Recent Advances in Robotics and Automation
Guest Editorial

This special issue titled “Recent Advances in Robotics and Automation” in the book series of “Studies in Computational Intelligence” contains the extended version of the papers selected from those presented at the 5th International Conference on Automation, Robotics and Applications (ICARA 2011) which was held in Wellington, New Zealand from 6–8 December, 2011. A total of 89 papers were presented at ICARA 2011, out of which this special issue contains only 26 papers.

The collection of papers presented in this book deals with the recent advancements in design methodologies, algorithms and implementation techniques to incorporate intelligence in robots and automation systems. Several articles deal with navigation, localisation and mapping of mobile robots, a problem that engineers and researchers are grappling with all the time. Fuzzy logic, neural networks and neuro-fuzzy-based CI techniques for real-world applications have been detailed in a few articles.

The first group of articles deal with fuzzy systems and neural networks. In the first article, Benjamin Johnen et al., have presented the design and evaluation of artificial neural networks for learning static and dynamic position behaviour of an industrial robot. Different layouts and configurations of feed-forward networks with back propagation learning algorithms were examined resulting in a multi-layer network based on the calculation of the forward transformation. Khalid Isa and M. R. Arshad have presented a mathematical model and motion control analysis of a buoyancy-driven underwater glider. The glider mathematical model uses the Newton–Euler method. In order to predict and control the glider motion, a neural network control has been used as a Model Predictive Control (MPC) as well as a gain tuning algorithm. Miguel A. Olivares-Mendez et al., have described the development of a visual line guided system for use on board an Autonomous Guided Vehicle (AGV) commercial car, controlling the steering and using just the visual information of a line painted below the car. In order to implement the control of the vehicle, a Fuzzy Logic controller has been implemented that
is robust against curvature changes and velocity changes. O. Hassanein et al., have researched on the system identification of Autonomous Underwater Vehicles (AUV) dynamics to obtain its coupled nonlinear dynamic model. Adaptive fuzzy technique has been used to overcome the uncertain external disturbance and the difficulties of modelling the hydrodynamic forces of the AUV.

The next group of five articles deal with localisation, mapping and path planning. Munir Merdan et al., have presented their research findings into a flexible multi-agent system architecture for task allocation in a complex and large industrial batch process system. Sobers Francis et al., have reported the importance of kinematic and dynamic constraints in a path planning module for AGV. The model has been simulated and the behaviour has been compared with a real robot. A Simultaneous Localization and Mapping (SLAM) algorithm, based on Incremental Maximum Likelihood (IML) has been implemented by Oussama El Hamzaoui et al., to give a robot the ability to navigate autonomously in an unstructured environment. Christoph Rasche et al., have presented an approach to coordinate Unmanned Aerial Vehicles (UAV) by setting up formation patterns using bifurcation theory. It has been combined with potential field approach for exploration, based on harmonic functions. Felix Hackbarth has presented the experimental results on localisation of indoor mobile robots with limited sensor capabilities. The robot is able to locate itself near obstacles on the basis of a Bayesian approach with probabilistic global occupancy knowledge of the environment.

Vision systems are being incorporated in many intelligent systems for machine inspection, surveillance, ranging and control. Luis Mejias et al., have presented an Omni-directional camera-based control system for micro aerial vehicles. The system has been tested using small quad rotors and shown to be effective in avoiding collision. Ben Drayton et al., have designed a compact, configurable, indirect time of flight imager for mobile robotic applications. Changing lighting conditions pose significant challenges to vision-based localisation algorithms. Jared Le Cras et al., have investigated the application of a colour model which separates brightness from chromaticity to eliminate features that may be caused by dynamic illumination. Gontje C. Classen et al., have presented a data fusion algorithm to integrate data from optical and inertial sensors to implement a tracking system for a servo-controlled handheld tool in a computer-assisted surgery system. A mobile robotic system used to image vehicle undercarriages has been described by Robert Ross et al. The system uses a wide-angle catadioptric camera and generates a mosaic view of the vehicle undercarriage. Two cameras and a controlling PC have been employed by Holger H. Rapp to predict the trajectory of a ping-pong ball using a novel fluid-dynamical model and control a standard industrial robotic arm to catch it. The proposed algorithm has been shown to drastically increase the intelligence and performance of the system.
An interesting concept of ‘smart floors’ has been introduced by Soo Hyeok Kang et al. A mobile robot is able to reach its target position using the information stored in the smart floor. Michael Schnurmacher et al., have combined data from a radar and lidar to obtain accurate velocity and position information for car-following on highways.

