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ADVANCED APPLICATIONS OF ELECTRICAL ENGINEERING

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Proceedings
of the 8th International
Conference
on Applications
of Electrical Engineering

Houston, USA, April 30-May 2, 2009

Sponsored, Organized and
Hosted by the
UNIVERSITY of HOUSTON
- DOWNTOWN
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**Preface**

This year the 8th WSEAS International Conference on Applications of Electrical Engineering (AEE ’09) and the 7th International Conference on Applied Electromagnetics, Wireless and Optical Communications (ELECTRO '09) were held in Houston, USA. The Conference remains faithful to its original idea of providing a platform to discuss theoretical and applicative aspects of applications of circuits, systems, electronics, applications of control and robotics, applications of power systems, applications of communications etc. with participants from all over the world, both from academia and from industry.

Its 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 this conference are published in this Book that will be indexed by ISI. Please, check it: www.worldses.org/indexes as well as in the CD-ROM Proceedings. They will be also available in the E-Library of the WSEAS. The best papers will be also promoted in many Journals for further evaluation.

A Conference such as this 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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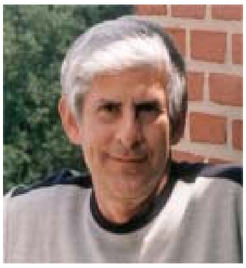
## Keynote Lecture 1

## Four Open Mathematical Problems Related to Computer Graphics and Geometric Modeling



**Professor Ron Goldman**
Department of Computer Science
Rice University

**Abstract:** Four unsolved problems that originate from research in Computer Graphics and Geometric Modeling will be presented. The first problem involves understanding the notion oscillation for Bezier surfaces, the freeform polynomial surfaces most common in Computer Graphics and Geometric Modeling. The second problem concerns gnerating smooth (C2 ) surfaces via subdivision from triangular or quadrilateral meshes of arbitrary topology. The third problem is related to Bezier curves and univariate Bernstein polynomials, and concerns the combinatorics of symmetrizing multiaffine functions. The fourth and final problem pertains to fractals and asks if there is an algorithm to determine whether two arbitrary sets of contractive affine transformations generate the same fractal.

**Brief Biography of the Speaker:** Ron Goldman is a Professor of Computer Science at Rice University in Houston, Texas. Professor Goldman received his B.S. in Mathematics from the Massachusetts Institute of Technology in 1968 and his M.A. and Ph.D. in Mathematics from Johns Hopkins University in 1973. He is an associate editor of Computer Aided Geometric Design. In 2002, he published a book on Pyramid Algorithms: A Dynamic Programming Approach to Curves and Surfaces for Geometric Modeling. Dr. Goldman's current research interests lie in the mathematical representation, manipulation, and analysis of shape using computers. His work includes research in computer aided geometric design, solid modeling, computer graphics, and splines. He is particularly interested in algorithms for polynomial and piecewise polynomial curves and surfaces, and he is currently investigating applications of algebraic and differential geometry to geometric modeling. He has published over a hundred articles in journals, books, and conference proceedings on these and related topics. Before returning to academia, Dr. Goldman worked for ten years in industry solving problems in computer graphics, geometric modeling, and computer aided design. He served as a Mathematician at Manufacturing Data Systems Inc., where he helped to implement one of the first industrial solid modeling systems. Later he worked as a Senior Design Engineer at Ford Motor Company, enhancing the capabilities of their corporate graphics and computer aided design software. From Ford he moved on to Control Data Corporation, where he was a Principal Consultant for the development group devoted to computer aided design and manufacture. His responsibilities included data base design, algorithms, education, acquisitions, and research. Dr. Goldman left Control Data Corporation in 1987 to become an Associate Professor of Computer Science at the University of Waterloo in Ontario, Canada. He joined the faculty at Rice University in Houston, Texas as a Professor of Computer Science in July 1990.

