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Advances in Sensors, Signals, Visualization, Imaging and Simulation

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- Proceedings of the 5TH WSEAS International Conference on Sensors and Signals (SENSIG '12)
- Proceedings of the 5th WSEAS International Conference on Visualization, Imaging and Simulation (VIS '12)

Sliema, Malta, September 7-9, 2012

Recent Advances in Electrical Engineering Series | 6

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Preface

This year the 5th WSEAS International Conference on Sensors and Signals (SENSIG '12) and the 5th WSEAS International Conference on Visualization, Imaging and Simulation (VIS '12) were held in Sliema, Malta, September 7-9, 2012. The conferences provided a platform to discuss sensors, optical radiation, photodetectors, data acquisition systems, nanosensors, signal processing, image processing, computer music, biometrics recognition, image-based modeling, image acquisition, cognitive vision, visualization, holographic imaging, multiprocessor systems, illumination models, finite elements 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

Table of Contents

Plenary Lecture 1

Improvements of Sound 3D Auralisation by Means of Non-Linear Convolution

Professor Lamberto Tronchin
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Abstract: The definition and measurement of sound spatialisation have been strongly enhanced in last years, as nowadays spatialisation is considered quite important during design of auditoria and virtual audio reproduction of sound quality in dedicated listening rooms for 3D reproduction purposes. Even though international standards like ISO 3382 require measuring some spatial parameters (i.e. LE, LF, IACC), usually only binaural measurements are performed, by means of a dummy head, and rarely 3D impulse responses are measured and utilised for sound reproduction. Furthermopre, the 3D spatialisation is obtained by means of linear convolution between dry signal and impulse responses.
In this paper, after an overview on the most common techniques utilised for 3D auralization, an innovative procedure of measuring and reproducing spatial sound characteristics is presented. The application of this new technique in virtual 3D sound reconstruction is presented and enhanced by means of non-linear convolution. Furthermore, the methodology is compared with other techniques of 3D sound reproduction. Moreover, the results of a wide campaign of measurements of spatial parameters among different auditoria all over the world, ranging from Italy to Japan and Australia, and conducted with the novel methodology, are compared with the results of standard binaural and 3D measurements. The possibility to enhance the spatial reproduction of sound quality in real spaces and the comprehensibility of spatial parameters is finally considered and presented in different cases.

Brief Biography of the Speaker: Dr Lamberto Tronchin is Associate Professor in Environmental Physics from the University of Bologna and is recognised internationally as a leading authority on the subject of sound and acoustics. A pianist himself, with a diploma in piano from the Conservatory of Reggio Emilia, Dr Tronchin's principal area of research has been musical acoustics and room acoustics. He is the author of more than 150 papers and was Chair of the Musical Acoustics Group of the Italian Association of Acoustics from 2000 to 2008. Dr Tronchin is a member of the Scientific Committee of the CIARM, the Inter- University Centre of Acoustics and Musical research, has chaired sessions of architectural and musical acoustics during several international symposiums, been a referee for a number of International journals and is Chair of Organising and Scientific Committees of IACMA (International Advanced Course on Musical Acoustics).
He was a visiting researcher at the University of Kobe in Japan, a visiting professor at the University of Graz in Austria and Special honored International Guest at the International Workshop, ‘Analysis, Synthesis and Perception of Music Signals', at Jadavpur University of Kolkata, India in 2005. He has chaired the International Advanced Course on Musical Acoustics (IACMA), organised with the European Association of Acoustics, which was held in Bologna, in 2005. In 2008 and 2009 he gave plenary lectures at International Congresses on Acoustics in Vancouver, Prague, Bucharest, Santander. He designed theatres and other buildings, as acoustic consultant, in collaboration with several Architects, among them Richard Meier and Paolo Portoghesi.

