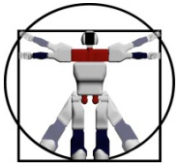
Robots in future collaborative working environments

Paolo Pierro

ppierro@ing.uc3m.es

Robotics Lab



http://roboticslab.uc3m.es

Napoli,

October 24th, 2008

Outline

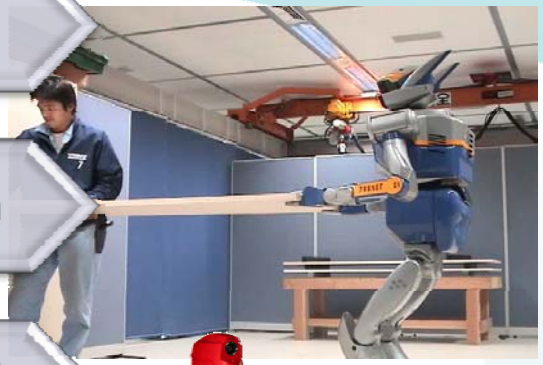
- Motivations
- Robotic platforms and technologies for collaboration
- A look to some EU projects related to CWE
- The Robot@CWE project
- Human-robot collaboration
- Future trends
- Conclusions

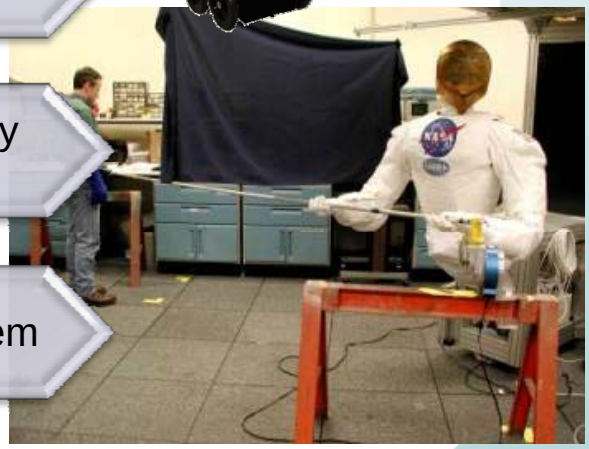
Motivations

- Collaboration (between individuals and groups and between humans and machines) can be one of the most stimulating ways to develop new concepts and ideas, and solve problems
- Without collaboration there is less innovation and less problem solving
- Research and demonstrate integrative concepts of advanced robotic systems
  - robots as collaborative agents, working together with humans in various environments
- Integrate collaborative robotic systems as active agent operated through various control paradigms

Robotics platforms and technologies for CWE

HRP-2	Collaboration tasks	Advanced Walking Capabilities
RH-1	Walking capabilities	H-R collaboration capabilities
Hermes	Environment exploration	Manipulation capabilities
Robonaut	Manipulation capabilities	Remote control
Coworker	Remote control	User-friendly interface
Asibot	H-R communication capabilities	Control system





