RECENT ADVANCES IN REMOTE SENSING

Editors:
Subhas C. Misra, Harvard University, U.S.A.
Roberto Revetria, Univ. degli Studi di Genova, Italy
Les M. Sztandera, Philadelphia University, U.S.A.
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Preface

This book contains the proceedings of the 4th WSEAS International Conference on REMOTE SENSING (REMOTE'08) which was held in Venice, Italy, November 21-23, 2008. This conference aims to disseminate the latest research and applications in Sensor Electronics, Data assimilation and fusion, Data management and mining, Image classification and analysis methodologies, Medical and biometric applications 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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Keynote Lecture

Multivariate Data Completion or Addition on a Single Curve Representation of a Hyperrectangulargrid via Fluctuation Suppression

Professor Metin Demiralp
Istanbul Technical University, Informatics Institute,
Group for Science and Methods of Computing,
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Abstract: This work is somehow about multivariate interpolation. If an N–variate function is given at certain points of the cartesian space of the N independent variables and its value at a point which is outside the data given points is sought then various methods available in the literature can be used to find this value. However, there is almost no unique universal way to do so and each method has its own capability, efficiencies, deficiencies and pitfalls. Data completion and data mining techniques can also be considered amongst them.

The work focuses on a finite hypergrid in N–dimensional cartesian space first and then a multivariate function's values are assumed to be given at certain nodes (we call them full nodes) of this grid. The next step is the dimension reduction. To this end we construct a single continuous curve passing through all nodes of the grid with respect to an appropriately chosen ordering. Curve construction is not unique and depends on the ordering of the nodes. It is better to choose the curves whose mathematical definitons are rather simple. This construction leaves us to use just a single parameter to specify any location on the curve. Although the nodes are defined as N tuples in the N–dimensional cartesian space their locations can also be given in terms of the curve parameter. Hence, the data completion or addition problem is converted to a univariate interpolation which is rather simple.

The full nodes are now represented by ordered pairs whose first elements are the position parameter values on the constructed curve while the second elements are the multivariate function's values at those points. Data completion (to inject one or a few missing data to a data set which is almost full everywhere) or data addition (to evaluate the function's value at an empty node within a sparsely data given hypergrid) then becomes to seek the multivariate function's value at a specified node which corresponds to a unique position on the curve.

There are a lot of univariate interpolation methods, each of which can be used for the interpolation on the curve defined above depending on the nature of the demands and produces some unavoidable errors. Quite recently a new method of interpolation is developed by Demiralp. It uses the Fluctuationlessness Theorem (conjectured and proven by Demiralp recently). Theorem dictates us that the matrix representation of a function over a subspace of the Hilbert space for analytic and square integrable functions is equal to the image of the independent variable's matrix representation on the same subspace under the same function as long as the fluctuation terms (differences between the means of specified powers of the independent variable and the same specified power of the mean of the independent variable). This fact can be used to approximate an integral and a quadrature like formula (the linear combination of the function values at certain points with positive linear combination coefficients (we call weights) can be obtained. The quality of the approximation depends on the dimension of the subspace mentioned above and becomes better as the dimension increases. Hence the two sufficiently high consecutive dimension will give the same value for the integration under consideration within a prescribed accuracy.

The integrand of the abovementioned integral is chosen in such a way that it becomes a linear combination of given values of the multivariate function for, say, n dimensional subspace while the same value is expressed as another linear combination of the given function values and the single sought values of the same function for the (n + 1) dimensional subspace. Since these two expressions should produce the same value it is possible to extract the sought value of the function under consideration. Presentation will focus on these topics and certain remarks.

Acknowledgment:
Author is grateful to Turkish Academy of Sciences for its support.

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.

Plenary Lecture I

Modern Approaches to Signal Processing in Remote Sensing Systems

Professor Vyacheslav Tuzlukov

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Abstract: The additive and multiplicative noise exists forever in any remote sensing system, including wireless sensor networks. Quality and integrity of any remote sensing systems and/or wireless sensor network systems are defined and limited by statistical characteristics of the noise and interference, which are caused by an electromagnetic field of the environment.

The main characteristics of any remote sensing system and/or, naturally, wireless sensor network system, are deteriorated as a result of the effect of the additive and multiplicative noise. The effect of the addition of noise and interference to the signal generates an appearance of false information in the case of the additive noise. For this reason, the parameters of the received signal, which is an additive mixture of the signal, noise, and interference, differ from the parameters of the transmitted signal. Stochastic distortions of parameters in the transmitted signal, attributable to unforeseen changes in instantaneous values of the signal phase and amplitude as a function of time, can be considered as multiplicative noise. Under stimulus of the multiplicative noise, false information is a consequence of changed parameters of transmitted signals; for example, the parameters of transmitted signals are corrupted by the noise and interference. Thus, the impact of the additive noise and interference may be lowered by an increase in the signal-to-noise ratio (SNR). However, in the case of the multiplicative noise and interference, an increase in the SNR does not produce any positive effects.

