CrossMark

20 Years of RoboCup

Gerald Steinbauer[1] · Alexander Ferrein[2]

✉ Gerald Steinbauer
steinbauer@ist.tugraz.at

Alexander Ferrein
ferrein@fh-aachen.de

[1] Institute for Software Technology, Graz University of
    Technology, Inffeldgasse 16b/2, 8010 Graz, Austria

[2] Mobile Autonomous Systems & Cognitive Robotics Institute,
    FH Aachen University of Applied Sciences, Eupener Straße
    70, 52066 Aachen, Germany

RoboCup started with the aim to foster research in Artificial Intelligence and robotics with the brilliant vision to build autonomous robots that are able to defeat the human world champion in soccer in 2050. The vision is brilliant for several reasons. First of all, the idea of designing autonomous agents that work cooperatively on a highly dynamic task in an non-deterministic environment raises research-wise a number of interesting and hard question. From an educational standpoint, a competition like RoboCup is easily able to carry away students at different age levels, from school learners to the PhD students. Finally, such an event is attractive for the general public and gives researchers the opportunity to explain their work and get into direct contact with people from outside academia. The soccer vision was, over the years, extended with competitions for school learners as well as a number of application-driven competitions. In 2016, the 20th RoboCup took place in Leipzig, Germany. We took this anniversary as an opportunity to reflect the achievements of RoboCup of two decades, to discuss them also critically and try to give an outlook on the remaining 34 years until the deadline of the RoboCup vision in 2050.

We start this special issue with an editorial article where the different RoboCup competitions are introduced. Moreover, the development within the leagues, mainly, over the last 10 years since the last German RoboCup held in 2006 in Bremen is discussed. The authors also give a more personal view on what RoboCup means and represents, beside pure scientific issues. Finally, future developments of RoboCup are discussed.

The technical contributions in this special issue origin from different RoboCup leagues. Seekircher et al. report on research done to optimise walking parameter for the humanoid robot Nao. A fast walk is still a key to success in RoboCup; adapting walking parameters online to the

actual behaviour of the robot is crucial, in particular, because RoboCup will ever more increase the realism of the games, for instance, by playing on grass and uneven ground. The paper by Baltes et al. is also about humanoid robots. The authors address the problem of motion planning for humanoids. They propose a sample-based tree planner and combine it with an incremental simulator. This allows to ensure that the robot is dynamically stable when executing a motion command. Schiffer gives a report on a cognitive robot architecture that origins from the RoboCup@Home league. In this league, robots perform domestic tasks in an home environment such as fetch objects or guide people. Therefore, adaptive human-like reasoning and human-robot interaction are among others the key questions. In their article, Sheh et al. reflect on the development of the RoboCup rescue league during the last 16 years. Rescue was introduced as the first application-oriented competition after the big Kobe earthquake when observing a lack of technology to deal with such disasters. The article reports on the development of real robots, mainly on individual capabilities such as navigation and mapping of these robots as well as on developments in simulations which mainly concern cooperation and coordination. Romay et al. give insights into their work on semi-automated manipulation of object with a humanoid robot. Although a large part of the work is related to the DARPA Robotics Challenge where the goal is to develop humanoid robots that can support first responders, the work show that RoboCup is well able to cooperate with other competitions and to exchange ideas between different events. Finally, Niemueller et al. report on activities in the RoboCup Industrial league. This application-oriented league is rather young and pushes the research into the direction of use-cases in logistics and smart factories. The article introduces the central game infrastructure that is important to conduct the competition in a fair way, but also allows to collect useful data and to set up well-defined benchmarks and experiments. This is important for a sound evaluation of the developed methods. In the next article, Kohlbrecher et al. give an overview on a research project that spins off of the activities the research group set in RoboCup Rescue and the DARPA Robotics Challenge. In the article, the authors introduce their robot system designed for the ARGOS Challenge where the use-case is the automated inspection and maintenance of oil and gas rigs. Finally, Allgeuer et al. report on the development of the igus Humanoid Open Platform. This platform is a light-weight 92 cm heigh humanoid robot with all its body parts being 3D printed.

This platform is an open design and was developed in a collaboration between researchers at the University of Bonn and igus GmbH, a leading manufacturer of polymer bearings and energy chains.

The special issue is rounded up with three interviews. The interviews were done with people who are with the RoboCup for quite a while and look at various different aspects. We start with Minoru Asada who is one of the founder of RoboCup initiative and knows the entire history of RoboCup. He will give fascinating insights in the motivation to found RoboCup and its influence on research in AI and robotics. The interview with Rodolphe Gelin from Aldebaran Robotics reports on the fruitful cooperation of RoboCup and the vendor of Nao. This interview also focuses on the training aspects and the perception of RoboCup by the industry. Finally, in the interview with Hans-Arthur Marsiske, a writer and journalist who accompanied RoboCup for more than a decade, a motivation for basic research and a rather critical view on the responsibility of RoboCup for its developed technology is given.

