

RoboCup : RoboCup World Championship and Conference

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Abstract— RoboCup (Robot World Cup Initiative) is the most famous soccer robot competition in the world. RoboCup was created in 1996 by a group of Japanese, American, and European artificial intelligence and robotics researchers with a formidable, visionary long-term challenge. However, RoboCup was originally established as an international joint project to promote AI, robotics, and related field. To go toward this aim, the soccer game is selected as a primary domain in RoboCup and soccer game competitions and international conferences have been organized at different places of the world every year since 1997. Currently, about 35 countries and 3,000 researchers are participating in the RoboCup project. The final goal of the RoboCup project is to develop a team of fully autonomous humanoid robot soccer players, according to the official rule of the FIFA that can win against the human World Cup champion team until 2050. In this article, we focus on RoboCup robot soccer, and present its five current leagues, which address complementary scientific challenges through different robot and physical setups.

I. INTRODUCTION

RoboCup (Originally called as Robot World Cup Initiative) is an international joint project to promote AI, robotics, and related field. It is an attempt to foster AI and intelligent robotics research by providing a standard problem where wide range of technologies can be integrated and examined, as well as being used for integrated project-oriented education. RoboCup chose to use soccer game as a central topic of research, aiming at innovations to be applied for socially significant problems and industries. RoboCup was founded in 1997 with the main goal of “developing by 2050 a Robot Soccer team capable of winning against the human team champion of the FIFA World Cup”. The domains offer a wide range of platforms for researchers with the potential to speed up the developments in the mobile robotics field. RoboCup chose to use soccer game as a primary domain, and organizes RoboCup: (originally called "The Robot World Cup Soccer Games and Conferences", now called "RoboCup World Championship and Conference").^[5]

Technology: In order for a robot team to actually perform a soccer game, various technologies must be incorporated including design principles of autonomous agents, multi-agent collaboration, strategy acquisition, real-time reasoning, robotics, and sensor-fusion. RoboCup is a task for a team of multiple fast-moving robots under a dynamic environment. RoboCup also offers a software platform for research on the software aspects of RoboCup. The name

RoboCup is a contraction of the competition's full name, "Robot Soccer World cup". The ultimate goal of RoboCup player is a humanoid type that can run and kick or pass a ball with its legs and feet, can throw a ball with its arms and hands. The contest currently has four major competitions, each with a number of leagues:^[9]

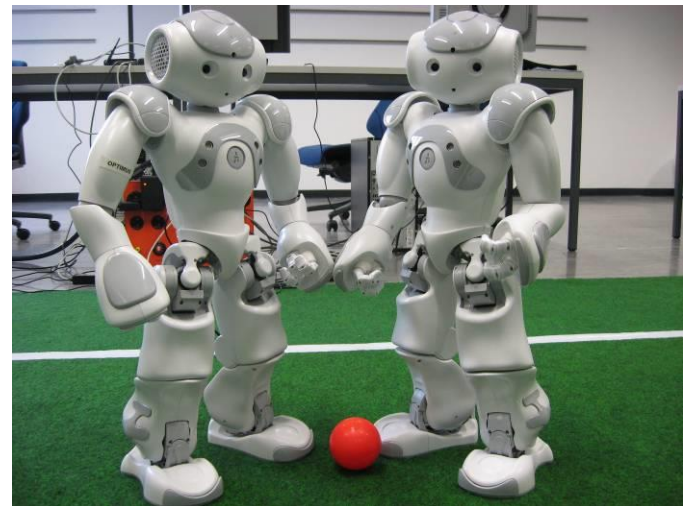


Fig. 1 Robot League

II. BRIEF HISTORY

The idea of robot playing soccer/football game was first mentioned by Professor Alan Mackworth (University of British Columbia, Canada) in a paper titled On Seeing Robots presented at VI-92, 1992. The concept of soccer-playing robots was first introduced in 1993. Soccer Server Version 1.0 (C++ Version) completed, and started distribution through the web site, as well as the first public demonstration was made at IJCAI-95. During the International Joint Conference on Artificial Intelligence (IJCAI-95) held at Montreal, Canada, August, 1995, the announcement was made to organize the First Robot World Cup Soccer Games and Conferences in conjunction with IJCAI-97 Nagoya. Following a two-year feasibility study, in August 1995, an announcement was made on the introduction of the first international conferences and football games. In July 1997, the first official conference and games were held in Nagoya, Japan. Followed by Paris, Stockholm, Melbourne and Seattle where the annual events attracted many participants and spectators.[3] The 6th RoboCup 2002 was held in Fukuoka, Japan in cooperation

with Busan, Korea, while the 7th edition in 2003 took place in Padua, Italy. In 2004 in Lisbon, Portugal. 2005 in Osaka, Japan, 2006 in Bremen, Germany, 2007 in Atlanta, USA, and RoboCup 2008 in Suzhou – China, RoboCup 2009 in Graz – Austria, RoboCup 2010 in Singapore, RoboCup 2011 in Istanbul – Turkey, RoboCup 2012 in Mexico City – Mexico, RoboCup 2013 in Eindhoven – The Netherlands, RoboCup 2014 in João Pessoa – Brazil, and in now RoboCup 2015 in Hefei –China and RoboCup 2016 Leipzig - Germany. The events were covered by national and international media all over the world. ^[5]

