

IMAGE PROCESSING FOR MEDICAL AND INDUSTRIAL APPLICATIONS

Dariusz Brzeziński: **Gauss Quadrature Evaluation for Signal Analysis** • Automatyka 2011, t. 15, z. 3

Part of the signal processing is to convert the signal specified in the time domain into the signal specified in the frequency domain. It allows to obtain the signal spectrum and its possible visualization. This conversion can be done by decomposing a continuous or discrete function in the Fourier series. To construct the Fourier series it is necessary to calculate their coefficients. We can calculate the coefficients numerically using quadratures. This paper provides an analysis of the calculation accuracy of the coefficients of the Fourier Series of five elementary, deterministic signals used in practical applications which should build a challenge by their characteristics for two, quiet differ from each other methods of numerical integration: Newton Cotes' Midpoint Rule and the Gauss–Legendre Quadrature. Additionally – the Fast Fourier Transform – the FFT was used as the point of reference concerning the accuracy. By decomposing elementary signals and analyse the accuracy of the calculated coefficients the author wished to find the basic types of real world signals for which the application of Gauss Quadratures may be smarter solution due to better accuracy and lesser computational complexity (by the means of radically reduced amount of the sample points) than the FFT.

Keywords: signal analysis, numerical integration, Gauss quadrature, coefficients of the Fourier Series

Agnieszka Dąbrowska-Boruch, Kazimierz Wiatr: **Implementation of FCT Transformation in JPEG-XR Standard in Programmable Devices** • Automatyka 2011, t. 15, z. 3

JPEG-XR is a new standard of still image compression. Paper presents basic information of the FCT transformation. Article presents modifications of FCT transformation blocks and results of hardware implementation of FCT transformation in V5LX110 Xilinx chip.

Keywords: FCT, hardware implementation, JPEG-XR, FPGA

Anna Fabijańska: **Graph Based Image Segmentation** • Automatyka 2011, t. 15, z. 3

In this paper problem of graph-based image segmentation was regarded. Specifically, min-cut/max-flow approach proposed by Boykov and Jolly was investigated. The influence of functions describing boundary and regional conditions on results of image segmentation of various images were presented and discussed.

Keywords: image segmentation, graph, min-cut/max-flow

Jarosław Goćławski, Joanna Sekulska-Nalewajko: **An Image Segmentation Method to Reveal Regions of Stress Manifestation in Stained Cucurbits' Leaves Using LVQ Neural Network** • Automatyka 2011, t. 15, z. 3

In the paper an image segmentation method has been presented, which enables to detect cucurbits' leaves stress manifestation featured by the accumulation of reactive oxygen species (ROS) like hydrogen peroxide (H_2O_2) or superoxide anion radical (O_2^-). After specific leaf staining the regions can be distinguished in colour space from the intact leaf parts. The proposed algorithm, developed in MATLAB environment, includes the segmentation of scanned leaf images with selected background, the exclusion of certain leaf parts and the classification of reminded leaf blade image pixels in H, S (hue, saturation) colour space. The classification is based on LVQ type neural network with several neurons in an internal layer and two neurons in an output layer, which represent image pixels of stained and unstained tissue respectively. The network learning process uses representative leaf image pixel data and binary template images of stress manifestation regions prepared manually by specialists. The classifier was 5-fold cross validated with the pixel H, S data of learned image and validated with the data of other images (with templates). The computed classification errors have been included. The experiments of stress regions detection carried out for the series of 12 images gave a few percent errors compared to manual classification.

Keywords: reactive oxygen species (ROS), image segmentation, HSV colour space, LVQ neural network, cost function, k-fold cross validation

Mirosław Jabłoński: **Scene Configuration in Stationary Camera Vision System** • Automatyka 2011, t. 15, z. 3

Issues related to camera calibration and scene configuration in stationary camera surveillance system have been discussed. Mathematical model of relevant imaging distortion of 3D objects been presented. A review of camera calibration algorithms has been presented. Results of image correction followed by scene configuration and camera calibration have been shown. Drawbacks of methods have been indicated in the article.

Keywords: *scene configuration, camera calibration, surveillance, perspective distortion*

Marcin Janaszewski, Michał Postolski, Laurent Babout, Łukasz Jopek: **Topological and Geometric Hole Closing in 3D Objects** • Automatyka 2011, t. 15, z. 3

Hole closing in 3D volumetric objects is an important problem in tomography image analysis applied in medicine and material science. The article presents new algorithm for geometric and topological hole closing. According to the authors knowledge the presented algorithm is the first which closes both types of holes in 3D volumetric objects.

Keywords: *geometric hole, tunnel, tunnel closing, 3D images*

Tomasz Jaworski, Jacek Kucharski: **Preprocessing and Clusterization of Thermal Images of Induction Heated Steel Cylinder** • Automatyka 2011, t. 15, z. 3

The aim of this paper is to present an algorithm dedicated for clusterization of 2D thermal images of inductively heated steel cylinder, taken by an IR camera. Besides the clustering method described, paper provides also description of pixel distortion models (radial, perspective, surface curvature) and its diminishing methods. The goal of developed algorithm is an attempt to describe a thermal image in terms of warmer/cooler areas interpreted further as fuzzy objects. Authors believe, that resulting description can be used together with fuzzy assessment of spatial relations between

fuzzy objects as a part of inferring mechanism of algorithm for controlling movable inductive heaters.

