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 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

Basic and applied research in 2016 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 first topic addressed the modelling and identification of nonlinear and complex dynamical systems. The research on methods for the dynamical systems' modelling was pursued in two directions: the development of Gaussian-process models and the development of model-tree ensembles. The research of modelling methods for environmental systems continued in the first track. In addition, a scientific monograph on modelling and control with Gaussian process models, authored by a member of department, was published by the Springer publishing house in 2016. The research of methods based on model-tree ensembles was focused on multivariable systems and on a comparison with other modelling methods.

The second topic was *advanced control.* We have continued the research and development of model predictive control (MPC) by using fast, online, first-order quadratic programming optimization techniques. Using singular value decomposition we have implemented an advanced MPC controller for the ITER plasma current and shape controller for the plasma magnetic control of the Iter fusion tokamak reactor, evaluated its simulation performance, and tested its numerical implementation in a low-latency Linux environment. Using an active-set approach, a new theoretical result on tight local convergence estimates was found for the dual gradient method, which explains different convergence rates observed in numerical simulations (Figure 1).

In the field of *fault detection and condition monitoring* our work included research dealing with robust fault detection in model-based approaches. In order to facilitate robust fault detection, we proposed a novel approach that combines elements of Gaussian process models and Jensen-Reny divergence. A Gaussian process model is employed in order to correct modelling errors due to a mismatch between measurements and a physical model employed for residual generation. Then, the residuals generated by employing physical and Gaussian models, are evaluated via Jensen-Reny divergence. The proposed approach was applied for SOFC fault detection and the results were presented at the *SysTOL* conference in Barcelona, Spain. The accurate anticipation of the remaining useful life (RUL) of a machine is also becoming mandatory in Industry 4.0 for efficient exploitation of the assets and avoiding unplanned downtimes. A novel, three-stage, data-driven approach to the RUL prediction has been developed and demonstrated on an industrial sand-blasting machine.

In 2016 we continued working on the diagnostics of PEM fuel cells with the use of its own developed fast electrochemical impedance spectroscopy. During the past 5 years we have achieved a considerable number of research and applied results in the area of PEM fuel-cell diagnostics. In 2016, all these results have been presented in a book, which is currently in the publishing process with the Springer publishing company.

In the area of **tools and building blocks for implementation** we have started the activities to upgrade the tool for analysis and optimisation of the production performance – ProOpter. We have overviewed current global initiatives and trends in the field of smart manufacturing. The main focus was to review functional and integrational aspects of the tool within the smart manufacturing ecosystem. Furthermore, architectural aspects were reviewed in order to be in line with the trends of Industry 4.0 (IoT, cloud, etc.) (Figure 2).

In the past year, a number of members of the department in collaboration with colleagues from other partner organisations, worked intensively on preparing a proposal for the public call entitled "Promoting the implementation of research and development programs (TRL 3-6)." We proposed
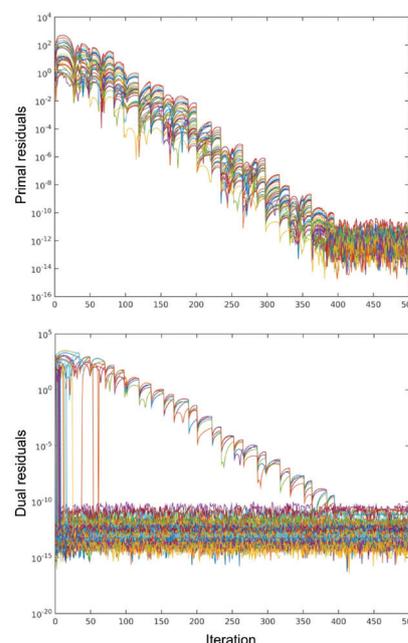
Head:
Dr. Vladimir Jovan

