



## **Progress and Research Results In Robot Soccer**

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# RoboCup : Goal

**By the year 2050,  
develop a team of fully autonomous humanoid robots  
that can win against the  
human world soccer champion team.**

- More than 3000 researchers from about 35 countries / regions.
- The RoboCup Federation: a Non Profit Organization registered in Switzerland.
- National Committees in more than 10 countries. Supporting conferences and coordinating research with industry and related government organization.





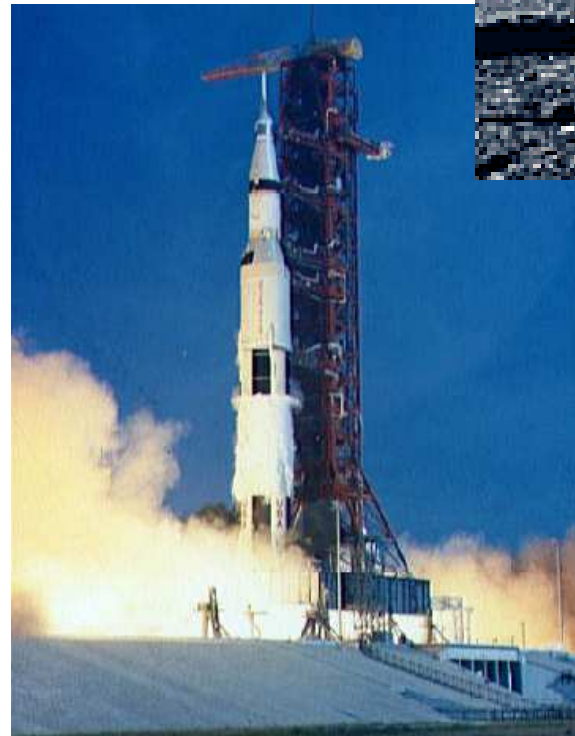
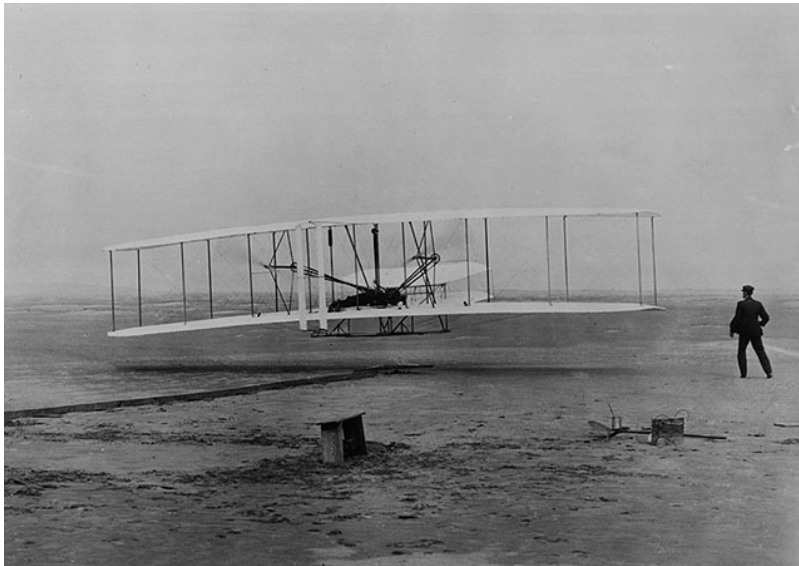
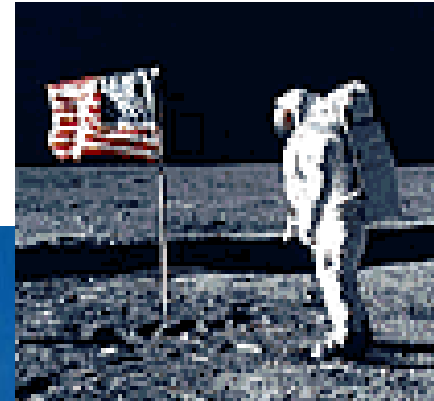
**RoboCup**

