

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Todor Boyanov Stefka Dimova
Krassimir Georgiev Geno Nikolov (Eds.)

Numerical Methods and Applications

6th International Conference, NMA 2006
Borovets, Bulgaria, August 20-24, 2006
Revised Papers

Volume Editors

Todor Boyanov
Stefka Dimova
Geno Nikolov
St. Kl. Ohridski University of Sofia
Faculty of Mathematics & Informatics
5 J. Burchier Blvd., 1164 Sofia, Bulgaria
E-mail: {boyanovt, dimova, geno}@fmi.uni-sofia.bg

Krassimir Georgiev
Bulgarian Academy of Sciences
Institute for Parallel Processing
Acad. G. Bonchev str., bl. 25A, 1113 Sofia, Bulgaria
E-mail: georgiev@parallel.bas.bg

Library of Congress Control Number: 2007920821

CR Subject Classification (1998): G.1, F.2.1, G.4, J.2, J.6

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN 0302-9743
ISBN-10 3-540-70940-1 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-70940-4 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2007
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12021581 06/3142 5 4 3 2 1 0

Preface

The international conference Numerical Methods and Applications has been a traditional forum for scientists of well-known research groups from various countries providing an opportunity for sharing ideas and establishing fruitful scientific cooperation.

The papers in this volume were presented at its sixth issue: International Conference on Numerical Methods and Applications (ICNM&A 2006) held in Borovets, Bulgaria, August 20–24, 2006. The conference was organized by the Faculty of Mathematics and Informatics at “St. Kliment Ohridski” University of Sofia, in cooperation with GAMM and IMACS. The Institute of Mathematics and Informatics and the Institute for Parallel Processing, Bulgarian Academy of Sciences, were co-organizers of this traditional scientific meeting.

In total, 119 participants from 27 countries all over the world attended the conference and 111 talks, including nine invited talks, were delivered. This volume contains 87 papers submitted by authors from 24 countries.

During ICNM&A 2006 a wide range of problems concerning recent theoretical achievements in numerical methods and their applications in mathematical modeling were discussed. Specific topics of interest were the following: *finite difference and finite volume methods; finite element and boundary element methods; multigrid and domain decomposition; level set and phase field methods; Monte Carlo methods; numerical linear algebra; parallel algorithms; computational mechanics; engineering applications*. The keynote lectures reviewed some of the advanced achievements in these fields. The ICNM&A 2006 talks were delivered by researchers representing some of the strongest research teams in the field of numerical methods and their application for solving wide range of practical problems.

The success of the conference and the present volume are due to the joint efforts of many colleagues from various institutions and organizations. We express our deep gratitude to all the members of the Scientific Committee for their valuable contribution to the scientific spirit of the conference, as well as for their help in reviewing the submitted papers. The special sessions represented the combined efforts of organizers whose contributions deserve to be recognized: Enrique Alba, Rene Alt, Radim Blaheta, Stefka Fidanova, Krasimir Georgiev, Todor Gurov, Aneta Karaivanova, Johannes Kraus, Svetozar Margenov, Svetoslav Markov, Gradimir Milovanović, Bojan Popov, Per Grove Thomsen, and Zahari Zlatev. We are also grateful to the staff involved in the local organization.

The conference was partly supported by project BIS-21++ funded by the European Commission in FP6 INCO via grant 016639/2005.

We hope that this meeting among scientists who develop and study numerical methods, on one hand, and researchers who use them for solving real-life problems, on the other, has broadened their horizons and has contributed to their mutual enrichment.

