SysInt

Conference Booklet

3rd International Conference on System-integrated Intelligence: New Challenges for Product and Production Engineering

June 13th – 15th 2016, Paderborn, Germany

www.sysint-conference.org

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Leibniz Universität Hannover

Universität Bremen

Editorial

System-Integrated Intelligence: New Challenges for Product and Production Engineering

Introduction

The volume contains the collected research and development activities presented at the 3rd International Conference on System-integrated Intelligence (SysInt) held in Paderborn, Germany from June 13th – 15th 2016. The SysInt 2016 is the third in a series of events started in 2012 in Hanover, Germany. Just like this first instalment, the current event derives its dynamic and innovative nature from the close cooperation between three major research centres which focus on similar topics, but maintain slightly different perspectives on it: Their complementary constitutes the strength ot the combined effort.

In 2016, this setting has attracted more than 70 contributions from 9 contries worldwide.

Scope of the Conference SysInt 2016

Based on the success of the 1st and 2nd, we now announce the 3rd International Conference on System-Integrated Intelligence: New Challenges for Product and Production Engineering.

This international event provides a forum for academia and industry to disseminate their latest innovations and practises. The focus is on integration of new, intelligent functionalities into materials, components, systems and products to enable future technologies with enhanced capabilities.

Development of new sensor materials and technologies, intelligent products including Cyber-Physical Systems (CPS) and self-controlled processes for logistics and production engineering (Industrie 4.0) are within the scope of the conference. Fundamental research areas thus include functional materials research, mechatronic systems and production engineering, microsystems technology, systems engineering and computer science.

Ansgar Trächtler, Berend Denkena, Klaus-Dieter Thoben

The Organizers behind SysInt 2016

Within this range, all three research centres set their very own specific stress. The Heinz Nixdorf Institute of Paderborn University as this year's host of the event is represented among the conference chairs by Prof. Trächtler as the head of the chair for "Control Engineering and Mechatronics" and as the director of the Fraunhofer Research Institution for Mechatronic Systems Design IEM. The Heinz Nixdorf Institute is an interdisciplinary research institute with a primary focus on Intelligent Technical Systems that are based on the interplay between engineering and computer science. Typically, such systems yield products in the field of information technology, communication technology, mechanical engineering, automotive and transport engineering, and the electrical and medical industry. The Heinz Nixdorf Institute aims to establish a new school of thought for the design of intelligent technical systems. Important research areas are:

- Self-coordination, self-optimisation and reconfiguration
- Mechatronics and sensing in distributed systems
- Design methodology
- Strategic planning and knowledge management

The Leibniz Universität Hannover, represented among the chairs by Prof. Denkena, stresses the concept of intelligent materials and components. According to this vision, products are to be equipped with a memory of their past experiences that covers their full life cycle from beginning to end. The idea is that development of new products should incorporate knowledge from the past in an analogy to the way genes and their expression control who we are in relation to the experiences of our ancestors. Realization of this concept is supported by the German Research Foundation (DFG) via the Collaborative Research Centre 653 Gentelligent Components in their Life Cycle.

The University of Bremen is represented among the chairs by Prof. Thoben as head of the Bremer Institut für Produktion und Logistik GmbH (BIBA) and as the speaker of the Bremen Research Cluster for Dynamics in Logistics (LogDynamics). LogDynamics conducts research investigating dynamic processes in logistic systems. It combines fundamental and applied research with transfer and education at the interface between science and industry. Important research areas are: autonomous control in logistic processes and networks, Cyber-Physical Systems for Industrie 4.0, Internet of Things and Services and Supply Chain (Event) Management. Four faculties of the University of Bremen cooperate in LogDynamics with the Bremer Institut für Produktion und Logistik GmbH (BIBA), the Institute of Shipping Economics and Logistics (ISL), as well as with the Jacobs University Bremen.

The Leading-Edge Cluster Intelligent Technical Systems OstWestfalenLippe (it's OWL) is sponsoring the SysInt 2016 and is funded by the German Federal Ministry of Education and Research (BMBF) via the Project Management Agency Karlsruhe (PTKA) and a pioneer in Industrie 4.0. It pools the resources of global market leaders in mechanical engineering and the electrical, electronics and automotive supply industries, as well as internationally renowned, cutting-edge research institutes. The objective they share is to secure the OWL region a leading position among global competitors in the field of intelligent technical systems.

Structure of the Event

The SysInt 2016 conference covers the full range of these topics. The conference programme, which is reflected in the proceedings volume, is divided into five different topics, namely

- Intelligent Systems: Enabling Technologies
- The Future of Manufacturing: Cyber-Physical Production and Logistic Systems
- Pervasive and Ubiquitous Computing
- Structural Health Monitoring
- Systems Engineering in Advanced Mechatronics

The first of these covers fundamental technologies that facilitate the broader introduction of system-intelligence on conceptual, software and hardware level. The following four topics address different application scenarios.

Conclusion and Outlook

To organize this event, to bring together all contributors, to fairly judge their work and to provide them with the lively, motivated and open-minded environment that alone allows exchange across the disciplines can never be a single person's work. We would therefore like to take the opportunity to thank all those many people who contributed to the success of the SysInt 2016 conference. This includes the members of the Organizing Committee, the International Programme Committee and the Editorial Committee as well as all those who assisted on site to make the SysInt 2016 conference as smooth and memorable event. We would also like to thank our sponsors, the Leading-Edge Cluster it's OWL, the German Research Foundation (DFG), the Project Management Agency Karlsruhe (PTKA) and the International Academy for Production Engineering (CIRP).

Organisation

International Program Committee

Prof. Alexandre Mendes Abrão, Brazil
Prof. Tojiro Aoyama, Japan
Prof. Pedro José Arrazola, Spain
Prof. Eric Bodden, Germany
Dr. Stefan Bosse, Germany
Prof. Matthias Busse, Germany
Dr. Manuel Collet, France
Prof. Welf-Guntram Drossel, Germany
Prof. Neil Duffie, USA
Dr. Roman Dumitrescu, Germany
Prof. Didier Dumur, France
Prof. Jürgen Gausemeier, Germany
Prof. Nikhil Gupta, USA
Dr. Peter Hehenberger, Austria
Prof. Carsten Heinzel, Germany
Prof. Lothar Kroll, Germany
Dr. Cheng Yee Low, Malaysia
Prof. Hans-Christian Möhring, Germany
Prof. Abdul Rahman Omar, Malaysia
Prof. Hong-Seok Park, South Korea
Prof. Roberto Teti, Italy
Prof. Kirsten Tracht, Germany
Prof. Eckart Uhlmann, Germany
Prof. Fred J.A.M. van Houten, Netherlands
Prof. Carlos Eiki Hirata Ventura, Brazil
Prof. Frank Vollertsen, Germany
Prof. Konrad Wegener, Switzerland
Prof. Thorsten Wuest, USA

Conference Chairs

Prof. Dr.-Ing. Ansgar Trächtler (Paderborn University, Heinz Nixdorf Institute)
Prof. Dr.-Ing. Berend Denkena (Leibniz Universität Hannover, IFW)
Prof. Dr.-Ing. Klaus-Dieter Thoben (University of Bremen, BIBA)

Organizing Committee

Dr.-Ing. Viktor Just (Heinz Nixdorf Institute, Paderborn University)
Peter Iwanek (Heinz Nixdorf Institute, Paderborn University)
Dr. Stefan Bosse (Computer Science Department, University of Bremen)
Dr.-Ing. Dirk Lehmhus (ISIS Sensorial Materials Scientific Centre, University of Bremen)
Marco Lewandowski (Bremer Institut für Produktion und Logistik GmbH, University of Bremen)
Gerold Kuiper (Institute of Production Engineering and Machine Tools, Leibniz Universität Hannover)
Dr. rer. nat. habil. Bernd Breidenstein (Institute of Production Engineering and Machine Tools, Leibniz Universität Hannover)

Table of Contents

Programme SysInt 2016

Monday, June 13th 2016			
08:00 am	**Registration & Welcome Coffee** (Heinz Nixdorf MuseumsForum)		
09:00 am	**Welcome & Introduction** Plenary Ansgar Trächtler		
09:30 am	**Keynote Session** Plenary Developing Intelligent Systems – methods, best practice and challenges *Ansgar Trächtler, Heinz Nixdorf Institute, Paderborn University* Industrie 4.0 from both a user's and a vendor's perspective *Gerhard Volkwein, Siemens AG, Germany*		
10:30 am	**Coffee Break** Lunch-Room		
11:00 am	**Session 1.1: Intelligent Systems** Seminar Room 1/2 *Chair: Carlos Eiji Hirata Ventura, Federal University of São Carlos* Distributed Inverse Kinematics for Shape-Changing Robotic Materials *Michael Andrew McEvoy, Nikolaus Correll* Hybrid Mechanical and Data-driven Modeling Improves Inverse Kinematic Control of a Soft Robot *Felix Reinhart, Jochen Steil* Adaptive state-space model for ultra-precision feed axis *Arne Bloem, Christian Schenck, Bernd Kuhfuss*	**Session 1.2: The Future of Manufacturing** Seminar Room 4 *Chair: Gerold Kuiper, Institute of Production Engineering and Machine Tools* Model Based Predictive Force Control in Milling – System Identification *Oliver Adams, Fritz Klocke, Max Schwenzer, Sebastian Stemmler, Dirk Abel* Self-optimizing cutting process using learning process models *Berend Denkena, Marc-Andre Dittrich, Florian Uhlich* Hierarchical Scheduling for Plug-and-Produce *Jan Jatzkowski, Achim Rettberg, Peer Adelt*	**Session 1.3: Systems Engineering** Seminar Room 5 *Chair: Cheng Yee Low, Universiti Teknologi MARA* Function-based feasibility study and benchmark for MID concepts *Christoph Jürgenhake, Tommy Falkowski, Christian Fechtelpeter, Roman Dumitrescu* The impact on organizational structures of model-based mechatronic system design *Andreas Kellner, Peter Hehenberger, Michael Friedl, Lukas Weingartner, Sandra Ringhofer* Model-based representation of protective measures as Solution Patterns *Daniel Kliewe, Harald Anacker, Roman Dumitrescu, Arthur Wegel*

12:30 pm	**Poster Presentation Session** **Plenary** *Chair: Dirk Lehmhus, University of Bremen* An Approach to describe Gentelligent Components in their Life Cycle *Wieben Scheidel, Iryna Mozgova, Roland Lachmayer* Intelligent Production System Planning with Virtual Design Reviews *Daniel Köchling, Jan Berssenbrügge, Joel Schlüssler, Jörg Stöcklein* A Support System for Sensor and Information Fusion System Design *Alexander Fritze, Uwe Mönks, Volker Lohweg* Direct Part Marking by Vibration Assisted Face Milling *Alexander Seibel, Thilo Grove, Berend Denkena* Integrated ultrasonic driven balancer for ultra precision high speed machine tools *Eike Foremny*, Christian Schenck, Bernd Kuhfuss Integration of humidity sensors into fibre-reinforced thermoplastic composites *Franziska Ebert, Nadin Reimann, Thomas Seider, Heike Illing-Günther, Klaus Nendel, Jörg Martin, Thomas Otto, Thomas Geßner, Daisy J. Nestler, Guntram Wagner* A critical view on PLM/ALM convergence in practice and research *Andreas Deuter, Stefano Rizzo* Stress Reduction in sputtered thin NiFe 81/19 layers for Magnetic Field Sensors *Lisa Jogschies, Johannes Rittinger, Daniel Klaas, Marc Christopher Wurz*
01:00 pm	**Lunch** **Lunch-Room**

02:30 pm	**Session 2.1: Intelligent Systems** **Seminar Room 1/2** *Chair: Hans-Christian Möhring, IFQ / Otto-von-Guericke-University Magdeburg* Development of a Humidity Sensor Element based on sputter-deposited thin ZnO-Layers *Daniel Klaas, Michael Rein, Marc Christopher Wurz, Lutz Rissing* Microstructure and Magnetic Properties of Cobalt and Zinc Containing Magnesium Alloys *Christian Demminger, Christian Klose, Hans Jürgen Maier* Embedded Electronic System based on Dedicated Hardware DSPs for Electronic Skin Implementation *Ali Ibrahim, Luca Noli, Paolo Gastaldo, Hussein Chible, Maurizio Valle*	**Session 2.2: The Future of Manufacturing** **Seminar Room 4** *Chair: Daniel Köchling, Heinz Nixdorf Institute, Paderborn University* Production Monitoring based on Sensing Clamping Elements *Berend Denkena, Dominik Dahlmann, Johann Kiesner, Markus Mücke* Novel design concept of an optoelectronic integrated RF communication module *Quang Huy Dao, Alexandra Skubacz-Feucht, Bernard Lüers, Philipp von Witzendorff, Christoph von der Ahe, Ludger Overmeyer, Bernd Geck* Enabling of Component Identification by High Speed Measuring of Grinding Wheel Topography *Bernd Breidenstein, Berend Denkena, Thilo Grove, Rolf Hockauf*	**Session 2.3: It's OWL – Systems Engineering** **Seminar Room 5** *Chair: Roman Dumitrescu, Fraunhofer IEM* Approach for an Integrated Model-Based Design of Intelligent Dynamic Systems Using Solution and System Knowledge *Felix Oestersötebier, Farisoroosh Abrishamchian, Christopher Lankeit, Viktor Just, Ansgar Trächtler* Towards Feature-based Product Line Engineering of Technical Systems *Thorsten Koch, Jörg Holtmann, David Schubert, Timo Lindemann* Modular Inspection Equipment Design for Modular Structured Mechatronic Products – Model Based Systems Engineering Approach for an Integrative Product and Production System Development *Meinolf Lukei, Bassem Hassan, Roman Dumitrescu, Thorsten Sigges, Viktor Derksen*

