China-Poland-UK International Workshop on Data-Driven Control

Conference Manual

会 议 手 册

May 10, 2025

Wuxi, Jiangsu, China

Function Room1（多功能厅1）

Crowne Plaza Wuxi Lake View Hotel（无锡融创皇冠假日酒店）

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FINAL PROGRAM

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Organizers：

Chair:
Tao Liu
Dalian University of Technology

Co-Chair:
Hongfeng Tao
Jiangnan University

Agenda：

Time	Title	Speaker
13:30-14:10	Energy Storage Optimization in RTG Cranes using different control strategies	*William Holderbaum*, University of Salford
14:10-14:40	PI-based data-driven set-point learning control for unknown batch processes with nonrepetitive uncertainties	*Shoulin Hao*, Dalian University of Technology
14:40-15:10	Efficient iterative learning model predictive control for uncertain nonlinear discrete-time systems	*Xuefang Li*, Sun Yat-sen University
15:10-15:20	Tea Break	
15:20-16:00	Design of iterative learning control laws in presence of actuator nonlinearities with experimental validation (online)	*Eric Rogers*, University of Southampton
16:00-16:40	Model-free ILC scheme for nonlinear batch processes designed within a repetitive process setting (online)	*Wojciech Paszke*, University of Zielona Gora
16:40-17:10	Data-enabled iterative learning control: A zero-sum game design for varying time-scale tasks	*Zhihe Zhuang*, Jiangnan University

Keynote Address 1

Energy Storage Optimization in RTG Cranes using different control strategies

William Holderbaum
University of Salford, U.K

Abstract：

In low voltage networks, Energy Storage Systems (ESSs) play a significant role in increasing energy cost savings, peak reduction, and energy efficiency whilst reinforcing the electrical network infrastructure. This talk will give an outline of an optimal management system based on different control strategies (Optimal Control and Model Predictive Control) for the control of an ESS equipped with a network of electrified Rubber Tyre Gantry (RTG) cranes. The stochastic management system aims to improve the reliability and economic performance, for given ESS parameters, of a single crane or a network of cranes by considering the uncertainty in the RTGs electrical demand. A specific case study is presented using real operational data of the RTGs network in the Port of Felixstowe, UK, and the results of the stochastic control system are compared to a standard set-point controller. The results of the proposed control strategies indicate that the stochastic management system successfully increases the electric energy cost savings, the peak demand reductions and successfully outperforms a comparable set-point controller.

Biography：

William Holderbaum is a Professor of control engineering with the University of Salford, U.K. His research has focused on control theory and systems modelling with applications. This ranges from highly theoretical contents such Lie group theory and wireless power transfer to practical aspects for example control theory applied to energy saving by using Energy Storage, rehabilitation engineering, and health-related problems. He has been very successful in numerous grant applications from different funding bodies such as EU, EPSRC, KTP, Innovate UK, and other industries. Over the past twenty years, he has over 150 publications and supervised 27 PhDs students and 23 Post-docs and Research Assistant.

Keynote Address 2

PI-based data-driven set-point learning control for unknown batch processes with nonrepetitive uncertainties

Shoulin Hao
Dalian University of Technology, China

Abstract：

In this talk, a novel adaptive data-driven set-point learning control (ADDSPLC) scheme is proposed for unknown batch processes subject to nonrepetitive initial conditions and disturbances, which has two loops, one for the dynamics within a batch and the other for the batch-to-batch dynamics. In the former case, a model-free tuning strategy is presented for determining the closed-loop PI controller gains. For the latter case, a set-point learning control law with adaptive set-point learning gain and gradient estimation is developed for batch optimization. Robust convergence of the output tracking error is rigorously analyzed together with the boundedness of adaptive learning gain and set-point command. Moreover, another iterative ESO based ADDSPLC scheme is further developed to enhance the robust tracking performance against nonrepetitive uncertainties. Two illustrative examples are used to demonstrate the effectiveness and superiority of the proposed schemes.

Biography：

Shoulin Hao is an Associate Professor with the Institute of Advanced Measurement & Control Technology, Dalian University of Technology, China. His research interests include industrial process control, iterative learning control, data-driven control, anti-disturbance control and so forth. He published more than 50 research papers and coauthored one monograph. He serves as an associate editor of Systems Science & Control Engineering.

Keynote Address 3

Efficient iterative learning model predictive control for uncertain nonlinear discrete-time systems

Xuefang Li
Sun Yat-sen University

Abstract：

In this talk, I will introduce a novel iterative learning model predictive control (ILMPC) design for nonlinear discrete-time batch systems. Different from the existing results, a novel efficient two-dimensional (2-D) ILMPC approach is firstly proposed based on the 2-D system theory, which is able to guarantee the H-inifinity tracking performance with lower computation load. Furthermore, based on the newly established event-triggered mechanisms, an event-triggered 2-D ILMPC is developed to reduce the occupation of the network resources while ensuring the H-inifinity tracking performance. For the proposed ILMPC schemes, the sufficient conditions for the H-inifinity tracking performance are established explicitly by using the linear matrix inequalities (LMI) techniques. Finally, the effectiveness of the proposed ILMPC strategies are demonstrated through numerical simulations.