## Keynote Lecture 2

## Cardiovascular Informatics: How to Stop a Heart Attack Before it Happens

**Professor Ioannis A. Kakadiaris**
Computational Biomedicine Lab Depts. of CS, ECE
Biomedical Engineering, University of Houston

**Abstract:** In this talk, first I will offer a short overview of the research activities of the Computational Biomedicine Laboratory, University of Houston. Then, I will present our research in the area of biomedical image computing for the mining of information from cardiovascular imaging data for the detection of persons with a high likelihood of developing a heart attack in the near future (vulnerable patients). Specifically, I'll present methods for detection and segmentation of anatomical structures, and shape and motion estimation of dynamic organs. The left ventricle in non-invasive cardiac MRI data is extracted using a novel multi-class, multi-feature fuzzy connectedness method and deformable models for shape and volume estimation. In non-invasive cardiac CT data, the thoracic fat is detected using a relaxed version of multi-class, multi-feature fuzzy connectedness method. Additionally, the calcified lesions in the coronary arteries are also identified and quantified using a novel hierarchical supervised learning framework from the CT data. In non-invasive contrast-enhanced CT, the coronary arteries are detected using our novel tubular shape detection method for motion estimation and possibly, for non-calcified lesion detection. In invasive IVUS imaging, our team has developed a unique IVUS acquisition protocol and novel signal/image analysis methods) for the detection (for the first time in?vivo) of 'vasa vasorum' (VV). The VV are micro-vessels that are commonly present to feed the walls of larger vessels; however, recent clinical evidence has uncovered their tendency to proliferate around areas of inflammation, including the inflammation associated with vulnerable plaques. In summary, our work is focused on developing novel computational tools to mine quantitative parameters from the imaging data for early detection of asymptomatic cardiovascular patient. The expected impact of our work stems from the fact that sudden heart attack remains the number one cause of death in the US, and unpredicted heart attacks account for the majority of the $280 billion burden of cardiovascular diseases.

**Brief Biography of the Speaker:** Prof. Ioannis A. Kakadiaris is an Eckhard Pfeiffer Professor of Computer Science, Electrical & Computer Engineering, and Biomedical Engineering at the University of Houston. He joined UH in August 1997 after a postdoctoral fellowship at the University of Pennsylvania. Ioannis earned his B.Sc. in physics at the University of Athens in Greece, his M.Sc. in computer science from Northeastern University and his Ph. D. at the University of Pennsylvania. He is the founder of the Computational Biomedicine Lab (www.cbl.uh.edu) and this year directs the Methodist-University of Houston-Weill Cornell Medical College Institute for Biomedical Imaging Sciences (IBIS) (ibis.uh.edu). His research interests include cardiovascular informatics, biomedical image analysis, biometrics, computer vision, and pattern recognition. Dr. Kakadiaris is the recipient of a number of awards, including the NSF Early Career Development Award, Schlumberger Technical Foundation Award, UH Computer Science Research Excellence Award, UH Enron Teaching Excellence Award, and the James Muller Vulnerable Plague Young Investigator Price. His research has been featured on Discovery Channel, National Public Radio, KPRC NBC News, KTRH ABC News, and KHOU CBS News.

## Keynote Lecture 3

## Compilation and Optimization for High Performance Computing

**Professor Kleanthis Psarris**
Department of Computer Science
The University of Texas at San Antonio
San Antonio, TX 78249
USA

**Abstract:** High end parallel and multi-core processors rely on compilers to perform the necessary optimizations and exploit concurrency in order to achieve higher performance. However, source code for high performance computers is extremely complex to analyze and optimize. In particular, program analysis techniques often do not take into account complex expressions during the data dependence analysis phase. Most data dependence tests are only able to analyze linear expressions, even though non-linear expressions occur very often in practice. Therefore, considerable amounts of potential parallelism remain unexploited. In this talk we propose new data dependence analysis techniques to handle such complex instances of the dependence problem and increase program parallelization. Our method is based on a set of polynomial time techniques that can prove or disprove dependences in source codes with non-linear and symbolic expressions, complex loop bounds, arrays with coupled subscripts, and if-statement constraints. In addition our algorithm can produce accurate and complete direction vector information, enabling the compiler to apply further transformations. To validate our method we performed an experimental evaluation and comparison against the I-Test, the Omega test and the Range test in the Perfect and SPEC benchmarks. The experimental results indicate that our dependence analysis tool is accurate, efficient and more effective in program parallelization than the other dependence tests. The improved parallelization results into higher speedups and better program execution performance in several benchmarks.

