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.

Head:
Dr. Vladimir Jovan

Basic and applied research

Basic and applied research in 2011 was devoted to three sub-areas: the methodologies for analysis and control-systems design; the tools and building blocks for implementation; and the applied research in the priority problem domains.

The sub-area **the methodologies for analysis and control systems design** included three topics. The first topic addressed the **modeling and identification of nonlinear and complex dynamical systems**. The research in the dynamic-systems modeling of the Gaussian-process models was directed towards the incorporation of various prior knowledge and model-optimization methods for dynamic-systems identification and the application of modeling with the Gaussian process models of traffic, process engineering and environmental systems. Performance analyses of several algorithms for the joint state and the parameter estimation of the nonlinear dynamic systems have been accomplished. It turned out that the standard identification algorithms can fail in the case of low-dimensional systems. It seems that for higher-dimensional systems the estimation of the covariance parameters is the main cause for divergence problems.

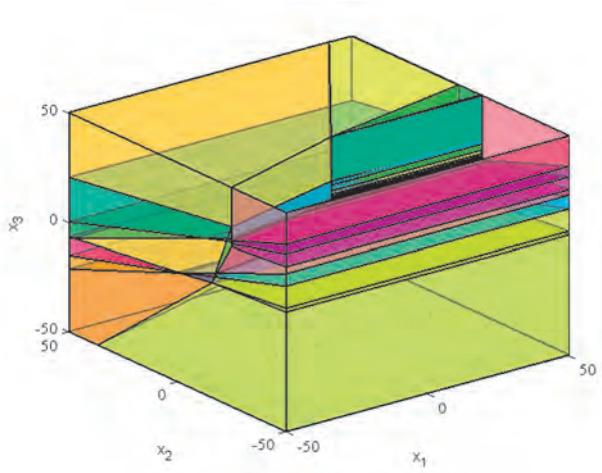

Figure 1: State-space partition of a parametric predictive controller

The second topic was the **(advanced) control.** Within the research and development of explicit predictive controllers we have developed an efficient method of complexity reduction of the polyhedral controller partition using a dual sampling rate, and formed a systematic approach to reliable computation of the partition using the parametric linear complementarity algorithm for the numerically challenging problems and degeneracies (Figure 1). Research in the field of the PID control algorithms has been expanded to oscillatory systems, where a combination of the Magnitude Optimum Multiple Integration and the Posicast method has been proposed in order to decrease oscillations in the closed-loop system.

The third topic of interest was **the condition monitoring and fault diagnosis**. Research has been focused on the diagnostics and prognostics of mechanical drives under the non-stationary operating conditions. A novel robust method for the detection of bearing faults based on the statistical-point processes has been proposed. The idea behind it is that the statistical pattern of the inter-event times between repetitive impacts depends, in major part, on faults and less on operating conditions. A new approach to an estimation of the remaining useful life (RUL) of the mechanical drives operating under non-stationary conditions was derived. It relies on an assumption that a fault can be treated as a hidden state of a dynamic process, while the transmitted power and the temperature are thought to be process inputs. The process is described by a linear model, whose parameters and states are estimated on-line in order to calculate the RUL horizon. We also developed the first prototype of a smart node for a wireless sensor network used for the on-line diagnostics and prognostics of industrial drives. The node performs data acquisition from the (micro)sensors installed on a drive and local signal processing, which results in the features being communicated to and stored on the server. The final diagnosis and prognosis are carried out on the server. One of the key ideas of the approach concerns the environment for the design of the application software in Matlab/Simulink and then an easy automatic conversion into the run-time code on the target smart node. The highly innovative approach is expected to significantly extend the applicability of the automated condition monitoring to a more efficient asset maintenance due to a powerful functionality that is less costly than the one currently used.

An important feature of the modern prognostics and health-management tools are their abilities to adapt to the changes in the operating conditions of the machine and an automatic update of the estimate and the prediction.

To this end, we have developed novel algorithms for an automatic on-line model learning that protect the robust systems from the changes in the operating conditions.

