

Cognitive Robotics

International Competitions

RoboCup

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June 2014

Robot Soccer as Testbed

- International initiative to foster AI and Robotics



- Organized by **RoboCup Federation**
 - RoboCup Soccer Games
 - RoboCup-Rescue
 - RoboCup@Home
 - RoboCup Junior
 - Conferences



Robot Soccer as Testbed



Chess:

- Static
- 3 Minutes per move
- Single action
- Single player
- Information:
 - reliable
 - complete

Soccer:

- Dynamic
- Milliseconds
- Sequences of actions
- Team
- Information:
 - unreliable
 - incomplete

| | | |
|--|------|-------------|
|  | 1997 | Nagoya |
|  | 1998 | Paris |
|  | 1999 | Stockholm |
|  | 2000 | Melbourne |
|  | 2001 | Seattle |
|  | 2002 | Fukuoka |
|  | 2003 | Padua |
|  | 2004 | Lissabon |
|  | 2005 | Osaka |
|  | 2006 | Bremen |
|  | 2007 | Atlanta |
|  | 2008 | Suzhou |
|  | 2009 | Graz |
|  | 2010 | Singapur |
|  | 2011 | Istanbul |
|  | 2012 | Mexico City |
|  | 2013 | Eindhoven |
|  | 2014 | Jeao Pessoa |

RoboCup Championships



Bremen 2006:
444 Teams in different leagues
with ca. 2500 participants
from 36 countries

Visions, Research and Championships

The RoboCup Challenge:

To play and win in 2050

with a team of humanoid robots

against the human FIFA world champion.

- Energy
- Materials
- Sensors
- Perception
- Control
- Actors



Research and Championships

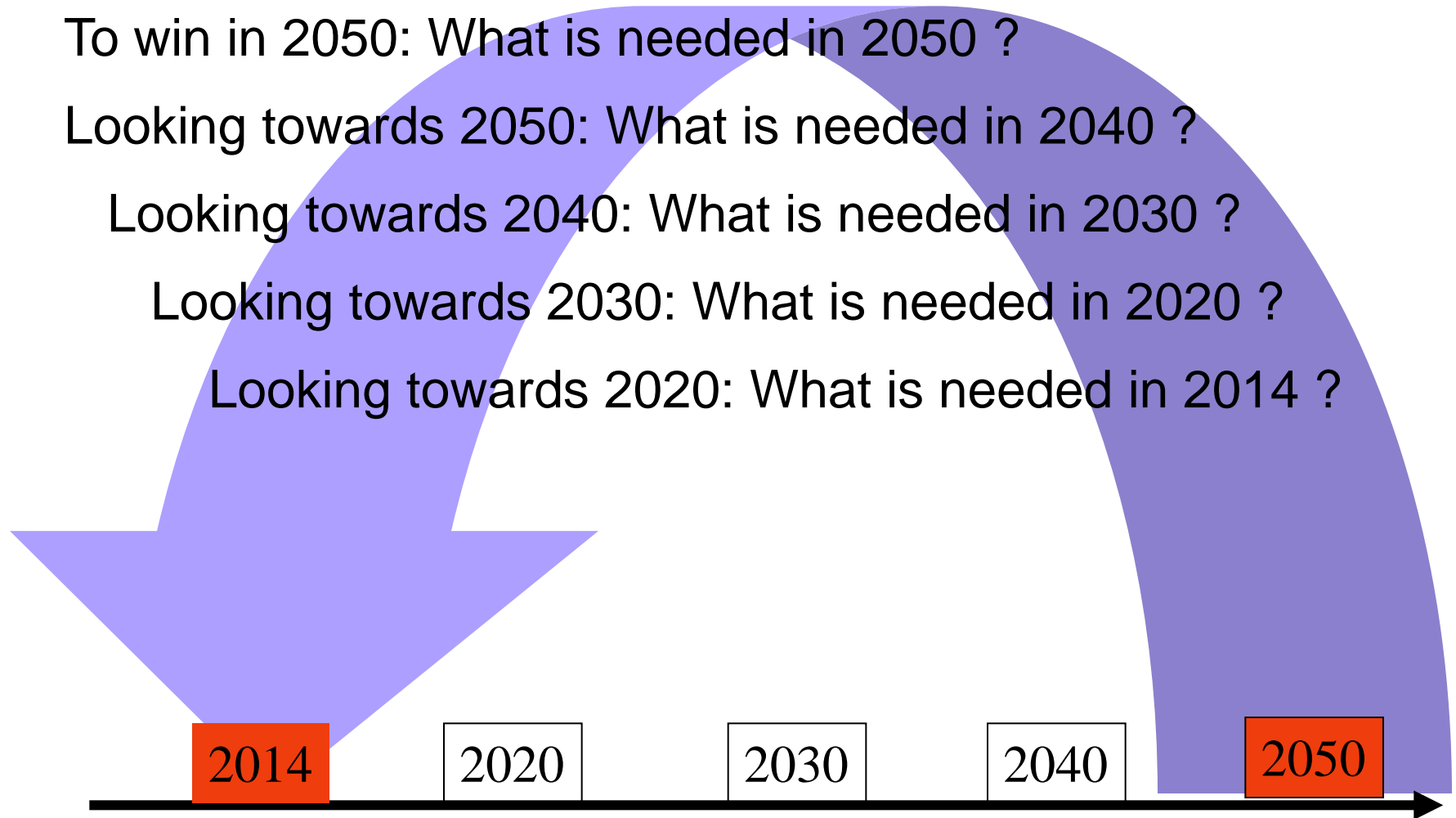
To win in 2050: What is needed in 2050 ?

