



The URUS project

(Ubiquitous Networking Robotics in Urban Settings)

<http://www-iri.upc.es/groups/urus/>

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URUS team at IST

Project id and partners



**6th Framework Programme - Priority 2
“Information Society Technologies”**

**FP6/2005/IST/6 – Strategic Objective
2.6.1 Advanced Robotics**

Project
coordinator ←

- AICIA (www.aicia.es)
- ETHZ (www.ethz.ch)
- IST (www.ist.utl.pt)
- LAAS (www.laas.fr)
- RT (www.robotechsrl.com)
- SSSA (www.sssup.it)
- TID (www.tid.es)
- UbEc (www.bcnecologia.net)
- UniS (www.surrey.ac.uk)
- UniZar (wzar.unizar.es)
- UPC (www.upc.es)

Urban issues addressed by the project

- Surveillance

- Urban furniture vandalism
- Abnormal (human) activities

URUS experiment 1

- Assistance to people

- Providing information to people on the urban area
- Transportation of goods/materials/people

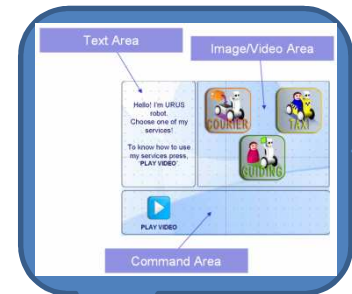
URUS experiment 2

Economically and socially relevant issues

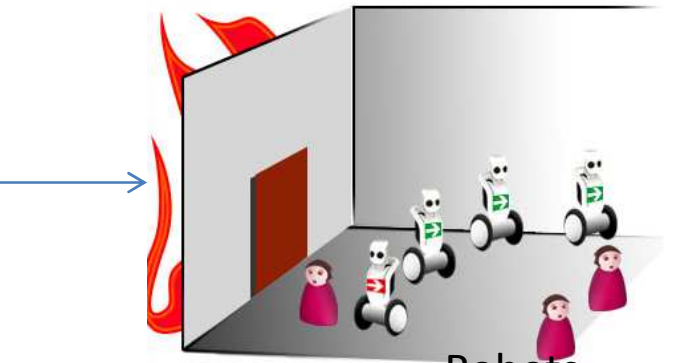
Urban robotics

- Single robots have been shown to have advanced autonomy
 - Museum tour guides
 - Receptionists
- Multiple robots have been shown advanced coordination capabilities
 - “Toy” problems (e.g. Robocup)
- Robotics might extend the capabilities of fixed sensor networks
 - For instance providing an active source of data