Keywords: *image clusterization, thermovision, image distortions, image processing*

Lukasz Jopek, Laurent Babout, Marcin Janaszewski, Michał Postolski: **A New Method to Segment X-Ray Tomography Images of Lamellar Microstructure in Titanium Alloys Based on Contourlet Transform** • *Automatyka* 2011, t. 15, z. 3

This paper presents a new approach to segment heavily 2D textured images such as the one of lamellar titanium alloys obtained from X-ray tomography. The presented method considers Contourlet transform to recognize direction texture elements. Thanks to that the image after the segmentation is matching with spatial arranging crystal inside material. The method is tested on 2D images, but also on real microstructure images of the above mentioned material.

Keywords: *texture segmentation, Contourlet transform*

Tomasz Kryjak: **Analysis and Evaluation of Background Subtraction Algorithms for Video Surveillance Systems** • *Automatyka* 2011, t. 15, z. 3

This paper deals with important issues when choosing a moving object detection method for a video surveillance system. It was investigated, how the choice of colour space affects the segmentation results. Also conversion times between different colour spaces were measured and presented. Several background generation algorithms were analyzed and tested. Particular attention was paid to such features as the ability to correctly initialize the background model, the resilience to sudden changes in lighting and background multimodality. In addition, experimental results indicate that the use of motion information, obtained by calculating optical flow, may enhance the segmentation and performance of background generation.

Keywords: *image processing, image analysis, background subtraction, motion detection, object segmentation, colour spaces, optical flow, video surveillance*

Tomasz Kryjak, Mateusz Komorkiewicz, Marek Gorgoń: **Implementation of a Background Generation Algorithm with Moving Object Detection and Shadow Suppressing in Spartan 6 Series FPGA Devices** • Automatyka 2011, t. 15, z. 3

The article describes an implementation of a moving object detection system consisting of a digital camera, a Spartan 6 FPGA device and a LCD monitor. The object detection method is based on differential images. It uses the following algorithms: background generation, background subtraction and shadow removal. The basis of the system are two modules designed in VHDL: advanced background generation and moving objects segmentation based on brightness, colour and texture analysis. In addition the construction of modules allowing communication with the camera, execution of the Bayer transform, RGB to CIE Lab colour space conversion and fast interface to the external DDR3 RAM is described. The paper also presents the usage of FPGA resources and tests results of the proposed system.

Keywords: image processing and analysis, background generation, shadow removal, background subtraction, Bayer transform, RGB to CIE Lab conversion, hardware acceleration, FPGA

Michał Postolski, Marcin Janaszewski, Łukasz Jopek, Laurent Babout: **Tangent Direction Estimation in Each Point of 3D Volumetric Curve in Application to Quantitative Human Airway Trees Analysis** • Automatyka 2011, t. 15, z. 3

Quantitative description of an airway tree consists in application of several steps: segmentation of the tree, skeletonization, decomposition and anatomical labelling, cross section generation and finally quantitative measurements. Each step needs to use different kinds of image processing algorithms and their results have strong impact to quality of the final measurements. In the paper authors tested four methods for tangent estimation of 3D volumetric curves which can be used in bronchial trees analysis. 3D curves and tangent directions are used to generate cross sections of the tree. Therefore curves can be irregular and very hard to analysis. The paper presents basic concepts of the algorithms and their application to

two artificial object with known parameters and real application to curve generated based on real human airway tree.

Keywords: curve, tangent, airway tree, quantitative analysis, direction

Jaromir Przybyło, Marcin Piątek, Mariusz Pauluk, Jakub Galicki: **Low-Cost Mobile Image Processing Platform** • Automatyka 2011, t. 15, z. 3

In recent years mobile application development has earned massive popularity. Many vendors provide platform development environments (i.e. Android) which boosts software development. However, the main drawback of these environments is a limited functionality for computer vision algorithms. The presented work focuses on developing a low-cost mobile image processing platform. A hardware description and an integration of software components with development environments (OpenCV, MATLAB/Simulink) has been described. Experimental results show possibilities and limitations of the platform.

Keywords: mobile applications, computer vision, Android

Joanna Sekulska-Nalewajko, Jarosław Gocławski: **An Image Analysis Method for the Automatic Measurement of Selected Morphological Features of Wheat Shoots** • Automatyka 2011, t. 15, z. 3

In the paper an image processing and analysis algorithm has been presented, which provides the automatic measurement of selected morphological features of young wheat shoots. The plants were subject of heavy metals treatment experiments as well as beneficial selenium influence, so they growth potential can differ from the control group. The proposed measurement system uses scanned leaf images, that are processed in MATLAB environment to get leaves lengths and areas. After the segmentation stage binary image skeletons are determined, then changed to the graph forms and corrected to obtain the medial axes of a stem and leaves. These axes are measured in length, after their smoothing with the cubic splines method. The selection of leaf branching pixels and their closest counterparts on the other edge of each leaf enables cutting

single leaves and the measurement of their areas. The length measurements for the selected population of shoots have been presented and compared with the results of manual and simplified methods. The example measurements of leaf areas with and without selenium influence have been included as well.

