Advances in Observer Design and Observer-Based Control: Methods and Implementation ⋆

Track Code: vgqp8

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Abstract: We are organizing an open invited track to present and discuss the latest advances in design methods for observers and observer-based control, addressing both theoretical developments and implementation aspects. The track welcomes contributions spanning diverse academic disciplines—such as electrical, mechanical, and aerospace engineering—as well as perspectives from different geographic regions. While all papers will align with the central theme of the track, they are expected to cover a broad spectrum of theoretical and application-oriented topics of significant interest to control researchers in both academia and industry.

1. DETAILED DESCRIPTION OF THE TOPIC

This open invited track highlights recent progress in the design of observers, observer-based controllers, and their deployment in practical systems. Observers are dynamic tools that estimate a system's internal states in real time, especially when direct measurement of all variables is impractical or prohibitively expensive. Their design is central to modern control methodologies, with applications spanning cyber-physical systems, autonomous vehicles, and energy networks.

While the theoretical foundations of observer design are well established, their methodological adaptation to real-world systems continues to pose challenges. These arise from model uncertainties, limited sensor information, and system complexity. Practical design must also address unknown inputs, disturbances, sensor and actuator faults, and resilience against cyber-attacks. Although generic solutions exist for uniformly observable systems, they frequently exhibit shortcomings in robustness or tractability when implemented.

The open invited track therefore seeks contributions that advance design-oriented frameworks and practical methodologies, bridging theory and implementation. Open directions include scalable design methods for observers and controllers in large-scale, interconnected systems; robust estimation and control strategies able to cope with dynamic adversarial conditions, partial knowledge, and time-varying uncertainties; and integrated design approaches that combine estimation and control within a unified framework. Addressing delay dynamics, switching behaviors, and communication constraints within these designs remains a key area requiring further exploration.

We encourage the presentation of research works related, but not limited to:

- robust and adaptive observers;
- sliding mode observers;
- interval and set-membership approaches;
- observer-based fault detection;
- observer design under constraints;
- observer-based control design, including observer-based (robust) model predictive control schemes;
- real-world applications and validation.

2. INFORMATION OF THE ORGANIZERS

Thach Ngoc Dinh received the M.Sc.Res. degree in Automatic Control (with honors) and the Diplôme d'Ingénieur (Master's) degree in Electrical Engineering from INSA

⋆ Open Invited Track in the frame of the IFAC World Congress 2026 https://ifac2026.org/.

Lyon, France, in 2011, and the Ph.D. degree in Physics from Paris-Saclay University in 2014. His Ph.D. was funded by INRIA and conducted in collaboration with the CAOR Laboratory of Mines Paris–PSL and the L2S Laboratory at CentraleSupélec, France. From 2015 to 2016, he was a JSPS Postdoctoral Fellow at the Kyushu Institute of Technology, Japan. In 2016 and 2017, he held a temporary position as an Assistant Professor at the Polytechnic University of Hauts-de-France, France. Since September 2017, he has been a tenured Associate Professor at the Conservatoire National des Arts et Métiers, France. He has also held visiting positions at Kyushu Institute of Technology (Japan), the Institute for Advanced Study (HWK) and the University of Oldenburg (Germany), Harbin Institute of Technology (China), and the Vietnam Institute for Advanced Study in Mathematics (Vietnam). His research focuses on robust control and observer design. Dr. Dinh has served as an Associate Editor for IEEE Control Systems Letters and the Journal of the Franklin Institute, a Subject Editor for Nonlinear Dynamics, and an Editorial Board Member or Guest Editor for several other scholarly journals. He is also a member of the IFAC Technical Committee on Linear Control Systems.

