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.
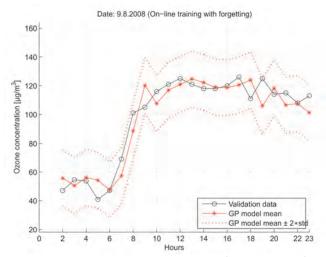
Basic and applied research

The basic and applied research in 2013 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 modeling and identification of nonlinear and complex dynamical systems. The research in the dynamic systems modelling of Gaussian process models was directed towards the on-line training and application of the on-line training for on-line control. The identification of Gaussian process models was used for the modelling of biological and environmental systems (Figure 1). A key feature of modern condition monitoring systems is the ability to predict the remaining useful life of the system or its components. To achieve this, we focus on the development of system identification algorithms for model-based prognostics and health management (PHM). We have developed a prognostics algorithm, which merges a sequential Monte-Carlo approach with a classical Kalman filter. The algorithm was applied to predict failures in both mechanical and electro-chemical systems.

The second topic was *advanced control*. We have continued the development and robustification of methods for the implementation of the simplified parametric predictive controller in practical control applications. We have implemented an improvement of a cascade scheme of magnetic plasma control for the Iter fusion tokamak reactor, where an additional feedback loop in charge of returning the vertical plasma position to the origin was introduced between the inner loop of vertical stabilisation and the outer loop of plasma current and shape control.

The third topic of interest was c*ondition monitoring and fault diagnosis*. Research in the area of condition monitoring has resulted in novel approaches to the robust diagnosis and prognosis of rotational machines and drives under incomplete information about variable operating conditions. The problem is notoriously difficult and relevant for practice. New results rely on the stochastic modelling of structural excitations that emerge from complex interactions between rotating and stationary parts by means of point processes. In addition, a new algorithm for detecting distributed faults in bearings from vibrational recordings has been developed. The solution to this nontrivial problem is applicable to the faults due to, e.g., electro-erosion in bearings. The most notable contribution in the area is related to the completed experimental prototype of a diagnostic and prognostic platform for rotational machines and successful implementation on three different industrial sites in Slovenia and abroad (Figure 2). The platform relies on an innovative holistic concept of the distributed sensor network, which allows for partial local signal processing, data fusion from different sensors, self-tuning of decision thresholds, remote configuration as well as integration with other information systems in the enterprise.

In the area tools and building blocks for implementation the MAGICS methodology for the development and automatic generation of process control software has been further developed. An experimental industrial prototype of an environment for this methodology has been developed, which supports the industrial practice of modelling and, partly, the automatic generation of the procedural part of the software for demanding process control systems.

In the field of production control, we were developing a software tool named ProOpter that enables the analysis of production dynamics using advanced methods like data mining, data reduction, determination of relevant manipu-
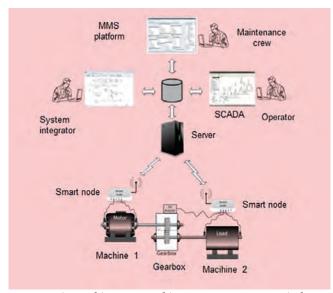
Head:
Dr. Vladimir Jovan

Figure 1: The predicted mean value and 95% confidence interval of ozone concentration for 9 August 2008 from GP model

Figure 2: Scheme of the prototype of diagnostics & prognostics platform

lated variables and production performance indicators model identification (Figure 3). The obtained models enable the prediction and optimization of the production dynamics.

A reliable estimate of the remaining useful life is getting to be one of the most significant requirements in modern maintenance. We continued our research of a class of data-driven methods that rely on stochastic models derived from run-to-failure experiments performed on an appropriate set of similar items of equipment. A method employing entropy indices calculated from vibrational records has been further improved. Dynamic relations between indices and time-to-failure are described by Gaussian Process Models with truncated Gausssian distributions, which results in efficient new algorithms.

In 2013 we continued working on the diagnostics of PEM fuel cells with the use of impedance measurements. The main focus was on a procedure for collecting the impedance information. In this manner we developed a procedure for the estimation of the instantaneous PEM fuel-cell impedance, which is based on PRBS perturbation signals and the continuous wavelet transform. The procedure provides the means for an approximately five-times faster estimation of the impedance compared to conventional approaches.