Keywords: *wheat shoots, image segmentation, image skeleton, Elliptical Fourier Descriptor, skeleton pruning, cubic splines*

Michał Sima, Wojciech Bieniecki, Szymon Grabowski: **Web Graph Visualizer** • *Automatyka* 2011, t. 15, z. 3

A piece of software for web graph visualization is presented. Web graph is a data structure, which stores for each URL address a list of all URLs in the HTML page. The graph is often presented as a square matrix, where 1 at location (i, j) denotes a link from document i to document j . The matrix can be displayed as a binary image.

The visualization helps to analyze the structure of the graph, which facilitates creation of effective (compact) algorithms for its representation and processing.

The program presented in this article enables rapid preview of the web graph structure. Furthermore, it allows zooming, searching and cropping most interesting parts of the structure and also previewing real URL addresses.

Keywords: *web graph, data structures visualization*

Magdalena Szymczyk, Piotr Szymczyk: **GPU Usage for Image Processing in Scene Analysis** • *Automatyka* 2011, t. 15, z. 3

The main objective of this article is presentation the usability of modern graphics processors for image analysis in interactive way. This work presents in rough differences in architectures between CPU and GPU. The necessity of using graphics card in vision systems is explained. The CUDA architecture for NVIDIA graphics card is shortly discussed including possibility effortless creating applications for vision systems. Some algorithms for CUDA are presented too with emphasis on their speedups. Some conclusions are drawn at the end.

Keywords: *GPU, CUDA, vision systems*

Piotr Szymczyk, Magdalena Szymczyk: **Scene Analysis Using Descriptors of Key Points** • Automatyka 2011, t. 15, z. 3

Article presents different algorithms used for scene analysis. Firstly, the software for edge and corners detection, then application based on descriptors of key points are presented. Practical tests show short times of execution of these programs, so that it is possible to include them in online systems. Further direction of work has been determined – the necessity of automatical parameters selection in particular algorithms for optimal detection of edge, corners and key points.

Keywords: scene analysis, descriptors of key points

Roman Vorobel, Magdalena Stobińska: **Extended Model for Logarithmic Image Processing** • Automatyka 2011, t. 15, z. 3

The analysis of the Jourlin–Pinoli model for logarithmic image processing is shown. Extended model using new universal algebra for logarithmic image processing is build. This method is based on the new universal algebra with extended operations of addition and multiplication by scalar. The results of such operation are real numbers, which can be not only positive but also negative. New method for images enhancement with affine transforms is proposed. The studies are illustrated by computational examples.

Keywords: logarithmic processing model, image, image enhancement

Tomasz Węgliński, Anna Fabijańska: **Image Segmentation Algorithms for Diagnosis Support of Hydrocephalus in Children** • Automatyka 2011, t. 15, z. 3

Paper presents the results of applying image segmentation algorithms for precise detection of hydrocephalus in children's brain. Presented research was aimed at the comparison of effectiveness of several segmentation methods used for this purpose. Extraction of the hydrocephalus along with the whole brain area in the CT image are important steps for further quantitative assessment of the disease. Precise segmentation of both brain and lesion areas is particularly important for the comparative analysis of their key characteristics (like size or volume). Proposed methods forms

the basis for further development of the system for an automatic detection and analysis of hydrocephalus. Results of applying proposed algorithms to real CT data sets are presented and discussed.

Keywords: *brain, hydrocephalus, CT, segmentation*

SIGNAL PROCESSING FOR IDENTIFICATION AND CONTROL SYSTEMS

Anna Broniec: **Control of Cursor Movement Based on EEG Motor Cortex Rhythm Using Autoregressive Spectral Analysis** • Automatyka 2011, t. 15, z. 3

Electroencephalography (EEG) is a study of the electrical activity of neurons from the cerebral cortex which can be used to direct communication between man and computer. Systems using the signal generated by the brain are called brain computer/machine interfaces (BCI/BMI). The main application of BCI interfaces is the communicate for patients who suffer from severe diseases, which limited or precluded any movement. In the present paper the BCI interface based on EEG motor cortex signals is presented. The differences in power spectrum in beta rhythm for left and right hand movement imaginations is used to control cursor movement in two directions. The preliminary research shows that the proposed algorithm interpret correctly the intended cursor movement at about 70 percent.

Keywords: *BCI, ERD/ERS, EEG, Autoregressive Spectral Analysis*

Andrzej Frączyk, Jacek Kucharski, Tomasz Jaworski, Piotr Urbaneck: **Rotation Speed Control within Computer-Based Measurement and Control System** • Automatyka 2011, t. 15, z. 3

In the paper semi-industrial computer-based research stand of induction heated rotating cylinder has been presented. The control of cylinder rotation speed has been focused on. Advantages and imperfections of PID control of cylinder rotation speed has been discussed. The studies included variable load braking torque.

