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.

Head:
Dr. Vladimir Jovan

Basic and applied research

The basic and applied research in 2015 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 dynamical systems' modelling was pursued in two directions: the development of Gaussian-process models and the development of model-tree ensembles. The developed and improved methods for Gaussian-process modelling were validated on environmental systems, while the methods based on model-tree ensembles were validated with process-engineering processes (Figure 1).

The second topic was *advanced control.* We have been researching the problem of implementing model predictive control (MPC) using fast, online, first-order quadratic programming optimization techniques. Using these techniques and methods for MPC complexity reduction, we have managed to implement a prototype MPC controller for the ITER plasma current and shape controller for the plasma magnetic control of the ITER fusion tokamak reactor, which resulted in a peak computation time of 10 ms on a standard laptop computer. This computation time is considered sufficiently short for practical control implementation at the anticipated sample rate, and is five times faster than the one achieved using the commercial optimization solver CPLEX.

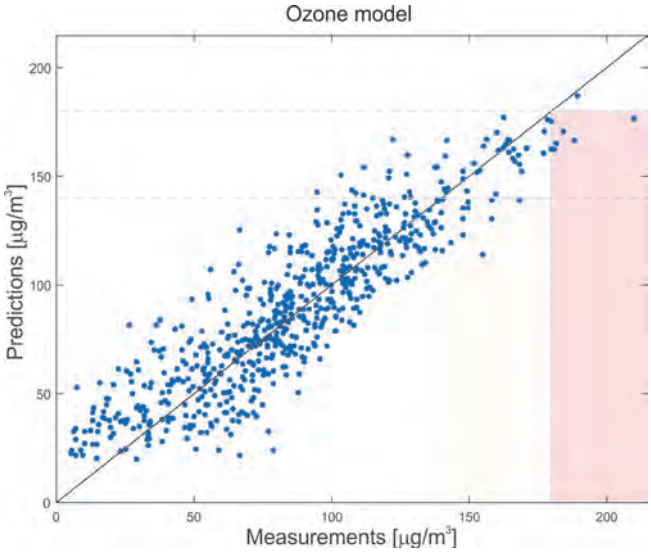

Figure 1. Validation of ozone-model predictions with measurements of maximum daily values

The third topic of interest was *condition monitoring and fault diagnosis*. Here, the focus was on diagnostic decision-making in which the system's condition is inferred from the "distance" between the ensemble of probability density functions (pdfs) of features captured in the current state and the ensemble of features in the nominal fault-free condition. This novel approach is radically different from conventional approaches in which usually one pdf from the current state is compared with a reference pdf in the fault-free state. The main theoretical contribution concerns a relatively simple approximation of the pdf of the Jensen-Reny divergence serving as a distance measure between two ensembles.

In 2015 we continued working on the diagnostics of PEM fuel cells with the use of the newly developed fast electrochemical impedance spectroscopy. The methodology was fused with an in-house-developed DC/DC converter and multi-channel fuel-cell voltage monitor. This fusion enables the seamless utilization of advanced diagnostics for PEM fuel-cell systems in industrial operating conditions. The results of this work were presented in journal papers published in *IEEE Transactions on Industrial Electronics*.

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. In the past year a new procedural control entities behaviour model was developed for the domain-specific modelling language *ProcGraph* and the MAGICS methodology for the development and automatic generation of the process-control software. The specifications for a new version of the MAGICS development environment prototype, based on the mentioned new behaviour model, has also been realized.

In 2015 we continued with the development and validation of a software prototype called *ProOpter*, which enables the analysis of production dynamics and supports the optimisation activities within the production process. The influential variable selection module was upgraded with new functionalities that were applied to the problem

of selecting the most relevant variables for the forecasting of ozone concentrations (ARRS project with MEIS d.o.o.). The software prototype was presented in an SCI journal *Computers in Industry*.