**Brief Biography of the Speaker:** Kleanthis Psarris is Professor and Chair of the Department of Computer Science at the University of Texas at San Antonio. His research interests are in the areas of Parallel and Distributed Systems, Compilers and Programming Languages. He received his B.S. degree in Mathematics from the National University of Athens, Greece in 1984. He received his M.S. degree in Computer Science in 1987, his M.Eng. degree in Electrical Engineering in 1989 and his Ph.D. degree in Computer Science in 1991, all from Stevens Institute of Technology in Hoboken, New Jersey. He has published extensively in top journals and conferences in the field and his research has been funded by the National Science Foundation and Department of Defense agencies. He is an Editor of the Parallel Computing journal. He has served on the Program Committees of several international conferences including the ACM International Conference on Supercomputing (ICS) in 1995, 2000, 2006 and 2008, the IEEE International Conference on High Performance Computing and Communications (HPCC) in 2008 and 2009, and the ACM Symposium on Applied Computing (SAC) in 2003, 2004, 2005 and 2006.

## Keynote Lecture 4

## If It's Fast It Must Be Newton's Method

**Professor Richard Tapia**
Computational & Applied Mathematics Department
Rice University
Houston, TX
USA

**Abstract:** Shifted inverse and Rayleigh quotient iteration are well-known algorithms for computing an eigenvector of a symmetric matrix. In this talk we demonstrate that each of these algorithms can be viewed as a standard form of Newton's method from the nonlinear programming literature. This provides an explanation for their good behavior despite the need to solve systems with nearly singular coefficient matrices. Our equivalence result also leads us naturally to a new proof that the convergence of the Rayleigh quotient iteration is q-cubic with rate constant at worst 1.

**Brief Biography of the Speaker:** Dr. Tapia is a mathematician and professor in the Department of Computational and Applied Mathematics at Rice University in Houston, Texas. He is internationally known for his research in the computational and mathematical sciences and is a national leader in education and outreach. His current Rice positions are University Professor, Maxfield Oshman Professor in Engineering, Associate Director of Graduate Studies, and Director of the Center for Excellence and Equity in Education. Among his many honors, he was the first Hispanic elected to the National Academy of Engineering. In 1996 President Clinton appointed him to the National Science Board. From 2001 to 2004 he chaired the National Research Council's Board on Higher Education and the Workforce. He has received the National Science Foundation's inaugural Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring; and the Lifetime Mentor Award from the American Association for the Advancement of Science. He was also named one of 20 most influential leaders in minority math education by the National Research Council. Currently, his NSF-supported programs, Alliances for Graduate Education in the Professoriate, and the Empowering Leadership Alliance have developed supportive communities of students and faculty members that ensure the success of underrepresented individuals in STEM fields at U.S. institutions of higher learning. Professor Tapia is recognized as a national leader in diversity and has delivered numerous invited addresses at national and international mathematics conferences, served on university diversity committees, and provided leadership at a national level.

## Keynote Lecture 5

## Geometric Analysis of SL(2,C) and Biologically-Mediated Computational Vision

**Professor Jacek Turski**
University of Houston-Downtown
Department of Computer and Mathematical Sciences
USA

**Abstract:** The group SL(2,C) of 2x2 complex matrices of determinant one occupies a truly remarkable place in mathematics and sciences. For example, it is inherently relevant to non-Euclidean geometries, modern complex analysis, and Einstein's special theory of relativity. In our work, SL(2,C) provides unified geometrical and numerical framework for computational vision, including visual neuroscience and machine vision systems.

