Video: RoboCup Robot Soccer History 1997 – 2011

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I. Introduction

RoboCup is an international initiative to foster interdisciplinary research and education in robotics, artificial intelligence, computer science, and engineering. We focus on the challenges of multi-robot systems, where robots cooperate with each other and when needed with humans to achieve goals in complex and uncertain environments, such as robot soccer, as RoboCupSoccer, robot rescue, as RoboCupRescue, and the wide spectrum of robot applications in daily life, as RoboCup@Home. We also include sponsored demonstrations that explore possible new scientific challenges, such as collaborative logistics. Furthermore, we are committed to contribute to the education of children in robotics: RoboCupJunior provides an exciting introduction to science and engineering for children. Overall, RoboCup is a large vibrant community, composed of university faculty and student researchers and engineers, school teachers, children, and parents. RoboCup serves as a substrate to a wide variety of academic entreprises, ranging from courses and class projects to undergraduate, Masters, and PhD research theses. RoboCup has an international annual event consisting of robot competitions and a symposium. RoboCup has consistently grown, from a few hundred participants in 1997 to close to 3,000 in 2011.

This 5mn video very specifically illustrates the RoboCup Robot Soccer Leagues and their technical evolution through these 14 years of research, development and competitions. The video is organized according to the four robot soccer leagues, namely the "Small-Size League," (SSL) the "Middle-Size League," (MSL) the "Standard Platform League," (SPL) and the "Humanoids League." Covering the 14-year evolution of four robot leagues in a 5mn video was clearly a challenging task, which we attacked with enthusiasm. We thank the help of Joydeep Biswas (SSL), Fernando Ribeiro (MSL), Brad Hall (SPL), and Marcell Missura and Ricarda Steffens (Humanoids). We hope that the general robotics community appreciates the effort in the celebration of the IROS Jubilee.

II. The RoboCup Small-Size League

The RoboCup Small-Size League (SSL) has been in place since the initial RoboCup in 1997. The league is set up as a field of pre-defined dimension for teams of up to five soccer robots of a pre-defined small dimension. The robots play with an orange golf ball. The teams are allowed to use at least one camera overhead of the field. Images captured by such a camera can be processed by an off board computer, which can plan and wirelessly communicate for the motion of the small robots on the field. The RoboCup SSL league offers challenges in hardware design, as the robots need to be small (about 15cm of width and 18cm of height); in image processing of the colored ball and colored marker identifiers of the robots; and in team strategy planning.

The video aims at illustrating the evolution of the robot hardware development from the early simple and brittle robots in 1997 to the sophisticated, fast, robust, kicking and dribbling, omnidirectional robot platforms of the current days. The hardware design of the RoboCup SSL has had a remarkable evolution over these years, and the league clearly pioneers small robot design, in contrast with all other much larger research robots in other applications. The video further aims at showing the evolution of both the vision processing and the playing strategy. Although the global view of the complete playing field is a clear advantage in capturing a complete view of the position of all the players and ball, it proved to be quite challenging to process in real time at 60Hz, 10 fast moving robots and a small orange golf ball. As the league evolved and some teams succeeded in devising vision processing algorithms, a couple of years ago such solutions became a shared vision system as part of the league setup that can be used by any team. This SSL vision is available to all researchers and can be set to be used in other applications that may need global overhead perception. In terms of strategy, the teams aimed at passing and positioning well on the field since the beginning of the league. The video clearly shows how both the capabilities of individual robots and teamwork became increasingly sophisticated and effective over the years, with the ability to dribble, to flat or chip kick, to perfectly navigate at high speeds in a space crowded with opponents as dynamic obstacles, and to coordinate the team with effective defense, accurate passes, and precise aim at narrow openings of the goals.

III. The RoboCup Middle-Size League

The RoboCup Middle-Size League (MSL) started in the first RoboCup event in 1997. The league is set on a much larger field than the SSL one, initially nine times larger than the ping-pong-table-sized SSL field. MSL robot teams are wheeled robots of a predefined larger dimension that play in teams of up to five robots. All perception and computation is required to be on the robots. The MSL robots play with an orange soccer ball of regulation size. These two SSL

and MSL leagues, which started RoboCup (along with the simulation league), were designed to offer frameworks for different robotics research interests in perception, planning, and mechanical robot design.

The video aims at showing the design of different robots evolving from a variety of initial experimental designs to the very effective, fast omnidirectional robots with creative kicking and defending actuation devices, in particular also in the goalie robots. At some point, robots had omnidirectional cameras that allowed each robot to compute the position of all the players on the field, for avoiding obstacles in its motion planning. Later, such views were not allowed by the rules, and current robots have directional cameras and wirelessly communicate with each other for sharing state information and eventual teamwork. As can be seen in the video, current teamwork accomplishments are based on the effective selection of robots to roles, with limited attacking passes. The video shows great defenses by the goalies and also amazing goals scored on rather small well defended goals. The MSL is compelling for the largest field size in RoboCup and robots of dimensions and speed that also allow humans to play with the robots. Since RoboCup 2007, a team of the RoboCup Trustees always plays a game against and with the MSL winning team. Such demonstrations are well appreciated and push forward RoboCup research.

IV. The RoboCup Standard Platform League

In 1997, Sony approached RoboCup to offer the challenge of using their four-legged AIBO robots for robot soccer. Three universities were selected to hold a demonstration at RoboCup 1998, which was a great success. RoboCup was again breaking new ground now with teams of completely new four-legged robots with all perception and computation onboard. RoboCup started a new league in 1999, the Four-Legged Robot League, which offered a new competition set-up, namely that all the teams had an opportunity and were required to use the same four-legged AIBO robots. When the AIBOs were unfortunately discontinued several years later, RoboCup searched for a new common robot platform and selected the Aldebaran humanoid NAO robots. By then we renamed the event to be the RoboCup Standard Platform League (SPL), to contrast with the other RoboCup leagues, in which the hardware design of the robots is included in the challenges of the competitions. In 2008, we held the last competition with the AIBOs and had the first one with the NAOs.

The video first shows the evolution of the robot platforms over the years, as the companies revised and improved their robots every year, also based on the analysis of the significant testing at RoboCup. The four-legged AIBO robots offered tremendous opportunities to RoboCup researchers in a wide variety of areas, including autonomous localization with limited robot field of view and ambiguous landmarks; task-focused perception; articulated and stable kicking; and fast motion. Furthermore, in 2002, the AIBOs were equipped with wireless communication and new algorithms were developed to enable sharing of information towards role assignment leading to beautiful emergent teamwork, as planned passes and receptions were still challenging and rare. The video continues then to show the NAO robots, as a biped platform with vision and computation onboard, as well as wireless communication. We can see the evolution in walk stability and coordination of the NAO teams, as well as successful localization.

V. The RoboCup Humanoid League

RoboCup has had a longstanding commitment to research and development of humanoids, as we have set up the challenging goal of creating a team of robots that can beat the human World Cup winners by 2050. In 2000, we saw the first demonstrations of humanoids at RoboCup, and the first RoboCup Humanoid League event took place in 2002. The video shows the evolution of robots in capabilities in multiple sizes: kid size, teen size, and adult size. The initial competitions started as just penalty shoot outs, to then become real games with robots kicking, passing, defending, and even goalies throwing the ball. As the smaller robots become faster and more agile so that they can be given improved strategy, the mechanical and power challenges are becoming focussed on the larger teen and adult-sized platforms.

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