III. Keynote speeches

Keynote speaker 1

Multi-Sensor Approach for Multivalent Applications in Nanometrology

Prof. Dr. –Ing. Eberhard Manske

Faculty of Mechanical Engineering
Ilmenau University of Technology

Abstract

In micro- and nanotechnology, the demands in the field of nanometrology are increasing. The dimensional structures are becoming more complex with smaller and smaller structure widths and increasingly larger surface regions, and with thousands of inspection features. Therefore it is necessary to the relevant metrology tools to provide the ability to measure in three dimensions with atomic resolution over large areas. For industrial application this must also be achieved at a suitable speed/throughput.

In order to solve the problems arising within this application spectrum, it becomes desirable and even necessary to combine multi-sensor technology with high precision large-area nanopositioning and nanomeasuring technology. The Nanopositioning and Nanomeasuring Machine NMM-1 developed mainly at the Institute of Process Measurement and Sensor Technology of the Ilmenau University of Technology and SIOS Meßtechnik GmbH comes with a measuring range of 25 mm x 25 mm x 5 mm and subnanometer resolution. Several optical, tactile and AFM probes can be applied in the NMM-1. Every probe shows different physical properties. Optical probes have got a diffraction limited lateral resolution of around 0.5 µm but a scanning speed up to 6 mm/s. AFM probes can achieve a lateral resolution of less than 10 nm. However, their scanning speed is limited to less than

100 µm/s. Therefore, it is desirable to combine several probes to a multi-sensor tool. This is possible with a microscope revolver system to combine five different probes in one arrangement for integration in the Nanopositioning and Nanomeasuring Machine.

First approaches for stitching technology, automatic data segmentation and directed AFM scans will be described and demonstrated. For the measurement of sidewalls and undercuts a measurement strategy with an additional rotary table and high precision fiducial elements was developed in the framework of a EU research project "NanoCMM". Therefore, the Nanopositioning and Nanomeasuring Machine in combination with the multi-sensor approach represents a key instrument to realize intelligent measurement strategies in the nanometer range.

Biography

Prof. Dr.-Ing. habil. Eberhard Manske holds a foundation professorship "Precision Measurement Technology" at the Ilmenau University of Technology, whereas this professorship was installed by the Sartorius AG in April 2008. He has been the spokesman of the collaborative research centre "SFB 622 – Nanopositioning and Nanomeasuring Machines" since June 2008, succeeding the initiator and long-standing head, Prof. Gerd Jäger.

Since 2010 he is interim head of the department "Mechanical Engineering Measurement and Production Measurement".

After the completion of his studies of electrical engineering in 1982, Prof. Manske worked as a scientific co-worker at the Institute of Process Measurement and Sensor Technology at the Ilmenau University of Technology. In 1986, he obtained the doctoral degree, and in 2006 the postdoctoral lecturing qualification.
He focuses his research work mainly on nanopositioning and nanomeasuring technology, fibre-coupled laser interferometry, laser stabilization, optical and tactile precision sensors and scanning probe techniques.

In June 2011, the paper with the title "3-D microprobe with optical detection" presented by his PhD student and him has received the Best-Poster-Award at International conference of the European Society for Precision Engineering & Nanotechnology, EUSPEN 2010.

Keynote speaker 2

Intelligent Robotics and Automation: The State of the Art Development, Challenges and Perspectives

Prof. Dr. Ren C. Luo

Irving T. Ho Chair and Distinguished Professor
National Taiwan University
President, Robotics Society of Taiwan

