Guest editorial

Bio-inspired manipulation and robotics

Nowadays, robots have become an important part for assembly automation. However, most robots in industrial application are programmed with the teach pedant or by demonstration, which limits their applications in unstructured environment. Recently, the interdisciplinary research on robotics, biology and cognitive neuroscience has drawn more and more attention from users, producers and researchers. Biological structure, mechanism and underlying principles could provide new ideas for the improvement of robotic design and control. How to improve the intelligence, flexibility, stability and compliance of robots has become the key problem in robotic research. This special issue aims to bring together the latest advances and developments in the bio-inspired manipulation and robotics. Topics include, but are not limited to:

- bio-inspired manipulation (such as grasping/assembly/welding);
- bio-inspired learning in robots;
- bio-inspired sensory-motor coordination;
- bio-inspired robotics;
- bio-inspired coordination of multi-agent systems;
- bio-inspired control or filtering in robots; and
- bio-inspired intelligent technologies in robots.

We have solicited submissions to this special issue from the scientists and engineers in the related research fields. After a rigorous peer review process, 12 papers have been selected that provide overviews, solutions, or early promises, to manage, analyze and interpret the bio-inspired algorithms and their applications in the manipulation and robotics. These papers have covered both the theoretical and practical aspects of manipulation and robotics in the broad areas of robotics, artificial intelligence, dynamical systems, mathematics and practical engineering.

This special issue is distinguished from others by providing various advanced bio-inspired algorithms and their applications in the manipulation and robotics. Specifically, in the paper entitled "An Advanced Immune Based Strategy to Obtain An Optimal Feasible Assembly Sequence" by M.V. Bahubalendruni *et al.*, novel and efficient strategies based on artificial immune system have been developed to obtain all valid assembly sequences and the assembly sequence has been optimized for a given assembled product by using assembly attributes. The introduced methodology has been proven effective in achieving optimal assembly sequence with less computational time. Based on the approximation property of the radial basis function neural networks, in the paper entitled "Neural-Network-Based Containment Control of Nonlinear Multi-Agent Systems under Communication Constraints" by C. Ma, the containment controller has been designed for multi-agent systems with unknown nonlinear dynamics and communication constraints. In the paper entitled "Bio-Inspired Kinematical Control of Redundant Robotic Manipulators" by A. Leylavi Shoushtari *et al.*, an innovative kinematic control algorithm has been proposed for redundant robotic manipulators by applying human upper arm-inspire concept of inter-joint dependency. The results from the simulations have confirmed the continuity and accuracy of generated joint profiles for given end-effector trajectories as well as algorithm robustness, singularity and self-collision avoidance. Inspired by formation flying of living organisms such as geese, in the paper entitled "Takagi-Sugeno System for Supervisory Formation Control of Seeker Mounted Unmanned Aerial Vehicles" by M.B. Menhaj *et al.*, the leader–follower formation problem of unmanned aerial vehicles has been investigated. By using a feedback linearization technique and a Takagi-Sugeno based supervisory control strategy, a controller has been designed that can keep formation and visibility maintenance in the presence of the leader maneuver. In the paper entitled "On the Small Fiber-Coupled Laser Controller for Animal Robot" by X. Lu *et al.*, a small remote-controlled laser control system has been designed, which provides the convenience for the development of portable optogenetics animal robot experiment.

Mobile robots have been used in a wide range of applications such as manufacturing, assembly, logistics and transportation, and the path planning is one of the most important topics in mobile robotics. In this special issue, some novel path planning approaches have been proposed based on the advanced bio-inspired algorithms. In the paper entitled "Path Planning for Intelligent Robot Based on Switching Local Evolutionary PSO Algorithm" by N. Zeng *et al.*, a novel particle swarm optimization (PSO) based on a non-homogeneous Markov chain and differential evolution (DE) has been presented for path planning of intelligent robot when having obstacles in the environment. The velocity updating equation of the presented switching local evolutionary PSO algorithm jumps from one mode to another based on the non-homogeneous Markov chain, which can overcome the contradiction between local and global search. In addition, DE mutation and crossover operations can enhance the capability of finding a better global best particle in the PSO method. In the paper entitled "A New Genetic Algorithm Approach to Smooth Path Planning for Mobile Robots" by Z. Wang *et al.*, the smooth path planning problem has been discussed for a mobile robot based on the genetic algorithm and the Bezier curve. The genetic operators including crossover and mutation have been used to search the optimum chromosome where the optimization criterion is the length of a piecewise collision-free Bezier curve path determined by the control points. A numerical experiment has been given to demonstrate the effectiveness of the proposed smooth path planning approach for a mobile robot. In the paper entitled "A Novel Path Planning Method for Biomimetic Robot Based on Deep Learning" by Y. Lu *et al.*, the deep learning technique has been used in the path planning problem of biomimetic robot and a new deep learning-based path planning algorithm has been proposed. It is well known that many robotic applications require 3D representation of environments. 3D laser range scanners have been applied to generate point clouds that portray spatial information about objects in both indoor and outdoor environments. To create a correct and consistent 3D global

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map, the scan matching has been considered as a key technique for creating 3D global maps. In the paper entitled "A Bio-Inspired Scan Matching Algorithm for Mobile Robots in Outdoor Environments" by K. Wang *et al.*, a bio-inspired scan matching algorithm has been proposed for mobile robots based on layered model graph in outdoor environments. The proposed algorithm can deal with the bad estimates of initial pose and increase the processing speed, and its computation time is short enough for real-time implementation in robotic applications in outdoor environments. The effectiveness and practicality of the algorithm have been verified by the experimental results.

Recognition technologies play an important role in many practical engineering applications and have received significant research attentions. In this special issue, with the help of the bio-inspired algorithms, several new recognition approaches have been proposed in terms of their specific application scenarios. In the paper entitled "Bio-Inspired Approach to Invariant Recognition and Classification of Fabric Weave Patterns and Yarn Color" by F. Han *et al.*, a biologically inspired processing architecture has been proposed to recognize and classify fabrics with respect to the weave pattern (fabric texture) and yarn color (fabric color). A comparison of proposed algorithm with existing computer vision algorithms has confirmed that fabric patterns can be recognized and classified more accurately by using biologically inspired machine vision algorithm. In the paper entitled "Bio-inspired Neural Network with Application to License Plate Recognition: Hysteretic ELM Approach" by Z. Ren *et al.*, the license plate recognition problem has been studied by using neural networks. To improve the information-processing capability of the existing artificial neural networks, a hysteretic neuron activation function has been introduced and an extreme learning machine has been chosen as the learning scheme. The advantages of the proposed hysteretic ELM neural network have been demonstrated in the automatic license plate recognition problem. In the paper entitled "Improved GA and Pareto Optimization-Based Facial Expression Recognition" by B. Shen *et al.*, the genetic algorithm and Pareto optimization algorithm have been combined to achieve facial expression recognition with high accuracy. The genetic algorithm has been improved by adjusting an appropriate fitness evaluation function and a new Pareto optimization model has been proposed that contains two objective functions indicating the achievements in minimizing within-class variations and in maximizing between-class variations. The experiment results have shown that the proposed facial expression recognition algorithm outperforms ones in the existing literature in terms of both the actuary and computational time.

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