Looking towards 2050: What is needed in 2040 ?

Looking towards 2040: What is needed in 2030 ?

Looking towards 2030: What is needed in 2020 ?

Looking towards 2020: What is needed in 2014 ?



Research and Championships



Nagoya 1997

Research and Championships



Melbourne 2000



Bremen 2006

RoboCup in 2014

Different leagues with different real or simulated robots for different challenges, e.g. human walking, coordinated play



Middle Size League



RoboCup 2011 Istanbul

Finale: Tech United vs. Water

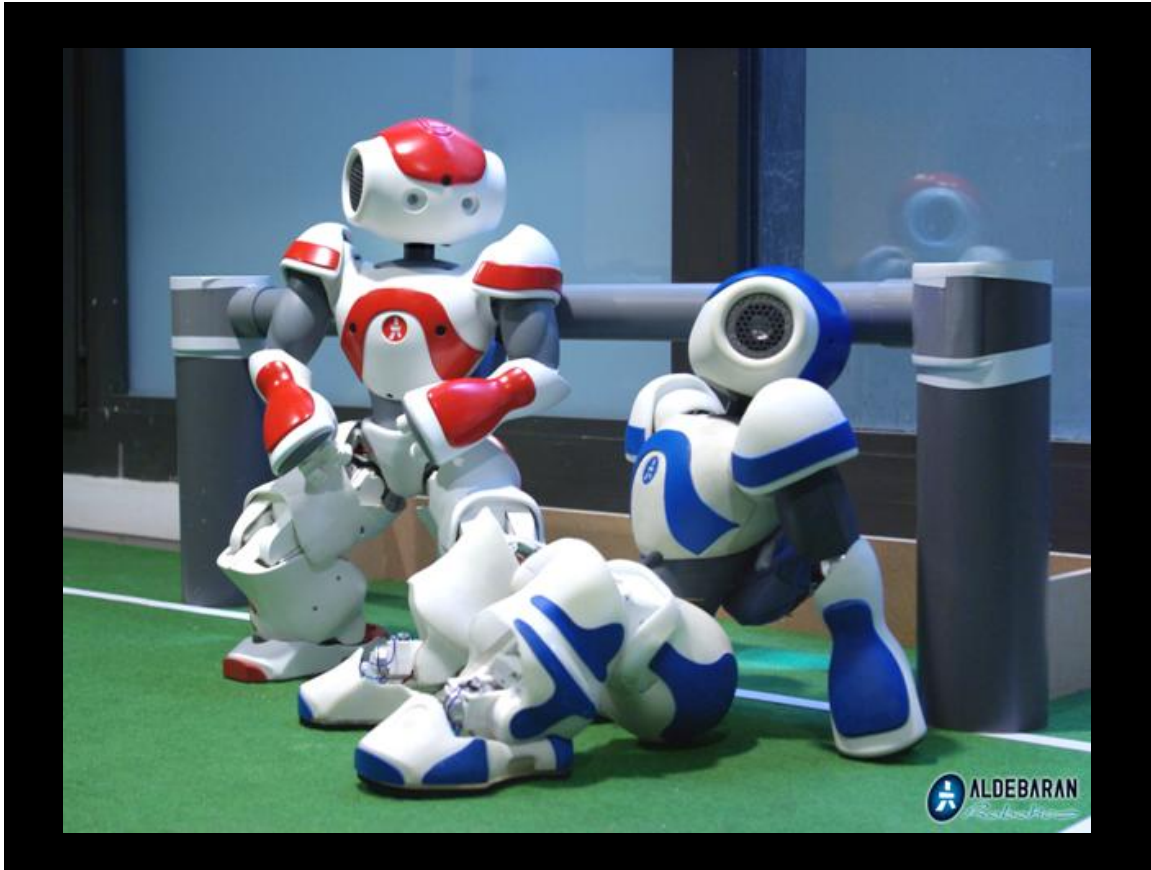
<http://www.youtube.com/watch?v=nleQLd5M1S4&feature=relmfu>