III. OBJECTIVE

It is our intentions to use robocup as a vehicle to promote robotics and ai research, by offering publicly appealing, but formidable challenge. One of the effective ways to promote engineering research, apart from specific application developments, is to set a significant long term goal. When the accomplishment of such a goal has significant social impact, it is called the grand challenge project. Building a robot to play soccer game itself do not generate significant social and economic impact, but the accomplishment will certainly considered as a major achievement of the field. We call this kind of project as a landmark project. Robocup is a landmark project as well as a standard problem.

The Dream: The official goal of the project: "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. ^[4]

IV. ROBOCUP LEAGUES

A. RoboCup Soccer: The main focus of the RoboCup competitions is the game of soccer, where the research goals concern cooperative multi-robot and multi-agent systems in dynamic adversarial environments. All robots in this league are fully autonomous. The RoboCup activities are competitive football. The games are important opportunities for researchers to exchange technical information. They also serve as a great opportunity to educate and entertain the public. There are five leagues in RoboCup Soccer: Simulation League, Small Size League, Middle Size League, Standard Platform League (formerly Four Legged League), Humanoid League. ^[1]

1). Simulation League: Independently moving software players (agents) play soccer on a virtual field inside a computer. This is one of the oldest fleet in RoboCup Soccer. There are subleagues: 2D, 3D, 3D development and Mixed Reality (formerly called Visualization). Mixed Reality subleague is using thumb-size robots (Eco-be system) bridging between simulation and physical robots.

2). Small-size Robot League: Small robots of no more than 18 cm in diameter play soccer with an orange golf ball in teams of up to 5 robots on a field with the size of 6.5m x 4.5m. Matches have 10-minute halves. This league focuses

on the issues of multi-agent cooperation with a hybrid centralized/distributed system.



Fig. 2 Small size internal league

3). Middle-size Robot League: A sample video of RoboCup Soccer Middle-Size League at the 2009 RoboCup German Open Middle-sized robots of no more than 50 cm diameter play soccer in teams of up to 6 robots with an orange soccer ball on a field the size of 12x18 metres. Matches are divided in 15-minute halves. All sensors are on-board. Robots can use wireless networking to communicate.



Fig. 3 Middle size leagues

4). Standard Platform League: The Standard Platform League replaces the highly successful Four-Legged League. In the league all teams use identical (i.e. standard) robots. The robots operate fully autonomously, i.e. there is no external control by humans or computers. RoboCup 2008 included the Four-Legged Standard Platform League with the Sony AIBO robots, and the Two-Legged Standard Platform League with the Aldebaran Robotics humanoid NAO robots.

5). Humanoid League: This league was introduced in 2002. Biped autonomous humanoid robots play in matches as well as "Technical Challenges". This league has two subcategories: Kid-size and Teen-size.

Area of Robotics: Control of the robots relies on several areas of robotics, including Adaptive control, artificial intelligence, classification and clustering, data mining techniques, digital control, feedback control regulation, etc

B. RoboCup Rescue: Disaster rescue is one of the most serious issues involving very large numbers of heterogeneous agents in a hostile environment. The intention of the RoboCup Rescue project is to promote research and development in this significant domain by involving multi-agent team work coordination, physical robotic agents for search and rescue, information infrastructures, personal digital assistants, standard simulator and decision support systems, evaluation

benchmarks for rescue strategies and robotic systems that are all integrated into a comprehensive system in future. There are two types of rescues: RoboCup rescue robot leagues, RoboCup rescue simulation leagues. ^[11]

C. RoboCup Junior: RoboCup Junior is a project-oriented educational initiative that sponsors local, regional and international robotic events for young students. The focus of the Junior league lies on education. RoboCup Junior provides a unique opportunity for participants with a variety of interests and strengths to work together as a team to achieve a common goal. Soccer Challenge, Dance Challenge, Rescue Challenge, General. ^[12]

D. RoboCup @Home: RoboCup @Home focuses on real-world applications and human-machine interaction with 1autonomous robots. The aim is to promote the development of robots that will aid humans in everyday life. The scenario involves the home itself. The first demonstration was held in 2007 Bremen. Each team is fully autonomous in all RoboCup leagues. Once the game starts, the only input from any human is from the referee. ^[11]

V. RESEARCH ISSUES OF ROBOCUP

The following list gives some of the research areas involved in RoboCup: (1) agent architecture, (2) combined reactive and modelling-planning approaches, (3) real-time Recognition, Planning, and reasoning, (4) reasoning and action in a dynamic environment, (5) sensor fusion, (6) multi agent system, (7) behaviour learning for Complex tasks, (8) strategy acquisition, (9) cognitive modelling.

