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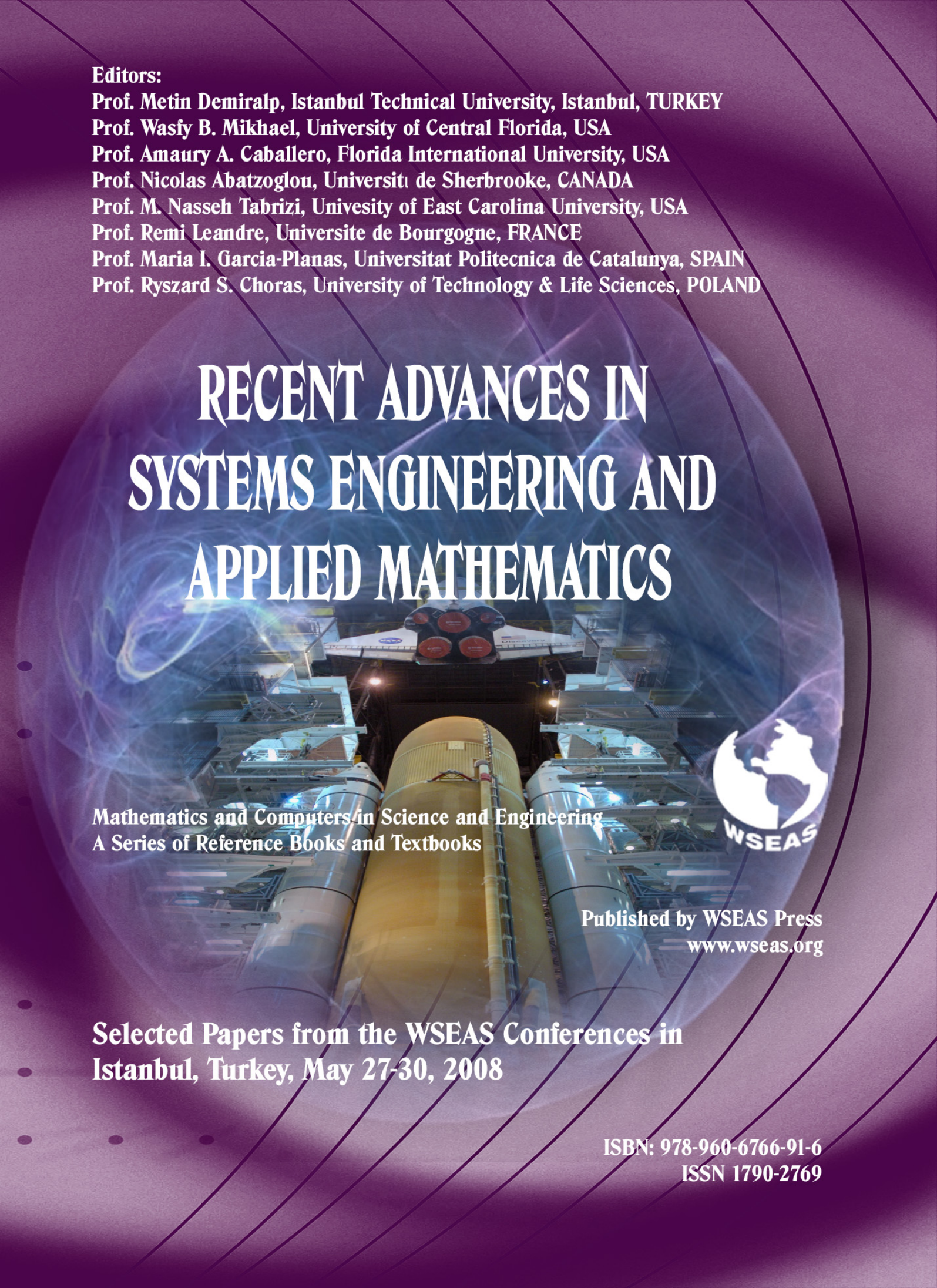
RECENT ADVANCES IN SYSTEMS ENGINEERING AND APPLIED MATHEMATICS



