



RoboCup

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What is RoboCup



- “Robot Soccer World Cup”
- It’s an international robotics competition founded in 1997
- It has the aim of promote robotics and artificial intelligence research
- Official goal (or dream...) set in 1998:

“By mid-21st century, a team of fully autonomous humanoid robot soccer players shall win the soccer game, comply with the official rule of the FIFA, against the winner of the most recent World Cup.”

The Leagues

- The RoboCup competition is divided in many leagues
 - each league is a subcompetition with **different rules, goals and scientific areas of interest**
- Some examples:
 - Small Size League 18x15 cm robots
 - Middle Size League 80 cm height robots
 - Four legged League dog-like robots
 - Humanoid League human-like robots
 - Rescue League rescue people in case of disasters
 - Simulation League 2D or 3D simulated robots

Rules for physical robots leagues

- Each robot must be controlled by its own **autonomous software agent**
- **No intervention by humans** allowed, except substitutions of faulty robots
- The rules tries to make robots play in the same condition and limitations of a real human player
 - In order to do a fair play against humans, robots must not “cheat” by doing things that are impossible for an human.

Small size league



Small size league - Rules



- High quality sensory information is given to player agents by **external sensors** set up by team organizers
 - A **vision system** tell players the exact position and orientation of each robot and the ball
- Robots merely execute commands given by **agents running in an off-field computer**
- Focus on the problem of intelligent multi-agent **cooperation**

Middle size league



Middle size league - Rules

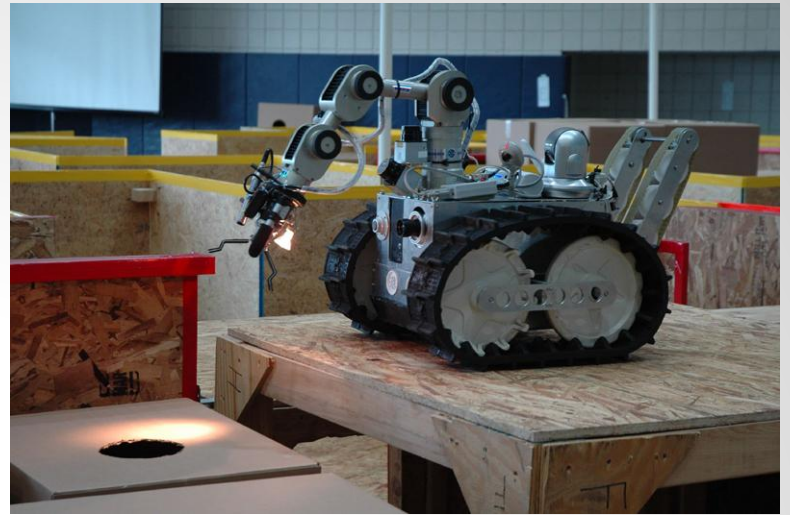
- Robots can **perceive information from the external world only with their own sensors** or the ones of their **teammates**
- Inter-team robots can wireless **communicate** with each other to establish **cooperation**
- No intervention by humans allowed, except substitutions of robots.
- Focus on making fully autonomous robots that can **perceive reality on their own**

Humanoid and four-legged leagues



- Focus on the mechanics of robots

Not only football...



- The **Rescue League** has the goal to make robots that can help save people in case of disaster like earthquakes
- The robots must **coordinate themselves** in order to find people in a devastated building
- Same technologies as playing soccer, but for a **socially important problem**

Simulation leagues (I)

- The goal is to develop a team of player agents that can win a **simulated soccer match**
- It uses a simplified model of reality
 - A robot might perform well in the simulator but poorly in the real world
- Let engineers **focus in the software development** without having to deal with hardware
 - Possibility of run thousand of soccer matches in a matter of seconds, useful for statistical analysis

Simulation leagues (II)

Exploring **strategies** with large teams of robots
(up to full 11 vs. 11)

- 2D simulation: uses a **2D kinematic-only model**, robots are just moving boxes
- 3D simulation: uses an **accurate 3D dynamic physical engine**, modeling the various part of an humanoid robot (arms, legs, ...)

Server simulation (I)

- A server simulates the world of the ball and players (dynamic, kinematics, ...)
- Teams of **fully autonomous client agents** that **separately** interact with the server
 - receiving **sensations** representing the view from its current location
 - deciding what **actions** to execute
 - sending the actions back to the server, for **execution**
- Each agent must be controlled by a completely separate process

