ETFA 2009
2009 IEEE Conference on
Emerging Technologies & Factory Automation
IEEE
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UIB
UPC
22-26 Sept 2009
Palma de Mallorca
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Javier Campos &
Gabriel Oliver, Eds.
ISBN: 978-1-4244-2728-4
ISSN: 1946-0759
IEEE Catalog number: CFP09ETF-CDR

ETFA 2009

14th International Conference on
Emerging Technologies and Factory Automation
September 22-26, 2009 @ Mallorca, Spain

2009 IEEE Conference on Emerging Technologies & Factory Automation

ETFA2009 PROGRAM

September 22-26, 2009
University of Balearic Islands
Mallorca, Spain

IEEE Celebrating 125 Years of Engineering the Future

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Message from the Program Committee Co-Chairs

These proceedings contain the papers presented at the *14th IEEE International Conference on Emerging Technologies and Factory Automation* (ETFA 2009), held in Palma de Mallorca, Spain, 22-26 September 2009. Since its establishment, the conference is among the prime events dedicated to all aspects of factory automation and related fields, and it witnessed an amazing evolution in this area. The tradition of ETFA to feature parallel, independently organized Tracks was maintained this year, covering relevant issues such as Information Technology in Automation, Industrial Communication Systems, Real-Time and Networked Embedded Systems, Automated Manufacturing Systems, Industrial Control, Computational Intelligence and Modern Heuristics in Automation, and Intelligent Robots and Systems. We would like to thank the Track Co-Chairs Dacfey Dzung, Thilo Sauter, Julián Proenza, Stefano Vitturi, Thomas Nolte, Roberto Passerone, Joaquín Ezpeleta, Armin Zimmermann, Weng Khuen Ho, Ramón Vilanova, Milos Manic, Sam Kwong, Beatriz López, Rafael García, and Alberto Ortiz for their excellent work.

In addition to the regular tracks, ETFA 2009 features 9 Special Sessions proposed by experts from various fields, covering selected topics like Power & Performance Evaluation of Embedded Systems, From RFID to the Internet of Things, Development of Automation Systems: the Impact of IEC Standards, Dependability of In Vehicle Embedded Systems, Building Automation and Smart Homes, Security for Industrial Applications, New Trends in Emerging Technologies and Automation Education, Fractional Systems and Control, Real-Time and Networked Embedded Systems. We would like to thank the Special Sessions Co-Chairs, John Gialelis and Herminio Martínez, and all the Special Sessions' Organizers for their valuable collaboration.

The call for papers attracted 283 submissions from 39 countries all over the world – hence these proceedings summarize the work of leading research groups from all five continents. All the submissions were thoroughly reviewed by the program committees of the relevant Tracks. To ensure a high standard of the conference, each paper was sent to minimum three reviewers. Based on the judgements, the Track Chairs selected the contributions to be accepted as regular papers and also indicated to the authors of rejected papers if a revision and resubmission as work-in-progress paper might be reasonable. Special Session papers were reviewed within the relevant main Tracks to ensure a harmonised review process for all the conference papers. At the end, 138 contributions were finally accepted as full papers in regular Tracks and another 53 as full papers in Special Sessions. Compiling the track committees and managing the review process in a timely fashion was a tough work, and we are really grateful to the Track Chairs, who accomplished this critical task.

As in recent years, ETFA provides also a platform for research work at the forefront of technology. The Work-in-Progress and Industry Practice ("WiP") Track permits timely publication of ongoing projects and novel ideas that would not be publishable in the regular Tracks. As a response to the respective call for papers, we received 119 submissions, out of which 85 were finally selected for presentation. To stimulate discussions and utmost feedback for the authors, the papers will be presented in a dual way: first a session of short oral presentations followed by a poster session for relaxed discussion and idea exchanging. We would like to particularly acknowledge Yolanda González and Lucia Lo Bello for the organization of a superb WiP program despite the strict time constraints.

Four outstanding plenary keynote speeches given by distinguished researchers will provide state-of-the-art overviews and hopefully also stimulate discussions on novel research topics. On Wednesday,

Christoffer Apneseth from ABB Robotics, Norway, will speak about Industrial Robotics – trends and opportunities in a rapidly changing world, while the talk given by Tei-Wei Kuo from National Taiwan University, Taiwan, will deal with Operating system and tool designs of multi-core embedded systems: energy efficiency and performance considerations. On Thursday, Manuel Silva from University of Zaragoza, Spain, will speak about Continuous Petri net models and automated manufacturing systems: Lights and shadows. On Friday, the talk given by Michel Parent from INRIA, France, will deal with Automated Vehicles: the Future is Now.

Compiling the actual conference program was not an easy task. With the exception of the keynotes, the large number of papers fills seven parallel tracks throughout the entire conference, and until the very last session, highly interesting presentations are to be expected. We tried hard to make the individual parallel sessions as orthogonal as possible and to avoid excessive congruence of the topics. A large-scale conference like ETFA is the result of the hard work of many people. Apart from the chair persons of the individual Tracks, WiP and Special Sessions, we would also like to thank the members of the international program committee and the reviewers for their careful review of submitted papers. Secondly, we would like to thank the ETFA 2009 General Co-Chairs, Antoni Grau and James C. Hung, as well as the ETFA 2009 Organizing Chairs, J. David Irwin and Richard Zurawski, for their continuous support to the Program Committee Co-Chairs. We also thank Milos Manic for handling the web-based reviewing system. Finally, we would like to thank all participants of the *14th IEEE International Conference on Emerging Technologies and Factory Automation* for attending this event. We hope that both this program and the excellent social events planned by the local organizers make you enjoy your stay in the wonderful city of Palma de Mallorca.

Gabriel Oliver and Javier Campos
ETFA 2009 Program Committee Co-Chairs

Track 1. Information Technology in Automation

T1-1. Smart Factory
Chairs: Thilo Sauter and Kai Hansen

Room A01 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	001317	**Reusable and flexible design of communication gateways** *Ingmar Kühl, Alexander Fay* Communication gateways have an indispensable role in the architecture of distributed automation systems. Numerous communication gateways have been implemented to address particular devices, data exchange requirements, programming languages, and communication protocols, and further will have to be implemented in the future. Typically, these communication gateways have been implemented from scratch; with little reuse being made, in terms of software reuse and knowledge reuse as well. In this paper, an approach is described to design communication gateways in a way to maximize the reuse even across different implementation technologies. This approach allows adapting communication gateways (instead of reprogramming them) in case of increasing requirements during operation.
2	001848	**An Approach for Modular Production from Mechanics to Decentralized Control, Realized in the SmartFactoryKL** *Stefan Hodek, Florian Floerchinger* In the leading industry countries a high automation degree is necessary to stay competitive. Cost-efficiency and quality are the main factors to achieve. In contrast to big lot sizes, it is difficult to build up a cheap and highly automated production line for small lot sizes. To overcome these drawbacks a more flexible design of production lines is essential. In this paper a modular architecture of production facilities is presented. To realize a modular architecture, interfaces in three domains have to be defined. In the first one the geometric dimensions and the mechanic hand-over points have to be fixed. In the second one information transfer and power supply have to be standardized. Finally, one of the most crucial points is the control architecture of the modular production lines.
3	002089	**Utilizing Semantic Web Services in Factory Automation towards Integrating Resource Constrained Devices into Enterprise Information Systems** *Ioakeim K. Samaras, John V. Gialelis, George D. Hassapis, Vincent A. Akpan* This paper proposes an advanced two-part middleware solution to the problem of integrating resource constrained devices located in the field of factory automation, such as Wireless Sensor Networks, into an enterprise information system. These networks seem to present the most difficult part to be integrated into such information systems. The first part of the proposed middleware is implemented at the client side

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		and provides a Service Oriented Architecture connection to the Internet. The second part provides to the wireless sensors a Service Oriented Architecture connection to the Internet by enhancing the exchanged information with semantic expressivity. Both parts are based on the Device Profile for Web Services which is a Service Oriented Architecture technology at the device level. By utilizing the proposed two-part middleware, we explain how such a Wireless Sensor Network can interact with a client with no previous knowledge on each other's services achieving in this way an automatic integration of the Wireless Sensor Network into the enterprise information system.
4	002615	**Development of a Universal Model for Description of Intelligent Field Devices through the Life-Cycle** *Konrad Gnauck, Andreas Goessling, Roman Frenzel, Martin Wollschlaeger, Dirk Schulz* Integration of field devices is currently performed using different device models which all have a different focus. These models are represented by a vast number of different device description formats. For effectiveness of the integration processes, a comprehensive device description model that catches all relevant information is required. Based on an analysis of important formats, a device description model has been designed that covers all relevant information that was formerly stored in those different formats. In this paper the requirements for such a model are discussed, and a universal model integrating existing definitions is described.

T1-2. System Integration
Chairs: Kai Hansen and Thilo Sauter

Room A01 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	000442	**Object oriented simulation of Hybrid Renewable Energy systems focused on Supervisor Control** *Jose Maria Gonzalez de Durana, Oscar Barambones* With eyes focused on simulation the authors review some of the main topics of Hybrid Renewable Energy Systems (HRES). Then they describe an Object Oriented model of a simple example of one of such systems, a micro-grid, oriented to designing a decentralized Supervisor Control. The model has been implemented using AnyLogic.
2	002488	**Integration of a Legacy Automation System into a SOA for Devices** *Sascha Feldhorst, Sergey Libert, Michael ten Hompel, Heiko Krumm* Although networked embedded devices (NED) and service-oriented architectures (SOA) are often proclaimed as next generation technologies in industrial automation, there are some steps to take before they can be widely adopted. At the moment, productive systems are not SOAready and that is why integration approaches are interesting for manufacturers and operators of industrial plants. We

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		suggest a solution for the integration of a legacy system into a so-called SOA for devices. Therefore, we use a thin abstraction layer which provides the technical functions of an industrial plant as re-usable services which can be arranged in control hierarchies and used as well in higher-level workflows. This enables a SOA-based automation with new control and monitoring approaches to be built upon the device services. To evaluate our solution a legacy material flow facility is used.
3	002976	**Generic sensor network gateway architecture for plug and play data management in smart laboratory environments** *Elmar Zeeb, Ralf Behnke, Christian Hess, Dirk Timmermann, Frank Golatowski, Kerstin Thurow* During the last years, recent technological advances enabled the development of tiny devices equipped with radio, micro controller and sensors, called sensor nodes. Collaborating networks of such devices, known as Wireless Sensor Networks (WSNs), are subject of many researches. A couple of network centric tasks like data transmission and aggregation, self-organisation, localization and energy awareness have been focused in various publications. Recent researches, e.g. IPv6 over Low power WPAN (6LoWPAN), are going to standardize the connection of sensor nodes with common internet protocols. Nevertheless, until now proprietary techniques are used within most networks, especially for the coupling towards the outside world as well as the data management. Depending on WSN hardware and software, the gateway software as well as storage and presentation of data differs for most sensor networks. In this work we present an infrastructure which bases upon a generic gateway. Standardized dataset will be stored by this device using Sensor Web Enablement (SWE) and standard protocols. By use of Devices Profile for Web Services (DPWS) plug and play abilities as well as a comfortable query interface for presentation is realized.
4	003468	**A Performance Study of Ethernet Audio Video Bridging (AVB) for Industrial Real-time Communication** *Jahanzaib Imtiaz, Juergen Jasperneite, Lixue Han* This paper investigates the potential of the emerging Ethernet Audio Video Bridging (AVB) in Industrial networks. An analytical model of AVB is described, and AVB's priority queuing (PQ) and credit-based shaper algorithms (CBQ) are evaluated and compared with Standard Ethernet.
5	003778	**System Management Standards for Traffic Management Systems** *Christoph Stoegerer, Wolfgang Kastner* Today's traffic management systems require interoperability of control units from different vendors on manifold communication infrastructures. The management of these control units is getting a complex task as different vendors supply proprietary management instrumentations (e. g. for uploading new firmware, update of contents, configuration, diagnostics and troubleshooting). A standardized data model and communication interface provides new possibilities for system owners and simplifies engineering for maintenance personnel. Additional to novel functional opportunities, a decrease in operative costs can be

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		expected because of eased troubleshooting and update tasks. This paper summarizes the state of the art of existing application management standards and shows their applicability for the domain of traffic management systems.

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Track 2. Industrial Communication Systems

T2-1. Real Time ethernet Networks

Chairs: Max Felser and Athanasios Kalogeras

Room A01 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	000191	**Real-time Ethernet – a solution for all communication-related problems within a digital production print line?** *Johannes Weber, Andreas Rehkopf* In the industry there is a growing trend to use realtime Ethernet for factory communication. In this case study from the digital print industry a new communication standard is selected to host an automation protocol. It would have been a natural choice to migrate to a real-time-Ethernet derivative. However, after a research project an industry consortium chose not to adopt real-time-Ethernet but migrate to a two-cable approach that separates the data to be communicated in terms of their real-time requirements although from a technical point of view, real-time Ethernet would have been a viable alternative. This paper explains the background of this decision and it further shows that incorporating only one physical hardware connection combining several types of information not necessarily simplifies an implementation.
2	001759	**A High-Performance CAN-like Arbitration Scheme for EtherCAT** *Gianluca Cena, Ivan Cibrario Bertolotti, Adriano Valenzano, Claudio Zunino* EtherCAT is a popular Ethernet-based solution conceived for connecting devices at the shop floor in industrial environments. Even though it features very high communication efficiency, that permits thousands of I/O points to be periodically exchanged between controlling devices and decentralized periphery with cycle times well below 1ms, it is not able to cope in a proper way with event-driven systems, where lots of devices may be producing asynchronous information in a sporadic and unpredictable way. In this paper, some modifications to the basic EtherCAT protocol are proposed which enable CAN-like arbitrations to take place in such networks, so as to achieve a true priority-based access scheme.
3	002623	**Passive PROFINET I/O OPC DA Server** *Rafal Cupek, Lukasz Huczala* This paper describes a PROFIET I/O passive OPC Server that was realized as a student's project built at the Institute of Informatics, Silesian University of Technology in cooperation with the company Softing A.G. The authors describe the project idea and present the practical results of the experiment. The results prove the thesis that the proposed solution for data exchange between horizontal and vertical industrial communication systems can give better data resolution and lower system overheads. The presented idea may be the basis for future works on vertical communication for industrial real-time systems.

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4	003603	**Real Time Ethernet Networks Evaluation Using Performance Indicators** *Lucia Seno, Stefano Vitturi, Claudio Zunino* The employment of Real Time Ethernet networks in factory automation systems is rapidly increasing and several commercial products, with different characteristics, are already available from various manufacturers. Most of these networks have been included in both the IEC 61158 and IEC 61784 International Standards that, in addition, define a set of Performance Indicators. In this paper we focus on two popular Real Time Ethernet networks, namely Ethernet POWERLINK and EtherCAT, and we evaluate their performance for a typically deployed factory automation configuration. Specifically, we compute the most relevant performance indicators introduced by IEC 61784 standard and two (purposely defined) additional ones, namely minimum cycle time and jitter, which are suitable for the two networks considered.
5	001589	**QoS in Switched Industrial Ethernet** *Linus Thrybom, Gunnar Prytz* As Industrial Ethernet evolves it will increasingly include integration with the “IT network” in order to utilize the benefits which the use of Ethernet provides. This will result in a mixed protocol environment also in the industrial networks, which in turn will require proper usage of QoS in order to maintain the demanding requirements of latency, jitter and packet loss in the Industrial Ethernet protocols. This paper highlights the emerging need for using QoS as well as some other related technologies in Industrial Ethernet networks and outlines some guidelines to achieve well-performing networks and efficient communication both for real-time control data and other less time critical data.

