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Editorial for the special issue on bio-inspired robotic dexterity intelligence

Living beings are extremely adept at executing complex and dexterous manipulation skills by integrating tactile, visual, and other stimuli. Robotics researchers aims to endow the robots with similar manipulation intelligence. From robotics and machine learning domains, although recent years we have seen lots of promising results on visual imitation/exploration learning for robot manipulation. e.g., the robot can learn the adaptive behavior from the trajectories of human demonstrations. However, these approaches face challenges in generalizing to diverse tasks, especially for the tasks involving contact. To this end, bunch of approaches have been developed exploiting the contact and adaptive force control in a compensation way. While these ad-hoc solutions are practical for implementing specific functionalities, they fall short of providing a comprehensive scientific understanding of manipulation, we have to figure out a unified framework to unveil the mystery of the manipulation. Living beings can systemically combine these two works together and finish the given task in a smooth, safe and intelligent way. This makes us believe that they have a special capability/mechanism to learn, generalize and control the complex manipulation exploiting their multi-modality feedback which we call dexterity intelligence. Understanding and evaluating the dexterity intelligence are not trivial, it needs input from different research domains. In this special issue, we accept 8 papers and hope that they can partially unveiling the mystery of "dexterity intelligence".

The accepted papers could be divided into three categories which covered the topics: hardware designing, bionics, human robot interaction and robotic manipulation. The dexterous mechanical designing is the basis for motion and manipulation, so we include two papers in this special issue. In [1], Wang et al. proposed a novel design of a compliant and flexible tensegrity robotic joint, which was endowed with advanced torsional performance and provides three actuated degrees of rotational freedom at a single joint, e.g. for wrist. This approach offered a direct and targeted solution, achieved more agile movement while retaining the compliance and flexibility of tensegrity structures compared to conventional rigid ones. Hofmair et al. [2] developed a soft robotic actuation of the diaphragm. These actuators could augment diaphragmatic contractions, aiding in ventilation and respiratory rehabilitation by aiding the creation of negative thoracic pressure. Authors in [3,4] mainly showed that how the robot's motion capability could be improved inspired by the reptiles behaviors. In [3], Zhou et al. proposed a rigid–flexible coupling structure and multiple motion gaits method to control the locomotion of robotic snake. The research highlights were (1) a dynamics model of actuator from air pressure to the joint torque, (2) a multiple motion gait planning method based on the wave motion in different planes. The results showed that the snake could navigate through intricate ground surface. Wang [4] studied another reptile — robotic crocodile, and put focus on the coordination between the robot's trunk and legs. Via simulation and experiment, they investigated the robot's motion stability, fault tolerance, and adaptability to environments with and without spine and tail movements. Except the bionic robots, the perception and dexterity of human-like robots also could be improved. In [5], Hu et al. proposed an approach to reconstruct the shape of unknown object. This is very important because knowing the geometry information is the pre-condition that any objects can be manipulated. Exploiting the dense tactile point cloud collected by an in-house developed sensor, an active shape reconstruction pipeline was presented. The re-construction results were quite promising. Ma et al. [6] studied relocating fingers to perform continuous in-hand manipulation. A gait-based manipulation method was proposed and it offered realtime regulation by dynamically changing the continuous finger–object interaction to ensure the force/moment balance of the object. The last topic in this special issue is Human Robot Interaction. There are two papers which are related to HRI. The first one is hand-over review [7]. From several dimensions: robot's roles, the end-effector and the robot abilities, authors summarized the state of the art and the challenges of human robot handover. The other one [8] is human robot collaboration for a joint task. The example task in the work was to jointly move the heavy object, which is very common the real-world. The highlight of the work was to combine the human-intention detection and robotic motion primitive generalization. The experiment showed that the method works for jointly handling curtain wall.

We hope that this special issue can show the SoTA approaches to our readers and foster the fruitful discussion. As guest editors' team, we would like to thank the support of the EiC of BIROB — Professor Max Q.-H. Meng, Executive EiC of BIROB Prof. Rui Song, and express our appreciation to the coordination of Prof. Qin Zhang in preparing this SI. We would like to thank all reviewers' time and provide their insight comments for the contributions and of course thank to all contributors for their considering to use this special issue to publish their works.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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