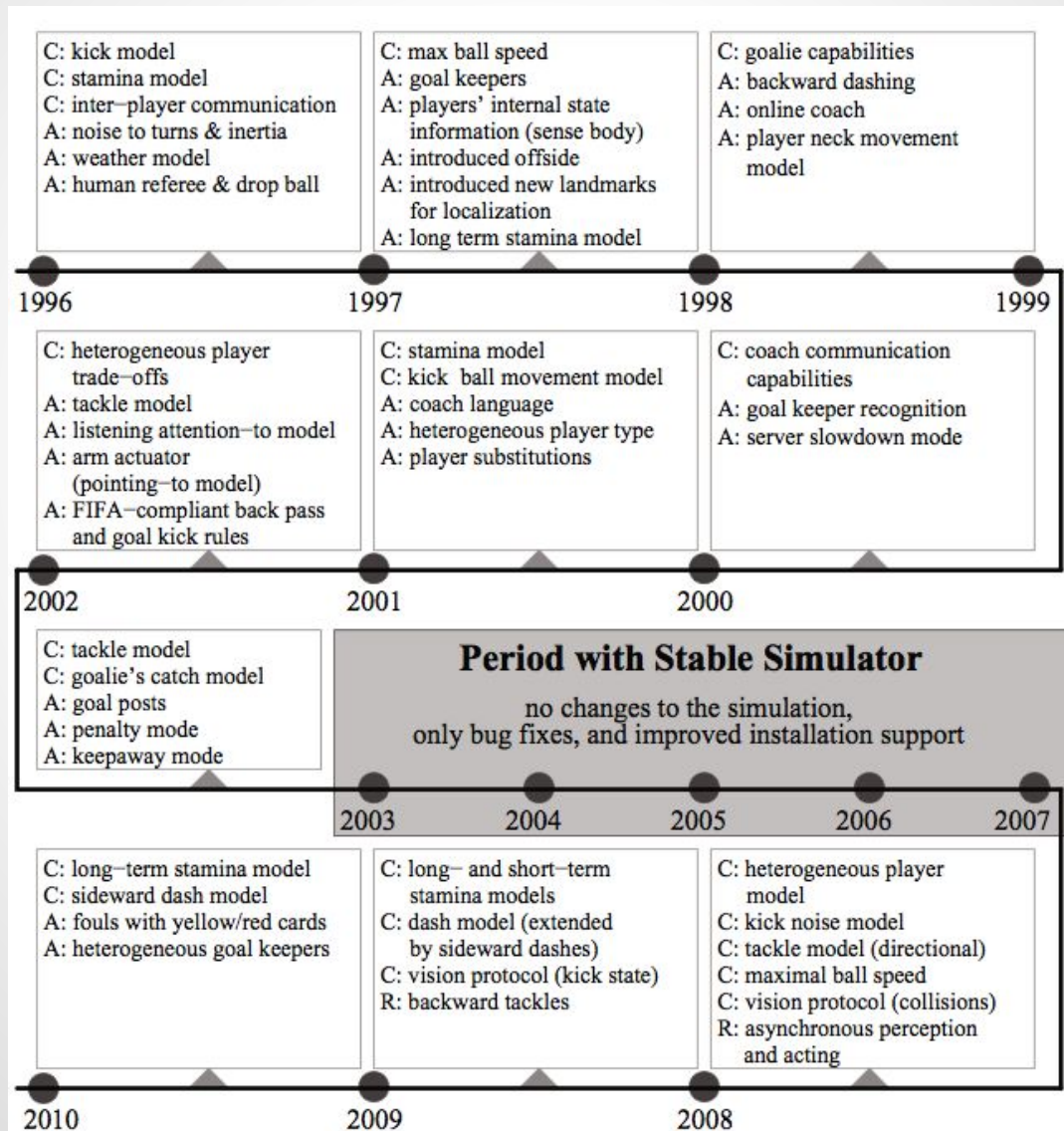
Server simulation (II)

- Each player receives **relative and noisy input of his virtual sensors** (visual, acoustic and physical)
- Each player is able to perform some basic action, in order to influence its (local) **environment**

Server simulation (III)

- Simulation more complex from year to year
- Hard to keep pace with the changes introduced
- Since the simulation environment was annually modified, a meaningful **comparison** across teams from different years was **impossible**
- From 2003 to 2007 the simulator development was **frozen** and the simulator retained as a **testbed for multiagent research**, allowing to compare and measure performance and progress over the years

Server simulation (IV)



2D simulation (I)

- realistic team-level strategic interactions
- the **ball** and the **player** are modeled as circles
- each player has:
 - a **direction** that its **body is facing**, which affects the direction it can **move**
 - a **direction** in which **it is loocking**, which affects its **sensations**

2D simulation (II)

- Actions are **abstract command**:
 - moving forward or backward with a specified power
 - turning the body or neck by a specified angle
 - kicking at a specified angle with a specific power
 - slide or tackling in a given direction
 - catching the ball
 - ...

2D simulation (III)



3D simulation (I)

- implements a **physically realistic world model** and an action interface that is reflective of that experienced by real robots.
- The agents interact with the simulator by sending **actuation command** to each of the robot's **joints**
- real challenge to enable robots to walk and kick without falling over

3D simulation (II)



Major issues:

- advanced learning
- teamwork
- opponent modeling

Advanced learning

TODO

Teamwork

TODO

Opponent modeling

- **recognizing** or **predicting** the behavior of the agents or team (formation, defense and offense system)
- allowing more **informed decisions**
- performed by a further “**coach**” agent (2001-2006)
 - which gets a noise free **global view** over the field
 - **observe** the game
 - **identify** weakness and strenghts of opponents (**behavior detection** with data mining techniques)
 - **provide** additional advice and information to players (**adjustable** autonomy)

//TODO

Agente autonomo vs agente che apprende autonomamente

References

Robocup 2010

On Progress in RoboCup: The Simulation League Showcase

Human vs. Robotic Soccer: How Far Are They? A Statistical Comparison

Hierarchical Multi-robot Coordination

Cooperative Localization Based on Visually Shared Objects

Robocup 2011

The Ontology Lifecycle in RoboCup: Population from Text and Execution

An Overview on Opponent Modeling in RoboCup Soccer Simulation 2D

Robocup 2013 website - <http://www.robocup2013.org/robocup-soccer/>

Robocup Wiki - http://wiki.robocup.org/wiki/Main_Page

General informations about the RoboCup competition and the various leagues

Middle size league rules 2013 - http://wiki.robocup.org/images/9/98/Msl_rules_2013.pdf

Small size league rules 2013 - <http://robocupssl.cpe.ku.ac.th/rules:main>.