T2-2. Distributed Systems Architecture

Chairs: Julián Proenza and Marga Marcos

Room A01 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	002828	**Moving Beyond the Component Boundaries for Efficient Test and Diagnosis of Automotive Communication Architectures** *Eric Armengaud, Allan Tengg, Michael Karner, Christian Steger, Reinhold Weiss, Martin Kohl* Integration work at system level has been made easier with the introduction of the time-triggered concept and technologies such as FlexRay. Paradoxically, the ongoing integration efforts at component level have led to complex local interactions between the subsystems that are difficult to analyze globally. We present in this work a test environment for automotive networks that goes beyond the component boundaries and enables the concurrent analysis of the entire communication architecture. This supports the investigation of data- and fault propagation within the system as well as the analysis of the

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		interactions between the components. Supported by an industrial use case, we discuss how this environment improves fault detection and diagnosis of the system.
2	000337	**Devices Profile for Web Services in Wireless Sensor Networks: Adoptions and Enhancements** *Guido Moritz, Elmar Zeeb, Steffen Prüter, Frank Golatowski, Dirk Timmermann, Regina Stoll* For Service-oriented Architectures, Web Services are claimed as state of the art to connect business execution layers as well as networking devices. Additionally, the deployment of Wireless Sensor Networks became applicable over the last years. The usage of application layer gateways and proxy concepts allow the integration of these sensor networks into real world scenarios and existing networks that make use of Web Services. This paper presents a new approach to adapt and enhance the Devices Profile for Web Services to be applied in Wireless Sensor Networks directly. Thus, seamless connectivity between business layers, device level networks, and Wireless Sensor Networks are possible.
3	000833	**Automatic device configuration for Ethernet ring redundancy protocols** *Oliver Kleineberg, Max Felser, Markus Rentschler, Michael Ries* In modern communication systems based on Ethernet technology, the use of physical ring structures and ring redundancy protocols has been common for some time in the past. A challenge remains the configuration of such a redundancy protocol on each device with the networks stretching out over large areas, like in offshore wind power stations, where each windmill houses at least one Ethernet switch. The distance between windmills can be several kilometers and configuration of the redundancy protocol on each device is an elaborate process. In this paper, a mechanism is proposed which automatizes the configuration of ring redundancy protocols and eliminates the need to configure each device separately. The actual protocol implementation is intended to be part of the next major software release of Hirschmann Industrial Ethernet Switches.
4	003476	**Towards New Hybrid Networks for Industrial Automation** *Thilo Sauter, Jürgen Jasperneite, Lucia Lo Bello* In factory communication systems, wireless networks are likely to complement wired automation networks, rather than replacing them. There is therefore an increasing interest in the way wireless and wired systems will interact and form a hybrid network. The hybrid network architecture proposed in this paper specifically addresses WLAN infrastructures in industrial environ-ments. The paper discusses design challenges and de-scribes the proposed system architecture and its main components.

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T2-3. Control Networks

Chairs: Marga Marcos and Hans Hansson

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Room A01 - *09:00 - 11:00, Thursday September 24th*		
Order	**ETFA Ref.**	**Title /Authors**
1	000582	**Efficient Communication in Control-Oriented Embedded Networks** *Andreas Scholz, Irina Gaponova, Stephan Sommer, Alfons Kemper, Alois Knoll, Christian Buckl, Jörg Heuer, Anton Schmitt* In the recent years, wireless sensor networks (WSNs) have drawn a lot of attention and a lot of work has been done to provide an efficient communication infrastructure for these systems. This paper focuses on another -not so well studied- class of embedded networks: embedded networks used for control and automation purposes. In contrast to WSNs, these networks have a comparably stable infrastructure, with a low probability of node or link failure. The main challenge for the communication in control oriented networks is the heterogeneity of the underlying infrastructure and the resource constraints already known from WSNs. We propose an adaptable communication layer that leverages existing network protocols and at the same time provides a seamless communication over heterogeneous networks and an efficient and scalable network stack for individual nodes. We show the feasibility of this approach with a demonstrator for the smart energy management in a future home automation scenario.
2	000825	**Fieldbus based isochronous automation application** *Max Felser* Fieldbus based automation solutions are widely accepted in industrial applications. In the last twenty years the number of Profibus nodes is growing every year with more than 5 millions nodes. The success of this technology is also based on a continuous development and adoption of new mechanism to increase the functionally of the fieldbus technology. One of the adopted features is the possibility to create isochronous automation systems. This paper shows how isochronous automation applications are implemented with Profibus and the performances which can be achieved. An outlook is given to the new Ethernet based fieldbus Profinet and the possibilities to reach the same performances as with the fieldbus.
3	001228	**Estimating Delays in Networked Control Systems Using Colored Petri Nets and Markov Chain Models** *Abouelabbas Ghanaim, Geovany Borges, Georg Frey* This paper presents a novel two-step approach for modeling forward and backward network delays in networked control systems (NCS). The first step is to build a colored Petri net (CPN) structural model for the simulation of Ethernet based networked control systems. The modular model captures the most important features of industrial networked control systems, such as client/server input/output scanning and cyclical execution of the control algorithm on a Programmable Logic Controller (PLC). CPN tools software is used to build and simulate the model with different parameter sets. This first easy to build model is used in a second step to identify a compact phenomenological model from an extensive set of simulation results. In this second step a finite state

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		Markov chain delay model (FSMD) is used to capture the delay patterns generated with the CPN model. The resulting model is more compact than the CPN model and due to its mathematical form it can be integrated in existing design and analysis methods for NCS.
4	001163	**The Influence of Event-Based Sampling Techniques on Data Transmission and Control Performance** *Andrzej Pawlowski, José L. Guzmán, Francisco Rodríguez, Manuel Berenguel, José Sánchez, Sebastián Dormido* Event-based systems are becoming increasingly commonplace, particularly for distributed real-time sensing and control. Furthermore, remote monitoring and control through data-communication networks are very popular for process supervision and control. The usage of networks provide many well-known benefits, but it also presents some limitations in the amount of transmitted data. This fact is especially visible in Wireless Sensor Network (WSN), where the bandwidth of communication channel is limited and typically all nodes are battery powered. Event-based sampling techniques appear as a some possible solution to face this problem allowing considerably saving network resources and reducing the power consumption. On the other hand, the control system performance is highly affected due to the event-based sampling techniques, being necessary to analyze and study a compromise between control quality and reduction in the control signal commutations. This paper presents all these ideas applied to the greenhouse climate control problem.
5	002445	**Multihop Multi-Channel Scheduling for Wireless Control in WirelessHART Networks** *Gabriella Fiore, Valeria Ercoli, Alf J. Isaksson, Krister Landernäs, Maria Domenica Di Benedetto* The WirelessHART standard uses TDMA and channel hopping to control access to the network and to coordinate communication between network devices, in order to enhance reliability and to improve the throughput of the network. A problem in utilizing multiple channels is that current devices are usually equipped with a single transceiver. Thus, a node can only transmit or receive on one channel at a time. Moreover, contrary to today's wired control systems, if a single access point is used the communication becomes the bottle neck of the control system. Therefore this paper presents how one may schedule the WirelessHART communication using two access points. Furthermore the paper describes a scheduling algorithm managing a multihop multi-channel networked control system based on the WirelessHART standard. A simulation example of a multihop multi-channel network is also shown, using the fixed packet lost utility of the Matlab/Simulink-based tool TrueTime.

T2-4. Performance of Wireless Networks for Industrial Applications

Chairs: Athanasios Kalogeras and Stefano Vitturi

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Room A01 - *14:00 - 16:00, Thursday September 24th*		
Order	**ETFA Ref.**	**Title /Authors**
1	000485	**A Simulation-based Performance Evaluation of Wireless Networked Control Systems** *Gennaro Boggia, Pietro Camarda, Vincenzo Divittorio, Luigi Alfredo Grieco* AWireless Networked Control System exploits a shared wireless network to logically link its sub-systems. Due to the peculiarities of the wireless channel, it is important to understand in which measure the Quality of Service provided by the communication infrastructure affects the Quality of Control. The aim of this work is to analyze the performance of a Wireless Networked Control System based on the IEEE 802.11 MAC. For that purpose, a model of such a system has been built using the ns-2 simulator and the impact of MAC parameters on the system dynamics has been evaluated. Simulation results have highlighted strengths and limitations of this kind of Wireless Networked Control System.
2	001171	**Retransmission strategies for cyclic polling over wireless channels in the presence of interference** *Giovanni Gamba, Federico Tramarin, Andreas Willig* In this paper we consider retransmission strategies for centralized cyclic polling-based systems over wireless channels subject to external interference. The considered strategies differ in the time when retransmissions for one particular node are carried out, and in the number of retransmissions that can be carried out for one node. We show experimentally and by simulation that two related strategies introduced in this paper, called the queueing-based strategies, significantly outperform the traditional strategy in which all admissible trials towards one node are carried out subsequently in terms of the average number of nodes that cannot be successfully served in a cycle. These performance gains are achieved without increasing the average total transmission effort.
3	001694	**Performance Evaluation of WirelessHART for Factory Automation** *Stig Petersen, Simon Carlsen* The WirelessHART specification has given the industry access to their first open standard specifically aimed at wireless instrumentation for factory automation. For WirelessHART to be a viable solution for the process and automation industry, it has to provide a robust and reliable alternative to today's wired networks. This paper presents the results of a performance evaluation of a WirelessHART network deployed in an industrial environment. It also presents a performance analysis and deployment considerations for IEEE 802.11g coexistence. The conclusion of the paper is that a WirelessHART network is capable of reliable operation in an industrial environment, and when coexisting with three IEEE 802.11g networks.
4	003484	**Evaluation of Real-Time Communication Performance in QoS-Enabled Infrastructure WLANs**

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		Gianluca Cena, Adriano Valenzano, Claudio Zunino, Lucia Seno Nowadays, industrial communication systems are experiencing the introduction of wireless technologies at all levels of automated factories. The benefits that derive from such a choice are manifold, including reduced deployment costs, enhanced flexibility and support for mobility. Unfortunately, because of a number of reasons, wireless systems can not be thought of as a complete replacement of wired networks at the field level. In this paper, the performance that can be achieved by QoS-enabled WLANs to support communication in industrial environments is analyzed. In particular, a detailed analysis of latencies in infrastructure networks is presented, obtained through numerical simulations, that takes into account both media access and queuing delays. Moreover, the impact of the internal architecture of the access point on performance is evaluated as well.
5	003174	**A DHT-based approach for Path Selection and Message Forwarding in IEEE 802.11s Industrial Wireless Mesh Networks** *Marcos Pinheiro, Silvio Sampaio, Pedro Souto, Francisco Vasques* Wireless Mesh Networks (WMNs) are a promising communication technology that may offer greater flexibility and reliability, when compared to traditional wireless networks. WMNs open up new applications domains, but still need to find efficient mechanisms to deal with scalability and timeliness requirements. This paper proposes a scheme for Path Selection and Message Forwarding in IEEE 802.11s networks, that is suitable to be used in industrial environments. We present the DHT-based Cluster Routing Protocol (DCRP), a routing protocol based on DHTs, clustering of nodes and use of proxies. DCRP allows to improve the overall network performance by reducing the time required for path selection and the number of communication hops in large sized networks.

T2-5. New Proposals on Wireless Networks for Industrial Applications

Chairs: Hans Hansson and Stefano Vitturi

Room A02 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001147	**A Cognitive Radio Approach to Realize Coexistence Optimized Wireless Automation Systems** *Kaleem Ahmad, Uwe Meier, Halina Kwasnicka, Andreas Pape, Bjoern Griese* The need for multiple radio systems in overlapping regions of a factory floor introduces a coexistence problem. The current research challenge is to design and realize radio systems that should be able to achieve a desired quality of service (QoS) in harsh, time-varying, coexisting industrial environments. As a solution cognitive radio (CR) built on top of a reconfigurable platform like software defined radio (SDR) can provide the required system properties. We provide a literature survey about existing coexistence problems and solutions and implement a CR testbed for experimental investigations. It can exploit three dimensions

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		of the hyperspace, which are frequency, time, and transmission power. This CR testbed is investigated in the coexistence of typical radio systems. The experimental results show satisfactory robustness against any of these interferers.
2	002577	**A Novel, High-Precision Timestamping Platform for Wireless Networks** *Reinhard Exel, Joergen Mad, Georg Gaderer, Patrick Loschmidt* The introduction of wireless networks in the factory floor offers many advantages. Besides a new flexibility for automation, also features like the localisation of wireless devices ease the use of this technology. However, for the application on the factory floor real-time guarantees have to be given, which can be ensured by schemes like TDMA, which is based on implicit or explicit clock synchronization. This is typically supported by a high accurate timestamping of incoming packets for the reduction of jitter effects introduced by the protocol layers. This paper introduces an open platform, which supports research on receiver and timestamper design. The receiver is implemented in a flexible fashion, in order to support simultaneous multi-channel monitoring as well as easy reconfiguration for technologies other than IEEE 802.11b/g for efficient deployment in automation systems.
3	003344	**Transparent Coordinator Failure Recovery for ZigBee Networks** *Rasmus Kölln, Armin Zimmermann* ZigBee is a network stack requiring only low power consumption, that is used in different application areas. The 2003 ZigBee implementation has flaws when the coordinator node fails, because it represents a single point of failure. This paper presents a new approach to overcome this pitfall. The solution is transparent for communicating end nodes, easy to use, and supports all ZigBee features. It uses a backup solution for coordinator nodes that is implemented at the application level. The approach has been implemented and tested in a real-life setup. In addition to that, the paper introduces a model of a more complex configuration and presents simulation results for the proposed approach.
4	003794	**A Multichannel Approach to Avoid Beacon Collisions in IEEE 802.15.4 Cluster-Tree Industrial Networks** *Emanuele Toscano, Lucia Lo Bello* The IEEE 802.15.4 standard leaves the problem of beacon collisions in cluster-tree topologies unsolved. Some recent work tries to solve this problem, either drastically reducing scalability or introducing some non-determinism that make them unsuitable for industrial communications. In this paper we propose a novel multi-channel approach to the beacon collision avoidance problem. Thanks to the use of multiple radio channels in the same network, it enhances scalability of cluster-tree IEEE 802.15.4 networks while allowing contention-free scheduling. A Multichannel Superframe Scheduling (MSS) algorithm is presented that, following the multichannel approach, can outperform singlechannel algorithms under given analytical conditions.
5	002712	**Distributed DBP: A (m,k)-firm Based Distributed Approach for QoS**

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		Provision in IEEE 802.15.4 Networks *Tiago Semprebom, Carlos Montez, Ricardo Moraes, Francisco Vasques, Ricardo Custódio* IEEE 802.15.4/Zigbee is one of the most widespread Wireless Sensor Network technologies. It may work either in beacon-enabled mode or in beaconless mode. When operating in beacon-enabled mode, it divides the superframe in sixteen equally-sized time slots, where the request for slot allocation is achieved through a CSMA/CA approach. This allocation method does not allow the provision of any service differentiation scheme, which is required for the transfer of time constrained messages. This paper proposes a QoS provision approach with minimal changes to existing protocols. Our approach improves the CSMA/CA algorithm by assigning decentralized priorities based on the (m,k)-firm task model. In this paper, a set of experimental results is presented and compared with the traditional approach currently offered by the standard. This set of experiments highlight the promising behavior of the proposed approach, when dealing with high network load scenarios.

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Track 3. Real-Time and (Networked) Embedded Systems

T3-1. Real-Time Networks
Chairs: Luis Almeida and Thomas Nolte
Room A02 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	002224	**Applying and optimizing Trajectory approach for performance evaluation of AFDX avionics network** *Henri Bauer, Jean-Luc Scharbarg, Christian Fraboul* AFDX (Avionics Full Duplex Switched Ethernet) standardized as ARINC 664 is a major upgrade for avionics systems. But network delay analysis is required to evaluate end-to-end delay's upper bounds. The Network Calculus approach, that has been used to evaluate such end-to-end delay upper bounds for certification purposes, is shortly described. In this paper we present how the Trajectory approach can be applied to an AFDX avionics network. Moreover we explain how this approach can be optimized in this context. We show that, on an industrial configuration, it outperforms existing end-to-end delays upper bounds.
2	002925	**Reliable Communication for DuST Networks** *Valerio Rosset, Pedro F. Souto, Francisco Vasques* We present a family of reliable broadcast protocols designed to take advantage of the dual scheduling TDMA (DuST) scheme provided by current state-of-the-art automotive control networks such as FlexRay. These protocols are a complement to FlexRay's native communication services, which do not provide sufficient fault tolerance for safety-critical applications. A reliability evaluation of the proposed protocols carried out with the help of the probabilistic model checker PRISM shows that the proposed protocols can achieve reliability levels suitable for safetycritical applications.
3	000671	**Real-time Transmission Over Switched Ethernet Using a Contracts Based Framework** *Joan Vila-Carbó, Joaquim Tur-Massanet, Enrique Hernández-Orallo* Switched Ethernet is being used for real time transmissions in industrial automation more and and more. Most modern industrial switches are equipped with mechanisms to deal with time predictability. However, real-time transmission not only requires these mechanisms, but also the proper policies for managing network resources. This paper proposes the use of contracts. A contract is a set of transmission specifications which are negotiated between the applications and the run-time support. They define the application workload and the required performance guarantees. We implement contracts for real-time streaming as an extension of FRESCOR (Framework for Real-time Embedded Systems based on COntRacts). This framework was initially thought for providing deterministic performance guarantees to strictly periodic workloads. This work extends it by using the concept of Classes Of Service (CoS) to deal with a wider range of workloads and guarantees and,

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		particularly, with the transmission of highly variable bit rate (VBR) streams, like video. CoS enables, for example, joint transmission of real-time periodic workloads and VBR streams. CoS are implemented using a combination of resource reservation and resource preallocation techniques. The packet scheduling facilities of managed switches and Linux are shown to be key for managing network resources. Evaluations about the effectiveness of the extended FRESCOR framework and the feasibility of using Switched Ethernet in real-time industrial environments are also presented.
4	000574	**Schedulability Analysis for CAN-based Networked Control Systems with Dynamic Bandwidth Management** *Manel Velasco, Pau Marti, Jose Yepez, Ricard Villa, Josep M. Fuertes* This paper presents the schedulability analysis for control messages when networked control loops, built on top of the Controller Area Network (CAN), are dynamically allocating bandwidth in terms of their controlled plants' dynamics. The bandwidth allocation policy is theoretically described by an optimization problem and practically solved by the distributed bitwise arbitration of CAN messages when message identifiers, i.e., priorities, reflect control applications demands. This poses the problem of assessing whether the set of real-time messages will meet their deadlines regardless of run-time priority changes. This is solved by a schedulability analysis based on recent results on worst-case response time techniques for real-time CAN applications. The analysis ends up with the schedulability test for this type of applications.
5	000361	**FIFO Networking: Punctual Event-Triggered Communication** *Viktor Leijon* It is desirable to be able to combine ease of implementation of a network with the ability to analyze the properties of the network. In order to address this we present a MAC protocol where the network acts as a FIFO, and examine the resulting properties of the network using both a theoretical study of the waiting times and a simulation experiment. It turns out that this type of protocol would allows us to achieve real-time guarantees for an eventtriggered system, as well as controlled jitter for message delivery. Further, temporal composability, and how to design a system using FIFO networking, is discussed.

