

Editorial

Robotics and Autonomous Systems in the 50th Anniversary of Artificial Intelligence

1. Motivation

The special issue on “Robotics and Autonomous Systems in the 50th Anniversary of Artificial Intelligence” collects a subset of the best papers in the fields of Robotics and Autonomous Systems presented at the Campus Multidisciplinary in Perception and Intelligence, CMPI-2006 [1]. The CMPI-2006 international conference, held in Albacete, Spain, from July 10 to 14, 2006, resulted in a forum for scientists in commemoration of the 50th Anniversary of Artificial Intelligence, which successfully reported recent research advances in AI and where the participants exchanged knowledge in close relation to the state-of-the-art of Perception and Intelligence. More specifically, this special issue gathers high-quality papers related to the general topics of Perception and Intelligence from both natural and artificial points of view.

About 90 articles were accepted for presentation at the Campus Multidisciplinary in Perception and Intelligence. A high percentage of them were directly linked to Robotics and Autonomous Systems, thus showing the great relevance that these subjects have in the state-of-the-art of Perception and Intelligence after 50 years of Artificial Intelligence being considered a research discipline.

The relevance of Robotics and Autonomous Systems can also be measured in each and every other international event linked to the commemoration of the 50th anniversary of the birth of Artificial Intelligence, namely:

- The “Dartmouth Artificial Intelligence Conference: The Next Fifty Years” [2] was held at the Dartmouth College, Hanover, NH, USA during July 13–15, 2006. Thirty one AI experts lectured during the morning, afternoon, and evening sessions of AI@50, after a historic gathering aiming to honour the five surviving founders of AI and unveil the plaque that commemorates the original Dartmouth Summer Research Project on Artificial Intelligence that created AI as a research discipline in 1956.
- The 21st National Conference on Artificial Intelligence [3] sponsored by the Association for the Advancement of Artificial Intelligence, with the theme “Celebrating Fifty Years of Artificial Intelligence”, was held in Boston, MA, USA during July 16–20, 2006. Some workshops

related to robotics were W2: Auction-Based Robot Coordination, W3: Cognitive Modelling and Agent-Based Social Simulation, W4: Cognitive Robotics, W10: Human Implications of Human–Robot Interaction, and The Mobile Robot Workshop. A good number of articles either presented orally or by means of posters were directly related to Robotics and Autonomous Systems.

- The 50th Anniversary Summit on Artificial Intelligence [4], held in Monte Verita, Switzerland, consisted of a great number of lectures and talks, by reputable scientists, on Artificial Intelligence. In relation to Robotics and Autonomous Systems, some talks such as: “Socially intelligent robots”, “Biologically inspired miniature robots”, “Design principles for emergent cooperation and communication in robotic swarms”, “Why social intelligence matters in the design and development of intelligent robots” or “Emergent cognitive capabilities for humanoids: Robots learning sensorimotor skills and task knowledge from multimodal observation of humans” stand out.

We should point out that the CMPI-2006 was the only event commemorating the 50th anniversary of Artificial Intelligence held in Spanish. The success of the conference is directly related to the excellent results of AI research in Spain and other Spanish speaking countries. Therefore, with this special issue we want to highlight the considerable progress in Robotics and Autonomous Systems in Spanish speaking countries.

Spain has a great potential in Robotics research (more than 60 groups). Spanish robotics research is well-represented in the main scientific networks and societies in the international scenario. In fact, Spain is the third country in number of groups, number of European projects and number of researchers in the EURON network (EUropean RObotics research Network) [5], one of the most important robotics network in the world. There are two other associations which highlight the Spanish presence in the international scenario: The International Federation of Automatic Control (IFAC) [6] and the International Association of Automation and Robotics in Construction (IAARC) [7]. IFAC is a multi-national federation of automatic control involving 46 countries, which places a great deal of effort on robotics research, among other subjects. Spain is the third most influential country in the world in IFAC. On the other

hand, IAARC is an international organization dedicated to the research in Robotics and Automation in the construction industry field. Once again, Spanish scientists are relevant in the running of the organization.

Autonomous Systems have also a strong presence in Spain mainly in the creation of intelligent robotic systems, which perceive their environment through sensors and use that information to generate intelligent, goal-directed behaviours. In other words, special research is being carried out in autonomous agents and multi-agent systems (MAS). The Agent's theory concerns the definition of agents and multi-agent systems, properties, architectures, communication, cooperation and coordination capabilities. As an example of the research dynamism going on in this field, "AgentCities.ES" [8] stands out. This is a research network funded by the former Spanish Science and Technology Ministry. The network has 18 members (17 University research groups on agent technology and the Artificial Intelligence Research Institute-III A). Its main aim is to join and coordinate the efforts of the Spanish research groups involved in the very successful AgentCities [9] European project, which intends to build a worldwide network of agent-based platforms that provide interesting services to citizens. It is worth mentioning that Spain is one of the leading countries in AgentCities activities, and there are also many Spanish research groups which are actively involved in AgentLink III [10] activities.

The work of the recently created Spanish Physical Agents network, called RedAF (Red de Agentes Físicos) [11], is also noteworthy. This network is an expression of the fusion of agency and robotics, which has as one of its primary objectives: "to serve as a communication forum about research, innovation and technology transfer in the subject of physical agents, including aspects such as integrated systems, Artificial Intelligence, mobile robotics, domotics and ubiquitous computing".

