# Guest editorial

This special issue titled by *Robotic Control for Industrial and Service Applications* is focused on advanced and intelligent robot control techniques which features at potentials in industrial and daily routine applications. This issue is with co-guest editors: Hesheng Wang (Shanghai Jiao Tong University), Hanlei Wang (Beijing Institute of Control Engineering), Long Cheng (Institute of Automation, Chinese Academy of Sciences) and Xuebo Zhang (Nankai University).

Robotics has blossomed in this decade, based on the advances in diverse robotic control technologies. Robots demonstrate superiority in efficiently completing repetitive and labor-costing tasks in structured industrial environments, such as assembling, welding, sorting, transportation and so forth. Despite the obvious manufacturing growth robots have brought to industry, continuous sustainment of this growth calls for evolution in robotic control technology to widen its applications. More concentrations are supposed to be exerted on flexible automation and precision machining tasks, which require a robot with high-level environmental adaptability, flexibility, interactive ability and performance accuracy. Scientists also dedicate to extend the robotic application into daily routine life, namely, as service robot applications. However, the complicated and dynamic environments arouse new challenges that may hamper the wider applications of this type of robots. A possible approach would be exploiting a robust sensorimotor control scheme combined with economic and precise sensing system. To enhance the applicability in high demanding machining tasks as well as in multi-scenario service applications, a robot is thought to be able to perform, if not better than, as well as its human being counterparts. That means, it should be capable of a wide variety of operational environments with unexpected disturbance and quickly rearrange operation strategies according to specific tasks, and meantime, maintaining its high accuracy of the operation. In short, to successfully apply robotic control into physical (industrial and service) applications, we need unify certain domain expertise such as knowledge of mechanism design, systematic modeling, advanced and intelligent control, sensing techniques and so forth. To this end, papers in this special issue are carefully reviewed and selected to demonstrate the current progress in, but not limited to, aforementioned areas.

Although many papers were submitted, we are sorry that only a small subset of them (16 papers) are accepted and published in this special issue. To promote robotic applications in industrial and service tasks involves cross-discipline cooperation. Therefore, we attempt to include a cross-section of papers addressing various research fields.

To enhance the performance of industrial robots in collaborative and interactive tasks, several papers present intelligent control algorithm giving considerations to practical constraints and application demands. Focusing on the performance of redundant robot manipulators in environments with the existence of humans, Xu *et al.* propose an adaptive neural network control to solve the modeling uncertainties and realize a combined tracking and impedance control. To improve the performance of series element actuator (SEA) for the sake of high flexibility and safe interaction demands in complex collaborative tasks, Ni *et al.* design a permanent magnet synchronous motor with high linearity to improve the model accuracy of the SEA joint and propose strategy-based back-stepping control method. Aiming at improve the operation performance of dual-arm robots in applications such as object transporting, Zhang *et al.* develop an effective way to solve symmetric coordination problem based on hybrid pose/force coordination method, which enables reduction in two arms' trajectory tracking error and guarantees safe operation on objects. Zeng *et al.* extensively investigate teaching by demonstration system and propose an extended dynamical motor primitives framework to enable industrial robot to learn stiffness regulation strategies from humans. Aiming at improve the performance of robotic arm with unmodeled dynamic nonlinearities, Yang *et al.* describe the nonlinear systematic dynamics of a robotic arm by a Takagi–Sugeno fuzzy model, based on which they propose the model predictive control to optimize system performance with respect to a user-defined cost function. Wu *et al.* improve the convergence speed of crane systems in the positioning tasks and eliminate payload residual swing by designing a dynamics-based time-optimal trajectory planner for overhead crane systems. Flexible manipulators are thought a good candidate in applications of space exploration, architecture and nuclear industry monitoring, whereas they always suffer from inaccurate system modeling and state measurements. To this end, Long *et al.* propose a tip state estimation method based on fuzzy logic adaptive Kalman filter to calculate the tip elastic deformation and sliding discrete Fourier transform to represent the vibration model and avoid the complicated computational process of differential equation. Multi-robot systems attract increasing attentions because of the ability beyond single robot especial in applications such as assemble industry, delivery service, parcel sorting service and container service. In aspect of multiple mobile robot systems, many researchers, starting from the nonhomogeneous constraints, study in depth the system dynamics to address limitations in existed methods and enable practical utilizations. To cope with system uncertainties and external disturbances, Chen *et al.* propose a finite-tine visual servoing control algorithm with a discontinuous three-step switching control strategy. To address the leader-following formation control problem, Yi *et al.* propose a distributed formation tracking control law based on the estimated state of the leader. In their study, a bio-inspired neural dynamic is introduced to solve the impractical velocity jumps problem. Wang *et al.* design a sliding mode control scheme with discontinuous and continuous sliding mode protocols based on the disturbance observer, and successively achieve finite-time consensus despite environmental noises. Chen *et al.* present a self-organized reciprocal control method to solve simultaneously coverage and tracking problem in multi-robot system. The method is valid in coupled tasks including area coverage, target tracking and collision avoidance. To improve consensus controllability of multi-agent system, Ma *et al.* introduce a non-fragile consensus protocol for networked