04:00 pm	**Poster Presentation Session** **Plenary** *Chair: Daniel Klaas, Leibniz Universität Hannover* Exhaustiveness of Systems Structures in Model-Based Systems Engineering for Mechatronic Systems *Lydia Kaiser, Christian Bremer, Roman Dumitrescu* Design and Development of Product Service Systems (PSS) – Impact on Product Lifecycle Perspective *Thorsten Wuest, Stefan Wellsandt* Conditioning of Surface Energy and Spray Application of Optical Waveguides for Integrated Intelligent Systems *Gerd-Albert Hoffmann, Thomas Reitberger, Jörg Franke, Ludger Overmeyer* Thermofluid-Acoustic Analysis of a Ranque-Hilsch Vortex Tube *Wirachman Wisnoe, Khairil Muhaimin Abd Rahman, Yusman Istihat, Valliyappan David Natarajan* A novel approach using model predictive control to enhance the range of electric vehicles *Julian Eckstein, Christopher Lüke, Frederik Brunstein, Patrick Friedel, Ulrich Köhler, Ansgar Trächtler* Investigation on aging of metallic surface integrated micro-POFs *Bechir Hachicha, Ludger Overmeyer* Computational modeling of the effect of different temperature and membrane thickness on Faraday efficiency in PEM electrolyzer *Alhassan Salami Tijani, Abdul Hadi Abdol Rahim*
04:30 pm	**Coffee Break with Poster Session** **Lunch-Room**
05:30 pm	**Guided Tour: Fraunhofer IEM** **Fraunhofer IEM (Zunkunftsmeile 1)**
06:30 pm	**Get Together: Fraunhofer IEM** **Fraunhofer IEM (Zunkunftsmeile 1)**

Tuesday, June 14th 2016

08:30 am	**Registration**		
09:00 am	**Keynote Session** **Plenary** *Chair: Berend Denkena, Leibniz Universität Hannover* Gentelligence or Industrie 4.0 – Technical inheritance within the whole product lifecycle *Berend Denkena, Leibniz Universität Hannover, Germany* The Challenge of Ubiquitous Sensing: Is More Always Better? *Gregory O'Hare, University College Dublin, Ireland* Material-integrated Intelligence for Robot Autonomy *Nikolaus Correll, University of Colorado, United States of America*		
10:30 am	**Coffee Break** **Lunch-Room**		
11:00 am	**Session 3.1: Intelligent Systems** **Seminar Room 1/2** *Chair: Thorsten Wuest, West Virginia University* Numerical Investigation for the Design of a Hot Forging Die with Integrated Cooling Channels *Bernd-Arno Behrens, Anas Bouguecha, Milan Vucetic, Martin Bonhage, Irfan Yousaf Malik* Non-destructive evaluation of integrated piezoelectric transducers by thermal waves and thermal pulses *Agnes Eydam, Gunnar Suchaneck, Gerald Gerlach* Mechanical and electrical contacting of electronic components on textiles by 3D printing *Nils Grimmelsmann, Yasmin Martens, Patricia Schäl, Hubert Meissner, Andrea Ehrmann*	**Session 3.2: The Future of Manufacturing** **Seminar Room 4** *Chair: Marc Christopher Wurz, Leibniz Universität Hannover* Vertical Integration and Service Orchestration for Modular Production Systems using Business Process Models *Sebastian Wrede, Oliver Beyer, Christoph Dreyer, Michael Wojtynek, Jochen Steil* Perspective on the design of a decision support system based on Linked Data for process planning *Gerald Rehage, Robert Joppen, Jürgen Gausemeier* Characterization of Cluster Structures in Material Flow Networks: A Network Approach *Darja Wagner, Till Becker*	**Session 3.3: Structural Health Monitoring** **Seminar Room 5** *Chair: Iryna Mozgova, Leibniz Universität Hannover* Classification and simulation method for piezoelectric PVDF sensors *Klaas Hauke Baumgärtel, Daniel Zöllner, Karl-Ludwig Krieger* Structural Monitoring with Distributed-Regional and Event-based NN-Decision Tree Learning using Mobile Multi-Agent Systems and common JavaScript platforms *Stefan Bosse* Fabrication and Sensing Applications of Multilayer Polymer Optical Waveguides *Maher Rezem, Axel Günther, Maik Rahlves, Bernhard Roth, Eduard Reithmeier*
12:30 pm	**Lunch** **Lunch-Room**		

02:00 pm	**Session 4.1: Intelligent Systems** **Seminar Room 1/2** *Chair: Tim Tiedemann, DFKI* Flexible Magnetic Reading/ Writing System: Heat-Assisted Magnetic Recording *Piriya Taptimthong, Jan Friedrich Düsing, Lutz Rissing, Marc Christopher Wurz* The Concept of Technical Inheritance in Operation: Analysis of the Information Flow in the Life Cycle of Smart Products *Christian Demminger, Iryna Mozgova, Melissa Quirico, Florian Uhlich, Berend Denkena, Roland Lachmayer, Peter Nyhuis* Towards part lifetime traceability using machined Quick Response codes *Carlos Eiji Hirata Ventura, Rafael Vidal Aroca, Armando Ítalo Sette Antonialli, Alexandre Mendes Abrão, Juan Carlos Campos Rubio, Marcelo Araújo Câmara*	**Session 4.2: it's OWL – Self Optimization** **Seminar Room 4** *Chair: Christian Henke, Fraunhofer IEM* A comparison of two predictive approaches to control the longitudinal dynamics of electric vehicles *Julian Eckstein, Sebastian Peitz, Kai Schäfer, Patrick Friedel, Ulrich Köhler, Mirko Hessel-von Molo, Sina Ober-Blöbaum, Michael Dellnitz* Design and Implementation of Intelligent Control Software for a Dough Kneader *Felix Oestersötebier, Phillip Traphöner, Felix Reinhart, Sebastian Wessels, Ansgar Trächtler* Multiobjective Model Predictive Control of an Industrial Laundry *Sebastian Peitz, Manuel Gräler, Christian Henke, Mirko Hessel-von Molo, Michael Dellnitz, Ansgar Trächtler*	**Session 4.3: Structural Health Monitoring** **Seminar Room 5** *Chair: Maik Rahlves, Leibniz Universität Hannover* Fibre optic sensors for the structural health monitoring of building structures *Kort Bremer, Frank Weigand, Michael Kuhne, Merve Wollweber, Reinhard Helbig, Bernhard Roth* A planar low-cost full-polymer optical humidity sensor *Christian Kelb, Martin Körner, Oswald Prucker, Jürgen Rühe, Eduard Reithmeier, Maik Rahlves, Bernhard Roth* Inherent load measurement and component identification by multi-dimensional coded data in the component's subsurface region *Sebastian Barton, Gregor Mroz, Wilfried Reimche, Hans Jürgen Maier*
03:30 pm	**Coffee-Break with Poster Session** **Lunch-Room**		

04:15 pm – 05:45 pm	**Session 5.1: Intelligent Systems** **Seminar Room 1/2** *Chair: Viktor Just, Heinz Nixdorf Institute, Paderborn University* Disturbance observer design for utilizing of time-delayed vision measurements in high dynamical Systems *Shuo Wang, Viktor Just, Ansgar Trächtler* Model-based method for the accuracy analysis of Hardware-in-the-Loop test rigs for mechatronic vehicle axles *Simon Olma, Phillip Traphöner, Andreas Kohlstedt, Karl-Peter Jäker, Ansgar Trächtler* Closed-loop Process Control for Laser Patterning of Thin Film Strain Sensors *Jan Friedrich Düsing, Jürgen Koch, Oliver Suttmann, Ludger Overmeyer*	**Session 5.2: Pervasive Computing** **Seminar Room 4** *Chair: Stefan Bosse, University of Bremen* Distributed Execution of Scenario-Based Specifications of StructurallyDynamic Cyber-Physical Systems *Joel Greenyer, Daniel Gritzner, Guy Katz, Assaf Marron, Nils Glade, Timo Gutjahr, Florian König* Condition Monitoring and Cloud-based Energy Analysis for Autonomous Mobile Manipulation – Smart Factory Concept with LUHbots *Jan Friederichs, Tobias Ortmaier, Jens Kotlarski, Daniel Kaczor, Fabian Schulz, Malte Pabst, Torben Carstensen, Jan Carstensen* An Automotive Distributed Mobile Sensor Data Collection with Machine Learning Based Data Fusion and Analysis on a Central Backend System *Tim Tiedemann, Christian Backe, Thomas Vögele, Peter Conradi*	**Session 5.3: Systems Engineering** **Seminar Room 5** *Chair: Shahruddin Mahzan, Universiti Tun Hussein Onn Malaysia* Automated control system generation out of the virtual machine *Stefan Scheifele, Alexander Verl* A Tool Chain for Model-Based Development of Heat Pump Dryers *Marcos Bockholt, Michael Katter, Georg Pohl, Jan Michael, Thomas Alpögger* ModelTracer: User-friendly Traceability for the Development of Mechatronic Products *Atakan Sünnetcioglu, Elisabeth Brandenburg, Uwe Rothenburg, Rainer Stark*
07:00 pm	**Shuttle-Service from Arosa and Welcome Hotel to the Benteler Arena (via Heinz Nixdorf MuseumsForum)**		
07:30 pm	**Conference Dinner** **Benteler Arena**		
11:00 pm	**Shuttle-Service back to the Hotels**		
12:00 pm	**Shuttle-Service back to the Hotels**		

Wednesday, June 15th 2016

08:30 am	**Registration**
09:00 am	**Keynote Session** **Plenary** *Chair: Michael Freitag, University of Bremen* Prospects for Intralogistics through Industrie 4.0 *Michael Freitag, University of Bremen, Germany* Digital Transformation – Challenges for the Manufacturing Industry *Ulrich Ahle, Atos IT Solutions and Services GmbH, Germany* Natural Fibre Reinforced Composite and Structural Health Monitoring: Possible or Feasible *Shahruddin Mahzan, Universiti Tun Hussein Onn Malaysia, Malaysia*
10:30 am	**Coffee-Break** **Lunch-Room**

Wednesday, June 15th 2016

11:00 am	**Session 6.1: Intelligent Systems** **Seminar Room 1/2** *Chair: Sven Zimmermann, Technische Universität Chemnitz* Sensor Integrated CFRP Structures for Intelligent Fixtures *Hans-Christian Möhring, Petra Wiederkehr, Christoph Lerez, Holger Schmitz, Harald Goldau, Charis Czichy* Sensory workpieces for process monitoring – an approach *Berend Denkena, Dominik Dahlmann, Haythem Boujnah, Markus Mücke* Development of a combined measurement system for torque and angular position *Tobias Menke, Claudia Unger, Anan Dai, David Kramer, Björn Eilert, Georg Ullmann, Ludger Overmeyer* Condition monitoring of piezoceramic fibers during joining by forming *Welf-Guntram Drossel, Volker Wittstock, Sebastian Hensel, Marek Max Schmidt*	**Session 6.2: The Future of Manufacturing** **Seminar Room 4** *Chair: Bernd Breidenstein, IFW* Customized Smartness: A Survey on links between Additive Manufacturing and Sensor Integration *Dirk Lehmhus, Claus Aumund-Kopp, Frank Petzoldt, Dirk Godlinski, Arne Haberkorn, Volker Zöllmer, Matthias Busse* Autonomous Modular Process Monitoring *Berend Denkena, Dominik Dahlmann, Thomas Neff* Flexible and low-cost production of waveguide based integrated photonic devices *Maik Rahlves* SHM-Systems for Composite Aircraft Structures based on Lamb wave Analysis *Michael Sinapius*	**Session 6.3: Systems Engineering** **Seminar Room 5** *Chair: Hong Seok Park, University of Ulsan* Classification of Electroencephalogram Data from Hand Grasp and Release Movements for BCI Controlled Prosthesis *Gerrit Lange, Cheng Yee Low, Fazah Akthar Hanapiah Fadhlan Kamaruzaman* Combined use of modified Hough Transformation, Random Sample Consensus and Linear Least Square to extract the Normal Parameterization of a Straight Line: An Application for Cable Driven Parallel Robots *Rudi Kurniawan, Muhamad Fauzi Othman, Dieter Schramm, Tobias Bruckmann* Enhanced absolute accuracy of an industrial milling robot using stereo camera system *Christian Möller, Hans Christian Schmidt, Nihar Hasmukhbhai Shah, Jörg Wollnack* Ultra-compact 122GHz Radar Sensor for Autonomous Aircrafts *Federico Nava, Christoph Scheytt, Thomas Zwick, Mario Pauli, Benjamin Göttel, Wolfgang Winkler*
01:00 pm	**Best Paper / Poster Award and Conclusion** **Plenary** *Chair: Ansgar Trächtler, Heinz Nixdorf Institute, Paderborn University*		
01:30 pm	**Lunch** **Lunch-Room**		

Keynotes

Monday, June 13th 2016

Keynote 1

Ansgar Trächtler, Heinz Nixdorf Institute, Paderborn University, Germany

Ansgar Trächtler has studied electrical engineering and got his Dr.-Ing and habilitation at the University of Karlsruhe. Afterwards he has been working for several years in the development of vehicle dynamics control systems at Robert Bosch Company. Since 2005, he is Professor for Automatic Control and Mechatronics at Heinz Nixdorf Institute of Paderborn University and, since 2011, the director of the Fraunhofer Research Institution for Mechatronic Systems Design IEM. His research interests are optimal control, automotive control, development methods for mechatronic systems and hardware-in-the-loop simulation.

Developing Intelligent Systems – methods, best practice and challenges

Intelligent technical systems (ITS) are characterized by four specific properties: they are adaptive which means that they adapt their behavior autonomously to varying environmental conditions. They are robust and thus can cope with unexpected situations which have not been foreseen in detail during development, they are anticipatory, i. e. on the basis of gained experience possible future trends can be predicted and taken into account for proper decisions and strategies, and finally, they are user-friendly and reveal transparent behavior to specific users. Another common feature is the multi-disciplinary nature of intelligent systems requiring a strongly interdisciplinary development process including methods from systems engineering. With increasing digitalization, product development processes will be closely linked to data management and decision processes. The talk gives an overview on technologies for developing intelligent systems, illustrates their application by several best practice examples and concludes with open questions and challenges.

Keynote 2

Gerhard Volkwein, Siemens AG, Germany

Dr. Gerhard Volkwein is serving as Director Digital Enterprise Architecture at Digital Factory Division of Siemens AG. He joined Siemens in 2010 as Head Strategy Industry Software at former Industry Automation Division. From 2005 to 2009 he held various senior management positions at Atena Engineering GmbH, a provider of advanced engineering services to the Aerospace and Automotive industries. From 1995 to 2004 he spent almost 10 years in the software industry, initially as Technical Director at startup company AnySIM Simulationssysteme GmbH and, since 1999, as Senior Product Manager at Tecnomatix GmbH. He started his career at ifp – Prof. Dr.-Ing. Joachim Milberg Institut für Produktionstechnik GmbH, a spin-off company of the Institute for Machine Tools and Industrial Management (iwb) at the Technical University of Munich. Gerhard Volkwein graduated with a degree in Mechanical Engineering and received a PhD in Manufacturing Simulation, both at the Technical University of Munich.

