

# DEPARTMENT OF SYSTEMS AND CONTROL

## E-2

*The department is engaged in the analysis, control and optimization of systems and processes. The activities of the department are focused on the research of new methods and algorithms for automatic control, the development of procedures and tools to support the design and construction of control systems, the development of specific measurement and control modules, and the development and construction of complete systems for the control and supervision of machines, devices and industrial processes.*

### Basic and applied research

The basic and applied research in 2009 was devoted to three sub-areas: methodologies for analysis and control systems design; tools and building blocks for implementation; and applied research in the priority problem domains.

The sub-area **methodologies for analysis and control systems design** included three topics. The first topic addressed the modelling and identification of nonlinear and complex dynamical systems. One part of this topic was devoted to research on modelling using Gaussian processes, where the emphasis was on the modelling of dynamic systems with models of fixed structure and variable parameters, which are represented as Gaussian process models; and the applicability of these kinds of models for control systems design was studied as well. The other part of this topic was related to the identification of stochastic nonlinear dynamical systems, where the main problem was on how to estimate the model parameters in the case of non-measurable system states. An iterative procedure for calculating the maximum-likelihood estimate of model parameters based on the Expectation-Maximization algorithm together with the Unscented Kalman filter (for a system-states estimation) has been designed.

The second topic was (advanced) control. One part of this topic was a continuation of the research and development of parametric predictive controllers based on linear and hybrid models; the emphasis was on the research of options for simplifying the partitions of parametric controllers by the sparse placing of constraints, and on improving the reliability of degeneracy handling during a controller-partition calculation. The other part of this topic was related to PID control. In 2009 a newly developed method for tuning PID controller parameters was tested. The advantage of the method is that all the required data can be obtained implicitly by the operator during open-loop experiments.

The third topic of interest was condition monitoring and fault diagnosis. Here, research was focused on the design of sensitive and reliable algorithms for the early detection of incipient faults in rotational machines and drives by means of sensor fusion. The main contribution concerns a detector of insufficiently lubricated bearings by means of a vibrations analysis. By employing a cyclostationary analysis and the analysis of spectral kurtosis, it was shown that a reliable distinction between normal and poorly lubricated bearings could be achieved. This important result found an immediate application in an end-quality assessment in the production of electronically commutated electrical motors (Fig.2). A part of the work, also related to condition monitoring, dealt with the problem of monitoring the depth of anesthesia. Our recent studies have shown that during the transition between deep and shallow anesthesia, changes occur in the strength of the directionality indexes of the amplitude couplings between selected EEG frequency bands. Our new results indicate that these changes are robust physiological phenomena and are unaffected by moderate hypothermia. We predict that changes in the amplitude couplings between the EEG frequency bands can detect the transition between the deep and shallow phases of anesthesia for different types of anesthetics.

The sub-area **tools and building blocks for implementation** also included three parts. The first part of our work was devoted to a further development of the program package for rapid prototyping of advanced control algorithms. In the past year the package was enhanced by algorithms for the detection of the non-linearity and tuning of multivariable controllers.



Head:  
**Prof. Stanislav Strmčnik**

**Within the Zois awards and distinctions, the highest awards of the Republic of Slovenia in the area of science, research and development activities, issued by the Slovenian Ministry of Higher Education, Science and Technology, the Zois distinction for important achievements in the area of the control of wastewater-treatment processes was this year granted to our colleagues Dr. Nadja Hvala, Dr. Darko Vrečko and Dr. Aljaž Stare.**



Figure 1: Left: Photo from the award ceremony of the 2009 ISA Transactions Best Paper Award (from the right: the first author of the awarded paper Mr. Matej Gašperin and Vice president, ISA publication Department Mr. Vitor Finkel) Right: Photo of the award.