A part of the work, which is also related to the condition monitoring, dealt with the problem of monitoring the water conditions inside a PEM fuel-cell stack. This year an experimental study of the PEM-fuel-cell water-condition diagnostics performed with the Electrochemical Impedance Spectroscopy (EIS) on the fuel-cell system produced by Hydrogenics was started. As the EIS was primary developed for diagnosing single fuel-cells, we first adapted the method in such a way that it became suitable for diagnosing larger fuel-cell stacks. Next, we conducted a series of measurements and we showed that the adapted method is effective at diagnosing the two main faults occurring during the fuel-cell system operation – the drying of the PEM membranes and the flooding of the gas-diffusion layer (Figure 2).

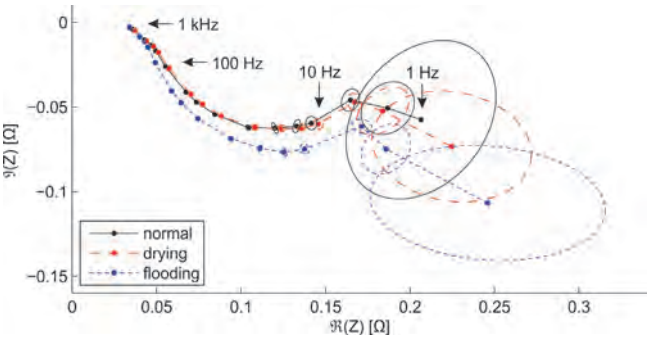

Figure 2: Nyquist plot of the impedance characteristics of the fuel-cells system under different operating conditions

Andrej Debenjak, our departmental member received a Prof. Vratislav Bedjanič Award for outstanding academic work in the field of industrial automation and electroenergetics for his diploma thesis entitled "The application of electrochemical impedance spectroscopy to PEM fuel cell systems".

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 the advanced control algorithms**. Control-systems-implementation environment is currently under integration with the program package "IDR blok" (a software package for the PLC controllers).

In the frame of the research dealing with **the tools and methodologies for a process-control-software synthesis**, the already-developed model-driven engineering approach to industrial process-control software was extended and named MAGICS (Modelling and Automatic Generation of the Industrial Process-Control Software). MAGICS approach consists of two engineering levels, development activities and guidelines, the formalized ProcGraph language and a supporting tool suite. One of the supporting tools has been newly developed – a professional version of the model editor (Figure 3).

In cooperation with **the Center of Excellence for Low-Carbon Technologies (CONOT)** we designed new components for the fuel-cell-based power systems. These include a controlled heater for the prevention of freezing of a stack, a prototype of a diagnostic module and a DC/DC converter (Figure 4). The DC/DC converter for the fuel-cell power systems is a conversion module converting the output voltage from the fuel-cell power module to the voltage of the energy-storage device. The control of the DC/DC converter is provided through the CAN-bus communication. Each converter is capable of a 2-kW power transfer and could be paralleled to obtain higher output currents. Each converter has a built-in stimulus generator intended for the support of the electrochemical impedance spectrometry of the fuel-cell stack during the operation.

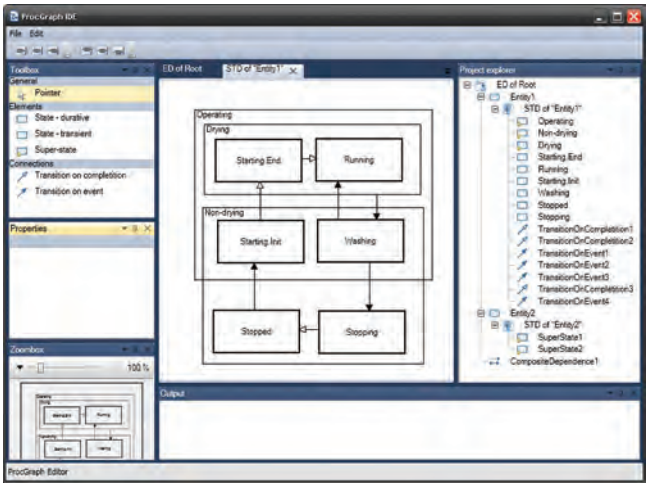

Figure 3: Screenshot of the professional version of the ProcGraph model editor

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.

A way of obtaining a more uniform thickness of metal sheets in cold rolling is to reduce the variance in the control input. This can be done by feeding the controller with the de-noised signals. The de-noising approach based on the adaptive Kalman filter was proposed, resulting in a reduction of the high-frequency content of the signal while guarantying an asymptotic tracking of the "noise-free" component of the signal. The work has been carried out in the frame of the international project called PROBASENSOR.

