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Soccer's Other World Cup, With Tabletop Robots

Michael Baker, Special to The Christian Science Monitor

TAEJON, SOUTH KOREA— A European soccer powerhouse sets up for a penalty kick, and America's best players prepare to form a human wall. But first, a substitution: For the US, a line of robots takes the field.

Not in soccer's real World Cup, though that scenario may play into what proponents of robotics have made their winningest sales pitch: When conditions become too dangerous for humans, send in the machines.

But in miniature form, robot soccer already has scientists revved up. The world's laboratories will show their best when 50 teams from 21 countries compete beside real soccer's World Cup in Paris June 30 through July 3. Scientists say their budding sport is helping push forward technology in ways that will transform our lives. It's also a blast.

Battling on a table-sized field at the Asia-Pacific semifinal in Taejon, South Korea, last week, the three-inch-tall, cube-shaped players raced around, antennas wiggling, while a full auditorium of mostly students watched on a TV monitor.

Humans have no direct control of the robots. Above the "field," cameras tell computers - one for each team - what's happening. The computers make decisions based on pre-programmed strategies, and send instructions to the robots.

Winners who can afford it will fly to Paris for The Micro Robot World Cup Soccer Tournament (MIROSOT), the brainchild of scientists at The Korea Advanced Institute of Science and Technology (KAIST). The first MIROSOT games were held here in 1996.

Soccer's special challenge

The massive science project forces students and scientists of different disciplines to work together. Engineers must give robots the most possible functions with a limited budget of electrical power. Programmers must keep their code terse. The months of preparation are exhausting.

"Sometimes we cut class just to get some sleep," says Seo Myong Jin, a KAIST student, as he watches his team get creamed.

The fundamental challenge is designing robots that can cope with novel situations. Unlike computer chess, which offers a large but finite number of possibilities, the permutations in a soccer game are unlimited. Because soccer is so unpredictable, you need an "idea of which rule makes the best decision as per the situation," says Prahlad Vadakkepat, a visiting professor from Calicut, India.

Humans program the robots to act on "If ... Then ..." commands. For example, "If the ball is close, Then kick it."

But what, exactly, is "close"? New scientific fields like "fuzzy logic" help overcome such ambiguities. "Artificial neural networks" enable robots to learn from experience. The software mimics how some scientists theorize a brain works.

The program creates outputs - a command to kick the ball, for example. Paths through the program that contribute to successful outputs - like scoring a goal - are strengthened. By narrowing paths leading to mistakes and widening those leading to successes, the computer has more successes when it encounters similar inputs in the future.

Before 1985 a project like MIROSOT would have been difficult. In the late 1980s, mini-robots were solving mazes for the first time. Even compared to 1996, the robots have gotten better, MIROSOT participants say.

Teams are limited to five robots, but designers hope they can eventually have 11 players and use humanoid forms instead of cubes. Robots will soon do all processing on-board, carrying their own sensor systems. Instead of having a central computer analyzing the field and giving commands, individual robots would make their own evaluations, communicate with one another, and work as a team. "I am here. You go there." They have to talk," says Professor Vadakkepat.

Technological trickle-down

Autonomous robots? Most robots today just perform rote tasks on assembly lines, Vadakkepat adds. Teams of smart microrobots could do regular maintenance in nuclear power plants and other hazardous environments. In the future they will fight our wars. "Unmanned tanks through satellite control - that's the equivalent to this," says Vadakkepat.

The technology spinoff has already begun. Human Interface, a Korean company, has invented a visual processor able to distinguish 254 different colors 60 times per second. "You may think of this only as [a game] but I'm thinking of developing 'Personal Robots,'" says Kim Jong Hwan, MIROSOT organizer.

"PRs" could sweep the house, cook, or take calls. But for now, even the little soccer players need some details worked out. The ram each other, and sometimes bump the ball into their own goal.

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At one match, programmers couldn't stop a robot from spinning like the Tasmanian Devil: "Just grab it," said one human participant.

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