Figure 1: Convergence courses of primal (top) and dual (bottom) residuals through iterations of the dual fast gradient method with restarting at the optimization of a sample quadratic program of the plasma current and shape controller in one time-step. Validation of ozone-model predictions with measurements of maximum daily values

a program entitled "Building Blocks, tools and systems for factories of the future", with the acronym GOSTOP, in the frame of the priority area Factories of the Future. The application was successful and the work on the program started in November. The program will last 42 months, until end of April 2020. The program involves 19 partners, of which there are 6 institutions and 13 companies. The program is structured in two ways, first of which is based on the content, and second on the technology readiness level (TRL). In terms of content, the program is divided into four pillars, namely Control technologies, Tooling technology, Robotics, and Photonics. According to TRL, each of the four pillars is divided into two research and development projects, of which first aims to achieve TRL 3-4 (industrial research), and second TRL 5-6 (experimental development). Hence, the program contains eight R&D projects. Members of our department are involved in the research and development activities of the program (in the Control technologies pillar), as well as in the program-management activities (deputy coordinator, member of the executive committee, chairman of the committee for the dissemination and exploitation of results, assistant of the program coordinator for R&D coordination, management of the Control technologies pillar, management of two activities of the Control technologies pillar).

Applied research in the priority problem domains was the third sub-area of our interest. In collaboration with SME Entia d.o.o. we completed Slovenian Research Agency project "Cost optimization of energy consumption for refrigeration in shopping malls," where we have developed a control system for freezers, which implicitly takes into account the prescribed temperature constraints according to the HACCP standard. The system simultaneously allows an adjustment of the total power consumption to the desired consumption profile.

Figure 2: Smart Manufacturing Ecosystem

For another on-going Slovenian Research Agency project named Development and implementation of a method for on-line modelling and forecasting of air pollution research on algorithms for modelling and prediction based on Gaussian process that can be used with a mobile station were pursued. Moreover, the research was also pursued on empirical modelling methods for improved modelling and forecasting pollution with ozone over Slovenia as a case study of complex terrain.

In the past year a new test rig for electronically commutated motors has been set up in Domel d.o.o. For this purpose a new graphical user interface for the control and monitoring of motor parameters has been developed. The test system has been connected to the information system in Domel d.o.o. in line with Industry 4.0 trends. In addition, a new instrument has been prepared for monitoring the vibrations of motors with MEMS accelerometers. The purpose of the instrument is to explore possible ways of mounting MEMS accelerometers on existing electronically commutated motors and determine whether the installation of the MEMS sensors is economically justified.

Within the new project L2-7663 "State-of-health estimation of electrochemical energy systems", funded by Slovenian Research Agency, we were studying various models that describe the degradation phenomena in PEM fuel cells. For that purpose we have built a test-bench for run-to-failure testing of PEM fuel cells under various operating conditions.

International R&D projects

Since April 2014 we have participated in the third EU FW7 project "Diamond - Diagnosis-aided control for SOFC power systems". A simple, model-free supervisory optimizer for SOFC (solid-oxide fuel cell) power systems was designed. The optimizer adjusts set-points for the low-level controllers in such a way as to maximize the electrical efficiency of the system and prevent stack voltage drops. The optimization problem is solved by using the extremum-seeking approach where the optimum is sought directly on the process. The optimizer shows encouraging performance and exceeds the weakness of model-based optimizers, which assume nominal process conditions all the time and do not take into account the degradation process.