Keywords: *rotation speed control, induction heating, rotating cylinder*

Maciej Garbacz, Mieczysław Zaczek: **The Potential Fields Method in Navigation of the Wheeled Mobile Robot** • Automatyka 2011, t. 15, z. 3

In the paper are presented the results of application the “artificial potential fields” method for the local navigation of the wheeled holonomic mobile robot Khepera III. For the detection of obstacles in the unknown environment and calculation repulsive potentials are used the infrared sensors of the robot.

Keywords: mobile robot, navigation, artificial potential fields

Szymon Grabowski, Jakub Swacha: **Compact Representation of URL Collections with Fast Access** • Automatyka 2011, t. 15, z. 3

Efficient representation of a string dictionary is a well-known problem with applications e.g. in Web searchers and spellchecking. Traditionally, the dictionary is relatively minor compared to the text from which the terms (words) are collected, but in several applications the number of dictionary items is huge, making a compressed format highly desirable. One of those cases are document addresses on the Internet, i.e., their URLs. Large collections of URLs are useful e.g. in analyses of (possibly large portions of) the Web graph. In this work we present an efficient compression algorithm for lexicographically ordered collections of URLs, supporting extract queries.

Keywords: compressed dictionaries, URL compression, random access, Web graph

Rafał Jachowicz, Piotr Duch: **Real Time Algorithm for Defined Simple Templates Detection and Tracking** • Automatyka 2011, t. 15, z. 3

This paper presents a robust algorithm for simple shapes detection and tracking on image sequence. Presented solution consists of two parts. In the first part the image is analyzed and an area where object can be detected is found using correlation method. In the second part of presented algorithm a pattern which was previously found is confirmed by the original one. In order to obtain better accuracy the size and the angle of found pattern are calculated. Experimental results show that the accuracy of the pattern detection in presented algorithm is over 90% and is independent from

lighting conditions and deformation of searched pattern caused by its spatial rotation.

Keywords: *template detection, object tracking, image processing*

Sławomir Jeżewski, Sylwester Błaszczuk: **Realization of Picture in Picture System Based on TMS320DM642 Digital Signal Processor** • *Automatyka* 2011, t. 15, z. 3

In this paper, we present practical realization of image transmission system from an autonomous mobile robot to robot's operator. The robot is equipped with a set of different cameras that observe different slice of surrounding space in different spectral ranges. To present information from such multi-camera, multi-band system the "Picture in Picture" concept was implemented. This concept is well known from the Television technique. Technical realization of the system implements TMS320DM642 signal processor advantaged with Enhanced Direct Memory Access (EDMA) controller. Implemented system offers high performance and relatively low power consumption.

Keywords: *robot, visual signal transmission, digital signal processing, Enhanced Direct Memory Access, Picture in Picture*

Leszek Kotulski, Adam Sędziwy: **Algorithm of State Diagrams Merging in Embedded Systems Modeling** • *Automatyka* 2011, t. 15, z. 3

In the paper implementation issues related to algorithm of merging state diagrams for cooperating embedded systems, are shown. Its polynomial complexity is also proven. The knowledge of such a merged graph enables one to detect deadlocks or other unwanted effects. Even for a few small graphs a resultant graph being their superposition may be large enough to make a manual merging impossible. For that reason one needs a tool automatizing that task.

Keywords: *LTS graphs, embedded systems, Alvis*

Wojciech Kreft, Mariusz Filipowicz, Andrzej Raźniak: **Architecture and Analysis of Measurements of District Heating Substation on Example of AGH Student Campus** • *Automatyka* 2011, t. 15, z. 3

One presented functionality of heating system including circuit of central heating and hot tap water. One described differences

of architecture of district heating substation of AGH complex building and AGH Student Campus. The state of automatic devices was shown in district heating substation of AGH Student Campus and also measurement results from exemplary substation was presented and analyzed.

Keywords: district heating substation, heat exchanger, automatics

Jacek Kucharski, Jerzy Zgraja, Piotr Urbanek, Andrzej Frączyk: **3D Modeling of Electromagnetic-Thermal Phenomena in Induction Heated Rotating Steel Cylinder** • Automatyka 2011, t. 15, z. 3

In the paper 3D numerical model of induction heating of the rotating steel cylinder has been presented. This type of a thermal plant is widely used in various branches of industry, and semi-industrial experimental setup being modeled has been developed in Computer Engineering Department TUL. Theoretical background of the model and the way of solution of coupled electromagnetic and thermal field have been given as well as nonlinearities of material properties has been introduced into the model. Induction heating of the cylinder using moving inductors has been analyzed. In particular the influence of inductor's mutual placement on the heating power generated in the cylinder has been examined.