A function block for the implementation of an explicit predictive controller on a programmable logic controller platform has been developed. This block enables the implementation of an MPC controller featuring advanced handling of the constraints on the process signals using standard industrial automation equipment.

The control of the wastewater-treatment plants is our traditional research area. In the area of the wastewater treatment a multi-criteria evaluation methodology for determining the optimum operating strategies for an anaerobic-digestion reactor under uncertainty was proposed. The method is based on the Monte-Carlo simulations and the probability theory in order to deal with the analysis of choices among risky operation strategies with multi-dimensional outcomes.

The 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 the product quality with no obvious reasons. Through the cooperation with the Kolektor Sinabit company a procedure for a systematic selection of the influential parameters in the pulley-production process has been developed. Additionally, we analysed their influence on the end-quality of the product. The information about these parameters is used to construct a mathematical model of the production process that can be used to reduce the possibility of faults and ensure a constant quality of the products.

In the field of production control, we continued with the evaluation of a hierarchical concept of a model-based production control. In the past year we reviewed this area and determined general instructions on implementing the Key Performance Indicators in the production; we also explored different methods for the input of a variable selection and determined controllability measures to examine the achievable output space.

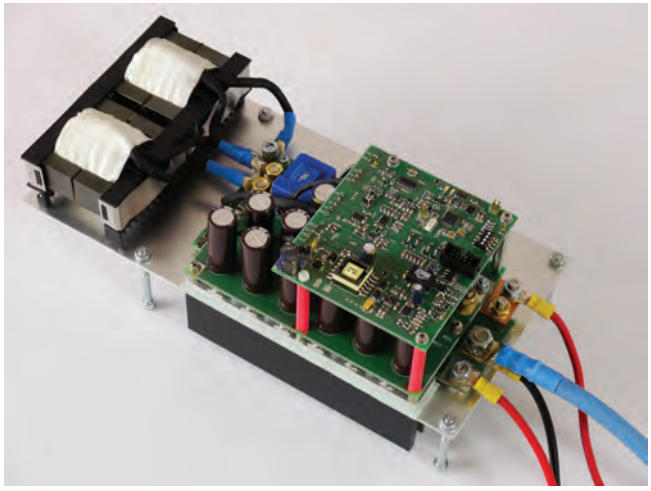

Figure 4: DC/DC converter for fuel-cell power systems

In the recent years, a part of our work was focused on the area of **fuel cells**. In 2011 we became involved in two new EU 7FP projects: "Fuel Cell Based On-Board Power Generation (FCGEN)" and ""Fluid Management component improvement for Back up fuel cell systems (FluMaBack)". The objective of the FCGEN project is to develop and demonstrate an auxiliary power unit (APU) for trucks that uses an auto-thermal reformer to produce hydrogen from fuel and a fuel-cell stack for electricity production. The goal is to substitute the low-efficiency main-engine idling and provide for the electricity consumption. Within the project both the key components and the system design will be further developed. The role of our group is to develop the power conditioning, complete electronics and to set up a control for all the subsystems and for the integrated APU system. In the FluMaBack project our group is responsible for improving the performance, the cost effictiveness and the life time of the essential balance-of-plant (BOP) components used in a fuel cell on the basis of the uninterruptable power back-up systems.

The department acquired the project "Integration and control of liquid fuel processor based on ceramic microsystems" financed by the European Space Agency.

Within the multidisciplinary project "Integration and control of liquid fuel processor based on ceramic micro-systems (CERACON)" we continue to develop the prototypes of the critical components of the miniature-sized fuel reformer that will serve as a source of hydrogen for the miniature fuel cells. The project is financed by the European Space Agency and performed in a collaboration of four partners: the Jozef Stefan Institute (Dept. of Electronic Ceramics and Dept. of Systems and Control), the National Institute of Chemistry, Slovenia (the Laboratory of the Catalysis and Chemical Reaction Engineering) and the company Hipot RR.

R&D projects for the 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 the development of special-purpose modules for fuel cells based on generator sets. The development related to the fuel-cell-based systems applications has been performed mostly within the **Centre of Excellence for Low-Carbon Technologies** where our group is leading these activities within the centre.