In the framework of the 3-year project "Fast Model Predictive Control for Magnetic Plasma Control - FMPCFMPC", "Enabling Research" activity of the EUROfusion Work Programme 2015 (part of Horizon 2020 / Euratom), we have been collaborating with the consortium ENEA/CREATE from Naples, Italy. The aim of the project is to apply novel fast MPC approaches to plasma magnetic control, where MPC is currently not applicable due to the large-scale multivariable nature of the problem and sub-second sampling rates.
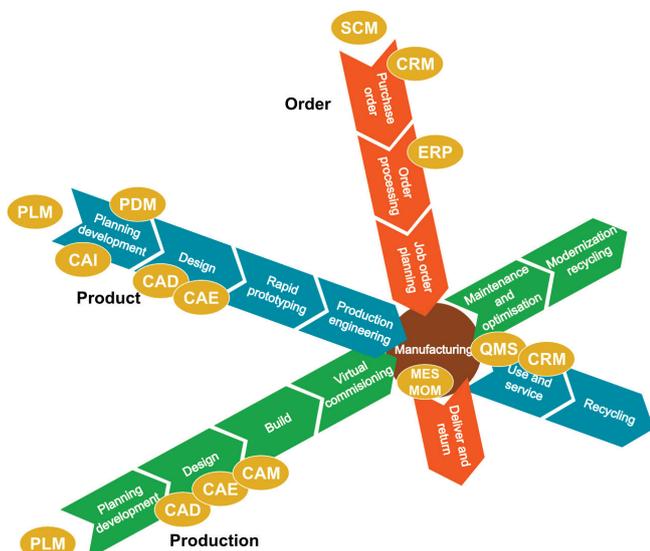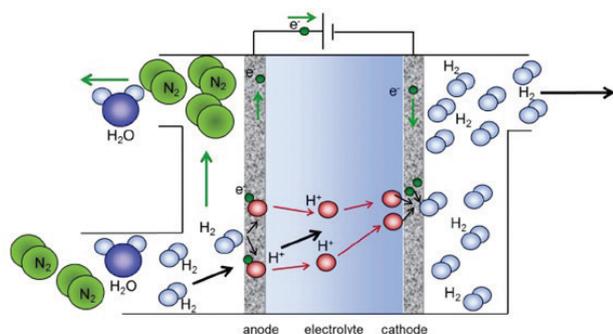

Figure 3: The principle of electro-chemical hydrogen compression and purification

At the beginning of 2017 a new H2020 hydrogen technology related project has been started where the Department of Systems and Control acts as a partner. The scope of the project is the development of an electro-chemical system for hydrogen compression and cleaning using membranes, similar to the ones used in PEM fuel cells. The compression system reaches pressure up to 1000 bar, it is driven by the electricity and it has higher energy efficiency than mechanical compressors. During decompression a part of the electrical energy utilized during compression is recuperated. The system can also be used for hydrogen cleaning since the membrane only conducts hydrogen protons (Figure 3).

Recent accomplishments in the health monitoring of solid-oxide fuel cells have given a boost to extending the methodology to a perspective technology of solid-oxide electrolyzers. The first step within a bilateral project with a French research institution CEA and our department, initiated in July 2016, was oriented towards a detailed feasibility study.

Within the COST Water_2020 project we have participated in the preparation of the book chapter "Model-based comparative assessment of innovative processes". The objective of the chapter is to compare the simulation results of three different wastewater-treatment-plant configurations using dynamic modelling. The chapter is part of the book "Innovative Wastewater Treatment & Resource Recovery Technologies: Impacts on Energy, Economy and Environment" which is prepared by the partners of the COST Action. The book, which has more than 160 contributors, will be released by the IWA Publishing in May 2017.

Figure 4: Gripper of the new system for the motor final quality control in Domel d.o.o.

Applied work

In the context of a long-term partnership with Danfoss Trata d.o.o in 2016 we started with the activities on the development of hardware and software for three new families of valve drives. There are various types and sizes of drives with a variety of functionalities to be used by both the HVAC systems as well as in district heating systems.

In Domel d.o.o. in 2016 the partial installation of a new diagnostic system for the end control of electronically commutated motors (type 771) has been completed. The system is based upon diagnostic systems on older production lines. Nevertheless, many innovations were introduced during the implementation on the electro-mechanical part as well as on the software part. The new system supports the diagnostics of two different motors, wherein one type of motor has a built-in controller, which further increases the complexity of manipulators and electronic components of the line (Figure 4). Next, on the software side the focus was on informatization of the production line in accordance with the current trend Industry 4.0 (iIOT – Industrial Internet Of Things). Thus, the majority of components and sensors has its own IP address and can communicate with the ERP system. The production line is scheduled to start operating in the first quarter of 2017.