Applied research in the priority problem domains was the third sub-area of our interest. A system for monitoring the performance tests of electronically commutated motors was developed. The system allows up to 10 concurrent tests. At each test point the system can acquire vibration signals, temperature, voltage and electrical current. Additionally, the system allows a detailed specification of the conducted performance tests, data analysis as well as the tracking of all the events connected with the tests. The system has been successfully installed at Domel d.o.o. For another of Domel's production units PE ECS an end-quality control system for blowers was also developed. The system allows the acquisition and analysis of vibrations, sound emissions, pressure as well as electrical parameters such as voltage, current and power. Unlike the standard end-quality control systems that have a fixed testing profile, the developed system offers a fully customizable definition of the test profile and the order of the data acquisition. Such a property allows the testing of different types of electrical blowers.

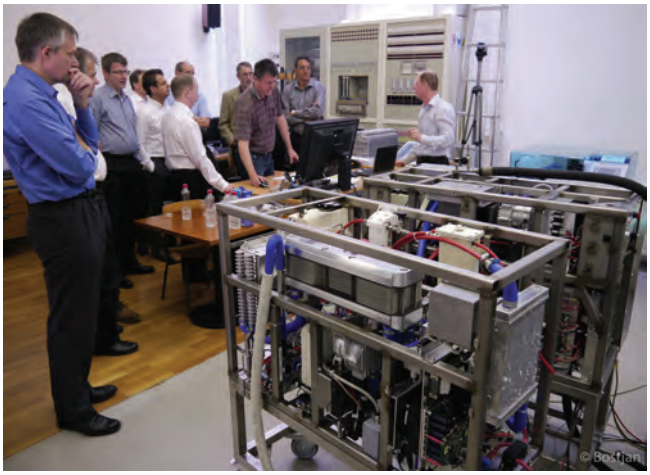

Figure 2: Presentation of a fuel-cells-based power system with diesel reforming during the closing meeting of the project FCGEN

Control of wastewater-treatment plants is our next traditional research area. We participated in the implementation of the physico-chemical model of the pH variation and ion speciation in a wastewater-treatment process. A special solving routine was developed in order to handle simultaneously ordinary differential equations and differential algebraic equations with multiple interdependencies. The strategy combines a multi-dimensional Newton Raphson method with the Simulated Annealing algorithm. The first method ensures a fast convergence, while the second one, which requires a larger number of iterations, is only used when the solution becomes unstable.

International and national R&D projects

In the final year of the 3-year international project Eurostar *ProDisMon-Probabilistic Distributed Industrial System Monitor* we have validated the algorithms for the threshold selection in the diagnosis and prognosis of rotational machines with a stress on the bearing faults. The methodology has been successfully implemented on a sanding machine. An online assessment of the system condition and a prognosis for the remaining useful life are made by processing signals from a vibration sensor mounted on the bearing supporting the rotor shaft.

In 2015 the FP7 project *FCGEN-Development and on-truck demonstration of a diesel-powered FC-based power unit* has been in its final stages and its goal was successfully achieved with an operating demonstration during the final project meeting in May 2015 (Figure 2). During this time the APU was located at the JSI, where initially the damaged reactor was replaced and the quality of the produced reformate was validated. Afterwards, the reformer part was merged with the fuel cell and the JSI-developed ECU and DC/DC converter was installed. The first integrated APU operations were targeted to control the fine-tuning and system troubleshooting, while later runs tested the real conditions and autonomous operation. The reformer completed over 50 operating days, during which numerous design modifications required for operating improvements have been identified.

This year also marks a successful end to the EU FP7-funded project FluMaBack-*Fluid Management component improvement for back up fuel cell systems*. The goal of the project was the development of advanced components for fluid management in systems with fuel cells. The final project results include the novel concept of a hydrogen recirculation pump, a more efficient air-blower unit, a new concept for a humidifier and the customization of the fuel-cell stack. The application of these components has a positive impact on the overall system durability. The team from our department was in charge of the development and the implementation of the end-quality control line for the hydrogen pump and the air blower.

