RoboCup: the Robot Soccer World Cup

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RoboCup

By 2050, build a team of fully autonomous humanoid which win against human world champion under the official regulation of FIFA

RoboCup
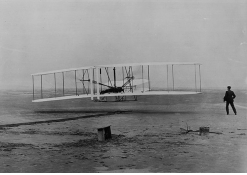
RoboCup goals

• Soccer
• Rescue + Home + Work
• Junior/Education

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Can we accomplish the goal?
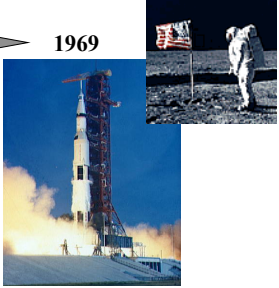
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1903 ⟶ 1969

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Computer Chess

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ENIAC
1946

Deep Blue
1997

Deep Blue

This 1.4 ton
8-year-old sure
plays a mean
game of chess

© IBM

RoboCups

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2013 Eindhoven
2014 Joao Pessoa

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RoboCup-97 Nagoya

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35 teams from 12 countries

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RoboCup-14

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July, 19-25th, 2014
João Pessoa, Brazil

Participants: 200 teams, 1500+1500, > 40 countries

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Robotic football (soccer)

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NO MULTI-ROBOT GAME: why?

Cooperative Multi Robot Systems
require *autonomy*

In RoboCup players in a *team* must
cooperate to play football

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Soccer Simulation

- •Teamwork, scale-up
- •Strategic decision making
- •Prepare the way

2D/3D

Small-size

Small and fast own built robots

Global vision system

Controlled by a remote host

Centralized system

- •Perception and action
- •Coordinated action
- •Teamwork
- •Learning the opponent model

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Middle size

Own-built large wheeled robots

Information on the game acquired through on board sensors

All computation Onboard

Communication (but unreliable)

Distributed system
- Omnidirectional Perception
- Cooperative localization
- Task assignment (dynamic)

RoboCup

Standard Platform League

Focus on software

initially 4 legged Sony AIBO

Standard Platform League

Information on the game acquired through on board sensors

All computation Onboard

Comunication

- Articulated Motion
- Robust perception
- Localization
- Teamwork

Focus on software

biped Aldebaran NAO

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Humanoid Robots

Teen size (60 cm)
Kid size (120 cm)
Adult size

Own built and commercial (Darwin)
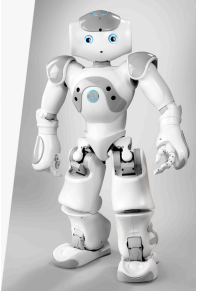
Additional challenges
- Mechanical design
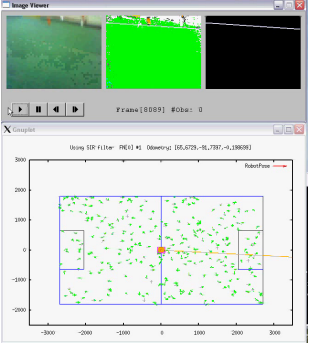- Biped walking
- Kicking-Ball throwing

RoboCup

Vision

Nao's perspective

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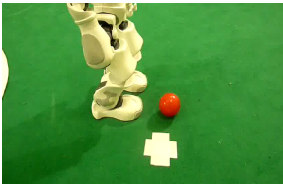

Localization

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Motion Control

Back-kick
(SPQR-UChile) 2010
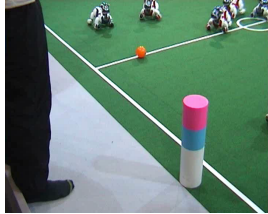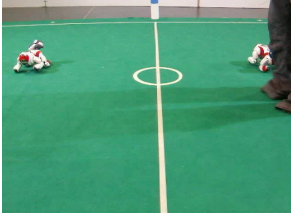
Penalty kicks
(S.P.Q.R.) 2005

Teamwork

Soccer challenge: overview

Soccer challenge

The complexity comes from the dynamics of
the environment (opponent):

- Complex perception-action
- Learning
- Cooperation/coordination
- Planning and game strategy

5

RoboCup long-term perspective

RoboCup Soccer

RoboCup-X Real world applications

RoboCup Jr. Education and Entertainment
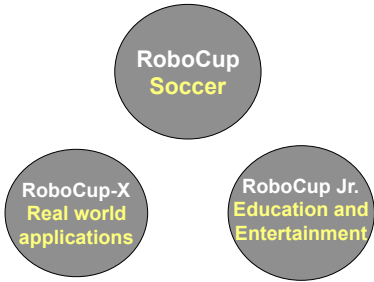
RoboCup Rescue Simulation

- Multi Agent Modeling (Foligno)
- Simulation of operation procedures
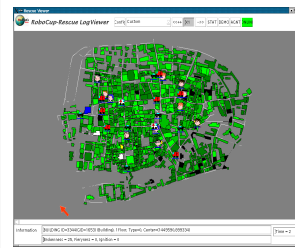
- Multi Robot Modeling
- System test& development