Another project in Domel d.o.o was installed in their unit PE ECS. We have developed and installed a configurable end-quality control line for electronically commutated blowers. The line is capable of self-reconfiguration, thus enabling total end-quality control of all the produced blower families. The line's design and implementation is completely in line with Industry 4.0 guidelines.

Figure 5: Bowling tournament to celebrate the department's 30th anniversary

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 four Ph.D. students.

Some outstanding publications in the past year

1. Dolanc, Gregor, Pregelj, Boštjan, Petrovčič, Janko, Pasel, Joachim, Kolb, Günter. Control of autothermal reforming reactor of diesel fuel. *Journal of power sources*, ISSN 0378-7753, may 2016, vol. 313, pp. 223-232

2. Nerat, Marko, Vrančić, Damir. A novel fast-filtering method for rotational speed of the BLDC motor drive applied to valve actuator. *IEEE/ASME transactions on mechatronics*, ISSN 1083-4435, 2016, vol. 21, no. 3, pp. 1479-1486

3. Dolenc, Boštjan, Vrečko, Darko, Juričić, Đani, Pohjoranta, Antti, Pianese, Cesare. Online estimation of internal stack temperatures in solid oxide fuel cell power generating units. *Journal of power sources*, ISSN 0378-7753, 2016, vol. 336, pp. 251-260

4. Pregelj, Boštjan, Micor, Michał, Dolanc, Gregor, Petrovčič, Janko, Jovan, Vladimir. Impact of fuel cell and battery size to overall system performance - a diesel fuel-cell APU case study. *Applied energy*, ISSN 0306-2619, 2016, vol. 182, pp. 365-375

5. Boškoski, Pavle, Juričić, Đani. Inverse Gaussian mixtures models of bearing vibrations under local faults. *Mechanical systems and signal processing*, ISSN 0888-3270, 2016, vol. 66/67, pp. 546-556

Some outstanding achievements in the past year

1. The Department of Systems and Control celebrates its 30th anniversary. On 22th of June, 2016 we celebrated this event with a barbecue and a bowling tournament (Figure 5)

2. The book entitled "Modelling and Control of Dynamic Systems Using Gaussian Process Models", authored by our Department member Prof. Dr. Juš Kocijan, has appeared in the Springer series "Advances in Industrial Control"

3. The "2016 Prešeren award" at the Faculty of Electrical Engineering, Ljubljana was awarded to our department member Tomaž Kos for his research project entitled Measurement system for automated low-frequency and high-temperature characterization of dielectric materials

4. "Jozef Stefan" Institute and the Ministry of Education, Science and Sport have signed an agreement on co-financing operation no. C3330-16-529000, **"Building Blocks, Tools and Systems for Factories of the Future" (GOSTOP).** Our department plays one of the main roles in this programme

5. Two new projects in the field of the development of hydrogen technologies (Memphys, Insight) were approved for financing within the scope of Horizon 2020 programme (Fuel Cells and Hydrogen Joint Undertaking)

Awards and appointments

1. Tomaž Kos: The 2016 Prešeren award at the University of Ljubljana, Faculty of Electrical Engineering for his research project entitled Measurement system for automated low-frequency and high-temperature characterization of dielectric materials

2. Stanislav Strmčnik: received the Professor Emeritus of the University of Nova Gorica award for his significant contribution to the development of scientific activities and his remarkable performance as professor and mentor

Patent granted

1. Janko Petrovčič, Damir Vrančić, Reducing oscillations in a control system, EP2356522 (B1), European Patent Office, 06. 01. 2016.