2. Special issue composition

Artificial Intelligence has been roughly divided into two schools of thought since its beginning: the symbolic and the subsymbolic one. These two approaches have also had strong influence on the robotics field. The first article "From bio-inspired vs. psycho-inspired to etho-inspired robots?" by J.M. Cañas and V. Matellán presents an approach to the generation of autonomous behaviour in mobile robots based on Ethology. Ethology is a part of Biology, but it does not concern "biological components". It works on how whole systems behave. The idea is to find keys that simplify and make robot behaviour more reliable. In the authors' approach, the behaviour is organized as a dynamic hierarchy of independent schemas.

Though some proposals have been put forth to solve the classical symbol grounding problem through robotic sensorimotor interactions, only little progress has been made in this direction with current working systems, and symbol grounding through physical interaction has been rarely dealt with. The second article "Symbol grounding through robotic manipulation in cognitive systems" by E. Chinellato,

A. Morales, E. Cervera and A. Pasqual del Pobil addresses this problem in the context of robotic manipulation for cognitive systems. The authors claim that there are symbols which do not refer simply to physical objects but rather to the embodied interactions between robots and the objects in their environment.

Potential methods and all their gradient-based derivations are extensively used in autonomous robots, primarily in association with reactive navigational strategies. In the third article of this special issue, namely "The centre of area method as a basic mechanism for representation and navigation" by J.R. Álvarez, J. Mira, F. de la Paz and J.M. Cuadra, the fundamentals, formalisation and application of a brand-new method based on first-order moments called the "centre of area method" is introduced. The authors also comment on its validity, at an individual level and in combination with other methods, in order to build a situated representation of the environment.

The fourth paper "Localization of legged robots combining a fuzzy-Markov method and a population of extended Kalman filters" by F. Martín, V. Matellán, P. Barrera and J.M. Cañas introduces an approach oriented to implement robot self-localization strategies in dynamic and noisy environments when efficiency is a strong requirement. The major contribution of this paper is the improvement of the existing fuzzy-Markov method. The proposal is based on the use of a population of Extended Kalman Filters to improve the performance of the FMK. In the experiments described, the characteristics of the combined methods have been tested in the Robocup environment.

The challenges of robotics have led researchers to develop control architectures composed of distributed, independent and asynchronous behaviours. One way of approaching decentralization is through cooperative control, since it allows the development of complex behaviour based on several controllers combined to achieve the desired result. Robots, however, require high-level cognitive capacities, and multi-agent architectures provide the appropriate level of abstraction to define them. The fifth article "A multi-agent architecture with cooperative fuzzy control for a mobile robot" by B. Innocenti, B. López and J. Salvi describes a multi-agent architecture combined with cooperative control developed within the agent.

The sixth paper also deals with MAS, now applied to multi-sensorial autonomous surveillance artefacts. Intelligent multi-sensor surveillance systems consist of several types of sensors, which are installed on fixed and mobile devices. These components provide a huge quantity of information that has to be contrasted, correlated and integrated in order to recognize and react to special situations. These systems work in highly dynamic environments, with severe security and robustness requirements. All these characteristics imply the need for distributed solutions. The article "Development of intelligent multi-sensor surveillance systems with agents" by J. Pavón, J. Gómez-Sanz, A. Fernández-Caballero and J.J. Valencia-Jiménez shows how to design surveillance system control as MAS.

Lastly, the seventh paper introduces “IVVI: Intelligent Vehicle based on Visual Information” by J.M. Armingol, A. de la Escalera, C. Hilario, J.M. Collado, J.P. Carrasco, M.J. Flores, J.M. Pastor and F.J. Rodríguez. In this article, a research platform for the implementation of systems based on computer vision is presented and different visual perception modules useful for some Advanced Driver Assistance Systems, such as Line Keeping System, Adaptive Cruise Control, Pedestrian Protector, or Speed Supervisor, are described.

Acknowledgements

We would like to thank all the authors for their high-quality contributions, and the reviewers for agreeing to do the reviews.

References

- [1] Campus Multidisciplinary in Perception and Intelligence. Available at: <http://www.info-ab.uclm.es/cmpi/>.
- [2] The Dartmouth Artificial Intelligence Conference: The Next 50 Years. Available at: <http://www.dartmouth.edu/~ai50/homepage.html>.
- [3] The Twenty-First National Conference on Artificial Intelligence. Available at: <http://www.aaai.org/Conferences/AAAI/aaai06.php>.
- [4] The 50th Anniversary Summit of Artificial Intelligence. Available at: <http://www.isi.imi.i.u-tokyo.ac.jp/%7Eimaxl/Events/ASAI50MV/>.
- [5] European Robotics Research Network. Available at: <http://www.euron.org/>.
- [6] International Federation of Automatic Control. Available at: <http://www.ifac-control.org/>.
- [7] International Association of Automation and Robotics in Construction. Available at: <http://www.iaarc.org/>.
- [8] AgentCities.ES. Available at: <http://grusma2.etse.urv.es/AgCitES/>.
- [9] AgentCities. Available at: <http://www.agentcities.org/>.
- [10] AgentLink III. Available at: <http://www.agentlink.org/>.
- [11] Red de Agentes Físicos. Available at: <http://www.redaf.es/redaf/index.php/Portada>.

Alicia Casals
*Technical University of Catalonia,
 Intelligent Robotics and Systems Group,
 08028 - Barcelona,
 Spain*
E-mail address: alicia.casals@upc.es.

Antonio Fernández-Caballero*
*Universidad de Castilla-La Mancha,
 Natural & Artificial Interaction Systems (n&aIS),
 02071 - Albacete,
 Spain*
E-mail address: caballer@dsi.uclm.es.

Available online 14 September 2007

* Corresponding editor.