In the area of fuel-cell models development the main objective was to build a Matlab/Simulink model of the HyPM ® HD 8-200 Fuel-cell-based power unit, purposed for testing control approaches and the optimization of power management. In the model, a combination of the use of the measured static characteristics and tuning of the physical equations that describe processes in the FC stack, as well as the Balance of Plant (BoP) components (blower, pumps, etc.) in the system. During this year the model has been extended with the stack temperature influence to internal resistance and output voltage. In parallel a load study and the assessment of battery choice for a FC-based APU has been made.

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 frame of the Slovenian Research Agency's project on energy optimisation, new dynamic models of chillers for the purpose of energy consumption optimisation have been developed.

Control of wastewater treatment plants is our traditional research area. In cooperation with the company Kolektor Sinabit d.o.o., in 2013 we have developed a feed rate control of the anaerobic reactor for organic waste removal and biogas production. The proposed control adjusts the feed rate of the substrate based on measurements of the volatile fatty acids and acetate in the reactor. The control enables stable biogas production and prevents acidification of the process. Control was tested on the anaerobic reactor pilot plant.

In the frame of the Eurostars project ProDISMon we started with the development of algorithms aimed to improve the reliability of distributed condition monitoring systems by means of an on-line assessment of the quality of the acquired data as well as the fusion of data from various sensory inputs.

In recent years, a part of our work was focused on the area of *fuel cells*. In 2011 we started cooperation on the 7th European project *FCGEN-Fuel Cell Based On-board Power Generation.* The objective of the FCGEN project is the development and demonstration of an auxiliary power unit (APU) for trucks, which uses an auto-thermal reformer to produce hydrogen from fuel and a fuel-cell stack for the electric energy production. In 2013 most of the process reactors for diesel conversion and reformate clean-up have been built and tested. Our group had two main work tasks. First, was the development of the complete APU control system and second was the development of the APU power-conditioning components. For the control system first the PLC version and HMI were finalized, and partially tested during the reactor tests. During the second half of the year the focus was on the development of the main controller, APU ECU, and the transfer of the control code from the PLC to the embedded controller. Within the power-conditioning task the prototype of the DC/DC converter and the power supply for the BoP component has been developed, built and tested.

Within the second 7th European project *FluMaBack-Fluid Management component improvement for Back up fuel cell systems* the control line for the final quality control of blowers for fuel-cell systems has been designed. It consists of two modules. The first module examines the bearing quality
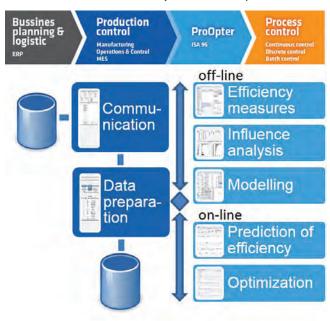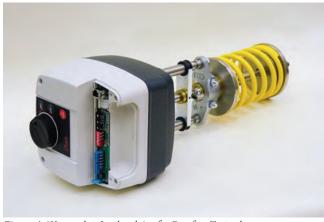

Figure 3: Placement scheme of a software tool ProOpter

by analysing the sound emissions. The second module examines the vibrational and electrical signals. The overall quality is estimated based on the calculated features.

R&D projects for industry and other users

A substantial part of the department's R&D activities for industry and other users is conducted within the project *Competence Centre for Advanced Control Technologies,* which has been concluded in 2013. Within the programme of the Competence Centre for Advanced Control Technologies our department members developed a number of innovative technological solutions in cooperation with industrial partners. The developed control tools and building blocks include advanced control algorithms that were implemented within the software tools of the Inea and Kolektor Sinabit companies for the easy implementation of advanced control in industrial processes. In addition, an industrial prototype of a tool for the model-driven development of the process control software was developed. In the field of a smart factory, a ProOpter production dynamics analyser and optimiser was developed and tested in batch production at our partner Helios, while the platform for on-line condition monitoring of industrial assets, implemented at the company Litostroj Power, was integrated with the existing information system in the company. The control solutions for the efficient use of energy include the design of an algorithm for the optimal selection of heating and cooling systems in smart buildings that was implemented and tested by the company Goap, while the improved control of the anaerobic fermenter in the production of biogas was implemented by Kolektor Sinabit and tested on a pilot-scale batch reactor. A particular

Figure 4: "Heavy-duty" valve drive for Danfoss Trata d.o.o.

challenge in the field of energy production is the control of a fusion reactor. Within the realistic demonstrator of controlling plasma position, which was designed by the company Cosylab, an improved control solution based on a predictive controller was developed for plasma position control. Finally, within this programme our department members are planning to submit two patent applications and two innovations as leading partners.

