Künstl Intell (2016) 30:5–9
DOI 10.1007/s13218-015-0421-9

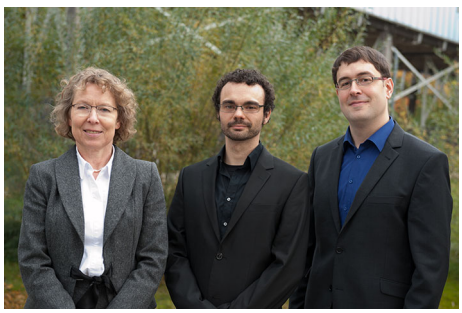
EDITORIAL

Special Issue on Companion Technologies

Susanne Biundo[1] · **Daniel Höller**[1] · **Pascal Bercher**[1]

Published online: 18 December 2015

Dear reader,



at present, we observe a rapid growth in the development of increasingly complex "intelligent" systems that serve users throughout all areas of their daily lives. They range from classical technical systems such as household appliances, cars, or consumer electronics through mobile apps and services to advanced service robots in various fields of application. While many of the rather conventional systems already provide multiple modalities to interact with, the most advanced are even equipped with cognitive abilities such as perception, cognition, and reasoning. However, the use of such complex technical systems and in particular the actual exploitation of their rich functionality remain challenging and quite often lead to users' cognitive overload and frustration.

Companion Technologies bridge the gap between the extensive functionality of technical systems and human users' individual requirements and needs. They enable the construction of really smart—adaptive, flexible, and cooperative—technical systems by applying and fusing techniques from different areas of research.

In our special issue we present interesting pieces of work—quite a number of new technical contributions, ongoing and completed research projects, several dissertation abstracts, as well as an interview—that are related to, or even fundamental for, Companion-Technology. In the community part of this issue, there is also a conference report on the first International Symposium on Companion-Technology [59].

1 Content

This issue starts with an introduction to Companion-Technology [48]; it reviews relevant research areas; possible fields of application of the technology; and related research projects including those that have a particular view on the notion of a technical Companion. The technical contributions span a wide range of areas: Worch et al. [73] introduce a robotic perception framework for perceiving and understanding everyday human tasks in a household environment. Schwarze et al. [68] introduce a system that assists visually impaired people to avoid obstacles in their close vicinity via sonification. The article by Gugenheimer et al. [58] shows how Companion-Technology can enhance a multi-screen TV system by placing projected screens anywhere in a user's home. Mehlmann et al. [62] present a modeling approach that enables the

✉ Susanne Biundo
susanne.biundo@uni-ulm.de

✉ Pascal Bercher
pascal.bercher@uni-ulm.de

Daniel Höller
daniel.hoeller@uni-ulm.de

[1] Institute of Artificial Intelligence, Ulm University, 89069 Ulm, Germany

realization of natural interaction in artificial social companions. The multimodal interaction between a human and a machine is empirically studied by Rösner et al. [65]. Demberg et al. [54] discuss challenges in natural language generation and show how this field can benefit from AI planning techniques.

Further articles present three excellent research programs, which are all funded by the German Research Foundation: The Transregional Collaborative Research Centre (CRC) "Companion-Technology for Cognitive Technical Systems" [50]; the CRC "Information Density and Linguistic Encoding (IDeaL)" [52]; and the CRC "Spatial Cognition" [64], which recently completed its 12 years research program.

Several dissertation abstracts from different fields of research show a variety of contributions to Companion-Technology. These include safety issues of intelligent and autonomous systems in open environments [55], multimodal behavior analytics [67], multimodal emotion recognition [69], and hierarchical planning [45, 66].

The issue ends with an interview with David E. Smith, a senior researcher in the Intelligent Systems Division at NASA Ames Research Center [47].

1.1 Survey

- *Companion-Technology: An Overview*
  Susanne Biundo, Daniel Höller, Bernd Schattenberg, and Pascal Bercher

