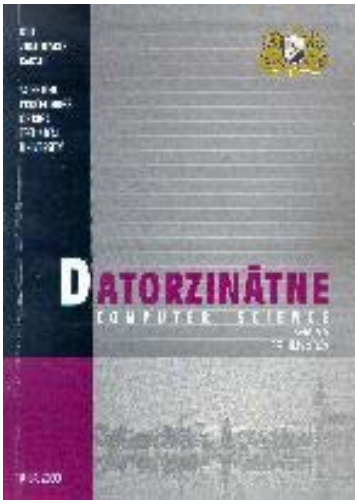

Scientific Proceedings of Riga Technical University in series "Computer Science", vol 21.

Riga: Riga Technical University,

2004. - 200 p.

("Boundary Field Problems and Computer Simulation";

46-nd issue). ISSN 1407-7493.

(C) Riga Technical University, 2004

This volume is the current 46-th thematic issue of the Riga Technical University (RTU) collection of scientific articles "Boundary Field Problems and Computer Simulation" in series "Computer Science". The collection continues (since 1999, with slightly changed title) the lasting international series "Boundary Field Problems and Computers", issued by RTU since 1966.

Scientific papers regarding simulation results and methods of model formulation in electrodynamics, hydrodynamics, signal processing, and hydrogeology.

The volume may be of importance to specialists and students interested in computer simulation of various environmental phenomena formulated as boundary field problems.

Editorial board:

A.Spalvins, Dr.sc.ing., RTU - Editor-in Chief

A.Kolishkin, Dr.math., RTU

M.Antimirov, Dr.hab.phys., RTU

P.Greber, Dr.hab.ing., Dresden Institute of Technology

R.Thunvik, Dr.hab.ing., Royal Institute of Technology (Stockholm)

A.Majewski, Dr.hab.ing., Warsaw University of Technology

R.Janbickis, M.sc.ing., RTU – Secretary

Address:

1 Meza Street, Riga, LV-1048, Latvia

Phone: +371 7089511; Fax: +371 7089531

E-mail: emc@egle.cs.rtu.lv

URL: http://www.emc.rtu.lv/

The full text of the selected paper you can order via emc@egle.cs.rtu.lv

Contents

Abstracts

Bednarek K. Electrodynamical and optimiztion problems of oval three-phase heavy current lines.

The work presents a method determining electrodynamical parameters of three-phase heavy-current busways and the problems related to optimization of their shapes and cross-sections. The integral equations method served for determining the distribution of current density in phase conductors and the one induced in the shield (using the equations of magnetic vector potential for previously defined sub-areas of the system). The current density distribution allowed for calculating active power losses in the system and temperature distribution in the conductors and shield. Moreover, maximal electric stresses of the system were determined. The electrodynamical calculation enabled optimizing the geometry of the heavy-current busways. As the optimization criterion the investment and operation cost was chosen, related to design and operating the heavy-current busways. A modified genetic algorithm was applied for the optimization purpose. The results of optimization calculation are presented and the summary includes an analysis of the results obtained during the study (pp. 6-15)

Ghidaoui M.S., Kolyshkin A., Vaillancourt R. Transient turbulent flow in a pipe.

Asymptotic solution of a problem describing an unsteady turbulent flow in a pipe is considered in the present paper. The fluid flux through the cross-section of the channel is set to zero at time t = 0. The flow before the rapid deceleration is assumed to be fully developed. Eddy viscosity model is used to describe the flow. The solution is obtained by means of the Laplace transform and the methods of singular perturbation theory. It is shown that the structure of the flow shortly after rapid deceleration is not affected by the eddy viscosity and can be satisfactorily described by a laminar model. (pp. 16-24)

Morimoto A., Ashino R., Vaillancourt R. Curve fitting of irregularly sampled data by multiwavelets neural networks.

Unshifted and shifted multiscaling functions are used as mathematical models for curve fitting of irregularly sampled data. This pre-processing procedure, combined with multiwavelet neural networks for data-adaptive curve fitting, is shown to perform well in the

case of high resolution. In the case of low resolution, it is more accurate than numerical integration and cheaper than matrix inversion. The curve fitting method for irregularly sampled data can be applied to a pre-processing design for the discrete multiwavelet transform. (pp. 25-35)

Qi W., Morimoto A., Ashino R., Vaillancourt R. Image denoising using spline and block singular value decomposition.

A new spline weight function is experimentally designed and used to denoise images with non-linear filtering based on block singular value decomposition (BSVD). With this spline method it was found to be better to denoise only the singular values of the singular value decomposition of noised images and not denoise the singular vectors. Thus the spline method is much faster than the orignal Devčić-Lončarić BSVD since there is no need to take the discrete Fourier transform of the singular vectors in order to denoise them in the Fourier domain. The proposed algorithm was favorably tested under different types of images and noises and a wide range of signal-to-noise ratios (SNR). On the basis of the SNR improvement, numerical results demonstrate that the new method removes more noise than BSVD. (pp. 36-46)

Nguyen-Ba T., Vaillancourt R. Hermite-Birkhoff differential equation solvers.