Plenary Lecture 2

Robust Computation in Geometry and Engineering

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Abstract: Development of new algorithms is a crucial part not only in research, but it is needed in Engineering applications, namely in all computational fields, Computer Graphics, Visualization and Computer Vision fields.
Understanding of projective geometry and the principle of duality enable to understand the substance of the solved problem as the problem can be transformed to a dual space, where the solution is simple and/or helps to develop new algorithms.
Projective geometry notation and use can be used in computational problems and in many cases helps to speed up computation. Especially if the matrix-vector architecture like GPU is used, the reformulation of the problem using projective notation increases the speed of computation.
The principles will be demonstrated on simple examples. Examples of computational problems, disasters caused by numerical computations will be presented as well.
• Typical engineering and geometrical problems
• Euclidean and projective spaces, transformations, properties
• Duality (linear), property of dual transformation, dual problems
• Algorithm complexity – simple geometrical examples – and dual problems
• How dual formulation can influence development of a new method, algorithm
• Robustness and influence to algorithm design
• Typical examples how projective/dual formulation can speed up computation
• How projective formulation supports algorithms for GPU architecture
• Typical examples of geometrical problems, their projective reformulation leading to significant speed up and in some cases to reconsideration leading to lower algorithm complexity

Brief Biography of the Speaker: Prof. Vaclav Skala is a Full professor of Computer Science at the University of West Bohemia, Plzen and VSB-Technical University Ostrava, Czech Republic. He received his ING.(equivalent of MSc.) degree in 1975 from the Institute of Technology in Plzen and CSc. (equivalent of Ph.D.) degree from the Czech Technical University in Prague in 1981. In 1996 he became a full professor in Computer Science. In 1997 the Center of Computer Graphics and Visualization (CCGV) was formally established and since then he is the Head of the CCGV in Plzen.

Prof.Vaclav Skala is an associate editor of The Visual Computer (Springer), Computers and Graphics (Elsevier), member of the Editorial Board fo Machine Graphics and Vision (Polish Academy of Sciences) and the Editor in Chief of the Journal of WSCG. He is a member of international program committees of prestigious conferences and workshops. He is a member of ACM SIGGRAPH, IEEE and Eurographics Association.
Prof.Vaclav Skala has published over 200 research papers at conferences and research journals. His current research interests are computer graphics and visualization, mathematics, especially geometrical algebra, algorithms and data structures.

Plenary Lecture 3

Flight Control Technology for the Re-Entry ADDASAT Platform

Professor Radu Dan Rugescu
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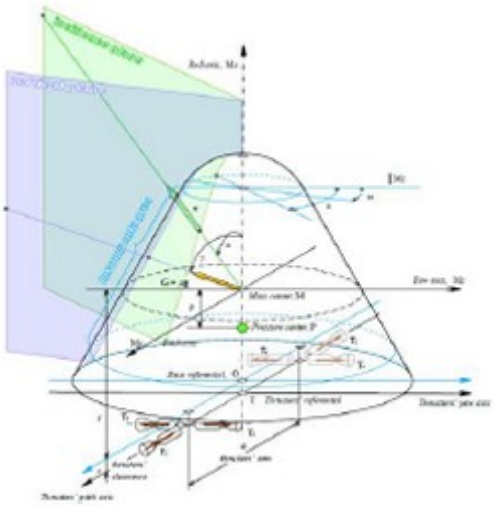
Abstract: The micro-satellite ADDASAT platform is the target payload for the small, space launcher NERVA, developed through the homonymous Romanian research and development program. This program is sponsored by the Romanian Ministry of Education, Research and Innovation through the national grants NERVA-82076 and ORVEAL-2-2934, that has been recently qualified for financing with a high score of 4 from 103 projects. The micro-launcher is under current experimental development, with the first flight test of the solid booster and of the guiding inertial platform performed at the NATO flight test range Cape Midia in June 2010 and the second on June 2011, under the NERVA project. The design and experimental development of the ADDASAT platform has begun in 2012 by the SME "ADDA – Association Dedicated to Development in Astronautics", the first Romanian private R&D Company engaged in building a recoverable micro-satellite with proprietary technology. The flight control technology is presented, with emphasize on the capability of securing the atmospheric re-entry with desired accuracy under a very restricted mass of the spacecraft. The atmospheric and extra-atmospheric ascent of the launcher is controlled by the combined aerodynamic and gasdynamic actuators called gaserons, under the guidance of the autopilot, located on the same micro-satellite. The gaserons are under national patenting process, application A/01210/2010.