1.2 Technical Contributions

- *Perception for Everyday Human Robot Interaction*
  Jan-Hendrik Worch, Ferenc Bálint-Benczédi, and Michael Beetz
- *A Camera-based Mobility Aid for Visually Impaired People*
  Tobias Schwarze, Martin Lauer, Manuel Schwaab, Michailas Romanovas, Sandra Böhm, and Thomas Jürgensohn
- *How Companion-Technology can Enhance a Multi-Screen Television Experience: A test bed for adaptive multimodal interaction in domestic environments*
  Jan Gugenheimer, Frank Honold, Dennis Wolf, Felix Schüssel, Julian Seifert, Michael Weber, and Enrico Rukzio
- *Modeling Grounding for Interactive Social Companions*
  Gregor Mehlmann, Kathrin Janowski, and Elisabeth André
- *Desiderata for the design of companion systems: Insights from a large scale Wizard of Oz experiment*
  Dietmar Rösner, Matthias Haase, Thomas Bauer, Stephan Günther, Julia Krüger, and Jörg Frommer
- *Search Challenges in Natural Language Generation with Complex Optimization Objectives*
  Vera Demberg, Jörg Hoffmann, David M. Howcroft, Dietrich Klakow, and Álvaro Torralba

1.3 Research Projects

- Companion-*Technology for Cognitive Technical Systems*
  Susanne Biundo and Andreas Wendemuth
- *Information Density and Linguistic Encoding (IDeaL)*
  Matthew W. Crocker, Vera Demberg, and Elke Teich
- *Cognitive Space and Spatial Cognition: The SFB/TR 8 Spatial Cognition*
  Marco Ragni, Thomas Barkowsky, Bernhard Nebel, and Christian Freksa

1.4 Doctoral Dissertations

- *Safety of Autonomous Cognitive-oriented Robots*
  Philipp Ertle
- *Multimodal Behavior Analytics for Interactive Technologies*
  Stefan Scherer
- *Emotional and User-Specific Acoustic Cues for Improved Analysis of Naturalistic Interactions*
  Ingo Siegert
- *Hybrid Planning and Scheduling*
  Bernd Schattenberg
- *Search Complexities for HTN Planning*
  Ron Alford

1.5 Interview

- *Interview with David E. Smith*
  Pascal Bercher and Daniel Höller

2 Service

Although *Companion*-Technology is an intrinsically interdisciplinary field, we restrict our review on publication media to those of AI and related areas.

2.1 Conferences, Symposia, and Workshops

Companion-Technology, Cognitive Technical Systems

- Advances in Cognitive Systems [1]
- International Conference on Advanced Cognitive Technologies and Applications (COGNITIVE) [2]

- International Conference on Cognitive Systems (CogSys) [3]
- International Symposium on Attention in Cognitive Systems (ISACS) [4]
- International Symposium on Companion Technology (ISCT) [5][1]
- International Symposium on Resilient Cognitive Systems (ISRCS) [6]
- International Workshop on Emotion Representations and Modelling for Companion Systems (ERM4CT) [7][2]
- International Workshop on Multimodal Pattern Recognition of Social Signals in Human–Computer-Interaction (MPRSS) [8]

Robotic Companions, Social Robots, Robot/Human-Interaction

- International Conference on Human–Robot Interaction (HRI) [9]
- International Conference on Human–Robot Personal Relationships [10]
- International Conference on Social Robotics (ICSR) [11]
- International Symposium on New Frontiers in Human–Robot Interaction [12]
- International Symposium on Robot and Human Interactive Communication [13]
- Symposium on Robot Companions: Hard Problems and Open Challenges in Human–Robot Interaction (2005) [14]

Human/Computer-Interaction

- Australian Conference on Human–Computer Interaction (OzCHI) [15]
- Conference on Human Factors in Computing Systems (CHI) [16]
- HCI International Conference [17]
- Intelligent User Interfaces (IUI) [18]
- International Conference on Human–Computer Interaction (INTERACT) [19]
- International Conference on Intelligent Environments (IE) [20]
- International Conference on Multimodal Interaction (ICMI) [21]
- International Conference on Pervasive Computing and Communications (PerCom) [22]
- International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp) [23]
- Nordic Conference on Human–Computer Interaction (NordiCHI) [24]
- The ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS) [25]

2.2 Journals

Companion-Technology, Cognitive Technical Systems

- Advances in Cognitive Systems [1]
- Cognitive Systems Research [26]
- Cognition, Technology and Work [27]
- Cognitive Technology Journal [28]
- IEEE Intelligent Systems [29]
- IEEE Transactions on Human–Machine Systems [30]
- Journal of Cognitive Engineering and Decision Making (JCEDM) [31]
- Special Issue on Cognition for Technical Systems (in Künstliche Intelligenz 2010) [46]
- User Modelling and User-Adapted Interaction [32]

Robotic Companions, Social Robots, Robot/Human-Interaction

- International Journal of Social Robotics (IJSR) [33]
- Journal of Human–Robot Interaction [34]
- Special Issue on Human–Robot Interaction (in IEEE Transactions on Robotics 2007) [61]
- Special Issue on Personal Robotics (in Autonomous Robots 2001) [51]

