Künstl Intell (2016) 30:225–232
DOI 10.1007/s13218-016-0449-5

TECHNICAL CONTRIBUTION

20 Years of RoboCup

A Subjective Retrospection

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Received: 10 July 2016 / Accepted: 20 July 2016 / Published online: 17 August 2016

Abstract This summer, RoboCup competitions were held for the 20th time in Leipzig, Germany. It was the second time that RoboCup took place in Germany, 10 years after the 2006 RoboCup in Bremen. In this article, we give an overview on the latest developments of RoboCup and what happened in the different leagues over the last decade. With its 20th edition, RoboCup clearly is a success story and a role model for robotics competitions. From our personal view point, we acknowledge this by giving a retrospection about what makes RoboCup such a success.

1 Introduction

The first RoboCup competitions were held in 1997. RoboCup [4] started out for bringing forward research in robotics and artificial intelligence by defining a common interesting and challenging problem; the robot soccer challenge was proposed. The challenge is phrased as: *By the middle of the 21st century, a team of fully autonomous humanoid robot soccer players shall win a soccer game, complying with the official rules of FIFA, against the winner of the most recent World Cup*. The beauty in this challenge that replaced earlier static benchmarks like chess is that everybody understands it easily, hooks up people emotionally with research and raises real hard problems like a robot team and a complex non-deterministic environment. Researchers from all over the world started to work on these problems within the RoboCup initiative. For 20 years now, annual competitions take place to assess how far the community is along the road to meet this grand vision.

The 20th edition of RoboCup has taken place in Leipzig, Germany, between June 30 and July 4, 2016. Participants from all over the world gathered to show their latest achievements in the field of autonomous robots and agents.

Similar to research and technology, RoboCup advanced but also changed dramatically during the last 20 years. For instance, better algorithms, novel sensors and immensely increased and mobile computational power allows robotics solutions that no one really imagined in the beginning. The technological advances and smart solutions made also the competitions increasingly attractive for a broader audience which led to a continuous interest of the general public in RoboCup. Following the grand challenge, soccer is still the main focus of RoboCup, competitions in the *Soccer Simulation League, Small-Size League, the Middle-Size League, the Standard Platform League* as well as the Humanoid League are held concentrating on different aspects of soccer robots. These range from simulated agents over small-scale semi-autonomous robots to humanoid robot soccer players. A more detailed overview of the different leagues will be given in the next section. Over the years, the scope of the robotic competition besides soccer has broadened towards other important robotic applications such as urban search and rescue robots, domestic service robots, and mobile robots in industrial applications. In the *RoboCup Rescue League* as well as the *Rescue Simulation League* rescue robots and simulated agents need to mitigate

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a disaster scenario such as an earthquake by extinguishing burning houses, navigating in an unstructured environment while mapping it and finding possible victims. In the *RoboCup@Home* league, domestic service robots have to solve challenging tasks such as guiding people or find lost items in a domestic home environment. In the *RoboCup Industrial Leagues*, mobile robots should organise the supply chain by bringing material to the right machines in time or assemble complex products. Finally, the *RoboCupJunior* leagues takes place with soccer, rescue and dance competitions to motivate students in school to get involved with technology. In RoboCupJunior Soccer and Rescue, robots play a slightly simplified soccer match (compared to the major leagues) or try and find victims at a simplified disaster site; with the dance competition, the students need to develop a choreography and dance with their robots on stage.

At the 10th anniversary, Visser and Burkhard reviewed the achievements of RoboCup [10] a first time. Against the backdrop of their report after 10 years of RoboCup, we review what happened in the second decade of RoboCup in the next section. But RoboCup is much more than improved algorithms and robots or new leagues and competitions. It is a great vehicle to educate future academic and technical staff, allows for imparting broad knowledge in the field of robotics, multi-agent systems and artificial intelligence. Moreover, it forms a dense and big enough network of talented people that allows to push forward ideas on a global scale. The authors have quite some experience with RoboCup and played different roles in the community over the years. We want to share our positive experiences with the other non-technological benefits of the RoboCup initiative in Sect. 3. Then in Sect. 4, we give an outlook of possible future ways for RoboCup, before we conclude.