The state of the art of the attitude control system for the NERVA launcher and the ADDASAT is presented, with emphasize on the first flight tests of the inertial platform and the laboratory tests of the first MRG-001 micro-thrusters.
The selection of attitude drivers for the satellite was decided upon the terms of service of the orbital guidance. With no orbit correction requirements, due to the very short life-in-orbit of the spacecraft of less than one day, the design terms generated the adoption of the partial non-compensated system of six independent thrusters, as seen in the draft.
Management policy and the first experimental development steps are presented in the conference by the main design heads of the program.

Brief Biography of the Speaker: Dr. Radu D. Rugescu, university professor, married (daughter and son), is born in Bucharest, Romania, E. U. He is affiliated since 1969 with University “Politehnica” of Bucharest (UPB), Dept. of Aerospace Sciences “Elie Carafoli”, successively as assistant professor, lecturer, associate and full professor. With expertise in Astronautics, with emphasize on Propulsion, Thermochemistry, Astrodynamics, Optimization, Statistics, Programming, Robotics and Manufacturing Technology, he teaches courses in Romanian, English and German languages on “Numerical methods”, “Processes in Rocket Engines”, “Technology of aerospace systems”, “Astrodynamics”, “Turbomaschinen”, “Orbital Launchers”, “Ecological combustion”, “Optics and Acoustics”, a. s. o. He has received the Doctor in Science degree from UPB in Aerodynamics and Fluid Mechanics and performed several specializations in Germany and U. S. A.
His research firsts include, some of them as patent applications, a Genuine Solid Rocket Propellant in 1959, The first Romanian liquid propellant rocket engine in 1969, the first Capture of freezing temperature of water-gas reaction in 1982, the first Romanian air-breathing rocket engine in 1987, a New variational method for discontinuous integrands in 1997, a new technology for Air captured imaging and TV live transmission from high altitude airplanes of solar eclipse in 1999, Non-Keplerian gravity coupling of very large space structures in 2004, Solar gravity-assisted Accelerator in 2006, The unit histogram for scarce statistical information in 2008, the Combined Rocket Engine in 2010, Solenoid microthruster for spacecraft orientation in 2012 and others. Project Director of NERVA grant (UEFISCDI) for the first Romanian orbital launcher, dr. Rugescu has authored 7 pending patents, many of them with students and young researchers.
He directs energy and space research projects, including initiatives with Stanford University in the Thermochemistry of Combustion, several 5-year collaborative exchanges with Texas A&M University, USA, as Fulbright alumnus and three ERASMUS contracts with INT-TELECOM & Management SudParis, Dépt. Réseaux et Services des Télécommunications, Istanbul Technical University, Faculty of Aerospace Engineering, Turkey and Institute Polytechnique des Sciences Avancee, Ivry-Paris. He is known for 251 public works, including 18 books. His works benefit of 150 quotations and citations, 137 of which are international, with 18 from ISI-Thomson. 54 papers are published with young specialists as co-authors. He was honored with 30 biographic awards, including Who’s Who in America 2007-2011, Honor Diploma of St Sava Romanian College 2011, Turkish NIST-2011 diploma and Medal and others.
He is member of the Astronautics Commission of the Romanian Academy since 1975, member of the International Institute for Acoustics and Vibrations since 2002, of the American Chemical Society since 2010 and in other societies. He was nominated in 2011 by the Romanian government as board member of the National Commission for Academic Titles CNATDCU in Aerospace and Transportation.

