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Recent Advances in Systems Theory, Signal Processing and Computation

Proceedings of the 13th International Conference on Signal Processing, Computational Geometry and Artificial Vision (ISCGAV '13)

Proceedings of the 13th International Conference on Systems Theory and Scientific Computation (ISTASC '13)

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ISSN: 1790-5117
ISBN: 978-960-474-320-9

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Published by WSEAS Press
www.wseas.org

All papers of the present volume were peer reviewed by no less that two independent reviewers. Acceptance was granted when both reviewers' recommendations were positive.
See also: http://www.worldses.org/review/index.html

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Preface

This year the 13th International Conference on Signal Processing, Computational Geometry and Artificial Vision (ISCGAV '13) and the 13th International Conference on Systems Theory and Scientific Computation (ISTASC '13) were held in Valencia, Spain, August 6-8, 2013. The conferences provided a platform to discuss nonlinear signals and systems, array signal processing, speech recognition, multidimensional systems, remote sensing, machine vision, systems theory, neural networks, distributed computing, finite elements, functional languages, communication protocols etc with participants from all over the world, both from academia and from industry.

Their success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The accepted papers of these conferences are published in this Book that will be sent to international indexes. They will be also available in the E-Library of the WSEAS. Extended versions of the best papers will be promoted to many Journals for further evaluation.

Conferences such as these can only succeed as a team effort, so the Editors want to thank the International Scientific Committee and the Reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

The Editors

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Keynote Lecture 1

No Need to be Afraid of Multivariance in Multiway Arrays: Eigenvalue and Singular Value Related Issues

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Abstract: Especially in the last two decays there have been an increasing tendency to use the multiway arrays in the analyses of the systems given by big number of data. Multiway arrays are given by the elements depending on more than two indices. Hence they constitute somehow an extension to the usual matrices and vectors of ordinary linear algebra. This extension separates their analyses from matrices and vector and gathers under a different title “Multilinear Algebra”. Many scientists call them “Tensors” despite the fact that this term defines more restricted items. Hence, like the presenter of this talk, many other scientists intend not to use the term “Tensor”. Instead, the terms “Multiway Arrays” or “Multilinear Arrays” are widely used.
Each index of the general term of an array corresponds to a different direction or way. So, the vectors of the ordinary linear algebra are unidirectional or one way arrays while the matrices are bidirectional or two way arrays in this sense. Beyond these, the simplest multiway array whose elements have three independent indices is a tridirectional or three way array. Geometrically, vectors and matrices correspond to lines (very specific case is dot) and rectangles (or specifically squares) while the three way arrays can be described by the rectangular prisms (or in specific cases by cubes).
Like matrices, the multiway arrays can be considered as either just linear vector space elements or some operators mapping one space to other. In this sense, vectors correspond to just points in the relevant linear vector space whereas the matrices take a vector from a linear vector space and produces another vector in a different linear vector space. In the case of multilinear arrays each way can be considered either domain or range depending on the modelling needs. Each of the directions or ways corresponds to a different linear vector space even though certain matching structures appear. These linear vector spaces are joined together to get a single domain and a single range. Then the multiway array under consideration can be considered as an operator mapping from this domain. The number of the possible unions (set theoretical combinations) in these operations increases quite nonlinearly as the multivariance grows. For this reason, the author and his colleagues in his group defined specific entities from the multiway arrays and called them “Folvec (folded vector)”, and “Folmat (folded matrix)” by regrouping the indices of the multiway array elements. Folmats have two group indices, separated by semicolon, such that the indices at the right are considered as column indices while the left indices are for row. Hence, the row and column concepts in this case are not unidirectional but multidirectional entities.
The dubiosity or uncertainty in the domain definition of multiway array also makes it difficult to define eigenvalue problems since the eigenvectors are specific directions which remain unchanged under the action of the considered array while the scaling is charac- terized by the eigenvalue. The conserved direction definition needs many specifications in comparison with the eigenvalue problems of the matrices in ordinary linear algebra. Hence, some of the scientists focusing on this issue used the Rayleigh Quotient optimisa- tion and similar concepts to define the eigenvalue and eigenvectors. However this may not be the case when each way of the multiway array is emphasized on differently for different needs. Then explicit and more than one definitions to be used in different cases should be considered. The presentation focuses on these issues.