2 Brief Review of the Last 20 Years

In this section, we will not be re-iterating the overview of the the 2006 paper by Visser and Burkhard [10] who gave an in-depth overview of the state of affairs of RoboCup after 10 years. Instead, we want to report on what happened during the second decade of RoboCup, assuming that the reader is somewhat familiar with the RoboCup idea or might have had a look at the paper by Visser and Burkhard. As an additional information source an online video on the history of the soccer competitions might serve [9]. Plenty of further information can be found on the Web as well.

2.1 The Leagues

Simulation League The focus of Simulation League competitions is on multi-agent systems and high-level decision making. In the 2D simulation league, two teams of eleven software agents compete against each other on a simulated soccer pitch. While noise is also simulated, this league mostly abstract away many of the problems that appear when real hardware is involved. The developer of software agents can focus on team strategies and decision making. This league has not much changed during the last ten years and still enjoys many participants (in 2015 there were 19 teams participating). As the simulator as well as the source code of the winning teams is publicly available, this league is an easy and cost-effective way to start teaching and research in the area of multi-agent systems. What changed significantly during the last decade was the 3D Soccer Simulation League. While in 2006 the first 3D simulation events took place where the players where represented by spheres, today, the the 3D simulation is about teams of nine simulated Softbank NAO robots that compete. The league developed from a purely agent-based approach more towards a simulation where the embodiment and the complexity of humanoid robots as well as the third dimension of the environment are of importance. Refer to http://wiki.robocup.org/wiki/Soccer_Simulation_League for more information.

Small-Size League The Small-Size League (SSL) is about semi-autonomous soccer robots of a diameter of 18 cm with a height of up to 15 cm. The robots and the players are tracked by a global overhead vision system. The information processed by a standardised vision system will be sent to both teams where the decision-making process takes place on off-side computers. In 2010, the standard SSL vision system was introduced [13]. Before, each team used their own cameras and vision systems. Over the years, also field size constantly grew from 3.4×4.9 m in 2006 to 6×9 m today. Despite constant rumours that not much new insights can be yielded by the SSL competitions, it survived for 20 years. Still, the matches are fascinating. Due to the limited mass of the robots and the off-board computers the game is unbelievably fast paced, the robots show impressive passing behaviours, loop shots and collaborative play which make matches in the SSL always fun to watch. An overview of the development of the SSL is also given in [11], the SSL web page is at http://robocupssl.cpe.ku.ac.th/.

Middle-Size League Another league from the first instance of RoboCup is the Middle-Size League (MSL). The league developed from slow-driving robots on very small soccer fields enclosed by walls to soccer robots that drive up to 4 m/s, are able to dribble and pass the ball precisely to a teammate who will score the goal. The field grew from 3×4 m to 12×18 m today. All colour codings which made the life easier for the robots disappeared during the last decade. The final major improvement was to enforce that robots have to pass the ball to their teammates

before crossing the half-way line in order to enforce cooperation between the robots. Unlike in SSL, MSL robots are fully autonomous, that is, they have all the sensors and computing power on-board. The rules of the match are governed by a referee box, an automated referee system, which is able to interrupt the match and send the game state to the robots. Still, a human referee has penalise rule infringements of the robots. Despite the fact that the robots still have wheels this league is the one closest to real soccer. A nice overview of the development of the MSL can be found in [7]. Further information on the MSL is available at http://wiki.robocup.org/wiki/Middle_Size_League.