EU projects related to CWE

Robotic projects

Remote attendance

H-R communication

H-R collaboration

H-R close collaboration

H-R space sharing

Dependability and safety

Crisis management

Non-robotic projects

Virtual Reality

European Technological Platform for CWE

Small Enterprise

CWE for crisis management

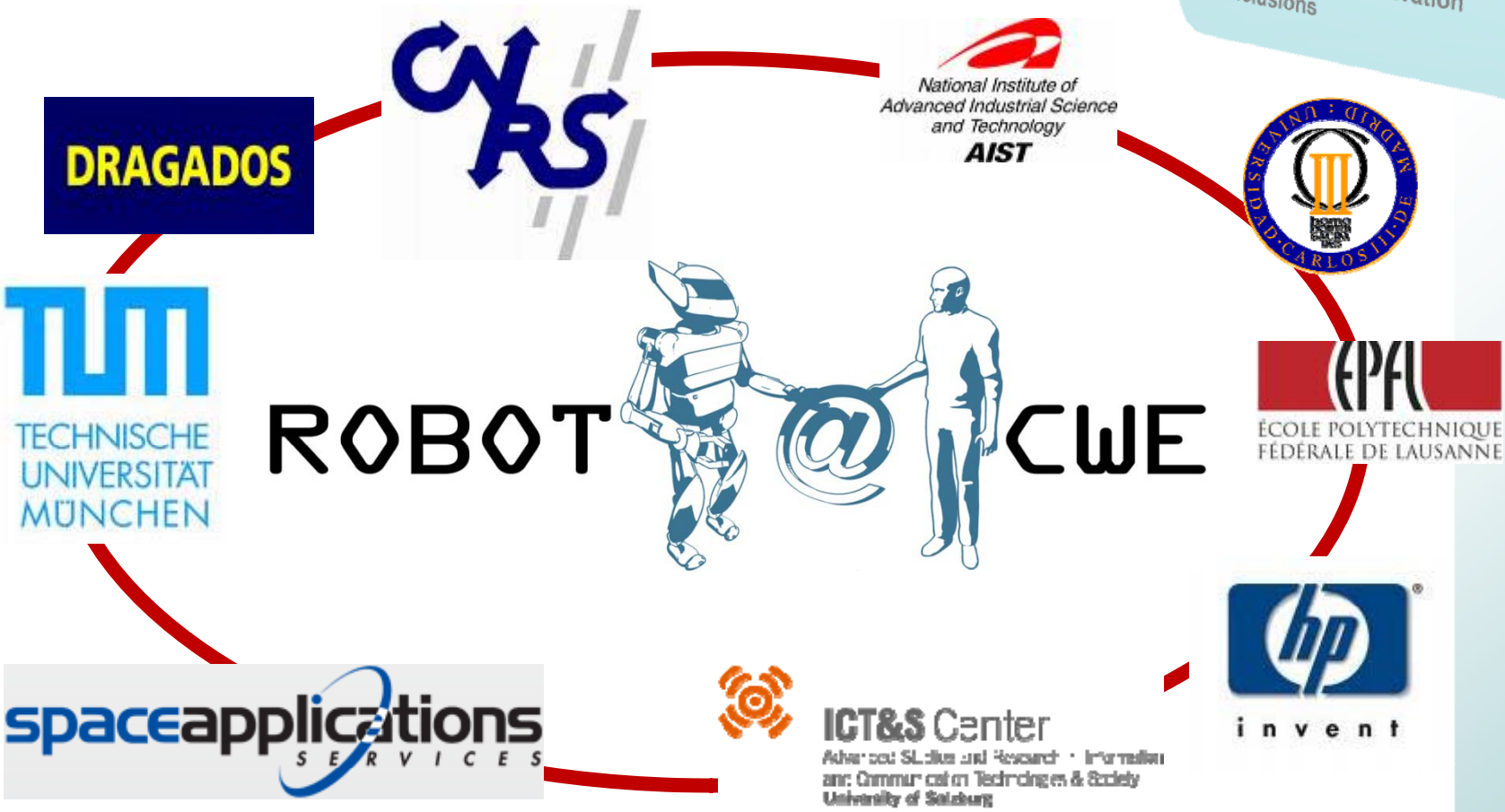
CWE for design and engineering

CWE for manufacturing and assembly industry

Robot@CWE project

- It aims to establish a concept for, and develop prototypes of, a collaborative working environment, conceived such as to include robots and, by so doing, to improve productivity and safety
  - What robots would bring to CWE?
  - How (mechanism of integration to CWE)?
  - Why (potentialities of advanced systems)?
  - Social impacts?
  - Definition of a high level knowledge oriented interface to collaborative work with robots
  - Specification of an open architecture framework for collaborative work, involving robots
  - Implementation of the architecture and iterative prototyping with a number of robotic applications