Brief Biography of the Speaker: Metin Demiralp was born in Türkiye (Turkey) on 4 May 1948. His education from elementary school to university was entirely in Turkey. He got his BS, MS degrees and PhD from the same institution, ˙Istanbul Technical University. He was originally chemical engineer, however, through theoretical chemistry, applied mathematics, and computational science years he was mostly working on methodology for computational sciences and he is continuing to do so. He has a group (Group for Science and Methods of Computing) in Informatics Institute of ˙Istanbul Technical University (he is the founder of this institute). He collaborated with the Prof. Herschel A. Rabitz’s group at Princeton University (NJ, USA) at summer and winter semester breaks during the period 1985-2003 after his 14 month long postdoctoral visit to the same group in 1979-1980. He was also (and still is) in collaboration

with a neuroscience group at the Psychology Department in the University of Michigan at Ann Arbour in last three years (with certain publications in journals and proceedings).
Metin Demiralp has more than 100 papers in well known and prestigious scientific journals, and, more than 230 contributions together with various keynote, plenary, and, tutorial talks to the proceedings of various international conferences. He gave many invited talks in various prestigious scientific meetings and academic institutions. He has a good scientific reputation in his country and he was one of the principal members of Turkish Academy of Sciences since 1994. He has resigned on June 2012 because of the governmental decree changing the structure of the academy and putting politicial influence possibility by bringing a member assignation system. Metin Demiralp is also a member of European Mathematical Society. He has also two important awards of turkish scientific establishments.
The important recent foci in research areas of Metin Demiralp can be roughly listed as follows: Probabilistic Evolution Method in Explicit ODE Solutions and in Quantum and Liouville Mechanics, Fluctuation Expansions in Matrix Representations, High Dimensional Model Representations, Space Extension Methods, Data Processing via Multivariate Analytical Tools, Multivariate Numerical Integration via New Efficient Approaches, Matrix Decompositions, Multiway Array Decompositions, Enhanced Multivariate Product Representations, Quantum Optimal Control.

Plenary Lecture 1

Iterative Method for Solving a Nonstationary Transport Equation in Absorbing Media

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Abstract: The integral-differential equations describe many physical phenomena in different fields of the science and nuclear engineering. The resolution of these equations is the subject of several papers in which the authors have approached in most cases numerical methods: the finite element method, Monte Carlo, truncated series of Chebyshev polynomials, the fictitious domain method, SN method.
In this paper we present an algorithm based on the Finite Differences Method and the techniques of the Homotopy Perturbation Method (HPM) to solve a homogeneous boundary value for a time dependent transport equation. The homotopy perturbation method is a coupling of traditional perturbation method and the homotopy function in topology, which deforms continuously the given problem to another that can be easily solved.
The new method leads to a rapid convergence of the series solution to the exact solution. Usually, if the time step is chosen correctly, a small number of iterations are needed to achieve high accuracy results. A numerical example proves the validity and the great potential of this new method for particle transport problems.

Brief Biography of the Speaker: Olga Martin graduated the Faculty of Mathematics and Mechanics, University of Bucharest, Romania. She received his PhD in mathematics with the specialization in Dynamic Plasticity with paper work 'Applications of the Finite Element Method in Dynamic Plasticity'. During of twenty years, she had been senior researcher in Aircraft Institute, Strength Materials Department. Technical experience: structural strength computing reports using ANSYS program (wing-fuselage, fuselage frame, fin, elevator, rudder and aileron), dynamic and static test-programs for aircraft structures, fatigue test-programs for aircraft structures, iterative methods for the study of the reactions, which correspond to movable control surfaces, attached at n – points to an elastic structure and program of this, static and fatigue computation of the propeller (mono-bloc hub, blades and blades retention system).
Nowadays, she is Professor at Applied Sciences Faculty, University "Politehnica" of Bucharest.
Fields of specialization: Mathematical Analysis, Mathematical Physics, Computational and Experimental Solid Mechanics, Plasticity Dynamics, Structural Strength Calculation, Numerical Analysis, Statistical Calculus. She has published over 90 research papers and 18 books.
Member of the editorial boards: Politehnica Sci. Bull. Series A, WSEAS Transactions on Applied and Theoretical Mechanics and she was involved in the program/organizing committees for many international conferences.
Membership of Professional Societies: Society of Computer Aided Engineering – Member National Union of Romanian Scientists (Founding member), Balkan Society of Geometers member, Romanian Society of Mathematicians.
Reviewer: WSEAS Press (books and journals), Scientific Bulletin, University "Politehnica" of Bucharest, Acta Mathematica universitatis Comenianae, Journal of Quantitative Spectroscopy and Radiative Transfer.
Scientific Evaluation Societies: RELANSIN, University "Politehnica" of Bucharest, ARACIS, Bucharest, Bucharest, National Science Fund of Bulgaria, Executive Unit for Research Development and Innovation of Romania