# Can we accomplish the goal?

1903



1969



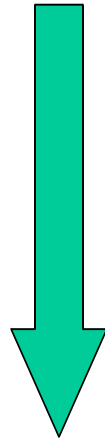
© NASA



# Computer Chess



ENIAC  
1946



Deep Blue  
1997



© IBM



## Why RoboCup?

- **A Landmark Project**
  - **Challenging goal and spill-over of technologies**
- **A platform for project-oriented education in science and technology**
- **A standard problem for AI and robotics.**



## Apollo Project

- **Dream: Send men to the moon and safely return them to the earth. (J.F.K.)**
- **Technologies: systems science, electronics, aviation, project management, etc.**
- **Effects: Major impacts on U.S. industries.**



# Computer Chess

- **Dream:** to develop a computer that can beat human chess champion.
- **Technologies:** Search algorithms, parallel computing, parallel machine architectures, etc.
- **Effects:** Basic computer algorithms, parallel programming, etc.



# Computer Chess Vs. RoboCup

## CHESS

- Static
- Turn-taking
- Complete information
- Symbolic
- Central control

## RoboCup

- Dynamic
- Real-time
- Incomplete info
- Non-symbolic
- Distributed control





# Application of RoboCup technologies

- Disaster rescue
- Intelligent Traffic Systems (ITS)
- Deep space exploration
- Office robots
- Distributed agents



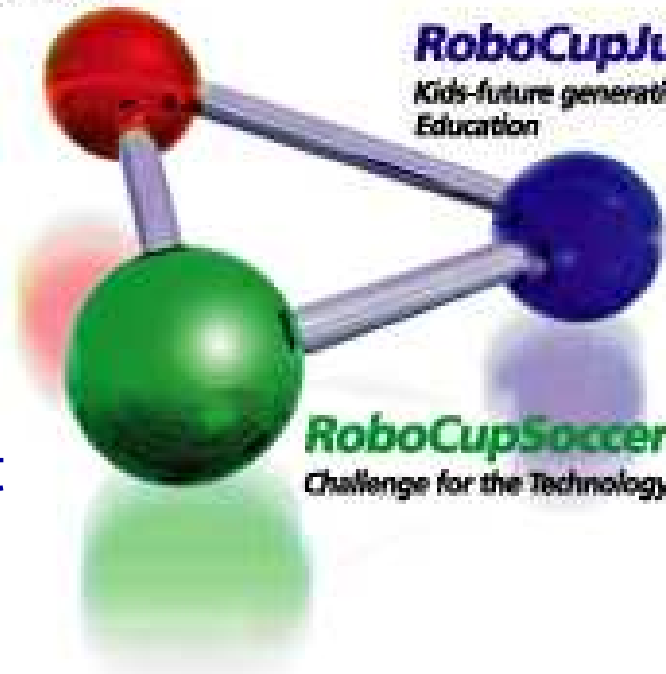
# RoboCup : Activities

- **RoboCupSoccer**  
Research project  
using soccer
- **RoboCupJunior**  
International education project  
using robots
- **RoboCupRescue**  
Disaster rescue system research