Plenary Lecture 4

New Sensors for Diagnosis Based on Radio-medical Devices

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Abstract: Radio frequency (RF) communication devices implanted in medical device can increase the range of applicability of the respective device and improve quality of life for the patient.
An actual challenge is designing an implantable antenna for operation in the MICS (Medical Implant Communication Service) band, 402 to 405 MHz, reserved for ultra low power communication with implanted medical devices. Developments in support electronics decrease design risk, but the implanted antenna remains a critical component of a communications link that operates at very low received power. Dielectric losses and wave trapping in the body result in transmission losses much greater than seen in free space communications.
For an implanted antenna, body tissues significantly perturb efficiency and operating bandwidth from their free space values.
Considering the above mentioned staff we are concerned about the data loss due to the RF communications implanted in medical devices, in order to perform a correct diagnose and/or treatment. Therefore, this paper is focused on the improvement of the automated medical diagnosis based on biological feature (BF) selection and classification, as we know that biological features represent patterns of important information. We see this new approach as complex radio implanted sensor which concur to a faster and better diagnosis. Medical diagnostic can be improved if the pattern is comprised by most of the significant biological features. In our study, common sequence measures were employed to determine the saliency of a wide range of applications in the area of medicine, computational biology, as well as string editing, pattern recognition and genetics etc. We assume that an important common sequence salience measure is to find the longest common subsequence (LCS) for a set of n sequences. In order to perform this hard task, we use discrete event formalisms, respectively Petri nets and we propose an algorithm for reducing the size of the digraphs. An interesting application to the ECG signals will demonstrate that salient input features effectively aid the diagnosis process.

Brief Biography of the Speaker: • Academic Positions: Assoc. Professor Ph.D. Eng., Dept. of Automatics and Computers, Faculty of Electrical Engineering and Computer Science, "Stefan cel Mare" University of Suceava, Romania.
• Fields of Scientific Activities: Discrete Event Systems, Complex Measurement Systems, Reliability and Diagnosis of Control Systems, Environmental Management.
• He published 11 books, 12 patents and over 160 scientific papers in conference proceedings and journals.
• Honor Member of the Romanian Society of Electrical & Control Engineering - Member of the Romanian Technical Experts Corp.
• Technical Expert of the Romanian Ministry of Justice.
• President of the Romanian Society of Electrical & Control Engineering, Suceava Branch.
• He is a member of the editorial boards of several international scientific journals and conferences of control systems and electric engineering science. He was designated chairmen at 21 international conferences.

Plenary Lecture 5

Combinations of Adaptive Filters

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Abstract: In this talk we consider the combination of two adaptive filters that are simultaneously applied to the same inputs. When designing an adaptive algorithm, one faces a trade–off between the initial convergence speed and the mean–square error in steady state. In case of algorithms belonging to the Least Mean Square (LMS) family this trade–off is controlled by the step-size parameter. Large step size leads to a fast initial convergence but the algorithm also exhibits a large mean–square error in the steady state and in contrary, small step size slows down the convergence but results in a small steady state error.
Recently there has been an interest in a combination scheme that is able to optimize the trade–off between convergence speed and steady state error. The scheme consists of two adaptive filters that are simultaneously applied to the same inputs. One of the filters has a large step size allowing fast convergence and the other one has a small step size for a small steady state error. The outputs of the filters are combined through a mixing parameter.
There are several ways to compute the combination parameter. In our treatment the combination parameter λ is computed from output signals of the individual filters. The scheme is optimal in the sense that it results from minimizing the mean square error of the combination.
The combination of two filters can be applied in different situations. The applications like line enhancement, system identification and beamforming will be examined in detail.

Brief Biography of the Speaker: Tõnu Trump received his Ph.D. degree from Tallinn University of Technology in 1993. He was from 1994 to 2006 with Ericsson AB in Stockholm Sweden, where he reached the position of expert in echo cancellation and voice enhancement devices. From 2002 to 2006 he was also the rapporteur of Question 17, Study Group 16 at International Telecommunication Union (ITU-T) in Geneva Switzerland. Since 2006 he has been the professor of Signal Processing at Tallinn University of Technology in Tallinn, Estonia.
Prof. Trump has published a number of scientific papers and is the author of more than 10 patents.