Another important part of our activities is also devoted to direct cooperation with various companies.

In the project for Danfoss Trata d.o.o., the hardware and the firmware for "heavy-duty" motor drives have been developed (Figure 4). The drives are now in a trial production phase at Danfoss Trata, d.o.o. The drives have an anti-oscillation function that increases the expected lifespan of the drives and decreases the energy consumption. In addition to the heavy-duty drives, the concept of so-called "integration drives" has been developed and tested as well. Integration drives are used for tighter control of the output water temperature from heat exchangers.

An online estimation of the remaining useful life of electromotors is a challenging task. In the company Domel d.o.o. we developed and installed a line for the long-life testing of electronically commutated motors. The installed measuring equipment allows sufficiently accurate data acquisition and local data processing as well as an estimation of the remaining useful life. The final goal is the development of an embedded module for the estimation of the remaining useful life that will be an integral part of the final product.

In collaboration with the Centre of Excellence Low-carbon technologies, special DC/DC converters have been finalised and delivered to a number of national and European customers.

Publication of the book *"Case Studies in Control - Putting Theory to Work"*

The book entitled *"Case Studies in Control - Putting Theory to Work"* appeared in 2013 in the Springer series "Advances in Industrial Control". The book editors Prof. Dr. Stanko Strmčnik and Prof. Dr. Đani Juričić raised the topic of advanced control based on a number of case studies presented by our department members. The book summarizes the long-standing efforts and knowledge of our department in the field of the research of advanced control methods and their transfer to industrial practice. Case Studies in Control presents a framework to facilitate the use of advanced control concepts in real systems based on two decades of research and over 150 successful applications for industrial end-users from various backgrounds.

Educational and training activities

Some members of the department are giving lectures and practical courses at different faculties and 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 Ph.D. students.
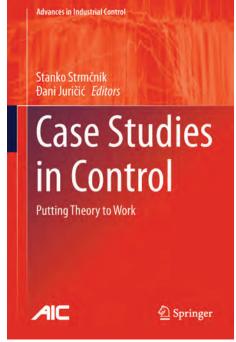

Figure 5. Cover of the book Case Studies in Control - Putting Theory to Work

Some outstanding publications in the past year

1. Kocijan, J., Hvala, N.: Sequencing batch-reactor control using Gaussian-process models. *Bioresource technology*, ISSN 0960-8524, vol. 137, 340–348
2. Hvala, N., Kukanja, D.: Modelling and simulation of semi-batch polymerisation reactor for improved reactants dosing control. *Simulation modelling practice and theory*, ISSN 1569-190X, vol. 33, no. 1, 102–114
3. Lukman, T., Godena, G., Gray, Jeffrey G., Heričko, M., Strmčnik, S.: Model-driven engineering of process control software beyond device-centric abstractions. *Control engineering practice*, ISSN 0967-0661, vol. 21, no. 8, 1078–1096
4. Petelin, D., Grancharova, A., Kocijan, J.: Evolving Gaussian process models for prediction of ozone concentration in the air. *Simulation modelling practice and theory*, ISSN 1569-190X, vol. 33, 68–80
5. Glavan, M., Gradišar, D., Atanasijević-Kunc, M., Strmčnik, S., Mušič, G.: Input variable selection for model-based production control and optimisation. *The international journal of advanced manufacturing technology*, ISSN 0268-3768, 2013, vol. 68, no. 9/12, 2743–2759
6. Glavan, M., Gradišar, D., Strmčnik, S., Mušič, G.: Production modelling for holistic production control. *Simulation modelling practice and theory*, ISSN 1569-190X, jan. 2013, vol. 30, 1–20

The most important achievements in the past year

1. The book "Case Studies in Control - Putting Theory to Work" edited by Prof. Dr. Stanko Strmčnik and Prof. Dr. Đani Juričić was published in the Springer series "Advances in Industrial Control".
2. The article on modelling and control of polymerization process has been ranked among the most downloaded articles in Computers & Chemical Engineering Journal.
3. The first dedicated DC/DC converters for fuel-cell systems have been sold on the European market.
4. Successful completion of a multi-annual project "Competence Centre for Advanced Control Technologies" where the department E2 was involved in several development subprojects.
5. Successful completion of a multi-annual work within the "Centre of Excellence Low-carbon technologies" where we were in charge for the research on the field of hydrogen technologies.