**Our department members Matej Gašperin, Prof. Dr. Đani Juričić and Dr.Bojan Musizza, and the Automatics, Biocybernetics and Robotics Department member Prof. Dr. Igor Mekjavič, are the recipients of the 2009 ISA Transactions Best Paper Award for the paper entitled “A model-based approach to the evaluation of flame-protective garments”. The award was determined by a five-member review committee from 45 papers (Fig. 1).**

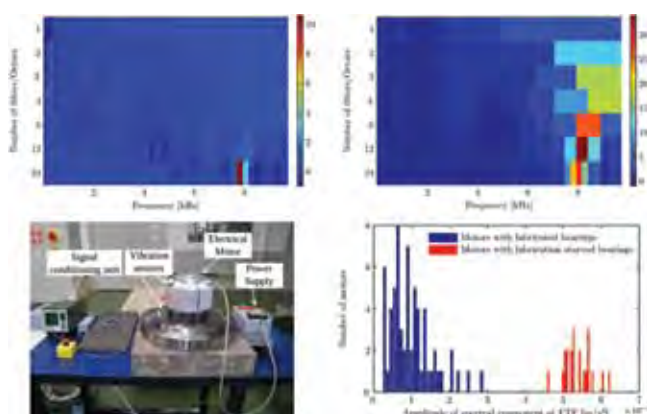


Figure 2: Spectral kurtosis of a normal motor (upper left) and a poorly lubricated motor (upper right), the prototype of the test bed (lower left), statistics of the diagnostic systems demonstrating the strong isolation capabilities (lower right).

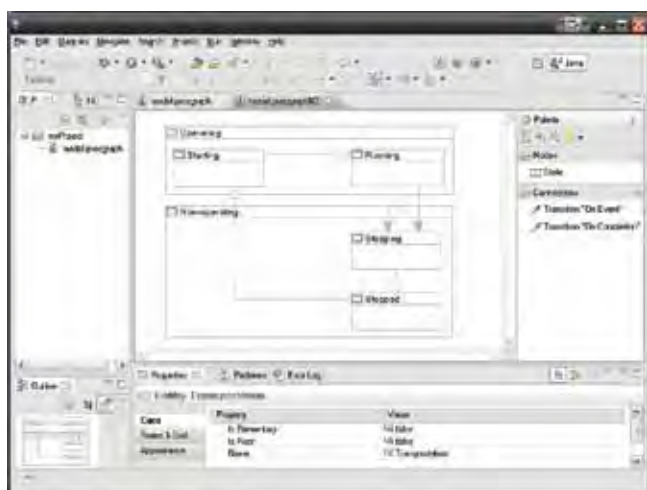


Figure 3: Screenshot of the development environment prototype for the ProcGraph language.

**At the 4th Slovenian Innovation Forum, the innovation “PLCbatch – a tool for PLC-based batch process control” was ranked in the group of 10 best innovations. The first author as well as the principal developer of the tool is our department member mag. Giovanni Godena.**

The second part included activities related to the development of tools and methods for control SW design, where we developed the first prototype of an integrated development environment for our domain-specific modelling language, ProcGraph. The development was carried out based on a model-driven engineering approach, and using a sophisticated metaCASE tool (Fig 3).

In the third part, further work on the environment, which enables the design of embedded control and digital signal processing systems, was carried out to fulfil our needs for the development of new electronic devices. The emphasis was given to the development of new tools related to the design of ARM-microcontroller-based modules for different applications.

Applied research in the priority problem domains was the third sub-area of our interest.

In this frame a substantial part of our activities was devoted to the development of the specific control systems described below.

In the past year we successfully completed our participation in the international 6FP project “PEGASE”, which was focused on the automatic landing of aircraft, based on onboard-camera-generated images. In this final year we developed a new predictive visual servoing control scheme to control the aircraft’s landing-path.

Within polymerization process control, research was devoted to a more accurate parameter estimation of an already developed complex mathematical process model, and to an analysis of the impact of the operating parameters on the process performance. As a result, the control algorithms for online-reactants dosing were designed, which keep the reactor temperature in a narrow region and maximize the reaction rate of the process.

Control of wastewater-treatment plants is a traditional research area of ours. Within the applied research project, which is performed for the Domžale-Kamnik wastewater-treatment plant, a simulation model of the SBR process for plant upgrading was designed and tested under a dynamic input load. Recent research was directed to the modelling of the existing anaerobic digestion process for sludge treatment with the purpose of optimising this treatment.