Humanoid League The goal of the Humanoid League (HL) is to have teams of humanoid robots playing football on a field of 9×6 m. The league is working towards the ultimate RoboCup goal to win against the FIFA world champion team with a team of humanoid robots by 2050. There are three different sizes of robots allowed: KidSize, TeenSize and AdultSize. The leagues made impressive progress. While in the first years robots only could do penalty shoot-outs, now the game-play enjoys passing behaviours and dives by the goal keepers. Several teams have developed standardised robots which can be used by other teams. Although the league benefits from tremendous developments in miniaturisation of sensors, actors and computers, in battery technology, and materials building a competitive humanoid robot remains a challenge by its own. The community also focuses on advancing the humanoid soccer challenge scientifically. There exists a workshop series on "Humanoid Soccer Robots"; a large number of high quality articles have been published from the community. An overview of the leagues and its development can be found at https://www.robocuphumanoid.org.

Standard Platform League The Standard Platform League (SPL) emerged from the Sony Four-Legged League as Sony stopped the production of the AIBO robot. Since 2008, the four-legged standard AIBO was replaced by the humanoid NAO platform. Many of the solutions resemble the problem of the KidSize Humanoid League. While part of the effort in the HL focuses also on hardware design of humanoids, the Standard Platform League (SPL) builds on equal hardware for all teams and the focus lies on the software design and control algorithms for humanoid robot. Up to five NAO robots (plus one coaching robot) per team compete on a field of 9×6 m. Research focuses in this league on perception with limited resources and shaky data and fast and reliable walking algorithms. In 2016—in order to push the grand challenge—a first game outdoor with artificial grass was conducted. More information on the SPL are available at http://www.tzi.de/spl/bin/view/Website/WebHome.

Rescue Robot Leagues The Rescue Robot League (RRL) deals with the development of robots that can assist first responders in mitigating a disaster such as an earthquake or an accident in an industrial environment. The goal is to keep the human out of the dangerous areas while providing decent reconnaissance and manipulation skills. The capabilities needed by these robots are quite different to soccer robots. The robots need advanced mobility skills to be able to traverse an unstructured environment such as a collapsed building. In order to provide as much information as possible from the disaster site remotely, sensors and algorithms for mapping the environment and detecting signs of life of potential victims are important. Moreover, as only one human supervisor is allowed in the competition, clever user interfaces are crucial, in particular, if multiple robots are deployed. In contrast to the soccer leagues, in this league autonomous as well as teleoperated robots are allowed. In the last years, the league came up with incredibly robust and skilled robot systems. During the years challenges for manipulation were added as this skill is important for disaster mitigation in order to clear debris, inspect confined spaces or close valves. What is more, the league strongly pushed into the direction of automated mapping leading to standard mapping tools [6]. The league also benefits from ROS as a common software framework. Currently, a shift from 2D mapping to 3D mapping is going on. Recently, the league re-organised its competition schema from a complete mission-oriented setup to a more skill-oriented setting. The idea is to improve the evaluation of individual skills. The original mission-oriented setup is still used in the finals to challenge the best teams at the end. Finally, following the common trend the league introduced challenges for UAVs and outdoor scenarios.

Rescue Virtual Robot Leagues In the Rescue Virtual Robot Leagues a high-fidelity simulation of a disaster site including collapsed and burning buildings is used. Moreover, all aspects of the robots used in the virtual competition such as sensing and locomotion are simulated in detail. The advantage of this league is that large scale scenarios can be simulated in a realistic fashion and that a number of homogeneous and heterogeneous robots can be deployed. Despite the fact that no real hardware is involved the challenges such as perception, mapping, self-localization or path planning are similar to the real robot league. Due to the higher number of robots and the way larger scenario the robots need to cooperate in order to mitigate the disaster in time. In recent years, the spread of the league was limited by a very special simulator setup. In the future the league will change to the well-recognised and commonly used ROS software framework and the well-connected Gazebo simulator. This step will increase the number of potential users.