Industrie 4.0 from both a user's and a vendor's perspective

Digitalization is affecting not only industrial value creation, it rather has a massive – sometimes game-changing – impact on the way how products are being sold and, in particular, on the additional customer value "smart" and "connected" products are able to provide. Those effects are the actual drivers for the continuing digitalization of the industrial value chain. In this context, Industrie 4.0 can be understood either as an enabling approach or as a mandatory reaction on progressing digitalization. The following presentation will elaborate on Industrie 4.0 as well as on various aspects of digitalization from a Siemens perspective. This perspective is unique insofar as it combines both the role of a global manufacturing company as well as the role of a leading enabler of digitalization in the manufacturing industry. To better illustrate the dual role of Siemens, the presentation will provide an insight into the Siemens factory in Amberg, where ongoing digitalization of the entire value chain enables continuous improvements of productivity and quality – based on Siemens technology.

Tuesday, June 14th 2016

Keynote 1

Berend Denkena, Leibniz Universität Hannover, Germany

Prof. Berend Denkena is Head of the Institute of Production Engineering and Machine Tools at the Leibniz Universität Hannover. After obtaining doctorate at the Faculty of Mechanical Engineering at the University of Hannover in 1992, he worked as a design engineer and Head of various research groups for Thyssen Production Systems both in Germany and the United States. From 1996 to 2001 he was Head of Engineering and Turning Machine Development at Gildemeister Drehmaschinen in Bielefeld. Since 2001 he has been a full professor of Production Engineering and Machine Tools and director of the Institute of Production Engineering and Machine Tools at the University of Hannover. He is a CIRP Fellow Member. His primary areas of research are geometry and functionalizing manufacturing processes, machine tools for cutting and grinding, production planning and control, and simulation of manufacturing processes.

Gentelligence or Industrie 4.0 – Technical inheritance within the whole product lifecycle

The last 250 years of technological development in manufacturing have been driven by innovative ideas and have been characterized by a continuous increase of performance. Important milestones of this development were the mechanization of production, the assembly line production and the automated production. The upcoming fourth industrial revolution is ignited by the demand for highly adaptable and connected process chains which are able to produce individualized products in an efficient, reliable and sustainable manner. The DFG funded Collaborative Research Center 653 has been pursuing the idea of sensitive and communicating products since its start in 2005. CRC 653 has realized this vision with the development of integrated sensors, on-demand maintenance and design evolution of products. In addition, material inherent information storage and technologies to deploy the gained information for process planning were focused in this research. An essential part of the realization was the concept of technical inheritance that enables following product generations to adapt to dynamically changing environments and changing requirements. While the vision of the CRC 653 tackles demands like adaptable and meshed process chains, which are also in the focus of the developments within the field of Industrie 4.0, it embraces additional aspects. Industrie 4.0 focuses on the production phase while the CRC considers the entire product life cycle including utilization. The presentation illustrates the relationship between Industrie 4.0 and technical inheritance by means of various applications.

Keynote 2

Gregory O'Hare, University College Dublin, Ireland

Gregory O'Hare completed his studies at the University of Ulster graduating with a B.Sc. M.Sc. and PhD He held the position of Head of the Department of Computer Science at University College Dublin (UCD) 2001 – 2004. Prior to joining UCD he has been on the Faculty of the University of Central Lancashire (1984 – 1986) and the University of Manchester (1986 – 1996). He is a Professor within the School of Computer Science at UCD. He has published over 445 refereed publications in Journals and International Conferences, 7 books and has won significant grant income (ca €28.00M). O'Hare is an established researcher of international repute. His research interests are in the areas of Distributed Artificial Intelligence and Multi-Agent Systems (MAS), and Mobile & Ubiquitous Computing, Autonomic Systems and Wireless Sensor Networks. He has supervised some 37 PhD to completion in his career to date. He referees extensively for Journals, International Conferences and funding agencies including the European Commission, Enterprise Ireland, Science Foundation Ireland, the Netherlands Organisation for Scientific Research, the National Science Foundation (US). In 2003 he received the prestigious Cooperative Information Agents (CIA), System Innovation Award for ACCESS: An Agent Architecture for Ubiquitous Service Delivery. O'Hare is a Fellow of the British Computer Society, a Fellow of the Irish Computer Society a member of the ACM, AAAI and a Chartered Engineer. He is the Chair of the European Research Consortium on Informatics and Mathematics (ERCIM) Working Group on Sensor Web. He has also held a prestigious Science Foundation Ireland (SFI) Principal Investigator Award 2003 – 2007. He is one of the Principal Investigators and founders of the Science Foundation Ireland funded (€16.4M) Centre for Science and Engineering Technologies (CSET) entitled CLARITY: The Centre for Sensor Web Technologies (2008 – 2013). In 2008 – 2009 he secured a Visiting Research Fellowship to the University of Oxford. In 2010 he was awarded a Fulbright Scholar visiting position at the Computer Science and Artificial Intelligence Laboratory (CSAIL) at Massachusetts Institute of Technology (MIT).

The Challenge of Ubiquitous Sensing: Is More Always Better?

Ubiquitous sensing demands an ability to effectively sense, route, conflate and utilise an ever increasing and ever diverse sources of streamed data. This presentation will describe attempts to provide the necessary infrastructure to support such an eclectic mix of data sources ranging from physical sensors to social media streams to participatory sensed data. The middleware infrastructure must be agnostic of data source and must treat all such sources as equal. In fusing such data this is often performed in the spatio-temporal domain with proximate data being used to reinforce or uplift the quality of individual data streams. This talk will consider the effect of vast volumes of data and how to ensure that low quality/low fidelity data does not in effect compromise the overall integrity of the data corpus. It will reflect on the paradox of is more data always better? It will examine how one might introduce a data quality quotient to mixed source mixed quality data mash ups.

Keynote 3

Nikolaus Correll, University of Colorado, United States of America

Nikolaus Correll is an Assistant Professor in Computer Science at the University of Colorado at Boulder with courtesy appointments in Aerospace, Electrical and Materials Engineering. Nikolaus obtained a degree in Electrical Engineering from ETH Zurich in 2003 with visits at Lund Tekniska Hogskola, Sweden, and Caltech, and earned a PhD in Computer Science from EPFL in Lausanne, Switzerland in 2007. He did a post-doc at MIT CSAIL from 2007 – 2009. Nikolaus is the recipient of a 2012 NSF CAREER award and a 2012 NASA Early Career Faculty Fellowship.

Material-integrated Intelligence for Robot Autonomy

Advances in miniature electronics, distributed algorithms and manufacturing technology have enabled a new generation of smart composites that tightly integrate sensing, actuation, computation and communication. Such "robotic materials" are inspired by multi-functional natural structures such as the skin of the cuttlefish that can change its color and patterning, bird wings that can change their shape, or the human skin that provides tactile sensing at high dynamic range. I will describe a series of recent results that best illustrate the benefits of material integrated computation: high-bandwidth sensing for texture recognition and localization in artificial skins, distributed optimization for controlling shape change, distributed classification for recognizing gestures drawn onto a modular facade, and feedback control of soft robotic actuators. I will then describe current challenges in robotic grasping and manipulation, and demonstrate how robotic materials can provide critical sensing and control during a series of manipulation tasks with applications to warehouse automation, manufacturing and lab automation.

Wednesday, June 15th 2016

Keynote 1

Michael Freitag, University of Bremen, Germany

Michael Freitag studied Electrical Engineering at the Brandenburg Technical University Cottbus, specializing in automation and communication technology. He then did his PhD at the Bremen University, focusing on the nonlinear dynamics of production systems. In 2004, he became Managing Director of the Bremen Collaborative Research Centre "Autonomous Cooperating Logistic Processes" (SFB 637), funded by the German Research Foundation (DFG). In 2008, he alternated and led projects with the steel manufacturer ArcelorMittal about the optimization of logistic processes. Beside his industry involvement, he was also guest lecturer at the Jacobs University in Bremen. In 2014, he was appointed as full professor at the University of Bremen.

Prospects for Intralogistics through Industrie 4.0

This keynote talk will present prospects and first solutions for intralogistics, which were enabled by Industrie 4.0 technologies. These solutions increase the operational safety of floor conveyors, enable a more efficient material supply in job shops, and support a highly flexible material flow by a reconfigurable conveyor system. To increase operational safety of floor conveyors, there are two general approaches: First, installing sensors into the environment and let them monitor the movements of the floor conveyors. Second, installing sensors onto the floor conveyors and let them monitor their local environment. The first approach was used to develop a centralized assistance system for forklift trucks based on infrared technology that enables a combination of collision avoidance and intelligent routing. The second approach was used to apply 2D/3D image processing methods to a local assistance system at a forklift truck. This assistance system notifies the driver of potential hazards. To enable a more efficient material supply in job shops, a demand-driven concept will be presented. The demand at the machines is communicated to the tugger train. The future demand can be forecasted by considering the remaining processing time of the part in the machine and the total processing time of the next part which already waits in the input buffer. The availability of data and the communication between machines, buffers, and tugger trains lead to less train trips and a higher train utilization. To support a highly flexible material flow, a cellular conveyor system, called "Celluveyor", will be presented. The system consists of numerous hexagonal modules each with three omnidirectional wheels. The arrangement of the wheels and the independent activation of their motors enable the movement of objects on any desirable path. This system is able to accomplish logistics tasks such as moving, segregating and reuniting, changing the transport direction and orientation, or clustering of packing units. The modular system can be reconfigured to get any desirable surface. The single modules are controlled in a semi-decentralized way. The presented systems show how Industrie 4.0 technologies can improve safety, efficiency, and flexibility of intralogistic processes and consequently save costs.

Keynote 2

Ulrich Ahle, Atos IT Solutions and Services GmbH, Germany

After an apprenticeship as Toolmaker at Hella KG, Ulrich Ahle studied Mechanical Engineering at the Paderborn University. Firstly he was a design engineer in the field Printer Development at Nixdorf Computer AG, later team leader Technical Processes and responsible project manager for the implementation of the Product Lifecycle Management System Metaphase. From 1996 on he was Director at Siemens Business Services responsible for the setup of the PLM business. After that he became General Manager for e-Business Practice Business Information Management in the area Knowledge Management, Product Lifecycle Collaboration and Business Intelligence. Today Mr. Ahle is responsible for the business with customers from Manufacturing, Retail & Transportation at Atos in Germany. In addition he is responsible for Industrie 4.0 at Atos in Germany. Atos is an international IT service provider with globally more than 100,000 employee.

Digital Transformation – Challenges for the Manufacturing Industry

Digital Transformation is on the agenda of decision makers from companies and organizations all over the world. For manufacturing companies Industrie 4.0 is the approach to leverage the opportunities of Digital Transformation. There are different definitions of Industrie 4.0 in place depending on the point of view of the different stake holders in the market. Digital Transformation will be highly disruptive to most industries, affecting not only revenue and cost structures but also shaking up the core business and operating models. This will be true for nearly all different industries as Digital will be cheaper, stronger and faster. There is no time to wait bud to identify the right approach and strategy for every single organization or company be it from public, finance or manufacturing. The market situation has changed dramatically. From 1973 to 1983 35% new companies came into the F1000. From 2003 to 2013 there have been 70% new. We are in the "age of the customer" – empowered buyers demand a new level of customer obsession (Forrester). One of the main technology enabler is connectivity – "always connected" is the trigger. Beside the question – how to do the business, better and more efficient processes – we have to ask the question – which business will I do tomorrow? While todays production is linearly organized and optimized within the boundaries of organizational and system siloes manufacturing of the future will fulfill individual customer needs by a collaborative and agile network of capabilities. All these different elements of the network have to be connected and need to be able to communicate to each other. Industrie 4.0 will provide this connectivity and the required standardization. Although this is definitely a future scenario it will be a major change for a lot of manufacturing companies. The presentation will describe how the above mentioned changes can be realized in Manufacturing companies. At the same time use cases will be shown and it will be explained which elements of Industrie 4.0 can already be realized today. Finally it will be presented how companies can be enabled to create their own Industrie 4.0 strategy.

Keynote 3

Shahruddin Mahzan, Universiti Tun Hussein Onn Malaysia, Malaysia

Shahruddin Mahzan is an associate professor at the Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia (UTHM) Malaysia. He received his Bachelor's degree in Mechanical and Material Engineering from Universiti Kebangsaan Malaysia (UKM), Malaysia in 1999. After having some experiences as a Mechanical Engineer in Sharp Roxy Electronics Corporation (SREC), he joined UTHM, as a tutor. Shahruddin Mahzan then pursued his PhD in University of Sheffield, UK and received his PhD in Mechanical Engineering in 2007 on the topics of Damage Detection in Composite Structure using Advanced Signal Processing Procedures. Shahruddin Mahzan has contributed his expertise in many units as the Head of Department of Engineering Mechanics, Deputy Dean (Academics and International) for the FKMP. At present, Shahruddin Mahzan served as the Dean of Faculty of Mechanical and Manufacturing Engineering (FKMP). Shahruddin Mahzan specialised and researched in mostly damage detection and composite engineering. His main research interests are on Structural Health Monitoring (SHM) and composite materials.

Natural Fibre Reinforced Composite and Structural Health Monitoring: Possible or Feasible

The emergence of various natural fibres as potential replacement for synthetic fibre has attracted various development and application. However, the issues of natural fibre reinforced composites is always on the mechanical strength and impact damage prone. Recently, structural health monitoring (SHM) has become popular due to its capability to integrate sensor fusion and its characteristics. The adaptability of SHM techniques toward natural fibre composites is investigated. The challenges and issues on implementation of SHM for natural fibre composite are also explored. This talk will discuss on the feasibility study and possibility on SHM implementation for the betterment of composite applications. Therefore a better understanding on feature extraction and selection, as well sensor optimisation can be achieved. Hence, a proper architectural algorithm can be derived in order to establish a good representation of actual condition.