1 Content

1.1 Editorial

Ferrein, Steinbauer: 20 Years of RoboCup—A Subjective Retrospection

1.2 Technical Contributions

Seekircher, Visser: An Adaptive LIPM-based Dynamic Walk using Model Parameter Optimization on Humanoid Robots

Baltes, Bagot, Sadeghnejad, Anderson, Hsu: Full-Body Motion Planning for Humanoid Robots Using Rapidly Exploring Random

Schiffer: Integrating Qualitative Reasoning and Human-Robot Interaction in Domestic Service Robotics

Sheh, Schwertfeger, Visser: 16 years of RoboCup Rescue

Romay, Kohlbrecher, von Stryk: An Object Template Approach to Manipulation for Humanoid Avatar Robots for Rescue Tasks

Niemueller, Zug, Schneider, Karras: Knowledge-Based Instrumentation and Control for Competitive Industry-Inspired Robotic Domains

1.3 Research Projects

Kohlbrecher, von Stryk: From RoboCup Rescue to Supervised Autonomous Mobile Robots for Remote Inspection of Industrial Plants

Allgeuer, Farazi, Ficht, Schreiber, Behnke: The igus Humanoid Open Platform—A Child-sized 3D Printed Open-Source Robot for Research

1.4 Interviews

Ferrein, Steinbauer: Interview with Prof. Minoru Asada
Ferrein, Steinbauer: Interview with Dr. Rodolphe Gelin
Ferrein, Steinbauer: Interview with Dr. Hans-Arthur Marsiske

1.5 Conference Report

Wachsmuth, Wrede: RoboCup 2016 Leipzig

2 Service

2.1 Journals

- Robotics & Autonomous Systems (http://www.elsevier.com)
- Autonomous Agents & Multi-Agent Systems (http://www.springer.com)
- International Journal of Robotics and Automation (http://www.actapress.com/)
- Autonomous Robots (http://www.springer.com)
- Artificial Intelligence (http://www.elsevier.com)
- Applied Artificial Intelligence (http://www.tandfonline.com/)
- Journal of Field Robotics (http://onlinelibrary.wiley.com/)
- International Journal of Humanoid Robotics (http://www.worldscinet.com/ijhr)
- IEEE Transactions on Robotics (T-RO), IEEE Robotics and Automation Society (http://www.ieee-ras.org/tro)
- Künstliche Intelligenz (http://www.kuenstliche-intelligenz.de/)
- Machine Learning (http://www.springer.com)

2.2 Conferences

- International RoboCup Symposium (http://www.robocup.org)
- International Conference on Intelligent Robots and Systems (IROS) (http://www.ieee-ras.org/)
- International Conference on Robotics and Automation (ICRA) (http://www.ieee-ras.org/)
- International Conference on Advanced Robotics (ICAR) (http://www.ieee-ras.org/)
- International Conference on Intelligent Autonomous Systems (http://www.ias-14.org/)
- International Conference on Machine Learning (ICML) (http://icml.cc/)
- International Joint Conference on Artificial Intelligence (IJCAI) (http://www.ijcai.org/)

- European Conference on Artificial Intelligence (ECAI) (http://www.ecai2016.org/)
- International Conference on Autonomous Agents and Multiagent Systems (AAMAS) (https://sis.smu.edu.sg/aamas2016)
- IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) (http://www.ieee-ras.org/)
- International Symposium on Safety, Security and Rescue Robotics (SSRR) (http://www.ieee-ras.org/)
- International Conference on Human-Robot-Interaction (HRI) (http://www.ieee-ras.org/)
- International Conference on Automated Planning and Scheduling (ICAPS) (http://www.icaps-conference.org/)

2.3 Books

- Siciliano and Khatib. *Springer Handbook of Robotics*. Springer. Second Edition. 2017.
- Russel and Norvig. *Artificial Intelligence: A Modern Approach*. Third Edition. Pearson Education. 2010.
- Wooldridge. *An Introduction to Multi-Agent System*. Second Edition. John Wiley & Sons. 2009.

2.4 Online Resources

- The RoboCup Federation (http://www.robocup.org)
- RoboCup Humanoid League (https://www.robocuphumanoid.org/)
- The RoboCup Soccer Simulator (https://sourceforge.net/projects/sserver/)
- RoboCup Small Size vision (https://github.com/RoboCup-SSL/ssl-vision)
- RoboCup Standard Platform League (http://www.tzi.de/spl/)
- RoboCup Rescue Agent Simulation (http://roborescue.sourceforge.net/)
- RoboCup@Home League (http://www.robocupathome.org/)
- RoboCup Logistics League (http://www.robocup-logistics.org/)
- RoboCup@Work League (http://www.robocupatwork.org/)
- RoboCupJunior Leagues (http://rcj.robocup.org/)

2.5 Mailing Lists

- RoboCup Worldwide—General Information (https://lists.cc.gatech.edu/mailman/listinfo/robocup-worldwide)

- Simulation League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-sim)
- Small Size Robot League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-small)
- Middle Size Robot League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-mid)
- Standard Platform League (https://mailman.cc.gatech.edu/mailman/listinfo/robocup-nao)
- Humanoid League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-humanoid)
- RoboCup@Home League (http://lists.robocup.org/listinfo.cgi/robocup-athome-robocup.org)
- RoboCup Rescue Robot League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-rescue-r)
- RoboCup Rescue Agent Simulation League (https://lists.cc.gatech.edu/mailman/listinfo/robocup-rescue-s)
- RoboCup Rescue Virtual Robots (https://lists.cc.gatech.edu/mailman/listinfo/robocup-rescue-v)

- RoboCup@Home (http://lists.robocup.org/listinfo.cgi/robocup-athome-robocup.org)
- RoboCup Logistics League (https://lists.kbsg.rwth-aachen.de/listinfo/robocup-logistics)
- RoboCup@Work (http://lists.robocup.org/listinfo.cgi/rc-work-robocup.org)
- RoboCupJunior (https://lists.cc.gatech.edu/mailman/listinfo/robocup-junior)