Rescue Agent Competition The Rescue Agent Competition resembles as well a large-scale disaster such as an earthquake in a city area. In contrast to the virtual robot league details of the robots are more abstract. Instead, the league used different kinds of agents; the agents belong either to the ambulance, the fire brigade or the police. The agents of the different groups provide different skills: a police agent is able to clear a blocked road while a fire brigade agent is able to extinguish a fire. The main challenge of the league is to coordinate the different agents in order to minimize the harm to the environment and civilians within it. Besides interesting research challenges in the area of multi-agent planning and scheduling, dealing with limited and uncertain information is a key issues. As the agents have only local and imprecise perception and communication is limited, it is a challenge to obtain a global consistent view on the disaster quickly. In recent years, the agent simulator was completely re-developed in JAVA. Moreover, standard libraries were developed that hide away the low-level aspects of the simulation. These advances made the use of the simulator quite easy and thus the simulator is popular also outside the RoboCup community as a benchmark for distributed decision making and coordination [5].

RoboCup@Home In 2006, the first RoboCup@Home competition was held. RoboCup@Home is a robotic league which aims at developing domestic service robots. Personal service robots are to support with chores and tasks in home environments ranging from finding lost objects to mixing beverages and cooking meals or help with grocery shopping. One of the main driver of the league is the development of (close to) product-ready robots. A variety of challenging robotics tasks from localization, object and speech recognition to mobile manipulation are involved to solve the different test scenarios that the robots have to cope with. The complexity of the tests gradually change from year to year. If most of the teams were able to fulfill a certain test in one competition, the tests will be even more challenging in next year's competition. This drives the development among the participating teams and pushes the limits in this applied RoboCup league. During the years a quite large variety of robots had been developed. This allowed the league to develop a quite large set of solution but also slowed down the league's development because standard modules can hardly be developed. Therefore, in 2016 the league decided to introduce two standard service robots (Softbank, Toyota) like in soccer standard platform league. It is expected that this will speed up the development of the league even more. Information about RoboCup@Home can be found at http://www.robocupathome.org/.

RoboCup industrial This year, the competitions in the RoboCup Logistics League (RCLL) and the RoboCup@Work Demonstration League took place under the umbrealla league RoboCup Industrial. The idea is to address problems relevant in manufacturing scenarios where mobile robots are deployed. In the RCLL, teams of mobile robots have to control the material flow in a production scenario, supplying machines with raw materials and delivering final products in order to fulfill production plans and orders that come in dynamically during the game. The challenges are here planning and scheduling of the individual tasks besides safe navigation of a group of robots. The focus in the RoboCup@Work chapter of the league is on challenging tasks in mobile manipulation. The motivation is how a mobile robot equipped with a manipulator can autonomously assemble parts. Important research questions are among others object recognition and manipulation. The official RCLL website is http://www.robocup-logistics.org/, information about RoboCup@Work can be found at http://www.robocupatwork.org/.

RoboCup junior The RoboCupJunior initiative had its first official competition in the year 2000. Since then, hundreds of learner teams in the ages group up to 19 years participate in RoboCupJunior Soccer, RoboCupJunior Rescue and RoboCupJunior Dance competition. In over 40 countries, national contests are held with thousands of participants. RoboCupJunior can be counted a big success to spark interest for science, technology and engineering (STEM) in learners. A large number of publications address the benefits and/or the shortcomings of RoboCupJunior as vehicle to teach STEM subjects [3]. RoboCup Junior is often also the start of a much denser and longer RoboCup career. RoboCup has now participants in the major leagues who pursuits their PhD and started in RoboCup Junior. A major difference to other robot competitions for young people is that in RoboCupJunior participants develop alongside with world-leading robotics and AI researchers. This motivates the youngsters a lot and shows them what is possible. More resources about RobCupJunior can be found at http://rcj.robocup.org/.

2.2 Achievements

During the last decade, the RoboCup initiative evolved quite a bit. In all leagues, the object and environment detection capabilities have improved as walls, colour markers and the like were banned from the field over the years. In all leagues the competition fields and arenas made tremendous progress towards realistic settings (i.e. increased size, less structured). The strategies of the behaviours of the robots became more sophisticated as fundamental perception and decisional problems are not finally solved, but advanced stable solutions exist. One can observe ball passing behaviours and strategic planning on the pitch. The hardware development in different leagues

became more mature, in some leagues certain hardware designs and sensor setups prevailed.