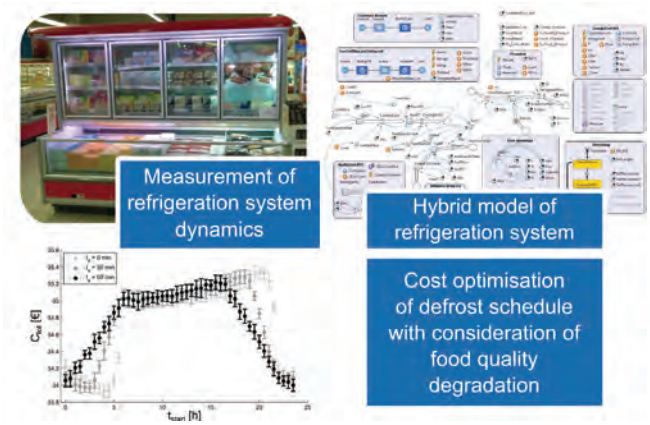

Figure 3: Optimisation of refrigerators' defrost schedule in a supermarket

From April 2014 we also participated in the third EU FP7 project *Diamond-Diagnosis-aided control for SOFC power systems*. The feedforward-feedback controllers that ensure fast load tracking of the solid-oxide fuel cell (SOFC) power system were designed during 2015 and verified via simulations. The feedforward part reacts to the electrical current demand in compliance with the stoichiometry of the electro-oxidation. The feedback part performs the corrections of the controlled system output by an additional manipulation of the system inputs. Crucial system variables, such as stack temperatures and fuel composition, were estimated from data as well as from

the stoichiometry. The designed feedforward-feedback controllers and soft sensors can be easily implemented in practice.

In collaboration with the consortium ENEA/CREATE from Naples, Italy, we also began activities within the project *Fast Model Predictive Control for Magnetic Plasma Control - FMPCFMPC.* 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.

Within the scope of the Slovenian Research Agency's applicative project *Optimisation of the refrigeration energy costs in shopping centres* in 2015 a hybrid model of a refrigeration system was developed. The model was applied to validate different measures for the minimisation of operating costs. Moreover, an innovative control scheme was designed that reduces the power peaks while dynamically adjusting the refrigerator's temperature reference (Figure 3).

Figure 4: Diagnostic system for the total quality control of eco-motors on the new production line ML-13 in Domel d.o.o.

For another on-going Slovenian Research Agency project *Development and implementation of a method for on-line modelling and forecasting of air pollution* a procedure for on-line Gaussian-Process modelling for ozone-concentration forecasting was developed. Moreover, a procedure for improved local-ozone forecasting using the integrated models was also developed. The integrated models also include data from meteorological and air-quality prediction models. The procedures were validated above the selected locations in Slovenia. The results were sent to be published in journals from the field of atmospheric phenomena.

In 2015 a new diagnostic system for the end-quality control of vacuum-cleaner motors on a new production line ML-13 has been installed in Domel d.o.o. The system is based upon already-installed diagnostic systems on the production lines ML-7, ML-8 and ML-10. Nevertheless, many innovations were introduced during the implementation on the electro-mechanical part as well as on the software part. The new system supports both AC and DC motors across a broad range of supply voltages, which is a significant improvement over previous systems. Next, on the software side, new diagnostic features were introduced that can detect bearing slip during motor start-up. Also, vibrations can now be measured over the whole motor housing. Finally, the most important improvement is the new connection to a central database, which improves the product traceability.

Figure 5. The TARAS award

For the company Danfoss Trata d.o.o. (project *iFlow*) we are developing (i) a method for calculating the current liquid flow on the basis of the feedback filtering of flow sensor signals and (ii) models for hydraulic components in the system based on the commercial datasheets of individual components. Among the most important results of this project is a new concept of HVAC system control that linearizes the operation of the entire system at various working points (e.g., summer–winter).

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.