Abstract

Intelligent robotics and automation industry has its unique characteristics , because of its high industrial relevance (such as ICT, services, manufacturing), and it provides high quality, high stability and high productivity with wide-spectrum of applications and value-added for improving the quality of life. Intelligent robotics and automation industry has become an important indicator of national competitiveness. The world's major developed countries in Europe, North America, Japan, Korea, China and other countries has ranked the development of intelligent robotics and automation industry as one of the national highest-priority industry. The January 2007 issue of Scientific American has published an article from Microsoft's Bill Gates which stated that the next hot field will be robotics. We are facing an aging and low birth rate society. It becomes an indispensible tendency for the 21st century in using new technologies to improve our quality of life. In view of many market study reports, Asia-Pacific will be the largest portion and growth in 2015 due to the growing demand from Japan, Korea, China and Taiwan. Among many field of applications, multifunctional service robot will be the mainstream development. In this talk, a review of the recent international state of the art development in intelligent robotics and automation will be presented. Some essential technical issues and challenges including robotics control aspects will be addressed. Examples of recent research results, such as adaptive impedance and velocity control of robot arm for service robotics applications in our Intelligent and Automation Laboratory at National Taiwan University will also be introduced. Finally, the future perspectives in terms of research trend and business opportunities will also be included.

Biography

Ren C. Luo (M'83–SM'88–F'92) received the Ph.D.degree in electrical engineering from the Technische Universitaet Berlin, Berlin, Germany. He is currently an Irvin T. Ho and Distinguished Professor in the Department of Electrical Engineering and Director of intelligent robotics and automation research at National Taiwan University and President of Robotics Society of Taiwan. He also served two-terms as President of National Chung Cheng University in Taiwan. He was a tenured Full Professor of Department of Electrical and Computer Engineering and Founding Director of center for robotics and intelligent machines at North Carolina State University, Raleigh, NC, USA and Toshiba Chair Professor in the University of Tokyo, Japan.

His research interests include sensor-based intelligent robotic systems, multisensor fusion and integration, computer vision, micro/nano technologies, rapid prototyping, and advanced manufacturing systems. He has authored more than 400 papers on these topics, which have been published in refereed technical journals and conference proceedings. He also holds several international patents. Dr. Luo received IEEE Eugean Mittlemann Outstanding Research Achievement Award, IROS Harashima Award for Innovative Technologies; ALCOA Foundation Outstanding Engineering Research Award, NCSU, USA; National Science Council Outstanding Research Awards, 1998-1999, 2000-2001, 2002-2005; National Science Council Distinguished Research Awards,2006-2008; TECO Outstanding Science and Technology Research Achievement Award, 2001. Dr. Luo is currently Co-Editor-in-Chief of IEEE Transactions on Industrial Electronics and was Editor-in-Chief of IEEE/ASME Transactions on Mechatronics (2003-2007). He served as President of IEEE Industrial Electronics Society (2000-2001). He also served as President of Chinese Institute of Automation Engineers, Program Director of Automation Technology Division, National Science Council; Adviser of Ministry of Economics Affairs and Technical Adviser of Prime Minister's Office in Taiwan.

He contributes regularly to IEEE sponsored international conferences by serving as conference General Chairs (IEEE IROS 1992, MFI 1994, IECON 1996, MFI 1999, ICRA 2003, IECON 2007, IROS 2010), Program Chairs, program committees, and offers short courses or tutorials and plenary/keynote speeches in various countries and research communities. Dr. Luo is a Fellow of IEEE since 1992 and a Fellow of IET.

Keynote speaker 3

Estimation of Production Times As Part of Decision Support

Prof. Predrag Cosic, PhD
Faculty of Mechanical Engineering and Naval Architecture
Department of Industrial Engineering
University of Zagreb, Croatia

Abstract

Estimation of production times, delivery terms, production costs,maximum profit etc. are some of the key problems related to unit production.

Different approaches or a combination of approaches can be applied in this process problem solving. The *first approach* can be the investigation of possible correlation between the features of the product drawing and production time by regression analysis. The *second approach* can be the one using multiobjective optimization. The *third approach* can involve the use of neural networks in process estimation of production times. The *fourth approach* can apply the use of discrete simulation in the process of production by making different variants or scenarios (flow material, sequence of operations, using different capacity and kinds of resources, etc).

