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Robot Competitors Meet on a Soccer Field of Dreams

By JEFFREY SELINGOAUG. 2, 2001

AN eight-day international soccer tournament that begins this week features all the trappings of your typical game: goals, blocked shots, even penalty cards. But you won't see any headers, and the matches certainly won't end with the winners ripping off their jerseys. After all, the players are robots, the field is a Ping-Pong table and the soccer ball is actually a golf ball.

RoboCup 2001, the fifth annual soccer competition for robots, is taking place over the next week in Seattle -- the first time the event is being held in the United States -- and is expected to draw some 111 teams from 23 countries.

The long-term goal of the competition is to create a team of fully autonomous robots by 2050 that can defeat the human team that wins soccer's World Cup. But RoboCup has a more serious, and immediate, side as well: to advance research in robots and artificial intelligence. What is learned through robots working with one another on the soccer field may help foster the development of robot teams that could perform surgery, fight large fires or lead search and rescue missions after natural disasters, researchers said.

"These are the types of systems that in the future will replace dull, dirty and dangerous tasks," said Raffaello D'Andrea, an assistant professor of mechanical and aerospace engineering at Cornell University and coach of its RoboCup team.

RoboCup's founder, Hiroaki Kitano, a senior researcher at Sony Computer Science Laboratories, said he chose soccer as the focus of the competition because the game is "clearly understood by everyone in the world" and can be played without the ball ever leaving the ground (important for players with square heads and no hands).

In RoboCup, teams compete in four leagues, depending on the type of robot: small, about the size of a softball; middle, about 20 inches in diameter; four-legged Sony Aibo robots, about a foot high; and the computer-simulation category, which dispenses with the robotic hardware entirely.

The robots are programmed to decide on the best moves. Once the game begins, they are totally on their own with no remote control by human players. Relevant objects, like the goals, players, ball and walls of the field, are different colors so that the robots can distinguish them from one another. The players can reach speeds up to five feet per second.

In the small-robot category, a video camera above the field keeps track of the ball, goals and all the robots. The information is fed to an off-court computer, which guides

strategy and tells the robots how to move. In the middle and four-legged leagues, the robots carry their own cameras, allowing each to operate autonomously.

''We can't preprogram everything,'' said Manuela M. Veloso, associate professor of computer science at Carnegie Mellon University and chairwoman of RoboCup 2001. ''We make them capable of handling a wide spectrum of situations. When we see the game, we get surprised by what they do.''

In 1998, for instance, the Carnegie Mellon team scored an ''own goal,'' or a goal against itself. Last year, the Cornell team decided at the last minute to write code for penalty shots. ''Good thing we did because we ended up going into penalty shots with Singapore and won by a goal,'' said Michael Babish, a member of the Cornell team. ''If we hadn't written the code, they would have beat us.''

Last week, teams from six American universities were making final preparations for the Seattle competition, which begins on Saturday with round-robin matches and ends next Thursday and Friday with quarterfinals, semifinals and finals. Like any other athletic team, the robots were hard at work practicing on the field. Designers played as many games as possible, pitting the robots against one another in specific situations to see how they would react, or against humans controlling the opposition with joysticks.

''We're not practicing to improve motor skills like humans do,'' said Michael Bowling, a member of the Carnegie Mellon team. ''But humans practice so they can work better together as a team and that's important for these robots as well.''

It takes up to a year to design, build and write code for a team of robotic soccer players. In Seattle, team members said they were looking forward to seeing the technological advances that their competitors had made since last year's RoboCup in Australia, where Cornell broke new ground by introducing a three-wheel, omnidirectional robot that enabled players to move sideways. Carnegie Mellon and other universities copied the idea this year.

After each year's competition, the RoboCup teams are required to share their software with one another. During the contest, teams will even scout the competition and update their code during breaks in the action.

Each year, Dr. D'Andrea said, the game gets faster and more sophisticated. In 1997, RoboCup's first year, the robots often missed the ball, but now, Dr. D'Andrea said, ''my students can't beat our system from last year, and they played video games their entire lives.''

RoboCup has yet to spur any new products or real-world applications, but give it time, researchers said. RoboCup participants dream of possible applications of what they will learn in the games. Teams of robots, for instance, might be sent to Mars to build structures for later human use.

This year's competition in Seattle will include a demonstration of how robots could be used in recovery operations after a natural disaster, and it could become a regular part of RoboCup.

The games have forced mechanical and electrical engineers, as well as computer scientists, to work together -- a feat in itself, researchers said.

"You can't just be a good electrical engineer and do well at this competition," said Brett Nadler, a member of the Cornell team. "It's a system, and RoboCup is really the only thing that makes us understand each other's language."

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