Invited Speaker

Invited Speaker

Michael Sinapius, Technische Universität Braunschweig, Germany

After his training as a machinist, Prof. Dr.-Ing. Michael Sinapius has studied mechanical engineering at the University of Kassel. Since 1989, he is a researcher of the German Aerospace Center (DLR) and completed his PhD at the RWTH Aachen University in 1993. His first research areas at the DLR were Structural Dynamics. In 2013, he was appointed a professorship for Adaptive Lightweight Structures at the Otto-von-Guericke University Magdeburg, and in parallel, became deputy director of the DLR-institute for Composite Structures and Adaptive Systems in Braunschweig. In 2011, he was offered a position as a professor for Adaptronic Systems at the Braunschweig University of Technology. For the past four years, he established the Institute for Adaptronics and Function Integration with 28 members already. Prof. Sinapius is the speaker of the German Research Foundation (DFG) research group 2021 of Acting Principles of Nano-Scaled Matrix Additives for Composite Structures. He is author and co-author of more than 200 publications.

SHM-Systems for Composite Aircraft Structures based on Lamb wave Analysis

The lecture presents recent results of collaborative research programs on Structural Health Monitoring (SHM) of Composite Airframe Structures through the analysis of guided waves. SHM techniques based on lamb wave propagation are promising for online testing of composite panel like structures. Lamb waves can be excited and received easily by piezoceramic patches attached on plates and plate-like structures. The guided waves propagate over large areas with small attenuation and interact with structural discontinuities such as impacts damages. Therefore, this principle can be used for damage detection and localization. The proposed SHM system is based on a network of a specially designed network of piezoceramic patch actuators. Aspects of the system design considering the in particular anisotropic behavior of composites are addressed as well as the complexity of aircraft design. Wave propagation and interaction in complex structures poses a hard challenge for signal validation due to reflections, refractions or mode conversions. Measuring and imaging techniques are presented which allow a deeper analysis and understanding of wave behavior. Finally, the lecture presents a case study of a SHM system installed and used to inspect a full scale Door Surround Structure. It is produced by means of an automated fiber placement technique. During the manufacturing process, a SHM network formed by nearly 600 piezoelectric transducers is integrated on the structure. The panel was impacted with a large number of impacts inducing skin delaminations and debondings of various structural features. The paper presents initial results of the related damage detection process via the integrated SHM system.

Book of Abstracts

Monday, June 13th 2016

Keynote Session

Developing Intelligent Systems – methods, best practice and challenges

Ansgar Trächtler

Intelligent technical systems (ITS) are characterized by four specific properties: they are adaptive which means that they adapt their behavior autonomously to varying environmental conditions. They are robust and thus can cope with unexpected situations which have not been foreseen in detail during development, they are anticipatory, i. e. on the basis of gained experience possible future trends can be predicted and taken into account for proper decisions and strategies, and finally, they are user-friendly and reveal transparent behavior to specific users. Another common feature is the multi-disciplinary nature of intelligent systems requiring a strongly interdisciplinary development process including methods from systems engineering. With increasing digitalization, product development processes will be closely linked to data management and decision processes. The talk gives an overview on technologies for developing intelligent systems, illustrates their application by several best practice examples and concludes with open questions and challenges.

Industrie 4.0 from both a user's and a vendor's perspective

Gerhard Volkwein

Digitalization is affecting not only industrial value creation, it rather has a massive – sometimes game-changing - impact on the way how products are being sold and, in particular, on the additional customer value "smart" and "connected" products are able to provide. Those effects are the actual drivers for the continuing digitalization of the industrial value chain. In this context, Industrie 4.0 can be understood either as an enabling approach or as a mandatory reaction on progressing digitalization. The following presentation will elaborate on Industrie 4.0 as well as on various aspects of digitalization from a Siemens perspective. This perspective is unique insofar as it combines both the role of a global manufacturing company as well as the role of a leading enabler of digitalization in the manufacturing industry. To better illustrate the dual role of Siemens, the presentation will provide an insight into the Siemens factory in Amberg, where ongoing digitalization of the entire value chain enables continuous improvements of productivity and quality – based on Siemens technology.

Session 1.1: Intelligent Systems

Chair: Carlos Eiji Hirata Ventura, Federal University of São Carlos

Distributed Inverse Kinematics for Shape-Changing Robotic Materials

Michael Andrew McEvoy, Nikolaus Correll

We present a distributed algorithm to calculate inverse kinematics for shape-changing beams with integrated sensing, actuation, computation and communication. The beam consists of n segments that can change their curvature and communicate with neighbors. The system is a kinematic chain. We derive a distributed algorithm for computing the inverse kinematics. The presented method distributes the computation among the segments, applying the inverse Jacobian method to m-segment neighborhoods, reducing complexity of individual operations to O(m^3) and solving the reduced problem sequentially along the beam. Validated using computer simulation, the algorithm allows trading accuracy and convergence rate with increased computation and communication.

Hybrid Mechanical and Data-driven Modeling Improves Inverse Kinematic Control of a Soft Robot

Felix Reinhart, Jochen Steil

Feed-forward control relies on accurate knowledge about the controlled plant, e. g. models of manipulator kinematics or dynamics. For many plants, mechanical models do not capture all aspects of a plant or the plant's intrinsic properties do hardly allow for exact and efficient mechanical modeling. In this context, machine learning is a suitable technique to extract non-linear models from data. The paper shows that feed-forward control based on inversion of a hybrid forward model comprising a mechanical model and a learned error model can significantly improve accuracy. The proposed approach is demonstrated for inverse kinematic control of a redundant soft robot.

Adaptive state-space model for ultra-precision feed axis

Arne Bloem, Christian Schenck, Bernd Kuhfuss

One method to produce surfaces with optical properties is the ultra precision cutting. One measure used to attain this precision is by using slow motions of the machine axes. One method to increase the velocities is to predict and compensate the resulting tool path error. This requires a precise model of the machine tool. The precision of the model can be increased if the parameters are identified not only once, but repeatedly. For this purpose an adaptive model is built, which parameters are adjusted by the prediction error method. In this work this model is applied to an experimental setup.

Session 1.2: The Future of Manufacturing

Chair: Gerold Kuiper, Institute of Production Engineering and Machine Tools

Model Based Predictive Force Control in Milling – System Identification

Oliver Adams, Fritz Klocke, Max Schwenzer, Sebastian Stemmler, Dirk Abel

Production in high-wage countries is subjected to a high cost pressure. Especially for the manufacturing of complex and expensive products, process monitoring and process control systems help to increase productivity and avoid scrap.Today, improvements in simulation technique enables computer based process set up and optimization. Hence, conducting costly and time consuming trials can be reduced. The quality and performance of the offline optimization strongly depends on the selected model and used database. Uncertainties in the real manufacturing process due to tool wear, deviating material properties cannot be taken into account

Self-optimizing cutting process using learning process models

Berend Denkena, Marc-Andre Dittrich, Florian Uhlich

This paper presents a method that uses a support vector machine to model cutting process data. With a numerical optimization of the obtained model, optimal process parameter can be determined, that minimize machining time and satisfy given boundary conditions. By modelling the process variance as well, the determined process parameters guarantee the process outcome within a freely selectable confidence interval. Through the complete automation of data capturing, data storing, modeling, optimizing and machining, a self-optimizing cutting process is achieved.

Hierarchical Scheduling for Plug-and-Produce

Jan Jatzkowski, Achim Rettberg, Peer Adelt

We aim at enabling Plug-and-Produce in CPS using hypervisor-based virtualization. This implies hierarchical scheduling of dependent real-time systems. Here, dependencies are given by precedence constraints of tasks. Based on an approach for detection of new components added to a real-time network, we focus on integration of enabled applications into the current schedule of a computation node. Here, enabled application refers to an application software that just got executable by plugging some component to the CPS. Applications are encapsulated by VMs and provide a self-description that is used to adjust global scheduling and thus include new functionality to the CPS.

Session 1.3: Systems Engineering

Chair: Cheng Yee Low, Universiti Teknologi MARA

Function-based feasibility study and benchmark for MID concepts

Christoph Jürgenhake, Tommy Falkowski, Christian Fechtelpeter, Roman Dumitrescu

Molded Interconnect Devices (MID) are three-dimensional structures with integrated electronic circuit traces that facilitate the miniaturization and functional integration of technical products. This opens up new possibilities for the conception and design of products but also comes with specific challenges. A systematic design approach is therefore necessary in order to successfully create a feasible product using MID technology. This paper presents the first part of a procedure that enables a systematic conception of MIDs and the associated manufacturing system while taking product functions into account, starting with a feasibility study for MID concepts.

The impact on organizational structures of model-based mechatronic system design

Andreas Kellner, Peter Hehenberger, Michael Friedl, Lukas Weingartner, Sandra Ringhofer

For an effective model-based mechatronic system engineering software tools are necessary which support collaboration between the involved disciplines. But it is not enough just to rollout a new tool in the company, in order to use all advantages, also the organizational structure has to be adjusted. This contribution discusses these influences on organizational structures and illustrates an analyzing method which can be performed before a rollout in order to give recommendations and hints for necessary changes. The method is shown on the industrial example of the rollout of the tool COMOS which is used for the design of sinter plants.

Model-based representation of protective measures as Solution Patterns

Daniel Kliewe, Harald Anacker, Roman Dumitrescu, Arthur Wegel

The mechanical engineering industry is undergoing a massive shift from classic mechanic-centered products to mechatronics. The push towards greater multichannel integration leads to new chances for intruders. For the effective protection of intelligent systems, suitable protection measures have to be found. Simultaneously the increasing complexity of the systems leads to the need for new methods to handle the complexity during the development process. Suitable measures for a preventive system protection have to be considered in the model-based systems design. The main goal is the seamless integration of the protection measures in modern methods for an interdisciplinary and holistic systems design.

Poster Presentation Session

Chair: Dirk Lehmhus, University of Bremen

An Approach to describe Gentelligent Components in their Life Cycle

Wieben Scheidel, Iryna Mozgova, Roland Lachmayer

In the Collaborate Research Center (CRC) 653 smart products, so called “Gentelligent Components in Their Lifecycle”, are developed, which recognize inherent information about themselves and from their life cycle. To structure and standardize these information a classification system is used. It has to consider aspects from the development, production and usage and life cycle. An approach to describe gentelligent components in their life cycle is developed. The resulted classification system is exemplified by a demonstrator. It shows how gentelligent components and their information can be structured and standardized, so a lossless exchange between different life cycle areas is possible.

Intelligent Production System Planning with Virtual Design Reviews

Daniel Köchling, Jan Berssenbrügge, Joel Schlüssler, Jörg Stöcklein

The conventional way of visualizing the material flow in a production system is to use simulation tools and their integrated symbols and pictograms. By going this way, a good relation to reality does not really exist. This paper introduces a procedure which enables a virtual design review of the planned process layout. As a result, the planning certainty and the system comprehension of all parties involved significantly increase, so that the presented procedure serves as a valuable decision support. This paper describes the steps to be taken from production-data to an optimized material flow verified in a virtual inspection.

A Support System for Sensor and Information Fusion System Design

Alexander Fritze, Uwe Mönks, Volker Lohweg

The complexity of industrial applications has constantly increased over the last decades. New paradigms arise in the context of the fourth industrial revolution by bringing together mechatronic systems and information technologies. Tasks like information processing, extensive networking, or system monitoring using sensor and information fusion systems are incorporated with the aim to design applications that are capable for self-configuration, -diagnosis, and -optimisation. This contribution focuses on the design of sensor and information fusion systems. A methodology for the design process of such systems is proposed that serves as tool for auto-configuration to facilitate self-diagnosis and -optimisation.

Direct Part Marking by Vibration Assisted Face Milling

Alexander Seibel, Thilo Grove, Berend Denkena

Direct part marking is a process to permanently mark parts with product information such as serial numbers, part numbers and barcodes. An advanced machining technology is presented, enabling the machining of Data Matrix Codes (DMC) and similar shapes into the components surface without any additional process step. The technology is based on a piezo-electrically driven milling tool. The dynamics of the tool enable a highly dynamic and controlled depth of cut variation during the cutting process. The technology is demonstrated on TiAl6V4. The machined result is evaluated on the machining quality of the data cells edges and the contrast.

Integrated ultrasonic driven balancer for ultra precision high speed machine tools

Eike Foremny, Christian Schenck, Bernd Kuhfuss

Ultra precision machining -in particular milling and drilling- is a flexible way to produce parts with optical surface quality. State of the art balancing of an ultra precision spindle is manually done and hence a time consuming and error prone procedure. In this paper a experimental model that evaluates the capability of an autonomous, in-spindle balancing system based on angular redistribution of masses is presented. The necessary torque is provided by a ring-shaped ultrasonic traveling wave motor. It is shown that the balance mass can be rotationally shifted with a resolution better than 0.05°, -fully adequate for ultra precision balancing.

Integration of humidity sensors into fibre-reinforced thermoplastic composites

Franziska Ebert, Nadin Reimann, Thomas Seider, Heike Illing-Günther, Klaus Nendel, Jörg Martin, Thomas Otto, Thomas Geßner, Daisy J. Nestler, Guntram Wagner

Due to the functional integration and weight reduction are lightweight structures more and more important, e. g. for automotive, boat or aircraft engineering. By integration of sensors in composites there give information about different mechanical stresses about errors, impacts of foreign objects and so on, further environmental conditions have a significant influence on the operation and the durability, e. g. temperature and humidity. Due to the importance of these variables, this contribution deals with the detection of moisture in composites. The developed foil-based humidity sensors was connected on foil tapes by means of stitching and integrated into fibre-reinforced thermoplastic composites.

A critical view on PLM/ALM convergence in practice and research

Andreas Deuter, Stefano Rizzo

The Internet of Things (IoT) is the main driver for industrial smart products which are a combination of hardware functions and software functions. For hardware there is PLM as lifecycle model, for software there is ALM as lifecycle model. Smart products force manufacturers to converge both lifecycle models step by step. Although seemingly important, the research community leaves this innovative area mostly up to the PLM tool vendors and the ALM tool vendors, resulting in them driving the convergence. This paper points out the mismatch between industry and academia regarding the PLM/ALM convergence. We encourage academia to increase research activities.

Stress Reduction in sputtered thin NiFe 81/19 layers for Magnetic Field Sensors

Lisa Jogschies, Johannes Rittinger, Daniel Klaas, Marc Christopher Wurz

Flexible magnetic field sensors using the anisotropic magnetoresistive effect that have been developed within the Collaborative Research Center 653 are to be transferred into industrial applications. Occurring challenges result from interactions between the flexible polyimide substrate and the functional layer namely a thin NiFe 81/19 film deposited by a DC sputter process. We have optimized the DC sputter process with regard to stress and roughness reduction.

