

# Biomimetic Perception, Cognition, and Control: From Nature to Robots

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A wide range of technological developments are inspired by biological individuals and advanced synthetic materials, cognitive sensors, control algorithms, artificial intelligence technology, and intelligent systems. One of the major challenges is to create a comprehensive study by integrating different techniques into robotic systems so that the performance of robots can be improved and applied to more complex and diverse scenarios. The articles in this issue focus on the state of the art in biomimetic perception,

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cognition, and control research and aim to explore related technical avenues in the multimodal bioinformation perception framework, intelligent cognition and learning, robotic systems and control, and new biomimetic sensors.

In the research of multimodal bioinformation perception framework, Zou et al. propose the clinical readiness of a multimodal fusion model to estimate hand force based on

surface electromyography signals and A-mode ultrasound signals of forearm muscles. Yu et al. introduce a hybrid visual-haptic framework enabling a robot to achieve motion synchronization in human-robot co-transporting. Graf et al. build a framework for transferring ideas from human scene perception to robot scene perception to contribute toward robots' holistic scene understanding, based on a wide survey and comparison of robotic scene perception approaches with neuroscience theories and studies of human perception.

In the area of intelligent cognition and learning, Zheng et al. propose a biomimetic electric sense-based localization scheme, including an electric sense-based localization scheme and three model-based perception methods for large-scale underwater localization. Lu and Wang introduce a novel biomimetic force and impedance adaption framework based on Broad Learning System for robot control in stable and unstable environments. The connections of created neural network layers and the settings of the feature nodes are explainable by human motor control and learning principles.

On the topic of robot system and control, Stella et al. develop a feather star-like robot that can actuate layers of flexible feathers and detach them at will. Based on this optimized feather and theoretical framework, the new robotic setup can change its motion path by

using the detachment of feathers while maintaining the same low-level controller. Bing et al. apply reinforcement learning (RL) on snake-like robot control that can fully exploit the hyper-redundant bodies of the robot. Simulations and experiments show that RL can generate substantially more energy-efficient gaits than those generated by conventional model-based controllers. Jiang et al. propose a humanoid control method based on visual servoing by utilizing a swivel angle derived from the human arm to realize the human-like behavior of anthropomorphic robot manipulators. The proposed method is substantiated based on a 7-degree-of-freedom Sawyer robot and a constructed visual servo physical platform.

In the field of biomimetic sensors, Zhang et al. design a rat-inspired whisker sensor for a biomimetic robotic rat and demonstrate its superior tactile perception performance. Experimental results demonstrate its outstanding texture discrimination ability and excellent performance on contour reconstruction. Xia et al. develop a soft magnetic tactile sensor and a multipole magnetization method for extracting contact surface features. We sincerely thank all the authors for their contributions and the editors for their efforts and hope that the contents of this issue can bring information and inspiration to researchers in related fields.

