

Scientific Seminars at Department

A. Kugi: Mathematical Modeling and Advanced Process Control for Industrial Applications in the Steel Industry (TU Vienna, Austria)



R. Mitze: Algebraic Dynamic Programming for Constrained Linear-Quadratic Optimal Control Problems (Ruhr University Bochum, Germany)



D. Dillkötter: Model-Based Feedforward Control of the Laser Metal Deposition Process (Ruhr University Bochum, Germany)



J. Drgoňa: Implementation and Remote Operation of White-Box Model Predictive Control in an Office Building (KU Leuven, Belgium)



G. Sanchez: Technologies for Crop Monitoring - Some Opportunities and Challenges in India (JK Lakshmiipat University, India)



B. Houska: Moment Based Learning (ShanghaiTech University, China)



K. Jastrěmská: Pressure driven membrane processes: Membrane and its role in the separation (Univerzita Pardubice, Czechia)



A.W.Y. Shardt: Big Data and System Identification: Challenges and Opportunities (TU Ilmenau, Germany)



J. Czczot, M. Fratzczak, P. Nowak and P. Grelewicz: Model-Based Control in Industrial Automation - Implementation and Tuning (Silesian University of Technology, Poland)



Habilitation lecture at Department

J. Oravec delivered his habilitation lecture on Advanced Methods of Robust Control Design for Energy Demanding Plants. He was named associate professor in December, 2019.



Awards



P. Bakaráč, K. Fedorová, M. Furka, L. Galčíková, M. Horváthová, P. Valiauga and M. Wadinger were awarded the Dean's Prize for the outstanding fulfilment of academic duties and representation of STU.

P. Valiauga and L. Galčíková were awarded the Prize of Student of the Year 2019 by Rector of STU in Bratislava for exceptional performance of study obligations.



Workshop in Mosonmagyaróvár, HU



Members of the department attended the three-day workshop in Mosonmagyaróvár, Hungary. Discussions evolved around the status of research and teaching activities, projects

and social activities. New PhD. students, M. Furka, M. Horváthová, K. Kiš and M. Mojto gave lectures about their research.

Slovak Student Scientific Conference

Members of our institute organised 21st Students' Scientific Conference "Chemistry and technologies for Life" held at our faculty. J. Oravec is the Chairman of the organizing committee. In our section we had an international attendance from Poland and the Czech Republic. 12 participants presented their projects and the committee awarded the best.



Master Theses:

D. Boroš: Methods of bi-level optimization

O. Čizmazia: Design of Control System for Pasteurization Process

M. Furka: Development of Control Algorithms for Rotational Inverted Pendulum

M. Horváthová: Convex-lifting-based robust control design

R. Hronec: Control of a Position of an Object in Air Flow

K. Kiš: Machine Learning Approaches Applied to Generation of Explicit Control Laws

M. Malovcová: Electronic System for Property Records using Barcodes and QR Codes

M. Mojto: Advanced Process Control of a Depropanizer Column

J. Nosko: Data Statistical Analysis in R Language

Contact information

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SLOVAK UNIVERSITY OF
TECHNOLOGY IN BRATISLAVA
FACULTY OF CHEMICAL
AND FOOD TECHNOLOGY



Department of Information Engineering and Process Control

Dear co-workers, colleagues, project partners, former members of the department,

As the year 2019 is nearing the end, it is time to reflect on achievements of our department. It has been a quite successful year for us. We were awarded a few new projects and continued close collaboration with TU Dortmund, TU Bochum, Imperial College London, ShanghaiTech University and Shinshu University. We were the main organizers of the Process Control 2019 conference held in Štrbské Pleso, Slovakia. The publication activity was above average with 15 journal papers, 25 conference papers and 1 Springer book. This year I was appointed by Dean of

FCHPT as the new head of the department. I replaced professor Miroslav Fikar, who became the Rector of STU in Bratislava. I believe that I will lead the department at least in the way it was led by the previous director.

I would like to thank my colleagues and partners for successful and pleasant collaboration. I sincerely hope for even more involved participation in research, project proposals, and industrial cooperation in 2020.

Michal Kvasnica
head of the department



University Elections



The Academic Senate of STU has elected professor Miroslav Fikar for the Rector of our university for the period 2019—2023.



Assoc. prof. Monika Bakošová has been approved by Academic Senate of STU as Vice-Rector for Education of the Slovak University of Technology in Bratislava for the period 2019—2023.

International Conference on Process Control 2019



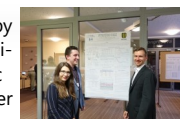
Our department was the lead organizer of the 22nd International Conference on Process Control held in Štrbské Pleso, Slovakia June 11-14, 2019. The objective of this three-day conference was to bring together theory-experts and control systems specialists, to discuss the new possibilities of techniques, design procedures and instruments in process control projects. The conference was organized into six regular sessions, two plenary lectures, two workshops and one poster session. The participants of the conference were



from 11 different countries, such as Bulgaria, China, Croatia, France, Portugal, Slovak Republic, etc. The conference proceedings has been opened with a plenary lecture titled as Survey of parameter and state estimation for (bio)chemical systems— A personal perspective given by D. Dochain. On the second day, S. Engell gave the plenary talk on

Robust NMPC by Multistage Optimization—Basic idea and further developments.