Keywords: numerical model, rotating steel cylinder, thermal phenomena

Maciej Nowak, Grzegorz Nowak: **Determining a Spectral Color Characteristics with the Use of Numbers of Arbitrary Precision** • Automatyka 2011, t. 15, z. 3

The article presents the method of determining the spectral characteristics of concentrated pigments, which cannot be directly measured because of the limited sensitivity and accuracy of spectrophotometers. Theoretical reconstruction of immeasurable values of characteristics faces the problem of the precision numbers for very small positive values. The use of numbers with arbitrary precision allows the correct calculation of concentrated pigment characteristics, which may have practical application in the formulation of colors.

Keywords: color matching, high precision numbers

Patryk Orzechowski, Adrian Słowik, Przemysław Misiewicz: **Towards Design of Web Service Based Vehicle Navigation System** • Automatyka 2011, t. 15, z. 3

Intelligent Transportation Systems (ITS) have been growing in popularity lately, especially in larger cities. In this article we present the result of a survey on vehicle navigation systems and on traffic measurement. Gathered information, including studies on psychological aspects of drivers decision making process, are a basis for designing a web service solution. Concept and prototypical implementation of a web service displaying traffic information for the city of Cracow is also included.

Keywords: vehicle navigation, traffic monitoring, web service, intelligent transportation system

Piotr Ostalczyk, Dariusz Brzeziński: **Numerical Evaluation of Variable – Fractional-Order Derivatives** • Automatyka 2011, t. 15, z. 3

In this paper we discuss the methods of calculating fractional-order derivatives (FOD) and integrals (FOI), which also can be used to calculate integer order derivatives and integrals. We focus on one of the methods – Riemann–Liouville formula. To calculate FOD/FOI by this method we need tools. The tools in this case were advanced methods of numerical integration. We have chosen a function which is often used in technical applications. The order of derivative to calculate was variable – designated by a function of time. Our goal was to determine which of the methods of numerical integration – Newton–Cotes or Gauss Quadratures allows to obtain the values with lowest level of absolute errors by the smallest number of sample points. As a point reference served the values of absolute error of the values calculated by using the Grünwald–Letnikov formula.

Keywords: variable, fractional-order derivative and integrals, numerical integration

Piotr Ostalczyk, Piotr Duch, Dominik Sankowski: **Fractional-Order Backward-Difference Grünwald–Letnikov and Horner Simplified Forms Evaluation Accuracy Analysis** • Automatyka 2011, t. 15, z. 3

The aim of this paper is to investigate two equivalent forms of the fractional-order backward difference (FOBD) simplified formulae

evaluation. The first form is known as the Grünvald–Letnikov form the second one as the Horner form. The simplifications are forced by microprocessor systems requirements. Two simplified forms are analyzed. The investigations are illustrated by numerical examples of simplified FOBD evaluation results.

Keywords: *fractional order backward difference*

Piotr Ostalczyk, Katarzyna Maciaszczyk, Anna Pajor: **Simple Method of a Dynamical System Asymmetric Transients Detection** • Automatyka 2011, t. 15, z. 3

In the paper a simple method of a dynamical system transient characteristics asymmetry detection is presented. One considers a non-linear multi-input single output dynamical system periodic orbit achieved by an appropriate input signals or non-zero initial conditions. The system asymmetry is modelled by an asymmetric static saturation element. Adding an additional state one can easily check the trajectory asymmetry. Appropriate asymmetry measure was proposed.

Keywords: *non-linear dynamics, saturation element*

Dominik Sankowski, Andrzej Albrecht, Rafał Wojciechowski, Marcin Bąkała: **New Concept of Hardware and Software Setup for Wettability and Surface Tension Analyzing System** • Automatyka 2011, t. 15, z. 3

The phenomena on solid and liquid phases boundary are playing an important role in many processes in metallurgy, material and surface engineering areas such as: soldering technologies, composite materials production, pulver sintering process, etc. Full analysis of interphase phenomena needs the knowledge of surface tension and wetting angle parameters. In the paper the concept of hardware and software setup for wettability and surface tension analyzing system – dedicated solution allowing design, carrying out and analysis of experiments to quantity determine above mentioned parameters, is described. Project details focused on system structure and interactions, as well as the methodology of measurement methods are introduced and discussed.

Keywords: *material engineering, surface tension, wettability, brazability*

Adam Sędziwy: **Transforming GIS Data to Graph Representation for Agent Processing** • Automatyka 2011, t. 15, z. 3

The availability of digital cartographic data opens a wide range of applications in such areas as finding optimal paths or design problems. On the other side some of those problems have high computational complexity. This obstacle may be avoided by the parallel processing. The necessary step prior to it is transforming geospatial data to the representation enabling an effective implementation of considered algorithms. That article presents such data model.

