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Editorial for the special issue on Advanced Technology in Autonomous Robots and Swarm Intelligence

The field of autonomous robotics has emerged as a cornerstone of modern technological advancements, influencing a multitude of applications across various sectors. Central to the achievement of true autonomy are the crucial components of perception and planning. Beyond the capabilities of standalone robots, swarm intelligence has been validated as a powerful paradigm for effective collaboration among multiple agents. This special issue seeks to encapsulate the current state of research in autonomous robots, focusing on key themes of perception, planning, and collaborative strategies. It is vital to delve into the latest advancements, recognize prevailing challenges, and outline future directions in this exciting and rapidly evolving field. This special issue, titled "Advanced Technology in Autonomous Robots and Swarm Intelligence", features eleven research articles that provide valuable insights into the present and future of autonomous robotic systems.

Included are three comprehensive survey papers. The first, authored by Chen et al. [1], reviews autonomous robotics and multi-robot collaboration, with particular emphasis on automation systems and multi-robot navigation. The study identifies three key benefits – perception, planning, and collaboration – and systematically explores a wide array of autonomous robot strategies, supported by an extensive reference list exceeding 170 entries. It also highlights the challenges in existing research and suggests potential pathways for future investigation.

Zhang et al. [2] contribute a thorough review focusing on the bioinspired design of jumping robots. Over recent years, researchers have looked to nature for inspiration, exploring jumping as a mode of locomotion for aquatic robots to enhance their adaptability in transitioning environments. This paper outlines the primary features of bioinspired aquatic jumping robots and evaluates their design, mechanisms, and performance while also discussing current challenges and future prospects in this area.

Additionally, a survey by Zhang et al. [3] addresses the critical topic of motion planning. This work emphasizes the challenges in the field and assesses the development of sampling-based methods, providing a detailed analysis of ten prominent planners utilized across various scenarios. The findings illustrate significant advancements in sampling-based techniques while also acknowledging ongoing obstacles that researchers face.

In addition to these surveys, this special issue comprises eight research articles that further explore various aspects of autonomous robotics. Notably, Ye et al. [4] introduce a hybrid artificial bee colony algorithm augmented by genetic exploration (HABC-GA) to facilitate safe and smooth path planning for mobile robots. Their study establishes a mathematical model that seeks to balance three objectives: path length, safety, and smoothness. Comparative simulations demonstrate the superior performance of HABC-GA against five alternative algorithms across multiple environments.

Complementing the discussion on path planning, localization also plays a pivotal role. Chen et al. [5] propose an innovative approach utilizing multiple tags for ultra-wideband (UWB) positioning to enhance accuracy in both position and rotation estimations. The proposed method is evaluated through simulations and real-world experiments, reinforcing its effectiveness in improving overall positioning performance. Furthermore, advancements in geolocalization are showcased through the work of Xavier et al. [6], which integrates cross-view geolocalization with a land cover semantic segmentation map. This methodology exhibits performance comparable to leading techniques, providing enhanced stability and filtering capabilities.

Detection and measurement using autonomous robot systems play essential roles in various applications. One prominent contribution discusses a railway crack robot system designed to enhance the detection of cracks in railway tracks [7]. The authors present an innovative approach to optimize mode selection for crack detection based on the sensitivity of guided wave modes. Through a thorough examination of frequency dispersion characteristics and mode shapes, they establish reliable indicators for assessing crack zone energy and reflection intensity. In the realm of complex part measurement, a novel point cloud registration network integrated with robotic scanning systems is proposed [8]. This research introduces the DBR-Net (Dual-line Registration Network) to address challenges associated with low overlap rates and perspective occlusion in the registration of intricate workpieces. The results showcase a significant improvement in feature extraction and registration accuracy compared to existing methods, highlighting the potential for enhanced performance in point cloud registration.

The importance of social companion scenarios is also addressed in this issue. A companion control strategy based on the Linear Quadratic Regulator (LQR) is introduced by Su et al. [9], offering enhanced coordination and precision for robotic companions. This method enables adaptive responses to sudden movements of companion targets and facilitates smooth obstacle avoidance. Experimental findings illustrate the robustness of this approach, which outperforms traditional control algorithms in

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both distance control and directional accuracy, ensuring cohesive interaction with individuals in social settings.

Additionally, advances in autonomous manipulation through a force-tracking robot have been explored. A fuzzy adaptive variable impedance contact force control strategy is proposed by Chen et al. [10], achieving remarkable accuracy and reliability in managing contact forces with humans. The results confirm that the designed deformable shield fits well to the human body, further emphasizing the significance of precise control in human–robot interactions.

Not limited to terrestrial applications, advancements in underwater robotics are also highlighted in [11]. A Multi-Color Space Residual Network (MCRNet) is introduced to enhance underwater images and leverage unique color representation features across different color spaces. The extensive testing conducted demonstrates significant improvements in color correction and contrast, particularly in challenging visual conditions.

Each article within this issue has undergone a stringent two-round peer review process, reflecting our commitment to maintaining the highest publication standards. The collective research showcased not only emphasizes the critical role of autonomous robots and swarm intelligence in overcoming contemporary challenges but also opens new avenues for future exploration.

We extend our heartfelt gratitude to all authors and reviewers for their invaluable contributions. Special thanks are due to the journal editors for their unwavering support throughout the organization and publication of this special issue. We trust that this compilation of works will serve as a vital resource for researchers dedicated to advancing the frontiers of autonomous robots and swarm intelligence for societal benefit.

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