



Teams of humans and robots

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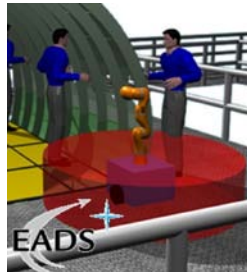
Motivation



- Robotic Assistants in Ambient Intelligence Environments
- Co-worker robot
- Robots as Teammate of Humans in « intervention » tasks

Contextes

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Context Robot / Ambient Intelligence

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- Toward an integration of robotics and its applications to ambient environment.
- The physical environment :
 - Home
 - Institutions: Rehabilitation, Elderly people care...
 - Public places
 - Office, workshop (humans – robots teams)
 - Groups of Humans and Autonomous Heterogeneous mobile and communicating systems that deploy a network while achieving a mission

Role of human

- Remote human decision
- In situ human decision (and action)

- Many common issues and approaches to share:
 - Robot decisional issues for sharing task, space and .. decision

Role of human / Mixed Initiative ...

- Human Control of robots at various levels:
- Controls action (and consequently decision)
 - "simple" tele-operation,
 - sophisticated tele-operation (shared control, env. models)

 - Controls situation assessment and planning
 - Total control: human builds plans, programs
 - Cooperation at planning level:
 - Human gives "hints" to the automatic planning system
 - Sliding autonomy

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- Control of several robots as a whole:
 - Robots in formation
 - Robots “filtering” high-level orders and performing local cooperation to achieve the high-level order

 - Human-aware planning and action

The presence of the human

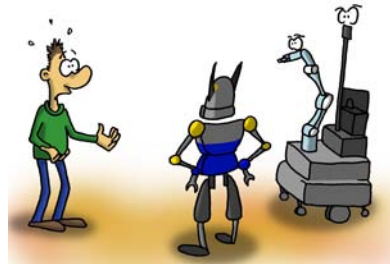
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- **A very important issue:** the presence of humans, to which the services are dedicated.

 - Need to take human explicitly into account at all levels:
 - dialogue, assistance, cooperative work, synergy, perception of humans and their activities , adaptation, compliance and reaction to their needs, behaviour, safety...
 - Notion of intentionality and of acceptability of robot behaviour

Decisional issues in Human Robot Interaction

Questions for a cooperative robot:
what, who, where, when, how?

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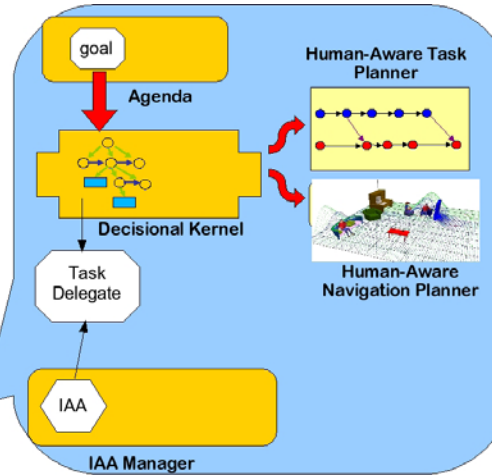
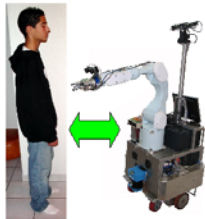
Contributions / Bricks for the collaborative abilities of an interactive robot

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- SHARY: collaborative human-robot task achievement (what, how and when.)
 - Navigation in presence of humans ... user studies (how)
 - Manipulation in presence/interaction with humans ..(where and how)
 - Perspective taking (where)
 - HATP: a Human Aware Task Planner (what, who and how)

A task-oriented architecture for an interactive robot

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- **Task-Oriented**
- How to perform a task, in presence or in interaction with humans, in the best possible way
 - Efficiency, Safety, Acceptability, Intentionality
- **Planning and On-Line Deliberation**
 - Anticipation, Reasoning



Notion of Joint Goal – Shared Plans based on abilities and preferences.

Handing an object to a person

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tvb



Where is Thierry ?



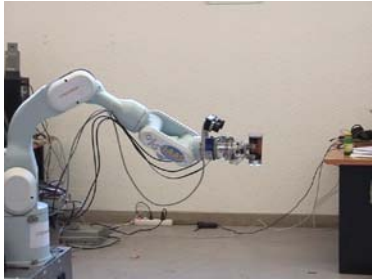
Thierry does not take the bottle



« Disturbed » attention

When to release the object ?

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Building a « good » plan

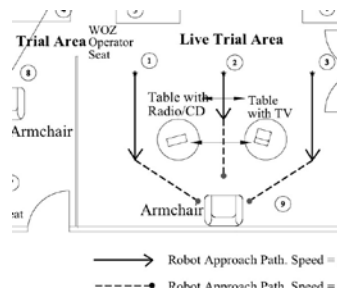
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- **Managing Joint task achievement**
- **Legibility** of robot actions and intentions (intentionality)
- **Acceptability** of robot actions
- Compliance with “conventions”
- Coherent attitudes and behaviours

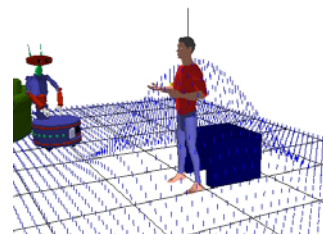
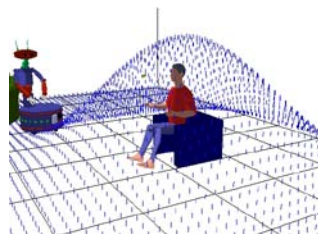
Constraints on robot plans
Constrained Cost Based Planning