The conformal camera, which models eyes imaging functions, produces image projective transformations generated by the linear-fractional mappings of the group SL(2,C). Thus, the camera's underlying geometry can be dually described as (1) one-dimensional complex projective geometry and (2) the conformal geometry imposed by the holomorphic complex structure of the Riemann sphere, also called Mobius, or inversive geometry. Although this geometry does not possess a distance, it provides a full set of descriptors for the Gestalt rules used in grouping fragmented contours into global shapes that primate visual system must solve when viewing natural images—one of the most difficult problems to model numerically. The unity of geometrical and numerical methods is established by the fact that the conformal camera has its own projective Fourier analysis, geometric Fourier analysis constructed on the group SL(2,C) in the framework of representation theory of semisimple Lie groups—a great achievement of the 20th century mathematics. Projective Fourier transform (PFT) provides image representation well adapted to both perspective transformations of retinal images and the retinotopy of the brain's visual and oculomotor pathways. Thus, PFT integrates the head, eyes, and visual cortex into one computational system. We use this binocular system to process visual information during fast scanning eye movements called saccades, employed to build up understanding of scenes despite the acuity limitations of foveate vision. We make about three saccades per second at the eyeball's maximum speed of 700 deg/sec. Visual sensitivity is markedly reduced, as we do not see moving retinal images. Despite these incisive eye movements, the fragmented pieces of visual information are integrated in the brain into a stable percept of the world. This visual constancy is maintained by neuronal receptive field shifts prior to saccade onset in various retinotopically organized cortical areas. These shifts give the brain access to visual information at the impending saccade target prior to the eyes' arrival. It integrates visual information across saccades and eliminates the need for starting visual information acquisition anew three times per second at each fixation. However this remapping is not perfect; around the time of saccades, the flashed probes are not perceived in veridical locations by humans in laboratory experiments, a phenomenon called perisaccadic mislocalization.

In our modeling of perisaccadic perception, we utilize basic properties of PFT. First, the PFT can be efficiently computed by a fast Fourier transform in logarithmic coordinates that approximate the retinotopy. Second, a simple translation in retinotopic (logarithmic) coordinates, modeled by the standard shift property of Fourier transform, remaps the presaccadic scene into a postsaccadic reference frame. This shift also accounts for the perisaccadic mislocalization.

This research program is guided by a strategy important in the contemporary neurocomputing research: linking known anatomical and physiological details with efficient computational modeling should be vital not only to emerging field of neural engineering but also to interpreting relevant neurophysiological data.

**Brief Biography of the Speaker:** Jacek Turski was awarded his Ph.D. from McGill University. After holding postdoctoral positions at the University of Manitoba and the University of Houston, he joined the University of Houston-Downtown where he is now a full professor in the Department of Computer and Mathematical Sciences. Five years ago Turski constructed projective Fourier analysis of the conformal camera in the framework of the representation theory of semisimple Lie groups. Based on this Fourier analysis, he is currently developing a physiologically realistic model of human and robotic vision systems. His research has been supported by the NSF grants. He was the recipient of the 2006 Scholarship/Creativity Award at UHD.

## Plenary Lecture 1

# Topological Electromagnetics and its Applications


**Professor Guennadi A. Kouzaev**
Norwegian University of Science and Technology
NORWAY



**Abstract:** Topological electromagnetics is the theory which studies the global spatiotemporal features of the electromagnetic field. It is dealing with the topological analysis of the electromagnetic field and with the qualitative solutions of boundary electromagnetic problems.
In this lecture, the basics of topological electromagnetism are introduced. The definition of the electromagnetic field topological schemes which are composed of the equilibrium points and separatrices of the field-force line portraits is given, and the Maxwell-like equations are introduced for topologies of the electric and magnetic fields.
The treatment of the boundary problems of the electromagnetism is considered. It consists of analytical or semi-analytical composition of the topological field schemes according to the field boundary graphs. The developed field computing approach is fast and, and it is for the effective initial solutions of boundary electromagnetic problems.
This theory is applied to the electromagnetic signaling and computing. The carrier of digital information is the spatio-time topology of electromagnetic impulses, and the digital processing of them can be realized even by passive circuits. This approach is applied to the modeling of the Boolean, predicate, reconfigurable, and pseudo-quantum logics. The brain pattern activity is proposed to be modeled by these signals, and a quasi-neural gate of the OR/AND type is modeled. The gates of one of the types are integrated into a topological processor for predicates, and its design and work are considered shortly in this lecture.