In 2011 we started with the activities within the Competence Centre for Advanced Control Technologies (CC ACT), which is co-financed by the Ministry of Higher Education, Science and Technology, and the European Regional Development Fund. In the competence centre, which involves 17 partners, we are actively involved in 6 out of 7 R&D projects addressing the design of the new components for the implementation of advanced control, the model-based production control, the control and optimization of the efficient energy consumption and clean environment, the automatic condition monitoring of the process equipment and the fusion power-plant control. This year we carried out an analysis of the project requirements and the design of the specifications for the new solutions, which will be implemented in collaboration with the key engineering companies involved in production automation and informatics: Danfoss, Helios and Litostroj Power.

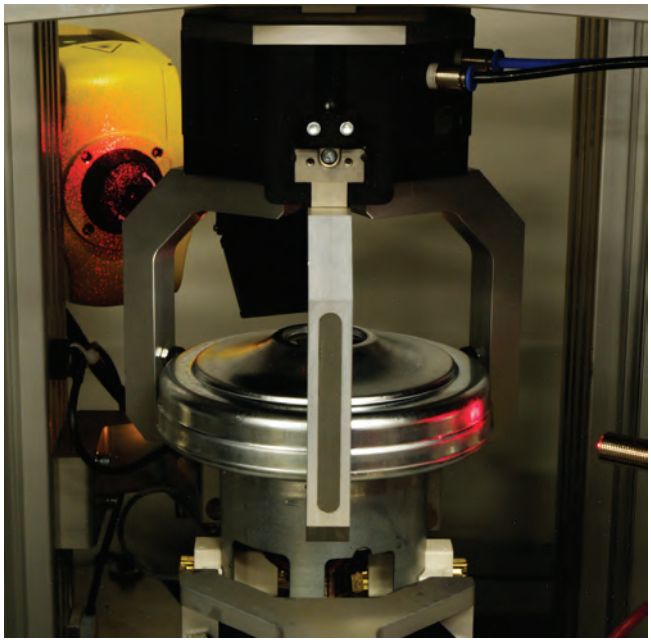

Figure 5: Electromotor during on-line diagnostics testing

The process-control tool C Batch, a partner product of INEA, d.o.o. and Mitsubishi Electric, whose principal developer is our departmental member Giovanni Godena, was chosen as the second best product of the month in the competition organised by a German magazine CAV.

As described below, an important part of our activities is also devoted to direct cooperation with various companies.

In 2011 an important part of the activities was performed in close co-operation with the INEA company. One of the activities to mention was the development of a new version of the batch control software tool. In the area of the development of the recipe-based batch process-control packages for the PLC platform (**PLCbatch**, **RTbatch**, **Cbatch**), an automatic generation of the parts of the application code was realized to avoid entering the same information repeatedly into different parts of the control system. The recording and archiving of the process events and the generating of the production reports were also implemented. In order to improve the commercialization of the tool, a professional user manual was written.

Within the "Kibernet" project that was, in 2011, completed in cooperation with the Inea company, a programme module for calculating the user reliability in the Microsoft Visual Basic.NET, in the form of a windows service, has been implemented. The service was incorporated into the integrated system of the service centre for electric-energy demand-side management.

In the framework of the ongoing project with Danfoss "intelligent" and integrating valve drives are being developed. In case of faults, soft sensors and optimization of actuators are applied.

The R&D group of Danfoss Trata d.o.o. and our Department of Systems and Control received the silver prize of the Chamber of Commerce and Industry of Slovenia for the HVAC electric valve innovation.

At the Domel Company, Železniki, a new diagnostic system for end-quality control on the production line for electrical motors of type 462 was completely installed in 2011 (Figures 5 and 6). The system is characterized by a new set of manipulators that enable suitable acoustical and vibrational isolation of the motors during the measurements on the production line. The new system is the fifth in the row of similar, very successful, diagnostic systems used in Domel. Up till now, the implemented systems have been used for the final-production quality control of more than 15 million motors.

Within the review of the preliminary design of the third stage of the Ljubljana Waste Water Treatment Plant, which was performed for the municipal company VO-KA in Ljubljana, a mathematical model of the existing plant was designed and upgraded with the proposed technical solutions for an improved nitrogen and phosphorus removal. Simulation tests were performed to verify the compliance of the upgraded plant performance with the legislation requirements.

Figure 6: Diagnostic system for end-quality control on the production line for electrical motors of type 462 at Domel d.o.o.

