Guest Editorial

MOBILE INTELLIGENT AUTONOMOUS SYSTEMS

Mobile intelligent autonomous systems (MIAS) is a fast emerging research area. Although it can be regarded as a general R&D area, it is mainly directed towards robotics. Several important subtopics within MIAS research are: (i) perception and reasoning, (ii) mobility and navigation, (iii) haptics and teleoperation, (iv) image fusion/computer vision, (v) modelling of manipulators, (vi) hardware/software architectures for planning and behaviour learning leading to robotic architecture, (vii) vehicle-robot path and motion planning/control, (viii) human-machine interfaces for interaction between humans and robots, and (ix) application of artificial neural networks (ANNs), fuzzy logic/systems (FLS), probabilistic/approximate reasoning (PAR), Bayesian networks (BN) and genetic algorithms (GA) to the above-mentioned problems. Also, multi-sensor data fusion (MSDF) plays very crucial role at many levels of the data fusion process: (i) kinematic fusion (position/bearing tracking), (ii) image fusion (for scene recognition), (iii) information fusion (for building world models), and (iv) decision fusion (for tracking, control actions). The MIAS as a technology is useful for automation of complex tasks, surveillance in a hazardous and hostile environment, human-assistance in very difficult manual works, medical robotics, hospital systems, auto-diagnostic systems, and many other related civil and military systems. Also, other important research areas for MIAS comprise sensor/actuator modelling, failure management/ reconfiguration, scene understanding, knowledge representation, learning and decision-making. Examples of dynamic systems considered within the MIAS would be: autonomous systems (unmanned ground vehicles, unmanned aerial vehicles, micro/mini air vehicles, and autonomous underwater vehicles), mobile/fixed robotic systems, dexterous manipulator robots, mining robots, surveillance systems, and networked/multi-robot systems, to name a few.

In this special issue, though not exhaustive, a few of the above aspects and applications have been considered in 10 contributed papers, a brief outline of which is given next.

In the paper 'Controlling a Mobile Robot with a Biological Brain', Prof Kevin Warwick and co-authors assess the aspects of computational and learning capacity of dissociated cultured neuronal networks. The team has created a hybrid system incorporating a closed-loop control of a mobile robot by a culture of (biological) neurons. Their system is rendered flexible and allows for closed-loop operation, either with hardware robot or its software simulation. The paper gives an overview of the problem area, an idea of the coverage of present ongoing research, and the details of their own system architecture. They also present the results of conducted experiments with real-life robots. Their study shows that a robot can have merely a biological brain to make its 'decisions'.

Mbali and Engelbrecht in their paper 'Robotic Architectures' survey various types of robot control architectures and design properties. Classification and comparison of different attributes and properties are presented. Different paradigms, the layered approach, design principles, programming and developmental tools are discussed. They also present their point of view about the current state of designing robot control architectures.

In the paper 'Temporal Logic Motion Planning', Motlatsi Seotsanyana addresses the problems of the motion planning in real-time, dynamic, uncertain and ever-changing environment. He conjectures that the use of theory of computation and formal methods is a promising direction of research in solving motion planning problems that are influenced by specification of complex tasks. The review focuses on the techniques to solve a motion planning problem. The author also proposes a robust platform that deals with the complexity of more expressive temporal logics.

Vrinthavani and Kaimal in the paper ' Motion Segmentation Algorithm using Spectral Framework' present a new motion segmentation method using iterative maximum likelihood (ML) framework. Their method consists of two steps: (a) motion regions are detected and motion vectors are computed for these detected regions, and (b) a similarity matrix is computed from the motion vectors and motion segmentation is done using ML method. The method has been validated using real world motion sequences and is found to give very low error rate. Their procedure also can detect the slow-moving objects.

Dr Naidu in the paper 'DCT-based Image Fusion' has implemented and evaluated fusion by multi-resolution discrete cosine transform (MDCT) algorithm and compared the performance of the new algorithm with well known wavelets-based image fusion technique. It was observed that the image fusion by MDCT performed almost similar to that of wavelets. However, it is computationally simple and well suited for real time applications.

In the paper 'Path Planning in the presence of Dynamically Moving Obstacles with Uncertainty', Singh and Gopal address the problem of path planning with dynamically moving elliptical obstacles and present a new analytical result for computing the axes-aligned bounding box. They consider the ellipses with bounded uncertainty in the position of the centre and the orientation. They use genetic algorithm for finding the shortest path from the initial point to the goal position while avoiding the moving obstacles.

In the paper 'Novel Redundant Sensor FDA Algorithm for an Air-breathing Combustion System and its Real-time Implementation', Walambe and co-authors present a novel fault detection and accommodation (FDA) algorithm based on analytical redundancy. The work focuses on the development

and testing of this FDA algorithm and provides some intelligence to a triplex redundant P_4 sensor measurement hardware. Their real-time implementation results showed that the design of the FDA scheme is suitable to implement and runs on an embedded hardware.

In the paper 'Sensor/Control Surface Fault Detection and Reconfiguration using Fuzzy Logic', Savanur and Patel present a scheme for sensor fault detection and reconfiguration using Kalman filter. Sensor fault detection and reconfiguration are carried out using non-model-based fuzzy logic technique and control surface fault detection and reconfiguration are carried out by identifying the elements of control distribution matrix using extended Kalman filter and fuzzy logic. Different implication methods such as Mamadani, Larsen, bounded product, and drastic product are used for performance evaluation of the presented scheme.

Twala in the paper 'Handling Out-Of-Sequence Data: Kalman Filter Methods or Statistical Imputation?' considers the issue of handling sensor measurements data over single and multiple lag delays. This problem is known as out-of-sequence measurement (OOSM). He argues that the problem can also be addressed using model-based imputation strategies and demonstrates the application of these for a multi-sensor tracking prediction problem. The author investigates the effectiveness of two model-based imputation procedures against five OOSM methods using Monte Carlo simulations.

In the paper 'Aircraft Height Estimation using 2-D Radar', Hakl and co-authors present a method to infer height information from an aircraft tracked with single 2-D search radar. It is assumed that the aircraft is in level flight and a good estimate of the speed of the aircraft is available. The method gives good results for medium-to-high altitudes. It can distinguish between high and low targets on normal 2-D radar and can achieve a height resolution of 100 m.

On the whole, there is a fair representation of various aspects and current issues related to the mobile intelligent autonomous systems.

The guest editors are very grateful to the reviewers for their time and providing expert comments for the improvements and revisions of these papers by the authors. We are also grateful to the Editor-in-Chief for prompt approval of our proposal to bring out a special issue on the current topic of MIAS.

I am very grateful to all the authors who have contributed papers covering various facets of this upcoming technology. I am indebted to all the reviewers for offering valuable suggestions. Finally, I would like to thank Director, DESIDOC and his team for their untiring efforts in bringing out this special issue.

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