
Volume 56, issue 1, 31 January 2008
ISSN 0921-8890
ELSEVIER
Robotics and
Autonomous Systems
Special Issue:
Humanoid Technologies: "Know-how"
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ScienceDirect
Robotics and Autonomous Systems 56 (2008) 1–3
Robotics and Autonomous Systems
www.elsevier.com/locate/robot

Editorial

Humanoid technologies: "Know-how"

The realization of a humanoid robot hinges upon a great deal of technical "know-how"; the impact on progress highly depends on such "know-how". This idea inspired a workshop on Humanoid Technologies, held at the IEEE-RAS International Conference on Humanoid Robots, Genova, Italy, December, 2006.[1] The workshop drew together research groups in the area of humanoid robotics to examine the past and recent advancements in humanoid technologies, and to propose ways to fast track towards a better future in the development of "humanoid technologies" in advancing at large the research field of Humanoid Robotics. This Special Issue on "Humanoid Technologies: know-how" serves as a follow on to the Workshop, with half of the papers being invited, as well as the inclusion of papers from an open public call for papers.

Historically, with a few notable exceptions, experimental robotics was very often based on industrial robots (the good old PUMA family for instance), modified to be interfaced to standard computers and completed by commercially available sensors integrated through a plethora of different interfaces. The controller was often centralized. The approach has changed now: it is common to find teams developing robots where the mechanics, the controller and the sensors are integrated into a complete mechatronic design. The problem at large is now how to make these technologies effective and to find ways to collate the effort of the individual into a coherent and harmonious technology that can be shared and reused, transferred, and improved at a faster pace.

Reliability is now an issue; experiments last longer than the typical 10 s benchmark demonstration which was customary in the past. In this new scenario, the old problem of interfacing and integrating different subsystems becomes even more significant. From the sensing and control point of view the paradigm of a centralized computer is not sufficient and, in fact, the emerging approach is based on the development of distributed sensors and control networks. System design, in this context, the development, maintenance, and upgrading of such robotic platforms, requires tools and perhaps new methodologies.

A great deal of effort and investments has been underway over the past decade with a great number of humanoid robots projects: noticeably, Honda P2-P3, ASIMO [4]; MIT COG [1]; Tokyo University H-Series [7]; AIST HRP [3]; ETL-Humanoid [6]; SARCOS DB; DIST Babybot [5]; iCub [10]; KAIST KHR series [8]; humanoid robots of Waseda University [9]; CB [2] are among them. These developments can be said to have a great deal in common in their labour in the construction of systems that encompass the integration of sophisticated components from multi-layered software architectures to intricate mechatronics subsystems.

Our motivations for the Workshop and in preparing this Special Issue are to highlight some of the issues being addressed by researchers in building their systems. As to discover what common "humanoid technologies" can be extracted, in an eventual hope to provide a common and sharable environment, putting forward a framework to make easier the development of humanoid robots.

Related issues considered

As our wish was to foster various aspects of related issues, some of the main thoughts being promoted during the workshop were:

- How to exploit distributed and parallel structures for sensing and control.
- How to develop new algorithms and protocols.
- How to integrate heterogeneous components flexibly and with an eye at scalability.
- Whether there is a need for specialized hardware and software (networks and protocols).
- Whether we require programmable vs. hardware devices, industrial state-of-the-art vs. custom chips.
- Whether there is any technological breakthrough along the way: e.g. self-reconfiguring connections.

Contributions

The contributing authors of this Special Issue took some of the above issues seriously within their papers.

The paper of Bäuml et al. endorses the concept of "agile Robot Development" (aRD); their concept advocates the significance of hard real-time when building complex robotic systems with strong mechatronic elements.

[1] http://eris.liralab.it/wiki/Workshop_humanoids06.

0921-8890/$ - see front matter
doi:10.1016/j.robot.2007.09.008

The software infrastructure of any humanoid systems depends greatly on the success and integration of the system as well as support for continuing research; the paper of Ceravola et al. presents their approach in dealing with these issues.

Placing an emphasis on the important significance of an architecture that can support intrinsically "incompatible architectures and frameworks" for the interfacing of sensors, processors and actuators, Fitzpatrick et al. present their experiences in the software architecture YARP for the iCub humanoid robot in dealing with these issues.

The work of Hosoda et al. presents empirical studies of multi-modal dynamic locomotion for their biped robot powered by antagonistic pneumatic actuators — jumping, walking and running was achieved by their robot.

In the paper presented by Asfour et al., they put toward a comprehensive humanoid architecture that was developed for applications in human-centred environments — in particular toward humanoid manipulation. They demonstrate aspects of control, planning, vision as well as localization in a single humanoid system.

The paper of Kondo et al. investigates issues involved in "In-Hand Manipulation" and multi-fingered robot hand control. They were able to perform object recognition utilizing a teaching system for their dextrous robotics hand.

As has been shown, the realization of complete humanoid systems can be a challenging undertaking. In this issue we are fortunate to have the inclusions of two such projects. Sugihara et al. present in the paper their high performance miniature anthropomorphic robots. Park et al. present the control hardware integration of the latest humanoid robot from the KAIST HUBO team; in this latest version they incorporated an android head with 31 DOFs, creating a humanoid system with 66 DOFs.

External interests in humanoid technologies

Recently, humanoid robots/technologies as research tools have attracted considerable attentions. Interests from Neuroscientists, Cognitive Scientists alike, with the foresight that these sophisticated systems can act as tools for the validation and evaluations of their fundamental hypotheses. In the light of all the technological investments into the development of humanoid robots, we urge and endorse this direction of interdisciplinary entrepreneurship, in the hope of further advancements of innovation in robotics, as well as enhancing our scientific understanding as a whole.

Acknowledgements

We would like to thanks all participants at the Workshop and all contributing authors of this Special Issue. We also wish to express our gratitude to the Editors-in-Chief and the publishing staff of Elsevier for their help and patience in making this publication possible. G.C. would like to thank Ms. Kazuko Davis for her help with the handling of papers and their reviews.

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