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Editorial

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In recent years, increasing attention has been received from researchers, educationists and engineers on robotics due to their extensive applications. This trend has been reflected not only in the publication of a large number of papers in the mobile robot area but also in the tremendous growth of applications in various areas. Today, mobile robot-related commercial products have been applied to perform daily house maintenance, patient care and senior services. NASA has successfully sent the most famous mobile robots, Spirit and Opportunity, to explore Mars in an extremely challenging environment. An autonomous mobile robot acquires information (knowledge) by interacting with the dynamic environment, and accordingly it adapts to its new environment by changing its behaviour. The robot needs to have the capabilities of autonomy and intelligence, and this forces the researchers to deal with key issues such as uncertainties (in both sensing and acting), reliability and real-time response. Therefore, a key challenge in robotics is to design algorithms that allow the robots to function autonomously in unstructured, dynamic, partially observable and uncertain environments. To deal with these and other problems related to mobile robotics, computational intelligence-based approaches, such as neural networks, fuzzy systems and genetic algorithms, provide unmatched utilities and novel solutions because of their demonstrated strength in handling imprecise information. During the past few decades, computational intelligence has gone through a tremendous development both in theory and in applications. These techniques can be applied to a wide variety of problems including mobile robots. Computational intelligence enables mobile robots to react intelligently to their unstructured dynamic environment.

The purpose of this special issue is to report the most recent research and developments of mobile robots, control and navigation algorithms and computational intelligence and its applications to mobile robotics. After rigorous peer reviews, 13 papers were accepted for publication in this special issue.

The article by Thomas Bräunl et al. describes the design and modelling of an Autonomous Underwater Vehicle (AUV), together with a simulation system for AUVs with arbitrary propulsion and sensor systems. The use of a simulation system can be convenient to rapidly test AUV designs and compare different AUV designs of their suitability for a given task before they even have been built, which will speed up the design process of an AUV.

Anthony S. Maida et al. consider the local path-planning and obstacle-avoidance module used in the Cajunbot autonomous ground vehicle. The sub-goal can be rapidly extracted for a global navigation system following GPS-supplied way-points by use of the proposed module. The algorithm is based on a grid-based, linear-activation field (a type of artificial potential field). Several novel properties are shown as follows:

1 The artificial potential field delivers local way-points.

2 The planner aggressively avoids obstacles.

3 The algorithm makes use of a repulsive expansion region to compensate for imperfect manoeuvrability.

An-Min Zou et al. investigate the mobile robot navigation in indoor environments using doorplate landmarks. The neural networks are employed to calibrate the camera and segment the doorplate from the image; then the doorplate number recognition algorithm is described and the topological map is created by treating the doorplate landmarks as topological nodes.

Anmin Zhu and Simon X. Yang present a novel tracking controller for real-time navigation of a non-holonomic mobile robot using a back-stepping model and a gated dipole model from a biological inspired neural system. Smooth, bounded acceleration control signals can be obtained by the model to track a reference trajectory. Using the proposed controller, the velocity jump problem in the conventional back-stepping controllers caused by a large initial tracking error can be solved; and the impractical assumption 'perfect velocity tracking' in the existing tracking control methods can be relaxed by considering the constraint of accelerations.

The paper by Lauro Ojeda, Giulio Reina, Daniel Cruz and Johann Borenstein introduces a sensor fusion algorithm that uses expert rules and fuzzy logic, called FLEXnav system. In addition, a few techniques for wheel slippage and correction are proposed. Detailed experimental results were obtained with the FLEXnav system, and comparison between the FLEXnav system and conventional Kalman Filter was made.

Zheng Liu, Marcelo H. Ang Jr and Winston Khoon Guan Seah develop a distributed learning controller, which integrates reinforcement learning with behaviour–based control networks, and a neural inspired distributed learning control algorithm for multi-robot tracking of multiple moving targets. The learning algorithm removes the assumption 'discrete state and action spaces with finite number of elements' of the traditional reinforcement learning algorithms. Using the learning controller, appropriate control policy can be obtained for the robots without the need for human design or hardcoding.

Thomas Hellström and Ola Ringdahl present a novel path-tracking algorithm by using recorded steering commands that can overcome the problem in the traditional algorithms, such as Pure Pursuit and Follow the Carrot, i.e. the actual curvature of the path is not considered. The algorithm is constructed within the behavioural paradigm common in intelligent robotics and is divided into three separate behaviours, each responsible for one aspect of the path-tracking task. The results compared with the Pure Pursuit and the Follow the Carrot algorithms show a significant improvement in performance.

Distributed visual navigation based on neural Q-learning for a mobile robot is studied by Guosheng Yang, Zengguang Hou and Zize Liang. The authors propose a general distributed structure based on the multiple processors for visual navigation according to the decomposition of the mobile robot visual navigation task, a local environment description method in terms of the general distributed structure by use of the PGF and fuzzy technology, and a controller based on neural Q-learning to guide the mobile robot navigation in each local environment description.

Guido Bugmann, Paul Robinson and Kheng L. Koay utilise a normalised Radial Basis Functions (RBF) neural network to encode the sequence of positions forming the path of an autonomous wheelchair. The neural network architecture combines the position-based and phase-based information to solve the aliasing problem, which makes the complex path-following possible. The use of normalised RBFs creates an attraction field over the whole space and enables the wheelchair to recover from perturbations, e.g. due to the avoidance of people.

Jose E. Naranjo et al. present an Intelligent Transport System (ITS) based on the global navigation satellite system and artificial vision information. The system is driven by introducing steering and velocity fuzzy controllers, according to a global planner. These controllers have been used to execute some automatic driving manoeuvres: route tracking, overtaking and adaptive cruise control.

The paper by Yangmin Li and Yugang Liu discusses the trajectory following problem of autonomous redundant non-holonomic mobile modular manipulators and proposes an integrated dynamic modelling method in consideration of non-holonomic constraints and self-motions caused by redundancy. A Robust Adaptive Neural Fuzzy Controller (RANFC) is employed to control the end-effector to follow the desired special trajectories. By incorporating the human expert knowledge, the RANFC does not require the precise plant dynamics and offline training phases and can suppress the external disturbances.

Jun Li and Tom Duckett investigate a growing RBF network that integrates unsupervised and supervised learning to acquire reactive behaviours for mobile robots. The learning algorithm can directly map the sensor information to the required motor action. A key property of the proposed learning system is that its network structure is able to dynamically adapt to different tasks and environments. Therefore, many of the different behaviours can be obtained by the same learning architecture.

The paper by Edgar A. Martínez-García, Akihisa Ohya and Shin'ichi Yuta describes a multi-robot system whose purpose is to guide conduction for groups of humans. The proposal includes: an approach to localise (track) the members of the group; a suitable multi-robot system architecture design; and a motion planner that synchronises and controls (guides) the trajectory of the group. The proposed methodology will find some potential tour-guiding applications.

Finally, we would like to thank all authors for their valuable contributions to this special issue and thank all reviewers for their close cooperation.