Some outstanding publications in the past year

1. Debenjak, Andrej, Petrovčič, Janko, Boškoski, Pavle, Musizza, Bojan, Juričić, Đani. Fuel cell condition monitoring system based on interconnected DC-DC converter and voltage monitor. *IEEE transactions on industrial electronics*, ISSN 0278-0046. [Print ed.], 2015, 62, no. 8, str. 5293 – 5305
2. Pregelj, Boštjan, Vrečko, Darko, Petrovčič, Janko, Jovan, Vladimir, Dolanc, Gregor. A model-based approach to battery selection for truck onboard fuel cell-based APU in an anti-idling application. *Applied energy*, ISSN 0306-2619, 2015, vol. 137, str. 64-76
3. Mileva-Boshkoska, Biljana, Boškoski, Pavle, Debenjak, Andrej, Juričić, Đani. Dependence among complex random variables as a fuel cell condition indicator. *Journal of power sources*, ISSN 0378-7753, jun. 2015, vol. 284, str. 566-573

4. Godena, Giovanni, Lukman, Tomaž, Steiner, Igor, Bergant, Franc, Strmčnik, Stanko. A new object model of batch equipment and procedural control for better recipe reuse. *Computers in industry*, ISSN 0166-3615, jun. 2015, vol. 70, 46-55
5. Boškoski, Pavle, Gašperin, Matej, Petelin, Dejan, Juričić, Đani. Bearing fault prognostics using Rényi entropy based features and Gaussian process models. *Mechanical systems and signal processing*, ISSN 0888-3270, feb. 2015, vol. 52/53, str. 327-337

Some outstanding achievements in the past year

1. Development and implementation of a new (the ninth) diagnostic system for final-quality control of electric motors on production line ML-13 in Domel d.o.o. (Figure 4)
2. At the 7th Industrial Forum of Innovation, R&D and Technology - IRT 2015, the TARAS statuette award for the most successful cooperation between research teams and industry was granted to the Danfoss Trata company and the Systems and Control research group at the Jožef Stefan Institute (Figure 5).
3. 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.
4. IEEE Spectrum, the leading magazine of the IEEE, the world's largest professional organization devoted to engineering and the applied sciences, reports on clean-energy production from diesel with fuel cells - a demonstrated technological solution developed in the FP7 FCGEN project finished in 2015 under the leadership of our department.

Awards and appointments

1. Boštjan Dolenc, Pavle Boškoski, Đani Juričić: the article "Distributed bearing fault diagnosis based on vibration analysis" has been ranked as the 11th most downloaded article in the journal Mechanical Systems and Signal Processing for the last quarter of 2015
2. Đani Juričić, Pavle Boškoski, Bojan Musizza, Janko Petrovčič, Boštjan Dolenc, Stanislav Černe: the first prize for the innovation with the greatest economic potential that was created in PRO's (public research organizations) in 2015 at the 8th International Conference on Technology Transfer and Innovation Day 2015
3. Danfoss Trata d. o. o. and the Systems and Control research group: the TARAS award for the most successful cooperation between research teams and organisations on one side and development teams in industry on the other side for the year 2015 at the 7th Industrial forum of Innovation, R&D and Technology - IRT 2015 held in Portorož
4. Andrej Debenjak: "Golden award" for his doctoral thesis "Condition monitoring of PEM fuel cells" in 2015 at the 25th Slovenian Trade Fair and Conference on Technical Maintenance, Otočec

Patents granted

1. Jože Vižintin, Jose Miguel Marques Querido Salgueiro, Boris Kržan, Gabrijel Peršin, Đani Juričić, Pavle Boškoski, Gregor Dolanc, Apparatus and method for on-line monitoring of oil condition and debris concentration, SI24579 (A), Slovenian Intellectual Property Office, 30. 06. 2015.
2. Damir Vrančić, Marko Nerat, Samo Krančan, Procedure of rapid signal filtering of rotational speed with automatic elimination of periodic deviation, SI 24580 (A), Slovenian Intellectual Property Office, 30. 06. 2015.