T3-2. Wireless Real-Time Networks
Chairs: Lucia Lo Bello and Thomas Nolte

Room A02 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	000469	**Adding multicast capabilities to wireless multi-hop token-passing protocols: Extending the RT-WMP** *Danilo Tardioli, José Luis Villarroel* Support for real-time traffic and multi-hop is a basic requirement in certain applications as, for example, cooperative robot team missions.

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		Normally, point-to-point communication is sufficient to allow such a collaboration. However, there exist situations in which multicast and/or broadcast capabilities, even with real-time requirements, allow a better usage of the available bandwidth leaving more time for unicast communications. This is the case, for example, in which a server generates real-time traffic that has to be delivered to a subset (that can be the whole set) of the nodes of the network. In this paper we present a solution to incorporate the capability of sending multicast messages in token-passing real-time wireless protocols. The solution has been implemented and tested as an extension of RT-WMP (a real-time wireless multi-hop protocol with priority management support). In addition, using these new characteristics, another type of unicast/multicast protocol is proposed, analyzed, evaluated and compared with the plain RT-WMP.
2	001368	**Lifetime Optimization in Hierarchical Wireless Sensor Networks** *Samy S. Botros, Hany M. ElSayed, Hassanein H. Amer, Magdy S. El-Soudani* Wireless sensor networks is a voracious field for research, especially after the great advances in MEMS based sensors. In this paper, environmental monitoring applications are considered where data may be continuously reported with the possibility of urgent alarming if necessary. Hierarchical architecture of the network is assumed in order to overcome the problem of energy constrained sensors. Two algorithms are proposed with the purpose of network lifetime elongation and the maximization of the use of the available energy. The first algorithm is a modification for LEACH-C to enhance its performance. It results in a 25% longer lifetime. The second algorithm is an energy efficient method to ensure full coverage of the network as long as sensors are still working. This achieves 32% longer lifetime than LEACH-C.
3	003972	**A Methodology for Power Consumption Evaluation of Wireless Sensor Networks** *Andrey Somov, Ivan Minakov, Alena Simalatsar, Giorgio Fontana, Roberto Passerone* Energy consumption is one of the most constraining requirements for the design and implementation of wireless sensor networks. Simulation tools allow one to significantly decrease the effort and time spent to choose the right solution. Existing simulators provide varying degrees of analysis for communication, application and energy domains. However, they do not provide enough flexibility to estimate the consumed power for a wide range of wireless sensor network (WSN) hardware (HW) platforms. In this paper we present a flexible and extensible simulation framework to estimate power consumption of sensor network applications for arbitrary HW platforms. This framework allows designers of sensor networks to estimate power consumption of the explored HW platform which permits the selection of an optimal HW solution and software (SW) implementation for the desired projects.
4	002194	**A Distributed Algorithm for Hexagonal Topology Formation in Wireless Sensor Networks**

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		Shashi Prabh, Chinmay Deshmukh, Shikhar Sachan Hexagonal wireless sensor network refers to a network topology where a subset of nodes have six peer neighbors. These nodes form a backbone for multi-hop communications. In a previous work, we proposed the use of hexagonal topology in wireless sensor networks and discussed its properties in relation to real-time (bounded latency) multi-hop communications in large-scale deployments. In that work, we did not consider the problem of hexagonal topology formation in practice – which is the subject of this research. In this paper, we present a decentralized algorithm that forms the hexagonal topology backbone in an arbitrary but sufficiently dense network deployment. We implemented a prototype of our algorithm in NesC for TinyOS based platforms. We present data from field tests of our implementation, collected using a deployment of fifty wireless sensor nodes.

T3-3. Resource Reservations
Chairs: Tei-Wei Kuo and Roberto Passerone

Room A02 - *09:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	002607	**Multi-level feedback control for Quality of Service Management** *Tommaso Cucinotta, Giuseppe Lipari, Luigi Palopoli, Luca Abeni, Rodrigo Santos* We consider the problem of power-aware Quality of Service (QoS) control for soft real-time embedded systems. Applications can have time-varying and scarcely known resource requirements, and can be activated and terminated at any time. However, they have the capability to switch among a discrete set of operation modes with different QoS levels and resource requirements. In addition, the platform provides resources with power-scaling capabilities and may be subject to power constraints. We present a QoS control architecture achieving optimum trade-offs between overall QoS and power consumption of the system, based on two nested control loops. The external one decides dynamically the optimum configuration for the system, in terms of application QoS modes and resource power modes, while the internal one modulates the resource allocations on a job by job basis, so as to respect timing constraints. We demonstrate the effectiveness of the approach by extensive simulations with trace data of real multimedia applications.
2	000701	**Adaptive Fair Resource Management with an Arbiter for Multi-tier Computing Systems** *Naoki Hayashi, Toshimitsu Ushio, Takafumi Kanazawa* Recently, there has been an increased reliance on computing systems supported by a multi-tier architecture. In multi-tier computing systems, it is important to appropriately manage resource allocation to ensure fairness of a QoS (Quality of Service) level avoiding overload conditions in tiers. This paper proposes an adaptive resource management algorithm for multi-tier computing systems in order that all clients have

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		the same QoS level. We introduce a computing architecture which consists of multiple tiers, a group of resource managers, and an arbiter. Each tier is specialized to execute each subtask of clients and hosts virtual machines on its server pool. Each resource manager handles resource allocation of each client and updates the resources by locally exchanging a QoS level of its client with some other resource managers. Then, the resource managers request the resources to the arbiter. The arbiter compensates the requested resources to avoid overload conditions in tiers. Based on the compensation by the arbiter, each resource manager reallocates the resources to the subtasks of its client. We show sufficient conditions for the proposed resource management algorithm to achieve a fair QoS level avoiding overload conditions in all tiers at each time.
3	003212	**Quantitative Analysis and Systematic Parametrization of a Two-Level Real-Time Scheduler** *Robert Kaiser, Dieter Zoebel* The computational power of embedded systems have increased steadily during the recent years. In contrast to former approaches which allowed at least one application per computational node the memory size and computational power of today allows to host more than one application per node. Often applications are delivered by suppliers as a whole including the operating systems where the application tasks run on top. In this case virtualization is a common software approach to maintain isolation between different applications on the same computation system. Virtual machine monitors are able to divide the resources of a physical system into several logical subsystems. However, those monitors which are available today do not focus on the preservation of real-time properties. Consequently, our working group develops and investigates a two-level hierarchy of real-time schedulers, where a global scheduler assigns temporal resources to guest systems, while each subsystem has its own local scheduler for its application tasks. In this contribution, we focus on a formal investigation of the real-time properties of the two-level scheduling hierarchy. The starting points are independent applications building subsystems, each containing a set of tasks and a local scheduler, which have to be integrated and configured at the global scheduling level. Utilization bounds are derived unfolding the overhead of such an approach. Furthermore we propose systematic process for the computation of the task parameters for both levels of scheduling. Representatively the whole approach is applied to the rate monotonic assignment of priorities to tasks at the low scheduling level. For reasons of abstraction all these tasks are mapped into a single task proxy. This enables the global scheduler to treat all of its subsystems as periodic tasks allowing again for the application of the rate monotonic assignment of priorities to tasks.
4	003565	**Towards Hierarchical Scheduling in AUTOSAR** *Mikael Åsberg, Moris Behnam, Farhang Nemati, Thomas Nolte* AUTOSAR is a partnership between automotive manufactures and suppliers. It aims at standardizing the automotive software architecture and separating software and hardware. This approach makes software more independent, maintainable, reuseable, etc. Still there is much work

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		to do in order for this standard to be usable. This paper focus on automotive software integration in AUTOSAR, with the use of hierarchical scheduling as an enabling technology. At this point, AUTOSAR components do not have any timing relation with its tasks. This causes an unpredictive runtime behavior which can only be analyzed and verified after integration phase. We will discuss how integration can be done in AUTOSAR, with runtime temporal isolation of components. This will enable schedulability analysis at the level of components rather than at the level of tasks.

T3-4. Methodologies and Platforms

Chairs: Tommaso Cucinotta and Roberto Passerone

Room A02 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	001902	**Testing Real-Time Task Networks with Functional Extensions Using Model-Checking** *Matthias Büker, Alexander Metzner, Ingo Stierand* Analysis and verification of safety critical systems is inevitable to assure functional and temporal correctness. For checking temporal system behaviour, real-time scheduling analysis has been proved to be an efficient method. As an analytical method, real-time scheduling relies on rather simple task network models mostly ignoring functional behaviour in order to remain computable and efficient. Functional and temporal system behaviour however are often closely related. By abstracting from functional behaviour, scheduling analysis often results in large over-approximation for such systems. We propose a task network model providing extensions to describe also functional system behaviour. The main elements are explicit data objects and tasks with internal states and data dependant executions. Since there are no analytical methods known to be available for such extended models we propose an analysis based on a combination of model-checking and testing. Although this technique does not provide exhaustive verification, it is a first step towards time-accurate analysis of complex realtime systems. Moreover, the approach provides a convenient way to check systems against functional and temporal requirements in contrast to analytical methods that are usually restricted to simple temporal properties like deadlines.
2	003654	**Efficiently Migrating Real-Time Systems to Multi-Cores** *Farhang Nemati, Moris Behnam, Thomas Nolte* Power consumption and thermal problems limit a further increase of speed in single-core processors. Multicore architectures have therefore received significant interest. However, a shift to multi-core processors is a big challenge for developers of embedded real-time systems, especially considering existing “legacy” systems which have been developed with uniprocessor assumptions. These systems have been developed and maintained by many developers over many years, and cannot easily be replaced due to the huge development investments

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		they represent. An important issue while migrating to multicores is how to distribute tasks among cores to increase performance offered by the multi-core platform. In this paper we propose a partitioning algorithm to efficiently distribute legacy system tasks along with newly developed ones onto different cores. The target of the partitioning is increasing system performance while ensuring correctness.
3	002682	**MLCCA - Multi-Level Composability Check Architecture for Dependable Communication over Heterogeneous Networks** *Michael Schulze, Georg Lukas* During the design of complex networked systems, it is cruical to ensure the composability of the de- ployed applications and network protocols. Special care has to be taken to provide non-functional requirements like bandwidth and latency. Existing solutions only tackle this problem during the design phase; later refactoring or added components are not covered, potentially causing QoS violations. We propose MLCCA, a multilevel architecture which complements the design-time composability checks with additional automatic checks performed at compile-time and at run-time. The required infrastructure is embedded into our communication middleware FAMOUSO, making it transparent to application developers. The architecture has been evaluated in a tele-operated mobile robot case study. If the QoS attributes could not be fullled due to refactoring or changed conditions, no communication was allowed by the middleware, ensuring that the application could enter a fail-safe state. No data was sent over insufficient channels. Thus, our combination of FAMOUSO and MLCCA enables the sustainable deployment of complex networked systems.
4	002747	**The DLR-ORECOP Real-Time Replication Control Protocol** *Anis Haj Said, Bruno Sadeg, Bechir Ayeb, Laurent Amanton* Many real-time applications need data services in distributed environments. Providing such data services is a challeging task due to long remote data accessing delays and stringent time requirements of real-time transactions. In this paper, we use data replication in distributed realtime database systems in order to improve meeting these stringent requirements and fault tolerance . We propose an optimistic replication control protocol, called DLRORECOP (Dynamic Level of Replication with Optimistic REplication COntrol Protocol), which finds a trade-off between updating replicas and meeting user transactions deadlines. We introduce a list, called List of Available Copies (LAC), associated with each data item in the database which contains the identifiers of the most updated replicas. Fault tolerance is provided by building LACs dynamically according to transactions executions and system load, giving then the real-time database a dynamic level of replication. The experimental results show that among the replication control protocols evaluated, DLR-ORECOP provides the best performance for a variety of workloads and system configurations. In addition, the experimental results show that DLR-ORECOP performances are not significantly affected by the loss of update messages.
5	000728	**A Data-Entity Approach for Component-Based Real-Time**

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		Embedded Systems Development *Andreas Hjertström, Dag Nyström, Mikael Sjödin* In this paper the data-entity approach for efficient design-time management of run-time data in componentbased real-time embedded systems is presented. The approach formalizes the concept of a data entity which enable design-time modeling, management, documentation and analysis of run-time data items. Previous studies on data management for embedded real-time systems show that current data management techniques are not adequate, and therefore impose unnecessary costs and quality problems during system development. It is our conclusion that data management needs to be incorporated as an integral part of the development of the entire system architecture. Therefore, we propose an approach where run-time data is acknowledged as first class objects during development with proper documentation and where properties such as usage, validity and dependency can be modeled. In this way we can increase the knowledge and understanding of the system. The approach also allows analysis of data dependencies, type matching, and redundancy early in the development phase as well as in existing systems.

T3-5. Control

Chairs: Pau Marti and Roberto Passerone

Room A02 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	002178	**Improving Task Responsiveness with Limited Preemptions** *Yifan Wu, Marko Bertogna* The optimality of preemptive EDF scheduling with relation to the achievable system utilization is a clear advantage of this scheduling policy for single processor realtime systems. However, recent works suggested that the run-time behavior of EDF might be improved by limiting the preemption support only to particular time instants, dividing each task into a sequence of non-preemptive chunks of execution, without affecting the schedulability of the system. In this paper, we will take a closer look to limited preemption EDF scheduling (LP-EDF), evaluating the potential advantages offered by this policy in terms of responsetime reduction and improved control performances. In particular, we will show how to increase the responsiveness of a control application by placing non-preemptive regions of maximal length at the end of the code of selected tasks. The effectiveness of the proposed method will be proved both analytically and by extensive simulations.
2	002836	**Designing Real-Time Embedded Controllers using the Anytime Computing Paradigm** *Andrea Quagli, Daniele Fontanelli, Luca Greco, Luigi Palopoli, Antonio Bicchi* In this paper we present a methodology for designing embedded controllers with a variable accuracy. The adopted paradigm is the so called any-time control, which derives from the computing paradigm

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		known as “imprecise computation”. The most relevant contributions of the paper are a procedure for designing an incremental control law, whose different pieces cater for increasingly aggressive control requirements, and a modelling technique for the execution platform that allows us to design provably correct switching policies for the controllers. The methodology is validated by both simulations and experimental results.
3	001864	**Methodology and tools for controller-networking codesign in WirelessHART** *Joonas Pesonen, Haibo Zhang, Pablo Soldati, Mikael Johansson* This paper describes a methodology for controller and communication scheduling co-design in control systems operating over wirelessHART networks. Data collection and dissemination operations are identified and scheduled to minimize the nominal communication latency. Techniques for improving the reliability of the network when link transmissions are unreliable are discussed, and a Markov-chain model for computing the latency distribution of data collection operations for a given schedule is proposed. The resulting latency models allow to represent the networked control loop as a jump-linear system, whose performance can be analyzed using techniques from stochastic control. We demonstrate how this framework can be used to co-design a networked LQG controller for a five-by-five MIMO control loop.
4	002208	**First Order Observers in Event-Based PID Controls** *Volodymyr Vasyutynskyy, Klaus Kabitzsch* Event-based sampling allows reducing the number of triggered events in networked control systems, promising better resource utilization. However, the resulting irregular samples lead to uncertainty in controller about the plant state between samples, which may strongly degrade the quality of control if standard PID controllers are used. The inter-sample plant behavior can be estimated using state observers, but the precise observers of higher orders require complex design, large computational efforts at runtime and are sensitive to the disturbance characteristics. This paper proposes using the simplified observers of first order to overcome the drawbacks of higher order observers. The properties of the simplified observers are investigated for different parameters based on simulations.