**RoboCupRescue**  
Application for Practice

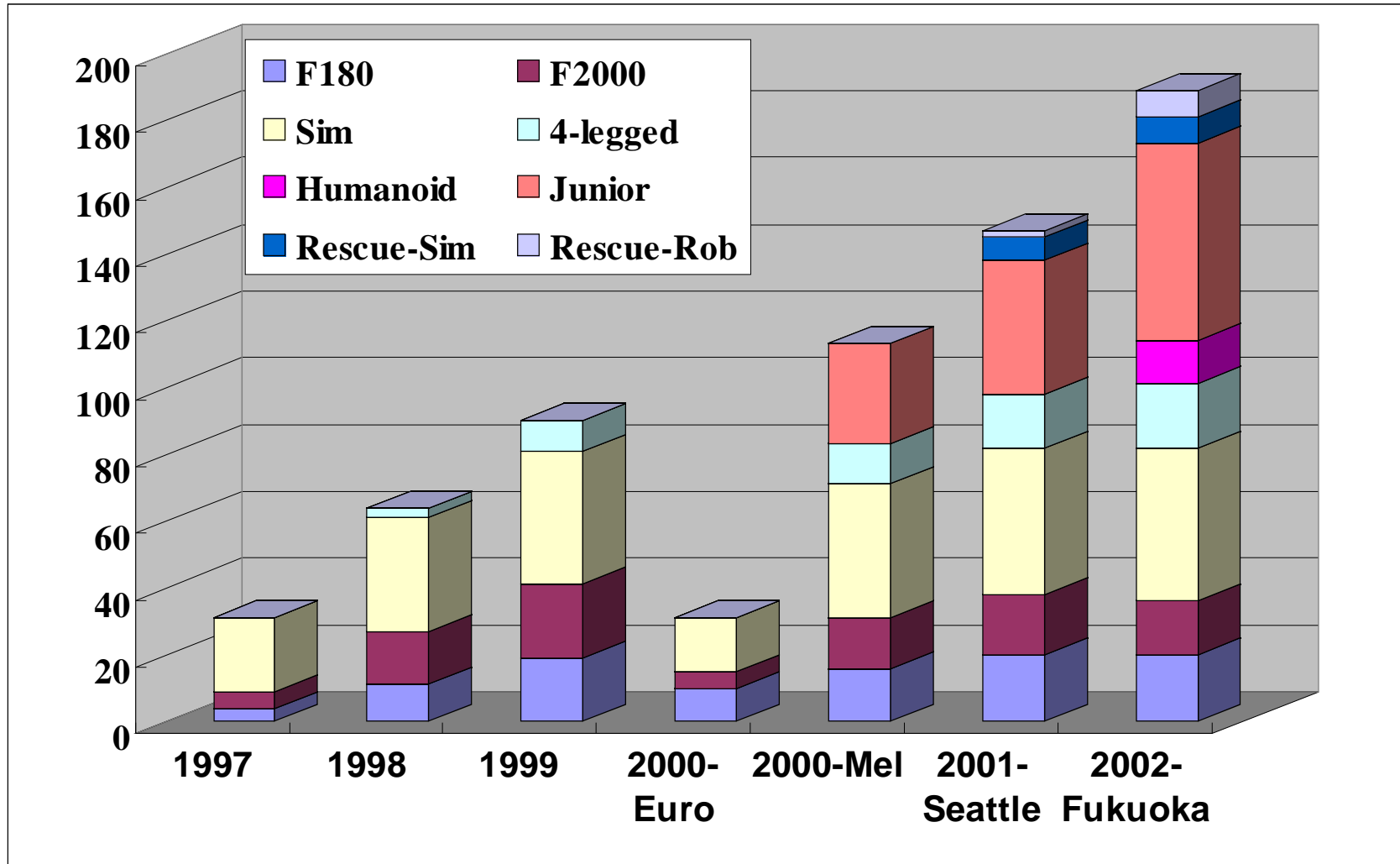
**RoboCupJunior**  
Kids-future generation  
Education

**RoboCupSoccer**  
Challenge for the Technology





# Number of Teams





# *RoboCup*

## International Championship

- **RoboCup-97 Nagoya**
- **RoboCup-98 Paris**
- **RoboCup-99 Stockholm**
- **RoboCup-2000 Melbourne**
- **RoboCup-01 Seattle**
- **RoboCup-02 Fukuoka/Busan**
- **RoboCup 03 Padua (Italy)**
- **RoboCup 04 Lisbon (Portugal)**
- **RoboCup 2050 .....**