December 2006

Todor Boyanov
Stefka Dimova
Krasimir Georgiev
Geno Nikolov

Organization

International Scientific Committee

A. Abramov (Russia)	A. Gulin (Russia)	G. Milovanovic (Serbia)
A. Andreev (Bulgaria)	M. Gunzburger (USA)	P. Minev (Canada)
P. Binev (USA)	R. Herbin (France)	M. Neytcheva (Sweden)
R. Blaheta (Czech Republic)	O. Iliev (Germany)	G. Nikolov (Bulgaria)
P. Bochev (USA)	R. Jeltsch (CH)	J. Pasciak (USA)
T. Boyadjiev (Bulgaria)	A. Karaivanova (Bulgaria)	Y. Popov (Russia)
B. Boyanov (Bulgaria)	M. Kaschiev (Bulgaria)	I. Puzynin (Russia)
C. Budd (UK)	O. Kunchev (Bulgaria)	S. Radev (Bulgaria)
B. Chetverushkin (Russia)	R. Lazarov (USA)	V. Thomee (Sweden)
C. Christov (USA)	I. Lirkov (Bulgaria)	P. Vabishchevich (Russia)
I. Dimov (Bulgaria)	V. Makarov (Ukraine)	E. Varbanova (Bulgaria)
I. Farago (Hungary)	S. Margenov (Bulgaria)	P. Vassilevski (USA)
K. Georgiev (Bulgaria)	S. Markov (Bulgaria)	L. Zikatanov (USA)
	P. Matus (Belarus)	Z. Zlatev (Denmark)

Organizing Committee

Chairperson: S. Dimova

T. Boyanov	S. Margenov	S. Stoilova
T. Chernogorova	L. Milev	D. Vasileva
I. Dimov	N. Naidenov	
N. Kolkovska	V. Rakidzi	

Table of Contents

I Invited Papers

On the Discretization of the Coupled Heat and Electrical Diffusion Problems	1
<i>Abdallah Bradji and Raphaèle Herbin</i>	
The Vector Analysis Grid Operators for Applied Problems	16
<i>Petr Vabishchevich</i>	
On Some Computational Aspects of the Variational Data Assimilation Techniques	28
<i>Zahari Zlatev</i>	

II Numerical Methods for Hyperbolic Problems

Weighted Iterative Operator-Splitting Methods: Stability-Theory	40
<i>Jürgen Geiser</i>	
Weighted Iterative Operator-Splitting Methods and Applications	48
<i>Jürgen Geiser and Christos Kravvaritis</i>	

III Robust Preconditioning Solution Methods

Multilevel Preconditioning of 2D Rannacher-Turek FE Problems; Additive and Multiplicative Methods	56
<i>Ivan Georgiev, Johannes Kraus, and Svetozar Margenov</i>	
A Parallel Algorithm for Systems of Convection-Diffusion Equations	65
<i>János Karátson, Tamás Kurics, and Ivan Lirkov</i>	
Comparative Analysis of Mesh Generators and MIC(0) Preconditioning of FEM Elasticity Systems	74
<i>Nikola Kosturski and Svetozar Margenov</i>	
Multigrid-Based Optimal Shape and Topology Design in Magnetostatics	82
<i>Dalibor Lukáš</i>	
Generalized Aggregation-Based Multilevel Preconditioning of Crouzeix-Raviart FEM Elliptic Problems	91
<i>Svetozar Margenov and Josef Synka</i>	
Solving Coupled Consolidation Equations	100
<i>Felicja Okulicka-Dłuzewska</i>	