Keywords: *web mapping, OpenStreetMap, JUNG*

Maciej Wielgosz, Ernest Jamro, Paweł Russek, Kazimierz Wiatr: **FPGA Implementation of Exchange-Correlation Potential Calculation for DFT** • Automatyka 2011, t. 15, z. 3

Implementation results of the exchange-correlation module are presented in this paper. The authors have ported a computationally intensive part of quantum chemistry code to FPGA, which involved a substantial modification of its structure so that it matches the platform's profile. Additionally, a set of the authors' customized modules for floating operations has been created along with software procedures handling FPGA-GPP intercommunication. Furthermore, several tests have been conducted to determine the speed-up achieved. Some more advanced computational cases have also been investigated to examine the module's performance increase with the number of atomic orbitals. The tests conducted for the orbital module revealed a significantly raised acceleration for higher atomic shells. This work also contains implementation results of the S matrix generation module, which are promising since the presented logic allows calculations to be conducted for 16 points simultaneously.

Keywords: *FPGA, quantum chemistry, Custom Computing, HPC, DFT*

Paweł Wołoszyn, Eliasz Kańtoch: **An Acoustic Interface for Simple Binary Image Presentation** • Automatyka 2011, t. 15, z. 3

Acoustic interfaces are prominent methods of human-computer interaction used widely in applications dedicated to blind people. The main purpose for most implementations is rendering text using synthesized speech. Image-to-sound presentation techniques

are less developed due to limitations in information bandwidth of human auditory sense and linearity of sound perception. To overcome these limitations an interactive method of aural image presentation is proposed. With the use of pointing device the user is able to decide which areas of image will be converted to sound and to determine the sequence and speed of this process. Proposed method was used to build a sample system limited to black and white images. Performed tests indicate possibilities of further development of this method.

Keywords: acoustic interface, vision substitution, binary image presentation

IMAGE ANALYSIS AND RECOGNITION

Paweł Fiderek, Jacek Kucharski: **A Computer Vision System for On-Line Two-Phase Gas-Liquid Flows Recognition Using Fuzzy Methods** • *Automatyka* 2011, t. 15, z. 3

The article contains an accurate description of the special research station constructed for the purpose of research on automatic recognition of two-phase gas-liquid flows. There is a detailed description used for that purpose hardware, the software, description of the most interesting algorithms of image processing and recognition and the description of the fuzzy requesting system, which is being developed for purpose of research.

Keywords: fuzzy logic, image processing, two-phase flows

Andrzej Głowacz, Zbigniew Mikrut, Piotr Pawlik: **Optical Flow as a Base for Videodetection Algorithm** • *Automatyka* 2011, t. 15, z. 3

The article presents the concept and implementation of an algorithm for detection and counting of vehicles, based on the analysis of optical flow. The effectiveness and computation time of three optical flow algorithms were compared. Horn–Schunck algorithm was selected and used for a separation of moving objects. It was found that after binarization (using a constant threshold) the algorithm truly isolates moving objects. Next a basic algorithm for detecting and counting of vehicles was constructed. The results were presented and plans for further research were formulated.

Keywords: optical flow, Horn–Schunck algorithm, segmentation, vehicle detection

Zbigniew Mikrut, Magdalena Smoleń: **A Neural Network Approach to Recognition of the Selected Human Motion Pattern** • Automatyka 2011, t. 15, z. 3

In this paper we proposed a representation of the activities performed by humans in the form of a histogram of optical flow directions. Histogram was calculated in the mask of object contour and aggregated to the eight bins. The data set was based on analysis of the video clip, in which four people were performing nine activities, such as walking, sitting and rising from a chair or reaching (up and forward). To recognize the performed activity the *backpropagation* neural network with one hidden layer was used. The recognition results varied from 80 to 88% for individuals. It was found that it is not possible to identify a person's activities using the network trained by data of another person.

Keywords: *action representation, action recognition, optical flow, Horn-Schunck method, backpropagation*

Piotr Pawlik, Zbigniew Bublik: **Face Recognition with Characteristic Points Descriptors** • Automatyka 2011, t. 15, z. 3

The paper presents an application of characteristic points descriptors method for human face recognition. This method was chosen based on results of psychological examinations, which show that only two eyesight fixations (located in nose and eyes region) are necessary to recognize a human face. The presented results – obtained on images from BioID database – confirmed that it is possible to recognize a human face using only three characteristic points.

Keywords: *face recognition, characteristic points*

Sebastian Stoliński, Wojciech Bieniecki: **The Algorithms for Automatic Evaluation of Selected Examination Tasks from the Geometry** • Automatyka 2011, t. 15, z. 3

In this paper the image processing algorithm for automatic detection and evaluation of drawn-by-hand plot is presented, which enables processing of the scanned examination sheets. The student is to draw the plot combined of several primitives (curves, polygons,

lines) given by an equation(s) on a printed sheet with a coordinate system. Because the plot is drawn manually, the process of evaluation should provide a limited accuracy and ought to be consistent with the way of assessment by the teacher. The algorithm has to be resistant to some unexpected objects (strike-throughs, amendments, lines drawn by mistake).

Our computer program compares the model plot to the query plot and as the result it returns the degree of compliance between the plots. The algorithm works in the following steps: extraction of the coordinate system area from the sheet (for query and model solutions); extraction of the plot segments from the coordinate system (for query and model solutions); comparison of the extracted plots with respect of some tolerance.

