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IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING

Special Issue on Generative AI Theories, Methods and Applications for Industrial Automation

Generative AI (GAI) has emerged as a transformative enabling technology for industrial automation, attracting substantial efforts from researchers and practitioners in both academic and industrial communities. Process and discrete manufacturing, the dual backbones of modern industrial manufacturing, generate massive multi-source, heterogeneous, high-dimensional industrial data from real-world physical production processes. The core goal of applying GAI in industrial automation is to provide efficient scientific and engineering solutions for industrial data utilization, manufacturing optimization, and intelligent upgrading. In recent years, significant advancements in GAI, industrial large models, and industrial task agents have created numerous opportunities for innovation in process and discrete manufacturing. By integrating physical first principles with advanced AI techniques, GAI enables industrial data augmentation, unified process/production line modeling, autonomous task execution, and collaborative intelligent control. Meanwhile, new challenges have emerged in applying these innovations across industrial types, including improving model interpretability and robustness, realizing lightweight deployment of industrial large models, achieving efficient collaboration of industrial task agents in complex scenarios, and adapting GAI methods to heterogeneous manufacturing data characteristics. These opportunities and challenges have significantly expanded the scope of traditional automation science and engineering for manufacturing as a whole.

The central theme of this Special Issue is GAI theories, methods, and applications for industrial automation, centered on industrial large models and industrial task agents. The focus is on original algorithmic development and practical industrial deployments of GAI in both process and discrete manufacturing, with an emphasis on automation-oriented perspectives rather than pure GAI theoretical research. This Special Issue aims to bring together researchers and practitioners from academia and industry to showcase the state-of-the-art research and applications of GAI in industrial automation, address key advancements, expose unsolved challenges across diverse industrial scenarios, present needs for integration with physical mechanisms and industrial deployment, and provide visions for future research and development. We aim to publish original, significant, and visionary papers that describe GAI theories, methods, and technologies with both solid theoretical development and practical importance. All submissions must deeply integrate the industrial-oriented GAI technical stack with core industrial automation tasks. Submissions of scientific results from experts in academia and industry worldwide are strongly encouraged. Topics to be covered include, but are not limited to the following topics in process and discrete manufacturing,

- GAI-driven industrial process/production line modeling and fault diagnosis: interpretable and generalizable methods based on physics-informed generative models/diffusion models for automation systems, including GAI-based industrial model selection and recommendation strategies for fault identification and early warning
- Industrial large model development for process and discrete manufacturing (the core GAI carrier): GAI-oriented pretraining with industrial physical constraints, domain adaptation based on GAI few-shot learning, lightweight design for edge deployment, and privacy-preserving generative training/deployment technologies
- GAI-driven heterogeneous manufacturing data processing and augmentation: multimodal industrial large model-based data fusion, synthetic data generation via VAEs/diffusion models, and zero/one-shot/transfer learning optimized by GAI knowledge reasoning
- GAI-driven plant-wide operation, dynamic production scheduling and intelligent decision-making: design of GAI industrial task agents, cooperative control and human-computer interaction for adaptive scheduling (via GAI-generated scenario data augmentation and real-time scheduling strategy generation)
- GAI-enabled process and discrete manufacturing multi-objective optimization: physics-informed generative model and industrial large model-based optimal parameter generation, high-dimensional solution space fast search via GAI generative reasoning
- GAI-driven continuous and discrete manufacturing systems upgrading: digital twin modeling via high-fidelity GAI synthetic data, virtual manufacturing simulation based on GAI dynamic scene generation
- GAI-augmented process monitoring, production line inspection and equipment health management: advanced signal processing via GAI denoising, machine perception based on GAI visual generation, and GAI industrial task agent-based predictive health management (PHM)

Important Dates

• Paper submission deadline: October 1, 2026
• Completion of the first round review: January 1, 2027
• Completion of the second round review: March 1, 2027

• Final submission due: May 1, 2027
• Tentative publication date: August 1, 2027

Guest Editors

- Prof. Chunhui Zhao, Zhejiang University, Hangzhou, China | chhzhao@zju.edu.cn
- Prof. Jinliang Ding, Northeastern University, Shenyang, China | jlding@mail.neu.edu.cn
- Prof. Biao Huang, University of Alberta, Edmonton, Canada | bhuang@ualberta.ca
- Prof. Denis Dochain, Université catholique de Louvain, Belgium | denis.dochain@uclouvain.be
- Prof. Yaochu Jin, Westlake University, Hangzhou, China | jinyaochu@westlake.edu.cn
- Prof. Furong Gao, Hong Kong University of Science and Technology, Hong Kong, China | kefgao@ust.hk

Paper Submission

All papers are to be submitted through the IEEE's Manuscript Central for Transactions on Automation Science and Engineering http://mc.manuscriptcentral.com/t-ase. Please select the Manuscript Category "Special Issue" under "Type" in Step 1 and this specific Special Issue in Step 6 of your article's submission process. **All manuscripts must be prepared according to the IEEE Transactions on Automation Science and Engineering publication guidelines** (http://www.ieee-ras.org/publications/t-ase)**.** Please address inquiries to the lead guest editor: chhzhao@zju.edu.cn.