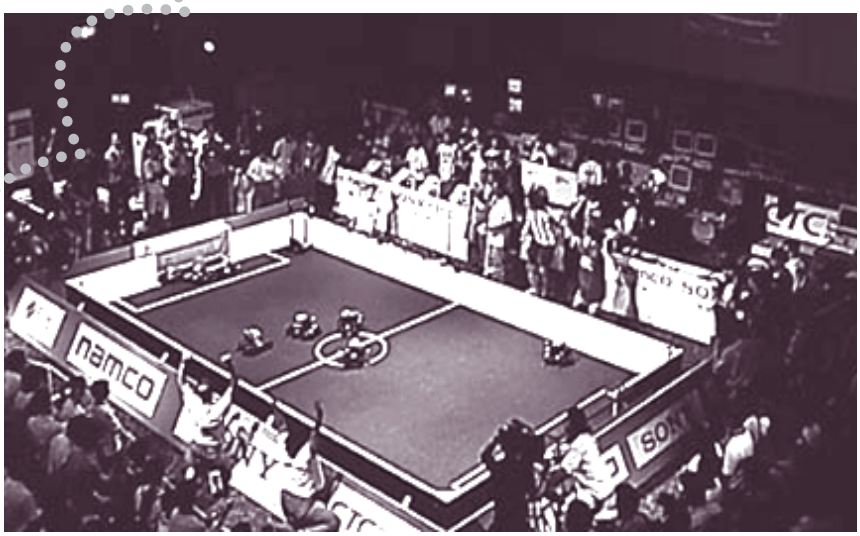
To Coincide with the World Cup, the Robots are Kicking off Also!

RoboCup '98 Paris

In May 1997, the world Chess champion Garry Kasparov was beaten by the IBM computer Deep Blue. It is said that the brilliance of one of Deep Blue's moves shocked Kasparov deeply and determined the flow of the game.
In August of the same year, the first RoboCup match, in which teams of intelligent robots play soccer, was held in Nagoya, Japan.
The common theme in Artificial Intelligence research around the world has switched from Chess to soccer. Soccer adds an element of robotics engineering to enliven technology development in Artificial Intelligence.
On November 16 of that year, the Japanese "human" soccer team won a place in the World Cup match for the first time.
In July of this year, which will see the World Cup finals, the "RoboCup '98 Paris" will also be held in France.
This event will be an important step on the road to the day when humans and robots take the field together.



RoboCup Home Page's http://www.robocup.org/RoboCup/

RoboCup Guidelines

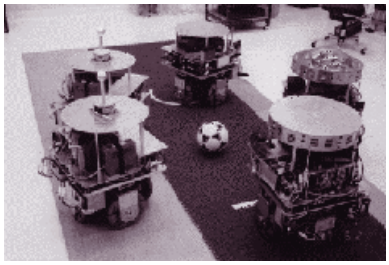
- **Areas**
  - Simulator league
  - Actual robot leagues (both are 5 robots per team)
    - – Small robot league (diameters up to 15 cm, etc)
    - – Middle size robot league (diameter up to 50 cm)
  - Shooting and other individual robot contests
- **1997 Nagoya Match (August 25 to 28)**
  - Simulator league
    - – 32 teams from 10 countries participated.
    - – First place: Humbolt University, Germany
  - Small robot league
    - – Four teams from 4 countries participated.
    - – First place: Carnegie Mellon University, USA
  - Middle size robot league
    - – Five teams from 3 countries participated.
    - – First place tie (identical scores): Osaka University and the University of Southern California
- **1998 Paris Match (July 2 to 9) Expected entries**
  - Simulator league: About 60 teams
  - Small robot league: About 20 teams
  - Middle size robot league: About 20 teams

∗: The Japan Open event will be held from April 9 to 11 this year for participating teams from Japan. (Location: TEPIA in Tokyo)

Interview with the Chairman of the RoboCup Federation

Hiroaki Kitano, Ph.D.
Senior Researcher
Sony Computer Science Laboratory Inc.

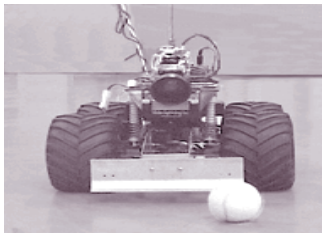
—Why did you choose a sport as a research topic?
At first, I considered more practical topics. For example, rescue robots. However, that has the problem that, for example, Japan suffers from earthquakes, same region of the US from forest fires, and Italy from floods. That is, the problems faced by each region are unique, thus making it difficult to establish common problem. We also considered home nursing care robots, but in this area simply installing rails in the home and having equipment that moves on the rails would be more practical than designing robots in the short run, although sophisticated robotics system is desired in the long run. That is, when considering establishing the foundations for the next generation of technology taking the technical capabilities of each country into account, we think that maintaining a certain distance from the actual details is preferable.
—How will technology that is of actual use to society be produced by research that is so divorced from reality?
There are two basic approaches to robot soccer. The first is to think of tactics as central, and to have each individual robot learn it's own techniques, such as shooting. The other is to have the robots communicate and determine the conditions themselves. Both of these techniques are indispensable for practical application. For example, in rescue robots, a balance is required between central control and having the robots act independently when there is interference in the communication system.
This is a single example. But, soccer has essential elements which are common in broad range of real applications.
—In addition to actual robots, there is also a division in which software systems compete against each other, isn't there?
Software has advanced to a point where it is more powerful than human control.