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Track 4. Automated Manufacturing Systems

T4-1. Control I
Chairs: Armin Zimmermann and Joaquín Ezpeleta
Room A03 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	002739	**Reference traces by simulation for Tracking Control-logic** *Jesus Trujillo, Pawel Pawlewski, Zbigniew J. Pasek* The controls for reconfigurable manufacturing systems RMS have to be capable not only of identifying exceptions on-line, but also simultaneously developing on-line strategies for unpredictable customer orders or inaccurate estimate of processing times. Trace-driven simulators are an efficient alternative but maintaining large traces can present storage and portability problems. This paper proposes a distribution-driven trace generation methodology as an alternative to traditional trace-driven simulation. An adaptation of the Least Recently Used Stack Model is used to concisely capture the key locality features in a trace and a two-position Markov chain model is used for trace generation. Simulation and analysis of a variety of RMS application traces demonstrate the characteristics of the synthetic traces should be generally very well preserved and similar to their real trace, and we also highlight the potential performance improvement over Tracking Control-Logic.
2	002585	**Implementation Of Supervisory Control Systems Based On State Machines** *Moacyr Possan, André Leal* This paper presents a new methodology for the implementation of discrete event-based control systems. An algorithm is proposed to transform an automata-based supervisor obtained from the Supervisory Control Theory (SCT) in a Mealy finite state machine. This machine may be simplified in order to have a reduced number of state transitions. The machine simplification represents a formal method for a discrete event control system to be implemented in a controller. It is presented an example of a manufacturing system to illustrate such procedure. The implementation of the control for this system is performed in Ladder, a useful language for Programmable Logic Controllers (PLCs). The methodology may be expanded to other programming languages and controller types as well.
3	001775	**Hierarchical Control of Production Flow based on Capacity Allocation for Real-Time Scheduling of Manufacturing Systems** *Karim Tamani, Reda Boukezzoula, Georges Habchi* This paper considers the modelling and simulation of a hierarchical production-flow control system. It uses a continuous control approach for machine capacity allocation at the design level and real time scheduling at the shop-floor level. Particularly, at the design level, the control of machine throughput has been addressed by a set of

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		distributed and supervised fuzzy controllers. The objective is to adjust the machine's production rates in such a way that satisfies the demand while maintaining the overall performances within acceptable limits. At the shop-floor level, the problem of scheduling of jobs is considered. In this case, the priority of jobs (actual dispatching times) is determined from the continuous production rates through a discretisation procedure. A case study demonstrates the efficiency of the proposed methodology through a simulation case study.
4	001953	**Integration of a Heterogeneous Low Level Control in a Multi-Agent System for the Manufacturing Domain** *Wilfried Lepuschitz, Mathieu Vallée, Munir Merdan, Pavel Vrba, Jürgen Resch* Currently employed manufacturing systems are very often historically grown systems that can comprise several different technologies of control software. Linking these diverse control subsystems in the manufacturing domain is therefore of vital importance to ensure the system's functionality. In this paper we introduce an agent-based approach with agents that integrate a High Level Control layer and a Low Level Control layer using a generic interface. Three use-cases are presented that illustrate the application of existing Low Level Control solutions. The shown communication concept offers a feasible way for integrating these different types of Low Level Control in a multi-agent system for the manufacturing domain. This allows to reduce the domain's complexity and to handle its heterogeneous nature.

T4-2. Control II
Chairs: Francisco Maciá-Pérez and Daniele Guidi

Room A03 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	000531	**Controllability for Siphons in S3PGR2** *Daniel Y. Chao* Insufficiently marked siphons cause deadlocks in FMS. To avoid deadlocks, monitors and control arcs are added upon these siphons. The number of such siphons grows exponentially with the size of the net modeling the FMS. Li et al. propose to add monitors only to elementary siphons (linear complexity) and indicated that it may be extended to weighted resource allocation systems (RAS). Computational efforts are required to select elementary siphons among all problematic siphons and to express the characteristic T-vector of each dependent siphon in terms of the linear summation of those of elementary siphons. We discovered earlier that elementary (resp. dependent, called compound), called basic siphons in an S3PR (systems of simple sequential processes with resources) might be synthesized from elementary (resp. compound) resource circuits. This has the advantage of avoiding the above computation. However, this no longer holds for those in an S3PGR2. This paper revises the definition of elementary siphons so that basic and compound siphons in an S3PGR2 (systems of simple

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		sequential processes with general resource requirements) remain to be elementary and dependent siphons, respectively. In addition, we will derive the exact controllability (both sufficient and necessary) so that the subsequent IP (Integer programming) test can be eliminated.
2	000779	**A Modular System Approach to DES Synthesis and Control** *Frantisek Capkovic* A modular approach to synthesis and control of DES (discrete-event systems) is proposed and tested1. The modules of flexible manufacturing systems (FMS) are modelled by place/transition Petri nets (P/T PN) and assembled in order to cooperate in the framework of subsystems of the global FMS. From system theory point of view PN models are understand to be subsystems (agents) of the global system (multi agent system). Both the author's previous results and existing knowledge in the area of supervisory control are utilized on this way. The applicability of the approach is demonstrated by examples.
3	001708	**SOAR-based Sequence Control for a Flexible Assembly Cell** *Tobias Kempf, Werner Herfs, Christian Brecher* For a long time self-optimizing production systems have been proposed as a contribution to make production processes more adaptive while keeping them synchronized towards a global goal. As today's industrial automation is identified as a bottle-neck, a control framework which is built around the cognitive platform SOAR is introduced in this paper. The main idea is the provision of a model-based approach to explicitly describe the application task and a control architecture which is able to generate adequate (or even optimal) action- flows to achieve the task. As an illustrative scenario a robot based handling cell is presented.
4	002755	**Supervisory Control Implementation into Programmable Logic Controllers** *André Bittencourt Leal, Diogo L. L. da Cruz, Marcelo da Silva Hounsell* This paper deals with the implementation of supervisory control of discrete event systems into Programmable Logic Controllers (PLCs). It discusses the problems that arise in this type of implementation and presents an implementation methodology that solves these problems. The local modular approach is used to synthesize the supervisors and a case study problem is presented as an example.

T4-3. Petri Nets
Chairs: Davide Giglio and Bo Svensson

Room A03 - *09:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	001651	**Improving real-time identification of Petri Nets using timing information** *Francesco Basile, Pasquale Chiacchio, Gianmaria De Tommasi*

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		This paper deals with the problem of identifying a Petri net system given an observed sequence of events generated by it and an observed sequence of output vectors associated to the marking of the measurable places. The problem is not new in the literature. The original contribution of this work consists in the use of the timing information associated to the net so as to improve its identification. The fact that a transition has not fired for a time larger than its expected delay is here exploited to obtain a list of counterexamples, i.e. the strings that does not belong to the language, even if a whole language is not known. This accelerates the identification procedure. The problem of identifying a λ-free labeled Petri net system is here considered, that is the identification of a net where a label may be associated to more than one transition, and no transition may by labelled with the empty string.
2	001988	**Performance evaluation of discret event systems using P-time event graph** *Abdelhak Guezzi, Philippe Declerck* The dater equalities constitutes an appropriate tool which allows a linear description of timed event graph in the field of (max,+) algebra. This paper give an equivalent model in the standard algebra. The application of a variant of Farkas'lemma allow the necessary condition of existence of upper and lower bounds of the cycle time. A linear programming defined on the particular incidence matrix of the P-time event graph are used to compute the cycle time.
3	002321	**An Approach to Control Generalized Warehouses** *Francesco Basile, Pasquale Chiacchio, Domenico Del Grosso* Generalized warehouses denote complex warehousing systems where several kind of resources, automated vehicles, manned vehicles and on-foot storemen have to execute a list of moving orders. This paper presents an approach to control these systems, which have an increasing relevance in real world but have not been well studied from a scientific point of view. The approach is based on the simulation of a Colored Timed Petri Net model in order to evaluate a set of dispatching rules used to assign the orders to the available resources.
4	002984	**Sequence-detectability analysis of Interpreted Petri nets under partial state observations** *Luis Aguirre, Alejandra Santoyo* In this paper we deal with the observability problem in discrete event systems modeled with interpreted Petri nets (IPN) under partial state observations with both silent and indistinguishable transitions. In particular, we study the sequence-detectability property which is a necessary condition for observability. We provide a characterization of sequence-detectability. This characterization takes into account both structural and dynamic aspects of the IPN model.

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T4-4. Models for Automation Systems
Chairs: Xue-Ming Yuan and Paul Maier

Room A03 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	001376	**Integrated Behavior Models for Factory Automation Systems** *Jewgenij Botaschanjan, Benjamin Hummel, Thomas Hensel, Alexander Lindworsky* Despite the large amount of models for different aspects of factory automation systems, many of these models target at individual and in most cases static aspects of the system, such as the geometry or its electric parts. There is a lack of suitable description methods, which integrate these individual models to a behavior model including spatial aspects and the handling of material. Furthermore, it is important that this model keeps the link to the more detailed individual models and is sufficiently formal in order to allow an automated analysis. This paper provides a solution to this problem by introducing a model which addresses both spatial structure and behavior and is based on a thorough mathematical theory. Complementary, we report on a tool realization of the modelling theory and explain how the model supports the development of mechatronic systems.
2	001406	**A hierarchical and concurrent approach for IEC 61499 function blocks** *Gareth D. Shaw, Partha S. Roop, Zoran Salcic* The IEC 61499 function block standard proposes a new specification language for describing distributed industrial control systems. The standard specifies the use of an execution control chart (ECC) for state control, with algorithm calls for data handling. The design of complex industrial systems such as baggage handling systems can be difficult because of large state-spaces or complicated component interactions. Additionally, the flat state machines used in the standard do not provide a simple method for specifying error handling within the process's execution. State machines from synchronous languages, however, have hierarchy and concurrent constructs to aid the developer. This paper presents a Hierarchical and Concurrent extension to ECCs, which we call HCECCs, which presents new design constructs adapted from synchronous languages in order to improve system specification with function blocks. The semantics of HCECCs, which are backward compatible with the standard, are described and design using HCECCs is compared with other specification approaches.
3	001465	**Automation Component Aspects for Efficient Unit Testing** *Dietmar Winkler, Reinhard Hametner, Stefan Biffl* Automation systems software must provide sufficient diagnosis information for testing to enable early defect detection and quality measurement. However, in many automation systems the aspects of automation, testing, and diagnosis are intertwined in the code. This makes the code harder to read, modify, and test. In this paper we

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		introduce the design of a test-driven automation (TDA) component with separate aspects for automation, diagnosis, and testing to improve testability and test efficiency. We illustrate with a prototype, how automation component aspects allow flexible configuration of a "system under test" for test automation. Major result of the pilot application is that the TDA concept was found usable and useful to improve testing efficiency.
4	001643	**Semantic-driven Manufacturing Process Management Automation** *Francisco Maciá-Pérez, Virgilio Gilart-Iglesias, Antonio Ferrándiz-Colmeiro, José Vicente Berná-Martínez, Jorge Gea-Martínez* The maturity of IT, in conjunction with certain modern theories about Business Processes Management (BPM), has propitiated an appropriate scenario for meeting the needs of new business models, which are increasingly centred on mass customization. Integration solutions provided within the framework of manufacturing organisations have opened up a wide range of possibilities in process management, which, paradoxically, is causing the traditional bottleneck between the enterprise level and production levels to now be transferred to the process management and modelling levels. This paper proposes the incorporation of knowledge into the definition of the processes and services involved by means of an ontology, thus maximising the automation of process modelling and facilitating the work of process engineers.
5	001872	**Hierarchical and cooperative approaches to logic control design in industrial automation** *Andrea Tilli, Andrea Paoli, Matteo Sartini, Claudio Bonivento, Daniele Guidi* In this work a general partitioning of logic control design strategies into two main approaches, cooperative and hierarchical, is proposed and some lines for a comparison are drawn. In the authors' opinion, the cooperative approach basically collects methods inspired by IEC 61499 and agent paradigms while, the hierarchical ap- proach, generally collects design procedures inspired by IEC 61131. Among the elements of the latter category, particular attention is devoted to the design methodology based on the Generalized Actuator framework, recently proposed by the authors. A case-study is considered to derive some starting considerations on the properties of the considered approaches.

T4-5. Optimization

Chairs: Athanasions P. Kalogeras and Nathalie Sauer

Room A03 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001597	**Simulation Based Optimization of a Sheet-Metal Press Line** *Bo Svensson, Fredrik Danielsson, Bengt Lennartson* An off-line optimization of a sheet-metal press line is performed with

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		improved production performances, both in terms of increased production rate and smoother robot motions. Smooth motions prevent the sheet-metal to slide out of position or even fall out, thereby causing lengthy down times. The simulation based method use a process optimizer connected to a time synchronized virtual manufacturing model including real industrial control systems, e.g. PLC. The key benefit herein is that all tuned control system parameters can be directly downloaded to the real press line without any postprocessing or transformations. The challenge to find suitable optimization algorithms for a press line that handle highly nonlinear, discontinuous functions; considerable number of parameters; and long evaluation times is reached.
2	002119	**Service rate optimization in inventory-production systems with time-varying and incomplete deterministic demand** *Davide Giglio, Riccardo Minciardi, Simona Sacone, Silvia Siri* A specific class of production systems is considered in this paper with the aim of minimizing inventory and production costs, over a finite horizon. In such a class of systems, all processes (arrival and departure of parts, production, demand to be satisfied) are modelled as piece-wise constant functions that change their values at asynchronous time instants. The decision variables are the constant rate at which raw parts enter the system and the service rate at the various time instants. In the paper, both the case of completely known demand and that of incomplete demand is taken into account. In both cases, a solution algorithm is provided in order to determine the optimal (or sub-optimal, in case of incomplete demand) solution of the optimization problem.
3	002798	**Optimal Number of Pallets for Reconfigurable Cyclic Manufacturing Plants** *Maziar Mashaei, Bengt Lennartson, Fredrik Sannehed, Göran Abbestam* In a cyclic manufacturing system, the number of pallets in a handling and locating pallet system (HLPS) can have a huge effect on the production cycle time. The complexity of calculating the optimal number of pallets that satisfies the minimal cycle time poses a challenging design problem. In this paper the optimal solution is presented for deterministic cyclic manufacturing systems having determined schedule of tasks for multi-product applications. Furthermore, a specific domain which includes the optimal number of pallets is obtained for any arbitrary schedule of various product types in an HLPS. To verify the optimal solution, a reconfigurable Colored Petri Net (CPN) model is developed for a simple X85 pallet system. For various cases of machine processing times, the optimal number of pallets is obtained for the suggested framework.
4	003204	**Qualitative stability analysis of an optimal balance for an assembly line with fixed stations number** *Evgeny Gurevsky, Olga Guschinskaya, Alexandre Dolgui* We focus on one of the simple assembly line balancing problems known

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		as SALBP-2 which consists in assigning a set of elementary operations V = {1, 2,…, n} to the m linearly ordered stations with respect to the precedence constraints and aims in minimizing the line cycle time c. The processing times of operations tj , j ∈ V may vary during the life cycle of assembly line for manual operations (represented by set V*) and be fixed for automated operations (set V \ V*). The goal of this paper is to derive necessary and sufficient condition (so-called qualitative analysis) of the stability of an optimal balance found for a given vector of operations times t = (t1, t2,…, tn) with regard to possible independent perturbations of the processing times of the operations from set V*.

T4-6. Planning & Scheduling
Chairs: Olga Guschinskaya and Maziar Mashaei

Room A01 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001287	**Integrated Plan Tracking and Prognosis for Autonomous Production Processes** *Paul Maier, Martin Sachenbacher, Thomas Rühr, Lukas Kuhn* Today's complex production systems allow to simultaneously build different products following individual production plans. Such plans may fail due to component faults or unforeseen behavior, resulting in flawed products. In this paper, we propose a method to integrate diagnosis with plan assessment to prevent plan failure, and to gain diagnostic information when needed. In our setting, plans are generated from a planner before being executed on the system. If the underlying system drifts due to component faults or unforeseen behavior, plans that are ready for execution or already being executed are uncertain to succeed or fail. Therefore, our approach tracks plan execution using probabilistic hierarchical constraint automata (PHCA) models of the system. This allows to explain past system behavior, such as observed discrepancies, while at the same time it can be used to predict a plan's remaining chance of success or failure. We propose a formulation of this combined diagnosis/assessment problem as a constraint optimization problem, and present a fast solution algorithm that estimates success or failure probabilities by considering only a limited number k of system trajectories.
2	001562	**Integrated System for Smart Transport Services** *Athanasios P. Kalogeras, Panagiotis Foundas, Manos Georgoudakis, Konstantinos Charatsis, Panagiotis Konstantinopoulos* Integrated supply chain management presents an advanced inter-enterprise integration business model, seamlessly integrating different involved enterprises ranging from manufacturing industries to retailers and comprising third party logistics and the transport sector. Offering smart transport services addressing safety and security contributes significantly to the transport sector sustainability and enhances the

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		overall inter-enterprise integration scheme. This paper presents an integrated system for the provision of such services utilizing standard open technologies, and comprising a central information system and specially designed embedded systems making trucks / containers "smarter". The system has been validated in the framework of a web-enabled safety / security alarm monitoring application.
3	002526	**Application of EM algorithm to hybrid flow shop scheduling problems with a special blocking** *Kun Yuan, Nathalie Sauer, Christophe Sauvey* In this paper, we consider hybrid flow shop (HFS) scheduling problem with a special blocking constraint. Objective function is makespan minimization. HFS and RCb blocking constraint are firstly presented. Then, an integer linear model is presented to find the optimal solution and a lower bound is proposed for high size problems. In order to faster obtain a solution, especially for big size problems, an electromagnetism-like (EM) algorithm is proposed and some mechanisms are introduced to adapt EM-algorithm to HFS scheduling problems. Its performances are compared with optimal solutions when they have been obtained and lower bound for more complex problems. Opportunity to develop and adapt such a meta-heuristic is clearly demonstrated with presented solutions accuracy and time.
4	002887	**Integration of Perception, Global Planning and Local Planning in the Manufacturing Domain** *Christoph Ertelt, Thomas Rühr, Dejan Pangercic, Kristina Shea, Michael Beetz* Current approaches for factory automation have not yet fully succeeded in realizing an autonomous manufacturing system for mass customized, highly variant products. In this interdisciplinary work between computer science and mechanical engineering departments, the authors report on an integral approach for a cognitive manufacturing system which uses planning, perception and knowledge capabilities to reach a level of flexibility and robustness as found in a traditional human workshop. Integrating a bottom-up approach for local machining planning, a global planning system and a perception system, an autonomously operating manufacturing system can be realized. The integrated approach is validated using a simple yet characteristic example part that demonstrates the potential of the approach and the interplay and interfaces between the methods. Overall, the approach demonstrates that a specialized local planning system for machining can be effectively integrated with a general, global planning system and a perception system and thus be integrated in the manufacturing system.