Plenary Lecture 2

On Digit Sum of Very Large Integers – An Algorithm to Expand the Capacity of a Computer for Representing Numerical Values

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Abstract: Every computer, no matter how advanced it is, has a limited capacity for representing numerical values. Suppose M is the largest integer representable on a computer, then only (part of) integers of log10M +1 digits or less can be represented by that computer. This presentation will propose an algorithm that enables the same computer to conduct various computations based on the digit sum of integers of as many as [M/9] digits. The implementation of this algorithm allows us to use this computer to numerically evaluate and theoretically analyze integers that are beyond the representation capacity of this computer. The algorithm is also very suitable for parallel computing. An application of this algorithm is included. A mathematical conjecture related to this algorithm is also raised.

Brief Biography of the Speaker: Yixun Shi graduated with a B.S. degree in mathematics from Anhui Normal University, China in 1981, and then with a M.S. degree in mathematics from Shanghai Normal University, China in 1984. From 1984 to 1987 he taught in the Department of Mathematics of Shanghai Normal University, China. From 1987 to 1992 He studied in the University of Iowa, USA, and graduated in 1992 with a Ph.D. degree in mathematics. Since then he has been a faculty member of the Department of Mathematics, Computer Science and Statistics at the Bloomsburg University of Pennsylvania, USA, serving as an assistant professor from 1992 to 1996, an associate professor from 1996 to 2000, and a full professor since 2000. His research interests include numerical optimization and nonlinear system of equations, scientific computing, computational statistics, mathematical modeling, financial mathematics, and mathematics education. He is author of a number of books and more than 50 papers published in international journals and conference proceedings. He has also delivered keynote speeches at various international conferences.

Plenary Lecture 3

Real Model Geometric Characterization using Gram-Schmidt Orthogonalization Concept

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Abstract: It is well known that modeling is to look for an adequate mathematical model to represent the real model by linking, mathematically, the inputs to the output data of the real model. In the case of a linear model, this relation is, usually, performed using a different kind of mathematical models, which are used to estimate the coefficients of the closest linear model to the real one. This sort of models are, usually, obtained by the LMS algorithm or the minimum square error (MSE) which suggests that the best linear approximation of any real model output corresponds to the minimum of the estimation error or, equivalently, must be, geometrically, orthogonal to the linear input space. The determination of the non linear model is, however, one of the most difficult tasks in modeling. In contrast to a linear model corresponding, geometrically, to a hyper plane with only a zero Riemannian curvature, a non linear model corresponds to a many possible variable Riemannian curvatures. The crucial question is, therefore, how to select the right mathematical non linear model to fit the real one. Theoretically, we have an infinite number of possible non linear models, but if we have, however, any faire indication about the real model curvature or non linearity, then the selected mathematical model could be restricted, accordingly, to a limited range of possible models to represent the real one. The selected model is, obviously, the one that has the least modeling error. This is indeed what we, usually, attempt to do, particularly, in neural networks field. This selected model, unfortunately, may not be the decisive one since we could not try all the mathematical models.
In the algebraic methods of modeling, we do not, usually, look how a real model is being constituted and what are its geometric components. We believe, therefore, that it is very important to represent a real model, geometrically, by its main components in order to see how they are, naturally, related to each other. As a result, we can understand how it is possible to obtain a better approximation for the real system (or model) In this talk, we try, thus, to discuss the main characteristics of a real model, in general, using geometric approach based on Gram-Schmidt concept. Some examples such as Autoregressive models, Kalmann algorithm and so on, are reviewed to clarify this geometric representation of a real model.

Brief Biography of the Speaker: Dr B. Yagoubi received the M. Sc degree in Electrical Engineering in 1985 from Bel-Abbes University, Algeria and the Ph. D degree (thin films) (1986-1989) in the Faculty of Sciences from Brunel University (UK). He was the head of the Signals and Systems Laboratory (1999-2003) and the head of the Department of Electrical Engineering (2005-2006). He is lecturing the theory of digital signal, systems modeling and identification, random processes and detection (1996-2013) at Mostaganem University, Algeria. Currently, he is involved in some national projects; forest fire detection, heart rate variability in the LF and HF bands to characterize the autonomous nervous system, and study and application of random processes. Further research interests are in real signals and models geometric representation based on Gram-Schmidt orthogonalization concept, as well as using a relative geometric space of observation.