Navigation in presence of humans Parameters deduced from user trials

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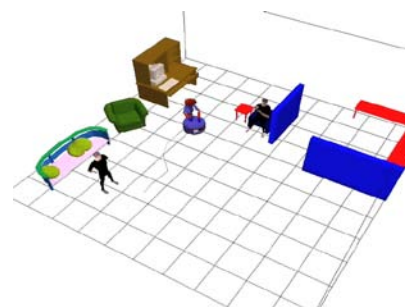
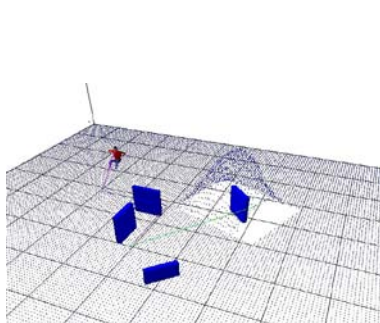


User trials performed at University of Hertfordshire

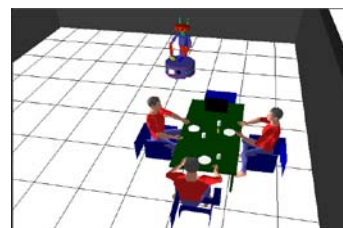


Human-friendly navigation

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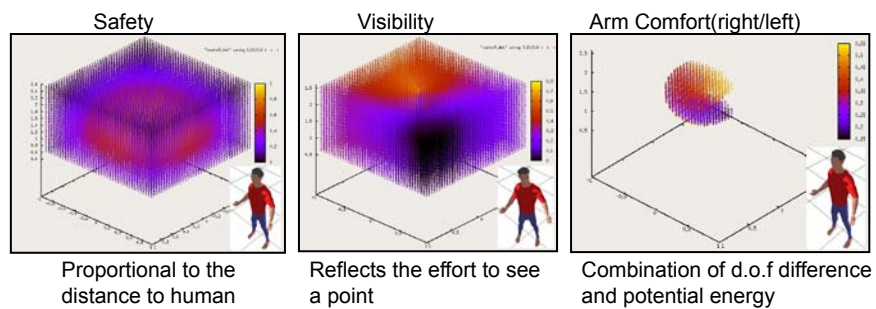


Real-time cost evaluation:
distance, posture, visibility



Handing an object to person

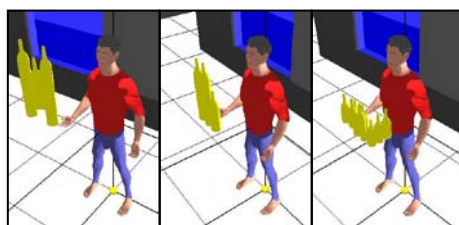
- The object should be placed in a safe and comfortable position.
- 3 different HRI properties are defined and represented as 3D cost grids around the human



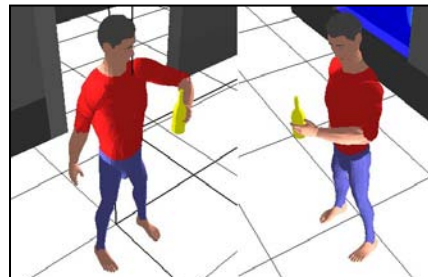
Handing an object to person

1- Calculating object position

- 3 grids are combined to form a final grid that merges all these properties.
- The cell with minimum cost is chosen to be the place where robot will place the object.



Dist > Vis > AC Vis > Dis > AC AC > Vis > Dis



Results

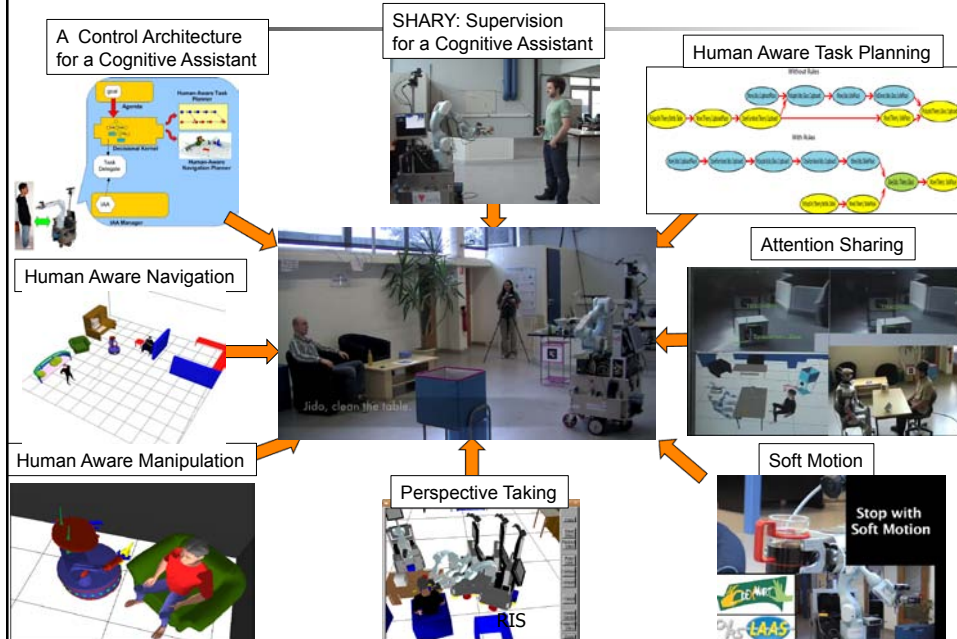


Classical Motion Planner with OTP pre-calculated



Human-Aware Planner

Interactive Autonomous Assistants



Thank you ...
