique should be used to verify the suggested in the literature formulas for the clinical application of the *GFR* calculations after taking only a single blood sample to measure the marker concentration.

Keywords: *multicompartment modeling, GFR, iohexol marker*

Przemysław Korohoda: **Simplified Flow Model of Hemodialysis - a Comparison with the Classical Two-Compartment Model** • Automatyka 2009, t. 13, z. 3

In the paper a simplified blood flow model of hemodialysis is suggested, being a modified version of the classical two-compartment model. A method of pseudorandom hemodialysis data generation has been designed to enable relevant comparative study of both models. For such test data, $N = 1000$, it has been shown that the flow model has very similar capability of modeling the concentration runs, as the classical two-compartment model. For the randomly generated data, the mutual relationship between the crucial model parameters has been shown. Such property makes the conversion between discussed models very simple. However, some differences in the runs obtained from both models were also indicated, which encourages further investigation of the blood-flow models.

Keywords: *kinetic modeling, hemodialysis, two-compartment model, blood flow model*

Tomasz Kryjak: **Video-Based Eye Tracking** • Automatyka 2009, t. 13, z. 3

This paper presents a video-based eye tracker. Firstly, three eye image acquisition systems were tested and the best solution, a camera with an infrared passing filter and infrared illumination, was chosen. The segmentation and center of mass calculation algorithms were described. A system calibration method was proposed. Finally sample test results and further research possibilities were discussed.

Keywords: *image processing, pupil detection, pupil segmentation, eye tracking*

Konrad Kułakowski: **Robust – Communication Model Mindstorms NXT and PC** • Automatyka 2009, t. 13, z. 3

Successful working of mobile robot highly depends on robust and reliable signals processing coming from the environment. An important part of such processing is the mechanism responsible for passing the readings from a sensor to a control unit. The aim of the article is to present a communication model between Lego Mindstorms NXT and PC computer defined on the top of the Bluetooth

protocol. The model is implemented in Robust platform – a Lejos library facilitating efficient communication between NXT and PC.

Keywords: *mobile robot, Java, Lejos, Lego Mindstorms NXT*

Konrad Kułakowski, Jarosław Wąs: **Architecture of Pedestrians Dynamics System** • Automatyka 2009, t. 13, z. 3

The article presents a concept of architecture of pedestrians dynamics system. It is build on the base of authors experiences and requirements of modern software engineering. The first part contains existing models of pedestrians dynamics, while in the second part new architecture model based on UML diagrams is proposed. The paper presents also application, which was build according to assumptions.

Keywords: *pedestrian dynamics modeling*

Patryk Orzechowski: **Method of Fitness Function Deterioration for Evolutionary Algorithms with Soft Selection** • Automatyka 2009, t. 13, z. 3

In this paper we present an initial version of fitness function deterioration method by applying linear combination of Gaussian functions. The algorithm may be used as a part of evolutionary search algorithm with soft selection. Experiments show that algorithm is especially helpful for population to cross saddles of multimodal functions. Further research is needed to optimally assign the algorithm parameters, as well as to set its use cases.

Keywords: *evolutionary algorithms, soft selection, Gauss function*

Adam Piłat, Paweł Piątek, Dariusz Marchewka, Mariusz Pauluk: **Analysis and Signal Processing in Dedicated Environment for Rapid Prototyping of Electric Motor Controllers** • Automatyka 2009, t. 13, z. 3

One of the most interesting application of the microprocessor based systems is control of the electric motor by the 8-bit microcontroller with simultaneous data acquisition via USB. The developed solution is an innovative application in the field of universal motor controllers. The most important features of this solution are: low cost, application of digital control and diagnosis algorithm. In the case of application to devices with variable torque the develo-

ped system allows to realize a wide range of research including identification, state estimation and synthesis of the optimal control strategy.

Keywords: *control, micro-controller, soft real-time, rapid prototyping, data acquisition, electric motor*

Dominik Sankowski, Włodzimierz Mosorow: **Application of Wireless Sensor Network Simulator in Sensor Networks Research**

• Automatyka 2009, t. 13, z. 3

The paper describes research of properties and behaviour for chosen sensor network topologies using the Wireless Sensor Network Simulator v.1.0.