Mathematics and Computers in Science and Engineering
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Preface

This book contains selected papers from the WSEAS Conferences which was held in Istanbul, Turkey, May 27-30, 2008. This conference aims to disseminate the latest research and applications in Numerical Analysis and Scientific Computation, Algorithms and Complexity, Graph Theory, Pattern Recognition, Parallel and Distributed Systems, Supercomputing, Systems Theory, Dynamical Systems, Control Systems, Control Engineering, Decision Support Systems, Hierarchical Control Systems, Aerospace Systems, Multidimensional Systems, and other relevant topics and applications.

The friendliness and openness of the WSEAS conferences, adds to their ability to grow by constantly attracting young researchers. The WSEAS Conferences attract a large number of well-established and leading researchers in various areas of Science and Engineering as you can see from **http://www.wseas.org/reports**. Your feedback encourages the society to go ahead as you can see in **http://www.worldses.org/feedback.htm**

The contents of this Book are also published in the CD-ROM Proceedings of the Conference. Both will be sent to the WSEAS collaborating indices after the conference: **www.worldses.org/indexes**

In addition, papers of this book are permanently available to all the scientific community via the WSEAS E-Library.

Expanded and enhanced versions of papers published in this conference proceedings are also going to be considered for possible publication in one of the WSEAS journals that participate in the major International Scientific Indices (Elsevier, Scopus, EI, ACM, Compendex, INSPEC, CSA .... see: www.worldses.org/indexes) these papers must be of high-quality (break-through work) and a new round of a very strict review will follow. (No additional fee will be required for the publication of the extended version in a journal). WSEAS has also collaboration with several other international publishers and all these excellent papers of this volume could be further improved, could be extended and could be enhanced for possible additional evaluation in one of the editions of these international publishers.

Finally, we cordially thank all the people of WSEAS for their efforts to maintain the high scientific level of conferences, proceedings and journals.

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Plenary Lecture I

Trends and challenges in RF-analog and mixed-mode signal designs for wireless applications

Professor Ahmed El Oualkadi
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Abstract: The expansion of wireless services and other telecom applications increases the need for low-cost highly integrated solutions with very demanding performances and specifications. This requires the development of intelligent front-end architectures that circumvent the physical limitations posed by the semiconductor technology. In addition, with the evolution towards nanometer CMOS technologies, the design of complex systems-on-chip (SoC) is emerging in consumermarket applications such as telecom and multimedia. These integrated systems are increasingly mixed-mode signal designs, embedding high-performance analog blocks and possibly sensitive RF front-ends together with complex digital circuitry on the same chip. These complex RF and mixed-signal SOC designs require accurate prediction early in the design schedule, and time-tomarket pressures dictate that design iterations be kept to a minimum. As an example, emerging wireless applications for logistics (e.g., RFID, intelligent home networks, smart dusts, & wireless body area networks) will need integration and fusion of a diverse set of technologies. These technologies include digital CMOS circuits, analog/RF circuits, sensors, MEMS components, embedded software, memories, antennas, displays, polymers, packaging and interconnections, new materials, and new integration process. True system-level integration requires a new multidisciplinary design methodology that defines the optimal miniaturization path of a wireless device when product design begins. It spans the development cycle, from device- to system-level design, through electrical, thermal and mechanical analysis including characterization, and on to component selection, product assembly and test. However, the main challenge remains cost and power consumption. For RF IC design, optimizing the architecture for a given application is a key requirement when considering ultralow- power consumption. The RF-analog-digital mixed signal co-simulation environment is one of the major challenges since many functional blocks depend on both analog and digital designs, to fully exercise and verify the proper functionality of those tunable and programmable loops. To have short and reliable design cycles, efficient verification methods and tools are necessary. Modeling and simulation need to accompany the design steps from the specification to the overall system verification in order to bridge the gaps between system specification, system simulation, and circuit level simulation. Very high carrier frequencies together with long observation periods result in extremely large computation times and requires, therefore, specialized modeling methods and simulation tools on all design levels.

