Lecture 2 – Interaction Management

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Readings


HR Interaction Design

Interaction design/management
• Efficiency and effectiveness of “interaction work”

Human-Robot Interaction design/management
• Efficiency and effectiveness of HRI

HRI Design as Planning

Interaction = execution of actions by humans and robots according to the current situation

Interaction Design = Action planning
Interaction Management = Plan execution

Formalisms & Tools
• Low-level (encoding interaction in the program/behavior)
• High-level (explicit representation of the interaction)
HR Interaction Design

High-level frameworks for HRI Design and Management

- HA-PTLplan – Human-aware Task Planner [Cirillo et al., 2010]
- HATP – Hierarchical Agent-based Task Planner [Lallement et al. 2014, de Silva et al. 2015]
- HATP + Sensing [Sebastiani et al. ICAPS 2017 (to appear)]
- ROSPlan conditional planning [Sanelli et al. ICAPS 2017 (to appear)]
- MDP + Sensing [Iocchi et al. ICAPS 2016]

Human-aware Task Planning

[Cirillo et al., 2010]

- Robots take into account human actions both at planning time and at execution time. Does not plan for human actions.
- Respecting interaction constraints.
- Multiple hypotheses about the world (Partial Observability/POMDP)
Human-aware Task Planning

Human actions predicted (env. sensors / HMM / plan recognition)
Monitor / Failure detection / Replanning

Hierarchical Agent-based Task Planner

[Lallement et al. 2014, de Silvae et al. 2015]
- Based on Hierarchical Task Networks (HTN)
- Distinguish different agents
- Generates different streams of actions (linear plans) for each agent
- Generate plans also for humans.
Hierarchical Agent-based Task Planner

Limitations

• Roles of humans and robots are decided at planning time
• Humans must be aware of the plan and execute it according to the given constraints
• No flexibility in on-line modification and adaptation

ROSPlan

kcl-planning.github.io/ROSPlan

Integrate planners in ROS
Modular and extendible
**ROSPlan**

Plan representation
- Sequence of actions
- Temporal model
- Petri Nets

Execution mechanism
- Continuous state estimation
- Re-planning

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**Discussion**

Classical/HTN Planning (e.g., STRIPS, HATP)
- Complete knowledge about the state
- Output is a linear plan (sequence of actions)
- No representation of uncertainty

MDP/POMDP Planning
- No explicit representation of sensing actions
- Assumes perfect or very reliable perception
Discussion

- Execution mechanism
  - State estimation error-prone (perception involving humans more difficult)
  - Monitor + replanning after failures not adequate for HRI tasks
  - Non-expert users highly unpredictable

Example

Service robot has to make sure user needs are satisfied. User needs are not known in advance.
Classical planning
• Guess a user need
• Plan with this guess
• Execute the plan
• If guess is wrong, adjust conditions and replan

When guess is wrong, behavior is not socially acceptable.
• The robot does not move, but the user needs something.
• The robot prepares food or drink that is not requested by the user.

Example

Plan with explicit sensing action
• Go to person
• Ask if s/he needs something // Sensing action
  • if (need_food AND need_drink)
    • Go to the kitchen
    • Prepare food and drink
    • Serve food and drink to person
  • if (need_food)
    • …
  • else
    • Do nothing