Small Size League



RoboCup 2008 Suzhou

Standard Platform League



All teams
use same robots:
Nao
from Aldebaran
(France)
(replaced Sony's
Aibo in 2008)

RoboCup 2013 Eindhoven
Finale: B-Humans (Bremen) vs. HWTK Leipzig

Simulation 2D

Communication
via protocols (TCP)

Effector messages

Motor commands
similar to real robot

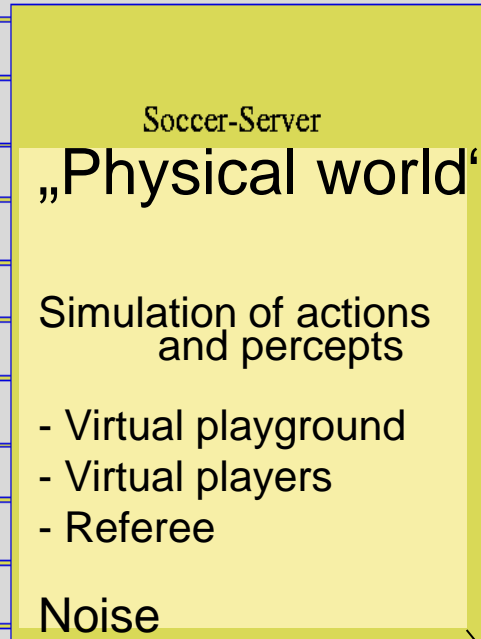
Perceptor messages

Vision, acoustic, inertial,
....

11 programs
Team 1



11 programs
Team 2



Control of
players

Coach

Control of
players

Coach



Server and Monitor developed
by volunteers of RoboCup community

- Simple physics
- Study of coordination
- Machine Learning: Behaviors

Simulation 2D

<http://www.youtube.com/watch?v=cDhSjSYPvdE>



RoboCup2012 Mexico City Final Match.

HELIOS2012 (Fukuoka University, Osaka Prefecture University, Japan) vs.
WrightEagle (University of Science and Technology of China, China)

Simulation 3D

Communication
via protocols (TCP)

Effector messages

Motor commands
similar to real robot

Perceptor messages

Vision, acoustic, inertial,
....

11 programs
Team 1

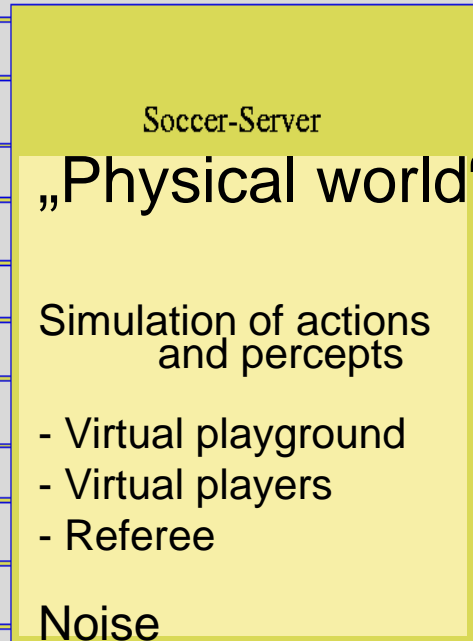


Control of
players

11 programs
Team 2



Control of
players



Server and Monitor developed
by volunteers of RoboCup community

- More realistic physics
- Study of low level skills
- Machine Learning: Motion

Simulation 3D

See for more information:

http://wiki.robocup.org/wiki/Soccer_Simulation_League



RoboCup2012 Mexico City Final Match (1.half)

UT Austin Villa (University of Texas at Austin, USA) vs.

