Instrumented Environments
Andreas Butz, butz@ifi.lmu.de, www.mimuc.de
Mon, 10-12 Uhr, Theresienstr. 39, Room E 46
Instrumented Environments

- Mobile Computing
- Ubiquitous Computing
- Wearable Computing
- Tangible interfaces

Intelligent Environments

- Human-Computer Interaction
- Multi-modal Dialogue systems
- Knowledge representation
- User Modeling
- Planning
- Plan recognition

Intelligent User Interfaces
Topics for the rest of the lecture

- A *very* brief intro to user modeling
- A *little* more on planning
  - Spread throughout the following section:
- Multimodal interaction
  - Mostly along examples
  - Multiple devices
  - Multiple contexts
  - Multiple modalities
- Examples of IEs and IE Infrastructures
  - ..until the cows come home..
A very brief intro to user modeling

- A user model is:
  - Any kind of information about the user
  - Stored in one or several systems (→ distr. UM)
  - Used for adapting system output and/or behavior

- Example:
  - Recommendations by Amazon
A practical example for UM

Hallo, Dr. Andreas Butz! Hier sind Ihre persönlichen Empfehlungen.
(Wenn Sie nicht Dr. Andreas Butz sind, klicken Sie bitte hier.)

Jetzt bei Spielwaren:
Mehr kaufen - mehr sparen!

Dr. Andreas Butz, verdienen Sie EUR 1080,10. Jetzt verkaufen und Platz schaffen!

Bis zu 35% reduziert!
Höchster Kaffeegenuss zum kleinen Preis: Kaffee- und Espresso-Maschinen wie die Saeco Magic Comfort Plus bis zu 35% reduziert!

700 CDs ab 7 EUR
Notting Hill, Tatsächlich... Liebe und viele weitere Top-Angebote: 700 CDs ab 7 EUR!
Acquisition of data for a UM

- Explicit
  - Type in your name, age, address, credit card
  - Adjust your preferences, skills, interests

- Implicit
  - Items purchased in the past
  - Money spent
  - Pages visited / items looked at ??
  - Navigation speed ??
  - Automatic detection of web bots ;-)
Construction of a UM from data

- According to data collected, systems can
  - Store an individual profile of the user
  - Assign the user to a predefined stereotype
  - Find new stereotypes by clustering users
  - Make default assumptions for missing info
    - From global defaults
    - From stereotype
Adapting system behavior from UM

- Greeting customers by name
- Offer customers to sell their used stuff
- Filling in the correct credit card number
  - security issues, cookies,
  - Try signing on to amazon.co.uk with your account (email address & PW) from amazon.de
  - What parts of the UM do they have?

- Recommendations from domain models
  - Buyers of a DVD Player need DVDs
- Recommendations from „collaborative filtering“
  - Customers who bought X, also bought Y in the past
Multimodal interaction

Some examples
REAL (Saarland University, 1998-2004)
Research Problems

- Given an instrumented environment and a user’s navigation task
  - How to adapt route descriptions to
    - the technical resources of the environment?
    - the cognitive resources of the user?
  - How to adapt presentations to
    - technical resources of the environment?
    - user preferences and interests?
Limited Resources

- Technical resources (of the environment)
  - Available media: e.g. displays, loudspeakers
  - Media attributes: screen size & resolution, colors
  - Quality of positional data: user’s location (e.g. indoor/outdoor), orientation and speed
  - Available CPU-power and memory
  - Communication bandwidth
Limited Resources (2)

- Cognitive Resources (of the user)
  - Cognitive load:
    - Use of working memory
    - Time pressure
  - Familiarity with the environment
  - Personal preferences:
    - Media, content and presentation styles
  - Limited vision, hearing, motor skills, etc.
  - Communication abilities: limited use of modalities, e.g. use of gesture and speech
Approaches

reaction of the intelligent environment

• Content presentation
• Interaction possibilities

A1: Design an architecture that supports resource adaptivity at several levels.