Parallel Schwarz Methods for T-M Modelling	106
<i>Jiří Starý, Ondřej Jakl, and Roman Kohut</i>	
Parallel Incomplete Factorization of 3D NC FEM Elliptic Systems	114
<i>Yavor Vutov</i>	
IV Monte Carlo and Quasi-Monte Carlo for Diverse Applications	
Extended Object Tracking Using Mixture Kalman Filtering	122
<i>Donka Angelova and Lyudmila Mihaylova</i>	
Exact Error Estimates and Optimal Randomized Algorithms for Integration	131
<i>Ivan T. Dimov and Emanouil Atanassov</i>	
Parallel Monte Carlo Approach for Integration of the Rendering Equation	140
<i>Ivan T. Dimov, Anton A. Penzov, and Stanislava S. Stoilova</i>	
Parallel Monte Carlo Sampling Scheme for Sphere and Hemisphere	148
<i>Ivan T. Dimov, Anton A. Penzov, and Stanislava S. Stoilova</i>	
A Hybrid Monte Carlo Method for Simulation of Quantum Transport	156
<i>Todor Gurov, Emanouil Atanassov, and Sofiya Ivanovska</i>	
Quasi-random Walks on Balls Using C.U.D. Sequences	165
<i>Aneta Karaivanova, Hongmei Chi, and Todor Gurov</i>	
On the Exams of a Multi-Attribute Decision Making Electronic Course	173
<i>Cornel Resteanu, Marius Somodi, and Marin Andreica</i>	
Random Walks for Solving Boundary-Value Problems with Flux Conditions	181
<i>Nikolai A. Simonov</i>	
Examining Performance Enhancement of p-Channel Strained-SiGe MOSFET Devices	189
<i>D. Vasilevska, S. Krishnan, and M. Fischetti</i>	
A Monte Carlo Model of Piezoelectric Scattering in GaN	197
<i>S. Vitanov, M. Nedjalkov, and V. Palankovski</i>	

V Metaheuristics for Optimization Problems

Solving the Illumination Problem with Heuristics	205
<i>Manuel Abellanas, Enrique Alba, Santiago Canales, and Gregorio Hernández</i>	
Optimal Placement of Antennae Using Metaheuristics	214
<i>Enrique Alba, Guillermo Molina, and Francisco Chicano</i>	
Sparse Array Optimization by Using the Simulated Annealing Algorithm	223
<i>Vera Behar and Milen Nikolov</i>	
An Iterative Fixing Variable Heuristic for Solving a Combined Blending and Distribution Planning Problem	231
<i>Bilge Bilgen</i>	
Hybrid Heuristic Algorithm for GPS Surveying Problem	239
<i>Stefka Fidanova</i>	
A Hybrid Metaheuristic for a Real Life Vehicle Routing Problem	247
<i>Panagiotis P. Repoussis, Christos D. Tarantilis, and George Ioannou</i>	
Multipopulation Genetic Algorithms: A Tool for Parameter Optimization of Cultivation Processes Models	255
<i>Olympia Roeva</i>	
Design of Equiripple 2-D Linear-Phase FIR Digital Filters Using Genetic Algorithm	263
<i>Felicja Wysocka-Schillak</i>	

VI Uncertain/Control Systems and Reliable Numerics

A Simple and Efficient Algorithm for Eigenvalues Computation	271
<i>René Alt</i>	
Numerical Computations with Hausdorff Continuous Functions	279
<i>Roumen Anguelov and Svetoslav Markov</i>	
Mixed Discretization-Optimization Methods for Nonlinear Elliptic Optimal Control Problems	287
<i>Ion Chrysosoverghi</i>	
Stability and Bifurcation Analysis of a Nonlinear Model of Bioreactor	296
<i>Neli Dimitrova and Plamena Zlateva</i>	