Plenary Lecture 6

MIMO Transmission in IEEE802.11a WLAN

Dr. Zoran Stamenkovic
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Abstract: MIMAX is a communication solution based on MIMO technology. In contrast to the approaches used by the conventional MIMO technology trend, e.g. 802.11n or LTE, MIMAX proposes to move signal processing functionalities from the digital baseband to the RF analogue front end, reducing the complexity of the system its costs and the overall system power consumption. In order to achieve these results MIMAX implements signal processing close to the transmitting and receiving antennas exploiting synergies in the radio access. MIMO processing is carried out in the analogue front-end by customised integrated circuits. These system blocks are able to weight the transmitted and received signals coherently in order to achieve the maximum performance during data transmission process. The challenge in designing these analogue weighting circuits consists in achieving a reproducible signal processing as in digital hardware. These circuits are assembled on a front-end PCB, which can be connected to a customised antenna array. MIMAX solution implements new MIMO algorithms able to exploit spatial diversity from the new front-end architecture.
The talk starts by giving an overview of the complete system architecture and its functional building blocks. The specifications are derived from the used wireless technology (IEEE 802.11a) and summarised on a system level. The MIMO signal processing concept is described too. The system performance evaluation is presented next. It is based on the analysis of processing gains and link budget. The use of multiple antennas provides several benefits in comparison to conventional single antenna 802.11a transceivers. In order to extract these gains, the baseband processor includes two new blocks equipped with optimal algorithms: the MIMO channel estimation block and the RF weight selection block. The link budget is calculated for a wireless system in an indoor environment based on the standard IEEE 802.11a. The next part describes baseband architecture and frame formats. The baseband architecture of transceiver takes the 802.11a standard as a reference and provides new MIMO functionalities. We focus on the specifications of the new blocks for the baseband processor, mainly the channel estimation block and the RF weights selection block. Furthermore, we consider the modifications needed in the 802.11a format frames to add the new MIMO functionalities. Two different frame formats are used. The first one is exactly the 802.11a frame. On the other hand, the new frame format is needed only for MIMO channel estimation in order to get the optimal set of RF weights. The transmission schemes, channel estimation, and robustness issues are discussed too. The basis for the MAC protocol is the well-established WLAN standard IEEE 802.11 Medium Access Control protocol. This standard MAC protocol needs a few extensions to handle special MIMO features. We discuss the new MAC functionalities imposed by the MIMO baseband processor. The MAC is implemented on a suitable FPGA platform, which allows easy testing and bug fixing. The part on analogue front-end architecture gives an overview of the applied concept of direct conversion for receiving and transmitting to further enhance the requirement of lowest complexity and power consumption.

Brief Biography of the Speaker: Dr. Zoran Stamenković is with IHP GmbH, Frankfurt (Oder), Germany. He received his Ph.D. degree in electronic engineering from the University of Niš, Serbia in 1995.
His research interests include wireless SOC design, HDL modelling, logic synthesis, chip layout, and IC yield modelling and prediction. He has leaded the EU funded project on a wireless MIMO system (MIMAX) at IHP GmbH. Currently he is in charge for the project on a vehicle wireless camera system funded by the German State of Brandenburg.
Dr. Stamenković has published a book on IC yield, six chapters in prestigious monographs, and more than 80 scientific journal and conference papers.

Plenary Lecture 7

JPEG Algorithm Adjustment for Different Quality Metrics

Professor Milan Tuba
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Abstract: JPEG algorithm is most widely used method for lossy digital image compression. It facilitated digital image revolution during the last decade. JPEG is not a fixed algorithm but a set of recommendations that can be adjusted for particular applications. One of the most often used JPEG adjustments is selection of the quantization tables that determine not only the degree of compression, but also other characteristics of the compressed image since the quantization tables remove or attenuate some frequency components of the image. By increasing the degree of compression the quality of the image decreases, but important question remains of what is the appropriate measure of the image quality. Most often it is a subjective human perception that can be somehow objectivized by statistical survey, but for many specific applications that quality measure is not relevant. Examples include medical images (usually from alternative imaging sources like ultrasound or x-ray) and specific image analysis like edge detection, image segmentation (by multilevel thresholding), biometrics (iris recognition using Hough transform and polar representation) etc. In such cases different objective metrics for compressed image quality are introduced and tested with different quantization matrixes. Such testing lead to exponential combinatorial problems that can only be solved by using some optimization metaheuristics.