INTERNATIONAL PROJECTS

1. 7FP - FLUMABACK; Fluid Management Component Improvement for Back up Fuel Cell Systems
   Dr. Pavle Boškoski
   European Commission
2. 7FP - DIAMOND; Diagnosis-aided Control for SOFC Power System
   Prof. Đani Juričić
   European Commission
3. COST ES1202; Water_2020: Conceiving Wastewater Treatment in 2020 - Energetic, Environmental and Economic Challenges
   Dr. Darko Vrečko
   Cost Office
4. ER-3-FU; Enabling Research; EUROFUSION
   Dr. Samo Gerkšič
   European Commission

RESEARCH PROGRAM

1. Program systems and control
   Prof. Đani Juričić

R & D GRANTS AND CONTRACTS

1. Development and implementation of a method for on-line modelling and forecasting of air pollution
   Prof. Juš Kocijan
2. Optimisation of energy cost for refrigeration systems in shopping malls
   Asst. Prof. Damir Vrančić

NEW CONTRACTS

1. Optimisation of energy cost for refrigeration systems in shopping malls
   Asst. Prof. Damir Vrančić
   Danfoss Trata, d. o. o.
2. Development of advanced control strategies to increase the reliability of medical accelerators
   Dr. Matej Gašperin
   Cosylab, Laboratorij za kontrolne sisteme, d. d.

VISITOR FROM ABROAD

1. Serena Invitto, University of Salerno, Salerno, Italy, 19 January to 25 July 2015
2. Vincenzo Apicella, University of Salerno, Salerno, Italy, 5 March to 7 July 2015
3. Erik Aberg, Modelon AB, Lund, Sweden, 18–19 May 2015
4. Jonas Eborn, Modelon AB, Lund, Sweden, 18–19 May 2015
5. Per Ekdunge, PowerCell Sweden AB, Gothenburg, Sweden, 18–19 May 2015
6. Gunther Kolb, Faunhofer ICT-IMM, Mainz, Germany, 18–19 May 2015
7. Johannes Kögler, VOLVO Gropup, Gothenburg, Sweden, 18–19 May 2015
8. Carlos Navas, FCH JU, Brussels, Belgium, 18–19 May 2015
9. Joachim Pasel, Forschungszentrum Jülich, Jülich, Germany, 18–19 May 2015
10. Ralf Peters, Forschungszentrum Jülich, Jülich, Germany, 18–19 May 2015
11. Behrooz Razaznejad, VOLVO Group, Gothenburg, Sweden, 18–19 May 2015
12. Jochen Surrer, Faunhofer ICT-IMM, Mainz, Germany, 18–19 May 2015
13. David Wails, Johnson Matthey PLC, London, Great Britain, 18–19 May 2015
14. prof. dr. Cesare Pianese, University of Salerno, Salerno, Italy, 27–31 July 2015
15. dr. Fernando Aller, University of Leon, Leon, Spain, 1–4 August 2015

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1. Dr. Pavle Boškoski
2. Dr. Gregor Dolanc
3. *Dr. Matej Gašperin, left 01.09.15*
4. Dr. Samo Gerkšič
5. Giovanni Godena, M. Sc.
6. Dr. Dejan Gradišar
7. Dr. Nadja Hvala
8. **Dr. Vladimir Jovan, Head**
9. Prof. Đani Juričić
10. Prof. Juš Kocijan
11. Dr. Bojan Musizza
12. Dr. Janko Petrovčič
13. Dr. Boštjan Pregelj
14. Prof. Stanislav Strmčnik
15. Asst. Prof. Damir Vrančić
16. Dr. Darko Vrečko

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18. Dr. Miha Glavan
19. Dr. Marko Nerat
20. Dr. Matija Perne

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22. Martin Stepančič, B. Sc.

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23. Stanislav Černe, B. Sc.
24. Primož Fajdiga, B. Sc.