Keywords: *sensor networks, network simulation, network life-time*

Piotr Urbanek, Andrzej Frączyk, Jacek Kucharski: **Shaping the Temperature Profile of Induction-Heated Charge by Moving Inductor** • Automatyka 2009, t. 13, z. 3

In the paper a new method of induction heating of the rotating steel cylinder based on the inductor's movement along cylinder axis has been proposed. The detailed analysis of the dependence of inductor's move along cylinder axis on the quality of temperature profile has been given. Obtained results confirm the effectiveness of the proposed method for flexible shaping of heating power and temperature distribution in the considered plant.

Keywords: *rotating cylinder, induction heating, uniform temperature profile*

Jarosław Wąs, Rafał Bieliński, Bartłomiej Gajewski, Patryk Orzechowski: **Issues of City Traffic Modeling Based on Cellular Automata** • Automatyka 2009, t. 13, z. 3

The article contains a concept of city traffic modeling based on classical Nagel-Schreckenberg model. Microscopic approach is used in the paper. The focus is given on realistic behavior of particular vehicles especially: acceleration, braking and lane changing rules. Digital GPS maps are used in the process of model topology construction. The authors use an interesting map format, widely known as Polish Map Format.

Keywords: *cellular automata, traffic modeling*

IMAGE ANALYSIS AND RECOGNITION

Łukasz Jopek, Robert Nowotniak, Michał Postolski, Laurent Babout, Marcin Janaszewski: **Application of Quantum Genetic Algorithms in Feature Selection Problem** • *Automatyka* 2009, t. 13, z. 3

In the article a feature selection problem for k-NN classifier in image segmentation has been analyzed. Feature selection has been considered as a two criteria combinatorial optimization problem. An objective of optimization process was to find a feature subset of image points, allowing good quality of segmentation in satisfactory time. A fitness function for feature subsets has been proposed, taking into account time needed for calculation of feature values and quality of segmentation. Three population-based heuristic methods of optimization have been compared: simple genetic algorithm and its two modifications, inspired by principles of quantum computing: QiGA (*Quantum-Inspired Genetic Algorithm*) and GAQPR (*Genetic Algorithm with Quantum Probability Representation*). Results of experiments with artificial and tomography textures have been presented.

Keywords: *genetic algorithms, quantum genetic algorithms, feature selection, segmentation*

Przemysław Korohoda: **Efficiency of the Keypoint Detection in the Stereoscopic Images with Use of the Hessian Matrix Eigenvalues** • *Automatyka* 2009, t. 13, z. 3

In the paper a computational experiment performed for the stereoscopic image pair has been described. The aim of the designed experiment was to investigate the similarities and differences between three methods used to localize the keypoints, basing on the Hessian matrix eigenvalues. The keypoints were obtained for the four-level Gaussian pyramid, and then the ones common for all levels were selected. Afterwards their locations were visually and statistically compared and then the disparity maps were computed. The disparity in that task was calculated with use of the correlation coefficient. The results indicate noticeable differences between theoretically similar techniques utilizing the eigenvalues ratio. The

advantageous properties of the third method, based on the difference between eigenvalues, have been confirmed.

Keywords: *keypoints, Hessian matrix, stereoscopy, disparity*

PROCESS TOMOGRAPHY

Robert Banasiak: **Validation of Numerical Model of 3D ECT Sensor** • *Automatyka* 2009, t. 13, z. 3

The 3D image reconstruction is a complicated and time consuming computational job. There are few important problems solved during this multistage, iterative process which can significantly influence on the effectiveness of the image reconstruction. One of the most crucial parts of image reconstruction process is a computation of forward model which is simulation of capacitance data and an accuracy of this process depends on the method we are using for that. Typically finite elements method and numerical 3D ECT model is used for maximizing the accuracy of the forward problem. In this paper a new idea of complete numerical model of 3D ECT sensor has been presented with its preliminary validation based on experimental data. The complete model of 3D ECT sensor with full screening arrangement and other constructional details is able to improve forward problem solution accuracy and also improves matching between simulated and experimental capacitance data.