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Track 5. Industrial Control

T5-1. Industrial Control I
Chairs: Ignacio Peñarrocha and Ramon Costa-Castelló
Room A04 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	003131	**Solving Robust Control Problems using Robust Pole Placement in a Disk** *Michael G. Skarpetis, Fotis N. Koumboulis* The problem of robust pole placement in a specific disk is solved for uncertain polynomials having uncertain degree. This particular problem is used for enhancing the results of many robust control problems based on Hurwitz invariability such as robust stabilizability of uncertain systems via static state feedback, robust asymptotic command tracking, robust PID design, etc.. The present results are successfully applied to control the pressure of a variable displacement hydraulic pump having uncertain leakage flow coefficient through asymptotic command tracking.
2	001236	**Disturbance Observer based Repetitive Controller for Time-Delay Systems** *Na Jing, Ramon Costa-Castelló, Roberto Griñó, Xuemei Ren* This paper presents a discrete control design for time-delay systems subjected to the periodical command signal or exogenous disturbances. Unlike other deadtime compensators (DTC), we take profit of the system components to construct an internal model. In addition, a novel disturbance observer is developed to compensate the effect of disturbances, and thus to achieve tracking and disturbance rejection simultaneously. The possible fractional delay from discretization is also handled by using a fractional delay filter. The stability conditions and robustness analysis under model uncertainties are provided. Two numerical examples including a supply chain management (SCM) is provided to illustrate the feasibility of the results.
3	000809	**Noise Monitoring of Aircrafts Taking off based on Neural Model** *Luis Pastor Sanchez Fernandez, Arturo Rojo Ruiz, Oleksiy B. Pogrebnyak* This work presents a computational model that allows the monitoring of aircraft generated noise. It makes spectral analysis and calculation of statistical indicators, as well as the aircrafts identification based on generated noise. This model also helps to foresee potential effects to health caused by this kind of noise during the aircraft takeoff, which is when the greatest impact are generated due to the sonorous levels that are reached. This model is implemented by means of software in a laptop, a data acquisition card and a calibrated sensor of acoustic pressure. The method can be included in a permanent monitoring system. The data acquisition is made at 25 KHz at 24 bits. The

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		identification of the aircraft noise is done through two parallel neural networks combined with a weighted addition. In order to generate the inputs to the neural networks, parameters that were obtained from the auto-regressive model and the 1/12 octave analysis are used. This system has 13 categories of aircrafts and it has an identification level of 80% in real environments.
4	001198	**Adaptive Compensation Strategy For The Tracking/Rejection of Signals with Time-Varying Frequency in Digital Repetitive Control Systems** *German A. Ramos, Josep M. Olm, Ramon Costa-Castelló* Digital repetitive control is a technique which allows to track periodic references and/or reject periodic disturbances. Repetitive controllers are usually designed assuming a fixed frequency for the signals to be tracked/rejected, its main drawback being a dramatic performance decay when this frequency varies. A usual approach to overcome the problem consists of an adaptive change of the sampling time according to the reference/disturbance period variation. However, this sampling period adaptation implies parametric changes affecting the closed-loop system behavior, that may compromise the system stability. This article presents a design strategy which allows to compensate for the parametric changes caused by sampling period adjustment. Stability of the digital repetitive controller working under time-varying sampling period is analyzed. Theoretical developments are illustrated with experimental results.
5	003158	**Control system and fault detection algorithm for a restored teeth fatigue assay machine** *Ignacio Peñarrocha, Marcos Orellana* In this work, the control system and fault detection algorithm applied on a real fatigue assay machine is addressed. The objective of the machine is to apply periodical forces to restored teeth and to detect the teeth collapse calculating the number of cycles until the fault occurs. There is a Scottish yoke mechanism that converts the torque of a brushless motor on linear forces. This motor is driven by a power drive that receives the torque reference from a computer operating on real-time, and where the fault detection algorithm is applied. There is also a user computer where the parameters of the assay are introduced and where the results are shown. In this work the control system that has been implemented is shown in detail and the developed fault algorithm with adaptive threshold for the system with several sampling times is addressed.

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T5-2. Industrial Control II
Chairs: Ramón Vilanova and Orlando Arrieta
Room A04 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	000639	**Multi-loop PI-based control strategies for the Activated Sludge Process** *Ramon Vilanova, Reza Katebi, Victor Alfaro* This paper proposes a multi loop decentralized control strategy for the control of a wastewater treatment plant based on an Activated Sludge (ASP) model. The ASP is a described by means of a nonlinear model and results on a Two-Input Two-Output multivariable system. Even though advanced control strategies have been presented in the literature, the proposal of this paper is to show that by appropriate tuning of decentralized PI controllers, it is possible to get comparable performance as with other approaches. With this purpose the paper proposes a way of addressing the design of the decentralized controllers as well as a regulation based tuning for a PI controller. Simulations are carried out on the nonlinear model showing the performance of the proposed approach.
2	002097	**On Estimation of Unknown State Variables in Wastewater System** *Abdelhamid Iratni, Reza Katebi, Ramon Vilanova, Mohammed Mostefai* This paper focuses on the estimation of the nonmeasurable physical states of wastewater systems when nonlinear models with uncertainties describe the processes. The Activated Sludge Process (ASP), as the most commonly applied biological wastewater purification technique, attracts a great deal of attention from the research community. We developed for this class of processes a State Dependent Differential Riccati Filter (SDDRF) for state estimation of nonlinear model describing the system. The resulting software sensor is simple to implement and has a relatively low computational cost. The results are compared with the Extended Kalman Filter (EKF) in order to demonstrate the better performance of the SDDRF filter. The filter allows the on-line tracking of process variables, which are not directly measurable. The simulation results point out to the advantage of using this approach.
3	002593	**Non Linear GPC Of a Nuttrient Romoval Biological Plant** *Hicham El Bahja, Pastora Vega, Othman Bakka, Fouad Mesquine* The aim of this work is to estimate and control a biological nitrogen removal process. The paper illustrates the use of a complex nonlinear model in the design of a software sensor and a non linear predictive control technique based on a phenomenalogical model of the process. This model describes the complete dynamics of autotrophic and heterotrophic biomasses, biodegradable organic and nitrogenous matters. The control approach structure is combined with the Kalman Filter, for the on-line reconstruction of unmeasured biological states and unknown parameters of the bioprocess. The efficiency of both the control and estimation are demonstrated via computer simulations.

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4	000108	**Optimal Control for Maximum Power in Thermal and Chemical Systems** *Stanislaw Sieniutycz* This research treats power optimization for energy converters, such like thermal, solar and chemical engines. Thermodynamic analyses lead to converter's efficiency and limiting power. Steady and dynamic systems are investigated. Static optimization of steady systems applies the differential calculus or Lagrange multipliers, dynamic optimization of unsteady systems uses variational calculus and dynamic programming. The primary result of the first is the limiting value of power, whereas that of the second is a total generalized work potential. The generalizing quantity depends on thermal coordinates and a dissipation index, h, i.e. the Hamiltonian of the problem of minimum entropy production. It implies stronger bounds on work delivered or supplied than the classical work of thermodynamics.

T5-3. Industrial Control III
Chairs: Ramón Vilanova and Stefano Piccagli
Room A04 - *09:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	000205	**Guidelines for Controller Structure in the Two Degrees of Freedom VRFT Framework based on a Correlation Test** *José David Rojas, Ramón Vilanova* Data-Driven Control is a methodology that attempts to find a suitable controller, based only on data taken from the system. Within this method, the Virtual Reference Feedback Tuning (VRFT), is a one-shot data-driven approach that transforms the control problem into an identification problem using restricted complexity controllers. However, how to choose the number of parameters, or the relation between them is a subject that often is left apart. In this paper, the VRFT framework is applied to an alternate Two-Degrees-of-Freedom (2DoF) structure and a "Covariance Test" is used in order to find the number of parameters needed. As it was expected, this test shows that the number of parameters is dependent on the way the controller is parameterized. A numerical example is shown at the end of the paper.
2	000566	**On the Practical Implementation of Feedforward Control Signals Given in Polynomial Form** *Stefano Piccagli, Paola Gervasio, Antonio Visioli* A Chebyshev optimization approach can be employed effectively for the determination of the (reference) command input to be applied to a feedback PID control system in order to achieve a minimum-time output transition subject to constraints on both the control variable and the system output. The resulting command input function is given in polynomial form, for which a practical implementation can be difficult. In this paper we propose a method for the determination of a stable low-order filter whose step response approximates the open-loop command

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		signal so that a standard two degree-of-freedom controller results. Simulation examples show that the technique is effective and yields a stable transfer function which can be easily implemented into a DCS control system.
3	001392	**PCA based Pressure control of a Gas Mixing Chamber** *Juan Manuel Escaño, Fernando Dorado, Carlos Bordons* PCA is a popular technique used in model reduction and fault diagnosis and isolation. In this work PCA is used to reduce the dimensionality of a MISO system. The coupling among the variables and the process output is taken into account through the projection into the PCA axis. The technique is applied to a gas mixing chamber in a Copper smelter factory, whose nonlinear behavior and large number of variables involved justify this approach. The control strategy is dened therefore in a straight and simple way making use of this new virtual and reduced system. The controller is simulated using a neurofuzzy model of the process that has been obtained using real data form the plant.
4	001686	**Reset Compensation Applied on Industrial Heat Exchangers** *Angel Vidal Sanchez, Alfonso Baños Torrico* This work aims at improving the control of an industrial heat exchanger used in the thermal treatment in food industry. The goal is to investigate the potentials of a hybrid compensator previously developed by the authors, the PI+CI reset compensator, in the robust control when signicant uncertainty is present. To this end, a PI+CI compensator has been designed by using a two step method: firstly, a base robust PI compensator is tuned by using the Quantitative Feedback Theory to satisfy (robust) relative stability and tracking specifications; and secondly, a partial reset action is added to the lineal PI compensator to improve transitory response. Finally, the reset conditions are simply modified in the PI+CI compensator to overcome the effect of the dominant time delay over the reset action, through the introduction of a reset band which can have fixed or variable values along the time.
5	002151	**Reset Control of an Industrial in-line pH Process** *Joaquín Carrasco, Alfonso Baños, Aurelio Arenas* This work presents a reset/hybrid control application of an in-line pH process. The nonlinear process dynamic is linearized around different operation points, and as a result a Second Order Plus Dead Time (SOPDT) plant with uncertain gain is obtained for control purposes. A standard PI compensator and a reset compensator are designed and tuned. The main result of this work will be to compare the performance of both compensators in basis to practical experiments. As result, the reset compensator is able to overcome fundamental limitations of LTI control with a faster tracking response and improving disturbance rejection.

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T5-4. Industrial Control IV
Chairs: Martin Mertens and Thomas Klotz
Room A04 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	000426	**On the Significance of Fault Tree Analysis in Practice** *Frank Reichenbach, Kjell-Joar Alme, Jan Endresen* With increasing system complexity and extensive use of computerized control of industrial processes and plants, it is essential to have a systematic approach for identifying failures that can expose people and environment for unacceptable risks. With focus on a drive system used to control a linear motor, the fault tree analysis method is utilized to reveal design weaknesses and to find mitigations that can improve the system safety characteristics. Starting with a set of top level hazards, elements with high risk impact are identified, and appropriate mitigations are suggested.
2	000698	**A sensor FDI strategy for safety critical systems** *Ramon Ferreiro Garcia, Javier Perez Castelo, José Luis Calvo Rolle, Andres Piñon Pazos* The research work is focused on sensors fault isolation, exploiting the synergy of functional and physical redundancy. Functional and physical redundancy is applied under a novel methodological approach to isolate individual sensor faults. The contribution uses a heuristic algorithm which combines a rule based strategy associated to a process parameter identification method to be applied on the instrumentation fault detection and isolation task. Implementation procedure is carried out on a pilot plant equipped with supervision facilities from DeltaV, state of the art software, which efficiently manage databases, rule based systems and appropriate identification support tools.
3	001201	**Formal Verification of UML-modeled Machine Controls** *Thomas Klotz, Eva Fordran, Bernd Straube, Juergen Haufe* Programmable Logic Controllers (PLCs) are applied in a wide field of application and, especially, for safetycritical controls. Thus, there is the demand for high reliability of PLCs. Moreover, the increasing complexity of the PLC programs and the short time-to-market are hard to cope with. Formal verification techniques such as model checking allow for proving whether a PLC program meets its specification. However, the manual formalization of PLC programs is error-prone and time-consuming. This paper presents a novel approach to apply model checking to machine controls. The PLC program is modeled in form of Unified Modeling Language (UML) statecharts that serve as the input to our tool that automatically generates a corresponding formal model for the model checker NuSMV. We evaluate the capabilities of the proposed approach on an industrial machine control.

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4	002046	**Plant Asset Management Functions driven by Property Models** *Martin Mertens, Ulrich Epple* During the plant's life cycle, plenty of information is generated manually and automatically, not only in the stage of plant operation. Such information concerns all entities which can be described by property models, for example field devices, functional roles from the P&IDiagram or even software units for process control. This article presents an approach to model these distributed properties in an integrated way. Property information is modeled by statements, which contain important semantics to support diagnosis and asset management related functions. In addition, the model may be used to automatically gain property values of a plant element which does not offer this information a priori. Typically, we address non-intelligent plant elements like pumps or other devices, that do not offer their own measurements. The presented algorithm is designed in a modular way which minimizes the engineering effort and scales with the plant complexity. The approach is already implemented within an industrial environment, realizing a fully automated monitoring application for pumps in a German BP refinery.

T5-5. Industrial Control V

Chairs: Orlando Arrieta and Fernando Morilla

Room A04 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001309	**Setpoint-oriented robust PID tuning from a simple min-max model matching specification** *Salva Alcántara, Carles Pedret, Ramon Vilanova, Weidong Zhang* This communication addresses the setpoint robust PID tuning for stable First Order Processes with Time Delay (FOPTD) from a general min-max model matching formulation. In order to get a standard PID compensator, several choices are possible. This work considers the problem of finding the simplest one, based on conveniently adopting an approximate delay-free model for the FOPTD along with a particularly simple instance of the general model matching problem. The adopted methodology leads to a PID tuning just depending on a single parameter. Attending to common performance/ robustness indicators, this parameter is finally fixed in order to provide an automatic tuning just depending on the model information.
2	000388	**Improved PID Autotuning for Balanced Control Operation** *Orlando Arrieta, Antonio Visioli, Ramon Vilanova* This paper analyzes optimal controller settings for controllers with One-Degree-of-Freedom (1-DoF) Proportional-Integral-Derivative (PID) structure. The analysis is conducted from the point of view of the operating mode (either servo or regulation mode) of the controlloop and tuning mode of the controller. Performance of the optimal tuning settings can be degraded when the operating mode is different from that selected for tuning and obviously both situations can be present in any

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		control system. In this context, a Performance Degradation index is minimized and based on this minimization, an autotuning procedure as a function of the normalized process dead-time is proposed.
3	001546	**Advanced variable structure PI controllers** *Aldo Balestrino, Veronica Biagini, Paolo Bolognesi, Emanuele Crisostomi* With the advance of digital control hardware the simple but effective proportional-integral-derivative (PID) con- trol technology is moving towards a higher level of per- formance and robustness. A more general class of Vari- able Structure (VS) PID has derived from original PIDs to improve their performances and capabilities. This paper revises the main properties of VS regulators and proposes a novel VS PI controller that combines the advantages of popular PIs with the more flexibility of VS controllers. The proposed regulator is compared with the classic PI over several examples taken from the literature, including first, second and fourth order dynamical systems. An experi- mental set-up is implemented on purpose using AVR□ R 32 Microcontrollers in a hardware in the loop approach to validate the simulation results in a more realistic environ- ment.
4	002399	**Anti-windup Coordination Strategies for Multivariable PID Control** *Fernando Morilla, Juan Garrido, Francisco Vázquez* This paper presents a coordination strategy of antiwindup mechanisms based on conditioning by “input scaling”. It is specially designed to be used in distributed control systems with PID controllers. The study considers three cases of TITO control systems: decentralized control, centralized control with decoupler and centralized control with four PID. In them, the allowable region in the control signal space is transformed into an allowable region in the signal space of PID controllers. In this way, PID controllers are able to keep their integral term at a proper value when actuator saturates. The coordination strategy assures that the control signals are always inside these allowable control regions. The proposed methodology is applied to two representative processes.