The main characteristics of the functioning any remote sensing systems and/or, naturally, wireless sensor network systems, are defined by an application area and are often specific for distinctive types of these systems. In the majority of cases, the main characteristics of any remote sensing systems and/or wireless sensor network systems are defined by some initial characteristics describing a quality of signal processing in the presence of noise: the precision of signal parameter measurement, the definition of resolution intervals of the signal parameters, and the probability of error.

Our main idea is to use the generalized approach to signal processing in noise in remote sensing systems and/ or wireless sensor network systems. The generalized approach is based on a seemingly abstract idea: the introduction of an additional noise source that does not carry any information about the signal and signal parameters in order to improve the qualitative performance of remote sensing systems and/or wireless sensor network systems. In other words, we compare statistical data defining the statistical parameters of the probability distribution densities of the observed input stochastic samples from two independent frequency time regions – a "yes" signal is possible in the first region and it is known a priori that a "no" signal is obtained in the second region. The proposed generalized

approach to signal processing in noise allows us to formulate a decision-making rule based on the determination of ***the jointly sufficient statistics of the mean and variance*** of the likelihood function (or functional). Classical and modern signal processing theories allow us to define ***only the mean*** of the likelihood function (or functional). Additional information about the statistical characteristics of the likelihood function (or functional) leads to better quality signal detection and definition of signal parameters in compared with the optimal signal processing algorithms of classical or modern theories.

Thus, for any remote sensing systems and/or wireless sensor network systems, we have to consider two problems – analysis and synthesis. The first problem (analysis) – the problem of study of the stimulus of additive and multiplicative noise on the main principles and characteristics under the use of the generalized approach to signal processing in noise – is an analysis of the impact of additive and multiplicative noise on the main characteristics of remote sensing systems and/or wireless sensor network systems, the receivers in which are constructed on the basis of the generalized approach to signal processing in noise. This problem is very important in practice. Analysis of the stimulus of additive and multiplicative noise allows us to define limitations on the use of remote sensing systems and/or wireless sensor network systems and to quantify the impact of additive and multiplicative noise relative to other noise and interference present in these systems. If we are able to conclude that the presence of additive and multiplicative noise is the main factor or one of the main factors limiting the performance of any remote sensing systems and/or wireless sensor network system, then the second problem – a definition of structure and main parameters and characteristics of the generalized detector or receiver under a dual stimulus of additive and multiplicative noise (the problem of synthesis) – arises.

The generalized approach to signal processing in noise allows us to extend the well-known boundaries of the potential noise immunity set by classical and modern signal processing theories. Employment of remote sensing systems and/or wireless sensor network systems, the receivers of which are constructed on the basis of the generalized approach to signal processing in noise, allows us to obtain high detection of signals and high accuracy of definition of signal parameters with noise components present compared with that systems, the receivers of which are constructed on the basis of classical and modern signal processing theories. The optimal and asymptotic optimal signal processing algorithms (of classical and modern theories), for signals with amplitude-frequency-phase structure characteristics that can be known and unknown a priori, are components of the signal processing algorithms that are designed on the basis of the generalized approach to signal processing in noise.

In the present time, the most widely used in remote sensing systems and/or wireless sensor networks systems signal processing algorithms are based on the Direct-Sequence Spread-Spectrum (DS/SS) Code-Division Multiple Access (CDMA) approach and its modifications. The target data rates for wideband CDMA remote sensing system are: 144kb/s for wide area users who be in motor vehicles, 384kb/s for small area users at pedestrian speeds, and 2.048 Mb/s for stationary users within offices. The chip rates for some third and future generations of CDMA remote sensing systems include 4.096 –16.384Mb/s, corresponding to bandwidths of 5 and 20 MHz, respectively.

The modern signal processing algorithms used in remote sensing systems and/or wireless sensor network systems can guarantee: low power, potential for high capacity and capacity increasing; antijamming, antimultipath characteristics, soft hand-off, soft capacity control, and information security. The modern signal processing algorithms used in remote sensing systems and/or wireless sensor network systems ***cannot guarantee low bit error rate (BER) and high-speed data transmission, simultaneously.***

Under the use of the generalized approach to signal processing in noise in remote sensing systems and/or wireless sensor network systems, we expect to obtain the following benefits in comparison with the modern signal processing algorithms: ***the low power, low bit error rate, more high noise immunity, high-speed data transmission, and approximately the same cost of production.***

The application area of remote sensing systems and/or wireless sensor network systems, the receivers in which are constructed based on the generalized approach to signal processing in noise, is the same as, for example, the application area of these systems employed the modern signal processing algorithms, i.e., for instance, health, military, vehicles, home and so on.