VI. RESCUE SIMULATION LEAGUE, THE AGENT COMPETITION

The final goal of RoboCup-Rescue is to create the safe social system worldwide. RoboCup-Rescue Simulation Project challenges this serious problem mainly by multi-agent system technology, large-scale simulation, distribution and acquisition of information, human interface such as PDA and wearable computers, comprehensive networked system technology in addition to existing disaster prevention technologies. RoboCupRescue Simulation Project is a new practical domain of RoboCup. Its main purpose is to provide emergency decision support by integration of disaster information, prediction, planning, and human interface. ^[9]

The Agent Competition

In the RoboCup Rescue Simulator, a generic urban disaster simulation environment constructed on a network of computers, provides a platform for multi-agent systems research problems such as heterogeneous agent coordination and cooperation, and decentralized decision making using incomplete information. Natural calamities such as earthquakes and floods cause massive damage to a city with certain temporary and permanent effects like infrastructural damage and loss of civilian life respectively. In such emergencies, effective planning and execution by

the paramedics, the police and the fire fighters, who form the core of search and rescue teams, with minimal response time is critical. The primary objectives are to save as many civilians as possible and control the damage to the city. Computer aided simulations of such scenarios help governments and other organizations gain experience in disaster mitigation and management which will prepare them for an actual disaster. The RoboCup Rescue Simulator is one such generic urban disaster simulation environment executed on a network of computers. It further helps researchers focus on multiple issues in multi-agent systems such as heterogeneous agent coordination and cooperation, and decentralized decision making use of incomplete information. The RoboCup Rescue Simulation Competition (RCRSC) is held annually as part of the RoboCup. Agent teams from different parts of the world compete against each other with notable improvements in strategies every year. The nature of the competition is open. This allows for (a) the experienced teams to enhance, if not fine tune, the efficiency of the algorithms and strategies for the next year, and (b) the new participants to adjust to the level of competition quickly in a smooth fashion. The scoring policy used in the current RoboCup Rescue Simulator, which outputs a scalar value, fails to showcase an agent team's performance during a game. This leads to an intensely close finish as the difference between the scores of any two agent teams is very small. Live monitoring of a game to select the winner is required. It is an interesting challenge for researchers in multi-agent systems and mechanism design to come up with an unbiased evaluation rule, with no weak points to exploit, that assesses how well the agent teams perform.

VII. RULES AND REGULATION

The regulations provided constitute official regulations of RoboCup games, administered by The RoboCup Federation. The initial regulations were drafted in 1994. Several revisions were made from technical and logistical point of view meanwhile. The basis of the current regulation was drafted in the 1996 version of the RoboCup regulations, and is modified every year for RoboCup World Championship games. Currently, rule revisions for RoboCup are under discussion. The most up-to-date rules per league are available for your reference below. RoboCup Policy of Rule changes RoboCup's rules change in order to promote advances in the science and technology of robots and to make the league challenges closer to real world, rather than to impose artificial setups to improve league specific performance. They are reviewed annually by each league technical committee, and discussed with participants and other knowledgeable researchers in the field to draft out new rules. Regularly roadmaps for 5-10 years are discussed and are used as reference for yearly rule changes. ^[10]

VIII. PROPOSED RESULT

RoboCup was founded in 1997 with the main goal of "developing by 2050 a Robot Soccer team capable of winning against the human team champion of the FIFA World Cup". In the next years, RoboCup proposed several

soccer platforms that have been established as standard platforms for robotics research.[6] This domain demonstrated the capability of capturing key aspects of complex real world problems, stimulating the development of a wide range of technologies, including the design of electrical-mechanical- computational integrated techniques for autonomous robots. After more than 15 years of RoboCup, nowadays robot soccer represents only a part of the available platforms. RoboCup encompasses other leagues that, in addition to Soccer , cover Rescue (Robots and Simulation), @Home (assistive robots in home environments), Sponsored and @Work (Industrial environments), as well as RoboCupJunior leagues for young students.^[5] These domains offer a wide range of platforms for researchers with the potential to speed up the developments in the mobile robotics field. RoboCup has already grown into a project which gets worldwide attention. Every year, multiple tournaments are organized in different countries all over the world, where teams from all over the world participate in various disciplines. There are tournaments in Germany, Portugal, China, Brazil, etc. In 2014, RoboCup will be hosted for the 1st time in South America, in Brazil.

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