Installation of an automatic diagnostic system for the total end-quality control of electrical motors on the production line ML-7 at Domel d.o.o. (Janko Petrovčič, Gregor Dolanc, Bojan Musizza, Stane Černe, Miroslav Štrubelj).

Other projects

In 2011 the activities within the project »Promoting Innovation in the Industrial Informatics and Embedded Systems Sector through Networking – I3E« funded by »**the South East Europe-Transnational Cooperation Programme**« have been continued. The basic objectives of this project are the promotion of innovation and entrepreneurship in the area of Southeast Europe with an emphasis on the development of advanced products and services in the sectors of industrial informatics and embedded systems. This year our group has collaborated with the other partners in the completion of the main project outcome called the Strategic Research Agenda. We are also developing a Methodology Guideline for Innovation supporting the transformation of research into innovation. The main project outcomes are disseminated within several workshops to the relevant audience from the South-East Europe Region.

Educational and training activities

Some members of the department give lectures and practical courses at different faculties and universities: the Faculty of Electrical Engineering, the University of Ljubljana, the Faculty of Logistics, the 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 the engineers from the industry. In 2011 topical courses covering the areas of control theory and its applications were organised for companies Danfoss and Cosylab.

Some outstanding publications in the past year

1. Boštjan Pregelj, Darko Vrečko, Vladimir Jovan,. Improving the operation of a fuel-cell power unit with supervision control – a simulation study,. J. power sources, . [Print ed.], 2011, vol. 196, no. 22, str. 9419-9428, 2011, doi:[COBISS.SI-ID 1016/j.jpowsour.2011.06.07724858151.]
2. Pavle Boškoski, Janko Petrovčič, Bojan Musizza, Đani Juričić,. An end-quality assessment system for electronically commutated motors based 3 on evidential reasoning,. Expert syst. appl., .. [Print ed.], 2011, vol. 38, no. 11, str. 13816-13826, 2011, doi:[COBISS.SI-ID 10.1016/j.eswa.2011.04.18524756775.]
3. Nadja Hvala, Fernando Aller, Teodora Miteva, Dolores Kukanja,. Modelling, simulation and control of an industrial, semi-batch, emulsion-polymerization reactor«,. Comput. chem. eng., .. [Print ed.], 2011, vol. 35, no. 10, str. 2066-2080, 2011, doi:[COBISS.SI-ID 10.1016/j.compchemeng.2011.05.01624978727.]
4. Matej Gašperin, IĆ, Đani Juričić, BOŠKOSKI, Pavle Boškoski, VIŽINTIN, Jože Vižintin,. Model-based prognostics of gear health using stochastic dynamical models,. Mech. syst. signal process., 2011, vol. 25, no. 2, str. 537-548, 2011, doi:[COBISS.SI-ID 10.1016/j.ymssp.2010.07.00323786791.]

Awards and appointments

1. Andrej Debenjak: at the regional IEEE student competition during the ERK 2011 Conference won the competition among seven contributions. His work addressed the application of electrochemical impedance spectroscopy to PEM fuel-cell systems.
2. Andrej Debenjak: received a Prof. Dr. Vratislav Bedjanič Award for his diploma thesis entitled The application of electrochemical impedance spectroscopy to PEM fuel cell systems.
3. Dejan Petelin: appointment for design, organization and editing proceedings for the 3rd Student Conference of the Jožef Stefan International Postgraduate School
4. Damir Vrančić, JSI, Janko Petrovčič, JSI, Samo Krančan, Danfoss Trata: Silver and gold prizes for the HVAC electrical valve innovation granted by the Chamber of Commerce and Industry of Slovenia