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

BIBLIOGRAPHY

Original Article

1. Darko Aleksovski, Juš Kocijan, Sašo Džeroski, "Model-tree ensembles for noise-tolerant system identification", *Advanced engineering informatics*, vol. 29, no. 1, pp. 1-15, 2015.
2. Darko Belavič, Marko Hrovat, Kostja Makarovič, Gregor Dolanc, Andrej Pohar, Stanko Hočevar, Barbara Malič, "3D LTCC structure for a large-volume cavity-type chemical microreactor", In: *Special issue IMAPS Poland 2014, 38th International IMAPS - CPMT Poland Conference & Exhibiton, September 21-24, 2014, Rzeszów-Czarna, Poland*, (Microelectronics international, Vol. 32, no. 2, 2015), Port Erin, Wela Publications, 2015, vol. 32, no. 3, pp. 133-137, 2015.
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4. Andrej Debenjak, Janko Petrovčič, Pavle Boškoski, Bojan Musizza, Đani Juričić, "Fuel cell condition monitoring system based on interconnected DC-DC converter and voltage monitor", *IEEE trans. ind. electron.*, 62, no. 8, pp. 5293 - 5305, 2015.
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6. Xavier Flores-Alsina, Christian Kazadi Mbamba, Kimberly Solon, Darko Vrečko, Stephan Tait, Damien J. Batstone, Ulf Jeppsson, Krist V. Gernaey, "A plant-wide aqueous phase chemistry module describing pH variations and ion speciation/pairing in wastewater treatment process models", *Water res. (Oxford)*, vol. 85, pp. 255-265, nov. 2015.
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8. Giovanni Godena, Tomaž Lukman, Igor Steiner, Franc Bergant, Stanko Strmčnik, "A new object model of batch equipment and procedural control for better recipe reuse", *Comput. ind.*, vol. 70, 46-55, jun. 2015.
9. Dejan Gradišar, Miha Glavan, Stanko Strmčnik, Gašper Mušič, "ProOpter: an advanced platform for production analysis and optimization", *Comput. ind.*, vol. 70, pp. 102-115, jun. 2015.
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11. D. A. Kenwright *et al.* (16 authors), "The discriminatory value of cardiorespiratory interactions in distinguishing awake from anaesthetised states: a randomised observational study", *Anaesthesia*, vol. 70, iss. 12, pp. 1356-1368, 2015.
12. Juš Kocijan, Marko Hančič, Dejan Petelin, Marija Božnar, Primož Mlakar, "Regressor selection for ozone prediction", *Simulation modelling practice and theory*, vol. 54, pp. 101-115, maj 2015.
13. A. J. Luhmann, Matt Covington, Joseph M. Myre, Matija Perne, Sydney W. Jones, E. Calvin Alexander, M. O. Saar, "Thermal damping and retardation in karst conduits", *Hydrol. earth syst. sci.*, vol. 19, pp. 137-157, 2015.
14. Montse Meneses, Henry Rafael Concepcion, Darko Vrečko, Ramon Vilanova, "Life Cycle Assessment as an environmental evaluation tool for control strategies in wastewater treatment plants", *J. clean. prod.*, vol. 107, pp. 653-661, 2015.
15. Biljana Mileva-Boshkoska, Marko Bohanec, Pavle Boškoski, Đani Juričić, "Copula-based decision support system for quality ranking in the manufacturing of electronically commutated motors", *J. intell. manuf.*, vol. 26, no. 2, pp. 281-293, 2015.
16. Biljana Mileva-Boshkoska, Pavle Boškoski, Andrej Debenjak, Đani Juričić, "Dependence among complex random variables as a fuel cell condition indicator", *J. power sources*, vol. 284, pp. 566-573, jun. 2015.