Consortium



Construction industry inputs

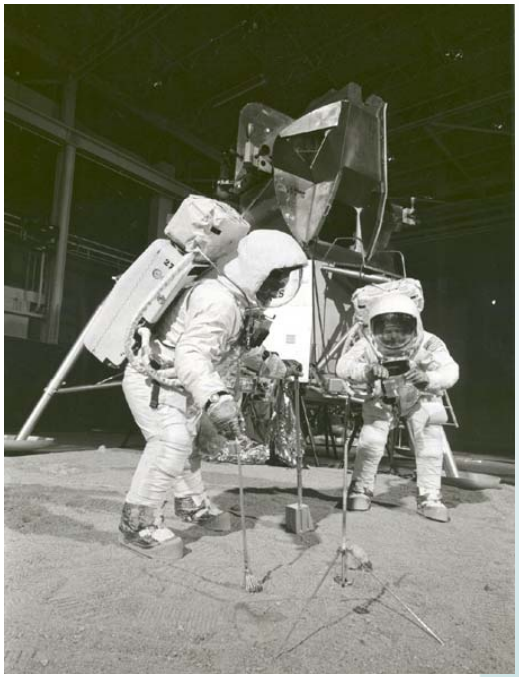
Topography

Pipe construction

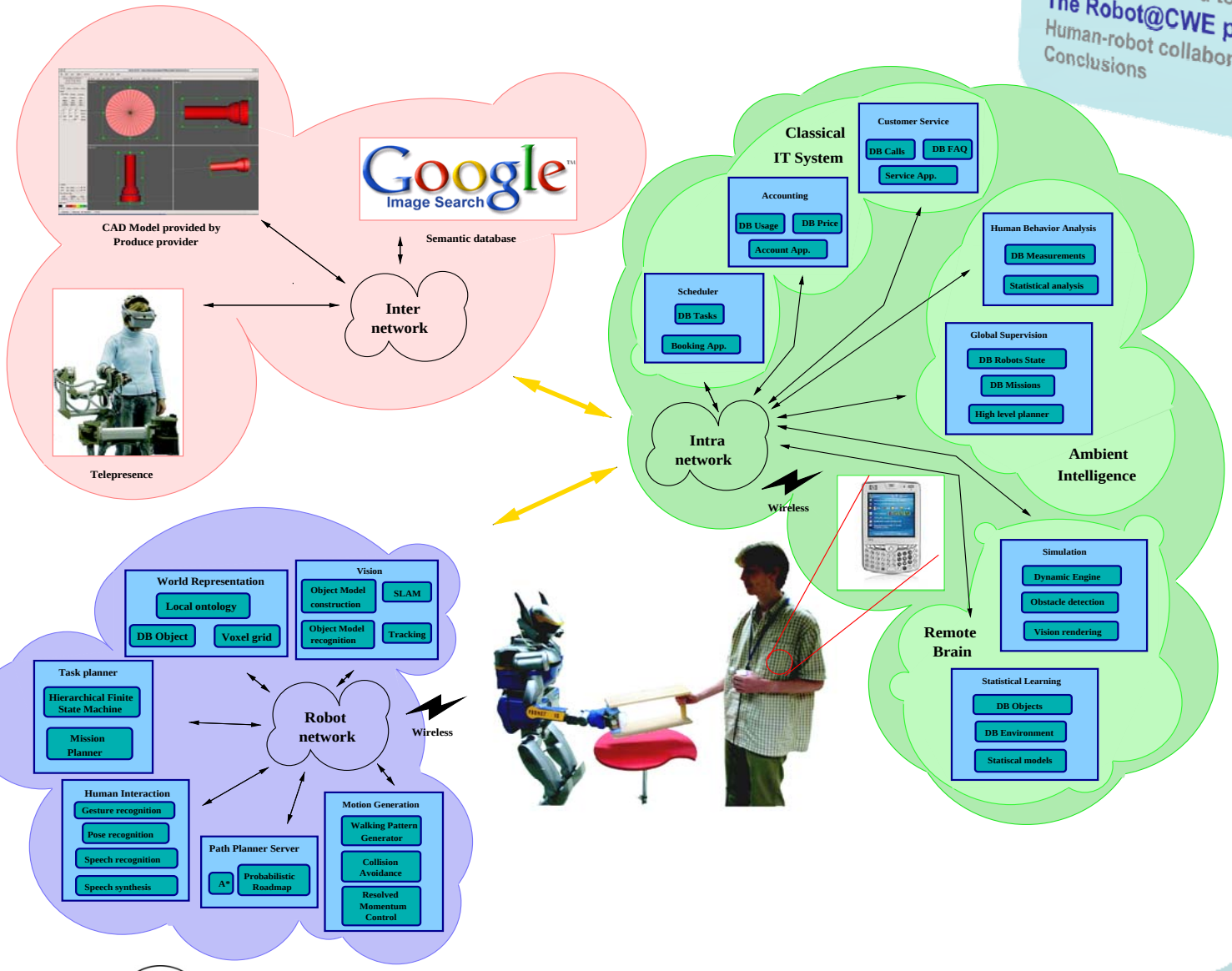
Civil engineering

Space industry inputs

- Preliminary definition of a realistic Planetary (Moon) Settlement Scenario (PSS)
- Analysis of
  - overall challenges
  - potential Moon habitats
  - life requirements and constraints,human physical and psychological issues
- Preliminary identification of
  - tasks to be performed in the PSS
  - best fitting robot platforms for the tasks to be performed
  - CW configurations and possible HR communication / interaction modalities for the PSS