Keywords: *capacitance tomography, 3D ECT, capacitance sensor model*

Zbigniew Chaniecki, Krzysztof Grudzień, Andrzej Romanowski, Dominik Sankowski: **Flow Characteristics Determination of Pneumatic Conveying Using Twin Plane Electrical Capacitance Tomography** • *Automatyka* 2009, t. 13, z. 3

This paper reveals a methodology of determination of the bulk solids pneumatic transport installation properties using twin plane electrical capacitance tomography system. The focus is to obtain information necessary for development of proper monitoring, diagnose and control of industrial installation. In case of pneumatic conveying the ultimate goal is to prevent pipeline blockage and material degradation as a result of misadjusted transportation parameters. Diagnostic information coming from ECT allows the effective

process control. This consists in velocity and pressure settings, in order to get the appropriate, for given medium, flow regime. In this paper there are flow results for different settings of choppers controlling the air blowjets and rotating feeder. On this basis, the work states characteristics of the pneumatic installation will be constructed.

Keywords: *pneumatic conveying, electrical capacitance tomography*

Krzysztof Grudzień, Jerome Adrien, Laurent Babout, Andrzej Romanowski, Zbigniew Chaniecki: **Quantitative Analysis of Bulk Solids Porosity with Use of X-Ray Tomography System** • Automatyka 2009, t. 13, z. 3

Paper presents feasibility study of X Ray tomography system application to porosity measurement of dense packed bulk solid in rectangular silo model. Obtained preliminary experimental results reveal the measurement capabilities of the tested system. Results presented are for static measurement of silo sand filling. There is a comparison between two different silo regions, with different packing density values of sand, and qualitative analysis of results is performed. Theoretical description of distinct parameters of X Ray tomography system parts influence on quality of obtained results is presented. Additionally, the discussion on procedure of preparation and adjustment of measurement system parameters in order to achieve best data for quantitative analysis of tomography images is cover in this paper.

Keywords: *solid, porosity, X-ray tomography, radiography*

Krzysztof Grudzień, Maciej Niedostatkiewicz, Zbigniew Chaniecki, Andrzej Romanowski, Dominik Sankowski: **Estimation of Material Packing Density in Silo Based on the Electrical Capacitance Tomography (ECT) Measurements Data** • Automatyka 2009, t. 13, z. 3

This paper describes the application of Electrical Capacitance Tomography (ECT) to measurement of porosity changes in bulk solid during the process of silo unloading. Authors focus on identification of the strict relationship between the change of bulk solid concentration and measured sensor inter-electrode capacitance records. The concentration changes are showed in the form of bulk

solid porosity indicator value changes. The derivation of the relationship between dynamic material concentration changes and resulting capacitance changes will allow to estimate the error of the material concentration determination. This will be helpful in quantitative analysis of measurement data. In addition, this will also help in better utilization of capacitance tomography systems in industrial control systems. This paper presents preliminary results of analysis for loading and storing of sand in smooth-wall silo. Presented results are part of the wider research programme targeted in development of the tomographical system for noninvasive diagnostic of material flow in silos.

Keywords: *Markov chain, MCMC, electrical tomography inverse problem*

Tomasz Jaworski, Radosław Wajman: **Graphical User Interface for Building the Spatial Definition of the Electrodes in 3D Electrical Capacitance Tomography** • *Automatyka* 2009, t. 13, z. 3

The following work presents the software, which has been designed as a CAD-like application for building spatial distribution of the electrodes on 3D meshes. The main features of it is to allow the development of the new spatial definitions of the electrodes in the simulated ECT sensor's geometry and the development of the sensors' layouts based on generated geometries or mask images for physical sensor implementations. The software ensures the high conformity of the built sensor with its computer model. Furthermore, this work contains description selected algorithms and transformations used for processing the layout and finite element mesh.

Keywords: *3D Electrical Capacitance Tomography, Finite Elements Mesh*

Sławomir Jeżewski, Sylwester Błaszczuk: **Comparison of Edge Detection Algorithms to Task Three-Dimensional Object Shape Reconstruction** • *Automatyka* 2009, t. 13, z. 3

In this publication was represented conception of three-dimensional object reconstruction based on edge detection algorithms. In this approach these edges are transformed to vectors, than the depth map is determined. Accuracy of vector determination depend on vectors length. Results show, that choose of appropriate edge detection algorithm is important in reconstruction process. The Fuzzy, LoG and Canny edge detection algorithms was tested. The propo-

sed algorithm is extension of edge stereovision and can be a supplement for correlation stereovision.