Production control is also an important domain of our research work. The major problems in manufacturing today still relate to unexpected breakdowns and the degradation of product quality with no obvious reasons. To cope with these problems, the concept of product quality and system condition monitoring has been designed and applied to the manufacturing of collectors. The research project was carried out in close cooperation with the company Kolektor Sinabit. We have also proceeded with an evaluation of the hierarchical concept of model-based production control developed in previous years. In 2009 different modelling, control, and optimization methods were tested in a case study of a chemical batch process and on the Tennessee Eastman benchmark process.

In recent years, a part of our work was focused on the area of fuel cells. Research activities in 2009 encompassed the following: an estimation of the actual efficiency of fuel-cells-based systems, an assessment of the actual energy and material flows inside fuel-cell-based systems, and an estimation of the water balance inside the reformer/fuel-cells system. These findings are very important for the future design of various systems, which include a fuel-cells-based generator set.

#### R&D projects for industry and other users

A significant part of the development activities of our department is oriented towards the implementation of fuel cells in various applications, and to the development of special-purpose modules for fuel-cells-based generator sets (projects “GCCOGEN”, “TESTLAB”, and “HyCORE”). In 2009 the

development project of the mobile-dwelling container unit with an in-built fuel-cells-based cogeneration system for the logistic needs of the Slovenian Army has been completed (Fig.4). The implemented cogeneration system effectively exploits the waste heat energy produced as a surplus during the production of electrical energy in the in-built fuel-cells-based generator set. The development in the area of fuel-cells-based systems applications will also be continued in the frame of the Centre of Excellence for Low-carbon Technologies that was approved for funding in 2009. The multidisciplinary project “Kerapro” is also related to fuel cells. Within this project a fuel reformer is being developed, which will represent a source of hydrogen for miniature fuel cells. In recent years we have studied the efficiency of the reforming process as a function of operating conditions and the type of catalyst.

Based on a contract with the Domel company, Železniki, a diagnostic system for electronically commutated motors (0.75 to 6 kW) was designed and produced (Fig. 5). The system provides a quality assessment of motors at the end of a production line. It includes the following: measurement of the basic electrical parameters of the free-running motor, bearing-fault detection, a determination of rotor unbalance, and a detection of general deviations, performed at the free run-out of the motor.

A substantial part of the activities was, in the past year, performed in close cooperation with the INEA company. One of the activities was the development of a new version of the batch control tool entitled PLCbatch, which has some important advantages, in particular the new object model of equipment and recipes. The model is based on the overlapping of equipment classes, which allows a reduction in the repetition of information in the recipes, resulting in an increased recipe reuse.

Another activity was related to the “KIBERNET” project, where we have developed the functional requirements for the module for estimation of the reliability of the prediction of electrical energy consumers’ adaptation. The output data from this module will assist the optimization algorithm in building a set of consumers that will be involved in the adaptation of energy consumption.

The last activity was the design of a communication node, which was designed using an ARM Cortex M3 microcontroller LM3S6965 (TI-Luminary Micro). This communication module connects the GSM communication network with an Ethernet-based LAN and a universal serial bus, which is based on the AnyBus modules. It also handles some digital I/O and flash memory cards.

A project entitled “Truck positioning under a crane”, which was carried out jointly with the Port of Koper, also represented a part of our activities in 2009. In the first phase of the project, all the relevant algorithms for detecting the object (truck) and calculating the object’s position have been successfully tested in a real environment.

### Other projects

In June 2009 the activities on the project “Promoting Innovation in the Industrial Informatics and Embedded Systems Sector through Networking (I3E)” started. The project is funded by the South East Europe Transnational Cooperation Programme. The project’s main objective is the promotion of innovation and entrepreneurship in Southeast Europe with the emphasis on the development of advanced products and services in the sectors of industrial informatics and embedded systems.