Urban robotics – URUS exp 1

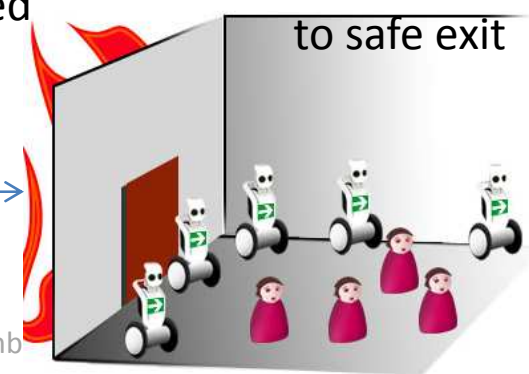


Detect
emergency



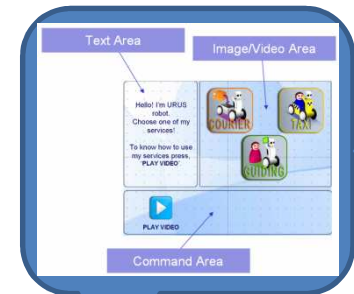
No emergency Robots wander around

Emergency declared



Robots move in formation, guiding people to safe exit

Urban robotics – URUS exp 2



Detect
guidance or
transportation
request

No request
detected

Allow assistant
robots to
wander around



Request
detected

A taxi robot
transports the
people/goods



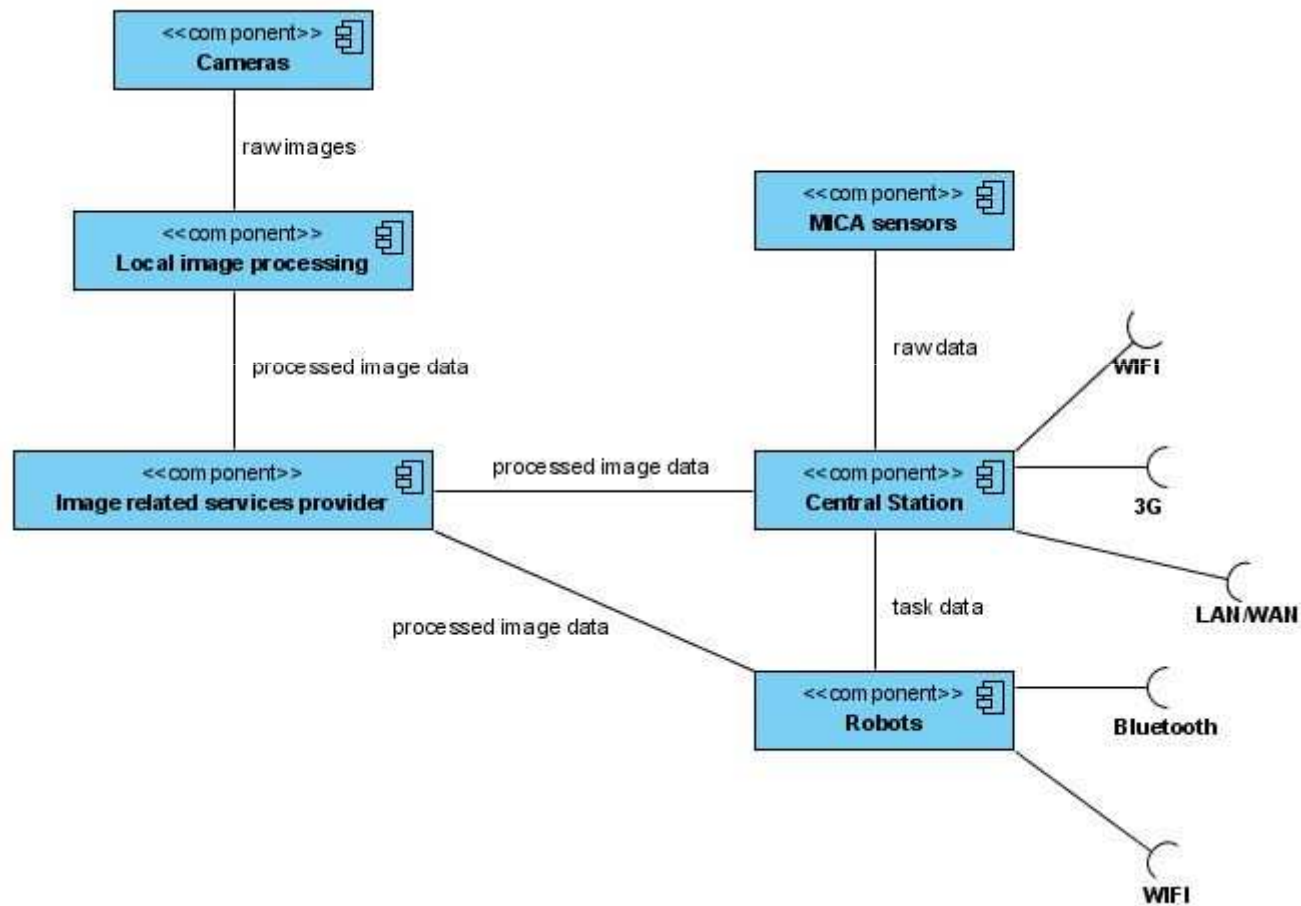
An assistant robot guides
the people and/or helps
finding the way to the
closest taxi robot