Awards and appointments

1. Nadja Hvala: The article "Modelling, simulation and control of an industrial, semi-batch, emulsion-polymerization reactor" in Computers and Chemical Engineering Journal has according to Elsevier more than 500 downloads. It has been identified as one of the most downloaded articles in this journal in the period from Sept. 2012 - Aug. 2013 and has received a certificate for this contribution.

INTERNATIONAL PROJECTS

1. Production of DC/DC Converters
   PowerCell Sweden AB
   Dr. Janko Petrovčič
2. 7FP - FCGEN; Fuel Cell Based On-board Power Generation
   European Commission
   Dr. Boštjan Pregelj
3. 7FP - FLUMABACK; Fluid Management Component Improvement for Back up Fuel Cell Systems
   European Commission
   Dr. Pavle Boškoski
4. CERACON; Integration and Control of Liquid Fuel processor based on Ceramic Micro-Systems
   ESA/ESTEC.
   Dr. Gregor Dolanc
5. COST IC0806, IntelliCIS; Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems
   COST Office
   Dr. Nadja Hvala

RESEARCH PROGRAM

1. Program Systems and Control
   Prof. Đani Juričić

R&D GRANTS AND CONTRACTS

1. Prognostics and health management of mechanical drives based on novel MEMS sensor networks
   Prof. Đani Juričić
2. Development and implementation of a method for on-line modelling and forecasting of air pollution
   Prof. Juš Kocijan
3. Optimisation of energy cost for refrigeration systems in shopping malls
   Asst. Prof. Damir Vrančić
4. On-line System Identification for Model-Based Prognostics and Health Management
   Dr. Matej Gašperin
5. Competence Centre for Advanced Control Technologies: CC ACT
   Asst. Prof. Damir Vrančić
6. Probasensor: EUROSTARS; Probalistic Bayesian Soft Sensor - A Tool for On-line Estimation of the Key Process Variable in Cold Rolling Mills
   Prof. Đani Juričić

NEW CONTRACTS

1. Process Control Software Development Methodology
   Inea, d. o. o.
   Giovanni Godena, M. Sc.
2. Prognostics and Health Management of Mechanical Drives Based on Novel MEMS Sensor Networks
   Domel, d.o.o.
   Prof. Đani Juričić

3. Development and Implementation of a Method for On-line Modelling and Forecasting of Air Pollution
   MEIS environmental services, d.o.o.
   Prof. Juš Kocijan

4. Optimisation of Energy Cost for Refrigeration Systems in Shopping Malls
   Entia, d.o.o.
   Asst. Prof. Damir Vrančić

VISITORS FROM ABROAD

1. Prof. Diego Galar, Luleå University of Technology, Luleå, Sweden, 2.–6. 9. 2013

2. Asst. prof. Václav Šmídl, University of West Bohemia, Plzen, Czech Republic, 2.–4. 10. 2013

STAFF

Researchers
1. Dr. Gregor Dolanc
2. Dr. Samo Gerkšič
3. Giovanni Godena, M. Sc.
4. Dr. Dejan Gradišar
5. Dr. Nadja Hvala
6. **Dr. Vladimir Jovan, Head**
7. Prof. Đani Juričić
8. Prof. Juš Kocijan
9. Dr. Bojan Musizza
10. Dr. Janko Petrovčič
11. Prof. Stanislav Strmčnik
12. Asst. Prof. Damir Vrančić
13. Dr. Darko Vrečko
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14. Dr. Pavle Boškoski
15. Dr. Matej Gašperin

16. Dr. Marko Nerat
17. Dr. Matija Perne
18. Dr. Boštjan Pregelj
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19. Andrej Debenjak, B. Sc.
20. Boštjan Dolenc, B. Sc.
21. Miha Glavan, B. Sc.
22. Dejan Petelin, B. Sc.
23. Martin Stepančič, B. Sc.
24. Aleš Svetek, M. Sc.
Technical officers
25. Stanislav Černe, B. Sc.
26. Primož Fajdiga, B. Sc.
Technical and administrative staff
27. Maja Janežič, B. Sc.
28. Miroslav Štrubelj