INTERNATIONAL PROJECTS

1. 7FP - DIAMOND; Diagnosis-aided Control for SOFC Power System
   Prof. Đani Juričić
   European Commission
2. COST ES1202; Water_2020: Conceiving Wastewater Treatment in 2020 - Energetic, Environmental and Economic Challenges
   Dr. Darko Vrečko
   Cost Office
3. ER-3-FU; Enabling Research; EUROFUSION
   Dr. Samo Gerkšič
   European Commission
4. Non-invasive Condition Monitoring of High Temperature Steam Electrolyser
   Prof. Đani Juričić
   Slovenian Research Agency

RESEARCH PROGRAM

1. Program systems and control
   Prof. Đani Juričić

R & D GRANTS AND CONTRACTS

1. State-of-health prognostics of electrochemical energy systems
   Dr. Pavle Boškoski
2. E-maintenance of electro-mechanical drives: prognostics and health management solutions under non-stationary operating conditions
   Prof. Đani Juričić
3. Development and implementation of a method for on-line modelling and forecasting of air pollution
   Prof. Juš Kocijan
4. Optimisation of energy cost for refrigeration systems in shopping malls
   Asst. Prof. Damir Vrančić
5. Building blocks, tools and systems for the Factories of the Future – GOSTOP
   Dr. Vladimir Jovan

NEW CONTRACTS

1. Design and assembly of diagnostic system for quality assessment of the 771 family of brushless motors
   Dr. Janko Petrovčič
   Domel, d. o. o.

2. Optimisation of energy cost for refrigeration systems in shopping malls
   Asst. Prof. Damir Vrančić
   Danfoss Trata, d. o. o.
3. Functional upgrades on existing diagnostics systems for on-line analysis of operating

characteristics and vibration measurement of motors
Dr. Janko Petrovčič
Domel, d. o. o.

VISITOR FROM ABROAD

1. prof. dr. Marco Ariola, Parthenope University of Naples, Naples, Italy, 25–26 February 2016
2. prof. dr. Gianmaria de Tomassi, University of Naples Federico II, Naples, Italy, 25–26 February 2016
3. prof. dr. Alfredo Pironti, University of Naples Federico II, Naples, Italy, 25–26 February 2016
4. dr. Denis Kalupin, EUROfusion, Garching, Germany, 25–26 February 2016
5. assoc. prof. Alexandra Grancharova, University of Chemical Technology and Metallurgy, Sofija, Bulgaria, 19 May 2016
6. prof. dr. Aneta Stefanovska, Department of Physics, Lancaster University, Lancaster, United Kingdom, 6 September 2016
7. dr. Attila Göllei, University of Pannonia, Veszprém, Hungary, 12–14 October 2016
8. dr. Attila Magyar, University of Pannonia, Veszprém, Hungary, 12–14 October 2016
9. Roland Bálint, University of Pannonia, Veszprém, Hungary, 12–14 October 2016

STAFF

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

Postdoctoral associates
17. Dr. Andrej Debenjak
18. Dr. Miha Glavan
19. Dr. Marko Nerat

Postgraduates
20. Boštjan Dolenc, B. Sc.
21. Tomaž Kos, B. Sc.
22. Gjorgji Nusev, B. Sc.
23. Martin Stepančič, B. Sc.

Technical officers
24. Stanislav Černe, B. Sc.
25. Primož Fajdiga, B. Sc.

Technical and administrative staff
26. Maja Janežič, B. Sc.
27. Miroslav Štrubelj