It is very often necessary to answer to some important requests for offers, generated for individual or batch production, for example: a great number of requested offers for production of products at once, small batches with very rare repetition,frequent changes of priorities during production, short delivery deadlines, market demands for bringing the prices of individual or batch production close to the prices of mass production etc. During product development we are often faced with evaluation of the best suppliers.

The most important characteristic of our approach presented here is the estimation of production times using group technology, regression analysis, and neural networks.

An experienced process planner usually makes decisions based on comprehensive data without breaking it down into individual parameters. So, as the *first phase* it was necessary to establish a technological knowledge base, define features of the 2D drawing (independent variables), possible dependent variables, size and criteria for sample homogenization (principles of group technology) for carrying out the analysis of variance and regression analysis. The *second phase* in the research was to investigate the possibility for easy automatic, direct finding and applying 3D features of an axial symmetric product to the regression model. The defined requirements resulted in the development of the procedure for retrieval of parameters from the 3D model with a low level of subjectivity, a very fast and reliable process via CAD report to the regression model. The *third phase*

in the research was to investigate the possibility for the application of neural networks in production time estimation and to compare the results between the regression models and neural network models.

In the previous research a strong correlation was discovered between the features of the product drawing and production time, which resulted in 8 regression equations or/and neural network. Since the optimization of these regression equations did not fully define the most frequent requirements, *multiobjective optimization* was applied. The applied criteria included: minimum production time, maximum work costs/total costs ratio for a group of workpieces.

Development of *different scenarios* (variants) in the management of production by discrete simulation is usually conditioned by the following criteria (dependent
variables): minimum term of delivery, minimum production costs, maximum profit of the combination of manufactured products quantities and maximum use of capacity resources. Different reasons for *production downtime* may include the following: low level of material quality, inadequate quality of income parts, machine failures, machine tools failures, low level of quality for process planning, over-occupancy of production capacities, etc.

Biography

Prof. Predrag Cosic is Chair of Production Design in Department of Industrial Engineering, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Republic of Croatia. He is also Head of Post Graduated Specialized Study named ''Product Life Cycle Management'', result of EU project TEMPUS IV JPCR_144959, ''Master Studies and Continuing Education Network for Product Lifecycle Management with Sustainable Production''.

In 1994 he has received his Ph.D. degree in Technical Sciences, in Faculty of Mechanical Engineering and Naval Architecture in University of Zagreb, Croatia. Since 1978 he has been employed in University of Zagreb.

His research fields include the following topics: Improving of metal forming processes, Knowledge Systematization of Process Planning, Connection process planning, development of database and e-learning, Criterions definition for selection technological processes (metal forming, machining, moulding, casting, etc.), Variants of process planning (criteria : costs, machining times), Statistical Analysis and estimation significant factors and regression analysis of influenced factors on costs and machining times, Sequencing operations in production, criteria : requested quality, economical and technological approach, Numerical evaluation of shape complexity 2D shape of workpiece, Improvement of production (reengineering, Kaizen, etc), Fast Estimation of Production Times/Costs, Receiving Features of 3D Model from CAD as Decision Support for Times/Costs Estimation, Total Cost Estimation, Life Cycle Assessment/Management, Multi Criteria Optimization, Genetic Algorithms.

He is Member of Technical committee named Management of Environment, field Life Cycle Management and Life Cycle Assessment, Croatian Standards Institute, http://www.hzn.hr/.

Since 2000 Prof. Cosic has joined in the EU project ”**EU TEMPUS Project, Scientific, Bilateral and Informatical Projects 2000 -2012 year.**

He is guest co-editor in the following journals:

Special Issue of Strojarstvo: Journal for Theory and Application in Mechanical Engineering, selected papers from MOTSP2009.

Special Issue of Journal of Industrial Engineering and Management.