Human-robot collaboration architecture within Robot@CWE

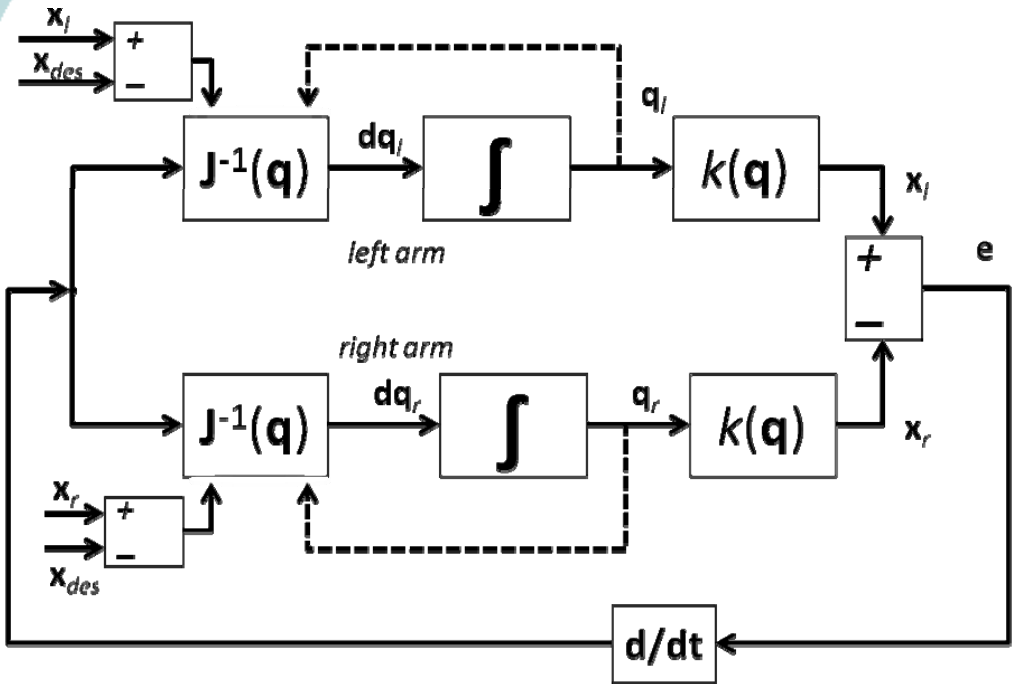


Human-Robot collaboration idea

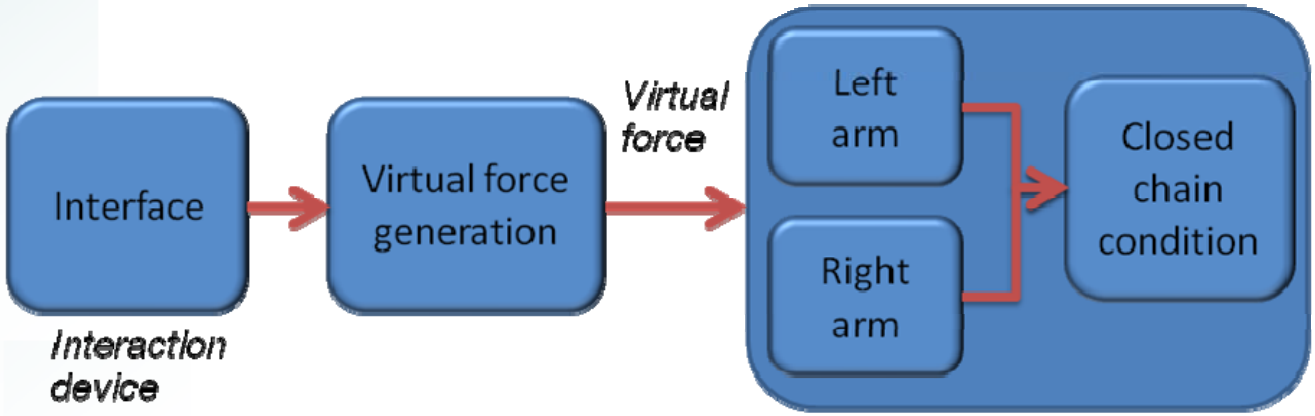
Realizing H-R collaboration

- The idea is attaining the aim:
  - a mobile/humanoid robot which can execute a coordinate task with a human, like transporting and/while manipulating an object
- The problem can be organized in several steps:
  - kinematics and dynamics of the robot arms in closed-chain (CC) with a bar
  - joint manipulation with the human
  - study of the dynamics of the human holding an object
  - carry the object together with the human

