# ROSENBROCK LECTURE SERIES

The University of Manchester is pleased to launch the Rosenbrock Lecture Series to celebrate groundbreaking research accomplishments in Control Engineering and Robotics. Four distinguished world-leading Control Engineering and Robotics experts will give the inaugural Keynote Lectures. We hope that this event will be of interest to academic colleagues, researchers, and PhD students across the nation and beyond. We look forward to welcoming you all in Manchester.

**VENUE:** University of Manchester, Oxford Road

**THURSDAY 21ST MARCH 2024**

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<th>Time</th>
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<tr>
<td>08:30-09:00</td>
<td>Registration + Coffee</td>
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<td>09:00-09:30</td>
<td>University of Manchester welcome</td>
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| 09:30-10:30 | **Keynote Lecture 1:** Prof. Rodolphe Sepulchre, KU Leuven & University of Cambridge  
                  "Spiking Control Systems"                                        |
| 10:30-11:00 | Coffee + Networking                                                 |
| 11:00-12:00 | **Keynote Lecture 2:** Prof. Jonathan P. How, Massachusetts Institute of Technology  
                 "Efficient, Agile, Data-driven Vision-Based Onboard Autonomy under Uncertainties" |
| 12:00-13:00 | Industrial Lecture, Quanser Inc.                                     |
| 13:00-14:00 | Catered Lunch + Networking                                          |
| 14:00-15:00 | **Keynote Lecture 3:** Prof. Maria Prandini, Politecnico di Milano  
                  "Multi-agent cooperative decision-making with application to energy systems" |
| 15:00-15:30 | Coffee + Networking                                                 |
| 15:30-16:30 | **Keynote Lecture 4:** Prof. Bruno Siciliano, University of Naples Federico II  
                 "Robot Manipulation and Control"                                  |
| 16:30-16:45 | University of Manchester closing remarks                           |

Registration is free via [eventbrite weblink](#). The registration deadline is **Wednesday March 1, 2024**. In case of queries, please contact the organisers: Alexander.Lanzon@manchester.ac.uk or Joaquin.Carrasco@manchester.ac.uk

The University of Manchester would like to thank Quanser UK Limited for their generous sponsorship of this event.
Spiking Control Systems

Professor Rodolphe Sepulchre
KU Leuven and University of Cambridge

Abstract

Spikes and rhythms organize control and communication in the animal world, in contrast to the bits and clocks of digital technology. As continuous-time signals that can be counted, spikes have a mixed nature. This talk will review ongoing efforts to develop a control theory of spiking systems via the classical concept of mixed feedback. The central thesis is that a theory of mixed feedback can be grounded in the operator theoretic concept of maximal monotonicity. As a nonlinear generalization of passivity, maximal monotonicity acknowledges at once the physics of electrical circuits, the algorithmic tractability of convex optimization, and the feedback control theory of incremental passivity. We discuss the relevance of a theory of mixed feedback systems in the emerging age of event-based technology.

Biography

Rodolphe Sepulchre is professor of engineering at the KU Leuven (Belgium) and at the University of Cambridge (UK). He is a fellow of IFAC (2020), IEEE (2009), and SIAM (2015). He received the IEEE CSS Antonio Ruberti Young Researcher Prize in 2008 and the IEEE CSS George S. Axelby Outstanding Paper Award [ieeecss.org] in 2020. He was elected at the Royal Academy of Belgium in 2013. He is Editor-in-Chief of IEEE Control Systems. He co-authored the monographs Constructive Nonlinear Control (1997, with M. Jankovic and P. Kokotovic) and Optimization on Matrix Manifolds (2008, with P-A. Absil and R. Mahony). He is a recipient of two ERC advanced grants (Switchlets (2015-2021) and SpikyControl (2023-2028)).

Efficient, Agile, Data-driven Vision-Based Onboard Autonomy under Uncertainties

Professor Jonathan P. How
MIT

Abstract

Real-world, large-scale, vision-based multi-agent autonomy demands the ability to efficiently sense, plan, and act under uncertainties. Although vision-based data is a rich and relatively easily acquired source of information, perceptual uncertainties and constraints—such as limited fields-of-view in planning, as well as onboard computational and communication limitations—necessitate careful consideration at the algorithmic level. In this talk, we present strategies to account for vision-based constraints at the control, planning, and localization levels. First, we introduce a strategy to enable computationally efficient learning of vision-based neural networks for control using Imitation Learning. Our method leverages the properties of a robust tube model predictive controller to collect data in a way that is data- and computation-efficient, requiring only a single demonstration, while accounting for the effects of real world uncertainties. In addition, we employ Neural Radiance Fields as part of the process to obtain extra training data, minimizing the sim2real gap in image space. Second, we showcase PUMA, an Imitation Learning-based uncertainty- and perception-aware multi-agent trajectory planner. PUMA plans its trajectories by integrating constraints that account for the uncertainty arising from state estimation drifts due to onboard sensing and from imperfect onboard detections of surrounding dynamic obstacles. PUMA also incorporates an image segmentation-based frame alignment pipeline that enables fully decentralized, safe trajectory sharing. Further, by learning a policy from PUMA using Imitation Learning, we significantly reduce PUMA's computation time. Last, we present a SLAM approach that leverages local graphs of detected objects/landmarks to build a local and global map. Thanks to the sparseness of this representation, our method enables computationally and communication-efficient re-localization by one or multiple agents. In addition, the employed sparse representation is robust to variations in the environment (e.g., such as seasonal changes) enabling long-term relocalization. We present evaluations on a variety of real and simulated aerial vehicles, including a novel, insect-scale soft aerial robot.