RoboCup Rescue: Robots

Goal: find victims in a disaster scenario

Rescue arenas from NIST

Two categoriesof robots
- Autonomy
- Tele-operated

Rescue Arenas & Field Exercises

- unknown
- unstructured
- dangerous

Rescue Robotics Camps

Italy, Roma 2004-2007

+ IEEE SSRR 2007

+ Thailand 2009 -2011

+ Turkey 2012

Roma, 2014   25

The development cycle

Camps
- Test of new devices and solutions
- Develop performance evaluation

Competitions
- Integrated prototype systems
- Test performance methods

Disaster Response Exercises
- Field evaluation of best in class
- Challenge industrial solutions

Market

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RoboCup@Home

RoboCup
@Home

RoboCup@Home focuses on *real-world applications* and *human-machine interaction* with *autonomous robots*.

- **Aim:** foster the development of useful robotic applications that can assist humans in everyday life.
- **Challenges:** Fast Follow, Fetch & Carry, Who's Who, Lost&Found, Partybot, Supermarket, Cleaning up, Cooking …

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Example Scenario: home

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Slide 1

Robocup@home Robots

Slide 2

Current focus of RoboCup @Home

Technical objectives:
- Ease of use
- Fast calibration and setup
- Attractiveness and ergonomics of the robot
- Natural and multi-modal interaction (natural programming)
- Adaptivity and general intelligence
- Robustness
- General applicability

RoboCup | Roma, 2014 | 30

Slide 3

Implementation of RoboCup @Home

General rules
- 2 stages with different focus
  - Stage 1 for singular, basic tasks
  - Stage 2 for more complex, integrated tasks
- Robot has to be autonomous
- High level of uncertainty in the environment (no standardization)
- Only natural interaction allowed
- Very short setup time (usually 1 minute)
- Partial score system for tests

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Slide 4

Tests in Stage 1

- **Introduce:** The robot introduces itself and the team to the other team leaders
- **Fast Follow**: Lead the robot quickly on a path through the scenario
- **Fetch & Carry:** The robot has to find and bring the object that the user asks for
- **Who's Who:** The robot has to find and introduce itself to unknown persons and recognize them later
- **Competitive Lost&Found**: 2 robots from different teams simultaneously have to find 3 hidden objects as fast as possible
- **Open Challenge:** Teams have to present and demonstrate their most important (scientific) achievements

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Slide 33

Tests in Stage 2

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- **Partybot:** Find persons, receive orders for a drink and bring it to the correct person
- **Supermarket:** The user does not know how to operate the robot. He has make the robot to retrieve certain objects from shelves
- **Walk&Talk:** Teach in locations in an unknown environment by showing the robot around
- **Cleaning up:** Recognize and arrange unknown objects on the floor
- **Demo Challenge Cooking:** Assist a person in preparing a meal by getting the recipe from the Internet and handing over the ingredients

Slide 34

Robotics for elderly people

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RoboCare

2003-2006
A. Cesta, R. Leone + group at CNR-ISTC

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Robocup@home 2006 in Bremen

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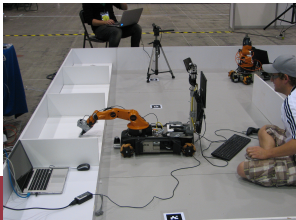SAPIENZA
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RoboCare

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RoboCup@work

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RoboCup@Work tackles open research challenges in *autonomous* **industrial robotics**:

- Indoor navigation
- Mobile manipulation
- Industrial object recognition, pickup and delivery
- Multirobot coordination
- Multirobot cooperation

Slide 1

RoboCup
@Work

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Slide 2

RoboCup Junior

- Soccer
- Dance
- Rescue

RoboCup

Slide 3

Impact of RoboCup: research

- Symposium
- Publications
- PhD
- Standard problems: Keepaway, …
- Standard solutions: CMU Vision, …
- Standard test methods: Rescue Arena, …
- New platforms: NAO, Darwin, …

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Slide 4

Impact of RoboCup: education

Beyond conventional curricula: complex, integrated system design, teamwork, competitiveness

- Courses: multi-agents, multi-robot, software development, perception
- Master theses
- Camps
- + Junior

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Impact of RoboCup: citizen awareness

- Simple and appealing message
- Outreach (promoted by cities as science events for the general public)
- High interest of media

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Success stories

- "RoboCup" Rescue Robots in Fukushima power plant
- "RoboCup" SSL hosted the genesis of Kiva Systems
- "RoboCup" SPL supported the development of Aldebaran NAO

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Success stories

Boat-speeding: Argos is operational in Venice since 2006

Logistics: SSL hosted the genesis of KIVA Systems
Rescue: Robot in Fukushima designed for RoboCup

Education: NAO is a RoboCup robot, now a product

Roma, 2014

Future

- Foster advancement of science and technology
- Community development (hw and sw)
- Test methods and benchmarking
- "RoboCup" curricula

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