T5-6. Industrial Control VI
Chairs: María Jesús Fuente and Frank Reichenbak

Room A02 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001716	**Fault detection and identification method based on multivariate statistical techniques** *Maria Jesus Fuente, Diego Garcia-Alvarez, Gregorio Sainz-Palmero, Thamara Villegas* Multivariate statistical methods such as principal component analysis (PCA) and partial least squares (PLS) have been widely applied to the statistical process monitoring and their effectiveness for fault detection

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		is well recognized, but they have a drawback: the fault diagnosis. In this paper a new method to detect and diagnosis faults is proposed that is composed of two parts: first the PLS method is used for detecting faults and the Fisher's discriminant analysis (FDA) is used for diagnosing the faults. FDA provides an optimal lower dimensional representation in terms of discriminating between classes of data, where, in this context of fault diagnosis, each class corresponds to data collected during a specific, known fault. A real plant is used to demonstrate the performance of the proposed method.
2	002186	**Application of a Model Based Fault Isolation Method for Nonlinear Dynamic Systems** *Dimitrios Fragkoulis, Zetao Li, Gilles Roux, Boutaib Dahhou* The goal in many fault isolation schemes is to decrease the isolation and identification time. The mathematical model of the physical system is the information available before hand. This paper presents the application of a nonlinear model based adaptive observer design to help in the isolation of faults in parameters of nonlinear dynamic systems. The method uses parameter partition and it fits many kinds of nonlinear dynamic systems. One important assumption is the monotonicity of the nonlinear function. The simulations results of an alcoholic fermentation model are used to demonstrate the method validity.
3	002305	**Identification of process models and controller design for vacuum coating processes with a long dead time using an identification tool with advisory support** *Helmuth Kubin, Thomas Unkelbach, Manfred Benesch, Frank-Holm Rögner, Alexander Dementjev, Klaus Kabitzsch, Christoph Metzner* Model identification and controller design for processes with long dead times requires the availability of tools which support static, dynamic and time series analysis as well as data preparation methods (e.g. dead time correction, filtering algorithms, etc.). ADM, a tool for process identification yields this functionality introducing a new philosophy of usability. In this article this philosophy is described using the example of identifying a process model for an electron beam physical vapor deposition (EB-PVD) coating process of metall stripes with a long dead time. Furthermore a controller design for this process is presented.
4	002348	**Avoiding heaters saturation-to-zero in temperature regulators** *Jose Ospina, Enrico Canuto, Wilber Acuña Bravo* A method is provided for avoiding heater saturation-to-zero in the design of automatic temperature regulators where both thermoelectric coolers (TEC) and heaters are used. The analysis is developed around a lumped parameter thermal model and the results are given for steady-state conditions. The particular case in which TEC commands should be found to avoid heater saturation is considered. A practical example is included.
5	002364	**Temporal Problem of Subcontracting of Manufacturing Unit under Joint Production Control and Maintenance Policy**

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		Mohammed Dahane, Christian Clementz, Nidhal Rezg In this paper, we consider a repairable production unit subject to random failures, which supplies input to a direct (main) customer. The production unit is submitted to a preventive maintenance action at instants kT (k=1,2,..). The corrective and preventive maintenance actions have random durations. In order to maximize the use of production capacity of the unit, it was decided to allocate it to perform periodic tasks of subcontracting for a contractor. A buffer stock is built up in order to guarantee a continuous supply of customer demand at a constant rate during repair and preventive maintenance actions, and subcontracting periods. We determine analytically the optimal instant to begin subcontracting which minimize the total average cost per time unit.

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Track 6. Computational Intelligence and Modern Heuristics in Automation

T6-1. Intelligent Knowledge Based Systems and its Applications
Chairs: Alireza Sadeghian, Alexander Holland and Milos Manic

Room A11 - *09:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	004723	**A Knowledge Based Decision Support Architecture for Designing Brushless DC Motors** *Vahab Akbarzadeh, Alireza Sadeghian* This paper presents a knowledge based decision support system that can be used to design brushless DC motors. A hybrid approach, that includes an object oriented paradigm using frames and procedural attachments together with a rule based mechanism, is used to build the proposed architecture. The design strategy is implemented using a rule-based successive iterative method, through which the expert designer approach is emulated and embedded in a knowledgebased system. The performance of the proposed system is compared with results from the literature.
2	001384	**Knowledge-Based Feedback Integration to Facilitate Sustainable Product Innovation** *Alexander Holland, Madjid Fathi* Since real product use information is not available, Design Simulation and Design Methods rely in many ways on assumptions regarding the product use today. These assumptions generally differ from the real conditions of product use. There are various reasons for not feeding back product use information. First, current business models lead to a loss of access to the product after sale. Second, due to their price and size appropriate sensors are only rarely embedded in the product. Third, there is a lack of an integrated framework for feeding back product use information into product development. This paper presents a new solution approach for the integration of product use information into product development. The first part of the paper provides a summary of the developed solution. While aspects like data management and knowledge discovery have been covered in previous work, this paper focuses on the representation of empirical product use information and the use of knowledgebased inference methods in order to carry out “What-If” analyses. These can serve the product developer to improve the design of next generation products.
3	000787	**Integration of Knowledge Discovery Techniques in the Quality Management Model to Achieve Higher Target Quality** *Fazel Ansari Ch., Christian Sassenberg, Ralf Montino, Madjid Fathi* Improving the quality of products is an important issue in the modern business world. Traditional approaches of Quality Management (QM)

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		are not adequate to fulfil the demands on target quality of products. This study reveals that synergetic approaches based on the integration of Knowledge Management (KM) in Total Quality Management (TQM) have a direct impact on enhancing the quality of products. We also propose a management model to synthesize elements of both methodologies under an integrative framework. Furthermore, Knowledge Discovery in Databases (KDD) is introduced to realize the effectiveness of the proposed management model and to illustrate the influence of this synergetic approach taking the semiconductor industry as exemplary field of application.
4	002429	**A Framework for Case-Based Diagnosis of Batch Processes in the Principal Components Space** *Xavier Berjaga, Álvaro Pallarés, Joaquim Meléndez* This paper presents a framework for fault detection and diagnosis of batch processes based on the information directly gathered from sensors. First, a statistical model of the process is build using Multiway Principal Component Analysis (MPCA) for dimensionality reduction and fault detection tasks. Afterwards, a Case-Based Reasoning (CBR) approach is used for fault diagnosis and for false alarm and missed detection reduction. This framework has been tested in two completely different fields: Power Quality Monitoring for relative location of voltage sags and Injection Moulding Processes for faulty sensor detection and diagnosis. Results obtained show that this framework presents a good performance and is general enough to be applied to any field, if the appropriate preprocess of the data is carried.

T6-2. Multiobjective Optimization Systems using Evolutionary Techniques
Chairs: A. Cemal Oezluek, Juan José Cárdenas and Beatriz Lopez

Room A03 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	002453	**Automated Design of Room Automation Systems by using an Evolutionary Optimization Method** *A. Cemal Oezluek, Henrik Dibowski, Klaus Kabitzsch* The design of room automation systems is a challenging task with growing complexity and a high optimization potential. On the market, a high number of prefabricated devices from different manufacturers is available for a large variety of functions. This leads to a high number of device combinations and many design variants respectively, that should optimally realize the requirements. To overcome this problem, an efficient and scalable solution method is needed, that can create multi-vendor designs with high quality. In this paper, a method that deals successfully with this objective is presented including test results. With the abstract design of the system and additional requirements given, it can synthesize optimal multivendor system designs by using an efficient evolutionary algorithm with directed operations.

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2	002801	**A Multi-Objective GA to Demand-side Management in an Automated Warehouse** *Juan José Cárdenas, Antoni García, Luis Romeral, Julio Urresty* The simultaneous operation of the automated storage and retrieval machines (ASRs) in an automated warehouse can increase the likelihood that high power demand peaks turn unstable the electric system. Furthermore, high power peaks mean the need for more electrical power contracted, which in turns leads to more fixed operation cost and inefficient use of the electrical installations. In this context, we present a multi-objective genetic algorithm approach (MOGA) to implement demand-side management (DSM) in an automated warehouse. It works minimizing the total energy demand, but without increasing substantially the time for the operation. Simulations show the performances of the new approach.
3	001066	**A Constraint-based Model for Multi-objective Repair Planning** *Irene Barba, Carmelo Del Valle, Diana Borrego* This work presents a constraint based model for the planning and scheduling of disconnection and connection tasks when repairing faulty components in a system. Since multi-mode operations are considered, the problem involves the ordering and the selection of the tasks and modes from a set of alternatives, using the shared resources efficiently. Additionally, delays due to change of configurations and transportation are considered. The goal is the minimization of two objective functions: makespan and cost. The set of all feasible plans are represented by an extended And/Or graph, that embodies all of the constraints of the problem, allowing non reversible and parallel plans. A simple branch-and-bound algorithm has been used for testing the model with different combinations of the functions to minimize using the weighted-sum approach.
4	002135	**Mathematical Programming Model and experiment of City and Urban Traffic System** *Takuya Matsumoto, Hisashi Tamaki, Tsutomu Inamoto* This paper deals with mathematical programming model of city and urban traffic. The aim of our research is to aquire ideal images of city and urban traffic for various purpose. To achieve the aim, we propose optimization models which consist of city, mobilities and inhabitants in the first place. Two kinds of models distinguished by accuracy and computation time are proposed. One is relatively accurate but takes a lot of time to compute. The other is less accurate, however, larger size instances can be computed. To confirm the proposed models, several scenarios which have excessive conditions are examined.
5	000124	**Automation of Automation - Definition; Components and Challenges** *Stefan Schmitz, Markus Schluetter, Ulrich Epple* The increasing number and range of automation functions along with the decrease of qualified personal makes an upgraded engineering process necessary. This article gives a general overview of one

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		approach, called the Automation of Automation, i.e. the automated execution of human tasks related to the engineering process of automation systems. Starting with a definition and a model describing the typical engineering process, some solutions for the needed framework are presented. Occurring problems within parts of this process model are discussed and possible solutions are presented.

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Track 7. Intelligent Robots & Systems

T7-1. Computer Vision
Chairs: Leopoldo Armesto and Alberto Ortiz
Room A11 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	002143	**Automation of Industrial Vehicles: A Vision-based Line Tracking Application** *Leopoldo Armesto, Josep Tornero* This paper presents some intermediate results of a Research Project regarding with Auto-Guided Vehicles (AGVs) and vision-based guidance. The paper describes three different degrees of autonomy, form the basic one to the full autonomous one. In particular, the paper focuses on the intermediate degree of autonomy, named as “Guided” driving, which includes several types of application under the same approach such as manualassisted driving, teleoperated driving and a vision-based line tracking application. The paper describes on the line-tracking problem with AGVs where a simple and robust line detection algorithm has been described and implemented on an embedded vision system. It also describes a line tracking control algorithm, which has been validated through experimental and simulation data. Finally, the paper discusses future work in the context of the project.
2	003107	**Influence of Surface Material on the Quality of Laser Triangulation Digitized Point Clouds for Reverse Engineering Tasks** *David Blanco, Pedro Fernández, Eduardo Cuesta, Sabino Mateos, Natalia Beltrán* Laser triangulation systems (LTS) are one of the most popular non-contact inspection techniques. These systems are widely used in reverse engineering tasks as they allow for a fast acquisition of thousands of points that represent the geometry of the part in a virtual 3D model. The accuracy and repeatability of these systems are lower than the traditional contact inspection techniques, as they depend on the surface properties, the illumination conditions and the LTS configuration. Present work deals with the influence of surface material on the quality of the virtual model. The objective is to evaluate the behaviour of different materials and their suitability for being digitized.
3	003026	**Visually Guided Robot for Radiator Sealing** *Félix Miguel-Trespaderne, Eusebio de la Fuente-López* A robotic vision-guided system that permits to manipulate different mixed parts is described in this paper. In order to work on a wide range of sizes and without stopping the products the industrial robot is equipped with two vision systems. A fixed vision system acquires a global image of the approaching radiators and computes a first pose estimation. This estimation is used for the robot to approach to the part and a second system, mounted on the robot arm, acquires a closer

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		image to determine precisely the position and orientation just before the manipulation is performed. The developed system is working nowadays in an industrial line making it possible to robotize a complex task without using costly and inflexible fixtures.
4	003328	**Validation of Stereo Matching for Robot Navigation** *Jörgen Lidholm, Giacomo Spampinato, Lars Asplund* This paper presents results from experiments on vi- sual stereo matching for robot navigation. Visual fea- tures are stereo paired with respect to their pixel position. Stereo triangulating all paired visual features results in a set of landmarks whereof a subset are true landmarks. Constraining the horizontal disparity limits the amount of spurious matches. The stereo matching is validated by finding which landmarks survives short motions measured with a complementary navigation system, like odometry, thus transferring the stereo matching problem from two to three dimensional space and robot motion is estimated from the landmarks surviving the motion. The results from our experiments show that the spurious matching algo- rithm for stereo matching validation works and that the system is able to estimate the motion.

T7-2. Robotics I
Chairs: Dietrich Paulus and Gabriel Oliver
Room A03 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	002704	**Elliptical Point to Point Trajectory Planning using Electronic Cam Motion Profiles for High Speed Industrial Pick and Place Robots** *Rene J. Moreno Masey, John O. Gray, Tony J. Dodd, Darwin G. Caldwell* As the speed of industrial pick and place robots continues to increase, new trajectory planning strategies will need to be developed in order to optimise the dynamic characteristics of high speed motion. The use of elliptical pick and place cycles coupled with a Modified Sine cam motion profile is proposed and compared to the traditional rectangular cycle with trapezoidal velocity profile. The elliptical cycle exhibits very smooth, continuous motion curves. Asymmetric acceleration can optionally be specified to reduce peak joint torques and increase maximum pick and place speed.
2	001325	**Immersive 3-D Teleoperation of a Search and Rescue Robot Using a Head-Mounted Display** *Henrique Martins, Rodrigo Ventura* This paper proposes an alternative approach to common teleoperation methods found in search and rescue (SAR) robots. Using a head mounted display (HMD) the operator is capable of perceiving rectified images of the robot world in 3-D, as transmitted by a pair of stereo

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		cameras onboard the robot. The HMD is also equipped with an integrated head-tracker, which permits controlling the robot motion in such a way that the cameras follow the operator's head movements, thus providing an immersive sensation to him. We claim that this approach is a more intuitive and less error prone teleoperation of the robot. The proposed system was evaluated by a group of subjects, and the results suggest that it may yield significant benefits to the effectiveness of the SAR mission. In particular, the user's depth perception and situational awareness improved significantly when using the HMD, and their performance during a simulated SAR operation was also enhanced, both in terms of operation time and on successful identification of objects of interest.
3	001244	**1-DOF-Robot for Fast and Accurate Throwing of Objects** *Heinz Frank, Anton Mittnacht, Thomas Moschinsky, Friedrich Kupzog* In a research project throwing or shooting is investigated as a new technology for the transportation of objects in production systems. For such an application a 1-DOF-throwing robot with a numerical controlled rotary axis was developed. It can throw objects with masses up to 100 g over distances of more than 10 m. The outstanding feature of the throwing device is, that different angles of throwing and different speeds of throwing can be achieved with only one numerical controlled servo axis. The simple kinematic chain of the robot is also a major reason for achieving a high throwing accuracy. At throwing of tennis balls over a distance of 3 m the accuracy is better than +/- 3 cm. This paper describes the concept, the realization and the test of the throwing robot.
4	001724	**Virtual Machine Vision in Computer Aided Robotics** *Jim Nilsson, Mikael Ericsson, Fredrik Danielsson* In this paper a concept for Virtual Machine Vision is proposed using a commercial Computer Aided Robotics software called RobCad. The system utilizes ideal virtual cameras and lights for the simulation of a real vision system. Sensory data is sent to a vision software for data analysis. The Virtual Machine Vision together with the simulation model can be used to offline programming of a vision system. Experiments have been performed by capturing images of a test piece both in the virtual environment and in a physical experimental rig. To evaluate the concept, image analysis has been performed on these images using the same vision software. The results from the vision analysis of both the virtual and the real images are compared and show good agreement. The proposed system seems to be very promising and further development is ongoing.

