

DEPARTMENT OF INFORMATION ENGINEERING AND PROCESS CONTROL

Fellow colleagues, project partners, former members of the department, and friends,

As the year 2020 has gone by, we should weigh on our accomplishments. Even though the COVID pandemic struck every branch of university life, our department's scientific and teaching activities remain at their highest level. In terms of our publication advancements, we published 12 journal papers and more than 15 conference papers. Moreover, we continued with very fruitful cooperation with TU Bochum, TU Dortmund, Imperial College London, University of Lorraine, CTU in Prague, ShanghaiTech University and many more. Members of our department have submitted 9 project proposals. Several members of our department, including master students, have received awards for their exceptional performance. Although the COVID negatively affects traditional teaching, we smoothly transitioned to online space. We took the opportunity and increased the media portfolio that covers our courses. Now, more than 90% of our courses have full video support for both lectures and exercises.

Our department has yet another change in administration. As of September 2020, I was appointed by Michal Kvasnica as the head of the department. Together with my deputy R. Paulen, we will continue to motivate our colleagues to increase the quality of both research and teaching domains.

Finally, I would like to extend my sincere thanks to all our department members for their continuous support and job well done.

Dr. Martin Klaučo
Head of the department



Awards

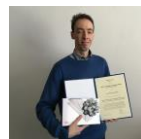
Our paper "Set-membership nonlinear regression approach to parameter estimation", co-authored by **Dr. Radoslav Paulen** and Dr. Nikola Peric, Dr. Mario Eduardo Villanueva (ShanghaiTech University), and Dr. Benoit Chachuat (Imperial College London), has been selected to win this year's Journal of Process Control Paper Prize.



Assoc. Prof. Juraj Oravec was awarded as Scientist of the year at STU in the category Young researcher.

Scientific team led by **Assoc. Prof. Michal Kvasnica** won the Excellent Team of STU award.

IAM student **Rudolf Trautenberger** was also awarded for his master thesis on "Software Properties for Computing Properties of Chemical Compounds".



Dr. Martin Klaučo and **Assoc. Prof. Michal Kvasnica** were awarded by Slovak literary fund for their publication „MPC – Based Reference Governors" in the category Scientific literature of the year 2019.



IAM students **Michaela Horváthová**, **Lenka Galčíková**, **Lucia Míková** and **Michaela Lehotová** were awarded the Prize of Student of the Year 2020 by Rector of STU in Bratislava.

IAM Scientific Seminars

In February 2020, our PhD students visited RUB Bochum, Germany, and gave lectures about their scientific research. **Michaela Horváthová** presented „Convex-lifting-based Robust Control" and **Matúš Furka** presented „Development of Control Algorithm for Rotational Inverted Pendulum".



In October 2020, **Assoc. Prof. M. Kvasnica** delivered a plenary lecture about "Low-Complexity Model Predictive Control of Systems with a Fast Dynamics" at 21st International Carpathian Control Conference.

In November 2020, **Assoc. Prof. M. Kvasnica** delivered an online plenary lecture at University of California, Berkeley, focused on „Towards Fixed-Complexity Explicit Model Predictive Control".



Scientific Seminar at our Department

In February 2020, **Prof. Martin Mönnigmann** (RUB Bochum, Germany) gave a lecture on "Accelerating MPC with Closed-Loop Optimal Sequences of Affine Feedback Laws". This was joint work with Prof. Gabriele Pannocchia (University of Pisa, Italy).



IAM at Conferences in 2020

The 6th Conference on Advances in Control & Optimization of Dynamical Systems 2020, Chennai, India	16. 2. – 19. 2. 2020	R. Paulen
European Control Conference 2020, Saint Peterburg, Russia	12. 5. – 15. 5. 2020	R. Paulen
IFAC World Congress 2020, Berlin, Germany	12. 7. – 17. 7. 2020	L. Čírka, , M. Fikar, M. Kalúz, M. Klaučo, M. Kvasnica, J. Oravec, R. Paulen, C. E. Valero
The 23rd Conference on Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction, Xi'an, China	17. 8. – 21. 8. 2020	M. Horváthová, A. Vasičkaninová
The 30th European Symposium on Computer Aided Process Engineering, Milano, Italy	31. 8. – 2. 9. 2020	M. Fikar, M. Mojto, R. Paulen
The 21st International Carpathian Control Conference, Starý Smokovec, Slovak Republic	27. 10. – 29. 10. 2020	M. Kvasnica
The 4th SPIL International Scientific Conference: Energy, Water, Emission & Waste in Industry and Cities, Brno, Czech Republic	18. 11. – 20. 11. 2020	M. Bakošová, M. Kalúz, A. Mészáros, A. Vasičkaninová
The 59th Conference on Decision and Control, Jeju Island, Republic of Korea	14. 12. – 18. 12. 2020	M. Horváthová, M. Kvasnica