In the area of intelligent and precise control, Christian Ziegler and Jorg Franke have used a low-cost stereoscopic measuring system in a closed-loop controller to position a patient couch with high accuracy. Kelvin Gong and Allan I. McInnes have implemented a modular, hierarchical control scheme for a mobile manipulator to coordinate the motion of the manipulator and the base. The controller can be extended to avoid obstacles without requiring redesign of the rest of the controller. There is a trend to shift functional behaviour of industrial automation systems from hardware to software to increase flexibility, but it increases the complexity of test-case generation for automated testing. Reinhard Hametner et al., have introduced an automated test case generation where the test cases are specified by UML state chart diagrams.

Yao Fu et al., have presented a realistic simulator for humanoid robot soccer which bridges the gap between the simulated environment and the real world. Another simulation work has been described by Mouna Souissi et al., for a humanoid robot movement. They have reported the outcome of their study of having a humanoid robot equipped with backbone pitch joints. The study concludes that a number of two pitch joints is a good trade-off in matters of work at the hip and the thorax inclination.

Andreas Kamagaew et al., have shown how a swarm of autonomous vehicles, with decentralized control architecture, can increase flexibility in a facility logistics system. Gottfried Koppensteiner et al., have researched into the application of knowledge-driven mobile robots for disassembly tasks. The proposed system has mobile robots with particular skills which are supervised by an agent with related objectives and knowledge. Munie Merdan et al., have presented their research which deals with automation of power distribution network. A multi-agent approach has been taken to realize and implement a reliable and efficient electric energy system.

In the last chapter of the book, Rini Akmeliawati et al., have presented an intelligent algorithm to estimate 2D human pose for action recognition. This work is of great significance in human–robot interaction.

We do hope that the readers would find this special issue informative and useful in augmenting their research or practical engineering work in the area of robotics and automation. We are very happy to be able to offer the readers such a diverse special issue both in terms of its topical coverage and geographic representation.
Finally, we would like to thank all the authors wholeheartedly who have contributed their work to this special issue. We are grateful to all reviewers from all around the world who have generously devoted their precious time to review the manuscripts.

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Editors Biography

Gourab Sen Gupta received his B.E. (Electronics) degree from the University of Indore, India, in 1982 and Masters of Electronics Engineering (MEE) degree from the Philips International Institute, Technical University of Eindhoven, Holland, in 1984. After working for 5 years as a Software Engineer in Philips India in the Consumer Electronics division he joined Singapore Polytechnic in 1989 where he worked as a Senior Lecturer in the School of Electrical and Electronic Engineering. In 2008 he was awarded a Ph.D. in Computer Systems Engineering for his research on Intelligent Control of Multi-Agent Collaborative Systems. Since September 2002 he has been with the School of Engineering and Advanced Technology (SEAT), Massey University, New Zealand where he is an Associate Professor.