Modelling robot arms when manipulating

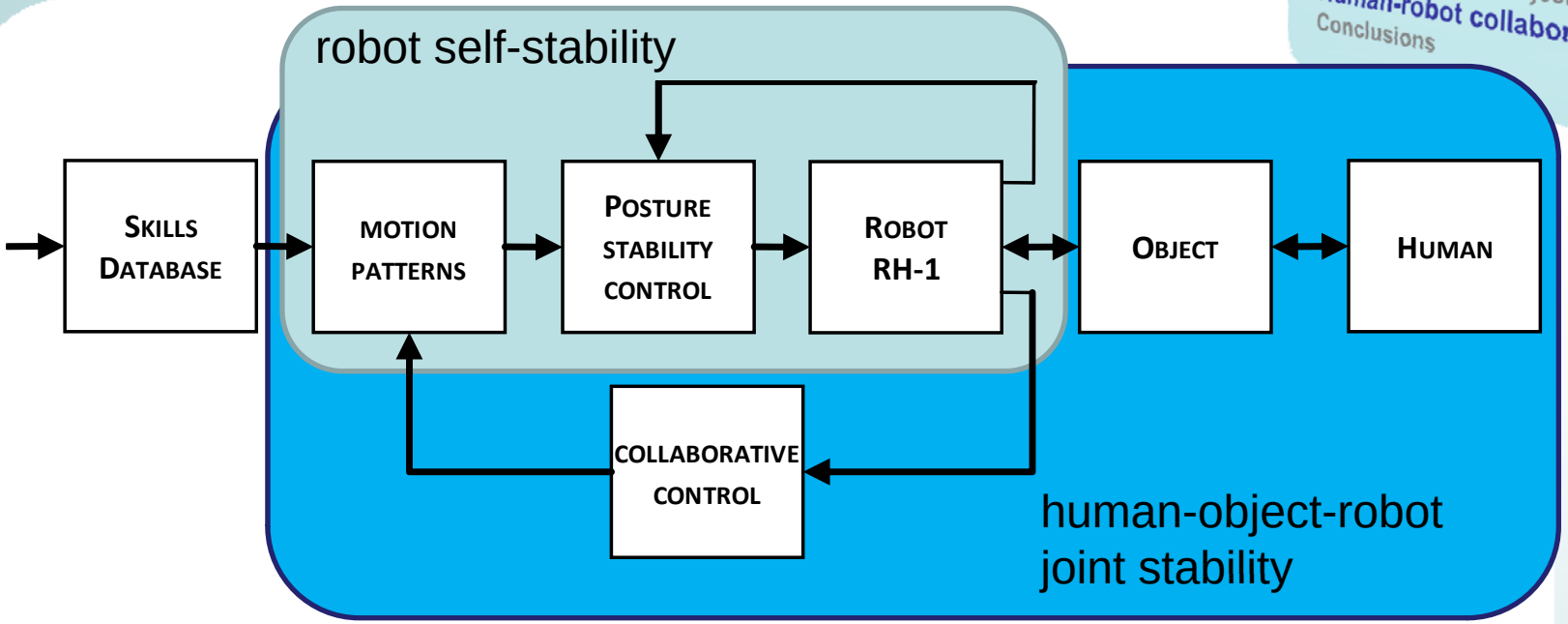


- Closed chain manipulator, solved considering two independent open-chain manipulators and imposing same position and orientation (6 d.o.f.s needed)
- Solved using Jacobian and priority-inversion in the solution, what we obtain is an open-chain-equivalent manipulator



Open chain equivalent manipulator