We construct a new six-stage general linear Hermite-Birkhoff (HB) method of order 9 with 4 off-step points and 2 backstep points. Particular choices of the off-step points produce corresponding particular variable-step and constant-step methods. Similar methods of order 10 and 11 are also considered. These methods lie between multistep and Runge--Kutta methods. It is seen that the regions of absolute stability of HB methods, obtained by a scanning method, are larger than those of multistep methods of comparative order. A local error estimator is used to control the stepsize. These methods were tested with the non-stiff DETEST two-body problems of class D and compared with the Dormand-Prince Runge-Kutta pair DP(8,7)13M of order 8. Generally, the HB methods have lower global errors and use fewer function evaluations. (pp. 47-64)

Yoshikawa M, Gong Y., Ashino R., Vaillancourt R. Case studies on SVD multiresolution analysis.

Basic results on the singular value decomposition of a matrix are recalled. The Kakarala and Ogunbona form of a multiresolution analysis for singular value decomposition is presented. Numerical case studies on a multiresolution analysis method based on the singular value decomposition include the 2001 Nikkei Stock Exchange, the 1940 El Centro earthquake wave, the 1995 Kobe earthquake wave and the MATLAB leleccum sample data. The MATLAB code used in this paper is listed in the appendix. (pp. 65-79)

Nazarovs S. Rapidly decelerated turbulent flow in an annulus

Asymptotic solution of a problem describing onedimensional axisymmetric flow in an annulus is obtained in the present paper. The flow is assumed to be fully developed. The flux through the cross-section of the channel is set to zero at time . Methods of singular perturbations are used to construct the solution. The model of eddy viscosity is used to describe the flow. The solution is obtained in the form suitable for numerical calculations. It is shown that the eddy viscosity does not affect the structure of the flow for small values of time. (pp. 80-87)

Volodko I. Unsteady intrinsic convection in an annulus.

Intrinsic convection in a vertical annulus filled with a viscous incompressible fluid is considered in the paper. Analytical solution of steady and unsteady problems is found. The flow is described by Navier-Stokes equations in cylindrical coordinates. Solution of unsteady problem is found by transforming the original equation and integrating it twice. Numerical solution is found for the case where the initial flow is zero at the distance a from both walls and is equal to a nonzero constant in the remaining part of the region. The solution is plotted for different values of R where R is the ratio of the radii of the inner and outer cylinders. Solution of the steady problem is found by means of the Laplace transform where the transformed ordinary differential equation is solved by the method of variation of parameters. General solution of this equation is expressed in terms of the Bessel functions. General solution of the initial value problem is obtained by the residue theorem (pp. 88-94)

Antimirov M. Ya., Dzenite I.A. On formulae for the change in impedance.

A new exact analytical formula for the impedance change used in non-destructive testing problems is derived. The derivation is based on the Green's formula in contrast with the previous studies that used Lorentz theorem for obtaining the formula known in literature. The new formula for the impedance change has the form of a triple integral of scalar product of two vector potentials: the vector potential in the flaw and the vector potential in the same region in the absence of the flaw over the region containing the flaw. The similar formula obtained earlier by previous authors has the form of a triple integral of scalar product of amplitude electric field vectors. It is strictly proved that the new simple formula is equivalent to the previous formula used in literature. (pp. 95-105)

Antimirov M.Ya., Ligere E.S. Analytical solution of the problem on the magnetohydrodynamic flow in the initial part of the plane channel in the Oseen approximation.

Solving the problem on a MHD flow in an initial part of a channel by using the Oseen approximation, usually it is supposed, that the velocity and the pressure of the fluid are given at the entrance of the channel. These boundary conditions overdetermine the problem. In the article the analytical solution of this problem is obtained with condition that only the velocity of fluid, flowing into the plane channel through the channel's lateral side in a longitudinal magnetic field is given. Dependence of length of the initial part on Hartmann and Reynolds numbers is found. The dependence of on Reynolds number becomes linear at Hartmann number . (pp. 106-112)

Chaddad I.A. On the form of magnetic field and MHD equations for fully developed MHD flow.

The form of magnetic field at which the fully developed flow in half-space $z>0$ with the roughness on the boundary $z=0$ is considered. The not uniform external magnetic field has x- and z-components, which don't depend on variable y. There is also the external current, which is parallel to boundary $z=0$, if the roughness is absent. The roughness has the form of infinitely long prism, parallel to y ax is, with constant arbitrary cross-section. The fully developed MHD flow of fluid with velocity arises only in the case, if the roughness of boundary $z=0$ exists. In the literature it is supposed at once, that in this case the induced magnetic field has single y-

component, which does not depend on variable y. In this paper this assertion is proved, using the symmetry of fully developed MHD flow in the y-axis direction and the Bio-Savare law. In contrast to it usually do in the literature, not only the velocity of fluid and the potential of induced current, but also the pressure of fluid both for uniform and for not uniform external magnetic field is obtained (pp. 113-122)

Antimirov M.Ya., Chaddad I.A. Analytical solution of the MHD problem to the flow over the roughness elements using the Dirac delta function.