Discrete Approximations of Singularly Perturbed Systems	304
<i>Tzanko Donchev and Vasile Lupulescu</i>	
A Generalized Interval LU Decomposition for the Solution of Interval Linear Systems	312
<i>Alexandre Goldsztejn and Gilles Chabert</i>	
On the Relationship Between the Sum of Roots with Positive Real Parts and Polynomial Spectral Factorization	320
<i>Masaaki Kanno, Hirokazu Anai, and Kazuhiro Yokoyama</i>	
Lie Brackets and Stabilizing Feedback Controls	329
<i>Mikhail I. Krastanov</i>	
Interval Based Morphological Colour Image Processing	337
<i>Antony T. Popov</i>	
Solving Linear Systems Whose Input Data Are Rational Functions of Interval Parameters	345
<i>Evgenija D. Popova</i>	
Differential Games and Optimal Tax Policy	353
<i>Rossen Rozenov and Mikhail I. Krastanov</i>	
Evolutionary Optimization Method for Approximating the Solution Set Hull of Parametric Linear Systems	361
<i>Iwona Skalna</i>	
 VII Interpolation and Quadrature Processes	
Formulae for Calculation of Normal Probability	369
<i>Vesselin Gushev and Geno Nikolov</i>	
Iterative-Collocation Method for Integral Equations of Heat Conduction Problems	378
<i>Lechosław Hącia</i>	
Numerical Computation of the Markov Factors for the Systems of Polynomials with the Hermite and Laguerre Weights	386
<i>Lozko Milev</i>	
Connection of Semi-integer Trigonometric Orthogonal Polynomials with Szegő Polynomials	394
<i>Gradimir V. Milovanović, Aleksandar S. Cvetković, and Zvezdan M. Marjanović</i>	
Trigonometric Orthogonal Systems and Quadrature Formulae with Maximal Trigonometric Degree of Exactness	402
<i>Gradimir V. Milovanović, Aleksandar S. Cvetković, and Marija P. Stanić</i>	

On the Calculation of the Bernstein-Szegő Factor for Multivariate Polynomials	410
<i>Nikola Naidenov</i>	
Quadrature Formula Based on Interpolating Polynomials: Algorithmic and Computational Aspects	419
<i>Dana Simian and Corina Simian</i>	
VIII Large-Scale Computations in Environmental Modelling	
Stability of Semi-implicit Atmospheric Models with Respect to the Reference Temperature Profile	427
<i>Andrei Bourchtein, Ludmila Bourchtein, and Maxim Naumov</i>	
Using Singular Value Decomposition in Conjunction with Data Assimilation Procedures	435
<i>Gabriel Dimitriu</i>	
New Operator Splitting Methods and Their Analysis	443
<i>István Faragó</i>	
On an Implementation of the TM5 Global Model on a Cluster of Workstations	451
<i>Krassimir Georgiev</i>	
On the Sign-Stability of the Finite Difference Solutions of One-Dimensional Parabolic Problems	458
<i>Róbert Horváth</i>	
Comprehensive Modelling of PM ₁₀ and PM _{2.5} Scenarios for Belgium and Europe in 2010	466
<i>C. Mensink, F. Deutsch, L. Janssen, R. Torfs, and J. Vankerkom</i>	
Parallel and GRID Implementation of a Large Scale Air Pollution Model	475
<i>Tzvetan Ostromsky and Zahari Zlatev</i>	
Simulation of an Extreme Air Pollution Episode in the City of Stara Zagora, Bulgaria	483
<i>Maria Prodanova, Juan Perez, Dimiter Syrakov, Roberto San Jose, Kostadin Ganev, Nikolai Miloshev, and Stefan Roglev</i>	
Studying the Properties of Variational Data Assimilation Methods by Applying a Set of Test-Examples	492
<i>Per Grove Thomsen and Zahari Zlatev</i>	