INTERNATIONAL PROJECTS

1. Fuel Cell Based On-board Power Generation
   FCGEN
   7. FP
   277844
   EC; Jazaer Dawody, Volvo Technology Corporation, 06130 Exhaust Aftertreatment & Fuel Reforming, Göteborg, Sweden
   Dr. Boštjan Pregelj
2. Probalistic Bayesian Soft Sensor - A Tool for On-line Estimation of the Key Process Variable in Cold Rolling Mills
   ProBaSensor
   EUROSTARS
   COMPUREG Plzen, s.r.o., Czech Republic
   Prof. Đani Juričić
3. 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 Kalogeras, Industrial Systems Institute / Research Centre ATHENA, Patras, Greece
   Dr. Vladimir Jovan
4. Integration and Control of Liquid Fuel Processor on Ceramic Micro-systems
   CERACON
   ESA PECS, 4000103742/11/NL/KML
   Bernard Zufferey, ESA - The European Space Agency, Paris, France; European Space Research and Technology Centre, Noordwijk, The Netherlands
   Dr. Gregor Dolanc, Asst. Prof. Marko Hrovat
5. Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems
   IntelliCIS
   COST IC0806
   EC; COST Office, Brussels, Belgium
   Dr. Nadja Hvala
6. Combining Soft Computing Techniques and Statistical Methods to Improve Data Analysis Solutions
   SOFTSTAT
   COST IC0702
   EC; COST Office, Brussels, Belgium
   Prof. Juš Kocijan
7. Specification of the Automation System for the Metal Plate Treatment Machine Using Plasma
   B0-10-0009
   Primož Eiselt, PlasmaBull Engineering GmbH, Lebring, Austria
   Dr. Gregor Dolanc
8. System Identification Based on Gaussian Process Model for Traffic Control Applications
   BI-CZ/10-11-014
   Dr. Jan Prikryl, Institute of Information Theory and Automation, Czech Academy of Science, Prague, Czech Republic
   Prof. Juš Kocijan

R & D GRANTS AND CONTRACTS

1. Identification and model analysis for dynamic systems control design with Gaussian process priors
   Prof. Juš Kocijan
2. Integrated diagnostic system for drive assemblies
   Prof. Đani Juričić
3. Modeling and control of wastewater treatment plants for improving the effluent quality and energy effective operation
   Dr. Darko Vrečko
4. Advanced model based procedures for product quality control and management in complex production processes
   Prof. Đani Juričić
5. Simplified explicit predictive controller
   Prof. Stanislav Strmčnik

6. Prognostics and health management of mechanical drives based on novel MEMS sensor networks
   Prof. Đani Juričić
7. Feasibility study for setting up Technology Development Centre "Japanese hub" in Slovenia for technology fields of new energy tehnologies and process control technologies
   Prof. Stanislav Strmčnik

RESEARCH PROGRAM

1. Program systems and control
   Prof. Dr. Đani Juričić

NEW CONTRACTS

1. Development activities on HyCore project-Development of key subsystems for high temperature PEM fuel cells
   Inea d. o. o.
   Dr. Vladimir Jovan
2. Prognostics and health management of mechanical drives based on novel MEMS sensor networks
   Domel, d. o. o.
   Prof. Đani Juričić
3. Support for the research programme of Aleksander Preglej in the area of advanced control algorithms
   Inea d. o. o.
   Dr. Samo Gerkšič
4. Upgrade and development of AMV 435 and AMV 65X valve drives
   Danfoss Trata, d. o. o.
   Asst. Prof. Damir Vrančić
5. Functional upgrades of diagnostic systems
   Domel, d.o.o.
   Dr. Janko Petrovčič

MENTORING

Ph. D. Theses

1. Pavle Boškoski, Condition monitoring of mechanical drives: feature extraction and fault diagnosis methods (mentor Đani Juričić; co-mentor Mile Stankovski).
2. Matej Gašperin, Parameter estimation of nonlinear dynamic systems with application to failure prognostics (mentor Đani Juričić).
3. Satja Lumbar, Predictive control of aircrafts based on visual servoing (mentor Drago Matko; co-mentor Stanko Strmčnik).

M. Sc. Theses

1. Tadej Kodelja, Simulation of system dynamics models with Simulink software (mentor Juš Kocijan).
2. Edvin Raubar, Increasing productivity of ship-to-shore cranes in Port of Koper using advanced electronic systems (mentor Damir Vrančić; co-mentor Đani Juričić).

Bologna M. Sc. Theses

1. Staša Györköš, An introduction of the new approach to the designing of continuous model for the purpose of stochastic inventory control (mentor Damir Vrančić; co-mentor Dejan Dragan).
2. Marko Intihar, Path planing in the process of acquistion of biological samples in the General hospital Celje (mentor Đani Juričić; co-mentor Dejan Dragan).
3. Grega Medved, The development of sophisticated inventory management policies with variable demand accompanied with a comparative analysis of obtained results (mentor Damir Vrančić; co-mentor Dejan Dragan).
4. Tea Vizinger, Development of the heuristic algorithm in the process of the biological material acquisition scheduling (mentor Đani Juričić; co-mentor Dejan Dragan).