Human/Computer-Interaction

- ACM Transactions on Computer-Human Interaction [35]
- ACM Transactions on Interactive Intelligent Systems (TiiS) [36]
- Communications of the ACM [37]
- Human–Computer Interaction [38]
- i-com: Journal of Interactive Media [39]
- Interacting with Computers [40]
- International Journal of Human Computer Interaction (IJHCI) [41]
- International Journal of Human–Computer Studies [42]
- Journal of Ambient Intelligence and Smart Environments (JAISE) [43]
- Journal on Multimodal User Interfaces (JMUI) [44]

2.3 Books

- Affective Computing (1997) [63]
- Close engagements with artificial companions: key social, psychological, ethical and design issues (2010) [71]

[1] See the conference report in this special issue [59].

[2] This workshop was previously named *International Workshop on Emotion Representations and Modelling for HCI Systems* (ERM4HCI) and *International Workshop on Techniques Towards Companion Technologies* (T2CT).

- Cognitive Behavioural Systems (2012) [57]
- Companion Technology—A Paradigm Shift in Human-Technology Interaction (2016, forthcoming) [49]
- Human–Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications (2012) [60]
- Joint Cognitive Systems: Patterns in Cognitive Systems Engineering (2006) [72]
- Socially intelligent agents: Creating relationships with computers and robots (2002) [53]
- The Oxford Handbook of Cognitive Engineering (2013) [70]
- Toward Autonomous, Adaptive, and Context-Aware Multimodal Interfaces (2011) [56]

References

1. http://www.cogsys.org
2. http://www.iaria.org/conferences/COGNITIVE.html
3. http://cogsys2012.acin.tuwien.ac.at
4. http://isacs2015.joanneum.at
5. http://isct2015.informatik.uni-ulm.de
6. http://resilienceweek2015.inl.gov/CognitiveSystems
7. http://www.erm4ct.cogsy.de/index.html
8. http://neuro.informatik.uni-ulm.de/MPRSS2014
9. http://humanrobotinteraction.org
10. http://hrpr.liacs.nl/
11. http://icsoro.org
12. https://www.cs.kent.ac.uk/events/2015/AISB2015/symposia.html
13. http://www.ro-man.org
14. http://uhra.herts.ac.uk/bitstream/handle/2299/2067/902186.pdf
15. http://www.ozchi.org/
16. http://www.sigchi.org/conferences
17. http://www.hci.international
18. http://iui.acm.org
19. http://www.interact2015.org
20. http://www.intenv.org/
21. http://www.acm.org/icmi
22. http://www.percom.org/
23. http://ubicomp.org/
24. http://www.nordichi.eu/
25. http://eics-conference.org/
26. http://www.journals.elsevier.com/cognitive-systems-research
27. http://link.springer.com/journal/10111
28. http://www.cognitivetechnologyjournal.com
29. http://www.computer.org/web/computingnow/intelligentsystems
30. http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=6221037
31. http://edm.sagepub.com
32. http://www.umuai.org/
33. http://www.springer.com/engineering/robotics/journal/12369
34. http://humanrobotinteraction.org/journal
35. http://tochi.acm.org/
36. http://tiis.acm.org/
37. http://cacm.acm.org/
38. http://www.tandfonline.com/toc/hhci20/current
39. http://www.degruyter.com/view/j/icom
40. http://www.sciencedirect.com/science/journal/09535438
41. http://www.cscjournals.org/journals/IJHCI/description.php
42. http://www.journals.elsevier.com/international-journal-of-human-computer-studies
43. http://www.jaise-journal.org/
44. http://www.springer.com/computer/hci/journal/12193
45. Alford R (2016) Search complexities for HTN planning. Künstliche Intelligenz. doi:10.1007/s13218-015-0396-6
46. Beetz M, Kirsch A (eds) (2010) Special issue on cognition for technical systems. Künstliche Intelligenz 24(4): 279–365
47. Bercher P, Höller D (2016) Interview with David E. Smith. Künstliche Intelligenz. doi:10.1007/s13218-015-0403-y
48. Biundo S, Höller D, Schattenberg B, Bercher P (2016) Companion-technology: an overview. Künstliche Intelligenz. doi:10.1007/s13218-015-0419-3
49. Biundo S, Wendemuth A (eds) (2016) Companion technology—a paradigm shift in human-technology interaction. Springer, Berlin (forthcoming)
50. Biundo S, Wendemuth A (2016) Companion-technology for cognitive technical systems. Künstliche Intelligenz. doi:10.1007/s13218-015-0414-8
51. Canny JF, Agah A (eds) (2001) Autonomous robots—special issue on personal robotics, vol. 10, issue 2. Kluwer Academic Publishers, Boston
52. Crocker MW, Demberg V, Teich E (2016) Information density and linguistic encoding (IDeaL). Künstliche Intelligenz. doi:10.1007/s13218-015-0391-y
53. Dautenhahn K, Bond AH, Canamero L, Edmonds B (eds) (2002) Socially intelligent agents: creating relationships with computers and robots, vol. 3. Springer Science+Business Media. doi:10.1007/b116424
54. Demberg V, Hoffmann J, Howcroft DM, Klakow D, Torralba Á (2016) Search challenges in natural language generation with complex optimization objectives. Künstliche Intelligenz. doi:10.1007/s13218-015-0409-5
55. Ertle P (2016) Safety of autonomous cognitive-oriented robots. Künstliche Intelligenz. doi:10.1007/s13218-015-0408-6
56. Esposito A, Esposito AM, Martone R, Müller VC, Scarpetta G (eds) (2011) Toward autonomous, adaptive, and context-aware multimodal interfaces (COST 2102 International Training School—revised selected papers). Springer. doi:10.1007/978-3-642-18184-9
57. Esposito A, Esposito AM, Vinciarelli A, Hoffmann R, Müller VC (eds) (2012) Cognitive behavioural systems (COST 2102 International Training School—revised selected papers). Springer. doi:10.1007/978-3-642-34584-5
58. Gugenheimer J, Honold F, Wolf D, Schüssel F, Seifert J, Weber M, Rukzio E (2016) How companion-technology can enhance a multi-screen television experience: a test bed for adaptive multimodal interaction in domestic environments. Künstliche Intelligenz. doi:10.1007/s13218-015-0395-7
59. Hoefinghoff J (2016) ISCT 2015—1st international symposium on companion technology. Künstliche Intelligenz. Conference report in this special issue
60. Jacko JA (ed) (2012) Human–computer interaction handbook: fundamentals, evolving technologies, and emerging applications. CRC Press, Taylor and Francis Group, Boca Raton
61. Laschi C, Breazeal C, Nakauchi Y (eds) (2007) Special issue on human–robot interaction. IEEE Trans Robot 23(5):837–1104
62. Mehlmann G, Janowski K, André E (2016) Modeling grounding for interactive social companions. Künstliche Intelligenz. doi:10.1007/s13218-015-0397-5
63. Picard RW (1997) Affective computing, vol 252. MIT press, Cambridge
64. Ragni M, Barkowsky T, Nebel B, Freksa C (2016) Cognitive space and spatial cognition: the SFB/TR 8 spatial cognition. Künstliche Intelligenz. doi:10.1007/s13218-015-0404-x