Mohammad Khajenejad is an assistant professor of mechanical engineering and electrical and computer engineering, specializing in estimation, verification, and robust control of nonlinear and hybrid dynamic systems. During his Ph.D. (2018-21), Mohammad worked at Arizona State University on guaranteed reachability analysis, state estimation, and resilient control of uncertain nonlinear systems subject to different uncertainty models and malicious agents/attackers. His Ph.D. thesis: "Set-Valued Methods for Reachability Analysis and Estimation of Nonlinear Dynamical Systems" won the prestigious 2021 ASU Dean's Dissertation Award. Then, he extended his work to distributed privacy-preserving and resilient optimization and estimation in adversarial networked cyber-physical systems during his postdoc at the University of California, San Diego (2022-24). Mohammad is a (co)-author of multiple articles in journals such as IEEE Transactions on Automatic Control, International Journal of Robust and Nonlinear Control, and IEEE Control Systems Letters. Mohammad's long-term research agenda is to draw on various tools from control theory, machine learning, and decision sciences to design distributed, tractable, robust, safe, and private sequential decision-making algorithms for multi-modal and switched cyber-physical robotic systems.

Fanglai Zhu received his Ph.D. degree in Control Theory and Control Engineering from Shanghai Jiao Tong University, Shanghai, China, in 2001. Supported by the Chinese government, he was a Visiting Scholar at Purdue University, West Lafayette, IN, USA, for six months in 2015. Before 2007, he was with Guilin University of Electronic Technology (GLIET), Guilin, China, serving as an Associate Professor for three years and a Professor for two years. During his time at GLIET, he was honored by the Guangxi local government as one of the "100 Young and Middle-Aged Disciplinary Leaders in Guangxi Higher Education Institutions." In recognition of his outstanding research work at GLIET, he was invited to join Tongji University, Shanghai, China, as a Professor in July 2007.His research interests include nonlinear observer design, distributed observer design, sliding-mode control, model-based fault diagnosis, fault-tolerant control, and multi-agent consensus control. Prof. Zhu was the recipient of the Third Prize of the Natural Science Award of Shanghai Science and Technology in 2011. He currently serves as an Editor for the Journal of Sensors and the Journal of Insight: Automatic Control, overseeing the section on System State Control.

Shyam Kamal received his Bachelor's degree in Electronics and Communication Engineering from Gurukula Kangri Vishwavidyalaya, Haridwar, Uttarakhand, India, in 2009, and his Ph.D. in Systems and Control Engineering from the Indian Institute of Technology Bombay, India, in 2014. He served as a Project Assistant Professor at the Kyushu Institute of Technology, Japan (2015–2016), and is currently an Associate Professor in the Department of Electrical Engineering at IIT (BHU) Varanasi, India. With over 130 journal and conference publications, he specializes in robot modeling and control, nonlinear control, fractional-order systems, contraction analysis, sliding mode control, and multi-agent systems. He has supervised 10 Ph.D. students, with 8 currently under his guidance. Since January 2022, he has also served as the Coordinator of the Centre for Faculty Development and Educational Technology at IIT (BHU) Varanasi. Dr. Kamal has received the INAE Young Engineer Award (2019) and excellence awards for his Ph.D. thesis. He has held visiting professor positions at RMIT University, Melbourne, Australia, and the Harbin Institute of Technology, China.

Zhenhua Wang received his B.Sc. degree in Detection, Guidance, and Control from the Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 2008, and his M.Sc. and Ph.D. degrees in Control Science and Engineering from the Harbin Institute of Technology, Harbin, China, in 2010 and 2014, respectively. He is currently a Professor in the Department of Control Science and Engineering at the Harbin Institute of Technology. His research interests include fault diagnosis and fault-tolerant control. He is a member of the IFAC Technical Committee 1.1 on Modeling, Identification and Signal Processing, and a member of the IEEE CSS Technical Committee on Robust and Complex Systems (TCRoCS). He serves as an Associate Editor for several international journals, including IEEE Transactions on Aerospace and Electronic Systems, IEEE Transactions on Industrial Informatics, Asian Journal of Control, and European Journal of Control.