Session 2.1: Intelligent Systems

Chair: Hans-Christian Möhring, IFQ / Otto-von-Guericke-University Magdeburg

Development of a humidity sensor element based on sputter-deposited thin ZnO-Layers

Daniel Klaas, Michael Rein, Marc Christopher Wurz, Lutz Rissing

A sensor concept for humidity measurement has been invented at the Institute of Micro Production Technology. The sensor element is manufactured on silicon oxide wafers with respect to the requirements of a new direct deposition process. This new process allows for thinner sensors with higher measuring accuracy. High purity 4N zinc oxide is used for the humidity sensing layer. Sensor properties and characteristics have been evaluated by using X-ray diffraction, scanning electron microscopy and atomic force microscopy. Finally, the evaluation electronic based on a field programmable gate array (FPGA) is presented and improvements are mentioned.

Microstructure and Magnetic Properties of Cobalt- and Zinc-Containing Magnesium Alloys

Christian Demminger, Christian Klose, Hans Jürgen Maier

The magnetic properties of lightweight alloys based on magnesium and cobalt offer a novel way to measure mechanical loads throughout the entire structural component using the magnetoelastic effect. Specifically, the cooling rate in the casting processes has a major influence on the resulting magnetic properties. In this study, Mg-Co-based alloys were produced by several casting methods which feature substantially different cooling rates, i. e. gravity sand casting, gravity die casting and high-pressure die casting. The differences between the manufactured alloys' micro- and phase structures are compared and the superior magnetic and mechanical properties of the high-pressure die cast material are demonstrated.

Embedded Electronic System based on Dedicated Hardware DSPs for Electronic Skin Implementation

Ali Ibrahim, Luca Noli, Paolo Gastaldo, Hussein Chible, Maurizio Valle

The effort to develop an electronic skin is highly motivated by many application domains namely robotics, biomedical, and replacement prosthetic devices. Our goal is the development of a dedicated embedded electronic system for electronic skin. This paper presents an embedded electronic system based on dedicated hardware implementation for electronic skin systems. It provides a Tensorial kernel function implementation for machine learning based on Tensorial kernel approach. Results assess the time latency and the hardware complexity for real time functionality. The implementation results highlight the high amount of power consumption needed for the input touch modalities classification task.

Session 2.2: The Future of Manufacturing

Chair: Daniel Köchling, Heinz Nixdorf Institute, Paderborn University

Production Monitoring based on Sensing Clamping Elements

Berend Denkena, Dominik Dahlmann, Johann Kiesner, Markus Mücke

Clamping errors in workpiece positioning decrease the production outcome of machine tools. An automated monitoring of these failures does not take place in practice, due to limited installation space for the sensor integration. Within the CRC 653, the IFW develops and investigates a condition and process monitoring system based on sensing clamping elements. Measureable quantities are hydraulic pressure, the clamping stroke and the process forces. This article describes the prototypical realization and shows its usability in condition and process monitoring. Experimental results from measurements during milling and the comparison with a dynamometer demonstrate the performance of the sensory clamping system.

Novel Design Concept of an Optoelectronic Integrated RF Communication Module

Quang Huy Dao, Alexandra Skubacz-Feucht, Bernard Lüers, Philipp von Witzendorff, Ludger Overmeyer, Bernd Geck

This contribution presents a novel design concept of a miniaturized 24 GHz radio frequency communication module suitable to be integrated in any metallic workpieces. The integration of optical and electrical components and the scope of functions of the communication unit are discussed. The development of a radio frequency circuit and the realization of through glass vias are some main aspects. The central control unit is an ultra-low power microcontroller capable of a flexible connection of sensors. By using an energy harvesting concept consisting of a solar cell different lighting conditions are investigated concerning the available power of the unit.

Enabling of Component Identification by High Speed Measuring of Grinding Wheel Topography

Bernd Breidenstein, Berend Denkena, Thilo Grove, Rolf Hockauf

However, this method needs the measuring of every single ground surface, which means a huge expenditure of time in the production chain. If it were possible to predict the grinding surface of the grinding tool precisely, occasional measurements of the grinding tool during the setup time would be sufficient to assign the right tool to the component's surface and the manufacturer behind it. The presented paper is focusing on methods for the determination of the topography of grinding tools. These topographies enable the manufacturer to predict and thus identify the surface of components.

Session 2.3: it's OWL – Systems Engineering

Chair: Roman Dumitrescu, Fraunhofer IEM

Approach for an Integrated Model-Based Design of Intelligent Dynamic Systems Using Solution and System Knowledge

Felix Oestersötebier, Farisoroosh Abrishamchian, Christopher Lankeit, Viktor Just, Ansgar Trächtler

In the design process of intelligent technical systems, simultaneous and concurrent engineering is generally encouraged on the one hand, while on the other hand cooperation and coordination of the involved disciplines is required. In multidisciplinary system development, 1) a common understanding of the objective is of vital importance for the system's success and 2) the combined artifacts of the different disciplines need to be analyzed before the system is built. We address these issues and present an approach for an integrated model-based design process, which facilitates the use of solution and system knowledge and reduces the huge effort for building and maintaining the required simulation models.

Towards the continuous development of mechatronic systems based on flexible STEP extensions and feature modeling

Thorsten Koch, Jörg Holtmann, David Schubert, Timo Lindemann

Today's technical products are characterized by high customer expectations regarding the product individualization. OEMs can apply classical approaches from product line engineering, like feature modeling, to cope with the variability and the induced development complexity. Furthermore, OEMs have to arrange product parts based on geometric assembly constraints. However, customers cannot configure and virtually layout a product variant in the same software tool since the respective information stems from different sources. In this paper, we present an extension of our tool support for feature models and outline our research roadmap to consider geometric assembly constraints in an e-commerce system.

Modular Inspection Equipment Design for Modular Structured Mechatronic Products – Model Based Systems Engineering Approach for an Integrative Product and Production System Development

Meinolf Lukei, Bassem Hassan, Roman Dumitrescu, Thorsten Sigges, Viktor Derksen

Quality control is an essential part of the production of modular mechatronic systems. In order to have the needed inspection equipment ready by the SoP and to consider additional requirements to the product, which are produced by the inspection equipment concept, an integrative mechatronic product and inspection equipment development procedure is needed. Furthermore, the inspection system has to consider the modularity of the system and often has to be designed in a modular way. The inspection equipment should also be designed with the help of MBSE. This paper describes an integrative procedure for modular mechatronic systems with the help of MBSE.

Poster Presentation Session

Chair: Daniel Klaas, Leibniz Universitaet Hannover

Exhaustiveness of Systems Structures in Model-Based Systems Engineering for Mechatronic Systems

Lydia Kaiser, Christian Bremer, Roman Dumitrescu

The increasing complexity of mechatronic systems results in a challenging development process. In an interdisciplinary design environment, the communication and cooperation between the disciplines is necessary to establish a basis for efficient and effective product development. The approach of MBSE focuses on this aspect by means of an abstract description of the system structure. The system structure is created and read by different persons. It is crucial that these semi-formal models, considered by very different stakeholders, are build up comparably. We classified model elements and derived modeling guidelines enabling the model-user to create comparable system structures.

Design and Development of Product Service Systems (PSS) – Impact on Product Lifecycle Perspective

Thorsten Wuest, Stefan Wellsandt

With the changing business models of PSS, away from a one-time sale towards a constant delivery of customer satisfaction and value, the whole lifecycle of a PSS is becoming increasingly important. A similar development can also be observed for 'traditional' products/services. However, for PSS this holistic emphasis can be considered a key factor for success. The changing requirements and needs brought forth by PSS and their impact on 'traditional' PLM models are discussed. An emphasis is on the three-phase model and its presentation, which is often used to illustrate the product lifecycle from a technical and IT perspective.

Conditioning of Surface Energy and Spray Application of Optical Waveguides for Integrated Intelligent Systems

Gerd-Albert Hoffmann, Thomas Reitberger, Jörg Franke, Ludger Overmeyer

Optical waveguides are the essential backbone to connect optical bus systems. Their flexible and high-resolution manufacturing, also on three-dimensional substrates, will be accomplished by a combination of two printing processes. In the first step, flexible substrates are conditioned by a printing technology with an adapted flexographic printing mechanism. To produce the optical waveguide itself, the Aerosol-Jet-Printing process of liquid polymer or varnish is used on pre-conditioned areas with hydrophobic or hydrophilic behaviour. This paper shows the mechanism for the use of the process and latest results concerning the printing technologies to achieve a self-assembly of UV-varnishes for high-resolution waveguides.

Thermofluid-Acoustic Analysis of a Ranque-Hilsch Vortex Tube

Wirachman Wisnoe, Khairil Muhaimin Abd Rahman, Yusman Istihat, Valliyappan David Natarajan

This paper aims to present analysis of sound produced from a Ranque-Hilsch Vortex Tube. A microphone was used to record the sound produced close to the hot tube. It is observed that, for one configuration of RHVT, the sound produced contains a specific set of frequencies. When the inlet pressure is varied, these frequencies remain almost the same, however, the magnitude changes. The RHVT produces different set of frequencies when using different swirl generator. These sets of frequencies-magnitudes represent signatures for each configuration. Different swirl generator nozzles were tested and presented. Frequency signatures with their related thermofluid performance are obtained.

A novel approach using model predictive control to enhance the range of electric vehicles

Julian Eckstein, Christopher Lüke, Frederik Brunstein, Patrick Friedel, Ulrich Köhler, Ansgar Trächtler

The energy consumption of comfort components influences the range of electric vehicles significantly. Thus, intelligent power distribution is required. In this contribution a piece-wise linear model predictive controller is proposed which influences the heating ventilation and air-conditioning. Predictive route data is used to identify high power demands in the drivetrain. The controller ensures a defined comfort level while reducing the power loss of the traction battery. To enable real-time capability a sophisticated driver cabin model is linearized and used in a bilinear optimization. The control performance is evaluated in detail and conclusions are drawn for further development.

Investigation on aging of metallic surface integrated micro-POFs

Bechir Hachicha, Ludger Overmeyer

Surface integrated optical waveguides present a possibility to realize inherent communication structures. Optical communication is especially used by smart parts exposed to humidity, high vibration or electromagnetic fields. We developed a method to integrate micro-polymer optical fibers (µ-POFs) into metallic surfaces using the dispensing process. After positioning, the mu-POFs are bonded to the surface by dispensing UV-curing adhesives. We investigated the possible influence of this aging on the position accuracy of bonded µ-POFs, and consequently to optical communication efficiency. The experimental set-up as well as the realized measurements are presented and discussed in this article.

Computational modeling of the effect of different temperature and membrane thickness on Faraday efficiency in PEM electrolyzer

Alhassan Salami Tijani, Abdul Hadi Abdol Rahim

In PEM water electrolysis, extensive mixing of the product gases due to gas crossover could lead to efficiency losses due to reduced Faraday efficiency. In this study, the effect of different temperatures, pressures and membrane thicknesses on the performance of a PEM electrolyzer have been carried out. The effect of membrane thickness on voltage was not apparent at lower current density but it increases from current density of 0.2 A/cm^2. On the other hand, Faraday efficiency increases as the current density increase. Faraday efficiency decreases with decrease in membrane thickness at 0.2 A/cm^2 current density and membrane thickness of 150 µm.

Tuesday, June 14th 2016

Keynote Session

Chair: Berend Denkena, Leibniz Universität Hannover

Gentelligence or Industrie 4.0 – Technical inheritance within the whole product lifecycle

Berend Denkena

The last 250 years of technological development in manufacturing have been driven by innovative ideas and have been characterized by a continuous increase of performance. Important milestones of this development were the mechanization of production, the assembly line production and the automated production. The upcoming fourth industrial revolution is ignited by the demand for highly adaptable and connected process chains which are able to produce individualized products in an efficient, reliable and sustainable manner. The DFG funded Collaborative Research Center 653 has been pursuing the idea of sensitive and communicating products since its start in 2005. CRC 653 has realized this vision with the development of integrated sensors, on-demand maintenance and design evolution of products. In addition, material inherent information storage and technologies to deploy the gained information for process planning were focused in this research. An essential part of the realization was the concept of technical inheritance that enables following product generations to adapt to dynamically changing environments and changing requirements. While the vision of the CRC 653 tackles demands like adaptable and meshed process chains, which are also in the focus of the developments within the field of Industrie 4.0, it embraces additional aspects. Industrie 4.0 focuses on the production phase while the CRC considers the entire product life cycle including utilization. The presentation illustrates the relationship between Industrie 4.0 and technical inheritance by means of various applications.

The Challenge of Ubiquitous Sensing: Is More Always Better?

Gregory O'Hare

Ubiquitous sensing demands an ability to effectively sense, route, conflate and utilise an ever increasing and ever diverse sources of streamed data. This presentation will describe attempts to provide the necessary infrastructure to support such an eclectic mix of data sources ranging from physical sensors to social media streams to participatory sensed data. The middleware infrastructure must be agnostic of data source and must treat all such sources as equal. In fusing such data this is often performed in the spatio-temporal domain with proximate data being used to reinforce or uplift the quality of individual data streams. This talk will consider the effect of vast volumes of data and how to ensure that low quality/low fidelity data does not in effect compromise the overall integrity of the data corpus. It will reflect on the paradox of is more data always better? It will examine how one might introduce a data quality quotient to mixed source mixed quality data mash ups.

Material-integrated Intelligence for Robot Autonomy

Nikolaus Correll

Advances in miniature electronics, distributed algorithms and manufacturing technology have enabled a new generation of smart composites that tightly integrate sensing, actuation, computation and communication. Such "robotic materials" are inspired by multi-functional natural structures such as the skin of the cuttlefish that can change its color and patterning, bird wings that can change their shape, or the human skin that provides tactile sensing at high dynamic range. I will describe a series of recent results that best illustrate the benefits of material integrated computation: high-bandwidth sensing for texture recognition and localization in artificial skins, distributed optimization for controlling shape change, distributed classification for recognizing gestures drawn onto a modular facade, and feedback control of soft robotic actuators. I will then describe current challenges in robotic grasping and manipulation, and demonstrate how robotic materials can provide critical sensing and control during a series of manipulation tasks with applications to warehouse automation, manufacturing and lab automation.