### Education and training activities

Some members of the department give lectures and practical courses at different faculties and the universities: the Faculty of Electrical Engineering, University of Ljubljana, the Faculty of Logistics, University of Maribor, the University of Nova Gorica and the “Jožef Stefan” International Postgraduate School. They also act as supervisors of M.Sc. and Ph.D. students. Special care was given to post-qualification training for engineers from industry. In 2009,

**Our department members taking part in the project entitled “Development of demonstration prototype of mobile cogeneration fuel cell based system for military purposes” were given an award by the Ministry of Defense of the Republic of Slovenia and the Slovenian Technology Agency for a very successful project implementation.**



Figure 4: Presentation of the mobile-dwelling cogeneration unit to the Slovenian Minister for Development and European Affairs, Mitja Gaspari M. Sc.; at the JSI, October 2009



Figure 5: Diagnostic system for electronically commutated motors.

**The paper entitled “Modelling, Simulation and Control of a Semi-Batch Industrial Polymerization Reactor”, authors Dr.Nadja Hvala, Teodora Miteva and Dr. Dolores Kukanja, was one of nine nominated papers for the best paper award at the Industrial Simulation Conference in UK.**

three one-week courses were organized. These courses were organized in close cooperation with the Faculty of Electrical Engineering, University of Ljubljana and the Information Technologies Knowledge Transfer Centre at the JSI.

### Some outstanding publications in the past three years

1. Aljaž Stare, Darko Vrečko, Nadja Hvala, Stanko Strmčnik. Comparison of control strategies for nitrogen removal in an activated sludge process in terms of operating costs : a simulation study. *Water res. (Oxford)*. [Print ed.], 2007, vol. 41, no. 9, p. 2004-2014.
2. Alexandra Grancharova, Juš Kocijan, Tor Arne Johansen. Explicit stochastic predictive control of combustion plants based on Gaussian process models. *Automatica (Oxf.)*. [Print ed.], 2008, vol. 44, no. 6, p. 1621-1631.
3. Gregor Dolanc, Stanko Strmčnik. Design of a nonlinear controller based on a piecewise-linear Hammerstein model. *Syst. control. lett.*. [Print ed.], 2008, vol. 57, no. 4, p. 332-339.

### The most important technological achievements in the past three years

1. A series of electronic drives for valves, based on BLDC motors, 2008, (Janko Petrovčič, Damir Vrančič, Aleš Svetek, Stane Černe, Miroslav Štrubelj)
2. A mobile dwelling container unit with in-built fuel-cells-based cogeneration system, 2009, (in cooperation with companies Domel and INEA) (Vladimir Jovan, Janko Petrovčič, Aleš Svetek, Stane Černe, Miroslav Štrubelj)

### Awards and appointments

1. Matej Gašperin, Prof. Dani Juričič, Dr Bojan Musizza and Automatics, Biocybernetics and Robotics Department member Prof. Igor Mekjavič, are the recipients of the 2009 ISA Transactions Best Paper Award for the paper entitled "A model-based approach to the evaluation of flame-protective garments". The award was determined by a five-member review committee from 45 papers.
2. Giovanni Godena: at the 4th Slovenian Innovation Forum, the innovation "PLCbatch - a tool for PLC-based batch process control" was ranked in the group of 10 best innovations. The first author as well as the principal developer of the tool is our department member.
3. Dr Nadja Hvala, Dr Darko Vrečko, Dr Aljaž Stare: within the Zois awards and distinctions, the highest awards of the Republic of Slovenia in the area of science, research and development activities, issued by the Slovenian Ministry of Higher Education, Science and Technology, the Zois distinction for important achievements in the area of control of wastewater-treatment processes
4. Dr Vladimir Jovan, Dr Janko Petrovčič, Aleš Svetek, Stane Černe, Miroslav Štrubelj: our Department members taking part in the project entitled "Development of demonstration prototype of mobile cogeneration fuel cell based system for military purposes" were awarded by the Ministry of Defense of the Republic of Slovenia and the Slovenian Technology Agency for very successful project implementation.