Biography

Jonathan P. How is the Richard C. Maclaurin Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology. His research focuses on safe and robust planning and learning under uncertainty with an emphasis on multiagent systems, and he was the planning and control lead for the MIT DARPA Urban Challenge team in 2007. His work has been recognized with multiple awards, including being inducted into the University of Toronto Engineering Hall of Distinction (2022), and receiving the 2020 IEEE CSS Distinguished Member Award and the 2020 AIAA Intelligent Systems Award. He is a Fellow of IEEE (2018) and AIAA (2016) and was elected to the National Academy of Engineering in 2021. He received a B.A.Sc (aerospace) from the University of Toronto in 1987, and his S.M. and Ph.D. in Aeronautics and Astronautics from MIT in 1990 and 1993, respectively, and then studied for 1.5 years at MIT as a postdoctoral associate. Prior to joining MIT in 2000, he was an assistant professor in the Department of Aeronautics and Astronautics at Stanford University.
Multi-agent cooperative decision-making with application to energy systems

Professor Maria Prandini
Politecnico di Milano

Abstract

The well-functioning of our modern society rests on the reliable and uninterrupted operation of large scale complex infrastructures, which are more and more exhibiting a network structure with a high number of interacting components/agents. Energy and transportation systems are prominent examples of such large scale multi-agent networked systems. Depending on the specific case, agents may act cooperatively to optimize the overall system performance or compete for shared resources. Based on the underlying communication architecture, and the presence or not of a central regulation authority, either decentralized or distributed decision making paradigms are adopted. In this presentation, we address the interacting and distributed nature of cooperative multi-agent systems arising in the energy application domain. More specifically, we present recent results on the development of a unifying optimization framework to cope with the main complexity features that are prominent in such systems, i.e.: heterogeneity, as we allow the agents to have different objectives and physical/technological constraints; privacy, as we do not require agents to disclose their local information; uncertainty, as we take into account uncertainty affecting the agents locally and/or globally; and combinatorial complexity, as we address the case of discrete decision variables. Possible application of the proposed framework to energy systems includes energy management in microgrids, prosumers aggregation for providing balancing services, coordinated operation of distributed energy resource systems with renewables, and electric vehicles charging.

Biography

Maria Prandini received the Ph.D. degree in Information Technology from the University of Brescia, Italy, in 1998. She was a postdoctoral researcher at the University of California at Berkeley from 1998 to 2000. She also held visiting positions at Delft University of Technology (1998), Cambridge University (2000), UC Berkeley (2005), ETH Zurich (2006), and University of Oxford (2022). In 2002, she joined Politecnico di Milano, where she is currently full professor and chair of the Automation and Control Engineering Study Program. She was elected Fellow of the IEEE in 2020 and received the IEEE Control Systems Society Distinguished Member award in 2018. In 2017, she was August-Wilhelm Scheer Visiting Professor and Honorary fellow of the TUM Institute for Advanced Studied. She was nominated Visiting Professor in Engineering at the University of Oxford for the triennium 2022-2025. She has been active in the IEEE Control Systems Society (CSS), the International Federation of Automatic Control (IFAC), and the Association for Computing Machinery (ACM), contributing to their activities in different roles. She is IFAC President-elect for the triennium 2023-26. Previously, she was Vice-President for conference activities for IFAC (2020-23) and IEEE CSS (2016 and 2017), and a member of SIGBED Board of Directors (2019-21). Her research interests include stochastic hybrid systems, randomized algorithms, distributed and data-driven optimization, multi-agent systems, and the application of control theory to transportation and energy systems.

Robot Manipulation and Control

Professor Bruno Siciliano
University of Naples Federico II

Abstract

This talk presents research results @ PRISMA Lab on robot manipulation and control. The talk is organized in four parts. In the first part, control techniques for dynamic nonprehensile manipulation are presented. The second part of the talk focuses on how to merge learning and model-based strategies to provide autonomy to robot manipulation. In the third part, several aerial robotics applications for inspection and maintenance are surveyed. The fourth part of the talk deals with recent advances on shared control including haptic guidance. Future perspectives and big challenges of this research area are finally discussed.

Biography

Bruno Siciliano is professor of robotics and control at the University of Naples Federico II. He is also Honorary Professor at the University of Óbuda where he holds the Kálmán Chair. His research interests in robotics include manipulation and control, human–robot cooperation, and service robotics. Fellow of the scientific societies IEEE, ASME, IFAC, he received numerous international prizes and awards, including the 2022 Engelberger Award for Education. He was President of the IEEE Robotics and Automation Society from 2008 to 2009. He has delivered more than 150 keynote speeches and has published more than 300 papers and 7 books. His book “Robotics” is among the most adopted academic texts worldwide, while his edited volume “Springer Handbook of Robotics” received the highest recognition for scientific publishing: the 2008 PROSE Award for Excellence in Physical Sciences & Mathematics. His team has received more than 20 million Euro funding in the last 15 years from competitive European research projects. More details are available at http://wpage.unina.it/sicilian.