Session 3.1: Intelligent Systems

Chair: Thorsten Wuest, West Virginia University

Numerical Investigation for the Design of a Hot Forging Die with Integrated Cooling Channels

Bernd-Arno Behrens, Anas Bouguecha, Milan Vucetic, Martin Bonhage, Irfan Yousaf Malik

Ongoing research at the Institute of Forming Technology and Machines (IFUM) within the scope of subproject E3 of the Collaborative Research Centre 653 deals with the generation of controlled cavities inside a sintered hot forging die. The current project stage aims at developing a hot forging die with integrated cooling channels. This paper presents the findings of numerical investigations carried out to analyze the hot forging die made of tool steel powder and equipped with internal cooling channels. Two different geometric variations have been numerically investigated in order to study the stress states within the die under process boundary conditions.

Non-destructive evaluation of integrated piezoelectric transducers by thermal waves and thermal pulses

Agnes Eydam, Gunnar Suchaneck, Gerald Gerlach

In this work, we apply the thermal wave method and the thermal pulse method for non-destructive evaluation of the polarization state of piezoelectric transducers. The pyroelectric response of the transducer is analyzed after heating it by a modulated laser beam or laser pulses. We demonstrate that the Fourier transform of the pulse response of a piezoceramic plate is equal to the frequency response. The time domain signal is determined at several bandwidths of the amplifier. Frequency spectra are derived by a discrete Fourier transform and divided by the transfer function of the measurement set-up.

Mechanical and electrical contacting of electronic components on textiles by 3D printing

Nils Grimmelsmann, Yasmin Martens, Patricia Schäl, Hubert Meissner, Andrea Ehrmann

Integrating electronic components in textiles still suffers from incompatibilities between soft, flexible, bendable textile fabrics and rigid electronic parts. Connecting conductive yarns with electronic components often cannot be performed by soldering nor by sewing. A new possibility to achieve such electrical and mechanical connections is given by 3D printing. We have studied chances and limitations of electric circuits combining textile fabrics with 3D printing. The talk will give an overview of possibilities and problems in electrical contacting of small electronic components on partly conductive textiles by conductive 3D printed connections. An outlook to other potential areas of application is given.

Session 3.2: The Future of Manufacturing

Chair: Marc Christopher Wurz, Leibniz Universität Hannover

Vertical Integration and Service Orchestration for Modular Production Systems using Business Process Models

Sebastian Wrede, Oliver Beyer, Christoph Dreyer, Michael Wojtynek, Jochen Steil

Individualized production challenges established manufacturing approaches in terms of modularization, flexibility and efficient reconfiguration. This contribution introduces an approach for flexible manufacturing comprised of reconfigurable production cells, which can be composed into production lines. Reconfigurability is achieved through exchangeable process components, the use of lightweight robots as versatile handling subsystems as well as a control scheme based on executable business process models to allow runtime service orchestration. The systemic approach can be applied to realize a customer specific production down to lot size one and was validated in a vertically integrated production line manufacturing an industrial product with high variability.

Perspective on the design of a decision support system based on Linked Data for process planning

Gerald Rehage, Robert Joppen, Jürgen Gausemeier

In simple terms, the Web of Linked Data is a distributed database with semantic facts about the world or any specific domain. However, it is not possible to use Linked Data from different publishers directly in a knowledge base. This paper presents the procedure model and architecture of a DSS based on Linked Data. The purpose is to overcome the high effort for maintaining the underlying fact base of these systems.

Characterization of Cluster Structures in Material Flow Networks: A Network Approach

Darja Wagner, Till Becker

Current manufacturing systems are subjected to a high level of dynamics due to shorter product lifecycles and increasing customer requirements. Therefore, present production planning and control is required to react quickly and flexibly to this increasing dynamics. Modern ICT merges with logistics systems and thus drives the transition from centralized to decentralized production control. For this purpose, it is promising to pool several workstations to clusters, so that decision making takes place inside the clusters. The aim of this paper is the structural characterization of clusters of material flow networks to support the introduction of decentralized control.

Session 3.3: Structural Health Monitoring

Chair: Iryna Mozgova, Leibniz Universität Hannover

Classification and simulation method for piezoelectric PVDF sensors

Klaas Hauke Baumgärtel, Daniel Zöllner, Karl-Ludwig Krieger

Piezoelectric PVDF holds the potential to be the core material of novel structure-borne sound sensors not only in research but also in industrial applications. This paper will give an overview of possibilities when PVDF is useful and when PVDF reaches its limits of applicability. To do so, a state of the art about current applications of PVDF will be given. Furthermore, the consecutive equations and an experimental setup for the classification of the piezoelectric constants and Young's moduli over frequency and temperature will be presented. A simplified FE simulation method will also be shown to model PVDF film sensors by computer aided design.

Structural Monitoring with Distributed-Regional and Event-based NN-Decision Tree Learning using Mobile Multi-Agent Systems and common JavaScript platforms

Stefan Bosse

Agent-based processing is deployed in Structural Monitoring (SM) of mechanical structures, suitable for ubiquitous SM systems by using self-organizing mobile multi-agent systems (MAS), executed on a highly portable JavaScript-based Agent Processing Platform (APP). Novel distributed-regional on-line learning is applied and performed by the agent system providing load class recognition from a set of sensors. The APP provides ML as a service. A case study shows the suitability, efficiency, and stability of the proposed learning algorithm for noisy and time-varying sensor data. Spatial global learning is reduced and mapped on local region learning with global voting.

Fabrication and Sensing Applications of Multilayer Polymer Optical Waveguides

Maher Rezem, Axel Günther, Maik Rahlves, Bernhard Roth, Eduard Reithmeier

For sensing applications in structural health monitoring, process technology or life sciences polymer micro-optical sensors are highly promising as they offer several advantages in comparison to other sensor types. In this work, a fabrication process of low-cost planar polymer optical waveguides based on hot embossing and doctor blading is presented. Such waveguides represent one of the main building blocks of micro-optical systems. The refractive index and propagation losses of several waveguide materials are characterized. In order to increase the integration density of optical components, the fabrication of multilayer waveguides is investigated. Finally, potential applications of the fabricated waveguides are outlined.

Session 4.1: Intelligent Systems

Chair: Tim Tiedemann, DFKI

Flexible Magnetic Reading/Writing System: Heat-Assisted Magnetic Recording

Piriya Taptimthong, Jan Friedrich Düsing, Lutz Rissing, Marc Christopher Wurz

Comparing with other storage technologies like labels, RFID tags and engraving, the inherent magnetic storage is rewritable and resistant to weathering. High temperature and a high magnetic field, however, can degrade or even delete magnetically stored data. This limitation can be coped with using a medium with higher coercivity. However, a higher write field is required to magnetize the medium. To solve this problem, a heat-assisted magnetic recording (HAMR) is proposed as a means to temporarily reduce coercivity during writing. A realization of a HAMR module and an experiment as well as its positive results are presented in this work.

The Concept of Technical Inheritance in Operation: Analysis of the Information Flow in the Life Cycle of Smart Products

Christian Demminger, Iryna Mozgova, Melissa Quirico, Florian Uhlich, Berend Denkena, Roland Lachmayer, Peter Nyhuis

This work continues a series of publications regarding the development of the concept of Technical Inheritance. Here, the process of Technical Inheritance is applied to improve gentelligent components. This was realized according to the biological principle to transfer hereditary information on the basis of evolutionary mechanisms and variations of the information transfer. At the example of a load-sensitive magnesium wheel carrier of the racing car RP09 this approach is demonstrated: the information flows over the life cycle are analyzed, the concept of Technical Inheritance applied and its advantages discussed.

Towards part lifetime traceability using machined Quick Response codes

Carlos Eiji Hirata Ventura, Rafael Vidal Aroca, Armando Ítalo Sette Antonialli, Alexandre Mendes Abrão, Juan Carlos Campos Rubio, Marcelo Araújo Câmara

The manufacturing industry has made several efforts aimed at better monitoring of products life-cycle through markings added during their manufacturing. Such monitoring is becoming relevant, in order to provide product traceability and other associated services. Thus, low-cost and flexible technologies able to carry data of a product play an important role. The advantages of using Quick Response (QR) codes motivate the use of this technology in several applications. Aiming to engrave this kind of code in metallic parts, this work discusses challenges in machining codes with different sizes and materials, as well as reading them.

Session 4.2: it's OWL – Self Optimization

Chair: Christian Henke, Fraunhofer IEM

A comparison of two predictive approaches to control the longitudinal dynamics of electric vehicles

Julian Eckstein, Sebastian Peitz, Kai Schäfer, Patrick Friedel, Ulrich Köhler, Mirko Hessel-von Molo, Sina Ober-Blöbaum, Michael Dellnitz

In this contribution we compare two different approaches to the implementation of a Model Predictive Controller in an electric vehicle with respect to the quality of the solution and real-time applicability. The goal is to develop an intelligent cruise control in order to extend the vehicle range, i. e. to minimize energy consumption, by computing the optimal torque profile for a given track. On the one hand, a path-based linear model with strong simplifications regarding the vehicle dynamics is used. On the other hand, a nonlinear model is employed in which the dynamics of the mechanical and electrical subsystem are modeled.

Design and Implementation of Intelligent Control Software for a Dough Kneader

Felix Oestersötebier, Phillip Traphöner, Felix Reinhart, Sebastian Wessels, Ansgar Trächtler

In traditional dough kneading machines the ingredients are filled into a cylindrical vessel and mixed by means of a rotating spiral. In order to assure consistent dough quality while environmental conditions and flour characteristics vary, an experienced baker needs to 1) manually set the rotational speed as well as the time for kneading and 2) continuously monitor the kneading process. The overall goal of this work is to develop an intelligent kneading machine that autonomously decides. We describe the design of intelligent information processing algorithms that were implemented in a technology demonstrator and validated with the expertise of professional bakers.

Multiobjective Model Predictive Control of an Industrial Laundry

Sebastian Peitz, Manuel Gräler, Christian Henke, Mirko Hessel-von Molo, Michael Dellnitz, Ansgar Trächtler

In a wide range of applications, it is desirable to optimally control a system with respect to conflicting objectives. Hence, instead of computing a single optimal solution, the set of optimal compromises has to be approximated. When it is not possible to compute the entire control trajectory in advance, model predictive control methods can be applied to control the system during operation in real-time. In this article, we present an algorithm for the solution of multiobjective model predictive control problems which can be applied in online or offline situations. The results are illustrated using the example of an industrial laundry.

Session 4.3: Structural Health Monitoring

Chair: Maik Rahlves, Leibniz University Hannover

Fibre optic sensors for the structural health monitoring of building structures

Kort Bremer, Frank Weigand, Michael Kuhne, Merve Wollweber, Reinhard Helbig, Maik Rahlves, Bernhard Roth

In this work different fibre optic sensors for the structural health monitoring of civil engineering structures are reported. A fibre optic crack sensor and two different fibre optic moisture sensors have been designed to detect the moisture ingress in concrete based building structures. Moreover, the degeneration of the mechanical properties of optical glass fibre sensors and hence their long-term stability and reliability due to the mechanical and chemical impact of the concrete environment is discussed as well as the advantage of applying a fibre optic sensor system for the structural health monitoring of sewerage tunnels is demonstrated.

A planar low-cost full-polymer optical humidity sensor

Christian Kelb, Martin Körner, Oswald Prucker, Jürgen Rühe, Eduard Reithmeier, Bernhard Roth

We present an all-polymer optical humidity sensor, based on a 1 mm plastic optical fiber (POF) with a U-bend, cladded with poly (N, N-dimethylacrylamide) (PDMAA) in the sensing region. The cladding changes its scattering properties on absorption of environmental humidity, thus modulating the transmitted optical power through the sensor. We explain the working principle of the sensor and show experimental results regarding scattering behavior of the cladding material and sensitivity to sudden humidity changes. We also propose a planar layout suitable for application to a hot embossing or lamination process for large-scale fabrication.

Inherent load measurement and component identification by multi-dimensional coded data in the component's subsurface region

Sebastian Barton, Gregor Mroz, Wilfried Reimche, Hans Jürgen Maier

In industrial production, the absence of component markings and unrecognized component failure can result in a lack of protection against product piracy and malfunctions of machinery and installations. A technique for storing data inherently in the subsurface region of the component was developed. Inherently stored data is highly resistant to external stresses and inseparably linked to the component. To evaluate the integrity of highly stressed components, material inherent sensors are induced in the subsurface region of the component to store the loading history. These techniques offer the potential for securely identifying and evaluating the status of components, and thus reducing failure costs.

Session 5.1: Intelligent Systems

Chair: Viktor Just, Heinz Nixdorf Institute, Paderborn University

Disturbance observer design for utilizing of time-delayed vision measurements in high dynamical Systems

Shuo Wang, Viktor Just, Ansgar Trächtler

The utilization of vision information for control in intelligent technical applications with high dynamics has been a central issue. The main obstacles are the low sampling rate of the cameras compared to the required sampling rate of the high dynamic applications and the time-delayed measurements due to the image processing. A model-based Event-Triggered Observer (ETO) has been proposed for linear systems to observe and predict the continuous undelayed state variables of the system from the sampled and delayed measurements. This ETO will be extended with an integrated disturbance model, to enhance the performance of the state estimation under disturbances and measurements noises.

Model-based method for the accuracy analysis of Hardware-in-the-Loop test rigs for mechatronic vehicle axles

Simon Olma, Phillip Traphöner, Andreas Kohlstedt, Karl-Peter Jäker, Ansgar Trächtler

This paper presents a model-based method to analyze the accuracy of Hardware-in-the-Loop (HiL) test rigs for mechatronic vehicle axles. In the first part of the method, the general HiL system structure is investigated and appropriate assessment criteria are defined. Subsequently, dynamic models of all subsystems are developed. The analysis itself is performed in two steps. Firstly, the individual subsystems are investigated. Secondly, the entire closed-loop system is analyzed according to the emulation fidelity to a reference system. The developed method is validated by its application to a HiL test rig for mechatronic vehicle axles.