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Original Article

1. Darko Aleksovski, Juš Kocijan, Sašo Džeroski, "Model tree ensembles for modeling dynamic systems", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 17-32, 2013.
2. Darko Belavič, Marko Hrovat, Gregor Dolanc, Kostja Makarovič, Marina Santo-Zarnik, "Design and fabrication of an LTCC structure for a microceramic combustor: invited paper", *J. microelectron. electron. packag.*, vol. 9, no. 3, pp. 120-125, 2013.
3. Andrej Debenjak, Matej Gašperin, Boštjan Pregelj, Maja Atanasijević-Kunc, Janko Petrovčič, Vladimir Jovan, "Detection of flooding and drying inside a PEM fuel cell stack", *Stroj. vestn.*, vol. 59, no. 1, pp. 56-64, Jan. 2013.
4. Andrej Debenjak, Bojan Musizza, Matej Gašperin, Janko Petrovčič, "Diagnostični modul za gorivne celice s protonsko prevodno membrano", *Ventil (Ljubl.)*, vol. 19, no. 3, pp. 200-206, jun. 2013.
5. Samo Gerkšič, Gianmaria de Tommasi, "Vertical stabilization of ITER plasma using explicit model predictive control", In: Proceedings of the 27th Symposium On Fusion Technology, SOFT-27, Liège, Belgium, September 24-28, 2012, *Fusion Eng. Des.*, vol. 88, no. 6/8, pp. 1082-1086, 2013.
6. Miha Glavan, Dejan Gradišar, Maja Atanasijević-Kunc, Stanko Strmčnik, Gašper Mušič, "Input variable selection for model-based production control and optimisation", *Int. j. adv. manuf. technol.*, vol. 68, no. 9/12, pp. 2743-2759, 2013.
7. Miha Glavan, Dejan Gradišar, Stanko Strmčnik, Gašper Mušič, "Production modelling for holistic production control", *Simulation modelling practice and theory*, vol. 30, pp. 1-20, jan. 2013.
8. Nadja Hvala, Dolores Kukanja, "Modelling and simulation of semi-batch polymerisation reactor for improved reactants dosing control", In: EUROSIM 2010 special issue, *Simul. Model. Pract. Theory*, vol. 33, no. 1, pp. 102-114, 2013.
9. Ulf Jeppsson *et al.*, (17 avtorjev) "Benchmark simulation models, quo vadis?", *Water sci. technol.*, vol. 68, no.1, pp. 1-15, 2013.
10. Juš Kocijan, Nadja Hvala, "Sequencing batch-reactor control using Gaussian-process models", *Bioresour. technol.*, vol. 137, pp. 340-348, jun. 2013.

11. Tomaž Lukman, Giovanni Godena, Jeffrey G. Gray, Marjan Heričko, Stanko Strmčnik, "Model-driven engineering of process control software beyond device-centric abstractions", *Control eng. pract.*, vol. 21, no. 8, pp. 1078-1096, 2013.
12. Dejan Petelin, Alexandra Grancharova, Juš Kocijan, "Evolving Gaussian process models for prediction of ozone concentration in the air", In: EUROSIM 2010 special issue, *Simul. Model. Pract. Theory*, vol. 33, pp. 68-80, apr. 2013.

Review Article

1. Ingrid Petrič, Dejan Gradišar, Miha Glavan, Stanko Strmčnik, "Ključni kazalniki za merjenje uspešnosti proizvodnje", *Uporab. inform. (Ljubl.)*, vol. 21, no. 2, pp. 95-106, apr./maj/jun. 2013.

Short Article

1. Matej Gašperin, Klemen Žagar, Drago Bokal, Klemen Strniša, Gašper Pajor, L. Medeiros-Romao, D. Vandeplassche, "Predictive diagnostics for high-availability accelerators", *Control sheet*, vol. 16, no. 9, pp. 2'3, 2013.

Published Conference Contribution (invited lecture)

1. Juš Kocijan, "Incorporating knowledge about model structure in the identification of Gaussian-process models", In: *Recent advances in telecommunications, signals and systems: proceedings of the 12th International Conference on Data Networks, Communications, Computer (DNCOCO '13), proceedings of the 12th International Conference on Non-Linear Analysis, Non-Linear Systems and Chaos (NOLASC '13), proceedings of the 9th International Conference on Dynamical Systems and Control (CONTROL '13), proceedings of the 6th International Conference on Sensors and Signals (SENSIG '13), proceedings of the International Conference on Visualization, Imaging and Simulations (VIS '13), Marc 21-23, 2013, Lemesos, Cyprus*, (Recent advances in electrical engineering series, 10), Andreas Kanarachos, ed., [S. l.], WSEAS, 2013, pp. 124-129.