Biography：

Xuefang Li is an Associate Professor of the School of Intelligent Systems Engineering of Sun Yat-sen University. She received the B.Sc. and M.Sc. degrees from the Mathematical College, Sichuan University, Chengdu, China, in 2009 and 2012, respectively, and her PhD degree from the Department of Electrical and Computer Engineering, National University of Singapore in 2016. From 2016 to 2019, she was a Research Associate with the Department of Electrical and Electronic Engineering (EEE), Imperial College London, London, U.K. She was awarded by several best conference paper awards including IEEE 9th DDCLS, IEEE 13th ICCAS, 10th ASCC. She has published over 90 research papers and coauthored 2 research monographs. Her research interests include that learning and adaptive control theory as well as their applications to robotics, new energy vehicles and intelligent vehicles.

Keynote Address 4

Design of iterative learning control laws in presence of actuator nonlinearities with experimental validation

Eric Rogers
University of Southampton, UK

Abstract：

Input saturation in iterative learning control received little research effort. This talk will develop a new design based on a branch of 2D systems theory, particularly Lyapunov-based stability theory. The resulting design is compared in simulation with an alternative, and the results of an in-depth experimental investigation of the new design's properties are reported. Meanwhile, some further work on other forms of nonlinearities, such as backlash, will also be discussed.

Biography：

Eric Rogers has been a professor of control systems theory and design at the University of Southampton, UK, since 1999. His primary research areas are in multidimensional systems theory and applications, iterative learning control with applications in engineering and healthcare, flow control, and long-range autonomy for AUVs. He is the editor-in-chief of the International Journal of Control and has an extensive record of service on funding panels in the UK and elsewhere.

Keynote Address 5

Model-free ILC scheme for nonlinear batch processes designed within a repetitive process setting

Wojciech Paszke
University of Zielona Góra

Abstract:

This presentation presents new results on data-driven iterative learning control for nonlinear batch processes. The dynamic linearization approach is used to obtain linearized local dynamical models utilizing only the collected process input and output data. As a result, no dynamic structure of the nonlinear model is required for the control design. Additionally, the design problem is formulated within the repetitive process framework, simplifying the design procedure and facilitating the integrated synthesis of feedback and learning controllers, while aiding in the adjustment of control parameters. The convergence of the proposed data-driven control method is demonstrated through the stability of the resulting repetitive process, ensuring that tracking error decreases along both the time and iteration (batch) axes. Moreover, a short comparison will be made with other approaches based on dynamic linearization but not using repetitive models. The advantages and disadvantages of the presented approaches will be indicated. Finally, a numerical example is included to highlight the application of the new results.

Biography:

Wojciech Paszke is affiliated to the Institute of Automation, Electronic and Electrical Engineering, University of Zielona Góra. He received his M.Sc. and Ph.D. degrees, both in electrical engineering, from the University of Zielona Góra in 2000 and 2005, respectively. Between 2008 and 2010, he was affiliated to the Eindhoven University of Technology, the Netherlands, where he was a control systems expert on high precision positioning of electron microscopes. His research is focused on multidimensional (nD) systems, repetitive processes, iterative learning control, and convex optimization in robust control problems.

Keynote Address 6

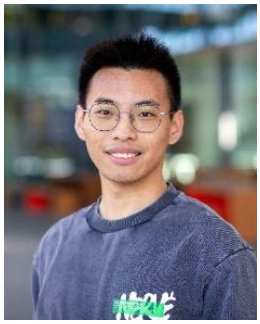
Data-enabled iterative learning control: A zero-sum game design for varying time-scale tasks

Zhihe Zhuang
Jiangnan University

Abstract:

Iterative learning control (ILC) is an efficient control methodology for tackling iteration-invariant exogenous inputs. It is of great significance to develop its extrapolation for more general repetitive tasks with mutual similarity, e.g., tasks with different time scales. In practice, discrete-time ILC with sampling behavior for varying time-scale tasks suffers from the failure of perfect corresponding learning and environment-dependent iteration-varying disturbances. In this talk, a novel direct data-based ILC algorithm is presented for tasks with varying time scales, where a reinforcement learning (RL) perspective is introduced to learn the optimal policy of the ILC controller directly from input/output (I/O) data. A zero-sum game formulation is given to handle the iteration-varying disturbances arising from varying time-scale tasks and the external environment. The trial sample efficiency of the data-based ILC design is assessed and ensured by using the well-known Willems' Fundamental Lemma. A simulation example is shown to demonstrate the effectiveness of the new data-based ILC design.

Biography:



Dr Zhihe Zhuang has been working at the School of Internet of Things Engineering in Jiangnan University, Wuxi, China. He received his B. Eng. degree in Automation and Ph.D. degree in control science and engineering from Jiangnan University. In 2023, he visited the Department of Mechanical Engineering at Eindhoven University of Technology, Eindhoven, the Netherlands. His research interests include iterative learning control, optimization, data-driven control, and reinforcement learning.