T7-3. Robotics II
Chairs: Naoki Uchiyama and Antoni Burguera

Room A11 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors

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1	001805	**Sound Source Tracking and Obstacle Avoidance for a Mobile Robot** *Naoki Uchiyama, Akihiro Yamamoto, Shigenori Sano, Shoji Takagi* Sound source tracking is an important function for autonomous robots, because sound is omni-directional and independent of light. This paper presents a new approach to sound source tracking for mobile robots using auditory sensors. We consider a general type of two-wheeled mobile robot that has wide industrial applications. Because obstacle avoidance is also an indispensable function for autonomous mobile robots, the robot is equipped with distance sensors to detect obstacles in real time. To deal with the nonholonomic constraint of the robot and combine information from the auditory and the distance sensors, we propose a model reference control approach in which the robot follows a desired trajectory generated by a reference model. The effectiveness of the proposed method is confirmed by experiments in which the robot is expected to approach a sound source while avoiding the obstacles.
2	004588	**Robot Localization Method by Acoustical Signal Identification** *Manuel Manzanares, Edmundo Guerra, Yolanda Bolea, Antoni Grau* Non-speech audio is a non-explored characteristic in robot localization but due to its potentiality it can yield a valuable information together with other sensorial systems. In this work, a novel robot localization method is proposed based on audio signal pattern recognition with extracted features from signal identification. To reinforce the localization, avoiding ambiguity and reducing uncertainty, a sensorial system is used aboard the robot to compute the angle between itself and the sound source. This method can be generalized to any non-speech sound signal because the acoustical meaning and the room geometry are related.
3	001414	**Sound Source Localization Using Sparse Coding and SOM** *Hong-shik Kim, Jong-suk Choi* Many kinds of sound source localization systems have been developed for detecting a direction of sound source. They are commonly using time delay of arrival (TDOA) or interaural time difference (ITD) algorithm for sound source localization where, especially, the ITD is the difference in arrival time of a sound between two ears. It is largely changed depending on frequency components of sound even though the sound source is located in the same place. In this paper we propose a binaural sound localization system using sparse coding based ITD (SITD) and self-organizing map (SOM). The sparse coding is used for decomposing given sounds into three components: time, frequency and magnitude. Moreover we estimate the azimuth angle through the SOM. This localization system is installed in our robot that has two ears, head and body. We use PeopleBot as a body of the robot.
4	001996	**Autonomous Mobile Robots Localization with Multiples iGPS Web Services** *Camilo Christo, Edwin Carvalho, Miguel Silva, Carlos Cardeira* Diverse systems have been proposed to aid the navigation of mobile robots in indoor environments. Simultaneously, communication

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		technologies that allow the integration of diverse systems even when these are developed on different platforms, have been proposed. The indoor Global Position Systems (iGPS) Web Service architecture proposed by Christo joins the emerging standard Web Services technologies with the iGPS idea to allow the integration of mobile robots in indoor environments in a fast and easy way. In this paper, we suggest an architecture for the use of multiples iGPS Web Services for mobile robots localization. To emphasize the usefulness of the multiple iGPS web services localization system, an application of localization of mobile robots is presented.
5	001295	**WiFi Localization System based on Fuzzy Logic to deal with Signal Variations** *Noelia Hernández, Fernando Herranz, Manuel Ocaña, Luis Miguel Bergasa, José María Alonso, Luis Magdalena* The goal of this paper is to study some of the most important WiFi signal variations, large and small scale variations and how they affect to WiFi localization systems. Moreover, the paper shows how to use Soft Computing techniques to deal with these uncertainties in WiFi localization systems. This work describes how to reduce uncertainty produced by small scale variations in indoor environments using fuzzy techniques. Some experimental results and conclusions are presented.

T7-4. Control and Automation
Chairs: Vinícius Oliveira and Antoni Grau

Room A04 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001856	**Time-Optimal Trajectory Generation and Contouring Control for Machine Tool Feed Drive Systems** *Kazunori Mori, Naoki Uchiyama, Takuya Honzu, Shigenori Sano, Shoji Takagi* Time-optimal trajectory planning for mechanical systems has been widely studied thus far because of its effectiveness to reduce the time required for many industrial tasks. However, in general, because, the time-optimal trajectory is generated based on ideal dynamics of controlled systems, it may be difficult to implement the obtained trajectory to actual syst4ems with vibration modes that are neglected in the trajectory generation. In other words, high-speed motion based on the time-optimal trajectory may cause the vibration of mechanical systems. We propose to employ the contouring control, which enables to reduce controller gain magnitudes while countouring performance are maintained, for the implementation of optimal trajectory. First, this paper presents a method of generating the time-optimal trajectory for machine tool feed drive systems. Next, the contouring controller is applied to implement the optimal trajectory to the actual machine tool system. The effectiveness of the contouring controller for implementation of the optimal trajectory is demonstrated by comparative experiments with the

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		conventional methods.
2	002518	**Real-Time Predictive Control of a Brachiation Robot** *Vinícius Oliveira, Walter Lages* The present work addresses the problem of real time predictive control of a brachiation robot, considering that the robot is constrained and a multivariable system, which implies a very difficult problem due to the large amount of on-line computation that is required. We show that it is not possible to consider the nonlinear model-based MPC under real-time constraints. Furthermore, to overcome this problem we present a linearized model-based MPC, which is able to be handled under real-time constraints.
3	002127	**Estimation Based Control of Flexible Systems-Sensorless Wave Based Technique** *Islam S.M. Khalil, E. D. Kunt, Asif Sabanovic* This paper presents an algorithm for parameters and positions estimation of lumped flexible systems. As soon as the parameters and the positions are estimated they can be used to design virtual sensors that can be moved along the system to estimate the position of any lumped mass keeping the system free from any attached sensors. The virtual sensors are nothing but a chain of estimators that are connected at the end of each other, starting with two actuator's measurements and ending up with system parameters and all the system lumped positions. An estimation Based PID controller is presented based on the feedback of the virtual sensor's estimates instead of the actual measurement.
4	002933	**A Probabilistic Methodology for Predicting Injuries to Human Operators in Automated Production lines** *Ruslan Asaula, Daniele Fontanelli, Luigi Palopoli* Mobile robots are increasingly utilised in automated plants to the purpose of moving wares and material between the different production lines and logistic areas. In this context, the presence of human operators in the facility is frequently allowed to carry out or supervise some phases of the production. The problem arises of how to make the coexistence possible with controlled risks for the operator and without affecting the productivity with frequent interruptions. In this paper we propose a solution to this problem based on a probabilistic technique. A system of visual sensor (mounted on the mobile robots) detects the presence of a human operator and a discrete abstraction (essentially a discrete-time Markov chain) is used to predict his/her motion and hence find the probability of an accidental injury. For the computation of the latter, we combine the probability of having a collision with a given speed with the probability of receiving an injury out of the collision (taken from physiological models suggested by the automotive literature).
5	003506	**Object selection using a spatial language for flexible assembly** *Batu Akan, Baran Cürüklü, Giacomo Spampinato, Lars Asplund*

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		In this paper we present a new simplified natural language that makes use of spatial relations between the objects in scene to navigate an industrial robot for simple pick and place applications. Developing easy to use, intuitive interfaces is crucial to introduce robotic automation to many small medium sized enterprises (SMEs). Due to their continuously changing product lines, reprogramming costs are far more higher than installation costs. In order to hide the complexities of robot programming we propose a natural language where the use can control and jog the robot based on reference objects in the scene. We used Gaussian kernels to represent spatial regions, such as left or above. Finally we present some dialogues between the user and robot to demonstrate the usefulness of the proposed system.

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WiP 1. Intelligent Robots and Systems

Chairs: Gabriel Oliver, Yolanda González and Alberto Ortiz

Room A13 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	004847	**Building a Qualitative Local Occupancy Grid in a new Vision-based Reactive Navigation Strategy for Mobile Robots** *Francisco Bonin-Font, Alberto Ortiz*
2	005371	**Stereo Vision Based Navigation for Automated Vehicles in Industry** *Giacomo Spampinato, Jörgen Lidholm, Lars Asplund, Fredrik Ekstrand*
3	005355	**New iterative algorithm for hyperbolic positioning used in an ultrasonic Local Positioning System** *F. Daniel Ruiz, Jesús Ureña, Isaac Gude, José M. Villadangos, Juan C. García, M. Carmen Pérez, Enrique García*
4	006017	**Ultrasonic Positioning System by using UWB techniques** *Enrique Garcia, J. Jesus Garcia, Alvaro Hernandez, Ana Jimenez, Jesus Ureña, Daniel Ruiz, M. Carmen Perez*
5	005525	**Efficient hardware implementation for detecting CSS-based Loosely Synchronous codes in a Local Positioning System** *Carmen Pérez Rubio, Jesús Urena Urena, Álvaro Hernández Alonso, Ana Jiménez Martín, Daniel Ruíz, Carlos De Marziani, Fernando J. Álvarez*
6	005959	**Range sensor data fusion and position estimation for the iLoc indoor localisation system** *Stefan Knauth, Christian Jost, Alexander Klapproth*
7	006033	**Magnetic Map Building for Mobile Robot Localization Purpose** *Danilo Navarro, Gines Benet*
8	005835	**Terrain Drivability Analysis in 3D Laser Range Data for Autonomous Robot Navigation in Unstructured Environments** *Frank Neuhaus, Denis Dillenberger, Johannes Pellenz, Dietrich Paulus*
9	005983	**Environmental surface boundary tracking and description using a UAV with vision** *Pablo Lanillos, Gonzalo Pajares, José J. Ruz, Jesús M. de la Cruz*
10	001473	**Fast Learning Algorithm for Gaussian Models to Analyze Video Objects with Parameter Size** *GuoQing Yin, Dietmar Bruckner*
11	004936	**Artificial Intelligence and Image Processing Based Techniques: A Tool for Yarns Parameterization and Fabrics Prediction** *Vítor Carvalho, Filomena Soares, Rosa Vasconcelos*
12	005231	**Compress Image Quality Measures in Image Processing Applications** *Javier Silvestre-Blanes*

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13	004987	**Automata-based modeling and control of a truck and trailer vehicle equipped with a kingpin sliding mechanism** *Stamatis Manesis, Vasileios Deligiannis*
14	005045	**The Mobile Robot "Little Helper": Concepts, ideas and working principles** *Mads Hvilshøj, Simon Bøgh, Ole Madsen, Morten Kristiansen*
15	005053	**A dynamic lighting system for automated visual inspection of headlamp lenses** *Silvia Satorres Martínez, Juan Gómez Ortega, Javier Gámez García, Alejandro Sánchez García*
16	006211	**Design of an Intelligent Field Transmitter** *Juan Gamiz, Antoni Grau, Herminio Martinez-Garcia*

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WiP 2. Industrial Communication Systems

Chairs: Julian Proenza and Lucia Lo Bello

Room A13 - *9:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	004804	**Mapping WirelessHART into PROFINET and PROFIBUS fieldbusses** *Spiro Trikaliotis, André Gnad*
2	005304	**16-Channel-Analyser for parallel IEEE 802.15.4 Monitoring** *Marko Kraetzig, Lutz Rauchhaupt, André Schimschar, Spiro Trikaliotis*
3	006025	**A Proposal towards Flexible Wireless Communication in Factory Automation based on the IEEE 802.15.4 Protocol** *Mario Collotta, Lucia Lo Bello, Emanuele Toscano*
4	005797	**Redundancy Approach to Increase the Availability and Reliability of Radio Communication in Industrial Automation** *Helmut Beikirch, Matthias Voss, Andreas Fink*
5	005908	**Scheduling Relay Nodes for Reliable Wireless Real-Time Communications** *Elisabeth Uhlemann, Thomas Nolte*
6	005495	**An RSU coordination scheme for WAVE safety services support** *Nuno Ferreira, Tiago Meireles, José Fonseca*
7	005754	**Performability Analysis for Fault-Tolerant WiFi Communication System** *Hassanein H. Amer, Magdi S. Moustafa, Ramez M. Daoud*
8	006009	**Enforcing Flexibility in Real-Time Wireless Communications: A Bandjacking Enabled Protocol** *Paulo Bartolomeu, Joaquim Ferreira, José Fonseca*
9	004928	**Security attack analysis of safety systems** *Kai T. Hansen*
10	004901	**The Future Factory Initiative at SAP Research** *Bart-Jan van Putten, Markus Kuestner, Martin Rosjat*
11	004731	**A Java-based remote GUI concept for distributed automation systems** *Johannes Weber, Andreas Rehkopf*
12	005614	**Demonstrating the feasibility of media management in ReCANcentrate** *Manuel Barranco, David Gessner, Julián Proenza, Luís Almeida*
13	005622	**First quantitative results of the dependability improvement achieved by ReCANcentrate** *Manuel Barranco, Julián Proenza, Luís Almeida*
14	005401	**A first design for CANsistant: a mechanism to prevent inconsistent omissions in CAN in the presence of multiple errors** *Julian Proenza, Ernesto Sigg*

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15	005746	**Experiments on timing aspects of DC-Powerline communications** *Pedro Silva, Luis Almeida, Daniele Caprini, Tullio Facchinetti, Francesco Benzi, Thomas Nolte*
16	005878	**A Risk Metric for Designing a Highly Reliable Real-Time Ethernet Network** *Lei Zhang, Robert Lehmann, Zhi Wang*
17	005924	**HSR Performance Evaluation; A pre-Specification Software Implementation** *David Gunzinger, Hans Dermot Doran*
18	000795	**HSR: Zero recovery time and low-cost redundancy for Industrial Ethernet (High availability Seamless Redundancy, IEC 62439-3)** *Hubert Kirrmann, Olivier Kleineberg, Karl Weber, Hans Weibel*
19	001481	**Access to Process Data with OPC-DA using IEC61499 Service Interface Function Blocks** *Federico Perez, Dario Orive, Marga Marcos, Elisabet Estevez, Guadalupe Moran, Isidro Calvo*
20	001058	**Self-configuring adaptive Networks** *Rahil Hussain*

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WiP 3. Computational Intelligence and Robotics

Chairs: Yolanda González and Antoni Burguera

Room A12 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	006157	**Neural Network Real Time Video Processor for Early Aircraft Detection** *Gregory Hauser, Milos Manic*
2	005681	**Neural Network Approach to Locating Cryptography in Object Code** *Jason L. Wright, Milos Manic*
3	005541	**Optimization of Simulated Production Process Performance using Machine Learning** *Andreas Leha, Dejan Pangercic, Thomas Rühr, Michael Beetz*
4	005932	**Implementation of a Transmission Encoding System for a Track Circuit** *Alvaro Hernandez, Maria Carmen Perez, Ana Jimenez, Juan Jesus Garcia, Jesus Ureña, Manuel Mazo*
5	005118	**An Autonomous Robotic System for Load Transportation** *Abdelbaki Bouguerra, Henrik Andreasson, Achim Lilienthal, Bjorn Astrand, Thorsteinn Rognvaldsson*
6	001821	**An Artificial Intelligence Planning tool for The Container Stacking Problem** *Miguel A. Salido, Oscar Sapena, Federico Barber*
7	002283	**Human Supervisory Interface Design in Automation Systems** *Pedro Ponsa, Ramon Vilanova*
8	004774	**Probabilistic models to assist maintenance of multiple instruments** *Joaquim Melendez, Beatriz Lopez, David Millán-Ruiz*
9	004561	**A jerk threshold-based involuntary lateral movement algorithm** *Cecilio Angulo, Gaspar Valls*
10	005002	**Electronic schuko socket for electrical energy saving** *Ricardo Morales, Nicolas Garcia, Jose Maria Sabater, Carlos Perez, Jose Antonio Martinez-Terres, Roque Saltaren*