**Brief Biography of the Speaker:** The speaker is a Professor at the Norwegian University of Science and Technology-NTNU, Trondheim, Norway. He received the Dr. Sciences (Habil.) degree from the Moscow State Institute of Electronics and Mathematics (Techn. University) in Computer Engineering and Microwave Electronics, in 1998. He was with the Russia Research Institute of Space Instrument Design, Moscow State Institute of Electronics and Mathematics, Gennum Corp. and McMaster University (Canada).
He has published more than 100 publications and 14 inventions for topological electromagnetism, topologically modulated signals and computing, microwave and high-speed three-dimensional and planar integrated circuits, physics of cold matter, and micro -and millimeter-wave biomonitoring.
Prof. G. Kouzaev was awarded with the Russian Government Prize (1997) and the Soviet Union Prize for Young Scientists (1990) for his achievements in three-dimensional integration and space-time signal processing hardware for airspace applications.
He is a Member of the IEEE, WSEAS, IMAPS, and Trans Black Sea Region Science Union for Applied Electromagnetics. Dr. G.A. Kouzaev is a Chair of several WSEAS conferences and a track-chair of the IEEE supported conferences. He was a Co-chair of a SPIE symposium on terahertz electronics and a Program Committee Member of several international meetings on applied electromagnetics, wave physics and computer engineering.

## Plenary Lecture 2

## Nanotechnology Research Advances in Mexico

**Professor Armando Barranon**
Department of Basic Sciences,
Universidad Autonoma Metropolitana-Azcapotzalco, Mexico City
MEXICO

**Abstract:** Nanotechnology research groups in Mexico typically have five members and are devoted to a wide range of research subjects. Nanotechnology Laboratories have been founded in several Mexican States, using computational techniques, nanomicroscopy and chemical synthesis to develop new materials as well as new theoretical approaches to understand nanotechnology properties. Other Mexican nanotechnology research groups study the social and environmental impact of nanotechnology. The size frequency distribution of these research groups follows a power law in agreement with a model for social interaction although there are no signs of an institutional organization of these research groups which might lead to the creation of a Mexican Nanotechnology Initiative. Nevertheless, by 2006 Mexican Council of Science of Technology funded several research groups to develop projects related to a Mexican National Initiative. In this plenary talk I will describe the research activities of about fifty Mexican nanotechnology research groups, comprising 300 researchers, and I will explain the need for governmental intervention in order to attain the objective of a Mexican Nanotechnology Initiative.

**Brief Biography of the Speaker:** Armando Barranon was born in Mexico City. B.Sc. in Mathematical Physics, Instituto Politecnico Nacional, Mexico City, 1986. M.Sc. in Applied Statistics, The University of Texas at El Paso, 1989. Dr. in Philosophy, U. La Salle, Magna Cum Laude, Mexico City, 2004. M.Sc. Physics, Instituto Politecnico Nacional, Mexico City, 2005. Dr. in Physics of Materials, Instituto Politecnico Nacional, Mexico City, 2008. Postdoctoral Fellow, U. Zacatecas, Mexico, 2008.
He is Full Professor at Department of Basic Sciences, Universidad Autonoma Metropolitana-Azcapotzalco, Mexico City. Research interests include Nuclear Physics, Computational Physics and Philosophy of Technology. In 2007, Dr. Barranon founded the Nanoeducation Seminar at UAM-Azcapotzalco.
Dr. Barranon is member of the Mexican National Research System, member of American Physical Society, Sociedad Mexicana de Fisica, Sociedad Mexicana de Matematicas, Sociedad Mexicana de Termodinamica, Sociedad Mexicana de Historia de la Ciencia y la Tecnologia, among others.