Analytical solution of the problem about MHD flow of conducting fluid in half space with a roughness of special form on boundary is obtained. External magnetic field is perpendicular to boundary . There is also external current, which is parallel to boundary , if the roughness is absent. The flow of fluid arises only in the case, if the roughness of boundary exists. The choice of the roughness in the form of infinitely long prism with constantsr cross-section, bounded by the step-function, allows to obtain the analytical solution of this problem using the Dirac delta function. The single approximate assumption that the height of this cross-section is small is used. The asymptotic solution of the problem at the large Hartmann numbers is obtained. In this case the various boundary layers of the flow and the induced current are found. The results of numerical calculations of x- and y-component of induced current are present. (pp. 123-136)

Burov G. Combinatorial computing models of iterative processes.

The iterative methods for formation of numerical information processing algorithms are considered. In such methods the address lexicographic combinatorial configurations (ALCCs) are used. They are created on the basis of ordered numerical sequences. The methods for formation of ALCCs of multiplicative operations with parallel properties are offered. The multiplicative character of these operations is taken into account by application of methods of hierarchical ALCC construction with the use of positional principles. The methods of ALCC formation with use of decision functions and classification of their fragments are used. With the purpose of creation of economic algorithms it is recommended to apply the informative compressed forms of ALCCs and intermediate computing space for transformation of the numerical information. The complexity of algorithms is offered to be reduced using methods of specification and allocation of control parameters of the making operators. It is shown, that

combinatorial principles can also be used in operations of polynomial division. Most preferable are the methods of numerical information processing, in which the principles of monitoring with consecutive mapping of numerical information are used. The developed methods of numerical sequence decomposition, which are used in the graph's ALCC, allow to improve parallel properties of algorithms. Adaptive algorithms with reorganization of structure ALCC in this case can be used. (pp. 137-149)

Burov G. Combinatorial models of numerical information processing

The problem of realization of multiplicative operations with the help of algorithms with parallel properties is considered. With this purpose the address lexicographic combinatorial configurations (ALCCs) are used. With their help the numerical information is placed and readdressed. ALCCs are formed using positional principles of processing of the numerical information. Therefore ALCCs are created on the basis of the ordered numerical sequences. They are represented as classes, which are determined relative to components of positional vector. ALCCs with parallel properties for realization of multiplicative operations are offered. The parallel properties of algorithms are adjusted with the help of arguments of the making operators. It is realized using methods of decomposition of numerical sequences. The basic part of operations of numerical processing of the information can be executed in ALCC space with the help of methods of monitoring. These methods are based on principles of information interchange between space of the numerical data and ALCC space. The complexity of algorithms is offered to reducing using the methods of the specification and change of arguments of the making operators. It can be achieved also at the expense of use of additional space, in which the numerical information will be transformed in the compressed form. For ALCC formation it is offered to use the hierarchical principles with use of variations of operators arguments. The positional principles in ALCC structure are realized using methods of the specification and classification of their fragments. It allows to change ALCC structure during numerical processing of the information and to keep positional principles of accommodation of the information (pp. 150-161)

Spalvins A., Slangens J., Janbickis R., Lace I., Eglite I., Skibelis V. Hydrogeological model for well field Otanki of Liepaja, Latvia.

Problems of protecting the well field Otanki against intrusion of seewater are considered by using a hydrogeological model for investigation. It has been found out that the production rate of the field can be enlarged threefold if special recharge wells are used to stop the seewater migration. No special protection is necessary if the production rate is smaller or equal to the present one. (pp. 162-171)

Spalvins A., Slangens J., Janbickis R., Lace I. Two methods used for strengthening of the MODFLOW system.

Two validated ideas are proposed for using in MODFLOW. The first idea proposes to apply an elevation map of a ground surface with water bodies (rivers, lakes, etc) included as the piezometric boundary condition on the top of 3D hydrogeological model (HM). In such a regime, HM automatically computes an infiltration flow distribution. The second idea offers to use a shell of HM as an interpolator for computing boundary conditions when the shell intersects with areas of hydrogeological windows. (pp. 172-178)

Spalvins A., Slangens J., Lace I. Interpolation for non-regularly located wells of hydrogeological models.

Locations of production and monitoring wells do not coincide with nodes of hydrogeological model and these locations may be considered as non - regular points that should be attached to HM by interpolation. The paper is devoted to this type of interpolation that improves accuracy of HM. New development and results are reported that are especially important for regional HM where approximation grids are coarse. (pp. 179-190)

Spalvins A. Historical survey of the scientific research laboratory of electrical simulation (1960-2004) .

The laboratory was founded in 1960 for developing methods and tools for solving boundary field problems by means of electrical simulation. Analog - digital systems were developed and they gradually reached the level of high scale integration (1990). After collapse of USSR, the

laboratory turned into the Environment Modelling Centre which is involved in modelling of hydrogeological problems for modelling Latvian and foreign customs. (pp. 191-200)