International Projects

New Directions in Guaranteed Estimation of Nonlinear Dynamic Systems and Their Applications to Chemical Engineering Problems is an EU project under the MSCA scheme which is granted to Assoc. Prof. R. Paulen and Prof. M. Fikar.

Embeded Optimal Control is a joint research project between the group of Prof. M. Fikar and the group Prof. M. Mönnigmann from Department of Automatic Control and Systems Theory, Faculty of Mechanical Engineering of the Ruhr-Universität Bochum, Germany.

Full-Authority Vehicle Control Strategy is an international project between STU in Bratislava, CTU, Prague and TU Wien. Dr. M. Klaučo is the STU's main investigator.

Optimal design and control of processes is a joint project between the group of Assoc. Prof. R. Paulen and M.A. Latifi from Institut National Polytechnique de Lorraine, Ecole Nationale Supérieure des Industries Chimiques.

Mobility of students and university employees between program countries and partner countries is an international project granted to Assoc. Prof. R. Paulen. It is a mutual project between STU and Chulalongkorn University (Bangkok, Thailand).

Projects in the Slovak Republic

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

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

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

Advanced Control of Energy Intensive Processes with Uncertainties in Chemical, Biochemical and Food Technologies is a VEGA project where Assoc. Prof. M. Bakošová is the principal investigator.

Safe process control focused on energy and cost savings is a Slovak project where M. Horváthová is the principal investigator.

Heart-Disease Diagnostic in Real Time with Neural Networks is a research project granted to Dr. M. Klaučo.

Journal Papers

J. Drgoňa – J. A. Bastida – I. C. Figueroa – D. Blum – K. Arendt – D. Kim – E. P. Ollé – J. Oravec – M. Wetter – D. Vrabie – L. Helsen: All you need to know about model predictive control for buildings. *Annual Reviews in Control*, pp. 1–43, 2020.

M. Horváthová – J. Oravec – M. Bakošová: Efficient Convex-Lifting-Based Robust Control of a Chemical Reactor. *Chemical Engineering Transactions*, vol. 81, pp. 865–870, 2020.

Y. Jiang – J. Oravec – B. Houska – M. Kvasnica: Parallel MPC for Linear Systems with Input Constraints. *IEEE Transactions on Automatic Control*, pp. 1–8, 2020.

K. Kusumo – L. Gomoescu – R. Paulen – S. García Muñoz – C. C. Pantelides – N. Shah – B. Chachuat: Bayesian Approach to Probabilistic Design Space Characterization: A Nested Sampling Strategy. *Industrial & Engineering Chemistry Research*, no. 6, vol. 59, pp. 2396–2408, 2020.

J. Oravec – M. Horváthová – M. Bakošová: Energy efficient convex-lifting-based robust control of a heat exchanger. *Energy*, no. 201, pp. 1–11, 2020.

J. Oravec – M. Horváthová – M. Bakošová: Multivariable Robust MPC Design for Neutralization Plant: Experimental Analysis. *European Journal of Control*, 2020.

S. Thangavel – R. Paulen – S. Engell: Robust Multi-Stage Nonlinear Model Predictive Control Using Sigma Points. *Processes*, no. 7, vol. 8, pp. 0851, 2020.

J. Theunissen – A. Sorniotti – P. Gruber – S. Fallah – M. Ricco – M. Kvasnica – M. Dhaens: Regionless Explicit Model Predictive Control of Active Suspension Systems With Preview. *IEEE Transactions on Industrial Electronics*, no. 6, vol. 67, pp. 4877–4888, 2020.

A. Vasičkaninová – M. Bakošová – A. Mészáros: Control of heat exchangers in series using neural network predictive controllers. *Acta Chimica Slovaca*, pp. 41–48, 2020.

A. Vasičkaninová – M. Bakošová – J. Oravec – M. Horváthová: Efficient Fuzzy Control of a Biochemical Reactor. *Chemical Engineering Transactions*, vol. 81, pp. 85–90, 2020.