VISITORS FROM ABROAD

1. Dr. Ilaria Rosso, Electro Power Systems SpA, Torino, Italy, 9 June 2011
2. Dr. Miroslav Kárný, Institute of Information Theory and Automation, Czech Academy of Sciences, Prague, Czech Republic, 19–21 June 2011
3. Dr. Jan Přikryl, Institute of Information Theory and Automation, Czech Academy of Sciences, Prague, Czech Republic, 24 August to 27 September 2011
4. Luka Cetina, Novatec d.o.o., Labin, Croatia, 16 September 2011
5. Roberto Gobo, Novatec d.o.o., Labin, Croatia, 16 September 2011
6. Damir Ratković, Novatec d.o.o., Labin, Croatia, 16 September 2011
7. David DeVries, Genesis Fueltech Inc., Spokane Valley, USA, 18–19 September 2011
8. Dr. Ladislav Jirsa, Institute of Information Theory and Automation, Czech Academy of Sciences, Prague, Czech Republic, 21–24 September 2011
9. Dr. Kamil Dedecius, Institute of Information Theory and Automation, Czech Academy of Sciences, Prague, Czech Republic, 21–24 September 2011

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9. Prof. Juš Kocijan
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21. Tomaž Lukman, B. Sc.
22. *Dr. Satja Lumbar, left 01.07.11*
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Technical and administrative staff
28. Maja Janežič, B. Sc.
29. Miroslav Štrubelj

BIBLIOGRAPHY

Original Articles

1. Kristjan Ažman, Juš Kocijan, "Dynamical systems identification using Gaussian process models with incorporated local models", *Eng. appl. artif. intell.*, vol. 24, no. 2, pp. 398-408, 2011.
2. Pavle Boškoski, Janko Petrovčič, Bojan Musizza, Đani Juričić, "An end-quality assessment system for electronically commutated motors based 3 on evidential reasoning", *Expert syst. appl.*, vol. 38, no. 11, pp. 13816-13826, 2011.
3. Pavle Boškoski, Janko Petrovčič, Bojan Musizza, Đani Juričić, Andrej Biček, "End-quality assessment of electrical motors based on the concept of virtual sensors", *Ventil (Ljubl.)*, vol. 17, no. 2, pp. 148-153, 2011.
4. Pavle Boškoski, Anton Urevc, "Bearing fault detection with application to PHM data challenge", *Int. j. progn. health manag.*, vol. 2, no. 1, pp. 003-1-003-10, 2011.
5. Aljaž Čufar, Vladimir Jovan, "Ocena bilance vode v sistemu reformer/gorivne celice", *Elektrotehniški vestnik*, vol. 78, no. 1/2, pp. 61-66, 2011.
6. Dejan Dovžan, Vito Logar, Nadja Hvala, Igor Škrjanc, "Monitoring and sensor fault detection in a waste-water treatment process based on a fuzzy model", *Elektrotehniški vestnik*, vol. 78, no. 3, pp. 142-146, 2011.
7. Dejan Dovžan, Vito Logar, Nadja Hvala, Igor Škrjanc, "Zaznavanje napak in spremljanje čiščenja odpadnih voda na podlagi mehkega modela", *Elektrotehniški vestnik*, vol. 78, no. 3, pp. 142-146, 2011.
8. Andrej Fabjan, Bojan Musizza, Fajko Bajrović, Marjan Zaletel, Martin Štrucl, "The effect of the cold pressor test on a visually evoked cerebral blood flow velocity response", *Ultrasound med. biol.*, Nov 18, 2011.
9. Matej Gašperin, Đani Juričić, Pavle Boškoski, Jože Vižintin, "Model-based prognostics of gear health using stochastic dynamical models", *Mech. syst. signal process.*, vol. 25, no. 2, pp. 537-548, 2011.
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11. Dejan Gradišar, "Interreg IV projekt I3E: pospeševanje inovacij na področjih industrijske informatike in vgrajenih sistemov z medsebojnim povezovanjem", *Ventil (Ljubl.)*, vol. 17, no. 4, pp. 308-309, 2011.
12. Alexandra Grancharova, Juš Kocijan, Tor Arne Johansen, "Explicit output-feedback nonlinear predictive control based on black-box models", *Eng. appl. artif. intell.*, vol. 24, no. 2, pp. 388-397, 2011.
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