Brief biography of the speaker: Ahmed El Oualkadi was born in 1976; he received B.S. and M.S. degrees in physics and electronics from Abdelmalek Essaadi University, Tetuan, Morocco, in 1998 and 2000, respectively. He received Ph.D. degree in electronics from the University of Poitiers, France, in 2004. From 1998 to 2000, he was a research assistant in the Electronics & Microwaves Laboratory, Tetuan, Morocco. During this period, he worked in numerical modeling methods (TLM & FDTD) in computational electromagnetic and computer-aided design of microwave circuits. From 2000 to 2003, he was a research assistant in the Laboratoire d'Automatique et d'Informatique Industrielle - Ecole Supérieure d'Ingénieurs de Poitiers, Electronics & Electrostatics Research Unit, University of Poitiers, France. In 2004, he was an assistant professor at University Institute of Technology,

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Angoulême, France. During this period, he worked, in collaboration with EADS-TELECOM, on various European projects (CORMORAN & MULTIMODULES) which concern the nonlinear analysis & RF circuit design of switched- capacitor filters for radio-communication systems. In 2005, he joined the Université Catholique de Louvain, Microelectronics Laboratory, Louvain-la-Neuve, Belgium, where he worked on the analog and mixed design of low power high temperature circuits and systems, in SOI technology, for wireless communication. During this period, he participates in several European and regional projects (EUREKA, A 109 Witness, MEDEA+, CROTALE...) in the areas of wireless communication and sensor networking. His main research interest is the analog, mixed-signal and RFIC design for wireless c ommunication and embedded system applications. He is author/co-author of more than 30 publications and communications in recognized journals and international conferences. He is an active IEEE volunteer member associated to the Circuits & Systems Society where he is a reviewer of IEEE circuits and systems journals (TCAS I & TCAS II) and many conferences on circuits and systems (ISCAS, ICECS…). He is a member of the program committee of WCECS (IAENG) conferences, and a member of the editorial board of Recent Patents on Electrical Engineering edited by Bentham Science Publishers.

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Plenary Lecture II

Real-Time NIR Monitoring of a Pharmaceutical Blending Process through Multivariate Analysis-derived Models

Professor Nicolas Abatzoglou
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Abstract: The Quality by Design (QbD) guideline of the USA Food & Drug Administration (FDA) and of the International Conference on Harmonisation (ICH) became lately the major driver of pharmaceutical processes optimization. The majority of these processes are complex and consequently multivariate. Although new insights have improved the knowledge on the phenomena taking place, it is not usually possible to develop deterministic models. Processes involving powders handling like the multi-component pharmaceutical formulations blending are common and the real-time monitoring of their physico-chemical attributes is challenging. This QbD initiative is nowadays possible through the use of Process Analytical Technologies (PAT). In this work we propose a multivariate analysis of a V-blender mixing unit operation using an in-line Near-Infra Red (NIR) measurement technique. For the NIR measurements, a system, consisting of an Axsun IntegraSpec XLP 410 spectrometer connected to an IP-65 encased optical measuring head (sampling probe) through a 1-meter length umbilical wire cord, was used. It uses the Diffuse Reflectance Sampling technology and provides a 40 mm spot size with a spectral range of 1350 nm to 1800 nm. The methodology includes the following steps: (1) modification of a nominal 1 ft^3 (30 l) V-blender unit to accommodate Axsun's NIR spectroscopy system; (2) 3 experimental runs, each with different mixing time, while monitoring powder homogeneity with NIR spectroscopy; (3) acquisition of 10 powder samples after each run from predetermined locations in the V-blender, evaluated both with Axsun NIR spectrometer and current QA/QC Lab methods, to determine mixing end point and (4) data analysis using SIMPA-P+ and GRAMS chemometrics softwares. Two qualitative algorithms (Analysis of Spectral Variance and Distance Analysis using Hostelling T2) for real-time homogeneity determination are developed and their efficiency is evaluated. A quantitative model was derived and tested with success; it relies on the development of a Partial Least Squares (PLS) model in a principal component hyperspace which better describes the blending information. In all cases, the size of the acquired information is not comparable to the classical "thief analysis" and the result (prediction of the mixing end point) proved equally or more efficient than with actually employed quality control protocols. In addition, this information can be obtained in real-time using chemometric models. The time savings are huge when compared to classical laboratory analysis (i.e. High Pressure Liquid Chromatography). It is expected that any one of the presented NIR analyses can be beneficial on many aspects of pharmaceutical blending, such as: (1) Real-time quality monitoring of current manufacturing batches; (b) Improve process efficiency and performance by selecting adequate process parameters and blending time; (3) Quality by Design (QbD) initiatives during the development of blending processes for new formulas.