# RoboCup 2002

120,000 visitors in 3 days





# RoboCup Soccer



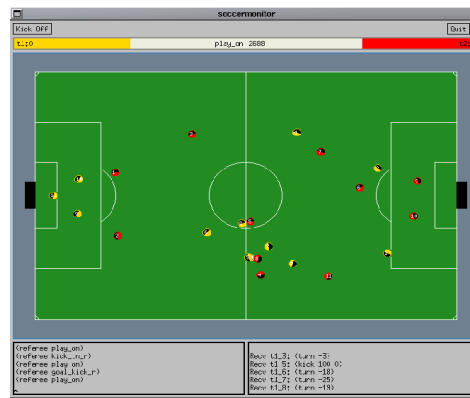
**Small-sized League**



**Middle-sized League**



**Legged Robot League**



**Simulation League**



**Humanoid League**



# Small-size robot league





# Middle-size robot league







# Four-Legged robot league



# Humanoid League

## 2. Standing on one leg

## 3. Walking

Walk the distance 5 times of the robot height.

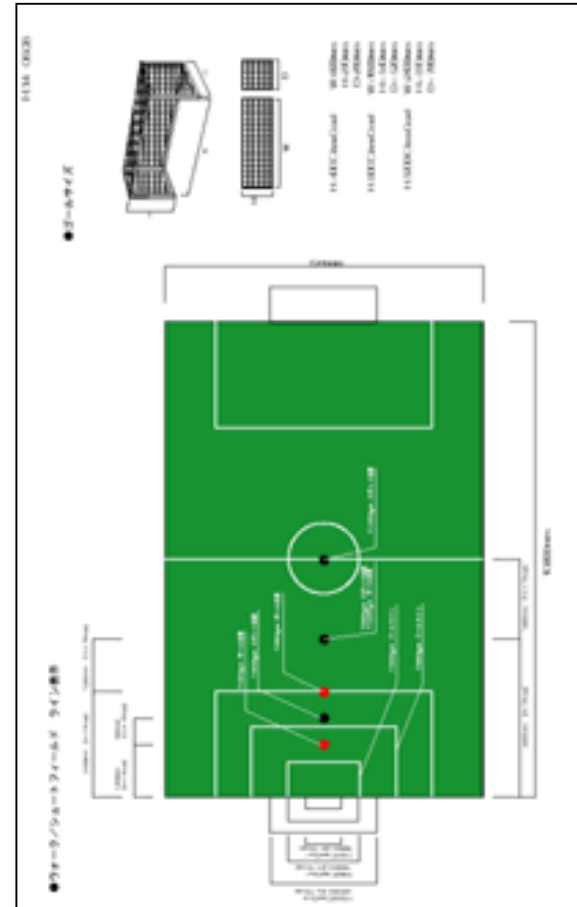
## 4. Penalty Kick

40cm, 80cm and 120cm classes.