Closed-loop Process Control for Laser Patterning of Thin Film Strain Sensors

Jan Friedrich Düsing, Jürgen Koch, Oliver Suttmann, Ludger Overmeyer

Thin film strain sensors are used in measurement tasks which require large temperature operating ranges or long operating periods without re-calibration. Using ultrashort pulsed laser beams the sensor bridge circuits can be patterned by direct laser ablation of the sensorial layers. However, additional bridge trimming is required in order to reduce bridge offsets. In this work we present a process control strategy which allows for automated bridge balancing during the structuring process. The process allows for high throughput during the manufacturing of integrated thin film strain sensors on the surface of mechanical components for monitoring or machine control applications.

Session 5.2: Pervasive Computing

Chair: Stefan Bosse, University of Bremen

Distributed Execution of Scenario-Based Specifications of Structurally Dynamic Cyber-Physical Systems

Joel Greenyer, Daniel Gritzner, Guy Katz, Assaf Marron, Nils Glade, Timo Gutjahr, Florian König

Cyber-physical systems are found in many areas, e. g., manufacturing or smart cities. They consist of multiple components that cooperate to provide the desired functionality. This need for cooperation causes complex interactions between components, which makes developing cyber-physical systems difficult, especially systems whose component structure changes dynamically at runtime. We have created a formal, scenario-based specification method which makes it easier to develop distributed cyber-physical systems. We previously presented an approach for the distributed execution of such specifications based on naive and inefficient broadcasting. In this paper we propose a more efficient approach which uses the available network resources more economically.

Condition Monitoring and Cloud-based Energy Analysis for Autonomous Mobile Manipulation – Smart Factory Concept with LUHbots

Jan Friederichs, Tobias Ortmaier, Jens Kotlarski, Daniel Kaczor, Fabian Schulz, Malte Pabst, Torben Carstensen, Jan Carstensen

In this paper, a smart factory concept for autonomous mobile robots is presented. The main purpose is to increase productivity. It is based on advanced methods for failure handling and prevention, leading to increased robustness, less downtime and lower maintenance. Here, the results for mobile manipulation in industrial scenarios in our lab during preparation for the RoboCup@Work 2016 will be presented. The transfer of raw measurement data to the hub is shown, as well as the proposed algorithms for allowing range prediction and optimized set point generation. The concept provides superior data collection, analysis of existing production and production planning.

An Automotive Distributed Mobile Sensor Data Collection with Machine Learning Based Data Fusion and Analysis on a Central Backend System

Tim Tiedemann, Christian Backe, Thomas Vögele, Peter Conradi

One example for ubiquitous computing is automotion. Vehicles and traffic infrastructure use many sensors and computing devices – but for fixed purposes. E. g., compensating for a broken sensor is not possible. The objective of the collaborative research project Smart Adaptive Data Aggregation (SADA) is linking data from on-board sensors with data from unknown stationary or mobile sensors (e. g., smartphones), including dynamic data fusion. One component is a backend system that uses machine learning and crowd sensing to generate new information (“virtual sensors”).The article gives an overview of SADA and describesn in more detail the concept of the backend system and the user interface.

Session 5.3: Systems Engineering

Chair: Shahruddin Mahzan, Universiti Tun Hussein Onn Malaysia

Automated control system generation out of the virtual machine

Stefan Scheifele, Alexander Verl

To drastically reduce the commissioning time of a machine tool innovative companies rely more and more on the possibilities of virtual commissioning – commissioning of real controls on virtual machines and plants in order to improve the accuracy and robustness of acting programs. These virtual machines and plants require data defining their behavior and appearance.

A Tool Chain for Model-Based Development of Heat Pump Dryers

Marcos Bockholt, Michael Katter, Georg Pohl, Jan Michael, Thomas Alpögger

This work describes a tool chain structured and synchronised in the actual development process for development of environment friendly heat pump tumble dryers for a sustainable model-based systems engineering. The challenge, the benefit and the success of a hardware-in-the-loop (HiL) test bench is presented as an example to demonstrate the sustainability of the tool chain.

ModelTracer: User-friendly Traceability for the Development of Mechatronic Products

Atakan Sünnetcioglu, Elisabeth Brandenburg, Uwe Rothenburg, Rainer Stark

The development of complex mechatronic systems demands an integration of models throughout the virtual product development process. Systems engineering is an approach for enabling the development of successful interdisciplinary products. Traceability, one of the most important aspects of systems engineering, is a method for explicit documentation of logical relationships between development artifacts. In this paper we present a prototype traceability tool, ModelTracer, which aims to reduce the cognitive effort for the creation and maintenance of traceability models in systems engineering.

Wednesday, June 15th 2016

Keynote Session

Chair: Michael Freitag, University of Bremen

Prospects for Intralogistics through Industrie 4.0

Michael Freitag

This keynote talk will present prospects and first solutions for intralogistics, which were enabled by Industrie 4.0 technologies. These solutions increase the operational safety of floor conveyors, enable a more efficient material supply in job shops, and support a highly flexible material flow by a reconfigurable conveyor system. To increase operational safety of floor conveyors, there are two general approaches: First, installing sensors into the environment and let them monitor the movements of the floor conveyors. Second, installing sensors onto the floor conveyors and let them monitor their local environment. The first approach was used to develop a centralized assistance system for forklift trucks based on infrared technology that enables a combination of collision avoidance and intelligent routing. The second approach was used to apply 2D/3D image processing methods to a local assistance system at a forklift truck. This assistance system notifies the driver of potential hazards. To enable a more efficient material supply in job shops, a demand-driven concept will be presented. The demand at the machines is communicated to the tugger train. The future demand can be forecasted by considering the remaining processing time of the part in the machine and the total processing time of the next part which already waits in the input buffer. The availability of data and the communication between machines, buffers, and tugger trains lead to less train trips and a higher train utilization. To support a highly flexible material flow, a cellular conveyor system, called “Celluveyor“, will be presented. The system consists of numerous hexagonal modules each with three omnidirectional wheels. The arrangement of the wheels and the independent activation of their motors enable the movement of objects on any desirable path. This system is able to accomplish logistics tasks such as moving, segregating and reuniting, changing the transport direction and orientation, or clustering of packing units. The modular system can be reconfigured to get any desirable surface. The single modules are controlled in a semi-decentralized way. The presented systems show how Industrie 4.0 technologies can improve safety, efficiency, and flexibility of intralogistic processes and consequently save costs.

Digital Transformation – Challenges for the Manufacturing Industry

Ulrich Ahle

Digital Transformation is on the agenda of decision makers from companies and organizations all over the world. For manufacturing companies Industrie 4.0 is the approach to leverage the opportunities of Digital Transformation. There are different definitions of Industrie 4.0 in place depending on the point of view of the different stake holders in the market. Digital Transformation will be highly disruptive to most industries, affecting not only revenue and cost structures but also shaking up the core business and operating models. This will be true for nearly all different industries as Digital will be cheaper, stronger and faster. There is no time to wait bud to identify the right approach and strategy for every single organization or company be it from public, finance or manufacturing. The market situation has changed dramatically. From 1973 to 1983 35% new companies came into the F1000. From 2003 to 2013 there have been 70% new. We are in the “age of the customer” – empowered buyers demand a new level of customer obses-

sion (Forrester). One of the main technology enabler is connectivity – “always connected” is the trigger. Beside the question – how to do the business, better and more efficient processes – we have to ask the question – which business will I do tomorrow? While todays production is linearly organized and optimized within the boundaries of organizational and system siloes manufacturing of the future will fulfill individual customer needs by a collaborative and agile network of capabilities. All these different elements of the network have to be connected and need to be able to communicate to each other. Industrie 4.0 will provide this connectivity and the required standardization. Although this is definitely a future scenario it will be a major change for a lot of manufacturing companies. The presentation will describe how the above mentioned changes can be realized in Manufacturing companies. At the same time use cases will be shown and it will be explained which elements of Industrie 4.0 can already be realized today. Finally it will be presented how companies can be enabled to create their own Industrie 4.0 strategy.

Natural Fibre Reinforced Composite and Structural Health Monitoring: Possible or Feasible

Shahruddin Mahzan

The emergence of various natural fibres as potential replacement for synthetic fibre has attracted various development and application. However, the issues of natural fibre reinforced composites is always on the mechanical strength and impact damage prone. Recently, structural health monitoring (SHM) has become popular due to its capability to integrate sensor fusion and its characteristics. The adaptability of SHM techniques toward natural fibre composites is investigated. The challenges and issues on implementation of SHM for natural fibre composite are also explored. This talk will discuss on the feasibility study and possibility on SHM implementation for the betterment of composite applications. Therefore a better understanding on feature extraction and selection, as well sensor optimisation can be achieved. Hence, a proper architectural algorithm can be derived in order to establish a good representation of actual condition.

Session 6.1: Intelligent Systems

Chair: Sven Zimmermann, Technische Universität Chemnitz

Sensor Integrated CFRP Structures for Intelligent Fixtures

Hans-Christian Möhring, Petra Wiederkehr, Christoph Lerez, Holger Schmitz, Harald Goldau, Charis Czichy

In milling of impellers and blisks, workpiece vibrations of the blades occur due to the excitation by the process and the dynamic compliance of the elements. Workpiece vibrations lead to inacceptable surface waviness and chatter marks and provoke increased tool wear. Within the European project INTEFIX, fixture solutions are developed which enable the detection and compensation of chatter vibrations during machining of thin walled workpieces. This contribution introduces the integration and application of piezo patch transducers which are embedded in CFRP components. The sensory CFRP sub-structure is located directly at the workpiece and pre-stressed by the clamping. Basic tests show the functionality and performance of the sensor system.

Sensory workpieces for process monitoring – an approach

Berend Denkena, Dominik Dahlmann, Haythem Boujnah, Markus Mücke

Workpieces represent the origin of forces and heats and offer a “higher quality” information source for mechanical and especially thermal process loads. The development of sensory workpieces allows novel process monitoring strategies. It leads, however, to challenges concerning sensor placement, energy and data transmission. This paper focuses on the vision and the actual developments of sensory workpieces for milling operations. The technical challenges and concepts to meet the requirements are presented. An approach for sensor placement in workpieces to detect mechanical loads while machining, is discussed. The design of signal devices and the data communication for process monitoring tasks are presented.

Development of a combined measurement system for torque and angular position

Tobias Menke, Claudia Unger, Anan Dai, David Kramer, Björn Eilert, Georg Ullmann, Ludger Overmeyer

In this article a combined contactless measurement method is presented which is based on angle differences. The aim is the development of a combined, optical measurement system to determine the angular position of a shaft and the applied torque on it as well as an appropriate production technology to apply markings. To ensure a simple integration of the system into any application, position markings are directly applied on the shaft using a laser. The selected technological approach is based on a contactless measurement method using angle differences. The concept as well as first research results are presented.

Condition monitoring of piezoceramic fibers during joining by forming

Welf-Guntram Drossel, Volker Wittstock, Sebastian Hensel, Marek Max Schmidt

New research activities enable a novel process chain for sensor integration in which piezoceramic fibers are integrated directly into the surface of metal sheets using joining by forming. Scope of the paper is to investigate a method for condition monitoring of the piezoceramic fibers during the joining process. Different test samples are prepared and studied by its inherent sensor function in terms of electrical impedance during various loads. As a result, a novel approach is presented for monitoring the preload status during the forming operation by electrical impedance spectroscopy. This method contributes to ensure a high-volume production.

Session 6.2: The Future of Manufacturing

Chair: Bernd Breidenstein, IFW

Customized Smartness: A Survey on links between Additive Manufacturing and Sensor Integration

Dirk Lehmhus, Claus Aumund-Kopp, Frank Petzoldt, Dirk Godlinski, Arne Haberkorn, Volker Zöllmer, Matthias Busse

The present work provides a brief introduction to the various AM techniques and and their capabilities of delivering structural electronics components. Following an overview and classification of several approaches towards this aim, four different techniques are studied in more detail, including AM techniques that allow for in-process switching of materials and thus have the potential of realizing complex systems not by combination of processes, but within the boundaries of a single process. Also addressed are potential application scenarios that profit specifically from the combination of AM and sensor integration. The paper closes with an overview of current research trends.

Autonomous Modular Process Monitoring
Berend Denkena, Dominik Dahlmann, Thomas Neff

Process monitoring is essential to detect process disturbances systematically in cutting machining processes. Hence, it can contribute significantly to process safety and thus to automatized production. Many different monitoring strategies have been developed and successfully tested. However, they usually require some manual parametrization effort by the machine operator and can be difficult to use. Furthermore, they usually focus on very specific process conditions. Therefore, an innovative modular autonomous monitoring system is being developed, which can monitor machining processes in single-item and series production and reduces parametrization effort for the operator to a minimum, thus, focusing on manageability of the system.

Flexible and low-cost production of waveguide based integrated photonic devices
Maik Rahlves

We present a process to fabricate fully polymer based integrated optical devices which is based on maskless lithography and hot embossing. Using the maskless lithographic setup, we are able to create a hot embossing stamp in a flexible and fast manner. We demonstrate that our process is capable of creating linear optical waveguides, Y-splitters and Mach-Zehnder interferometers designed by preliminary optical simulations. The fabricated structures are analyzed with respect to optical smoothness and line edge roughness. In the future, our process will greatly enhance a fast design and fabrication of complex optical sensor structures.

SHM-Systems for Composite Aircraft Structures based on Lamb wave Analysis
Michael Sinapius

The lecture presents recent results of collaborative research programs on Structural Health Monitoring (SHM) of Composite Airframe Structures through the analysis of guided waves. SHM techniques based on lamb wave propagation are promising for online testing of composite panel like structures. Lamb waves can be excited and received easily by piezoceramic patches attached on plates and plate-like structures. The guided waves propagate over large areas with small attenuation and interact with structural discontinuities such as impacts damages. Therefore, this principle can be used for damage detection and localization. The proposed SHM system is based on a network of a specially designed network of piezoceramic patch actuators. Aspects of the system design considering the in particular anisotropic behavior of composites are addressed as well as the complexity of aircraft design. Wave propagation and interaction in complex structures poses a hard challenge for signal validation due to reflections, refractions or mode conversions. Measuring and imaging techniques are presented which allow a deeper analysis and understanding of wave behavior. Finally, the lecture presents a case study of a SHM system installed and used to inspect a full scale Door Surround Structure. It is produced by means of an automated fiber placement technique. During the manufacturing process, a SHM network formed by nearly 600 piezoelectric transducers is integrated on the structure. The panel was impacted with a large number of impacts inducing skin delaminations and debondings of various structural features. The paper presents initial results of the related damage detection process via the integrated SHM system.