Brief Biography of the Speaker: Vyacheslav P. tuzlukov is currently Full Professor of the School of Electronic

Engineering, Communications Engineering and Computer Science at the Yeungnam University, Gyeongsan, South Korea. His research emphasis is on signal processing in wireless communications, wireless sensor networks, radar, remote sensing, sonar, and mobile communications. Prior to this, he was with Electrical and Computer Engineering Department of Ajou University, Suwon, South Korea, where he defined, led and managed research teams in the area of signal processing in CDMA wireless communications, particularly, in wireless sensor networks, serving as Invited Full Professor.

He has published more than 150 scientific journal and conference papers, five books in signal processing area published by Springer-Verlag and CRC Press, and has also contributed chapters “Underwater Acoustical Signal Processing” and “Satellite Communications Systems: Applications” to Electrical Engineering Handbook: 3rd Edition, 2005. He has been keynote speaker, has organized sessions, and has served as Tutorial Instructor and Speaker at major International Conferences on Signal Processing.

Dr. Tuzlukov was highly recommended by U.S. experts of Defense Research and Engineering (DDR&E) of the United States Department of Defense as a recognized expert in the field of humanitarian demining and minefield sensing technologies and had been awarded by Special Prize of the United States Department of Defense in 1999. Dr. Tuzlukov is distinguished as one of the leading achievers from around the world by Marquis Who’s Who and his name and biography have been included in the Who’s Who in the World, 2006 (23) Edition, Marquis Publisher, NJ, USA; Who’s Who in World, 25th Silver Anniversary Edition, 2008, Marquis Publisher, NJ, USA; Who’s Who in Science and Engineering, 2006-2007 (9) Edition, Marquis Publisher, NJ, USA; and Who’s Who in Science and Engineering, 10th Anniversary Edition, 2008-2009, Marquis Publisher, NJ, USA.

Plenary Lecture II

Remote Sensing of Atmospheric Particles using LIDAR, Calipso Satellite & AERONET

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Abstract: Improvement of regional climatological model and weather prediction capabilities depend heavily on the atmospheric particles (or aerosols) which are distributed in the column of the atmosphere, and ranging in size from 1 to 10 microns. Light Detection And Ranging (LIDAR) system can depict the profile of aerosols distribution in the atmosphere on a regular basis, the system can be located on the land (UPRM Lidar) or on a satellite (Calipso), observing the aerosol column from both vertical directions as satellite passes over the Lidar location. The Calipso Lidar satellite transmits laser and collects backscattered light at two standard wavelengths (one wavelength at two polarizations). The AERONET network is a complementary method of determining the Optical Depth of the aerosol. These three systems operate based on multiple wavelength laser light transmission and reception. Each system is explored in this paper, and full emphasis is given to the Lidar system which presently is near operation at the UPRM, explaining the functionality of the Laser, optical telescope, optics, sensors, signal processing systems, and the algorithm responsible for providing the power profile reflected from the aerosols at standard wavelengths of 355, 532, and 1064nms. The results of the remotely sensed atmospheric particles are obtained in terms of Aerosol Size Distribution, Angstrom coefficient, and Single Scattering Albedo. The latter two parameters enhance understanding of the effects of aerosols on the climate. The plots of aerosol distribution in the column of atmosphere in terms of these important aerosol parameters have been produced using the Lidar data over New York urban area.

Brief Biography of the Speaker: Hamed Parsiani is a full professor of Electrical & Computer Engineering at the University of Puerto Rico at Mayaguez (UPRM). He is currently directing the development of the first three wavelengths Lidar System laboratory for the advanced atmospheric research in Puerto Rico, and the Caribbean region. He is the research director of the UPRM NOAA-CREST grant which is now in its seventh year, covering research in Tropospheric, Hydroclimate, and Coastal Remote Sensing areas. He is presently a UPRM-PI of grant sponsored by NSF-3DGeo company in the area of Aquifer Delineation using Ground Penetrating Radar. His interests are in remote sensing using radar and lidar, image processing, image compression, soil type, soil moisture, and aquifer detection using ground penetrating radar.

His earlier research grants were sponsored by GSSI Inc. (PI), NASA-Tropical Research Center (Co-PI), NSF-PRECISE, NASA-PaSCOR as research collaborator. He contributed in the development of JPEG compression algorithm during his research work with Bell Communications Research (BELCOR), and Global Positioning System (GPS), a NASA grant. He was the co-organizer and co-chair of two NOAA-CREST Technical Symposiums (2006 & 2008), the chair of the International Symposium on Intelligent Systems in Communications (SISCAP-94) held at UPRM. He has served on several conferences paper review boards, and has over 50 publications in journals and proceedings.
He is an alumnus of the Oregon State University (BS EE & Math), and Texas A&M University (MEE, PhD in ECE), and a member of Eta Kappa Nu honor society, and IEEE.

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