A2: Use a declarative approach to specify system behavior under limited resources, represent what has to be presented!
Adaptive *graphical* route descriptions

Limited Resources
- technical
- cognitive

Wayfinding

Presentation Planning

Media specific Information Presentation

Resource sensitive route

Presentation script

Adaptive route description
Resource-adaptive route finding

Optimization criteria:

- Shortest (fastest) route
- Reduce amount of turning points
- Reduce complexity of turning points
- Exploit spatial familiarity
Hierarchical Planning Formalism

- Show-way-description
- show-sketch
- sketch-show-path
- sketch-show-ground-plan
- sketch-show-start-point
- sketch-draw-circle
- sketch-show-trajectory
- sketch-show-trajectory-step
- sketch-show-trajectory-segment
- sketch-draw-arrow
- sketch-draw-cross
- sketch-write-label
- show-3d-walkthrough
- sketch-draw-thumbnail
- sketch-write-label
- alternative
- incremental
- additional
- conditional
Output for different devices + contexts

Presentation

Server

Information Booth

Mobile Indoor

Mobile in/outdoor
Using Information Kiosk and PDA

Requesting a route description at the Information kiosk **without time pressure**

Requesting route descriptions **on the fly**. A Special transmission protocol adapts the **level of detail** to the user’s speed
Adaptation: Information Kiosk

Presentation time (low to high)
Adaptation example PDA (1)

Cognitive load (high to low)
Adaptation example PDA (2)

Quality of positional information (high to low)
Coping with Limited Bandwidth

Incremental transmission of vector graphics
Indoor-Outdoor Navigation

System adapts 3D-graphics to user’s position and speed and uses different positioning technologies (GPS, infrared).
Extensions of REAL → M3I

- Put all the functionality on a PDA
- Introduce speech and multimodal interaction
- Adapt to computational constraints by using resources of the environment
  - Speech processing on server
  - Use Displays/microphones in the environment
Pedestrian Navigation System

- Navigation server and Pocket PC
- Pocket PC
  - Mobile multi-modal interaction (M3I) platform
  - Supports indoor and outdoor navigation and exploration

Language: C/C++

Incorporated packages: IBM Embedded ViaVoice formant synthesizer & dynamic rule grammar recognizer, Cortona PocketPC VRML 2D/3D graphics

Hardware: GPS, infrared port, magnetic compass, bluetooth (communication with car/server over HTTP).
Graphics output on PDA

2D maps

3D bird’s eye

Ego perspective
Multimodal input (gesture + speech)

Types of gestures
- Intra – pointing gesture on screen
- Extra – pointing to world objects

Intra-gestures
- point (building)
- line (street)
- circle (Area)
Speech recognition and synthesis

Fusion of speech with Intra-gesture

"Command and Control"

Landmarks, point gesture

Street, line gesture

# Long speech segment:
Gehen Sie 210 Meter. Biegen Sie dann nach rechts ab in die MAX-DIAMOND-STRASSE.

# Middle speech segment:
Biegen Sie dann nochmals nach rechts ab in die MAX-DIAMOND-STRASSE.

# Short speech segment:
Hier nach rechts in die MAX-DIAMOND-STRASSE.
Hybrid positioning within a building
Another physical variation: The Bum Bag Navigator
Using other displays in the environment

- mobile client
- steerable projector
- intelligent door signs
Implicit interaction and fusion across multiple modalities
The Virtual Room Inhabitant
Character Engine

- Character engine server (Java) and character animation (Flash) connected via XML socket connection
- Different character gestures can be combined smoothly using a top level movie and several gesture sequences
- CE-server also controls and synchronizes the spatial audio device and the steerable projector
Example Scenario

User enters Intelligent Environment room
PDA puts position on event heap
CE-Server reads position information
CE-Server requests devices
CE-Server waits for access to devices
Presentation manager grants device access
CE-Server creates virtual display + image stream
CE-Server moves devices to init position
CE-Server sends script to character animation
Demo