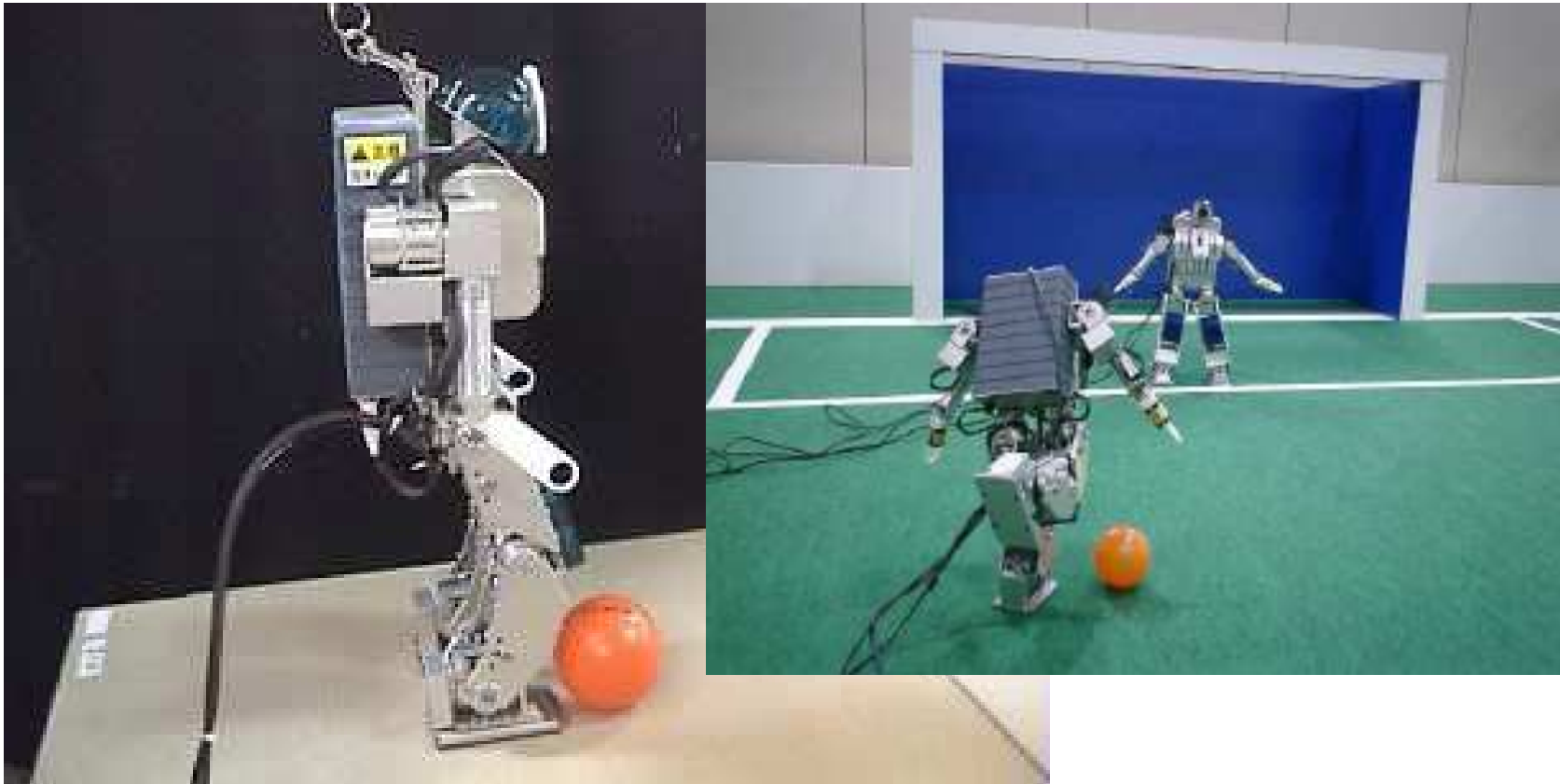
5 goals per team.