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WiP 4. Industrial Control

Chairs: Ramón Vilanova and Gabriel Oliver

Room A13 - *14:00 - 16:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	001341	**An efficient control for a domestic tumble dryer** *Stefano Piccagli, Antonio Visioli, Davide Colombo*
2	003549	**Tool Compensation by Means of Touch Trigger Probes in CNC Turning** *Gonzalo Valiño, Yago Prado, Jose Carlos Rico, Braulio Jose Alvarez*
3	005274	**Modeling and Process Simulation of a Single Screw Food Extruder** *Clemente Cardenas, Javier Becares, Eduardo Moya*
4	006041	**Methodology and experiences with embedded hardware development** *Johannes Weber, Thomas Schmidt-Behounek, Andreas Rehkopf*
5	004863	**Power saving in mobile hydraulic systems via Embedded Model Control** *Wilber Acuna-Bravo, Enrico Canuto, Stefano Malan*
6	005991	**Stability Analysis for the Intermediate Servo/Regulation PID Tuning** *Orlando Arrieta, Asier Ibeas, Ramon Vilanova*
7	004618	**Asynchronous Control of Unstable Linear Systems via L2-gain-based Transformations** *Manuel Lopez-Martinez, Juan M. D. Cano, Francisco R. Rubio*
8	005312	**Sliding Mode Control Strategy for Variable Speed Wind Turbine** *Oscar Barambones, Jose Maria Gonzalez de Durana*
9	004839	**Improving Control Loop Performance using Dynamic Rate Adaptation in Networked Control Systems** *Ana Antunes, Alexandre Mota*
10	005398	**An Experience in Embedded Control Software Verification** *Pierluigi Rolando, Riccardo Sisto*
11	000434	**Asynchronous Combo 4/8/12bit, 140MS/s, 0.12mm2 ADC with Binary Tree Structure** *Nikos Petrellis, Michael Birbas, John Kikidis, Alexios Birbas*
12	002437	**Application of Fourier Descriptors and Pearson Correlation for Fault Detection in Sucker Rod Pumping System** *Fábio Lima, Luiz Affonso Guedes, Diego Silva*
13	006165	**Designing asynchronous analog-to-digital converter with I2C interface** *Dariusz Koscielnik, Marek Miskowicz*
14	005088	**Allowance-Fit: A Partitioning Algorithm for Temporal Robustness of Hard Real-Time Systems upon Multiprocessors** *Frédéric Fauberteau, Serge Midonnet, Laurent George*

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WiP 5. Advanced Manufacturing Systems

Chairs: Joaquín Ezpeleta and Rei Itsuki

Room A13 - *9:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	001554	**Consideration for Efficient RFID Information Retrieval in Traceability System** *Rei Itsuki, Atsushi Fujita*
2	005215	**RFID tuning methodology applied on airport baggage tracking** *Carlos Jacinto, Mário Romano, Ana Montes, Pedro Sousa, Mário Nunes*
3	005703	**Using CloudRFID middleware for fuel supply control of vehicles fleets** *Leonardo A. Amaral, Fabiano P. Hessel, Eduardo A. Bezerra, Jerônimo C. Corrêa, Oliver B. Longhi, Thiago F. Dias*
4	005029	**Exploring an Open-loop RFID Implementation in the Automotive Industry** *Daniel Hellström, Mathias Wiberg*
5	005266	**Design and Control of an Intelligent Dual-Arm Manipulator for Fault-Recovery in a Production Scenario** *Jose de Gea Fernandez, Johannes Lemburg, Thomas M. Roehr, Malte Wirkus, Iliya Gurov, Frank Kirchner*
6	005096	**High-accuracy automatic system to assemble vehicle headlamps** *Javier Gamez-Garcia, Juan Gomez-Ortega, Alejandro Sanchez-Garcia, Silvia Satorres-Martinez*
7	000329	**The Possibilities of and Limits to Detecting Incomplete Fusion via In-Process Monitoring in the Case of Laser Welding** *Michael Kuhl, Paul-Michael Mickel*
8	005177	**Business Driven Engineering for Powertrain Industry** *Robert Harrison, Radmehr Monfared, Les Lee*
9	006114	**On the development of an Agent Supported e-Manufacturing environment** *Adriana Giret, Vicente Botti*
10	005576	**An Agent-Based Approach for Automating The Disturbance Handling for Flexible Manufacturing Systems** *Iman Badr, Peter Göhner*
11	005851	**A multiagent-based system to support the decentralized collaborative decision-making process in the automobile supply chain sector** *Jorge E. Hernandez, Raúl Poler, Josefa Mula, David de La Fuente*
12	004871	**Three-View-Concept for modeling process or manufacturing plants with AutomationML** *Miriam Schleipen, Rainer Drath*

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13	005711	**Factory Monitoring and Control with Mixed Hardware/Software, Discrete/Continuous Models** *Paul Maier, Martin Sachenbacher*

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WiP 6. Real-time and Networked Embedded Systems

Chairs: Tullio Facchinetti and Radu Dobrin

Room A13 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	004677	**Towards managing hardware - software dependencies in embedded systems** *Johannes Weber, Andreas Rehkopf, Timo Sponer*
2	005975	**Multiplexing Real-time Timed Events** *Mike Holenderski, Wim Cools, Reinder Bril, Johan Lukkien*
3	005479	**Improved SIRAP analysis for synchronization in hierarchical scheduled real-time systems** *Moris Behnam, Thomas Nolte, Reinder Bril*
4	005347	**Execution Time Monitoring in Linux** *Mikael Åsberg, Thomas Nolte, Clara Otero Perez, Shinpei Kato*
5	005894	**Optimizing the Fault Tolerance Capabilities of Distributed Real-Time Systems** *Abhilash Thekilakkattil, Radu Dobrin, Sasikumar Punnekkat, Huseyin Aysan*
6	005452	**A Novel Framework for Scheduling Distributed Tasks** *Adrián Noguero, Isidro Calvo, Federico Perez*
7	005738	**Investigation of Implementing a Synchronization Protocol under Multiprocessors Hierarchical Scheduling** *Farhang Nemati, Moris Behnam, Thomas Nolte, Reinder J. Bril*
8	002038	**Experimental Evaluation of the Linux RT Patch for Real-Time Applications** *Wolfgang Betz, Marco Cereia, Ivan Cibrario Bertolotti*
9	005673	**An uRT51 Real-Time Processor Evaluation** *Ricardo Cayssials, Edgardo Ferro*
10	000736	**FPGA-based Implementation Alternatives for Keyed-Hash Message Authentication Code in Networked Embedded Systems** *Enrico Heinrich, Marian Lüder, Ralf Joost, Ralf Salomon*
11	005223	**Real-time platooning of mobile robots: design and implementation** *Marco Luigi Della Vedova, Tullio Facchinetti, Antonella Ferrara, Alessandro Martinelli*
12	002631	**A New Method for Recognizing Operating Systems of Automation Devices** *Joao Paulo S. Medeiros, Agostinho M. Brito Jr., Paulo S. Motta Pires*

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SS01. Power & Performance Evaluation of Embedded Systems

Chairs: Armin Zimmermann

Room A04 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	003999	**Energy Reduction Techniques for Systems with Non-DVS Components** *Chuan-Yue Yang, Jian-Jia Chen, Tei-Wei Kuo, Lothar Thiele*
2	002461	**Stochastic Fault Trees for cross-layer power management of WSN monitoring systems** *Laura Carnevali, Lorenzo Ridi, Enrico Vicario*
3	002879	**Petri nets and autonomous systems: a case study** *Guilherme E. Leite, Norian Marranghello, Aledir S. Pereira*
4	003921	**Future Design Challenges for Electric Energy Supply** *Holger Hermanns, Holger Wiechmann*

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SS02. From RFID to the Internet of Things

Chairs: László Monostori and Elisabeth Ilie-Zudor

Room A11 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	004391	**From Tracking with RFID to Intelligent Products** *Kary Främling, Jan Nyman*
2	003867	**A solution for Integrated Track and Trace in Supply Chain based on RFID & GPS** *Wei He, Eng L. Tan, Eng W. Lee, T. Y. Li*
3	004146	**A Context-Aware Smart Infrastructure based on RFID Sensor-Tags and its Application to the Health-Care Domain** *Luca Catarinucci, Riccardo Colella, Alessandra Esposito, Luciano Tarricone, Marco Zappatore*
4	004502	**Integration and Uses of RF Memory Tags with Smart Space Semantic Web Middleware** *Ian Oliver, Kary Främling, Joni Jantunen, Sergey Boldyrev, Jukka Honkola*
5	004006	**From Tracking Operations to IOT - The Small Business Perspective** *Zsolt Kemény, Elisabeth Ilie-Zudor, László Monostori*
6	003166	**Authentication and location control via RFID analysis** *Khalid Agurare, Fabrice Mourlin*

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SS03. Development of Automation Systems: the Impact of IEC Standards

Chairs: Kleanthis Thramboulidis, Georg Frey, Kari Koskinen

Room A12 - *09:00 - 11:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	003875	**Methodology and Tools for implementing IEC 61131-3 Compliance Tests** *Elisabet Estevez, Edurne Irisarri, Marga Marcos, Fabian Lopez*
2	004049	**Close integration between UML and IEC 61131-3: New possibilities through object-oriented extensions** *Daniel Witsch, Birgit Vogel-Heuser*
3	003832	**Semantic correct transformation of IEC 61131-3 models into the IEC 61499 standard** *Monika Wenger, Alois Zoitl, Christoph Sünder, Heinrich Steininger*
4	003522	**Enabling Agile Manufacturing through Reconfigurable Control Solutions** *Alessandro Brusaferri, Andrea Ballarino, Emanuele Carpanzano*
5	003891	**Conjunction of a Distributed Control System based on IEC 61499 with a Commercial Batch Management System** *Wilfried Lepuschitz, Franz Königseder, Alois Zoitl*
6	003336	**Model-Checking for the Functional Safety of Control Component-based Heterogeneous Embedded Systems** *Mohamed Khalgui, Hans-Michael Hanisch, Atef Gharbi*

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SS05. Dependability of In Vehicle Embedded Systems

SS05-1. Dependability of In Vehicle Embedded Systems
Chairs: Françoise Simonot-Lion and Sébastien Faucou
Room A11 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	003417	**Steer-By-Wire System Development Using AUTOSAR Methodology** *Khaled Chaaban, Patrick Leserf, Sébastien Saudrais*
2	003409	**Robustness of modular multi-layered software in the automotive domain: a wrapping-based approach** *Caroline Lu, Jean-Charles Fabre, Marc-Olivier Killijian*
3	004472	**Automated Software Diversity for Hardware Fault Detection** *Gerald Gaiswinkler, Andreas Gerstinger*

SS05-2. Dependability of In Vehicle Embedded Systems
Chairs: Françoise Simonot-Lion and Sébastien Faucou
Room A11 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	003905	**Aperiodic traffic in response time analyses with adjustable safety level** *Dawood Khan, Nicolas Navet, Bernard Bavoux, Jörn Migge*
2	004308	**An analysis of the AUTOSAR OS timing protection mechanism** *Dominique Bertrand, Sebastien Faucou, Yvon Trinquet*
3	003441	**A Spatial and Temporal Partitioning Approach for Dependable Automotive** *Damien Chabrol, Christophe Aussaguès, Vincent David*
4	003956	**Design and Deployment of a Generic ECC-based Fault Tolerance Mechanism for Embedded HW Cores** *Juan Carlos Ruiz, David de Andrés, Pedro Gil*

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SS06. Building Automation and Smart Homes

Chairs: Alexander Klapproth, Rolf Kistler, Albert Treytl, Wolfgang Kastner

Room A12 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	001538	**A Semantic Requirement Ontology for the Engineering of Building Automation Systems by means of OWL** *Stefan Runde, Henrik Dibowski, Alexander Fay, Klaus Kabitzsch*
2	004499	**Functional Safety in Building Automation** *Wolfgang Kastner, Thomas Novak*
3	003247	**Comparison of energy-efficient sampling methods for WSNs in building automation scenarios** *Joern Ploennigs, Volodymyr Vasyutynskyy, Klaus Kabitzsch*
4	003786	**Tunneling Smart Energy Protocols over ZigBee** *Rolf Kistler, Marcel Bieri, Rolf Wettstein, Alexander Klapproth*

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SS07. Security for industrial applications

Chairs: Kai Hansen, Dimitrios Serpanos

Room A12 - *13:30 - 15:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	003492	**Certification and Evaluation: A Security Economics Perspective** *Ross Anderson, Shailendra Fuloria*
2	003581	**Leveraging Determinism in Industrial Control Systems for Advanced Anomaly Detection and Reliable Security Configuration** *Hadeli Hadeli, Ragnar Schierholz, Markus Braendle, Cristian Tuduce*
3	000418	**Introducing Security Modules in PROFINET IO** *Johan Akerberg, Mats Bjorkman*
4	001112	**Security Considerations for the WirelessHART Protocol** *Shahid Raza, Adriaan Slabbert, Thiemo Voigt, Krister Landernäs*
5	003816	**Security Concepts for Flexible Wireless Automation in Real-Time Environments** *Albert Treytl, Thilo Sauter, Heiko Adamczyk, Svilen Ivanov, Henning Trsek*
6	004405	**An Engineering Approach for Secure and Safe Wireless Sensor and Actuator Networks for Industrial Automation Systems** *Steffen Peter, Oliver Stecklina, Peter Langendoerfer*

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SS09. New trends in Emerging Technologies and Automation Education

SS09-1. New trends in Emerging Technologies and Automation Education
Chairs: Ramón Costa and Montse Gil

Room A13 - *16:00 - 17:30, Wednesday September 23rd*

Order	ETFA Ref.	Title /Authors
1	003743	**Virtual Laboratory for the dissemination of energy management systems. The case of the metropolitan transport system.** *Alba Escolà, Ferran Babot, Arnau Dòria-Cerezo, Ramon Costa-Castelló*
2	003859	**Cardiolab: A Virtual Laboratory for the analysis of Human Circulatory System** *Alher Mauricio Hernandez, Gino Pierfranco Herrera, Miguel Angel Mañanas, Ramon Costa-Castello*
3	003301	**Virtual and remote experimentation with the Ball and Hoop system** *Ernesto Fabregas, Natividad Duro, Raquel Dormido, Sebastian Dormido-Canto, Hector Vargas, Sebastian Dormido*

SS09-2. New trends in Emerging Technologies and Automation Education
Chairs: Ramón Costa and Antoni Grau

Room A12 - *16:30 - 18:00, Thursday September 24th*

Order	ETFA Ref.	Title /Authors
1	003751	**PLC Control and Matlab/Simulink Simulations. A Translation Approach** *Teresa Deveza, João Martins*
2	003433	**Virtual Lab For Programmable Logic Controllers** *Juan Antonio Muñoz, José Luis Guzmán, Francisco Rodríguez, Manuel Berenguel, Andrzej Pawlowski*
3	004375	**Free Open Source Software in Control Engineering Education: A Case Study in the Analysis and Control Design of a Rotary Inverted Pendulum** *Carlos Meza, J. Alexis Andrade-Romero, Roberto Bucher, Silvano Balemi*
4	004367	**A course on MIMO time delay process control from practice** *Montserrat Gil-Martinez, Javier Rico*

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SS10. Fractional Systems and Control

SS10-1. Fractional Systems and Control
Chairs: Ivo Petras and Richard Magin

Room A12 - *09:00 - 11:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	004596	**Fractional DC/DC Converter in Solar-Powered Electrical Generation Systems** *Ruben Martinez, Yolanda Bolea, Antoni Grau, Herminio Martinez*
2	004383	**Fractional PI Controller Design with Optimized Robustness to Time Delay Changes in Main Irrigation Canals** *Shlomi N. Calderon Valdez, Miguel Angel Ruiz Torija, Raul Rivas Perez, Vicente Feliu Batlle*
3	004154	**Simple tuning rules for fractional PI controllers** *Juan J. Gude, Evaristo Kahoraho*
4	003387	**Autotuning of Fractional Order PI^λD^μ Controllers using a PLC** *Concepción A. Monje, Blas M. Vinagre, Guillermo E. Santamaría, Inés Tejado*
5	004359	**A Proposal for Optimal Tuning of Fractional Order Proportional Integral - Proportional Derivative (PI^αD^β) Controllers** *Bettou Khalfa, Abdelfatah Charef, Blas M. Vinagre*

SS10-2. Fractional Systems and Control
Chairs: Blas Vinagre and Concepción Monje

Room A11 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	004464	**Matrix Approach to Discretization of Fractional Derivatives and to Solution of Fractional Differential Equations and Their Systems** *Igor Podlubny, Tomas Skovranek, Blas M. Vinagre*
2	003182	**Fractional - Order Chaotic Systems** *Ivo Petras, Dagmar Bednarova*
3	003808	**Fractional-Order Memristive Systems** *Ivo Petras, YangQuan Chen, Calvin Coopmans*
4	004294	**Fractional Order NMR Reflects Anomalous Diffusion** *Richard Magin, Belinda Akpa, Qing Gao, Xiaohong Joe Zhou, Thomas Neuberger, Andrew Webb*

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SS11. Real Time and Networked Embedded Systems

Chairs: Juan Carlos Ruiz and Danilo Tardioli

Room A12 - *14:00 - 16:00, Friday September 25th*

Order	ETFA Ref.	Title /Authors
1	000213	**Microprogrammable Hardware Abstraction Layer for Flexible Automation** *Uwe Schmidtmann, Gerhard Kreutz, Matthias Barkhoff, Kristian Virkus, Tobias Stöckmann, Marcel Jovic*
2	002569	**On the Use of Hash Tables in Real-Time Applications** *Romulo de Oliveira, Carlos Montez, Rodrigo Lange*
3	000752	**Effective Remote Control Of Electric Motors Using GSM Technology** *Abraham J. J. Mouton, George Smith*
4	002259	**Generation of Function Block Based Designs using Semantic Web Technologies** *Uwe Ryssel, Henrik Dibowski, Klaus Kabitzsch*

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