IX Contributed Talks

On the Numerical Solutions of Eigenvalue Problems in Unbounded Domains	500
<i>Andrey B. Andreev and Milena R. Racheva</i>	
Mesh Independent Superlinear Convergence of an Inner-Outer Iterative Method for Semilinear Elliptic Systems	508
<i>István Antal</i>	
Solving Second Order Evolution Equations by Internal Schemes of Approximation	516
<i>Narcisa Apreutesei and Gabriel Dimitriu</i>	
Target Detection and Parameter Estimation Using the Hough Transform	525
<i>Vera Behar, Lyubka Doukouska, and Christo Kabakchiev</i>	
Mechanical Failure in Microstructural Heterogeneous Materials	533
<i>Stéphane Bordas, Ronald H.W. Hoppe, and Svetozara I. Petrova</i>	
Round-Trip Operator Technique Applied for Optical Resonators with Dispersion Elements	542
<i>Nikolay N. Elkin, Anatoly P. Napartovich, Dmitry V. Vysotsky, and Vera N. Troshchieva</i>	
On the Impact of Tangential Grid Refinement on Subgrid-Scale Modelling in Large Eddy Simulation	550
<i>Jochen Fröhlich, Jordan A. Denev, Christof Hinterberger, and Henning Bockhorn</i>	
Detection Acceleration in Hough Parameter Space by K-Stage Detector	558
<i>Ivan Garvanov, Christo Kabakchiev, and Hermann Rohling</i>	
A Method for Calculating Active Feedback System to Control Vertical Position of Plasma in a Tokamak	566
<i>Nizami Gasilov</i>	
Numerical Algorithm for Simultaneously Determining of Unknown Coefficients in a Parabolic Equation	574
<i>Nizami Gasilov, Afet Golayoglu Fatullayev, and Krassimir Iankov</i>	
Data Compression of Color Images Using a Probabilistic Linear Transform Approach	582
<i>Evgeny Gershikov and Moshe Porat</i>	
On a Local Refinement Solver for Coupled Flow in Plain and Porous Media	590
<i>Oleg Iliev and Daniela Vasileva</i>	

Properties of the Lyapunov Iteration for Coupled Riccati Equations in Jump Linear Systems	599
<i>Ivan Ganchev Ivanov</i>	
Numerical Analysis of Blow-Up Weak Solutions to Semilinear Hyperbolic Equations.....	607
<i>Boško S. Jovanovic, Miglena N. Koleva, and Lubin G. Vulkov</i>	
A Monotone Iterative Method for Numerical Solution of Diffusion Equations with Nonlinear Localized Chemical Reactions	615
<i>Juri D. Kandilarov</i>	
Numerical Solution of an Elliptic Problem with a Non-classical Boundary Condition.....	623
<i>Natalia T. Kolkovska</i>	
Contour Determination in Ultrasound Medical Images Using Interacting Multiple Model Probabilistic Data Association Filter	628
<i>Paulina Konstantinova, Dan Adam, Donka Angelova, and Vera Behar</i>	
Computational Model of 1D Continuum Motion. Case of Textile Yarn Unwinding Without Air Resistance.....	637
<i>Yordan Kyosev and Michail Todorov</i>	
A Numerical Approach to the Dynamic Unilateral Contact Problem of Soil-Pile Interaction Under Instabilizing and Environmental Effects.....	646
<i>Asterios Liolios, Konstantina Iossifidou, Konstantinos Liolios, Khairedin Abdalla, and Stefan Radev</i>	
Analysis of Soil-Structure Interaction Considering Complicated Soil Profile.....	652
<i>Jang Ho Park, Jaegyun Park, Kwan-Soon Park, and Seung-Yong Ok</i>	
Numerical Method for Regional Pole Assignment of Linear Control Systems	660
<i>Petko Hr. Petkov, Nicolai D. Christov, and Michail M. Konstantinov</i>	
Solution Limiters and Flux Limiters for High Order Discontinuous Galerkin Schemes	668
<i>Natalia Petrovskaya</i>	
Numerical Analysis of the Sinuous Instability of a Viscous Capillary Jet Flowing Down an Immiscible Nonviscous Fluid	677
<i>Stefan Radev, Kalin Nachev, Fabrice Onofri, Lounes Tadrast, and Asterios Liolios</i>	
Order Adaptive Quadrature Rule for Real Time Holography Applications.....	685
<i>Minvydas Ragulskis and Loreta Saunoriene</i>	

FEM Modelling of Resonant Frequencies of In-Plane Parallel Piezoelectric Resonator	693
<i>Petr Rálek</i>	
Numerical Algorithm for Non-linear Systems Identification Based on Wavelet Transform	701
<i>Elena Şerban</i>	
Simulation of Turbulent Thermal Convection Using Finite Volumes	709
<i>Olga Shishkina and Claus Wagner</i>	
Phase-Field Versus Level Set Method for 2D Dendritic Growth	717
<i>Vladimir Slavov and Stefka Dimova</i>	
Author Index	727