Brief Biography of the Speaker: Milan Tuba is Professor of Computer Science and Provost for mathematical, natural and technical sciences at Megatrend University of Belgrade. He received B. S. in Mathematics, M. S. in Mathematics, M. S. in Computer Science, M. Ph. in Computer Science, Ph. D. in Computer Science from University of Belgrade and New York University. From 1983 to 1994 he was in the U.S.A. first as a graduate student and teaching and research assistant at Vanderbilt University in Nashville and Courant Institute of Mathematical Sciences, New York University and later as an Assistant Professor of Electrical Engineering at Cooper Union Graduate School of Engineering, New York. During that time he was the founder and director of Microprocessor Lab and VLSI Lab, leader of scientific projects and supervisor of many theses. From 1994 he was Assistant professor of Computer Science and Director of Computer Center at University of Belgrade, from 2001 Associate Professor, Faculty of Mathematics, and from 2004 also a Professor of Computer Science and Dean of the College of Computer Science, Megatrend University Belgrade. He was teaching more than 20 graduate and undergraduate courses, from VLSI Design and Computer Architecture to Computer Networks, Operating Systems, Image Processing, Calculus and Queuing Theory. His research interest includes mathematical, queuing theory and heuristic optimizations applied to computer networks, image processing and combinatorial problems. He is the author or coauthor of more than 130 scientific papers and coeditor or member of the editorial board or scientific committee of number of scientific journals and conferences. Member of the ACM since 1983, IEEE 1984, New York Academy of Sciences 1987, AMS 1995, SIAM 2009.

Plenary Lecture 8

Research in the Field of Human–Machine Interaction in Transport Systems: Development of Analyzing Tools, Measurement Methodologies and Advanced Interactive Simulators

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Abstract: A problem of reliability and safety of interaction between the human operator (driver) and him controlled artificial (machine, vehicle) plays a crucial role in the overall safety in transport industry over the world. Most of the accidents happened due to the failure of human factor. It can off course happen not only when controlling the machine (vehicle) but also when maintaining it or even when it is manufactured or designed. This is often caused either by a bad design of the system or an insufficient or unsuitable training of the human operators. Since the only communication between the operator and artificial systems is realized via the interfaces, just the field of interfaces is the topic of our contemporary research performed in our laboratories.
The lecture introduces problems of the Human-Machine Interaction (HMI) research field as well as problems of the user interface in systemic point of view. These will be discussed in general, seamlessly moving towards the field of driver- vehicle interaction reliability and safety (vehicle here is meant in its general sense). Within the research work of the Laboratory of Systems Reliability and consequently the Driving Simulation Research Group we have been focused on this research field for almost 15 years. The objective approaches to investigate in the reliability of operator-machine interaction will be introduced as well as mathematical modeling tools. Beside those general approaches, the lecture will introduce in more detail our main research focus - ergonomics and human factors in vehicle control.
Second part of the presentation will be dedicated to research tools – the advanced interactive simulators, which are continuously being developed by the Driving Simulation Research Group. It covers not only simulation technology but also scenario and experiment design and mainly measurement tools and methods, which are fitted just for such kind of experiments. Indisputable role in this area is played by special measuring devices, especially those which work with so called psychophysiological measures. The data measured during such experiments are usually hard to be interpreted in straightforward way, mainly those which have biological nature. Therefore also some advanced analytical and classification tools will be discussed.
At the end of the presentation most recent and/or most valuable results and conclusions will be shown. Lecture is accompanied with vivid videos captured during the most interesting experiments.

Brief Biography of the Speaker: Academic career: 2003 - Master Degree at CTU Prague (Faculty of Electro-engineering), specialization in computer engineering, 2007 - Doctoral Degree at CTU Prague (Faculty of Transportation Sciences) “Driving simulators for HIM research”, 2011 degree of associate prof. (doc.) at CTU Prague. Since 2003 researcher and university teacher, since 2007 Head of Driving Simulation Research Group, since 2008 deputy head of Laboratory of Systems Reliability of FTS,CTU and Institute of Informatics of Academy of Sciences of Czech Republic, since 2011 head of Department of Transporting Technologies.
Scientific activities: research activities in interactive and driving simulator construction and development, HMI in vehicles, human factors in transportation, measurements and analysis of complex data, implementation of virtual

reality tools into the experiments, design of experiments and their analysis, member of editorial board of scientific journal Neural Network World.
Since 2003 wrote several tens of papers, chapters in journals, book chapters, research report with topics on interactive simulators, human factors in transportation, ergonomics, driver's attention and fatigue, worked in expert groups of PIARC and European Committee. Main solver of several national scientific and applied research projects (grants).