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Editorial

Launching Advanced Mechatronics—Intelligent Machines across Scales

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It is with great pleasure and a profound sense of responsibility that we present the inaugural issue of Advanced Mechatronics. The launch of this journal is motivated by a simple yet far-reaching observation: mechatronics is no longer confined to the classic integration of mechanics, electronics, and computer control. Driven by rapid advances in artificial intelligence, sensing, materials, and actuation, mechatronic systems are becoming intelligent, autonomous, and collaborative, and they now operate at scales ranging from sub-micrometre devices inside the human body to large robotic platforms acting in the physical world. Advanced Mechatronics is founded to capture this transformation. Centred on the core attribute of "advanced", the journal focuses on smart robotic technology, intelligent robotic arm systems, and micro-/nano-manipulation and control, integrating interdisciplinary frontiers across mechanical engineering, control engineering, electronics, artificial intelligence, materials science, and biomedical engineering, etc. Our goal is to provide a high-end platform for researchers, engineers, and scholars to present groundbreaking research, disruptive technologies, and cross-domain achievements, and to accelerate the transition from frontier research to industrial implementation.

This inaugural issue brings together six contributions that, collectively, map the contemporary landscape of advanced mechatronics. Read together, they span the full chain of a mechatronic system—from microscale robots designed to operate in complex biological environments, through intelligent manipulators, wheeled mobile robots, and unmanned aerial vehicles acting in the physical world, to the electric drives and circuit systems that form the actuation and sensing backbone beneath them. Across this diversity, two threads are consistently visible. The first is intelligence, embodied in learning-based and adaptive planning and control. The second is trustworthiness, embodied in safety guarantees, disturbance rejection, and fault diagnosis.

Reinforcement-Learning-Based Optimal Control: An ADP Survey for Robotics. The issue opens with the survey by Chan et al. (University College London, the University of Manchester, and the Midea Global Innovation Center), "Reinforcement Learning Based Optimal Control: A Survey of Adaptive Dynamic Programming for Manipulators and Wheeled Mobile Robots". Where previous surveys organized the adaptive dynamic programming (ADP) literature by algorithm type or control problem, this review adopts a robotics-oriented, platform-centric perspective, examining how the physical characteristics of robotic manipulators and wheeled mobile robots shape controller architecture, modelling assumptions, and stability analysis. Comparing actor–critic, single-critic, decentralized, and event-triggered formulations, the authors identify recurring patterns—most notably the predominance of uniform ultimate boundedness (UUB) as the primary stability guarantee and the limited scale of hardware validation—and articulate an agenda of open challenges that includes certified safety, high-dimensional scalability, sample efficiency, sim-to-real transfer, and perception-driven ADP. The survey offers a valuable map for researchers seeking to reconcile optimal control theory with practical learning-based robotics.

Disturbance Suppression in Dual Three-Phase PMSM Drives. In "Disturbance Suppression of Dual Three-Phase PMSM Drives Based on Model Predictive Repetitive Control", Gao, Liu, and Wang (Sany Heavy Machinery Company Ltd. and Zhejiang University of Technology) address a long-standing problem in multiphase motor drives: the coexistence of periodic harmonic disturbances and non-

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periodic disturbances that degrade current quality and mechanical performance. Building on the internal model principle, they propose a model predictive repetitive control (MPRC) strategy that suppresses specific-order periodic harmonics in the harmonic subspace defined by vector space decomposition, thereby preserving the dynamic control performance of the fundamental subspace. To counter non-periodic disturbances arising from parameter variations, an improved equivalent input disturbance (IEID) observer with a dedicated phase compensation (PC-IEID) is designed. Comparative experiments on a dual three-phase PMSM platform demonstrate that the proposed scheme reduces the total harmonic distortion of the harmonic-space currents to 5.33% and 3.98% under light and heavy loads, respectively, outperforming the MPC-IEID baseline. The method is generalizable to other multiphase drives with decoupled harmonic subspaces and provides practical parameter selection guidance for engineering deployment.

Hierarchical Safe Reinforcement Learning for UAVs. Gao and Sun (Huazhong University of Science and Technology) consider safety-critical control of unmanned aerial vehicles (UAVs) in dynamic environments in "Hierarchical Safe Reinforcement Learning Control for UAVs via Adaptive Control Barrier Function and Interacting Multiple Model". Their hierarchical framework reconciles two objectives that are often in conflict: optimal mission performance and strict safety guarantees. A proximal policy optimization (PPO) agent generates reference control inputs that adapt to uncertain environments, while a three-dimensional interacting multiple model (IMM) filter predicts the finite-horizon trajectories of dynamic obstacles; an adaptive control barrier function (ACBF) with an adaptive coefficient then minimally modifies the reference inputs to rigorously enforce safety. Simulation studies on a physics-based quadrotor platform show that the proposed RL + ACBF framework achieves higher task success rates and lower tracking errors than both a PID-based safety-filtered baseline and a purely learning-based controller. The work is a compelling demonstration of how formal safety filters and learning-based control can complement each other.