Keywords: *stereovision, edge detection, algorithms: Fuzzy, LoG, Canny's*

Sławomir Jeżewski, Adam Wulkiewicz: **Idea of Perceptual Space of Mobile Robot** • Automatyka 2009, t. 13, z. 3

Modern mobile robots use many different sensors to self-localize in the environment. They collect and process sensory information on different levels of their's operating systems in different manner. The most important point where all positional sensory information is integrated are localization and mapping algorithms. Authors presents data structure for and the algorithmic structures which enables fast integration of measurements from various sensors and fast data access. Presented structure has local access capability which is important in the multiprocessing environment. It was presented also the intuitive way of visualization collected data.

Keywords: *robot, localization, mapping, SLAM, sensor, integration, sample structure, data, visualization*

Bartosz Matusiak, Krzysztof Grudzień, Andrzej Romanowski: **Usability of ECT for Investigating Liquid Distribution in Trickle Bed Reactors** • Automatyka 2009, t. 13, z. 3

Trickle bed reactors are widely used for a number of different applications in industry. Investigations are very difficult to perform due to the opaque nature of such systems. The researches on trickle bed reactors hydrodynamics are conducted for a long time. Since now some attempt to use local probes, colorimetric and tomographic techniques were performed. However, MRI, X-ray and gamma ray transmission tomography suffer from low temporal resolution and are cost-intensive. On the other hand, Electrical Impedance or Resistance Tomography need to be in contact with investigated substance and cannot be used for non-conducting materials. At this background Electrical Capacitance Tomography seems to be very attractive technique. In this paper, the results of performed investigations on trickle bed reactor experimental setup, with a use of Electrical Capacitance Tomography combined with a sensors comprised of internal electrodes, are presented.

Keywords: *electrical capacitance tomography, trickle bed reactor, liquid holdup, internal ECT sensors*

Andrzej Romanowski, Krzysztof Grudziń, Dominik Sankowski:
Markov Chain Applications to Tomographical Inverse Problem with Monte Carlo Methods – a Review • Automatyka 2009, t. 13, z. 3

In order to solve capacitance tomography inverse problem, a number of mathematical difficulties needs to be overcome. These problems exist no matter the if the solutions is the reconstructed image, or an estimation of process parameters (i.e. material concentration value calculated on the basis of post processed tomograms). This paper presents properties of Markov chain Monte Carlo (MCMC) methods, which application can be a way to solve the inverse problem. Paper covers the specific properties of MCMC algorithms, discussion about using the measures of a posteriori probability density functions, construction of appropriate Markov chains, strategies for proposed values updates, initial values, determination of initial, transient period length and termination, and results validation. The last is a review of possible applications of discussed methods in order to prove its general character and moreover, eventual usefulness for ECT.

Keywords: *Markov chain, MCMC, electrical tomography inverse problem*

Mariusz R. Rząsa, Radosław Wajman: **The Selection of the Sensitivity Maps Calculation Method for ECT of Higher Sensitivity near the Sensor Wall** • Automatyka 2009, t. 13, z. 3

The process tomography is commonly used for non-invasive investigation of any industrial processes like two-phase gas-liquid flows. In this paper the new concept of dedicated sensor is introduced. This sensor is of higher sensitivity near the sensor wall with additional electrodes. This design is especially helpful for visualization the annular counter current flow structure. For this approach there was a need to implement a new methods of sensitivity maps calculation. In this work the description of different methods of sensitivity maps calculation is presented as well as the results of the research for applying the most efficient one. The result of image reconstruction process for described flow structures are also shown.

Keywords: *Electrical Capacitance Tomography, sensitivity maps, two-phase gas-liquid flows*

NEURAL NETWORKS

Joanna Grabska-Chrzastowska, Wojciech Lazar: **Automating of the Process of Neuro-Expert Classification Systemtesting Based on Statistica Software Programme in Practical Use** • Automatyka 2009, t. 13, z. 3

The paper presents the use of an automated system choosing neural system network parameters in order to classify patients into two groups. Categorisation of spirometric tests was chosen for practical testing of the created software. The results of the system were compared to the earlier published attempt of an empirical choice of network system parameters.