17. Dejan Petelin, Primož Mlakar, Marija Božnar, Boštjan Grašič, Juš Kocijan, "Ozone forecasting using an online updating Gaussian-process model", *Int. j. environ. pollut.*, vol. 57, no. 3/4, pp. 111-122, 2015.
18. Boštjan Pregelj, Darko Vrečko, Janko Petrovčič, Vladimir Jovan, Gregor Dolanc, "A model-based approach to battery selection for truck onboard fuel cell-based APU in an anti-idling application", *Appl. energy*, vol. 137, pp. 64-76, 2015.
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22. Jože Vižintin, José Salgueiro, Gabrijel Peršin, Đani Juričić, "System for automated online oil analysis", *Cond. monit.*, iss. 336, pp. 5-10, Mar. 2015.

Review Article

1. Matt Covington, Matija Perne, "Consider a cylindrical cave: a physicist's view of cave and karst science: pogled fizika na znanost o jamah in krasu", *Acta carsol.*, vol. 44, no. 3, pp. 363-380, 2015.

Published Conference Contribution (invited lecture)

1. Pavle Boškoski, Andrej Debenjak, Đani Juričić, "Spremljanje stanja gorivnih celic PEM", In: *Zbornik devete konference Avtomatizacija v industriji in gospodarstvu, 9. in 10. april 2015, Maribor, Slovenija*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2015, 10 pp.

Published Conference Contribution

1. Erik Åberg, Jens Pålsson, Karin Fröjd, Karin Axelsson, Gregor Dolanc, Vladimir Jovan, "HIL simulations of a real-time fuel processor model", In: *5th European PEFC & H2 Forum 2015, 30 June - 3 July 2015, Lucerne, Switzerland: proceedings*, (European fuel cell forum, 19), Frano Barbir, ed., Luzern, European Fuel Cell Forum AG, 2015, pp. 44-53.
2. Andrej Debenjak, Gregor Papa, Janko Petrovčič, "Modularni sistem za upravljanje Li-Ion baterije", In: *Zbornik devete konference Avtomatizacija v industriji in gospodarstvu, 9. in 10. april 2015, Maribor, Slovenija*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2015, 8 pp.
3. Boštjan Dolenc, Pavle Boškoski, Đani Juričić, "Change detection based on entropy indices with application to bearing faults", In: *9th SafeProcess 2015*, 9th IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes, September 2-4, 2015, Paris, France, [S. l.], IFAC = International Federation of Automatic Control, pp. 1438-1443.
4. Boštjan Dolenc, Pavle Boškoski, Đani Juričić, "Condition monitoring of mechanical drives based on entropy indices", In: *Zbornik: 2. del: part 2*, 7. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 7th Jožef Stefan International Postgraduate School Students' Conference, 20.-22. 5. 2015, Ljubljana, Andraž Rešetič, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2015, zv. 1, pp. 92-103.
5. Boštjan Dolenc, Pavle Boškoski, Đani Juričić, "Optimal threshold selection in fault diagnosis of mechanical drives based on information indices", In: *Surveillance 8: International Conference - October 20-21, 2015, Roanne, France*, [S. l., s. n.], 2015, 9 pp.
6. Boštjan Dolenc, Đani Juričić, Pavle Boškoski, Matej Gašperin, Jurij Pfajfar, "Sprotno napovedovanje preostale življenjske dobe elektromehanskih pogonov", In: *Zbornik devete konference Avtomatizacija v industriji in gospodarstvu, 9. in 10. april 2015, Maribor, Slovenija*, Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2015, 8 pp.
7. Boštjan Dolenc, Darko Vrečko, Đani Juričić, Antti Pohjoranta, Jari Kiviaho, Cesare Pianese, "Soft sensor design for estimation of SOFC stack temperatures and oxygen-to-carbon ratio", In: *Papers presented at 14th International Symposium on Solid Oxide Fuel Cells, SOFC-XIV, July 26-31, 2015, Glasgow, Scotland, UK*, (ECS transactions, Vol. 68, no. 1, 2015), Subhash C. Singhal, ed., K. Eguchi, ed., Pennington, Electrochemical Society, 2015, vol. 68, no. 1, pp. 2625-2636, 2015.
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