Special Issue of Journal of Mechanical Engineering (Strojniški Vestnik)

Keynote speaker 4

A Unified Fuzzy Model-Based Framework for Nonlinear Control of Mechanical Systems: From Backing-up of Truck-Trailers to Tracking Control of Flying Vehicles

Prof. Kazuo Tanaka

Department of Mechanical Engineering And
Intelligent Systems,
The University of Electro-Communications, Japan

Abstract

This talk gives an overview of a unified fuzzy model-based framework for nonlinear control of mechanical systems. A number of practical applications, ranging from backing-up truck-trailers to tracking control of flying vehicles, are discussed indetail. These applications have been investigated in our laboratory at the University of Electro-Communications (UEC), Tokyo, Japan.

The first part of this talk gives a comprehensive treatment of advances on fuzzy control utilizing linear matrix inequalities (LMIs) and more recently sum of squares (SOS). A key feature of both approaches is that they provide simple, natural and effective design procedures as alternatives or supplements to other nonlinear control techniques that require special and rather involved knowledge. The LMI-based design approaches entail obtaining numerical solutions by convex optimization methods such as the interior point method. Though LMI-based approaches have enjoyed great success and popularity, there still exist a large number of design problems that either cannot be represented in terms of LMIs, or the results obtained through LMIs are sometimes conservative. A post-LMI framework is SOS-based approaches for modeling and control of nonlinear systems using polynomial fuzzy systems.

The second part of this talk discusses applications to nonlinear mechanical systems.

The applications include not only robust control, guaranteed cost control, multi-objective control problems, etc., of mechanical systems but also challenging control tasks from backing-up truck-trailers to tracking control of flying vehicles. Recently, backing-up control problems for a vehicle with a single trailer or multiple trailers have been used as a testbed for a variety of control design methods. In order to

successfully back up the trailer-truck, the so-called jackknife phenomenon needs to beavoided. This talk presents our successful experimental results for the triple trailers casebased on the LMI approach. This talk also provides an attempt to reduce some of the important sensors to detect relative angles in the triple trailer case in the LMI designframework.

Another application is control of flying vehicles such as a micro helicopter, a powered paraglider, etc., via the LMI and SOS approaches. Flying vehicles control is more challenging than the backing-up control problem. Their dynamics are unstable, nonlinear in addition to the coupling between the positions and attitudes. Furthermore, this talk also briefly mentions a most recent result on wireless vision-based stabilization of an indoor micro helicopter via visual simultaneous localization and mapping. Although path tracking control using only a small single wireless vision sensor is a quite challenging task, the results demonstrate the viability of our approach. Finally, this talk introduces our newly developed powered paraglider control system for rescue missions.

Biography

Kazuo Tanaka received Ph.D. degree, in Systems Science from Tokyo Institute of Technology, in 1990, respectively. He is currently a Professor in Department of Mechanical Engineering and Intelligent Systems at The University of Electro-Communications. He was a Visiting Scientist in Computer Science at the University of North Carolina at Chapel Hill in 1992 and 1993. He received the Best Young Researchers Award from the Japan Society for Fuzzy Theory and Systems in 1990, the Outstanding Papers Award at the 1990 Annual NAFIPS Meeting in Toronto, Canada, in 1990, the Outstanding Papers Award at the Joint Hungarian-Japanese Symposium on Fuzzy Systems and Applications in Budapest, Hungary, in 1991, the Best Young Researchers Award from the Japan Society for Mechanical Engineers in 1994, the Best Book Awards from the Japan Society for Fuzzy Theory and Systems in 1995, 1999 IFAC World Congress Best Poster Paper Prize in 1999, 2000 IEEE Transactions on Fuzzy Systems Outstanding Paper Award in 2000, the Best Paper Selection at 2005 American Control Conference in Portland, USA, in 2005.

He is currently serving on the IEEE Control Systems Society Conference Editorial Board. He is also an Associate Editor for IEEE Transactions on Fuzzy Systems, Automatica, etc. He is the author of two books and a co-author of 9 books. Recently, he co-authored (with Hua O. Wang) the book Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach (Wiley-Interscience). He is a senior member of IEEE. His research interests include nonlinear control systems design and analysis, flying-robot and aerial-vehicle control, and brain-machine interface.