His current research interests are in the area of embedded systems, robotics and automation, real-time vision processing and sensor applications. He has published and presented over 110 research papers in various journals and conferences. He has been a guest editor for leading journals such as IEEE Sensors Journal, International Journal of Intelligent Systems Technologies and Applications (IJISTA), and Studies in Computational Intelligence (Special Issue on Autonomous Robots and Agents) by Springer-Verlag. He is a Senior Member of IEEE and a Distinguished Lecturer of the IEEE Instrumentation and Measurement Society (2013–2015).
Donald G Bailey received the B.E. (Hons) degree in Electrical Engineering in 1982, and the Ph.D. degree in Electrical and Electronic Engineering from the University of Canterbury, New Zealand in 1985. From 1985 to 1987, he applied image analysis to the wool and paper industries within New Zealand. From 1987 to 1989, he was a Visiting Research Engineer at University of California at Santa Barbara. He joined Massey University in Palmerston North, New Zealand as Director of the Image Analysis Unit at the end of 1989. In 1996, he was a Visiting Research Fellow at the University of Wales, in Cardiff, and in 2002 as a Visiting Associate Professor at University of California at Santa Barbara. In 2008, he was a Visiting Research Fellow at Imperial College, London. He is currently an Associate Professor at Massey University in the School of Engineering and Advanced Technology. Professor Bailey is Leader for the Electronics, Information and Communications Systems Cluster within the School, and is leader of the Image and Signal Processing Research Group.

His primary research interests include applications of image analysis, machine vision and robot vision. One area of particular interest is the application of FPGAs to implementing real-time image processing algorithms. He has published over 200 papers, and is the author of the book “Design for Embedded Image Processing Using FPGAs”. He is a senior member of IEEE.

Serge Demidenko is professor and Head of Centre of Technology as well as Centre of Communication and Design at RMIT International University Vietnam. He is also an adjunct academic staff with Monash University and RMIT University (both—Australia). Areas of his professional specialisations include electronic design and testing, digital signal processing, instrumentation and measurement. He has been an academic and research staff of institutions of higher learning in a number of countries in Europe, Asia and Australasia. Professor Demidenko has enjoyed working in close collaboration with major industrial companies such as Texas Instruments, Free scale Semiconductors, Flextronics and Intel. His publication list includes 3 co-authored research monographs, 14 book chapters, more than 30 refereed journal and over 100 refereed conference papers, 14 edited books and journal special issues and 25 engineering patents.
He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) as well as a Fellow of the Institution of Technology and Engineering and a UK Chartered Engineer.

He is an associate editor for six international peer-reviewed journals. Professor Demidenko also devotes time and energy to professional societies and professional registration and accreditation bodies, having held leadership roles in IEEE Instrumentation and Measurement Society, Test Technology Technical Council of IEEE Computer Society, Institution of Engineering and Technology, etc. He has also contributed to organisation of over 100 international conferences as a general and technical program chair and committee member.

Dale Carnegie has a multi-disciplinary approach to research. In 1987 he graduated with a B.Sc. in Theoretical Physics and Applied Mathematics, in 1989 he attained an M.Sc. with first-class honors in Applied Physics and Electronics, and in 2000 he was awarded a Ph.D. in Computer Science. After working at the lecturer and then senior lecturer level at the University of Waikato’s Department of Physics and Electronic Engineering, he took up a position at Victoria University of Wellington, New Zealand, where he helped establish a new Engineering Programme. He also established Victoria University’s first Mechatronics Research Group. A full Professor since 2008, he is now the Head of School of Engineering and Computer Science.

Professor Carnegie’s current research interests are in the area of Mechatronics, autonomous mobile robots, sensors, embedded systems, adaptive control and engineering education. Specific areas of on-going research include autonomous search and rescue robots and full field image ranging systems. He has published and presented over 150 research papers in various journals, book chapters, conferences and patents. In 1994, Professor Carnegie founded the Electronics New Zealand Conference series which is still held annually. He was a foundation member of the New Zealand Robotics Alliance and the NZ Mechatronics Forum. He has been a senior member of the IEEE since 2002, and is currently a member of the Robotics and Automation Society, the Circuits and Systems Society, the Systems, Man and Cybernetics Society and the Instrumentation and Measurement Society.