Human-Robot collaboration algorithm

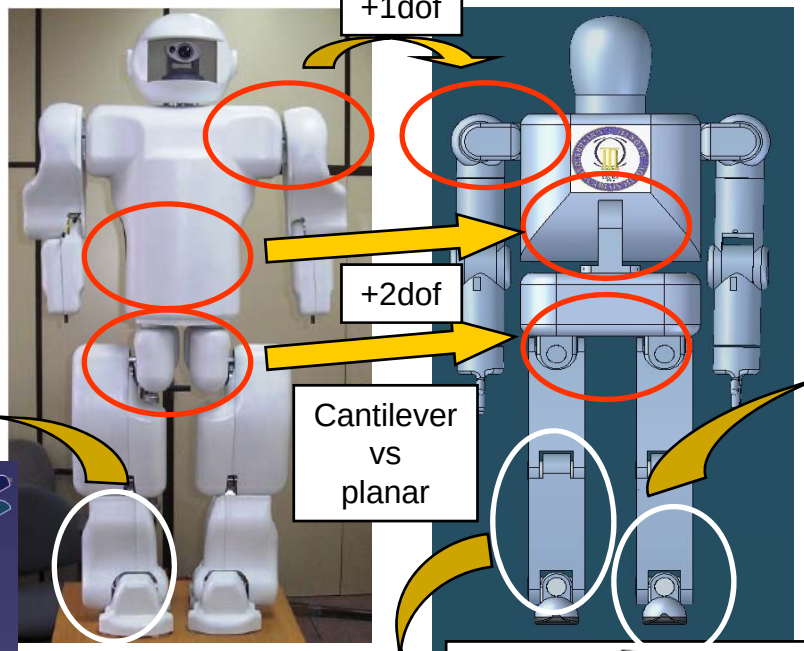


- Humanoid classical problem of stability is working only for stand-alone robots
- When physically interacting with an object and/or a human, the concept of stability is changing

RH2 Re-Design

RH-1:
- 50Kg
- 150cm
- 21 dof
- 500gr Manip.

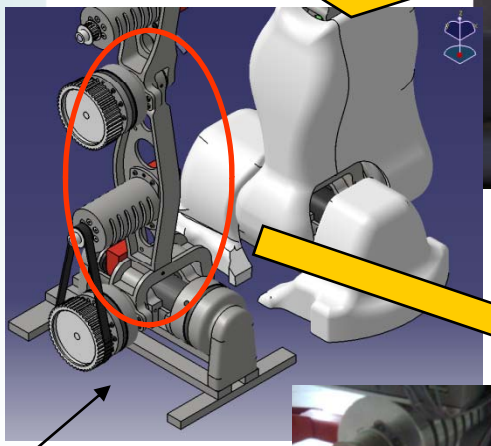
RH-2:
- 60Kg (est.)
- 160cm
- 25 dof
- 2Kg Manip.