Session 6.3: Systems Engineering
Chair: Hong Seok Park, University of Ulsan

Classification of Electroencephalogram Data from Hand Grasp and Release Movements for BCI Controlled Prosthesis
Gerrit Lange, Cheng Yee Low, Fazah Akthar Hanapiah, Fadhlan Kamaruzaman

In this work, a novel EMG-assisted approach has been developed for classification of EEG data from hand grasp and release movements. It shows feasibility for a more intuitive control of upper limb prosthetic terminal device using low-cost BCI without the risk associated with invasive measurement.

Combined use of modified Hough Transformation, Random Sample Consensus and Linear Least Square to extract the Normal Parameterization of a Straight Line: An Application for Cable Driven Parallel Robots
Rudi Kurniawan, Muhamad Fauzi Othman, Dieter Schramm, Tobias Bruckmann

The current approach to determine the platform position of the Cable Driven Parallel Robot (CDPR) is by using camera system or forward kinematics. However both has their drawbacks. Alternatively, a laser scanner is introduced. Three popular algorithms to extract the straight line is applied to estimate two among three component of platform position vector. Then, the proposed method is applied on the physical prototype. Two estimated coordinates of the position vector are compared with the desired trajectory in order to evaluate the platform position accuracy. The comparison shows that the platform has deviation from the desired position.

Enhanced absolute accuracy of an industrial milling robot using a stereo camera system
Christian Möller, Hans Christian Schmidt, Nihar Hasmukhbhai Shah, Jörg Wollnack

The high demand of efficient large scale machining operations by simultaneously decreasing operating time and costs has led to an increasing usage of industrial robots in contrast to large scaled machining centers. The main disadvantage of industrial robots used for machining processes is their poor absolute accuracy, caused by the serial construction, low structural stiffness and gear backlash. The recent advancements in the field of photogrammetry aided by faster, low cost cameras and high computation power are promising fast, highly accurate position measurements in a relatively large volume. This paper introduces the utilization of a stereo camera system using the principles of stereo photogrammetry to determine the position and orientation (pose) of the robot tool center point (TCP) externally. In the experimental setup an industrial robot with a milling spindle is used. The camera system measures the position of retro-reflective coded targets which have been applied to a target holder especially designed for highly accurate pose measurements and high orientational accuracy. This target holder is mounted on the milling spindle next to the robot TCP and hence is observable during machining processes by the camera mounted near the robot base. Additionally a laser tracker system is used to calibrate pose relationships between the workpiece, the robot and the camera system as well as the pose relationship between the TCP and the milling tool. To accurately represent this actual pose from the robot base, a novel method for so called Hand-eye calibration is performed. Utilizing the lasertracker system as a reference, multiple relative robot movements with orthogonal rotational axes are performed to minimize measurement noise and eliminate the effect of the robot absolute positioning inaccuracies. The calibrations and algorithms developed in this work demonstrate a precise way to calculate the absolute pose of the robot TCP with

respect to the workpiece with help of the stereo camera system. In the future, a “Look Then Action” type iterative static control strategy will be realized using repeated measurements of the robot end-effector. The camera system is able to provide the actual position and along with the intended target position from the robot control, a target-actual comparison directly shows the positioning error. Advanced validation algorithms are established to monitor the accuracy during the process, with both the stereo camera system and the laser tracker to detect absolute positioning errors of the robot. The goal is to show that the robot position accuracy can be brought down to the level of the total camera measurement inaccuracy. Thus, this setup is able to provide a configuration of measurement devices and an industrial robot that is capable of machining large-scaled workpieces for a variety of applications. It can be concluded from these results that the integration of a stereo camera system in an adaptive milling robotic work-cell offers a fully automated and highly efficient alternative for automated machining of large-scaled components for the manufacturing plants of the future.

Ultra-compact 122 GHz Radar Sensor for Autonomous Aircrafts

Federico Nava, Christoph Scheytt, Thomas Zwick, Mario Pauli, Benjamin Göttel, Wolfgang Winkler

In this paper a prototype of an ultra-compact continous-wave (CW) and frequency-modulated continous-wave (FMCW) radar system using a highly-integrated radar chip and in-package antennas will be presented. An introduction will be given on the concept of antenna integration for millimeter-wave radar and the advantages of such systems. The radar then will be described in its main components, a 122 GHz Integrated Circuit including in-package antennas as well as the acquisition and processing system realized using FLEX-PCB technology. Furthermore Initial measurements of the radar system will be presented and explained.

Helpful Information

Conference Dinner

The SysInt 2016 Conference Dinner will take place in the Benteler Arena.

Shuttle buses will start from the Arosa and Welcome Hotel at 7:00 pm (via Heinz Nixdorf MuseumsForum).

Shuttle buses will start from the Benteler Arena to the hotels at 11:00 pm and 12:00 pm.

You can reach the Benteler Arena also by car:
Benteler Arena | Paderborner Str. 89 | 33104 Paderborn

from Heinz Nixdorf MuseumsForum

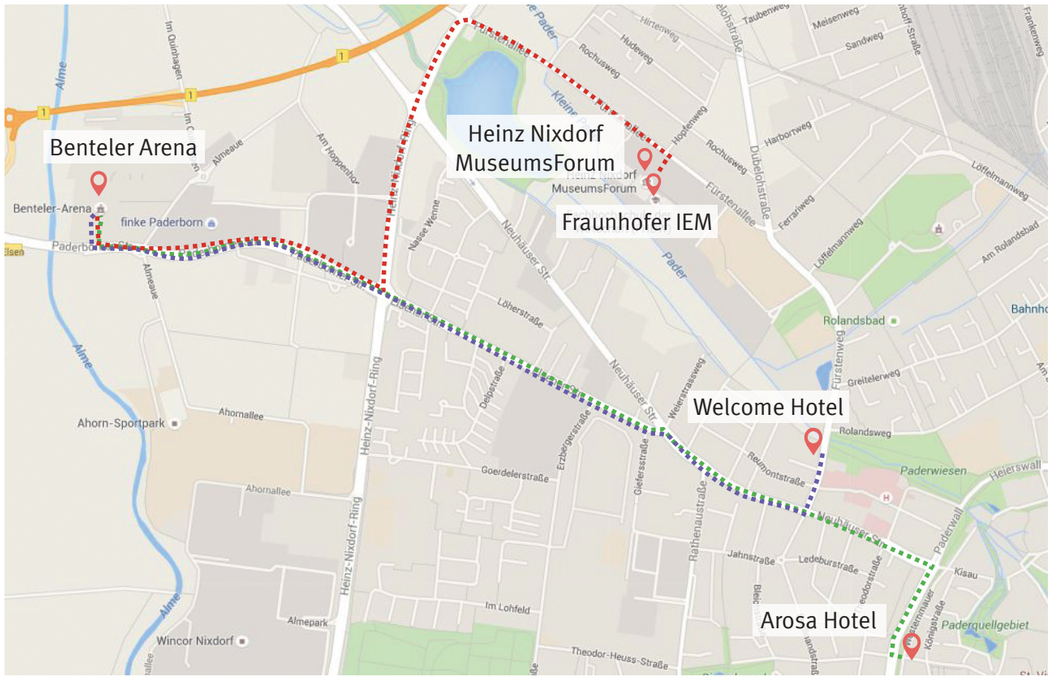
- Head northwest on Fürstenallee toward Hopfenweg
- Turn left onto Heinz-Nixdorf-Ring
- Turn right onto Paderborner Str.

from Welcome Hotel

- Head south on Fürstenweg toward Ransohoffweg
- Turn right onto Neuhäuser Str.
- Turn left onto Elsener Str.
- Continue onto Paderborner Str.

from Arosa Hotel

- Head south on Westernmauer toward Marienstraße
- Turn right onto Marienstraße
- Turn right onto Friedrichstraße
- Use the left 2 lanes to turn left toward Neuhäuser Str.
- Continue onto Neuhäuser Str.
- Turn left onto Elsener Str.
- Continue onto Paderborner Str.



Conference Venue

The SysInt 2016 will be held in the Heinz Nixdorf MuseumsForum.
The Get Together will take place at Fraunhofer IEM (Zukunftsmeile 1), located next to the Heinz Nixdorf MuseumsForum.

Travelling by car

From the A33 take the exit Paderborn-Elsen. Turn onto Bundesstraße (main road) B1 towards Bad Lippspringe/Detmold. After approx. 1,5 km leave Bundesstraße B1 at the exit Paderborn/Schloss Neuhaus. Continue straight ahead at the traffic lights (Heinz-Nixdorf-Ring, Dubelohstraße) onto the Heinz-Nixdorf-Ring and turn left at the next set of lights (Heinz-Nixdorf-Ring, Fürstenallee) onto Fürstenallee. The Heinz Nixdorf MuseumsForum is approx. 300 m along this street on the right-hand side.

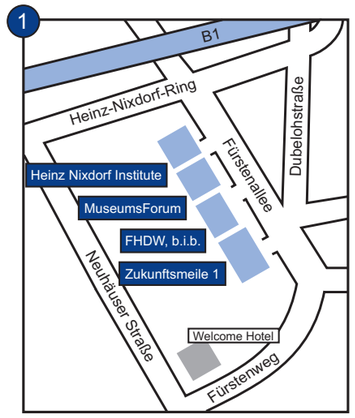
Travelling by air

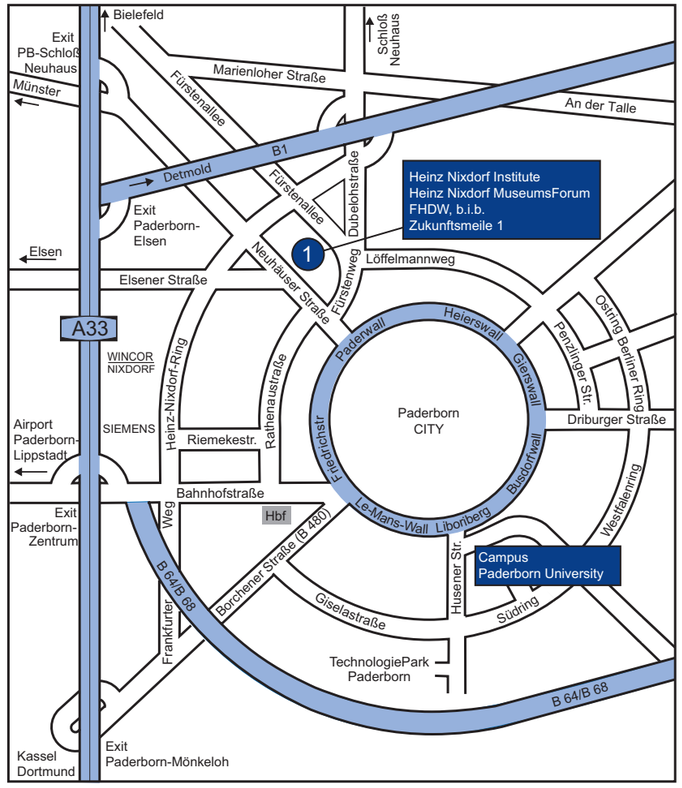
From Paderborn/Lippstadt airport take a taxi (total journey time 25 minutes, approx. 35 Euro) or take bus No. 400/460 towards Paderborn main station (Hauptbahnhof). From the main station take bus No. 11 towards Thuner Siedlung and get off at the MuseumsForum stop (total journey time approx. 50 minutes).

Travelling by train

From Paderborn main station (Hauptbahnhof) take a taxi (total journey time 10 minutes, approx. 8 Euro) or take bus No. 11 towards Thuner Siedlung and get off at the MuseumsForum stop (total journey time approx. 10 minutes).

Heinz Nixdorf MuseumsForum
Fürstenallee 7
33102 Paderborn





Taxi Companies:

Taxi Hermesmeyer: 0 52 51 / 3 50 50
Taxi Klima: 0 52 51 / 6 11 11
Taxi Stern: 0 52 51 / 6 33 77 or 0 52 51 / 20 50 55

Bus Connections:

Welcome Hotel (Bus Stop *Rolandsweg*) – **Heinz Nixdorf MuseumsForum** (Bus Stop *MuseumsForum*):
Bus 11, Direction Thuner Siedlung

13.06.2016	14.06.2016	15.06.2016
08:22 am	08:22 am	08:22 am
08:52 am	08:52 am	08:52 am

Arosa Hotel (Bus Stop *Neuhäuser Tor*) – **Heinz Nixdorf MuseumsForum** (Bus Stop *MuseumsForum*):
Bus 11, Direction Thuner Siedlung

13.06.2016	14.06.2016	15.06.2016
08:20 am	08:20 am	08:20 am
08:50 am	08:50 am	08:50 am

Heinz Nixdorf MuseumsForum (Bus Stop *MuseumsForum*) – **Welcome Hotel** (Bus Stop *Rolandsweg*):
Bus 11, Direction Hauptbahnhof

13.06.2016	14.06.2016	15.06.2016
08:06 pm	05:36 pm	01:36 pm
09:06 pm	06:06 pm	03:06 pm
10:06 pm	06:36 pm	03:36 pm

Heinz Nixdorf MuseumsForum (Bus Stop *Museumsforum*) – **Arosa Hotel** (Bus Stop *Neuhäuser Tor*):
Bus 11, Direction Hauptbahnhof

13.06.2016	14.06.2016	15.06.2016
08:06 pm	05:36 pm	01:36 pm
09:06 pm	06:06 pm	03:06 pm
10:06 pm	06:36 pm	03:36 pm

Shuttle-Service to the Conference Dinner in the Benteler Arena:

07:00 pm Arosa Hotel – Heinz Nixdorf MuseumsForum – Benteler Arena
07:00 pm Welcome Hotel – Heinz Nixdorf MuseumsForum – Benteler Arena

11:00 pm Benteler Arena – Welcome Hotel – Arosa Hotel
12:00 pm Benteler Arena – Welcome Hotel – Arosa Hotel

SysInt

Organizing Bodies

HEINZ NIXDORF INSTITUT
UNIVERSITÄT PADERBORN

Collaborative
Research Centre 653

isis
SENSORIAL MATERIALS

LogDynamics

HEINZ NIXDORF INSTITUT
UNIVERSITÄT PADERBORN
LogDynamics
Collaborative
Research Centre 653
isis
SENSORIAL MATERIALS