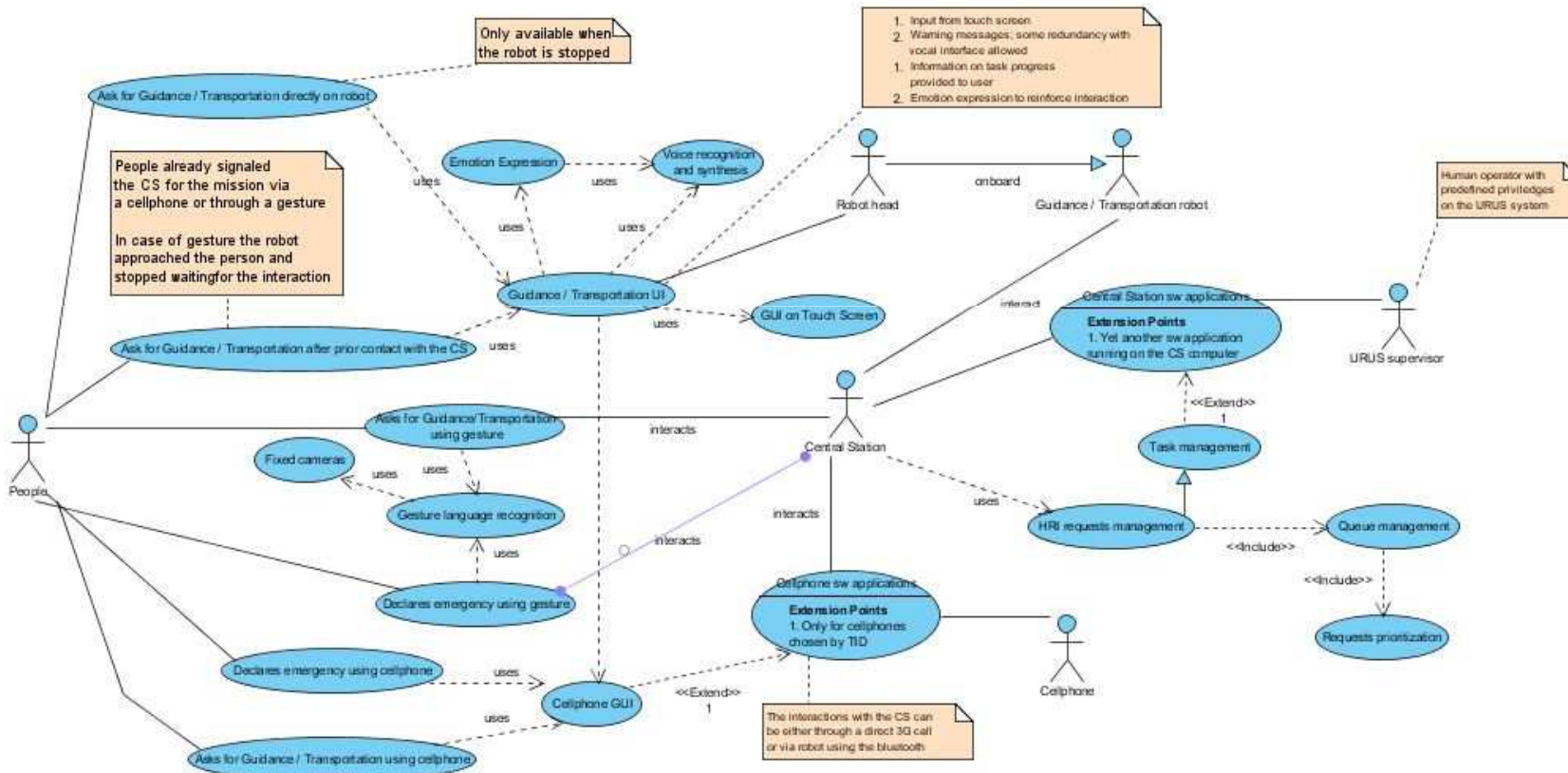
Urban robotics

- Common (non expert) people are expected to interact with the robots
 - User friendly interaction strategies are required
- Outdoors environments mostly adapted to legged locomotion
 - However, urban environments often cope with the use of wheeled locomotion
- Common networking media is in general available to interconnect sensors, robots and computing devices

URUS - A component view



URUS - Main use case sketch



Architectural concerns

- Flexibility, platform independence, scalability, development process simplification, real-time performance, integration with existing infrastructure, promoting software reuse, programming language independence, robustness → **Common to most architectures used in IS**
- Layered supervision, separating machine-like behavior from human-like behavior → **Rooted on psychology theories of personality**
- Human robot interaction advanced techniques → **Key element to wide acceptance by humans**

Urban test sites (Barcelona)