### Organization of conferences, congress and meetings

1. Production management and information systems: continuing education (specialisation) course in Control Technology, Ljubljana, 2-6 February 2009
2. Automation and information technology projects: continuing education (specialisation) course in Control Technology, Ljubljana, 30 March to 3 April 2009
3. Building blocks for computer automation: continuing education (specialisation) course in Control Technology, Ljubljana, 2-6 November 2009

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## INTERNATIONAL PROJECTS

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| <ol style="list-style-type: none"> <li>1. Design of Advanced Controllers for Economic, Robust and Safe Manufacturing Performance<br/>CONNECT<br/>6. FP, COOP-CT-2006, 031638<br/>EC; Dr. Constantinos Pantelides, Process Systems Enterprise Limited, London, Great Britain<br/>Dr. Samo Gerškšič, Dr. Vladimir Jovan</li> <li>2. HelicoPter and aEronef naviGation Airborne System Experimentations<br/>PEGASE<br/>6. FP, AST5-CT-2006-030839</li> </ol> | <ol style="list-style-type: none"> <li>EC; Bruno Pattin, Claire Lallemand, Dassault Aviation, Paris, France<br/>Prof. Stanko Strmčnik, Dr. Gregor Dolanc</li> <li>3. Probabilistic Bayesian Soft Sensor - A Tool for On-line Estimation of the Key Process Variable in Cold Rolling Mills<br/>ProBaSensor, EUROSTARS<br/>COMPUREG Plzen, s.r.o., Czech Republic<br/>Prof. Dani Juričič</li> </ol> |
|---|---|

- Promoting Innovation in the Industrial Informatics and Embedded Systems Sectors through Networking  
I3E, South East Europe Programme  
SEE/A/219/1.1/X  
Dr. Athanasios Kalogerias, Industrial Systems Institute / Research Centre ATHENA, Patras, Greece  
Dr. Vladimir Jovan
- Application of Gaussian Processes to the Modelling and Control of Complex Stochastic Systems  
BI-BG/09-10-005  
Dr. Alexandra Grancarova, Institute of Control and System Research, Bulgarian Academy of Sciences (ICSR-BAS), Sofia, Bulgaria  
Prof. Juš Kocijan

## R & D GRANTS AND CONTRACTS

- Identification and model analysis for dynamic systems control design with Gaussian process priors  
Prof. Juš Kocijan
- Integrated diagnostic system for drive assemblies  
Prof. Dani Juričić
- Modelling and control of wastewater treatment plants for improving the effluent quality and energy effective operation  
Dr. Darko Vrečko
- Advanced model-based procedures for product quality control and management in complex production processes  
Prof. Dani Juričić
- Simplified explicit predictive controller  
Prof. Stanislav Strmčnik
- Rapid prototyping of advanced control algorithms in industrial environment  
Asst. Prof. Damir Vrančić

## RESEARCH PROGRAM

- Program systems and control  
Prof. Dani Juričić

## VISITORS FROM ABROAD

- Pavle Boškovski, Faculty of Electrical Engineering, Ss. Cyril and Methodius University, Skopje, R. Macedonia, 1 January to 31 December 2009
- Edrisi Muñoz Mata, Department d'Enginyeria Química - CEPIMA, Universitat Politècnica de Catalunya, ETSEIB, Barcelona, Spain, 3 April 2009
- Marta Moreno Benito, Department d'Enginyeria Química - CEPIMA, Universitat Politècnica de Catalunya, ETSEIB, Barcelona, Spain, 3 April 2009
- Assist. Prof. Aleksandra Grancarova, Institute of Control and System Research, Bulgarian Academy of Sciences, Sofia, Bulgaria, 12-20 May 2009
- Hristina Hristova, Institute of Control and System Research, Bulgarian Academy of Sciences, Sofia, Bulgaria, 12-20 May 2009
- Aleksander Krastov, Institute of Control and System Research, Bulgarian Academy of Sciences, Sofia, Bulgaria, 12-20 May 2009
- Dr Pavel Etlter, Compureg Plzen, Plzen, Czech Republic, 23-25 November 2009

## STAFF

### Researchers

- Dr. Gregor Dolanc
  - Dr. Samo Gerškšič
  - Dr. Nadja Hvala
  - Dr. Vladimir Jovan
  - Prof. Dani Juričić
  - Prof. Juš Kocijan
  - Dr. Janko Petrovčič
  - Prof. Stanislav Strmčnik, Head**
  - Asst. Prof. Damir Vrančić
  - Dr. Darko Vrečko
- ### Postdoctoral associates
- Dr. Dejan Gradišar
  - Dr. Gregor Kandare
  - Dr. Bojan Musizza
  - Dr. Boštjan Pregelj
  - Dr. Alenka Žnidaršič\*