Tactics Examples—From the '97 RoboCup

▼ Joint Utsunomiya University, Toyo University, and Institute of Physical and Chemical Research team

These robots adopt a cooperative scheme in which the robots recognize each other's identities, directions, and speeds using infrared sensors. These robots make about 3000 different decisions, such as deciding whether to shoot or pass depending on the position of the other robot.



▼ Osaka University team

These robots adopt Learning-based scheme in which they recognize visual images from a CCD camera and make decision based on experiences of pre-game trainings.

* A Sony CCD camera was used in the Osaka University robot that came in first (in an identical score tie with the USC team) in the 1997 RoboCup.

Also, after the competition between the top four teams has completed, there is a rule that requires that the programs be made public. This means that the techniques that worked one year will not work the next, and that each year the level of the competition will increase.

—Were there any particularly unique ideas?

The University of Maryland team adopted the approach of producing a large number of programs randomly, having these programs play each other, then "crossbreeding" the winners and repeating the process. They "evolved" the programs by running this simulation on a supercomputer for six months. The process of this "evolution" was fascinating. At first the robots moved arbitrarily, and then they crowded around the ball. Then they realized that that was inadequate and one robot remained to guard the goal. The position of goalkeeper developed without any special instruction. Then, the robots refined their tactics, developing ideas such as flank attacks. This team made it to the best 16 level.

—Do you think this type of learning program will become the mainstream at some point?

Well, it certainly is beyond the ability of human programmers to envision and code all the variations possible in player and ball movement. However, when a learning-type program is installed in a humanoid robot and sent out to play, it plays completely autonomous and we end up just watching. That is, the concept of coaching is required. That is, a person should direct the overall strategy and within that context, the robot performs according to the particulars of the circumstances. If that sort of technological system were established, we could create practical robots that were both useful and sensitive to our needs. I can conceive of no better problem domain than soccer from the standpoint of creating this sort of broad technological foundation.

—And, of course, soccer is extremely popular worldwide.

Italy has established a RoboCup national project, and the soccer federation is in close contact with this work. The enthusiasm in France, Germany, and the US is phenomenal. When a European team competes with an American team, they demand an Asian referee for impartiality. It has gotten to the point of saying "Is that really necessary?" (Laughs)

—I understand that the final goal of the RoboCup is to produce a team that can compete with the strongest human teams.

The author Takashi Tachibana also suggested that during a TV talk show I was on. Still, it only took 50 years from the Wright brothers first flight to the manned space mission to the moon. By the middle of the 21st century robots will be able to beat human players. And that is without even a single yellow card! Such a robot would be perfectly safe as a home health care robot.

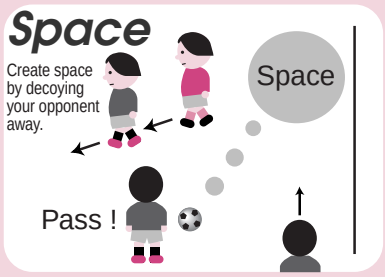
—I think that the majority still feel it unthinkable that robots could beat people at soccer.

That's probably correct. But people will begin to doubt that in a few years.

With RoboCup, the World Cup will be even more interesting!

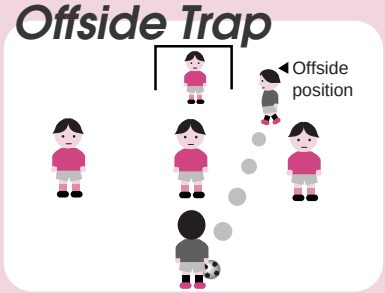
If you understand soccer, you will understand the technical issues involved in the RoboCup. Inversely, if you get to know the RoboCup, you will appreciate the profundity of soccer even better.

Space



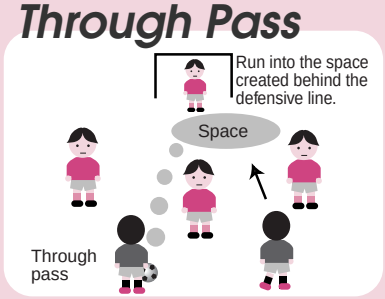
It is not adequate simply to pass to where your teammate is standing. The high-level technique is to envision the space where your teammate will enter and pass into that space. In TV commentary on soccer matches you hear terms such as "motion to create space" by decoying for the team's benefit and, inversely, "defense that erases space".

Offside Trap



Offside position refers to the situation where there is only one opponent team member (usually the opponent's goalkeeper) between one's own position and the opponent's goal. It is against the rules for a pass to come from behind one if one is in this position. This rule adds subtlety to soccer tactics, and will be adopted in the RoboCup starting with the Paris event. Offside trap refers to moving up the defensive line at the same time to cause the opposing team to violate the offside rule.

Through Pass



In this technique, the player with the ball passes into the space created behind the defensive line when the defensive line moves up. At the same time, a teammate rushes into that space to receive the pass. This differs slightly from an offside foul and, if successful, has a high probability of achieving a goal. The fate of the Japanese team at the World Cup depends on whether Japan's ace passers, such as Nakata and Nanami, can succeed with their deadly through passes. When will robots display this sort of high level play in which the motions of both the ball and the opponents are predicted accurately?