Another major step of the RoboCup initiative was the integration of so-called "application leagues" such as RoboCup Rescue, RoboCup@Home and RoboCup Industrial. With these leagues interesting and also societal and economical relevant problems are addressed under the roof of RoboCup competitions. RoboCup Rescue and RoboCup@Home celebrate their sixteenth and tenth anniversary, respectively. The latest entry of a RoboCup league is the RoboCup Industrial league, which unites the RoboCup Logistics League and the RoboCup@Work Demonstration League—both have been running for several years now—under a common name. While the grand soccer challenge still drives general developments within RoboCup due to the lack and need of a "real" purpose, the application leagues foster solutions to concrete practical problems.

Further achievements throughout the different leagues are that the participants in the leagues together with their league executives always were willing to improve the rules and prepare new challenges for the teams from year to year. Sometimes these adaptations are rather smooth, but sometimes they are quite disruptive. For instance, the removal of the colour markers of the goals in the soccer leagues required the teams to develop methods that are able to maintain a global orientation on a basically symmetric field. On short terms, such changes negatively affect the performance and the beauty of the competitions, but, in the longer run, allow significant progress.

Another achievement of the RoboCup community as a whole is to disseminate results inside the community in the annual RoboCup Symposium, but also outside the community; numerous RoboCup-related contributions to renowned conferences and high-ranked journals have been made, for instance, special issues in journals or special sections [1, 2, 12]. The different leagues also provide bibliographies of league-related publications, for instance, more than 400 papers in the SL[1], more than 400 MSL papers[2] or more than 400 papers in RoboCup@Home[3]. This shows that after 20 years RoboCup with its different challenges is still a driving force for scientific advancements. But also for researchers who do not participate directly in the RoboCup competitions, the different challenges are useful as they serve as well-recognised benchmarks in various research areas such as planning, machine learning [8] or multi-agent coordination [5].

[1] http://www.cs.utexas.edu/~pstone/tmp/sim-league-research.

[2] http://wiki.robocup.org/images/8/80/Msl_bib.

[3] https://robocup.rwth-aachen.de/athomewiki/index.php/Publications.

3 What is Intriguing About RoboCup: A Personal View

During the last two decades, quite some steps forward to reach the ultimate goal of RoboCup have been taken. The competitions become more and more challenging from year to year. Likewise, the environment becomes gradually more realistic, or, to put it differently, less artificial. Colour markers, for instance, have nearly completely disappeared from the soccer competitions. For the participating teams, this means that they have to cope with new challenges every year.

Besides these technical challenges on the road to win against the then reigning human football world champion team with a team of humanoids, there is much more to RoboCup than *just* the technical competition. Having ever participated or visited a RoboCup event and experienced the atmosphere of some three thousand robot enthusiasts, it is clear that a RoboCup is a very special event. RoboCup is different to any other scientific conference and any other technical exhibition. Cutting-edge research and development do not stay abstract, but rather follow the "get-your-fingers-dirty" paradigm. Thus, the participants are much more directly exposed to the technology and also visitors get attached; this leads to a fascinating outreach to the general public. The latter is important to help the broader audience to understand the developed solutions, but also to learn about the open problems in robotics and AI. RoboCup allows to interact with researchers directly and on equal footing.

From the authors' experience (who filled quite different roles in RoboCup from team captains with different teams in different leagues, league chairs, and even RoboCup general chairs), one can say that students participating in RoboCup can, besides learning to program or build robots and agent systems, acquire a number of additional skills:

- *Interdisciplinary work* to run and maintain a team, usually, a number of different disciplines are required: from electrical or mechanical engineers over software developer to AI experts. These need to work together as a team. Right from the beginning, RoboCup participants learn to deal with different disciplines, different languages and contexts and diverse people.
- *Organisational skills* The team members have to organise their time and their work, often also their trips, need to raise funds to finance a RoboCup participation. Participation in a team is often a spare time activity besides studies or research activities.
- *Deadline-driven work* One of the best lessons of RoboCup to learn is that, if the software is not ready on time, the robot possibly will not move. This bitter experience helps to try and make better project plans in

advance and sometimes it works out. Further, it is a good experience to sit late hours with teammates to debug code right before the next competition.
- *Team-driven development* The robot hardware and software has to be developed in a team as well. The students learn state-of-the-art design and software development tools; a subject that is not necessarily part of every university's curriculum.
- *Community building* RoboCup gives participants exposure to the scientific community. The teams get into touch with other students, staff, but also with renowned researchers without any barriers. It is easy to build up networks that could even be relevant in future careers. Usually these networks are sustainable and allow also to set up things easily in academia and industry outside of RoboCup. These network also allows a constant exchange of RoboCup with the other world.

Many of the skills are not only required in academia. We learnt from former students that many of the things experienced during RoboCup was very valuable in their later industry jobs. Also from the industry side one can hear that it is valued if a candidate has RoboCup background, in particular, resilience, focus, and self-management skills are esteemed. Besides these skills that may or may not be achieved when being part of a RoboCup team, RoboCup is able to excite people. Visitors of a RoboCup tournament are excited about (sometimes) thrilling football games, about cool and cutting-edge technology (of which most is hold together by duct tape), and a bunch of nerdish people who are actually able to communicate with others just like ordinary human beings.

Another positive influence of RoboCup is on the teaching side. Not only the RoboCupJunior activities show that robotics competitions is a good vehicle to teach STEM. Also as university lecturers, we value the excitement of the students when they get to solve "real" robotics problems in their practicals, rather than working on already known stuff from the last year's course.

All in all and not only in our opinion, the RoboCup initiative as being one of the first such competition has left a bold impression in the landscape of the robotic and AI competitions of these days. It gives an impression of the state of robotics and AI technology and displays it to a broader audience. RoboCup is great for education with its project-based approach where participants learn complex subject matters from maths, computer science and engineering hands-on. The mostly student teams often organise themselves and gain experience how to run projects, skills which they will need in their future jobs.

Fascinating to see is also the self-organisation of the RoboCup. The participants not only invest a lot in preparing their robots for the competition. RoboCup is carried by voluntary work by the participants. A lot of effort is made by the participants by developing new ideas for the league, maintaining the rule books, providing the infrastructure for the competitions and last but not least prepare and conduct the actual competitions. This work is usually also done besides the regular studies or research and teaching work. Probably, this is also one of the secrets of the ongoing success of RoboCup as academia should have exactly such an altruistic mission, as we want to call it, and can provide support like this.

4 Thirty-Four More Years to Go!

Reviewing the timeline of the different RoboCup leagues (Fig. 1) it becomes apparent that there is quite some way to go until the 2050 deadline. A lot more effort will be required to meet the ultimate RoboCup goal, but there is also a fair amount of time left.

In times where robots start becoming more and more part of our every day lives, where we experience the first self-driving cars, where service robots start showing us our ways around in shopping malls or airport terminals, what future directions and challenges need to be taken and focussed on to keep pushing the envelope.

We asked Itsuki Noda, the serving president of the RoboCup Federation, about his views on future directions: "In the next 10–20 years, RoboCup will move toward realising robots that can interact flexibly with humans. For this goal, we need to establish technologies to handle 'intentions'. The question is how robots understand human intentions and how robots can express their intentions to human. In the case of human-human collaboration, people understand each other's intentions so that the collaboration is so smooth. On the other hand, current human-robot interaction is quite awkward, because both, human and robot, cannot understand each other's intentions or action plans."

The problem Noda addresses here is quite obvious. For instance, when it comes to driving in street traffic, humans communicate a lot with gazing or pointing. This is something that is quite a challenge for self-driving cars. Noda points out that intention estimation is of key importance in all human-robot interaction: "In RoboCup, recently, @Home is attracting new participants so much. In @Home games, interaction with human is a key technology. To handle 'intention' is also important in soccer games. In our final goal, we are thinking to have a soccer match between humans and robots. In such a game, both of humans and robots need to understand intentions for their safety and smooth teamwork."