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Darko Aleksovski, Juš Kocijan, Sašo Džeroski, "Ensembles of fuzzy linear model trees for the identification of multi-output systems", *IEEE trans. fuzzy syst.*, vol. 24, no. 4, pp. 916-929, 2016.
2. Pavle Boškoski, Đani Juričić, "Inverse Gaussian mixtures models of bearing vibrations under local faults", *Mech. syst. signal process.*, vol. 66/67, pp. 546-556, 2016.
3. Andraž Bradeško, Đani Juričić, Marina Santo-Zarnik, Barbara Malič, Zdravko Kutnjak, Tadej Rojac, "Coupling of the electrocaloric and electromechanical effects for solid-state refrigeration", *Appl. phys. lett.*, vol. 109, no. 14, pp. 143508-1-143508-7, 2016.
4. Nadja Damij, Pavle Boškoski, Marko Bohanec, Biljana Mileva-Boshkoska, "Ranking of business process simulation software tools with DEX/QQ hierarchical decision model", *PloS one*, vol. 11, no. 2, pp. 0148391-1-0148391-16, 2016.
5. Gregor Dolanc, Boštjan Pregelj, Janko Petrovčič, Joachim Pasel, Günter Kolb, "Control of autothermal reforming reactor of diesel fuel", *J. power sources*, vol. 313, pp. 223-232, maj 2016.
6. Boštjan Dolenc, Pavle Boškoski, Đani Juričić, "Distributed bearing fault diagnosis based on vibration analysis", *Mech. syst. signal process.*, vol. 66/67, pp. 521-532, 2016.
7. Boštjan Dolenc, Darko Vrečko, Đani Juričić, Antti Pohjoranta, Cesare Pianese, "Online estimation of internal stack temperatures in solid oxide fuel cell power generating units", *J. power sources*, vol. 336, pp. 251-260, 2016.
8. Miha Glavan, Dejan Gradišar, Serena Invitto, Iztok Humar, Đani Juričić, Cesare Pianese, Damir Vrančić, "Cost optimisation of supermarket refrigeration system with hybrid model", *Appl. therm. eng.*, vol. 103, pp. 56-66, 2016.
9. Miha Glavan, Dejan Gradišar, Damir Vrančić, "Modeliranje hladilnih elementov v nakupovalnih središčih za namene optimizacije energijskih stroškov", *Avtomatika*, vol. 2016, no. 149, pp. 42-49, 2016.
10. Dejan Gradišar, Boštjan Grašič, Marija Božnar, Primož Mlakar, Juš Kocijan, "Improving of local ozone forecasting by integrated models", *Environ. sci. pollut. res. int.*, vol. 23, no. 18, pp. 18439-18450, 2016.
11. Juš Kocijan, Dejan Gradišar, Marija Božnar, Boštjan Grašič, Primož Mlakar, "On-line algorithm for ground-level ozone prediction with a mobile station", *Atmos. environ. (1994)*, vol. 131, pp. 326-333, 2016.
12. Marko Nerat, Đani Juričić, "A comprehensive 3-D modeling of a single planar solid oxide fuel cell", *Int. j. hydrogen energy*, vol. 41, no. 5, pp. 3613-2627, 2016.
13. Marko Nerat, Damir Vrančić, "A novel fast-filtering method for rotational speed of the bldc motor drive applied to valve actuator", *IEEE/ASME trans. mechatron.*, vol. 21, no. 3, pp. 1479-1486, 2016.
14. Boštjan Pregelj, Gregor Dolanc, Janko Petrovčič, "FCGEN - razvoj in izvedba sistema vodenja za pomožni agregat z gorivnimi celicami na dizelsko gorivo", *Avtomatika*, vol. 2016, no. 145, pp. 42-49, 2016.
15. Boštjan Pregelj, Michał Micor, Gregor Dolanc, Janko Petrovčič, Vladimir Jovan, "Impact of fuel cell and battery size to overall system performance - a diesel fuel-cell APU case study", *Appl. energy*, vol. 182, pp. 365-375, 2016.
16. Tadej Rojac, Maja Makarovič, Julian Walker, Hana Uršič, Dragan Damjanović, Tomaž Kos, "Piezoelectric response of $BiFeO_3$ ceramics at elevated temperatures", *Appl. phys. lett.*, vol. 109, no. 4, pp. 042904-1-042904-4, 2016.

PUBLISHED CONFERENCE CONTRIBUTION

1. Darko Aleksovski, Dejan Dovžan, Sašo Džeroski, Juš Kocijan, "A comparison of fuzzy identification methods on benchmark datasets", In: *Proceedings of the 4th IFAC Conference on Intelligent Control and Automation, ICONS 2016, 1-3 June 2016, Reims, France*, IFAC-PapersOnline, vol. 49, no. 5, pp. 31-36, 2016.
2. Matjaž Bostič, Alexander Marinšek, Miha Glavan, Damir Vrančić, Iztok Humar, "Agent za upravljanje hladilnih sistemov z vidika zniževanja stroškov porabe", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož,*

Slovenija, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 121-124.

