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Edited by
Renhong Wang Jieqing Tan

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Yousheng Zhang

Jinjin Zheng

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Yunshi Zhou

Xiaolin Zhu

Preface

Proceedings of ISCIAIS 2005

The International Symposium on Computing and Its Applications in Information Science (ISCIAIS 2005) was held at Hefei University of Technology, Hefei, China from August 15 to August 19, 2005.

The theme of the symposium concentrated on advances of computing theory, methods and their applications in information science. The invited speakers were: Annie Cuyt (Belgium), Peter Graves-Morris (UK), Walter Schempp (Germany) and Hongbin Zha (China). The contributed papers were presented in parallel sessions on the following topics:

- Numerical Analysis
- Nonlinear Numerical Methods
- Computer Aided Design
- Computer Graphics
- Computational Geometry
- 3D Object Recognition
- Digital Image Processing
- Wavelets Analysis and Applications
- Neural Computing

This proceedings contains the shortened texts of 91 presented papers. We want to thank all the referees for their valuable comments and advices which make it possible to publish this proceedings in time.

The organizers would like to thank the National Natural Science Foundation of China, Anhui Provincial Natural Science Foundation, the Education Department of Anhui Province, Anhui Association for Science and Technology for the financial supports. Thanks are due to Hefei University of Technology for both the financial support and the hospitality. Thanks also go to Mengmeng Hou, Xing Huo, Ping Jiang, Benyue Su, Zhongqing Wang, Weihong Zhang, Qianjin Zhao and Xingguo Zheng for their very kind assistance in doing the editorial work. Last but not least we express our gratitude to all participants for their contribution which makes the symposium an interesting and pleasant event.

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Rational Approximation Theory and Scientific Computing

Annie Cuyt

Department of Mathematics and Computer Science, University of Antwerp, Middelheimlaan 1,B-2020 Antwerp,Belgium

Abstract

In recent years several highly technological problems could profit from some classical results in rational approximation theory, as can be seen from the existing literature. We discuss following selected problems:

(1) The computation of the packet loss probability as a function of the buffer size in the context of multiplexing techniques, to support variable bit rate communication, can be realized in almost real-time making use of multipoint Padé-type approximants.

(2) The reconstruction of general two- and three-dimensional shapes from indirect measurements such as bi- and trivariate moment information, is possible because of the relationship between several integral transforms and homogeneous multivariate Padé approximants.

(3) Models describing complicated physical devices or extremely time-consuming simulations, can be highly simplified using adaptive scattered rational interpolation, while maintaining at the same time a required accuracy.

(4) A large collection of special functions from science and engineering, can be evaluated reliably and efficiently by means of modified continued fraction approximants, guaranteeing evaluations up to a user defined accuracy which can be chosen from a few digits to several hundreds or thousands, truncation and round-off error included.

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An Adaptation of BiCGStab for Nonlinear Systems

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Abstract

We will review the principles that underlie Van der Vorst's BiCGStab. This is a popular method for the iterative solution of a sparse system of linear equations. Methods for the solution of nonlinear systems are usually recursive and in general require forming Jacobians to linearize the nonlinear terms. The solution of the resulting large sparse nonlinear system usually involves the use of a linear solver. Here we propose a method like BiCGStab which combines the two processes. It is based on the principles of vector Pade' approximation and minimising the residuals during the iteration. We consider the feasibility and efficiency of the proposed method in the context of Burghers' equation, the Bratu equation and models of a fish population.

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Superconducting Microchip Design for Quantum Computers and the Application to Diagnostic Imaging

Walter Schempp

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Abstract

In modern high technology, the term photonics has come into use. This term, which was coined in analogy with electronics, reflects the rapidly growing tie between quantum optics and electronics forged by the increasing role that semiconductor materials play in opto-electronic devices. Electronics involves the control of electric-charge flow in vacuum or in matter and superconducting materials. Photonics involves the control of photons in free space or in matter. The two disciplines clearly overlap since electrons control the flow of photons and, conversely, the photons of ultrafast laser pulse trains control the flow of electrons. Unfortunately, the majority of mathematicians is not familiar with the application of modern mathematics to photonics, quantum computation, flow control by microwave pulse sequences and ultrafast laser pulse trains, condensed matter physics, and medical radiology. It is the purpose of the lecture to present an introduction to the high tech applications of nilpotent harmonic analysis to quantum computer devices and high resolution magnetic resonance imaging (MRI) of non-invasive radiological diagnostics. It is shown that the three-dimensional Heisenberg nilpotent Lie group N, its transversally foliated unitary dual $\hat{N}$ formed by the equivalence classes of irreducible unitary linear representations of N, the metaplectic automorphisms of N induced by the Galois correspondence of its covariant group system $(SL(2,\mathbf{R}),N)$, and the compact Heisenberg nilmanifold associated with N provide the mathematical substrate of a wide spectrum of innovative applications. In this context, the compact Heisenberg nilmanifold should be viewed as a principal circle bundle over the two-dimensional flat torus that represents a photonic crystal in nanoscale optical imaging. In terms of the Hopf fibration of the three-sphere, the quantum entanglement of circular polarizations is implemented by the paratactic concept of Clifford parallelism. The spectrum of advanced applications of the concept of metaplectic symmetry ranges from the microworld of ultracold planar quantum wells and superconducting microchip design to the evanescent wavelets in metamaterials, an emerging class of artificially structured and designed materials of unprecedented electromagnetic properties in microwave or THz regimes, and the effects of surface plasmon resonance in photonic crystals of negative refraction and ultrasmall opto-electronic devices to the macroworld of solar and extrasolar astrophysics, and brane cosmology of black and white holes. High resolution MRI-videos of the beating heart will illustrate the application of harmonic analysis of N to non-invasive clinical diagnostics and the progress recently made by fast spin echo (FSE) imaging in the field of routine medical radiology. The lecture closes with the volume interpolated breath-hold MRI-examination technique. Due to recent hardware and software advances, it improves the partial volume effect and reduces the artifacts caused by the shape and size of pixels in the image.

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3D Digital Technology and Its Applications

Hongbin Zha

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Abstract

3D digital technology for object and scene modeling offers significant potential for a variety of applications ranging from industrial design, virtual reality, intelligent human-computer interaction, to digital heritage conservation. Until now, while most of the researches have been devoted to the analysis of digital images, a lot of attempts have appeared to produce 3D object and scene models by integrating 3D range data and different kinds of image data. In particular, recent achievements in laser scanning technology have made it possible to create high-quality 3D models of complex objects by using dense point clouds and high-resolution texture images. However, to make these models really useful, we also need to develop novel methods for interactive exploration and analysis of the usually large-scale and noisy datasets. To the end, some new outcomes from machine vision and graphics fields, such as LOD (level of details) and point-based reconstruction techniques, have to be integrated in the traditional approaches. In the talk, the speaker will give an overview for some basic concepts and processes in the 3D digital technology and related digital geometry processing research. Then, he will introduce some research results obtained by his group in Peking University. The topics include: dynamic LOD control techniques for fast rendering of large 3D scenes; shape analysis and matching for building model-retrieval systems; video-driven facial animation and expression synthesis; 3D data registration and integration for modeling of built architectures. Finally, some case studies in digital cultural heritage are discussed to show the potential of the 3D digital technology in real applications.

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