## 5. Free Style

5 minutes free demonstration



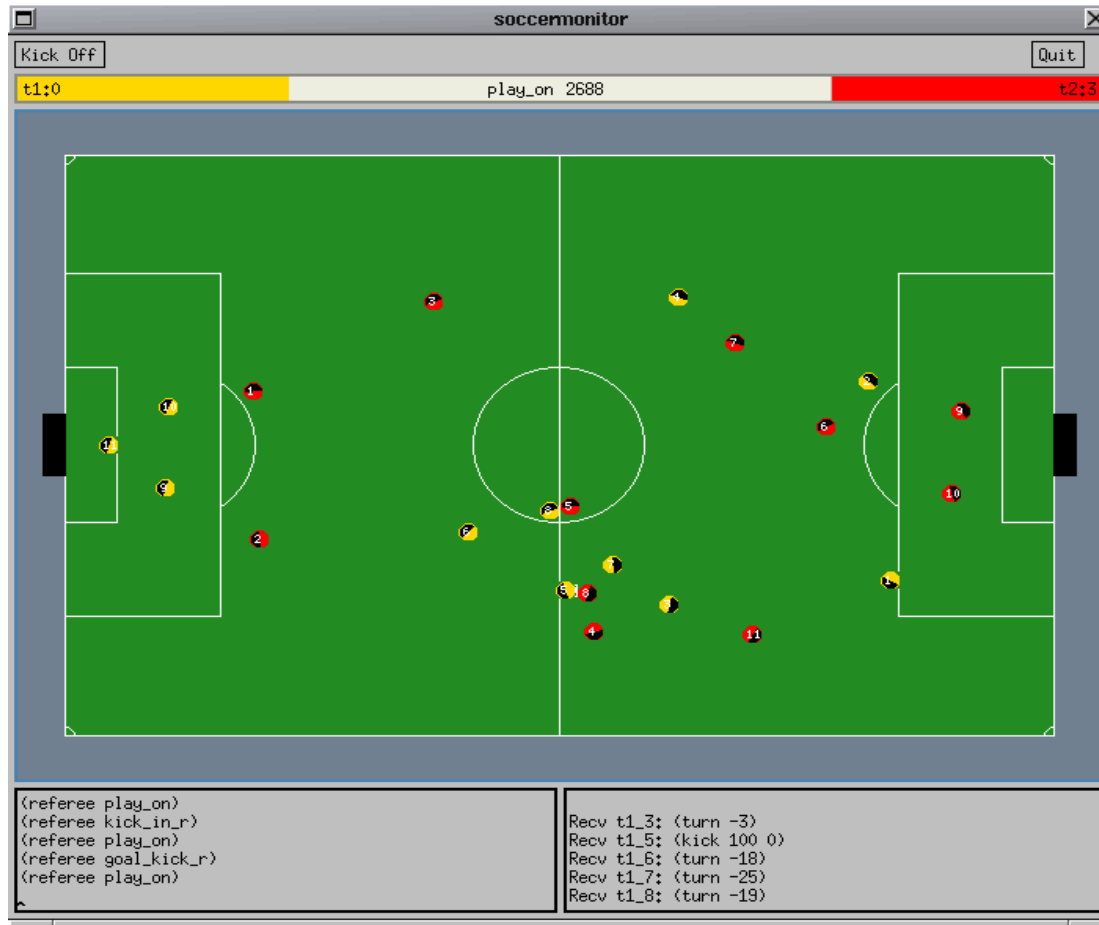
# Humanoid PK



Osaka University "Senchans" team (HOAP-1)



# Simulator system





# RoboCup Rescue



Burning    Extinguished    Fire Brigade Agents

RoboCup-Rescue Log Viewer     Agents     Pathway    << X16 -->>    STAT    START

Information    Welcome to LogViewer Version 1.35  
by the RoboCup-Rescue Project    Time = 22





# Rescue vs. Soccer

Heterogeneous agents

Homogeneous agents

Very large number of agents ( $> 1,000$ )

11 agents / team

Hostile environment

Hostile opponent

Logistics

Reactive teamwork

Resource sharing

Real-time planning

Emergent teamwork



## Current Status

- Large Scale Disaster Simulator publicly available.
- Study on rescue robots underway.
- First competitions were at RoboCup-2001



# 3D Simulation and Visualization



Computer Graphics by the Port Authority Research Center, Ministry of Construction, Government of Japan





# Vision of RoboCup-Rescue

- Develop a comprehensive Rescue Simulator and make it available to public.
  - Create “Rescue Science”
  - Evaluation of rescue strategies
  - Promote AI and robotics research
- Integrate with real command control system
- The standard for rescue systems.

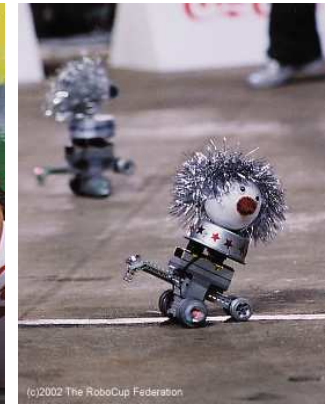


# RoboCupJunior

## SOCCER



## DANCE





# RoboCup Drives Research in

- Control algorithms,
- Machine vision, sensing and localization,
- Real-time distributed computing,
- Real-time ad hoc networking,
- Mechanical design,
- Machine learning, and
- Autonomous multiagent systems