The algorithm has been tested upon a group of 50 sheets.

Keywords: e-marking, image processing

PROCESS TOMOGRAPHY

Krzysztof Grudzień, Zbigniew Chaniecki, Andrzej Romanowski, Jakub Betiuk, Bartosz Matusiak, Dominik Sankowski: **Industrial Monitoring Systems of Gravitational Flow of Granular Materials in the Large Scale Silo with the Use of ECT Tomography – Preliminary Study** • *Automatyka* 2011, t. 15, z. 3

The paper is a continuation of the authors investigation, conducted in the laboratories of the Computer Engineering Department TUL in collaboration with other scientific units. The article describes the issue involving the project of Electrical Capacitance Tomography sensor for the measurements of the gravitational flow in silo. The transfer of the structure, methods of measurement and analysis of ECT data acquired from the silos of relatively small diameter, 0.2 m, to systems measurement of the silo with much larger diameter, occurring widely in industrial applications, is the main issue of the ongoing work. The design process of the ECT sensors bases on an assessment of its quality by means of numerical analysis of the parameters of the sensor sensitivity maps. The proposed method of analyzing the sensitivity of the sensor is designed to shorten the implementation of the final draft of the sensor and de-

termine the usefulness of the prepared sensors for gravitational flow measurements.

Keywords: *electrical capacitance tomography, analysis of ECT sensor sensitivity, gravitational flow of solid*

Radosław Wajman, Henryk Fidos, Tomasz Jaworski, Robert Banaś: **Three-Dimensional Sensor for Electrical Capacitance Tomography System with the Internal Electrodes** • *Automatyka* 2011, t. 15, z. 3

In the paper the novel three-dimensional capacitance tomographic measurement system dedicated for monitoring the two-phase flows is presented. The authors described the new design of the sensor with the electrodes placed inside the volume. The sensor has an ability to detect two phases in the medium with the high gradient of relative permittivity value like air and water in contrast to the classical sensor with the electrodes placed outside the pipeline. In the next chapters of the paper the authors present their results of the experiments carried out using both sensors comparing the reconstructed 3D images. In addition, the detailed sensitivity analysis of both sensors was introduced.

Keywords: *3D ECT, electrical capacitance tomography, bare electrodes, capacitance measurement, gas-liquid flow, flow structures identification*

NEURAL NETWORKS

Przemysław Korohoda, Joanna Grabska-Chrzęstowska: **Prediction of Hemodialysis Treatment Results with Neural Networks and Two-Compartment Model** • *Automatyka* 2011, t. 15, z. 3

In the paper an experiment is described, designed and conducted to verify hypothesis that neural networks of relatively small size can provide relevantly accurate approximation of unknown analytical solution of the two-compartment hemodialysis model with variable volume of the extracellular compartment. The experiment was based on a thousand pseudo-randomly generated sessions. The concentration values at the end of treatment and the equilibrated Kt/V index were approximated with absolute relative error less or

equal 2% for around 90% values, with only 8 or 12 hidden neurons. Such results have been considered to confirm the main hypothesis.

Keywords: multilayer perceptron network, hemodialysis modelling, two-pool model

Robert Nowotniak, Jacek Kucharski: **GPU-Based Massively Parallel Implementation of Metaheuristic Algorithms** • Automatyka 2011, t. 15, z. 3

In this paper, implementation of Quantum-Inspired Genetic Algorithm(QIGA) in massively parallel environment (Graphics Processing Units) has been presented. Contrary to many recent papers concerning parallel implementation of evolutionary algorithms, in this paper a novel approach has been taken. QIGA algorithm has been implemented entirely as a computational kernel. Parallelization of the algorithm has been performed on two levels: In a block of threads, each thread transforms a separate individual or different gene; In each block, separate populations with same or different parameters are evolved. Finally, the computations have been distributed to eight GPU devices, and over 400× speedup has been gained in comparison to sequential implementation of the algorithm in ANSI C on one Intel Core i7 2.93 GHz CPU core. Correctness of the results has been verified in statistical analysis. The presented approach can be applied to experimentation with a broad class of metaheuristics.

Keywords: evolutionary computing, genetic algorithms, parallel algorithms, GPGPU

Joanna Simińska, Jacek Kucharski: **Fuzzy Modelling of Thermal Systems with Distributed Parameters** • Automatyka 2011, t. 15, z. 3

In the paper the method of modeling of chosen electroheat systems – electric resistance furnaces, as an example of thermal system with distributed parameters, has been presented. The proposed fuzzy description of dynamic properties of such a plant comprises typically used transfer function model (first order inertia) as well as linguistic information of the specific behavior of the plant in

different thermal states. This supplementary information concerning “initial time constant” and “final time constant” of the furnace have been introduced to the model using fuzzy sets and fuzzy inference. Takagi–Sugeno–Kanga fuzzy structure has been used for this purpose. The parameters of the fuzzy model have been determined by a genetic algorithm assuring best fitting of its output to that of insulation wall of the furnace. The article also provides a brief description of the application created in MATLAB for the purpose of this and future research.