RoboCanes (University of Miami, USA)

Humanoid League Kid Size



RoboCup 2008 Suzhou
Team Nimbro vs. Team Osaka (7:6)

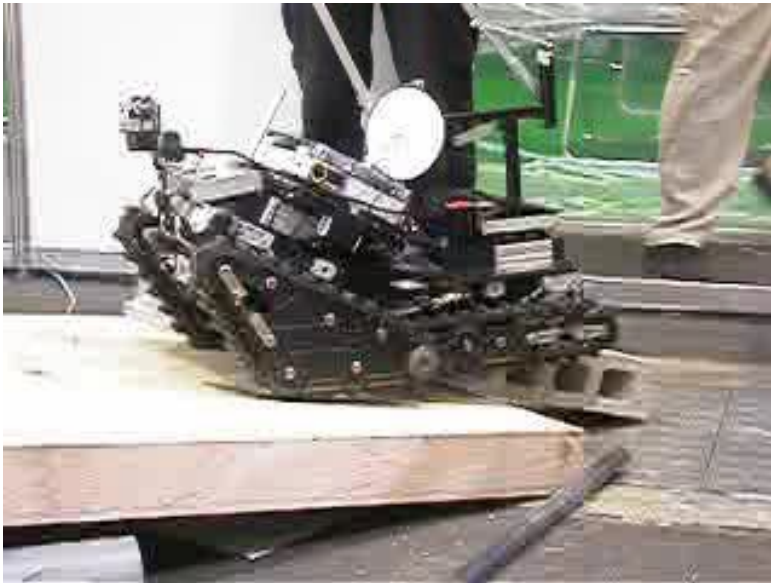
Humanoid League Adult Size



RoboCup 2011 Istanbul: Final
1:0 in the 'Dribble & Kick' competition
won by robot CHARLI from Virginia Tech.

RoboCup Rescue

- Simulation
- Robots in Test Arena



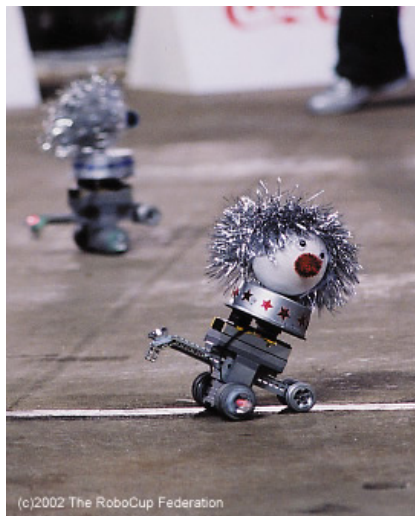
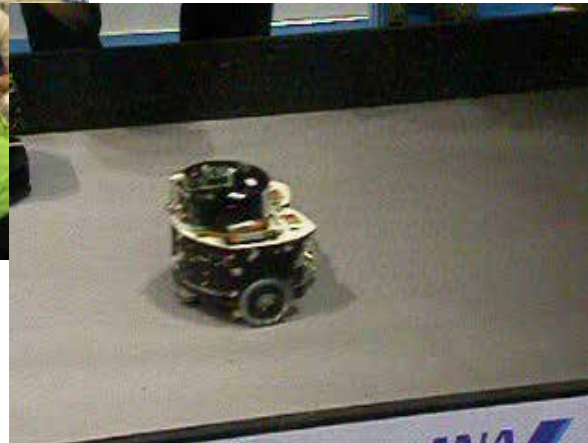
RoboCup@Home

Robots in Daily Environments



RoboCup Junior

- Soccer
- Dance
- Rescue



RoboCup at Humboldt University Berlin



RoboCup at Humboldt University Berlin

AT Humboldt (Simulation League)

World Champion Nagoya 1997

Vice Champion Paris 1998

Vice Champion (3D) Lisbon 2004, Singapore 2010



Aibo-Team Humboldt (Sony Four Legged League)

Winner German Open Paderborn 2001, 2004

2nd Place German Open Paderborn 2002, 2003, 2005



German Team (Sony Four Legged League)

(Berlin, Bremen, Darmstadt, Dortmund)