M. E. Villanueva had a workshop on Robust Model Predictive Control for Nonlinear Systems using Sets and G. Hukó on Control of Distributed Parameter Systems—An Engineering Approach. Members of our department are authors of 13 papers from 70 accepted papers at the Process Control Conference 2019. Process Control Conference was attended by 20 members of our department, of which six were PhD. students and two undergraduate students.



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Participation at Conferences



M. Fikar delivered the plenary lecture at the *International Conference Process Systems Engineering Asia*, in Bangkok, Thailand.

M. Mojto and **R. Paulen** participated at the *Advanced Process Modelling*, in London, UK. M. Mojto presented a poster of the results in cooperation with Slovnaft, a.s.



M. Fikar and **R. Paulen** participated at the *29th European Symposium on Computer-Aided Process Engineering*, in Eindhoven, Netherlands.

M. Kalúz and **L. Čirka** presented a paper at the *IFAC Symposium on Advances in Control Education*, Philadelphia, USA.

R. Paulen, **C. Valero** and **P. Valiauga** authored a publication at the *IFAC Symposium on Dynamics and Control of Process Systems*, in Florianopolis, Brazil.



Members of our department are authors of three papers presented at *Conference on Process Integration for Energy Saving and Pollution Reduction*, in Crete, Greece.

Scientific Seminars of Our Members Abroad



P. Valiauga: Guaranteed Parameter Estimation and **C.E. Valero**: Effective Recursive Set-membership State Estimation for Robust Linear MPC (TU Dortmund, Germany)

R. Paulen: Model-based design of optimal experiments using exact confidence regions (Imperial College London, UK)

J. Oravec, **M. Horváthová**: Experimental Analysis of Advanced Controller Design Strategies (Shinshu University, Japan)



P. Valiauga: Moving-horizon Guaranteed Parameter Estimation (ShanghaiTech University, China)



R. Paulen: Effective recursive parallelotopic bounding for robust output-feedback control (KU Leuven, Belgium)

R. Paulen: Optimal Control of Membrane Diafiltration Processes (Imperial College London, UK)

M. Mojto: Control structure analysis and design of inferentials for an industrial depropanizer column and

R. Paulen: Optimal Control of Batch Membrane Processes (TU Dortmund, Germany)

R. Paulen: Optimal operation of membrane processes (University of Chemistry and Technology, Prague and at University of Pardubice)

New Members

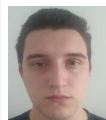


Matúš Furka received his MSc. degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. Currently, he continues with his research as a PhD. student in Process Control (supervisor: M. Kvasnica). His research is focused on safe and secure control algorithms.

Michaela Horváthová is currently a PhD. Student in Process Control (supervisor: M. Bakošová) at Slovak University of Technology in Bratislava. She obtained her master degree also at STU in Bratislava. Her research activities are focused on robust and model predictive control, controller design based on the convex lifting, and implementation of the designed control strategies on the laboratory plants.



Karol Kiš received his MSc. degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. Currently, he is a PhD. student in Process Control under the supervision of M. Kvasnica. His main field of interest is machine learning and its applications.



Martin Mojto received his MSc. degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. He continues to work at our department as a PhD. student in Process Control (supervisor: R. Paulen). His research focuses on design of linear multidimensional inferential sensors from industrial data.

International Projects

New Directions in Guaranteed Estimation of Nonlinear Dynamic Systems and Their Applications to Chemical Engineering Problems (GuEst) is an EU project under the MSCA scheme, which is granted to our department and assoc. prof. R. Paulen. Up to now, only three projects of this kind were awarded to Slovak institutions (MSCA, IF H2020).

Verified Estimation and Control of Chemical Processes is a joint mobility grant with participation of the group of assoc. prof. R. Paulen and the group of prof. B. Houska, ShanghaiTech University, China (APVV, Slovakia).

Reliable and Real-time Feasible Estimation and Control of Chemical Plants is a joint research project between the group of assoc. prof. R. Paulen and the group of prof. S. Engell, Technische Universität Dortmund (DAAD, Germany).

Embedded Optimal Control is a joint research project between the group of prof. M. Fikar and the group of prof. M. Mönnigmann from Department of Automatic Control and Systems Theory, Faculty of Mechanical Engineering of the Ruhr-Universität Bochum, Germany (A. von Humboldt Foundation, Germany).

National Projects

Optimal Control for Process Industries is a research project funded by the APVV organization. The principal investigator is prof. M. Fikar.

On-Line Tunable Explicit Model Predictive Control for Systems with a Fast Dynamics is a VEGA research project where the principal investigator is assoc. prof. M. Kvasnica.

Control of Energy Intensive Processes with Uncertainties in Chemical Technologies and Biotechnologies is a VEGA research project where the principal investigator is assoc. prof. M. Bakošová.

