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EDITORIAL

Special issue on emerging topics of Advanced Robotics and Mechatronics

Zhijun Li[1], Chenglong Fu[2], Ye Zhao[3] and Hang Su[4]

[1]University of Science and Technology of China, Hefei, China
[2]Southern University of Science and Technology of China, Shenzhen, China
[3]Georgia Institute of Technology, Atlanta, GA, USA
[4]University of Paris-Saclay, University of Evry Val Essonne, Evry, France
Corresponding author: Hang Su; Email: hang.su@ieee.org

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1. Introduction to special issue

The realm of Advanced Robotics and Mechatronics (ARM) is experiencing an unprecedented surge in research interest and industrial application, marking it as one of the most dynamic and promising areas in technology today. Despite the remarkable strides made in this field, ARM still confronts a myriad of challenges that shape its trajectory and impact. These challenges are diverse and complex, ranging from the integration of bio-inspired designs to the advancement of neuro-robotics, and from the development of human-augmentation technologies to the intricacies of human-robot interaction. Each of these areas not only requires technical sophistication but also a nuanced understanding of their interplay with human capabilities and societal needs. This issue brings together 25 cutting-edge papers, meticulously selected and peer-reviewed, that represent a broad spectrum of ARM research. The topics range from novel robot designs and bio-mechatronics to human-robot interaction and dynamics control, reflecting the diversity and depth of the field.

The special issue commences with a series of innovative approaches in robotic control systems. Wei et al. [1] present an innovative control method for the Pendubot system, addressing both matched and mismatched uncertainties. Zeng and colleagues [2] tackle the challenge of contact inspection in unknown environments using unmanned aerial manipulators. Their control law demonstrates an advanced approach to aerial manipulation. Emphasizing actuator fault management, Niu and his team [3] blend neural networks and broad learning theory to enhance the flexibility and resilience of two-link manipulators. In the realm of motor control, Zhen et al. [4] leverage Lyapunov-based strategies to refine the precision of permanent magnet synchronous motors in collaborative robots, marking a significant step in robotic control fidelity. A new method for gait template planning and dynamic motion control in biped robots is presented by Han et al. [5]. The approach combines heuristic planning with dynamic control, offering improvements in the locomotion and stability of bipedal robotic systems.

This issue also highlights groundbreaking research in medical robotics and diagnostics. Li et al. [6] developed an analytical model for the magnetic localization of wireless capsule endoscopes. This innovation is crucial for precise navigation and treatment in gastrointestinal diagnostics. Chen et al. [7] present a single-parameter adaptive fuzzy control for a pneumatic lower limb exoskeleton. Their approach, which ensures safety and precision in gait training tasks, demonstrates significant advancements in wearable robotic devices and rehabilitation technology. A novel method for estimating contact forces in continuum robots using local curvatures is presented by Xiao et al. [8]. This approach is a significant step

in enhancing the control and interaction capabilities of continuum robots. Furthering medical interventions, a flexible robot is developed by Zhang et al. [9] for transbronchial lung biopsy. This innovation enhances the capability of endoscopic surgery, providing a novel solution for early lung cancer diagnosis. Zhou et al. [10] provide a comprehensive theoretical analysis for spotlight-based instrument localization in retinal surgery, potentially revolutionizing surgical navigation techniques. Kang et al. [11] contribute to structural health monitoring with their novel inspection system, integrating ultra-wideband radar and depth camera for precise hollowness detection, showcasing the potential of ARM in manufacturing quality control. In the medical field, Li et al. [12] enhance sleep apnea detection by ingeniously integrating medical rules into a deep learning framework, a step forward in improving the accuracy and reliability of automated medical diagnostics.

In the context of robotics applied to energy and environmental sectors, this issue highlights the contribution of Liang et al. [13]. They propose an advanced machine learning model to improve boiler combustion efficiency, demonstrating the role of robotics in promoting sustainable energy practices. Cai et al. [14] introduce an enhanced dilated convolution framework for recognizing underwater blurred targets, pushing the boundaries of autonomous underwater vehicle technology. Chen et al. [15] explore the fusion of reinforcement learning and fuzzy systems for continuous control in robotic odor plume tracking, a novel approach to environmental monitoring.

The special issue also explores human-robot interaction and autonomous systems. Huang et al. [16] advance the field of semantic segmentation with a novel few-shot method, optimizing data-scarce scenarios. An adversarial learning framework for augmenting emotional gait datasets is proposed by Sheng et al. [17]. Their work, a first in achieving the mutual transformation between natural and emotional gait, opens new possibilities for human-robot interaction and emotion recognition. Zhong et al. [18] innovate in robotic teleoperation with their development of a flexible, wearable e-skin sensing system, enhancing human-robot interaction intuitively. Addressing long-term object search, Zhou et al. [19] present an efficient framework using incremental scene graph updating, significantly improving the efficacy of object search in dynamic environments.

Furthermore, the issue spotlights cutting-edge techniques in robotic learning and automation. Li and his colleagues [20] demonstrate the potential of reinforcement learning in automating instrument delivery for vascular surgeries, aiming to improve surgical outcomes. Su et al. [21] propose an advanced control scheme for robots with moving Remote Center of Motion (RCM) constraints, a milestone in precision robotic control. Chen et al. [22] present a pioneering reinforcement learning framework for robotic manipulation, exemplifying the seamless transition from simulation to real-world application.

For cable-driven musculoskeletal systems, a feedforward compensation approach is proposed by Fan et al. [23]. Their research contributes to the development of more flexible, safe, and efficient biomimetic robots. Addressing key challenges in autonomous navigation, Peng et al. [24] present a dual heuristic programing approach based on potential fields for path-following and obstacle avoidance in wheeled mobile robots. The final paper by Meng and his colleagues [25] discusses new methods for contact-based landing and vision-based localization in rotorcraft aerial vehicles, which have significant implications for the deployment of drones and unmanned aerial vehicles in various applications.

The success of this special issue is attributed to the collective efforts of many individuals. We extend our heartfelt gratitude to all authors for their invaluable contributions and the reviewers for their meticulous evaluations and insightful feedback. Their dedication and expertise have been crucial in maintaining the high standards of Robotica. We also express our appreciation to the editorial staff of Robotica and particularly to Prof. Jian S Dai and Prof. Giuseppe Carbone, the editor-in-chief, for their support throughout the publication process.

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