Brief biography of the speaker: Dr. Nicolas Abatzoglou is full professor at the department of Chemical Engineering of the Universite de Sherbrooke. He has earned his Ph.D from the NTU Polytechnic School Metsovion, Athens, Greece in 1989. He is co-founder with Professor Chornet of the company Enerkem Technologies Inc., a spin-off of the Universite de Sherbrooke; Enerkem commercializes technologies in the field of energy from renewable resources. N. Abatzoglou has fulfilled the role of vice-president, technology, from 1999 to 2002 to insure the start-up and the necessary technology transfer during the first three years of the company. He has a career of many years at both the academic and industrial levels. He is a known researcher in the field defined at the junction of Energy & Environment. He represented Canada at the International Energy Agency

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(Gasification Task) from 1997-2001 and was the secretary of the Board of Directors and the Executive Committee of the AQME from 1996-2000. A specialist of the chemical reactors and the use of granular materials in reactive and non-reactive environments Prof. N. Abatzoglou has focused his research activities during the six last years to: a) Establish industry-university R&D collaborative programs with pharmaceutical companies (Wyeth and Merck-Frosst) to study the mechanisms of particulate matter segregation and develop new prediction tools in order to improve the Design and operation protocols of industrial processes within a process Analytical technologies (PAT) context. b) Design, optimize, model and scale-up of a H2S reactive adsorption process for biogas purification in collaboration with an industrial partner (commercialized by Bio-Terre). c) Study water and dry reforming of methane, ethanol and biofuels for catalyst-supported SOFC application (recent US Patent application). d) Develop a technology for Carbon sequestration through CO2 (dry) reforming (recent US patent Application). e) Establish a knowledge base for the study and improvement of technologies leading to higher alcohols and green diesel synthesis from biosyngas (recently approved CRD/NSERC Project). f) Study and simulate the behavior of a new granular hot gas mobile bed filter, patented lately (USA & Canada). His production as a researcher includes more than 50 publications in scientific reviews, international conferences, patents and a book chapter. He currently supervises or co-supervises 10 graduate students, a post-doc fellow and 3 undergraduate students in specialty projects or training sessions. He has won twice the first price in environmental R&D at the Quebec Eastern Townships. He is a recognized chemical engineering teacher (2002, 2003, 2004, 2005, 2006 Bazinet awards for the best Chem. Eng. Professor) at the department of Chem. Engineering of the Universite de Sherbrooke. He teaches mainly: Design of Chemical Processes, Reactor Engineering and Pharmaceutical Process Engineering. Prof. Abatzoglou is trilingual (French, English, Greek) with an average but functional knowledge of Spanish. He has a wide cultural education and a natural ability in team motivation and hard work.