Keywords: fuzzy modeling, electroheat plants

Piotr Urbanek, Jacek Kucharski, Andrzej Frączyk: **Neural Network Modelling of Chosen Nonlinearities in Induction Heated Industrial Plants** • Automatyka 2011, t. 15, z. 3

Dynamic and static characteristics of induction heated rotating steel cylinder depend among others on heat accumulation and heat losses from its surface. Value of heat losses strongly depend of speed rotation of cylinder. To determine heat exchange coefficient from the cylinder surface two methods are proposed: classic optimization (based on widely used algorithms) and artificial neural network as well accepted tool for nonlinearity modeling.

Keywords: heat exchange, artificial neural Network, rotating steel cylinder

BUSINESS INFORMATION SYSTEMS

Ewa Dudek-Dyduch, Krzysztof Rączka: **Information System for Real Estate Valuation** • Automatyka 2011, t. 15, z. 3

The article presents the idea of an information system to support the work of real estate experts. It should be noted that currently there is no professional systems for real estate valuations. The reason for it is the difficulty of formalizing knowledge and experience held by real estate experts. The article presents basic stages of a real estate market analysis and basic algorithms for real estate valuation. It presents structure of the designed system, characterize basic functionality and describes the physical architecture. The system will be implemented in Java. The language has been chosen

because there are many free libraries for Java which can be used to implement applications. The use of various additional libraries is necessary to implement the system.

Keywords: *real estate expert, appraisal report, information systems, real estate valuation, algorithms for real estate valuations, comparative approach, comparison in pairs method, corrected mean price method*

Ewa Dudek-Dyduch, Hubert Sękowski: **Algebraic-Logical Model Implementation for Failure Modes Simulation in Production** • Automatyka 2011, t. 15, z. 3

The paper shows a way algebraic-logical model may be used to simulate failures in production systems. Two phase method is proposed. The method aim is to minimize failure results. RPN factors for FMEA method are estimated in the first phase. Simulation experiments for failures modes based on algebraic-logical model for which RPN factors value is the highest are done in the second phase. This paper is to define basis for possible scenarios for failure modes.

Keywords: *failure modes, algebraic-logical model, FMEA*

Marcin Pietroń, Kazimierz Wiatr: **The Ontology Alignment System Based on Algorithms Using Data Similarity Metrics** • Automatyka 2011, t. 15, z. 3

Integration of data from different sources is a very important task in complex IT systems and global web applications. In many applications it is a necessary issue to be dealt with, because of increasing amount of data from various sources, but concerning the same scope. Therefore, there is a lot of research in this area to create algorithms which could conduct these operations automatically. Such algorithms have two main criteria: precision of alignment and computational complexity. The publication presents prototype of the ontology alignment framework. The framework is based on similarity metrics computation at the start of algorithm execution. It is mainly structural and linguistic based similarity. These global similarities decrease complexity of integration algorithm and increase the effectiveness. In the article, there will be depicted the type of metrics and architecture of the system.

Keywords: *ontology, data integration, data alignment, OWL*

Bartosz Waresiak, Paweł Skrzyński: **Using Quad Tree as Data Storage for a Terrain Representation and a Core For a Path Finding Algorithm** • Automatyka 2011, t. 15, z. 3

This paper presents the concept of using single quad tree data structure for data storage for terrain representation and simultaneously a core for a path-finding algorithm. The simulated world is an artificially created two-dimensional world that consists of an island surrounded by water, which is considered to be an impassable terrain. Furthermore, the path-find operation is a possible route for a ship that has to avoid the island. The application of the quad tree data structure for Level of Detail implementation in 3D rendering is also discussed. Implementation details are presented together with initial results. Further research paths are presented in the conclusion.

Keywords: quad tree, path-finding, terrain representation, A*, graph search, level of detail

WIRELESS TECHNOLOGIES AND DATABASES

Artur Sierszeń, Łukasz Sturgulewski: **Traffic Analyzer Based on Data Flow Patterns** • Automatyka 2011, t. 15, z. 3

In the field of network security, there are many tools for the detection and prevention of well-known threats. In this context, great problems are caused by new threats, which have not been described in signatures which are samples of threats. Recently, mechanisms of network behavioral analysis have been developed. Collecting data in an isolated model environment, they create a model of a properly operating network; they, they verify its functioning and search for any anomalies occurring in the network.

Keywords: network behavioral analysis system, intrusion detection system, intrusion prevention system, honey pot trap

Łukasz Sturgulewski, Artur Sierszeń: **System of Distance Measurement and Localization of Wireless Devices Communicating Based on Wi-Fi Technologies** • Automatyka 2011, t. 15, z. 3

Wireless networks are very popular nowadays. Wireless networks administrators have access to a great deal of information

about users. They may use selected information in order to try to locate a user who is active in a network. A mechanism has been implemented which enables the user to locate computer devices communicating based on Wi-Fi technologies, using coordinates or references to characteristic points. An important aspect was to achieve the lowest measurement error.

Keywords: *wireless network, user location, Wi-Fi, distance measurement*