## Plenary Lecture 3

## The Real Time Control of Modular Walking Robot Stability

**Professor Luige Vladareanu**
Romanian Academy, Institute of Solid Mechanics, Bucharest
ROMANIA

**Abstract:** The paper presents an open architecture system for real time control of stability for modular walking robots with applications in the MERO structured walking robots. Starting with direct and inverted kinematic modelling of the movement of walking robots, determining the mathematical equations in Cartesian coordinates for the support point Pi, found at the extremity of the leg i, in relation to the system attached to the platform and through quasi-dynamic analysis of the mathematical modelling for defining the walking type, the speed and the direction of movement, the robot's stability control algorithm has been deduced. For stability control an open architecture system has been developed which ensures a real time hybrid position-force control in which the position errors representation is given in relation to a squared Jacobean matrix of maximum rank, a selection matrix S and a pseudo-invert (SJ)+ of the SJ matrix. In force control, the force Cartesian error fe , is calculated as the difference between the actual and desired force. By using S+, which represents the orthogonal complement of S, the selected Cartesian force errors are determined and the robot/s transposed Jacobean matrix transforms Cartesian forces in torques corresponding to the joints. Using, in particular, the selected Cartesian force errors, the selected torque joints errors are obtained. This architecture is based on a series of associated projection matrixes which allow dividing a vector by transforming the matrix A, into two perpendicular components. Thus modifying the hybrid position-force control system ensures all the conditions for stability. Mainly this is due to the fact that calculation the inverted Jacobean matrix is no longer necessary, which used to provoke kinematics' instability of the hybrid position-force control system. The obtained results have allowed the graphical determination of the walking robot model's reply to round the coordinate axis rotation and have led to an improvement in the response time to disturbances and to following the movement trajectory in conditions of high stability.

**Brief Biography of the Speaker:** Luige Vladareanu received his M.Sc. degree in electronics from the Polytechnic Institute Bucharest, in 1977. From 1984, scientific researcher of the Institute of Physics and Material Technology, from 1990, team leader of data acquisition systems and real time control systems of the Institute of Solid Mechanics, from 1991, President General Manager of Engineering and Technology Industrial VTC company. In 1998 he received Ph.D. degree in electronics field from the Institute of Solid Mechanics of Romanian Academy. From 2003, Ministry of Education and Research, executive Department for Financing Superior Education and of Scientific University Research - High Level Expert Consulting for MEC/CNCSIS project, from 2003-2005, member of Engineering Science Committee of Romanian National Research Council, from 2005, Scientific Researcher Gr.I (Professor) of Romanian Academy. His scientific work is focused on real time control in solid mechanics applied in robot trajectory control, hybrid position – force control, multi-microprocessor systems for robot control, acquisition and processing of experimental physical data, experimental methods and signal processing, nano-micro manipulators, semi-active control of mechanical system vibrations, semi-active control of magnetorheological dissipaters systems, complex industrial automations with programmable logical controllers in distributed and decentralized structure. He has published 4 books, over 20 book chapters, 11 edited books, over 200 papers in journals, proceedings and conferences in the areas. Director and coordinator of 7 grants of national research – development programs in the last 5 years, 15 invention patents, developing 17 advanced work methods resulting from applicative research activities and more then 60 research projects. In 1985 the Central Institute of Physics Bucharest awarded his research team a prise for the first Romanian industrial painting robot. He is the winner of the two Prize and Gold of Excellence in Research 2000, SIR 2000, of the Romanian Government and the Agency for Science, Technology and Innovation. 3 International Invention and Innovation Competition Awards and Gold of World's Exhibition of Inventions, Geneva 2007 and 2008, and other 7 International Invention Awards and Gold of the Brussels, Croatia, Bucharest International Exhibition. He received "Traian Vuia" (2006) award of the Romanian Academy, Romania's highest scientific research forum, for a group of scientific papers published in the real time control in the solid mechanics. He is a member of the International Institute of Acoustics and Vibration (IIAV), Auburn University, USA (2006), ABI/s Research Board of Advisors, American Biographical Institute (2006), World Scientific and Engineering Academy Society, WSEAS (2005), International Association for Modelling and Simulation Techniques in Enterprises-AMSE, France (2004), National Research Council from Romania(2003-2005), etc.