Besides interaction with humans, robots need to get out of the laboratories and need to operate under the harsh

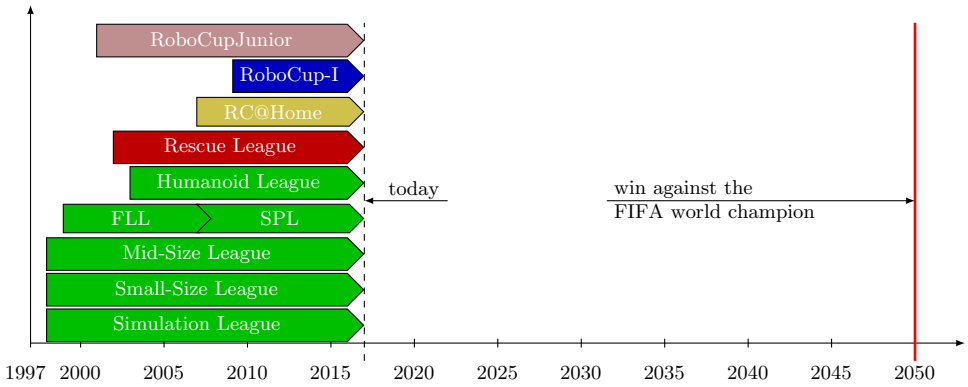

Fig. 1 Timeline of RoboCup Leagues

conditions of the real world. Noda states: "Wide-range availability is also important. Now, robots become to be used for various purposes in various environments. An ultimate goal of robotics is to develop robots that can work in any natural and non-controlled environments. From this year, we will start 'outdoor' challenges in various leagues, in which, robots must play games under sun-light and non-well-controlled surfaces. We will push each league to this direction shortly."

The question is also if the RoboCup grand challenge is still valid given the integration of several non-soccer leagues and the rapid development of robotics outside of RoboCup. The former president of RoboCup Minoru Asada gave a good answer to this question. RoboCup has room for both—soccer and non-soccer leagues. While the soccer leagues drive the development towards a visionary and (possibly not) reachable goal, it stimulates very basic development on a broad basis (e.g. novel materials and actuators), non-soccer leagues nicely tackle practical real-world problems. Although RoboCup is a really big and well-recognised robotics competition, several other robotics competition with clearly different objectives such as the DARPA challenges emerged. RoboCup decided to benefit also from that development and opened the stage also for competitions from outside. In 2016, the "Amazon Picking Challenge" was held at a RoboCup for the first time in order to allow cross-fertilisation between different competitions.

5 Conclusions

The different RoboCup leagues try to push the development by changing the rules from year to year in a way that the environment and the tasks become ever more realistic and obviously harder. While in the beginning of RoboCup competitions, colour markers helped the robots to localize themselves on the field or to detect the goals or the ball, now the teams have to cope with goals with nets, ordinary balls and no extra landmarks on the pitch. Likewise, laboratory conditions with controlled light conditions to facilitate object detection by cameras are given up. The teams will have to cope with daylight conditions at some point. These are in line with some of the current challenges in the field as pointed out by Itsuki Noda, the president of the RoboCup Federation. A further challenge is to improve human-machine interaction.

But RoboCup has also taken other steps to address relevant challenges. With RoboCup Rescue, RoboCup@Home and RoboCup-Industrial, important application areas for robotics technology are reflected in the competition. While the question why we need robots play soccer may have been posed, the benefit of search and rescue robots, service robots and factory robots are more obvious. Finally, with RoboCupJunior, the initiative helps to interest learners in technology.

RoboCup is quite a complex structure that addresses several issues and provides opportunities in many ways. RoboCup is having its 20th anniversary this year. By constantly changing and adapting to changes in research, academia, industry and society, RoboCup has maintained to be a relevant and a driving force in robotics and AI. For us, the RoboCup story is clearly a success story and given the momentum within the RoboCup community this will remain.

Acknowledgments We would like to thank Ubbo Visser for his advice and support in putting together this issue.

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