Assembly Automation
38/5 (2018) 537–538
 [ISSN 0144-5154]
[DOI 10.1108/AA-11-2018-200]

Assembly Automation
Volume 38 · Number 5 · 2018 · 537–538

robotic manipulators, using topology-dependent memory, where information exchanges are through sampled data and past communications are allowed. In aspect of unmanned autonomous vehicle systems, researchers specifically contribute to enhancing the motion performance of underwater shuttle and aerial vehicle systems. Li *et al.* concentrate their study on underwater vehicle message scheduling modeling in sensor network based on transmission-time optimization method. They propose an adaptive genetic scheduling algorithm in framework of the sliding model control scheme and validate in heading control tasks with time-delay effect and dynamic uncertainties. Andaluz *et al.* design a unified kinematics-based motion control scheme for quadcopters which simultaneously solves the point stabilization and trajectory tracking problems. Multiple experiments have been conducted to prove controllability in different control objectives. Service robots attract high attentions because of increasing application demands in daily life such as education, entertainment, medical use and so forth. Rehabilitation robots are highlighted because of the huge marketing gap and demand. Ni *et al.* design a seven-DOF cable-driven exoskeleton robot that is suitable for patients of different body measurements. They then propose both active and passive rehabilitation training modes and experimentally validate the controllability. Soft robotics is among the hottest researching topics these decades because of its inherent capacity in working in highly constrained and interactive environments. To improve the applicability of a bio-inspired soft robot arm in underwater exploration, Xu *et al.* develop a dynamics-based adaptive visual servoing controller in uncalibrated environment.

We are appreciatory for impressive progress of robot control technology in industrial and service applications presented in aforementioned papers. Nevertheless, we are also fully aware of limitations in current robotic research. For example, traditional program-by-teaching method, which is commonly used in industrial robot control tasks, requires considerable time and labor to complete the training process and performs poorly if any changes happen in working environments. Accurate environmental perception ability is vital for both industrial and service robot, whereas high economic cost of current sensing device increases the upfront cost of a robotic system. Other upfront requisites for physical applications such as environmental ability, interactive ability, precise operation, robust control with modeling uncertainties and environmental disturbance, though has achieved improvements in this decade, still have limitations that hindering the evolution of robotics into more intelligent level. This special issue aims to make a very first step in further exploration in robotic control related fields and provide a communicating platform for advanced technology. We hope this issue could, if not much, contribute our part to further expansion of the industrial and service robot application.

And last but not least, we would express our heartfelt appreciation to all authors who present their papers at this special issue, and to all editors for their contributions in proceedings of publication.

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