Energy Efficient Process Control is a VEGA research project where the principal investigator is prof. M. Fikar.

Economically Effective Control of Energy Intensive Chemical Processes is a Grant: Excellent Teams of Young Researchers at STU in Bratislava. The principal investigator is Dr. M. Klaučo.

Machine Learning and Artificial Intelligence in Process Control and Automation is a postdoc research stay financed by the Slovak University of Technology in Bratislava. The principal investigator is assoc. prof. M. Kvasnica.

STU as the Leader of Digital Coalition is a State project supported by the funding of Slovak Ministry of Education, Science, Research and Sport. The principal investigator is Dr. M. Klaučo.

Development and Design of Smart Sensors for Chemical Industry is a Grant for Young Researchers of STU in Bratislava. The principal investigator is P. Bakaráč.

Journal Papers

P. Bakaráč – M. Kvasnica: Approximate explicit robust model predictive control of a CSTR with fast reactions. *Chemical papers*, no. 3, vol. 73, pp. 611–618, 2019.

M. Bakošová – J. Oravec – A. Vasičkaninová – A. Mészáros – P. Valiauga: Advanced Control of a Biochemical Reactor for Yeast Fermentation. *Chemical Engineering Transactions*, vol. 76, pp. 769–774, 2019.

K. Fedorová – P. Bakaráč – M. Kvasnica: Agile Manoeuvres using Model Predictive Control. *Acta Chimica Slovaca*, no. 1, vol. 12, pp. 136–141, 2019.

F. Freeling – N. Alygizakis – P. C. von der Ohe – J. Slobodník – P. Oswald – R. Aalizadeh – L. Čirka – N. Thomaidis – M. Scheurer: Occurrence and potential environmental risk of surfactants and their transformation products discharged by wastewater treatment plants. *Science of The Total Environment*, vol. 681, pp. 475–487, 2019.

M. Klaučo – M. Kalúz – M. Kvasnica: Machine learning-based warm starting of active set methods in embedded model predictive control. *Engineering Applications of Artificial Intelligence*, vol. 77, pp. 1–8, 2019.

M. Kvasnica – P. Bakaráč – M. Klaučo: Complexity reduction in explicit MPC: A reachability approach. *Systems & Control Letters*, vol. 124, pp. 19–26, 2019.

J. Oravec – M. Bakošová – L. Galčíková – M. Slávik – M. Horváthová – A. Mészáros: Soft-constrained robust model predictive control of a plate heat exchanger: Experimental analysis. *Energy*, vol. 180, pp. 303–314, 2019.

J. Oravec – M. Bakošová – M. Horváthová – L. Galčíková – M. Slávik – A. Vasičkaninová – A. Mészáros: Convex-lifting-based Robust Control of a Laboratory Plate Heat Exchanger. *Chemical Engineering Transactions*, vol. 76, pp. 733–738, 2019.

J. Oravec – J. Holaza – M. Horváthová – N. A. Nguyen – M. Kvasnica – M. Bakošová: Convex-lifting-based robust control design using the tunable robust invariant sets. *European Journal of Control*, vol. 49, pp. 44–52, 2019.

R. Paulen – M. Fikar: Dynamic real-time optimization of batch processes using Pontryagin's minimum principle and set-membership adaptation. *Computers & Chemical Engineering*, vol. 128, pp. 488–495, 2019.

R. Paulen – M. Fikar: Dual-Control-Based Approach to Batch Process Operation under Uncertainty Based on Optimality-Conditions Parameterization. *Industrial & Engineering Chemistry Research*, no. 30, vol. 58, pp. 13508–13516, 2019.

A. Sharma – R. Valo – M. Kalúz – R. Paulen – M. Fikar: Implementation of optimal strategy to economically improve batch membrane separation. *Journal of Process Control*, vol. 76, pp. 155–164, 2019.

T. B. L. Tran – M. Törngren – H. D. Nguyen – R. Paulen – N. W. Gleason – T. H. Duong: Trends in preparing cyber-physical systems engineers. *Cyber-Physical Systems*, no. 2, vol. 5, pp. 65–91, 2019.

A. Vasičkaninová – M. Bakošová – J. Oravec – A. Mészáros: Control of Heat Exchangers Using Complex Control Structures with Neural Network Predictive Controllers. *Chemical Engineering Transactions*, vol. 76, pp. 361–366, 2019.

A. R. Gottu Mukkula – R. Paulen: Optimal experiment design in nonlinear parameter estimation with exact confidence regions. *Journal of Process Control*, vol. 83, pp. 187–195, 2019.

Book Chapter

M. Bakošová – J. Oravec – A. Vasičkaninová: *The Environmental Benefits of Automation (in Slovak)*, In *Chemia, biológia a životné prostredie*, SCHK FCHPT STU v Bratislave, pp. 95–114, 2019.

Book

M. Klaučo – M. Kvasnica: *MPC-Based Reference Governors*, Editor(s): M. J. Grimble, A. Ferrara, Springer, 2019.