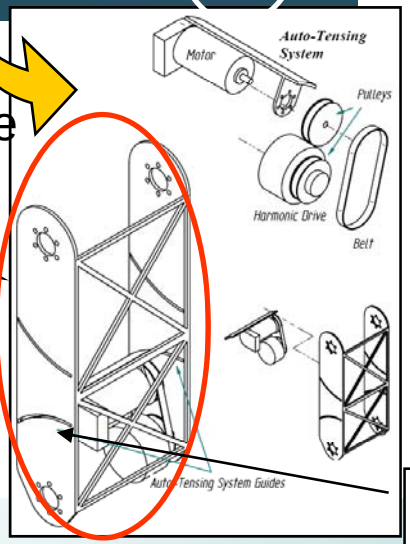
+1dof

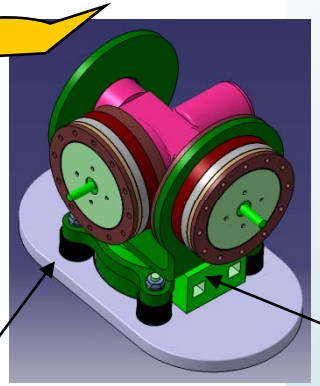
+2dof

Cantilever vs planar



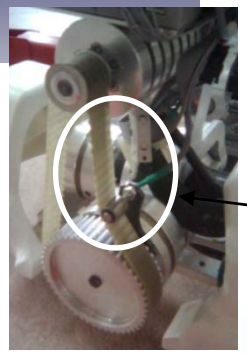
Different structure





Force/torque Sensor

Step impact absorber



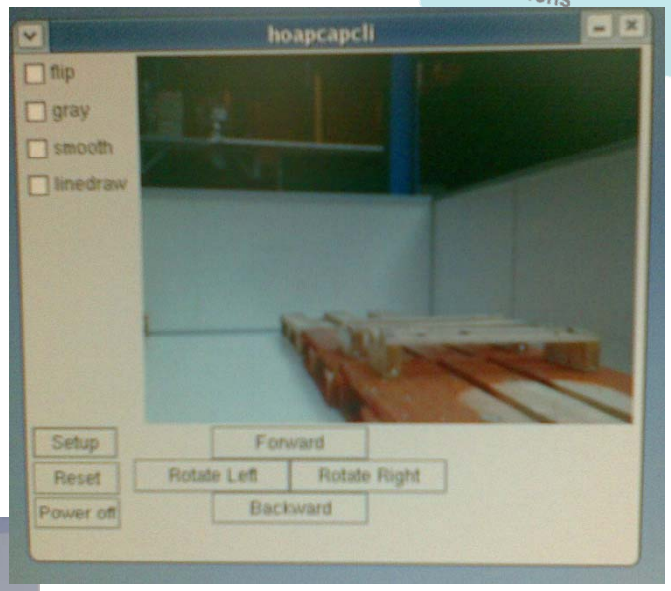
No sensor Rigid foot structure

Belt Tensioner needed

Built-in Auto-tensing
No tensioner → No power loss

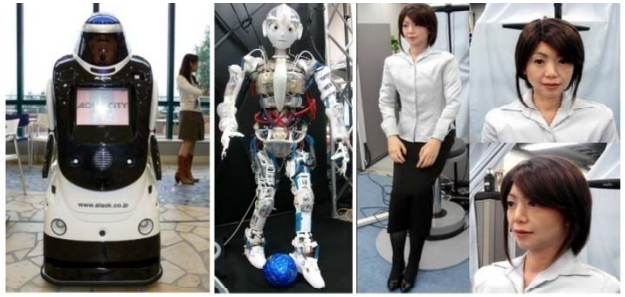
Hoap-3 as a collaborative agent

- 60 cm, 8.8 Kg
- 28 DOF
- USB 1.0 (12Mbps), Wifi
- 1 gyro (3 axes),
- 1 accelerometers (3 axes)
- 4 FSR each foot
- Power sensor each hand
- Ultrasound sensor
- 2 USB cameras
- Intel Pentium Mprocessor 1.1GHz



Where will robot collaborate?

Construction industry



Surveillance - Reception

Factory

Defense - Rescue

Space

Conclusions

- Advantages of having a robot as a collaborative agent
  - Robot as a partner of the human
  - The robot does what the human cannot and vice-versa
- The Robot@CWE project
  - Objectives and achievements
- How we think to implement physical collaboration

Robots in future collaborative working environments

THANK YOU

Paolo Pierro

ppierro@ing.uc3m.es

Robotics Lab

http://roboticslab.uc3m.es

Napoli,

October 24th, 2008