3. Marija Božnar, Boštjan Grašič, Primož Mlakar, Dejan Gradišar, Juš Kocijan, "Analysis of the daily cycles in the data on air pollution through the use of advanced analytical tools", In: *Proceedings*, fHARMO-17, 17th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 9-12 May 2016, Budapest, Hungary, pp. 171-176.

4. Boštjan Dolenc, Pavle Boškoski, Đani Juričić, "Ocenjevanje stopnje degradacije skladov gorivnih celic", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 155-158.

5. Boštjan Dolenc, Martin Stepančič, Đani Juričić, Juš Kocijan, Dario Marra, Cesare Pianese, "Accounting for modelling errors in model-based diagnosis by using Gaussian process models", In: *3rd International Conference on Control and Fault-Tolerant Systems, SysTOL 2016, Barcelona, September 7-9, 2016*, pp. 510-515.

6. Xavier Flores-Alsina, Christian Kazadi Mbamba, Emma Thomson-Brewster, Kimberly Solon, Darko Vrečko, Stephan Tait, Ulf Jeppsson, Krist V. Gernaey, Damien J. Batstone, "The use of an advanced aqueous phase chemistry approach with IWA biological process models in a plant-wide context", In: *5th IWA/WEF Wastewater Treatment Modelling Seminar, 2-6 April 2016, Annecy, France*, 4 pp..

7. I. Ganchev, Damir Vrančić, "Automatic control aspects of the Czochralski crystal growth process", In: *Proceedings: John Atanasoff celebration days*, International Conference Automatics and Informatics '2016, Bulgaria, October 4-5, 2016, Sofia, pp. 223-225.

8. Samo Gerkšič, "ITER plasma current and shape control using MPC", In: *2016 IEEE Multiconference on Systems and Control, MSC 2016, September 19-22, 2016, Buenos Aires*, pp. 599-604.

9. Miha Glavan, Dejan Gradišar, Iztok Humar, Damir Vrančić, "Vodenje električne moči v trgovskih centrih", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 159-162.

10. Dejan Gradišar, Boštjan Grašič, Marija Božnar, Primož Mlakar, Juš Kocijan, "Local ozone prediction with hybrid model", In: *SIMULTECH: proceedings of the 6th International Conference on Simulation and Modeling Methodologies, Technologies and Applications, July 29 - 31, 201, Lisbon, Portugal*, pp. 262-269.

11. José Marín-Medina, Dejan Gradišar, Juan Carlos Seck-Tuoh-Mora, Norberto Hernandez-Romero, Federico Nuñez-Piña, "A Petri net model to obtain the makespan in the flow shop scheduling problem", In: *Proceedings of the World Congress on Engineering and Computer Science 2016, WCECS 2016, October 19-21, 2016, San Francisco, USA*, 5 pp..

12. Primož Mlakar, Dragana Kokal, Boštjan Grašič, Marija Božnar, Dejan Gradišar, Juš Kocijan, "Validation of the performance of meteorological forecasts in fine spatial and temporal resolution designed as an input for dispersion models", In: *Proceedings*, fHARMO-17, 17th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 9-12 May 2016, Budapest, Hungary, pp. 30-35.

13. Boštjan Pregelj, Samo Gerkšič, Matic Knap, Matija Perne, "Koraki za zmanjšanje računske zahtevnosti prediktivnega regulatorja za vodenje plazme v IRT fuzijskem reaktorju", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 139-142.

14. Martin Stepančič, Boštjan Dolenc, Đani Juričić, "Model-based fault diagnosis with Gaussian process regression of nominal model residuals", In: *Zbornik*, 8. Študentska konferenca Mednarodne podiplomske Šole Jožefa Stefana, 31. maj in 1. junij 2016, Ljubljana, Slovenija, pp. 180-192.

