Towards Context-Aware User Guidance in Smart Environments

Presented by Marcus Ständer
Agenda

- Vision
- SmartProducts
- Smart Interactive Guidance
- Problem Statement
- Sketch: Approach
- Conclusion
Vision in UbiComp
SmartProducts Software Platform

SmartProducts Prototypes
- smart kitchen
- aircraft manufacturing
- smart car

smartproducts-project.eu
Products are getting very complex
- Not only novice users might be overwhelmed
- Not everything might be automated

Actively support users with their task
- Instructions
- Observation
- Automation
Scenarios

- **Smart Factory**
  - Machine Configuration
  - Quality Control
  - Guidance
  - ...

- **Smart Home Environments**
  - Entertainment
  - Energy Management
  - Support / Ease of work
  - ...

Marcus Ständer
User Guidance

Plan Recognition

Context Processing

Raw Data Preprocessing
User Guidance
Plan Recognition
Context Processing
Raw Data Preprocessing

(Higher Level) Context
Context
Context
1. The Problem of Modeling and Learning

- Model-Based
  - Predictable
  - Limited flexibility

- AI-Planner-Based
  - „Half-Unpredictable“
  - Flexible
  - Very hard to design

- Learner-Based
  - Unpredictable
  - High effort for labelling
  - Highly dependent on user and environment
  - Hard to generate guidance UIs
2. Coping with User Actions
   - Users might deviate from the proposed solution
   - Activity recognition unreliable

3. Recognizing Concurrent Processes
   - Problem of assigning events to processes / users

Focussing on these two problems
Plan Recognition

Plan

Dependencies

Events
Problems with plan recognition: Uncertainty

- Plan context **footprint** might vary
- Which **user** processed an activity
- Activities *(e.g. cutting or hacking)*
- Hardware **problem** *(sensor, network)*
- Users find solutions **not foreseen** by designers
Approach - Sketch

- **Increase plan state recognition**

  1 → 2 → ? → 4 → 5

  - Generate *sets* of possible plans (logically correct for the system)
  - *Adjust* these behaviors for more flexibility (maybe logically uncorrect)
  - AT runtime evaluate which behavior is *most probable*
Approach - Maintain basic HMMs

- Probabilities to skip change on
  - progress (the more in the past the more probable)

- skip (allow going back)
Traditional Activity Recognition

Support: improve recognition
For activities that are hard to...
  ▪ distinguish
  ▪ correlate
Approach - Multiprocesses

- OK for one process

- What with **different processes**?
  - Exclusive events
  - Optimization problem

- What with **different users**?
  - Basically the same
Approach - Multiprocesses

- **MultiDimensional Tree (MDT)**
  - Root State: \([1,1]\)
  - Probability: 1
  - Complexity issues
    - MDT only for processes-of-interest
    - Pruning
    - Preprocessing of context (clustering)
Conclusions

- Especially „expert“ users never do what you tell them.

- Human instructor can adapt
  - An AmI system must also be able to adapt!

- No final / „efficient“ solutions
  - How to model „behavior“
  - How to recognize best what the user does
Thank you!