Winner „Technical Challenge“ Padova 2003, Atlanta 2007

World Champion Lisbon 2004, Osaka 2005, Suzhou 2008



2006 and 2007: Humanoid Team Humboldt

Since 2008: Nao Team Humboldt

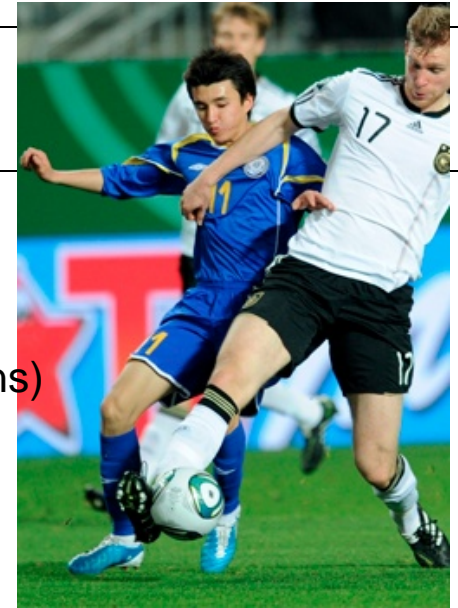
4th Place, Suzhou 2008



Soccer Playing Robots

Challenge: Human Dimensions

- Body
- Autonomy
- Skills
- Behavior



Picture by 999amir
(Wikimedia Commons)



Challenge: Humanoid Robots

- Not a big fast moving car
- Not 6 legs for kicking
- Not a knight with arms
- No gun
- No wings
- No remote control
- ...

But ...

Challenge: Humanoid Robots

But:

- Fully autonomous
- Human like shape: Arms, legs, ..., soft skin
- Run, jump, grasp, carry, ...
- Understanding of the world
- Rational behavior
- Communication und cooperation

...

A robot which plays and understands soccer could accompany you in the metro and assist in different tasks.

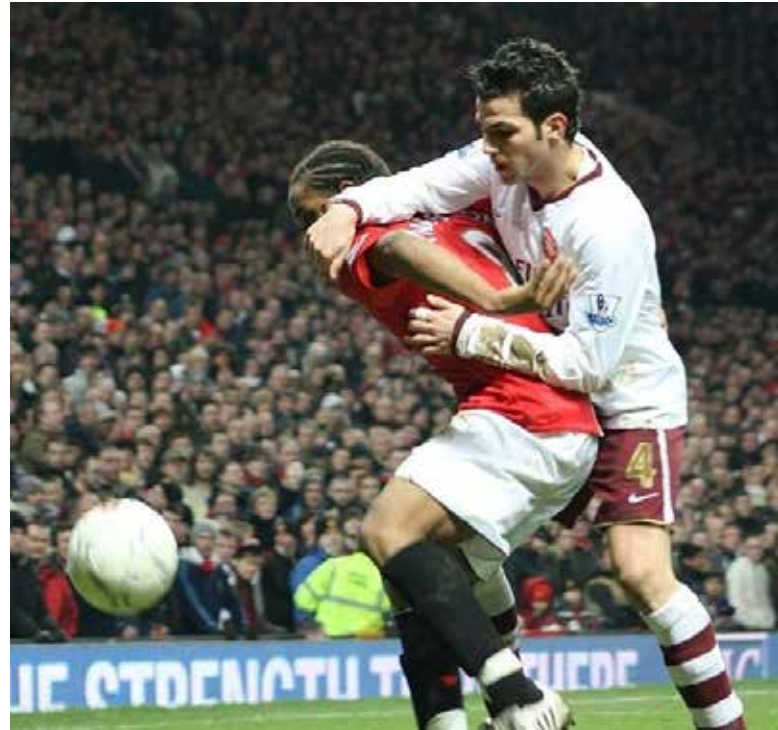
Humanoid Robots



Assistance Robot:
HRP-2 Promet (Kawada)

