

## **ROBOCUP**

When the Czechoslovakian playwright Karel Capek first coined the word 'robot' in 1920, in his play, Rossum's Universal Robots, he took it from the Czech word 'robota', meaning slave workers. In the story, his robots rise up against their creators and try to destroy the human race. Capek, who later admitted to a horror that such beings might be created, might have been cheered to know that they would one day be used for such innocent entertainment as the annual RoboCup competition – held every year in a different country, with the aim of advancing the capabilities of artificial intelligence.

RoboCup is divided into two separate parts: RoboCupSoccer and RoboCupRescue. The competition's central activity is robotic football, known as RoboCupSoccer, which provides opportunities for researchers to share information, at the same time as capturing the interest of the public in an entertaining way.

The mission of the RoboCupSoccer's competition – devised by Hiroaki Kitano, Director of the Sony Computer Science Laboratories – is to design and build a team of fully autonomous robots, with no need for external control by humans or computers, that will be capable of winning at world-championship soccer against a human side in the year 2050.

In order to play soccer, robots must draw on a number of technologies, including those that enable them to operate autonomously, to acquire strategies and reason in real time.

Each year, the RoboCup competition is followed by a symposium, for which all members of the public – whether or not they are participants in the event – are invited to submit papers relating to a diverse list of topics, ranging from Disaster Rescue Information Systems to Robotic Entertainment. The list exists purely as a set of guidelines into areas for study, and any new suggestions are welcomed – and if they are of interest to other members, are eagerly adopted. All submissions are then entered for The Scientific Challenge Award, which has been established to recognize excellence in research for topics related to the International Symposium.

The tournaments are organized into the following categories:

#### SIMULATION LEAGUE

The Simulation league – the oldest in the competition – is a computer screen-based software game, played on a graphical pitch, with animated players, in matches consisting of two five-minute halves. A central server keeps track of the position of each of the 22 players, and each player receives information about the game from its own position, and can use it to make decisions such as to run, kick, turn and so on.

#### SMALL-SIZE ROBOT LEAGUE

Small-size robot league is played by two teams of five players each, with competitors of up to 18cm in diameter. Play takes place on a green carpeted field no larger than a ping pong table, using an orange golf ball, in matches of 10-minute halves. There are two types of players: those with 'global

vision', which track the robots as they move around the field by means of an overhead camera three metres above the playing field, linked to vision sensors on the robot itself, and to an off-field computer; and those with 'local vision', which uses sensing mechanisms located on the robots themselves.

#### MIDDLE-SIZE ROBOT LEAGUE

Two teams, each consisting of four mid-size robots battle it out autonomously. The only permitted human intervention is in placing them in the field or removing them. Every robot contributes data to a 'shared world model' – a central information bank consisting of its own position and that of the others in the game. Each player use this to keep track of the objects that it sees, as well as those seen by its fellow team members, to make predictions about the success of its next action – a facility not available to human players! This 'four heads are better than one' approach greatly enhances each robot's decision-making capability.

#### FOUR-LEGGED ROBOT CATEGORY

In the Four-legged robot category – known as the Sony Four-Legged Robot League – play takes place on a 6 metre x 4 metre field. Each team is made up of four players, and the players operate autonomously, with each half lasting 10 minutes.

#### HUMANOID LEAGUE

The most ambitious category is the Humanoid league, introduced in 2002, with biped autonomous robots, which

compete in walking and shooting contests, as well engaging in penalty kicks and one-against-one matches.

Humanoid robots were first developed by the Sony Corporation, mainly for entertainment, and unveiled in 2000. The latest generation, the Sony's SDR-3X model – which the company estimates would cost the price of a car to manufacture – has an awesome range of powers, including the ability to walk at speeds of up to 15 meters per minute, make gymnastic movements, disco dance in time to a tune with a fast tempo, and get up from lying on its back or front. As well as being able to recognize speech and images, the SDR-3X can reply verbally to a command, select a ball of a colour specified by an operator, then kick it into a goal 50 yards away. The robot stays in balance in the upright position by moving its arms and twisting its torso. It also uses sensors in different parts of its body to monitor its posture, based on information such as the angle of the floor and its own axis.

In the 2004 RoboCup competition, there were an impressive 16 competing teams from a number of different countries.

## ROBOT RESCUE

A separate category, RoboCupRescue, is aimed at developing robots for use in search and rescue operations. The competition is divided into two leagues: RoboCupRescue Robot League and RoboCupRescue Simulation League. In the competition, an urban disaster is simulated on a group of network computers. A virtual environment is created, and a search-and-rescue operation is simulated on network

computers, involving fire fighters, commanders, victims, volunteers, and so on. Real-world input from sources such as helicopter images are integrated with simulated data to minimize the disaster damage.

## FACT FILE

### RoboCup History

The idea for soccer playing robots was first conceived in Tokyo in 1993 by a team of Japanese researchers, and after a busy four years of feasibility studies and intensive planning, the first official conference and games took place in Nagoya, Japan, in 1997. The success of the event laid the foundation for an annual competition – hosted each year in different cities, including Paris, Stockholm, Melbourne, and Seattle – which regularly attracts large numbers of participants and spectators.

## FACT FILE

### RoboCup Junior

Young people are also represented in the RoboCupJunior initiative, which sponsors local, regional and international events for students from primary school age up to college level. Its aim is to provide opportunities to learn about robotics through practical experience, working in teams. Participants can join international exchange programmes, and share ideas with those from other countries. Co-operation is encouraged as much as competition, and there is the choice of a range of challenges, in three separate categories – soccer, dance and rescue.

## FACT FILE

For a number of years there have been a number of robot competitions around the world, so in 2004 the Robot Society of America decided to try and gather all the major events under one roof. The first ROBOlympics took place at the Fort Mason Center Herbst Pavilion, San Francisco, California, and such was its success that in 2005 a larger venue had to be found. The range of attractions included a robot triathlon – in which contestants had to complete a three-stage race on legs, wheels and water. Other events included jumping, rolling, fighting, climbing, walking, racing and problem-solving.

## INTO THE FUTURE

The RoboCup project's ultimate aim is to develop a fully autonomous humanoid robotic football team, which will be able to beat the world champion human team at that time. Can this be done? The past 50 years have seen astonishing advances in computers and electronic equipment, and the past 10 years have shown an steep upward curve in this process. If the trend continues at the same rate, it seems entirely possible that robots will have advanced enough to compete physically with humans. However, if there are any drawbacks, they are likely to be in the robots' capacity to make decisions – as evidenced by the progress of chatbots (cross ref Issue 6), which have extremely advanced linguistic and calculating abilities, but lack the spontaneity of the human brain. It is likely, therefore, that they will have the ability to outrun and outmanoeuvre their human opponents, but when it comes to subtle tactics, second-guessing likely

moves and so on, their tendency to reason in a strictly logical way is likely to leave them open to being bluffed. However, they are unlikely to complain, charge exorbitant fees or get involved in brawls, so they could win favour with managements - and, when it comes to post-match socializing, if they can be taught to drive, they will probably endear themselves to everyone else as well...