Two-Photon Polymerization-Enabled Microrobots. Chen et al. (City University of Hong Kong, Harbin Institute of Technology (Shenzhen), and the University of Science and Technology of China) contribute a comprehensive review, "Two-Photon Polymerization-Enabled Microrobots: Fabrication, Actuation, and Biomedical Applications". Microrobots hold great promise for biomedical tasks in complex and confined *in vivo* environments, yet clinical translation has been limited by manufacturing bottlenecks, in particular the submicrometre integration of heterogeneous functional materials. The review connects two-photon polymerization (TPP) fabrication—including free-form three-dimensional printing, multimaterial integration, and stimulus-responsive "4D" microprinting—with actuation strategies spanning magnetic, optical, acoustic, and hybrid fields, and with emerging applications in targeted therapeutic delivery, single-cell micromanipulation, tissue engineering, deep-tissue imaging, and *in vivo* fabrication. Crucially, the authors also identify the central barriers that remain: manufacturing throughput and process stability, biocompatibility and molecular programmability of material systems, and reliable autonomous operation in complex physiological environments. The review provides a systematic roadmap for the micro-/nano-manipulation community, a cornerstone topic of this journal.

Mixed-Reality-Assisted Multimodal Teleoperation. Zhang et al. (Guizhou University and The City College of New York) present "Mixed Reality-Assisted Multimodal Teleoperation System for Mobile Robotic Arms", addressing a central theme of human–robot collaboration. Teleoperation in hazardous or inaccessible environments is often limited by reduced perception, constrained operational ability, and low operator immersion. The proposed system integrates stereoscopic vision through a head-mounted display with an augmented-reality interface that provides real-time feedback and safety alerts, and supports both collaborative and supervisory control modes. Experiments with novice operators show that the system achieved a 92.42% success rate in object retrieval and placement tasks, while success rates in narrow-corridor tasks increased from 84.08% with conventional displays to 89.41% under mixed-reality-based collaborative control. The results demonstrate a practical and usable path toward safer and more accessible remote operation of mobile robotic arms.

Adaptive Fault Estimation for Switched Circuit Systems. Kang, Tan, and Chen (Harbin Engineering University) investigate "Adaptive Observer-Based Fault Estimation for Switched Circuit Systems with Actuator and Sensor Faults". Switched circuit systems are fundamental to power electronics and energy systems, yet their reliability analysis under faults remains challenging. The authors establish a switched circuit model describing mode-dependent dynamics, then develop a multimode adaptive observer based on an augmented descriptor system to estimate system states and unknown actuator and sensor faults simultaneously. Using mode-dependent Lyapunov functions together with the average dwell-time (ADT) switching technique, sufficient conditions are derived to guarantee uniform ultimate boundedness of the estimation errors. Both numerical simulations and experiments on a physical switched circuit platform validate the observer, which tracks states and faults under switching operations and external disturbances and, notably, reconstructs unmeasurable current states from voltage measurements alone. The work underscores the importance of model-based intelligence in ensuring the dependability of mechatronic hardware.

Taken together, the six contributions of this inaugural issue reveal several defining characteristics of advanced mechatronics as a field. First, intelligence is becoming a first-class design objective: learning-based methods such as adaptive dynamic programming, proximal policy optimization, and adaptive observers are moving from

theoretical constructs to practical controller components. Second, safety, robustness, and reliability are no longer afterthoughts but are engineered into the system architecture itself—through control barrier functions, disturbance observers, and fault-estimation schemes. Third, a culture of validation runs through the issue: whether on motor drive platforms, physics-based flight simulators, circuit prototypes, or teleoperation experiments with human operators, each contribution subjects its claims to experimental scrutiny, narrowing the gap between theory and practice that has long challenged our discipline. Finally, the field is inherently multi-scale and interdisciplinary: the same principles of sensing, actuation, and control recur from micrometre-scale robots to industrial machinery, and progress at each scale enriches the others.

As we embark on this journey, the editorial board is committed to upholding rigorous peer review, rapid publication, and broad open access, ensuring that high-quality research reaches the global community without delay. We warmly invite submissions on the frontiers of advanced mechatronics—including, but not limited to, learning-based and safety-critical control, intelligent robotic systems, micro-/nano-manipulation and manufacturing, human–robot collaboration, and the seamless integration of perception, planning, decision-making, and actuation. We also encourage reviews and perspectives that identify open challenges and chart future directions.

We express our sincere gratitude to all the authors who entrusted their work to this inaugural issue, to the reviewers whose rigorous and constructive evaluation underpins the quality of the journal, and to the editorial and production teams of Scilight Press for their dedication. We hope this first issue will serve both as a source of inspiration and as a marker of the ambition of our field.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.