PUBLISHED CONFERENCE CONTRIBUTION

1. Pavle Boškoski, Đani Juričić, "Detection of bearing faults based on inverse Gaussian mixtures model", In: *Surveillance 7: international conference: October 29-30, 2013, Chartres, France*, Chartres, Institute of Technology, 2013, 12 pp.

2. Pavle Boškoski, Đani Juričić, "MIMOSA OSA-EAI standard za E-Vzdrževanje", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp..

3. Pavle Boškoski, Đani Juričić, "Modeling localized bearing faults using inverse Gaussian mixtures", In: *PHM`13*, Annual Conference on Prognostics and Health Management Society, 14 October - 17 October 2013, New Orleans, USA, Denver, IEEE, 2013, 7 pp..

4. Henry Rafael Concepcion, Darko Vrečko, Montse Meneses, Ramon Vilanova, "Control strategies for removing nitrogen compounds in waste water treatment plants", In: *ASCC 2013*, 2013 9th Asian Control Conference, June 23-26, 2013, Istanbul, Turkey, Piscataway, IEEE, cop. 2013, 6 pp.

5. Henry Rafael Concepcion, Darko Vrečko, Montse Meneses, Ramon Vilanova, "Evaluating the environmental performance of wastewatertreatment plants control strategies", In: *Book of abstracts*, 11th IWA Conference on Instrumentation Control and Automation, ICA 2013, 18-20 September 2013, Narbonne, France, [S. l.], IWA, 2013, 4 pp.

6. Andrej Debenjak, Matej Gašperin, Janko Petrovčič, "On-line tracking of fuel cell system impedance using extended Kalman filter", In: *Proceedings of the PHM2013, 2013 Prognostic and System Health Management, 8-11 September 2013, Milano, Italy*, (Chemical engineering transactions, vol. 33, 2013), Milano, AIDIC, 2013, vol. 33, pp. 1003-1008, 2013.

7. Andrej Debenjak, Bojan Musizza, Matej Gašperin, Janko Petrovčič, "Modul za sprotno diagno stiko PEM gorivnih celic", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp..

8. Gregor Dolanc, Marko Hrovat, Primož Fajdiga, Stanko Hočevar, Andrej Pohar, Kostja Makarovič, Darko Belavič, "System with ceramic LTCC micro-reactor for steam reforming", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & theWorkshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 251-256.

9. Jaka Fritz, Boštjan Pregelj, Janko Petrovčič, Maja Atanasijević-Kunc, "Modeliranje sistema s PEM gorivnimi celicami", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 185-188.

10. Franci Gabrovšek, Matija Perne, "Evolution of conduit network in transition from pressurised to free surface flow", In: *Proceedings*, 16th International Congress of Speleology, Brno, Czech Republic, July 21-28, 2013, Michal Filippi, ed., Pavel Bosák, ed., Brno, International Union of Speleology, Czech Speleological Society, 2013, vol. 2, pp. 347-348.

11. Matej Gašperin, Pavle Boškoski, "Signal processing and stochastic filtering for EIS based PHM of fuel cell systems", In: *FDFC 2013*, 5th International Conference on Fundamentals & Development of Fuel Cells, 16-18th April, 2013, Karlsruhe, Germany, [S. l., s. n.], 2013, 8 pp.

12. Samo Gerkšič, Boštjan Pregelj, Stanko Strmčnik, Aleš Šink, Tadej Jerovšek, Aleksander Pregelj, Igor Steiner, "Aplikativna izvedba poenostavljenega eksplicitnega prediktivnega regulatorja na pilotni napravi", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp..

13. Samo Gerkšič, Gianmaria de Tommasi, Klemen Žagar, "Regulacija vertikalnega položaja plazme v fuzijskem tokamak reaktorju Iter", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 5 pp..

14. Miha Glavan, Dejan Gradišar, Gašper Mušič, "Podatkovni model za celostno vodenje proizvodne", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor,*

15. Miha Glavan, Dejan Gradišar, Stanko Strmčnik, Gašper Mušič, "Orodje za analizo proizvodne dinamike", In: *Vir znanja in izkušenj za stroko: zbornik foruma*, 5. industrijski forum IRT, Portorož, 10.-12. junij 2013, Tomaž Perme, ed., Darko Švetak, ed., Škofljica, Profidtp, 2013, pp. 107-112.

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