P. C. von der Ohe – F. Freeling – N. Alygizakis – J. Slobodník – P. Oswald – R. Aalizadeh – L. Čirka – N. Thomaidis – M. Scheurer: Explaining the rationale behind the risk assessment of surfactants by Freeling et al. (2019). *Science of The Total Environment*, vol. 721, pp. 136828, 2020.

Book Chapter

A. Vasičkaninová – M. Bakošová – J. Oravec: Fuzzy control of heat exchangers in series using complex control structures. In *Advanced Analytic and Control Techniques for Thermal Systems with Heat Exchangers*, Editor(s): Libor Pekař, Academic Press Elsevier, pp. 287–306, 2020.

Technical Report

J. Holaza – J. Oravec – M. Kvasnica – R. Dyrská – M. Mönnigmann – M. Fikar: Accelerating Explicit Model Predictive Control by Constraint Sorting. 2020.

Registered Trademark

J. Oravec – M. Bakošová: PIDDESIGN (in Slovak). 2020.

PhD Thesis

A. Sharma: Mathematical Modeling and Optimal Operation of Membrane Processes, supervised by Prof. M. Fikar.

PhD Mini-Thesis

C. Valero: Set-membership State Estimation, supervised by Assoc. Prof. R. Paulen.

Master Theses

T. Ábelová: Static and Dynamic Optimization of Virtual Power Plants, supervised by Assoc. Prof. M. Kvasnica.

K. Fedorová: Decentralized Machine Learning and Optimization, supervised by Assoc. Prof. M. Kvasnica.

L. Galčíková: Explicit Model Predictive Control Design for Heat Exchanger, supervised by Assoc. Prof. J. Oravec.

M. Kintler: Guaranteed identification and its use in hybrid modelling, supervised by Assoc. Prof. R. Paulen.

R. Kohút: Fast Nonlinear Model Predictive Control, supervised by Assoc. Prof. M. Kvasnica.

A. Morozov: Nonlinear Model Predictive Control of Rotary Pendulum, supervised by Assoc. Prof. M. Kvasnica.

M. Nemeš: Wireless Sensor Network, supervised by Dr. M. Kalúz.

M. Slávik: Model Predictive Control of Laboratory Neutralisation Plant, supervised by Assoc. Prof. J. Oravec.

R. Trautenberg: Software Development for Computing Properties of Chemical Compounds, supervised by Assoc. Prof. J. Oravec.

Our New Members

Tereza Ábelová received her master degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. After master's study, she continues to pursue a PhD externally under the supervision of M. Kvasnica while working for the Slovak company TESLA Blue Planet. Her areas of interests are optimization, predictive control and energy engineering.



Kristína Fedorová is a PhD student in Process Control under the supervision of M. Kvasnica. She received her master degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. Her research is focused on distributed and decentralized optimization and its application in process control, also model predictive control and machine learning.

Lenka Galčíková is a PhD student at Slovak University of Technology in Bratislava in the study field of Process control under the supervision of J. Oravec. She obtained her master degree also at STU in Bratislava. Her research targets are focused on robust, explicit, model predictive control as well as implementation of the control design on laboratory plants.



Roman Kohút received his master degree in Automation and Information Engineering in Chemistry and Food Industry from STU in Bratislava. He is a PhD student in Process Control under the supervision of M. Kvasnica. Currently his research targets are focused on model predictive control, machine learning and distributed optimization.

Workshop of the Department

Our department members attended two-day online workshop. The discussions were focused on the status of research, teaching activities and scientific projects. Also, the first-year PhD students T. Ábelová, K. Fedorová, L. Galčíková and R. Kohút presented their research results and future goals.



Slovak Student Scientific Conference



Members of our department participated in organizing of the 22nd Student Scientific Conference „Chemistry and Technologies for Life“ which was held online. Assoc. Prof. J. Oravec was the Chairman of the organizing committee. In our session Process Control 12 participants from Slovak and Czech Republic presented their scientific projects and the best of them were awarded.

Outlook for 2021

Beside scientific and teaching activities, our department also organizes **The 23rd International Conference on Process Control** which will be held on June 1 – 4, 2021 (<https://www.process-control.sk>). We also participate in organizing **The 7th IFAC Conference on Nonlinear Model Predictive Control** held on July 11 – 14, 2021 (<https://www.nmpc2021.org>).

Contact

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