Keywords: neural network, neuro-expert classification system, automatic neural networks designer

Zbigniew Mikrut, Mariusz Duplaga: **Extracting Data from the Bronchoscopic Images for the Subsequent Classification** • Automatyka 2009, t. 13, z. 3

The goal of the experiments was to compare HS pixel representation with HSV (*Hue Saturation Value*) during detection of bleedings in bronchoscopy images. The interactive algorithm was developed to refine the bleeding regions pointed out by the doctor. Six different images were chosen and the bleeding areas were extracted based on the developed algorithm. The mutual percentage coverages of the bleeding regions were computed and compared for the two pixel representations.

Keywords: bronchoscopy, bronchoscopic images, bleeding, representation of color

Zbigniew Mikrut, Mariusz Duplaga: **Bleeding Detection in Bronchoscopic Images: a Neural Network Approach** • Automatyka 2009, t. 13, z. 3

In the paper the experiments with using SOM-supervised neural networks for pixel (HSV) classification were presented. Six visually different images were chosen to be the basis for the SOM training. For these images learning sets were created based on the refined masks of the bleeding regions pointed out by the doctor. Next the six learning sets were merged and the ambiguous pixel

representations were removed. Two types of SOM-supervised networks (of “normal” and “small” sizes) were created and learned. The classification results were obtained and analyzed both for learning sets and for 14 test images. Several conclusions were stated concerning the learning methodology and the bleeding areas post-processing.

Keywords: *bronchoscopy, bronchoscopic images, bleeding, SOM, SOM supervised, HSV representation*

BUSINESS INFORMATION SYSTEMS

Wojciech Bieniecki, Jacek Stańdo, Sebastian Stoliński: **Requirement Analysis for an e-Evaluation System for Examination Assignments** • *Automatyka* 2009, t. 13, z. 3

In his paper the idea of e-evaluation is presented. This is a system for checking sheets of paper in the examination by the examiner directly on the computer screen. The advantage of such a solution is, as experience has shown, to improve the quality of the preparation of the test and its evaluation. The process of automation of the examination includes systems of electronic tests, commonly implemented both as a standalone or distributed application. We present the project architecture of a web system for scanning exam sheets, distributing the scans to examiners and managing the whole process of examination in a secure and effective way. A long-term goal is to let Central Examination Board deploy the system in maturity and high school examinations.

Keywords: *e-evaluation, software engineering*

Katarzyna Grobler: **MRP and CRP Algorithms in IFS Applications** • *Automatyka* 2009, t. 13, z. 3

The paper discusses issues connected with support of manufacturing management in IFS Applications – ERP system. Firstly, the author presents IFS Manufacturing system. In the main part of the article it is described operation of two basic algorithms in support of manufacturing planning. Finally, the operation of these algorithms is explained on a practical example.

Keywords: *IFS Applications, IFS Manufacturing system, Material Requirements Planning, Capacity Requirements Planning*

Joanna Kwiecień, Bogusław Filipowicz: **Assignment Problems in Air Transport** • Automatyka 2009, t. 13, z. 3

With the rapid development of air transport traffic, the models for allocating airport and airline resources become much complicated. Assignment problems are very important issues during airlines operations. In this paper we present mathematical models of the airport gate assignment problem, the aircraft landing problem and the crew assignment problem. Their objective is to minimize the overall costs or connection times. The results of computational experiments are also presented.

Keywords: gate assignment problem, aircraft landing problem, crew assignment problem

Dominika Lisiak-Felicka: **Selected Aspects of Informatization of Local Government Units** • Automatyka 2009, t. 13, z. 3

The article presents information about number and cost of IT projects which were realized by local government units. Information is based on budget analyze and own research. Information of IT projects implemented in framework of the Regional Operational Programs were also analyzed. The article presents the degree of informatization of offices in Poland and shows basic problems in the development of e-Administration.

Keywords: informatization, administration, local government

Zdzisława Rowińska: **Accustoming of Microsoft Windows 2003 Server and Active Directory in Big International Firm** • Automatyka 2009, t. 13, z. 3

The article presents the process of accustoming of operating system in big firm about international coverage. Firm owns some tens outposts in the area of CEE. All of them owns personal, independent structure. It is effective separating and logical isolation of network. The offices use different net systems: Novell 4.x, Novell 5.x, Windows NT, Windows 2000 and Windows 2003. The firm needed homogeneous, hierarchic net structure. Accustoming of Microsoft Windows 2003 Server and Active Directory allows to obtain such effect exactly.