65. Rösner D, Haase M, Bauer T, Günther S, Krüger J, Frommer J (2016) Desiderata for the design of companion systems: insights from a large scale wizard of oz experiment. Künstliche Intelligenz. doi:10.1007/s13218-015-0410-z
66. Schattenberg B (2016) Hybrid planning and scheduling. Künstliche Intelligenz. doi:10.1007/s13218-015-0390-z
67. Scherer S (2016) Multimodal behavior analytics for interactive technologies. Künstliche Intelligenz. doi:10.1007/s13218-015-0401-0
68. Schwarze T, Lauer M, Schwaab M, Romanovas M, Böhm S, Jürgensohn T (2016) A camera-based mobility aid for visually impaired people. Künstliche Intelligenz. doi:10.1007/s13218-015-0407-7
69. Siegert I (2016) Emotional and user-specific acoustic cues for improved analysis of naturalistic interactions. Künstliche Intelligenz. doi:10.1007/s13218-015-0394-8
70. Lee JD, Kirlik A (2013) The Oxford Handbook of Cognitive Engineering (Oxford Library of Psychology). Oxford University Press
71. Wilks Y (2010) Close engagements with artificial companions: key social, psychological, ethical and design issues. In: Natural language processing, vol 8. John Benjamins Publishing
72. Woods DD, Hollnagel E (2006) Joint cognitive systems: patterns in cognitive systems engineering. CRC Press Inc, Boca Raton
73. Worch JH, Bálint-Benczédi F, Beetz M (2016) Perception for everyday human robot interaction. Künstliche Intelligenz. doi:10.1007/s13218-015-0400-1