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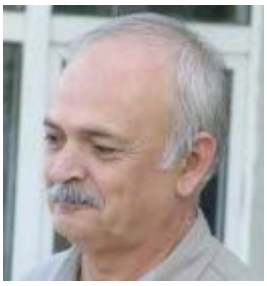
Plenary Lecture III

Space Extension Based Extended Fluctuationlessness Theorem



Professor Metin Demiralp
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Abstract: Fluctuationlessness Theorem is a recently created very efficient tool for matrix representations. It dictates us that the matrix representation of an algebraic operator which multiplies its argument by a scalar univariate function is identical to the the image of the independent variable's matrix representation over the same space via same basis set, under that univariate function. This helps us to create very rapidly converging univariate numerical integration schemes which can be used in many diversive areas of science and engineering. The multivariate counterpart of this theorem has also been conjectured and proven quite recently. In these theorems, the matrix representations are defined on Hilbert spaces which are defined through certainappropriate inner products.

On the other hand, the space extension methods aim at the building of simple structures which can be handled by well–known techniques to get solutions many applied mathematical problems. There the number of unknowns are increased to put the equation to be solved to an amenable form. Quite recently, this method is applied to the solution of ordinary differential equations and a universal form which leads us to use two–term recursions is obtained. This was for linear case. By using same approach in an indirect way via partial differential operators we could be able to deal with a quite large class nonlinear ODEs.

This talk is about the extension of two fluctuationlessness theorems for higher accuracy with the aid of space extension.

Brief Biography of the speaker: Metin Demiralp was born in Turkey on 4 May 1948. His education from elementary school to university was all in Turkey. He got his BS, MS, 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 is working on methodology for computational sciences. 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. H. A. Rabitz's group at Princeton University (NJ, USA) at summer and winter semester breaks during the period 1985--2003 after his 14 months long postdoctoral visit to same group in 1979--1980. Metin Demiralp has roughly 70 papers in well known scientific journals and is the full member of Turkish Academy of Sciences ince 1994. He is also a member of European Mathematical Society and the chief--editor of WSEAS Transactions on Mathematics currently. He has also two important awards of Turkish scientific establishments.

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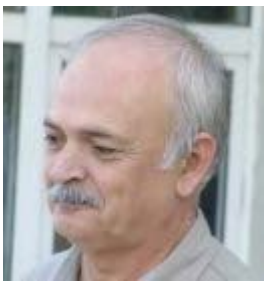
TUTORIAL I
Hilbert Space, Orthogonality and Quality Measurement Milestones of HDMR, High Dimensional Model Representation



Professor Metin Demiralp
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Istanbul Technical University
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Abstract: High Dimensional Model Representation is perhaps the most interesting and efficient tool developed in last fifteen years for multivariate analysis. The basic concept was proposed by Sobol. Rabitz brought the weight function and geometry extensions to the method although the orthogonality of the geometry proposed by Sobol was preserved. Later, Demiralp established the bridge between the vanishing conditions and the orthogonality conditions amongst the HDMR components. He also defined certain functionals to measure the contribution percentage of different variete HDMR components to norm square of the whole HDMR expansion. Sobol, Rabitz and his group, and Demiralp's group is continuing to make research in various aspects of HDMR. Today, a lot of new variants of HDMR are constructed and being successfully used. Quite recently constructed fluctuation expansion technique, which is proceeding in the way of becoming a theory, has facilitated to construct an approximate but integration free algorithm in HDMR. This tutorial will focus on the Hilbert space components of HDMR theory starting from its birth to the present form.

Brief Biography of the speaker: Metin Demiralp was born in Turkey on 4 May 1948. His education from elementary school to university was all in Turkey. He got his BS, MS, 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 is working on methodology for computational sciences. 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. H. A. Rabitz's group at Princeton University (NJ, USA) at summer and winter semester breaks during the period 1985--2003 after his 14 months long postdoctoral visit to same group in 1979--1980. Metin Demiralp has roughly 70 papers in well known scientific journals and is the full member of Turkish Academy of Sciences ince 1994. He is also a member of European Mathematical Society and the chief--editor of WSEAS Transactions on Mathematics currently. He has also two important awards of Turkish scientific establishments.