15. Emma Thomson-Brewster, Stephan Tait, Darko Vrečko, Xavier Flores-Alsina, Christian Kazadi Mbamba, Kimberly Solon, Ulf Jeppsson, Krist V. Gernaey, Damien J. Batstone, "Modelling physico-chemistry in extreme conditions", In: *5th IWA/WEF Wastewater Treatment Modelling Seminar, 2-6 April 2016, Annecy, France*, 3 pp..

16. Damir Vrančić, "Izboljšanje regulacijskih lastnosti zanke s pomočjo kompenzacijskega člena", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 147-150.

17. Darko Vrečko, Marko Nerat, Damir Vrančić, Gregor Dolanc, Boštjan Dolenc, Boštjan Pregelj, Fabien Meyer, Siu Fai Au, Robert Makkus, Đani Juričić, "Control design for a 2.5kW solid oxide fuel cell power system", In: *Zbornik petindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2016, 19. - 21. september 2016, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ..., 25), zv. A, pp. 135-138.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Franci Gabrovšek, Martin Knez, Janja Kogovšek, Andrej Mihevc, Bojan Otoničar, Janez Mulec, Matija Perne, Metka Petrič, Tanja Pipan, Mitja Prelovšek, Tadej Slabe, Stanka Šebela, Nataša Ravbar, Nadja Zupan Hajna, "Development challenges in karst regions: sustainable land use planning in the karst of Slovenia", In: *Preserving karst environments and karst caves: karst dynamics, environments, usage and restauration: towards an international karst preservation system*, (Zeitschrift für Geomorphologie, Supplementband, N. F., vol. 60, suppl. issue 2), Elena Trofimova, ed., Jean-Nöel Salomon, ed., Stuttgart, Gebrüder Borntraeger, 2016, pp. 293-318.

2. Juš Kocijan, Dejan Petelin, "Closed-loop control with evolving Gaussian process models", In: *Complex systems: relationships between control, communicatins and computing*, (Studies in systems, decision and control, vol. 55), Georgi M. Dimirovski, ed., [S. l.], Springer, 2016, pp. 505-521.

SCIENTIFIC MONOGRAPH

1. Martin Knez, Tadej Slabe, Franci Gabrovšek, Janja Kogovšek, Andrej Kranjc, Andrej Mihevc, Janez Mulec, Bojan Otoničar, Matija Perne, Metka Petrič, Tanja Pipan, Mitja Prelovšek, Nataša Ravbar, Stanka Šebela, Nadja Zupan Hajna, Pavel Bosák, Petr Pruner, Hong Liu, Martin Knez (urednik), Tadej Slabe (urednik), *Cave exploration in Slovenia: discovering over 350 new caves during motorway construction on classical karst*, (Cave and karst systems of the world), Cham [etc.], Springer, cop. 2016.

2. Juš Kocijan, *Modelling and control of dynamic systems using Gaussian process models*, (Advances in industrial control), Cham [etc.], Springer, cop. 2016.

UNIVERSITY, HIGHER EDUCATION OR HIGHER VOCATIONAL EDUCATION TEXTBOOK

1. Juš Kocijan, Stanko Strmčnik, *Osnove avtomatskega vodenja*, V Novi Gorici, Založba Univerze, 2016.

PATENT

1. Janko Petrovčič, Damir Vrančić, *Reducing oscillations in a control system*, EP2356522 (B1), European Patent Office, 06. 01. 2016.

MENTORING

1. Giovanni Godena, *Models of batch process control software:* doctoral dissertation, Ljubljana, 2016 (mentor Stanko Strmčnik).

2. Matej Gabrijelčič, *Closed-loop control of multi-zone furnace for heat treatment of steel ropes:* master's thesis, Nova Gorica, 2016 (mentor Juš Kocijan).

3. Tomaž Kos, *Measurement system for automated low-frequency and high-temperature characterization of dielectric materials:* master's thesis, Ljubljana, 2016 (mentor Gregor Klančar; co-mentor Tadej Rojac).