Keywords: Microsoft Windows 2003 Server, Active Directory, network operating system

Paweł Skrzyński, Tadeusz Szuba: **The Concept of Molecular Model of Computation in the Analysis of Invisible Hand Process** • Automatyka 2009, t. 13, z. 3

Invisible hand process which is widely believed to be present in free market is perceived as the process in which the outcome to be explained is produced in a decentralized way, with no explicit agreements between the acting agents. The second essential property is that the process is not intentional, however its impact on the market is very strong. Such process might be described using collective intelligence computational model [2]. The paper describes the concept of market simulator which derives from microeconomic theory of utility and is based on collective intelligence computational model and the transformation of such model into a molecular model in which information is carried by information molecules among which reasoning processes might occur which lead to creation of new molecules carrying conclusions of such processes. Research made in this area proved [4] that such model is efficient and moreover has natural computation parallelism. Usage of such model might add extra value to the analysis of the nature of economic processes including invisible hand process. Initial experiments made by authors were aimed in investigation relation between real sphere and financial sphere in economic system – it is widely known that one of the main roles of the financial sphere is stimulation production in real sphere.

Keywords: *Collective Intelligence, computational model, inference process in social structure, Adam Smith Invisible Hand of Market, simulation model, self-regulation, molecular model of computation*

Michał Turek: **3D Rotary Scanned Mesh Optimization for Fast Real-Time Rendering** • Automatyka 2009, t. 13, z. 3

In this paper a method was presented to improve quality of three-dimensional shapes used in the construction of virtual scene presentation or 3D games. It's well known that one of the sources for such material (3D models) is a three-dimensional scanning of real objects. Not every 3D model is immediately suitable for use with a 3D engine. Sometimes it is necessary to adapt its contents in a very arduous way. The paper proposes improved methods for 3D mesh conversion, providing an automatic process able to eliminate

some 3D mesh flaws we can meet. Particular emphasis was made for the processing of 3D nets obtained by scanning rotation. Results has been tested with multiple mesh samples improved and checked in a rapid 3D engine written by the author.

Keywords: *3D-graphics, 3D-mesh, polygon mesh, 3D engine, 3D model, 3-dimensional scanning, rotary scanning, 3D mesh optimization, rendering, OpenGL*

COMPUTER SCIENCE IN EDUCATION

Andrzej Cader, Krzysztof Przybyszewski: **Distributed e-Learning Platforms** • *Automatyka* 2009, t. 13, z. 3

Distributed e-learning environments has been presented in this paper. There was made a comparison of properties both distributed and centralized platforms. Distributed platforms can shape an individual learning profile and fit it to student possibilities and needs more effective than centralized systems. They can transform to Individual e-learning Platforms. The best way to implement distributed environments is to use agent technologies. There was proposed a layers model for this solution.

Keywords: *e-learning platform, distributed e-learning system, agent e-learning platform*

Krzysztof Przybyszewski, Andrzej Cader, Alina Marchlewska: **On the Usefulness of Some Methods for Effectiveness Determination of Classical Education and e-Learning Systems** • *Automatyka* 2009, t. 13, z. 3

In the paper we have described a principle of elements separation of any education system (classical or electronic). We have proposed method of determination of an effectiveness of the education systems based on the separation principle and on the modified education added-value method. It is useful in wider area as a classical method: it is possible to determine an effectiveness coefficient of an unit element of a system (learner, teacher) and it is useful for any level of education, for the high schools, for example. It is simple for calculation and any added estimations are needed. The results that obtained with it have been compared with those from the classical

education added-value method. That comparison certifies new method advantage over an classical one.

Keywords: *education systems, e-learning systems, effectiveness of education system, education added-value*

Agata Skowrońska-Kapusta, Paweł Kapusta, Piotr Goetzen: **Analysis of Selected Aspects of Knowledge Acquiring and Gathering Processes in Distance Learning Systems** • *Automatyka* 2009, t. 13, z. 3

Automatic adaptation of e-learning tools to VLE (*Virtual learning environment*) users' needs supports teaching/learning process. Adaptation takes place during the process of analysis of data gathered when e-platform user session has been established. Wide range of information must be analyzed.

