Guest Editorial

Vladimir Ivancevic

Land Operations Division,
Defence Science & Technology Organisation,
P.O. Box 1500, 75 Labs, Edinburgh SA 5111, Australia
Fax: +61 8 8259 4193
E-mail: Vladimir.Ivancevic@dsto.defence.gov.au

Biographical notes: Vladimir Ivancevic, senior research scientist, Land Operations Division, Defence Science & Technology Organisation, Australia – is an applied mathematician working in Human Sciences. He is the author of the world-class human motion simulator called Human Biodynamics Engine, as well as over a 100 publications, including 10 graduate-level books (Springer and World Scientific).

The Special Issue on Human-Robot Teaming of the *IJIDSS* includes four papers devoted to modelling and simulations of human – robot teaming and related system complexity issues. The papers cover a range of issues relevant to the task of enabling co-action between autonomous platforms and human operator(s).

First, Aidman et al. propose a generalised reaction–diffusion field model for robot navigation in their paper 'A coupled reaction–diffusion field model for perception–action cycle with applications to robot navigation'. The model is based on the interaction between two mutually antagonistic neural fields counteracting in patterns similar to that of flexor/extensor muscles controlling the movements in all major joints in the human body. Combining local activation and generalised inhibition represented by Amari's neural field equations and extended by the Fitzhugh–Nagumo and Wilson–Cowan activator-inhibitor systems, results in the type of neural attractor dynamics that may lead to spontaneous oscillatory pattern formation. Such oscillatory behaviour is characteristic of a number of biological systems including the oscillatory neural ensembles found in the cerebellum, olfactory cortex, and neocortex, all representing the basic mechanisms for the generation of oscillating (EEG-monitored) activity in the brain. This generalised associative bi-neural filed approach can also be employed to enable robotic navigation in complex environments that are dominated by the elements of uncertainty. Preliminary simulation data suggest that this approach has utility in enabling a team of autonomous vehicles to navigate in a crowded pedestrian crossing.

The second paper, 'Cooperative Target Observation of UAVs using Simulated Annealing' by Moses et al. deals with cooperative target observation by groups of Unmanned Aerial Vehicles (UAV), by proposing a Modified Simulated Annealing algorithm for optimising the position of each of the UAVs to observe the maximum number of targets. Cooperative target observation is a very good example for study of multi agent cooperation. This paper compares Hill Climbing algorithm and Modified

Simulated Annealing algorithm and proposes that the Modified Simulated Annealing algorithm is superior for almost all target speeds, UAV sensor ranges and various group sizes.

D. Reid in his paper 'On the complexity of system designs' asserts that the concept of a system archetype is formalised as characterisation of the possible designs that a given system design approach can generate, and the ability of the approach to address design problems of increasing scale is investigated formally using this characterisation. In particular, system design methodologies can be regarded according to the range of designs they can generate. This leads to the realisation that the ability to appropriately constrain the set of designs that may be generated as the system size increases is crucial to the success of a system design approach. This paper supports earlier author's work in which a new system design methodology was proposed, in which user requirements are dominated by more enduring concerns, especially the requirement for a flexible, structurally scalable and open platform for evolutionary development. This methodology then proposes that such factors be embodied in a system 'archetype', which is very loosely defined as a compact pattern for generating system designs of arbitrary size. This represents a recognition that many system design approaches do not scale well at least in part because they fail to provide sufficient limitations on the range of designs they can produce. Here, the design archetype is defined as a characterisation of the formal language of designs induced by a system design approach; in this way, the analysis of design methodologies is independent of the many different modelling techniques that might used to express the designs themselves. The Kolmogorov and uniform complexities of the design archetype are used to quantify the scalability of its corresponding design methodology. Approaches to system design are thereby classed according to the upper bounds on these measures of complexity as the system size increases.

Finally, the paper 'Artificial cognition for autonomous planar vehicles: modelling collision avoidance and collective manoeuvre' by Ivancevic et al. proposes a hierarchical (five-level) cognitive robotics model for distributed control, collision avoidance and collective manoeuvre for a team of unattended robotic vehicles. The first (base) level rigorously defines conflict resolution for a couple of UGVs, using approach of dynamical games on SE(2)-groups of rigid motions in the plane. The second, collective de-confliction level, extends the base-level formalism to n UGVs, using Hamiltonian form of the non-cooperative Nash-equilibrium approach. The third, adaptive guidance level, defines an adaptive output tracking control for several groups of de-conflicted vehicles within the whole team, using adaptive Lie-derivative control formalism. The fourth, collective manoeuvre level, proposes a combination of an attractor neural model and a model-free fuzzy-neural 'supervisor', to perform an adaptive path definition and waypoints selection, as well as chaos control (if necessary). The fifth, cognitive level, performs both overall mission planning and supervisory feedback control for all lower levels. The utility of the presented cognitive hierarchy is discussed in the context of real-world applications for unattended vehicles.

A word of gratitude goes to Chief Editor, *IJIDSS*, Professor Lakmi Jain, for supporting the initial idea for this special issue, and to the reviewers and referees of the papers who made a significant contribution to its quality. I would also like to thank Steve Quinn, Neville Curtis, Mike Brennan and Darryn Reid for their comments and encouragement. Thanks are due to Jyothi, E-Edit Solutions for her excellent support during the development phase of this volume.