UPC Campus Nord

Gracia superblock



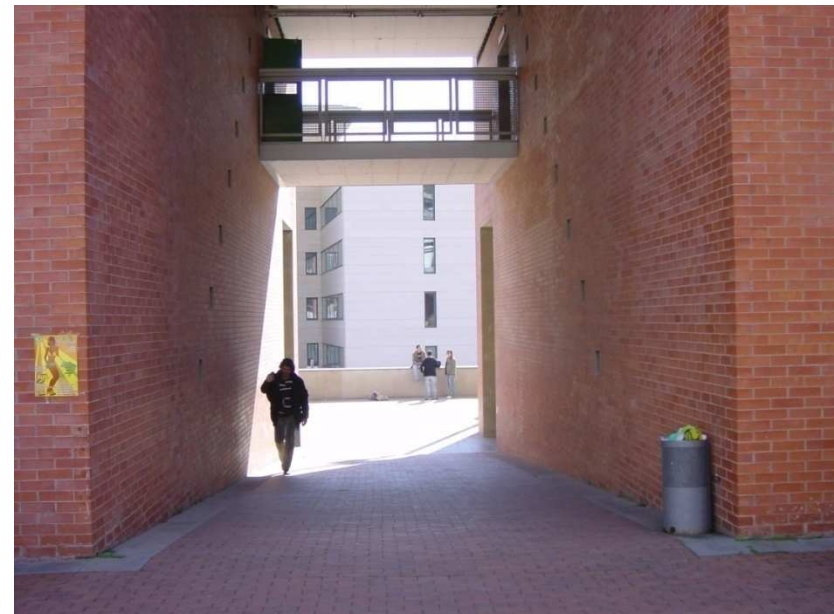
UPC Campus Nord



Around 20 IP cameras placed outdoors cover most of the test site area



UPC Campus Nord



Gracia superblock

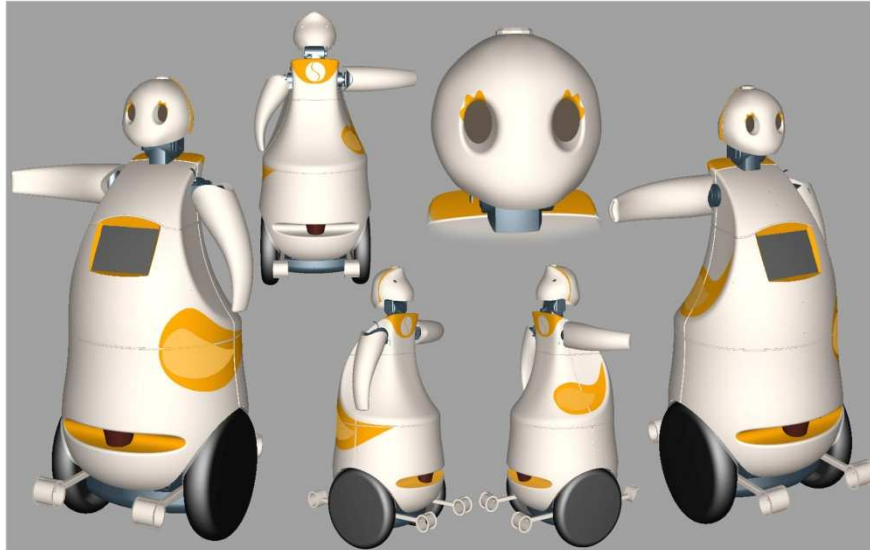


Gracia superbblock



The robots

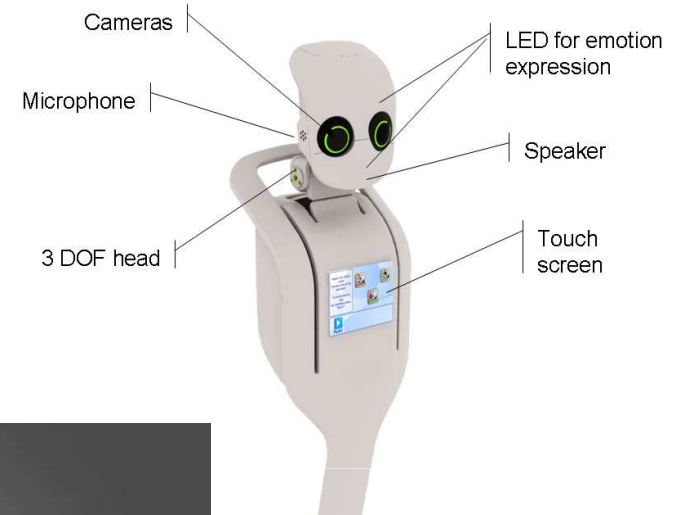
UPC ROBOT



The robots



Head and torso to be installed onboard some of the wheeled robots

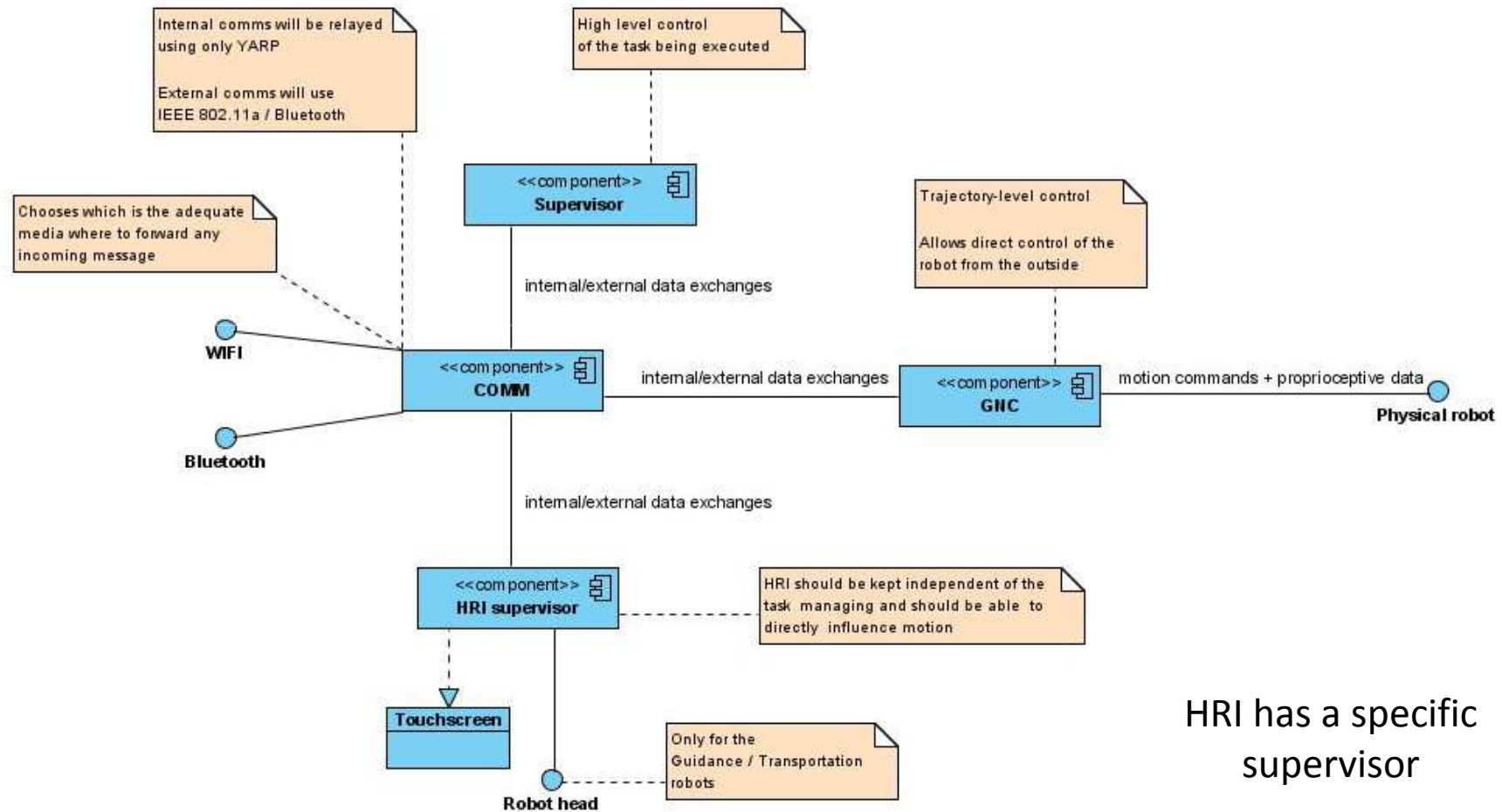




Addressing the architectural concerns

- The overall system is a network of distributed services
 - Services built around the Active-Object design pattern
- Cooperative perception information fusion using POMDP techniques

Addressing the architectural concerns



HRI has a specific supervisor

Addressing the architectural concerns



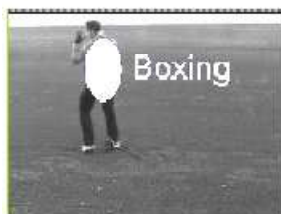
Expressive motion and facial expressions to improve Human-Robot interaction



Addressing the architectural concerns



Recognizing
human activities
using the fixed
camera network



(a)



(b)



(c)



(d)

Final remarks

- Real urban environments pose scientific/technical challenges
- Standard concerns in networked systems apply also to urban networked robotics
 - Code reuse, platform independence, etc
 - Information fusion strategies from multiple sensors in the network
 - Security issues related to data exchange
- Main architectural concerns related to Human-Robot interaction
 - Layered supervision
 - Human activities recognition
 - Expressive motion generation
- The widespreading of networked robotic systems will raise security issues, at the interaction level, in a near future
 - Humans might interact with robots in such a way to lead them to wrongdoings
 - Safety/security measures will probably need to be explicitly addressed in the architectural constraints