## NEW CONTRACTS

- Specification of the procedural control for the Synthesis process at Color company Inea, d. o. o.  
Giovanni Godena, M. Sc.
- Specification of the batch server  
Inea, d. o. o.  
Giovanni Godena, M. Sc.
- Determination and analysis of diagnostic procedures for the quality assessment of electronically commutated motors for HVAC applications  
Domel, d. d.  
Dr. Janko Petrovčič
- Specification of the models and control recipes according to S88.01  
Inea, d. o. o.  
Giovanni Godena, M. Sc.
- Prototype of a system for industrial load control in electrical distribution network  
Inea, d. o. o.  
Prof. Dani Juričić
- Diagnostic system for electronically commutated motors with external rotors for HVAC applications  
Domel, d. d.  
Dr. Janko Petrovčič
- Support for the research programme of Aleksander Pregelj in the field of advanced control algorithms  
Inea, d. o. o.  
Dr. Samo Gerškšič
- HyCore - development of the key subassemblies for HT PEM fuel cell  
Inea, d. o. o.  
Dr. Vladimir Jovan

### Postgraduates

- Matej Gašperin, B. Sc.
- Giovanni Godena, M. Sc.
- Tomaž Lukman, B. Sc.
- Satja Lumbar, B. Sc.
- Jernej Mrovlje, B. Sc.
- Dejan Petelin, B. Sc.
- Aleš Svetek, M. Sc.

### Technical officers

- Stanislav Černe, B. Sc.
- Primož Fajdiga, B. Sc.
- Dr. Zoran Marinšek\*

### Technical and administrative staff

- Maja Janežič, B. Sc.
- Miroslav Štrubelj

Note:

\* part-time JSI member

# BIBLIOGRAPHY

## ORIGINAL ARTICLES

1. Fernando Aller, Dolores Kukanja, Vladimir Jovan, Michael C. Georgiadis, "Modelling the semi-batch vinyl acetate emulsion polymerization in a real-life industrial reactor", *Math. comput. model. dyn. syst.*, vol. 15, no. 2, pp. 139-161, 2009.
2. Kristjan Ažman, Juš Kocijan, "Fixed-structure Gaussian process model", *Int. J. Syst. Sci.*, vol. 40, no. 12, pp. 1253-1262, 2009.
3. Sašo Blažič, Igor Škrjanc, Samo Gerkšič, Gregor Dolanc, Stanko Strmčnik, Mincho B. Hadjiski, Anna Stathaki, "Online fuzzy identification for an intelligent controller based on a simple platform", *Eng. appl. artif. intell.*, vol. 22, no. 4/5, pp. 628-638, Jun. 2009.
4. Andrew Crossan, Roderick Murray-Smith, Stephen Brewster, Bojan Musizza, "Instrumented usability analysis for mobile devices", *International journal of mobile computer interaction*, vol. 1, no. 1, pp. 1-20, 2009.
5. Matej Gašperin, Đani Juričić, "The uncertainty in burn prediction as a result of variable skin parameters: an experimental evaluation of burn-protective outfits", *Burns*, vol. 35, no. 7, pp. 970-982, 2009.
6. Giovanni Godena, "A new proposal for the behaviour model of batch phases", *ISA trans.*, vol. 48, no. 1, pp. 3-9, 2009.
7. Janko Petrovčič, Vladimir Jovan, Aleš Svetek, "Agregat na gorivne celice v uporabi v SV", *Slov. vojs. (Tisk. izd.)*, vol. 17, no. 2, pp. 25-28, 2009.
8. Stanko Strmčnik, Đani Juričić, Bojan Musizza, Janko Petrovčič, "Od senzorja do prave odločitve", *Ventil (Ljublj.)*, vol. 15, no. 3, pp. 254-262, 2009.
9. Jure Vindišar, Vladimir Jovan, "Mobilna kogeneracijska enota na gorivne celice", *Ventil (Ljublj.)*, vol. 15, no. 6, pp. 552-553, 2009.
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11. Sebastjan Zorzut, Dejan Gradišar, Vladimir Jovan, Gašper Mušič, "Use of a procedural model in the design of production control for a polymerization plant", *Int. j. adv. manuf. technol.*, vol. 44, no. 11/12, pp. 1051-1062, 2009.
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- 2009, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2009, 4 pp.
6. Dejan Gradišar, P. J. Copado, E. Muñoz, M. Moreno-Benito, Antonio Espuña, Luis Puigjaner, "Communication within an integrated batch control", In: *MATHMOD Vienna 09: proceedings*, (ARGESIM Report, no. 35), 6th Vienna Conference on Mathematical Modelling, February 11-13, 2009, Vienna University of Technology, Austria, Inge Troch, ed., Felix Breitenecker, ed., Vienna, ARGESIM, cop. 2009, pp. 2490-2493.
7. Dejan Gradišar, Antonio Espuña, Luis Puigjaner, "Komunikacijski sistem znotraj celovitega vodenja šaržne proizvodnje", In: *Avtomatizacija v industriji in gospodarstvu: zbornik konference AIG'09, 29. junij - 3. julij 2009*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2009, 5 pp.
8. Dejan Gradišar, Juš Kocijan, "Nelinearni proizvodni model systems Tennessee Eastman: Nonlinear production model of TE system", In: *Zbornik Osemnajste mednarodne elektrotehniške in računalniške konference - ERK 2009, 21-23. september 2009, Portorož, Slovenija*, Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2009, zv. A, pp. 305-308.
9. Alexandra Grancharova, D. Nedialkov, Juš Kocijan, H. Hristova, A. Krastev, "Application of Gaussian processes to the prediction of zone concentration in the air of Burgas", In: *Proceedings: John Atanasoff celebration days*, International conference Automatics and Informatics '09, Bulgaria, Sofia, 29.09 -4.10.09, Sofia, Union of Automation and Informatics, 2009, pp. IV-17-IV-20.
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16. Gregor Kandare, "Oxygen control in a wastewater treatment plant using adaptive predictive controllers", In: *Proceedings of the 10th International PhD Workshop on Systems and Control, Hluboká and Vitavou, Czech Republic, September 22-26, 2009*, R. Hofman, ed., Václav Šmídl, ed., L. Pavelková, ed., Prague, Department of Adaptive Systems, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, 2009, 5 pp.
17. Juš Kocijan, Kristjan Ažman, "Applications of varying parameters modelling with Gaussian processes", In: *ICONS 2009, 2nd IFAC International Conference on Intelligent Control Systems and Signal*

## PUBLISHED CONFERENCE PAPERS

### Regular papers

1. Pavle Boškosi, Bojan Musizza, Janko Petrovčič, Đani Juričić, "Bearing fault detection in brushless DC motors: a sensitivity study", In: *Proceedings of the 10th International PhD Workshop on Systems and Control, Hluboká and Vitavou, Czech Republic, September 22-26, 2009*, R. Hofman, ed., Václav Šmídl, ed., L. Pavelková, ed., Prague, Department of Adaptive Systems, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, 2009, 6 pp.
2. Pavle Boškosi, Damir Vrančič, Anton Urevc, Jože Vižintin, "Condition monitoring of rotational machines", In: *Avtomatizacija v industriji in gospodarstvu: zbornik konference AIG'09, 29. junij - 3. julij 2009*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2009, 5 pp.
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  19. Satja Lumbar, Gregor Dolanc, Stanko Strmčnik, Darko Vrečko, Drago Matko, "Prediktivno vodenje letala s pomočjo strojnega vida", In: *Avtomatizacija v industriji in gospodarstvu: zbornik konference AIG'09, 29. junij - 3. julij 2009*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2009, 5 pp.
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## THESES

### Ph. D. Theses

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2. Boštjan Pregelj, *Use of hybrid systems for disturbance handling in low-level process control: doctoral dissertation*, Ljubljana, [B. Pregelj], 2009.
3. Sebastjan Zorzut, *Production control in process industry using key performance indicators: doctoral thesis*, Ljubljana, [S. Zorzut], 2009.

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