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TUTORIAL II
High Dimensional Model Representation (HDMR) Methods In Multivariate Interpolation Problems

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Abstract: If a multivariate data set is given to specify a multivariate function and it is asked to determine an analytical structure for the sought multivariate function, instead of using standard interpolation methods, given multivariate data can be partitioned into low–variate data and then an analytical structure is determined with the aid of these partitioned data. For this purpose, two different plain HDMR based methods, HDMR and GHDMR (Generalized HDMR) methods can be used. The algorithms for these two methods are based on the Sobol's HDMR expansion including Rabitz's and Demiralp's criteria. Because data partitioning is the main purpose of these methods Dirac delta function structure is used inside these algorithms. When a multivariate function is given by its values at a finite number of nodes of a hyperprismatic regular grid instead of its global analytical structure, HDMR can used to approximately partition this given multivariate data into low–variate data.

When data for describing the multivariate function are not given at all nodes of hyperprismatic regular grid GHDMR can be used to partition the randomly chosen multivariate data. As HDMR expansion has an additive nature, to obtain better results in interpolation problems having dominantly or entirely multiplicative nature
Factorized High Dimensional Model Representation (FHDMR) can be used. The components of this representation can be obtained with the aid of the HDMR or the GHDMR components of the same function. Hybrid High Dimensional Model Representation (HHDMR) method can be used when the sought function has intermediate nature, that is it has neither a dominantly additive nor a dominantly multiplicative nature. This method uses both HDMR (or GHDMR) expansion and FHDMR product in a single formula under a hybridity parameter.

Brief Biography of the speaker: M. Alper Tunga was born in Turkey on 11 June 1975. His education from elementary school to university was all in Turkey. He got his BS, MS, and PhD from the same institution, Istanbul Technical University. He is working on methodology for computational sciences. He is Assistant Professor in Computer Engineering Department of Bahcesehir University and he is a member of Group for Science and Methods of Computing in Informatics Institute of Istanbul Technical University. M. Alper Tunga has 6 papers in various scientific journals and he is in scientific committee of this conference.

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TUTORIAL III
Weight, Geometry and Transformation Dependence of High Dimensional Model Representation (HDMR)

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Abstract: High Dimensional Model Representation (HDMR) is one of the very important tools in the approximation of multivariate functions. It has proposed by Sobol, extended by Rabitz via weight and arbitrary orthogonal geometry introduction. Beside many HDMR applications in Rabitz's group, Demiralp's group brought the Hilbert space tools like orthogonality quality measuring functional and transformations to the topic. HDMR is a finite number term including representation. However this number grows awkwardly as the number of independent variables increases. Hence, the tendency of the scientists is to use at most bivariate level truncations as approximants. If the desired quality of approximation is not achieved then not to attempt to use higher variate truncations but to change the structure of the HDMR is preferred. This can be accomplished by using appropriately chosen transformations. Then, not the function itself but its image under the chosen transformation is expanded to HDMR. The dependence of HDMR on weight, geometry and transformation is quite important. Under appropriate choices of these entities the additive nature may become dominant. This dominancy means high quality of univariate or bivariate truncations. As long as there is no limitation on the choices of weight and gemometry, they can be constructed to increase the additivity. Otherwise particular transformations may be needed to get dominancy in additivity. This talk aims at the presentation of certain experimentation results together with the conceptual discussions.

Brief Biography of the speaker: N. Abd¨ulbaki BAYKARA was born in ˙ Istanbul,Turkey on 29th July 1948. He received a B.Sc. degree in Chemistry from Bosphorous University in 1972. He got a PhD from Salford University, Lancashire,U.K. in 1977 with a thesis entitled "Studies in Self Consistent Field Molecular Orbital Theory ". Between the years 1977-1981 and 1985-1990 he worked as a research scientist in the Applied Maths Department of The Scientific Research Council of Turkey. During the years 1981-1985 he did postdoctoral research in the Chemistry Department of Montreal University, Quebec,Canada. Since 1990 he is employed as a Staff member of Marmara University. He is now an Associate Professor of Applied Mathematics mainly teaching Numerical Analysis courses and is involved in HDMR research and is a member of Group for Science and Methods of Computing in Informatics Institute of Istanbul Technical University.

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