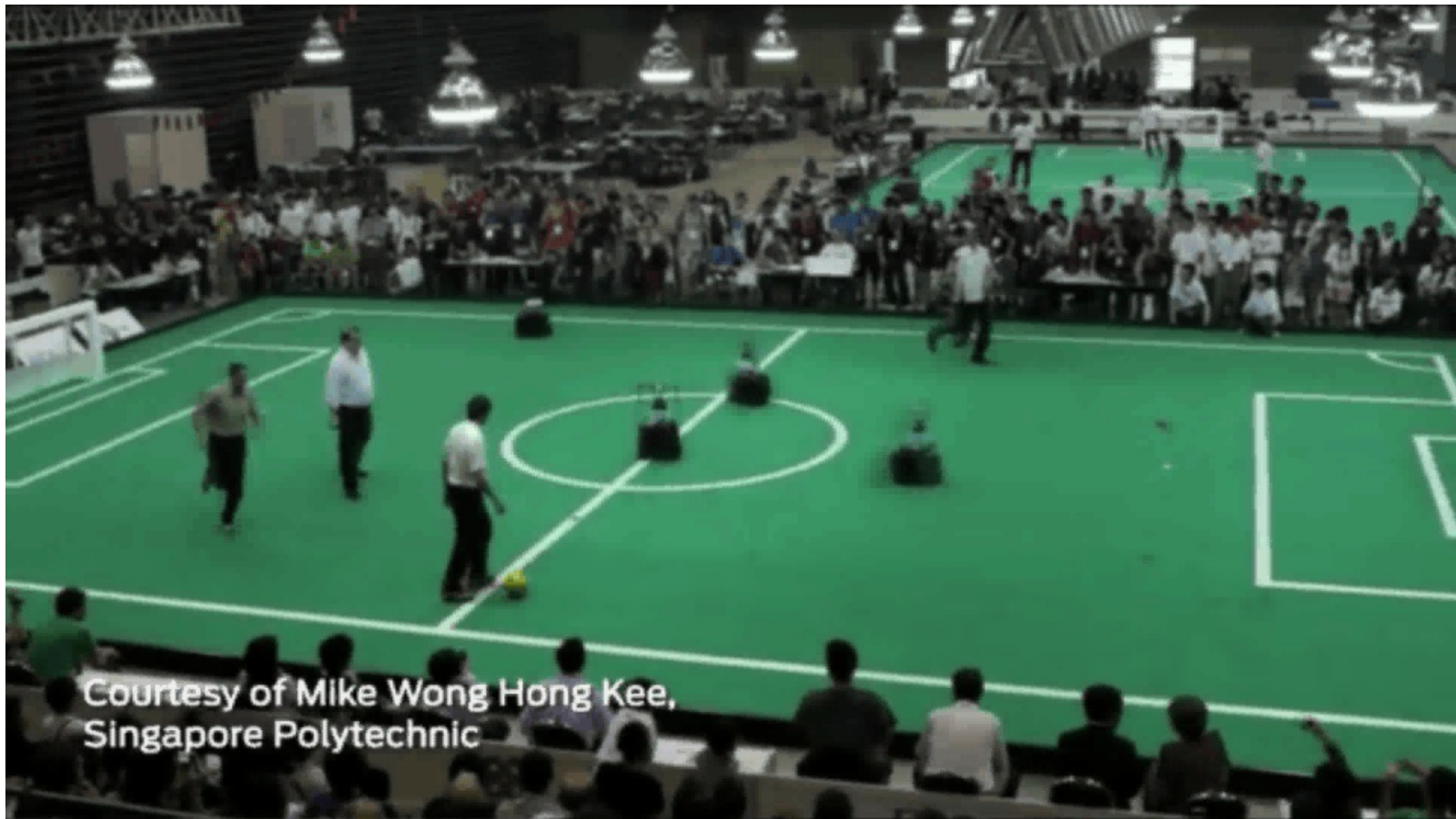
Robots vs. Humans in 2050?

- What does it mean
“Play by the rules of FIFA”?
- What exactly are humanoid robots ?
- Play like humans?



Picture by Gordon Flood
(Wikimedia Commons)

Robots vs. Humans in 2010



Possible Advantages - Disadvantages

- Robots may have less flexible motions than humans.
- Robots may perform more precise planning (e.g. exact calculation of ball trajectories).
- Robots may have to economise energy.
- Robots may have less elasticity but more precise motion.
- Robots may be less emotional.
- Robots may be more rational.
- Robots must not harm humans.



Picture by Ras
(Wikimedia Commons)

Next Steps in RoboCup

- Outdoor games
- Natural conditions for perception
- Larger and faster humanoid robots
- Running, jumping, dribbling, kicking ...
- 11 players: strategic behavior
- Mixed teams from different institutions



Problems to Be Solved: Motion

2-legged Walk by different approaches, e.g.:

- Motion Capturing (like for animated movies)
- Physical Models
- Clever Design
- Biologically Inspired Motion