The aim of this paper is to define selected statistic data which, later on, will be treated by analysis algorithms. Collector and Analysator subsystems are introduced. Thanks to gathered data the e-learning system might become more secure and more efficient. The data can reorganize many independent VLE for one user which will lead to more individual teaching/learning. Proposed solutions define fundamental assumption of the project which uses Moodle platform an e-learning VLE.

Keywords: *data mining, e-learning, e-learning platform, Moodle*

WIRELESS TECHNOLOGIES AND DATABASES

Tomasz M. Kowalski, Paweł Cebula, Kamil Kuliberda, Jacek Wiślicki, Radosław Adamus: **Query Optimization by Indexing for Object Query Language** • *Automatyka* 2009, t. 13, z. 3

In paper we present an overview of query optimization by indexing for SBQL (Stack-Based Query Language). Developed methods have been implemented and tested in Odra prototype system. The Odra index implementation is based on linear hashing and works in a scope of a standalone database. It consists of transparent optimization, automatic index updating and management facilities. The semantic equivalence of proposed query optimization

methods in the context of object data model and query language is discussed on several examples.

Keywords: *ODRA, SBQL, database, indexing, query optimization*

Tomasz M. Kowalski, Kamil Kuliberda, Cezary Draus, Radosław Adamus, Jacek Wiślicki: **Generalized Approach to Automatic Index Updating in OODBMS** • *Automatyka* 2009, t. 13, z. 3

We describe a generalized approach to the problem of the automatic index updating in response to modification of corresponding data. To enable creation and transparent maintenance of indices supporting keys defined using arbitrary, deterministic and side effects free expressions the authors propose applying a special kind of database triggers. Query language for object-oriented model (classes, inheritance, polymorphism, class methods, etc.) allows easy defining of more complex selection predicates; nevertheless, in order to provide full indexing transparency, index updating requires substantial revising. Inadequate index maintenance can lead to serious errors in query processing. The authors work is based on the Stack-Based Architecture (SBA) and has been implemented in the ODRA (Object Database for Rapid Applications development) OODBMS prototype.

Keywords: *index maintenance, automatic index updating, indexing, triggers, OODBMS, SBA, SBQL, ODRA*

Kamil Kuliberda, Tomasz M. Kowalski, Jacek Wiślicki, Radosław Adamus, Michał Meina: **Integration and Indexing of Distributed Data Resources in a Data Grid Technology** • *Automatyka* 2009, t. 13, z. 3

The problems of integration of distributed resources are currently one of the most substantial issues in the domain of collecting data and retrieving consistent and reliable information – the answer has been included in the following paper. Authors describe aspects of transparent integration of distributed data into an object-oriented data grid with application of the p2p technology and introducing extremely crucial issues of indexing. The presented solution has been implemented and verified in the completely functional prototype. The paper presents basics of application of the p2p architecture and procedures of indexing data originating from remote sources.

These procedures accelerate data access by orders of magnitude and data transportation becomes limited to the necessary minimum.

Keywords: *transparent integration, data grid, distribution, index, indexing, object-oriented database*

Kamil Kuliberda, Jacek Wiślicki, Tomasz M. Kowalski, Radosław Adamus, Michał Meina: **Integration of Legacy Relational Databases to an Object-Oriented Data Grid** • *Automatyka* 2009, t. 13, z. 3

Authors present the implemented and verified with the fully functional prototype approach to integration of legacy relational data into an object-oriented data grid. The presented process is completely transparent due to application of the virtual repository concept and updatable virtual object-oriented views defined in the stack-based approach (SBA). In the described process much stress has been put on employing native optimizers of relational databases. Hence, transportation and processing of retrieved data within the virtual repository have been limited to the required minimum. Due to the described procedures and architecture, an end user receives a purely object-oriented schema reflecting his/her business requirements and/or access privileges, whose data can be queried with an object-oriented query language (SBQL). Data available in relational systems are retrieved as objects and they can be arbitrarily combined with results coming from other integrated data sources (e.g., object-oriented, relational, XML), so that the user is not aware of their actual origin.

Keywords: *data grid, transparent integration, object-oriented database, relational database, legacy data*