4 – User Interfaces for Ubiquitous Computing

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May 4, 2015

Some of the slides in this lecture are very closely based on the slides for the HCI Book, Chapter 4, so have a look at the original: [http://www.hcibook.com/e3/chaps/ch4/resources/](http://www.hcibook.com/e3/chaps/ch4/resources/)
Which Computers / Programs Did You INTERACT with already today?
# Days and Topics

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<tr>
<th>March 11</th>
<th>Intro</th>
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<td>March 16</td>
<td>Designing Interactive Systems – Assignment 1 Published in Detail</td>
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<tr>
<td>March 23 (10-13)</td>
<td>Prototyping + Evaluating Interactive Systems</td>
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<td>- Paper Presentation and Discussion (Assignment 1)</td>
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<td>- Assignments 2-4 Published in Detail</td>
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<td>- Android Sensing Tutorial Day will be Announced!</td>
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<td>April 20</td>
<td>Presentation Assignment 2/3</td>
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<td>- Submission Assignment 4</td>
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<td>May 4</td>
<td><strong>User Interfaces for Ubiquitous Computing</strong></td>
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<td></td>
<td>- Assignment 5 Published in Detail</td>
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<td>May 11</td>
<td>Context-Aware Computing</td>
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<td>May 18</td>
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<td>June 1</td>
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<td>June 8</td>
<td><strong>Submission Final Paper</strong></td>
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Recap

1. UbiComp Definition, Vision, History
2. Methods of Designing Interactive Systems:
   - Storyboards
   - Stakeholder Analysis, Context Diagrams, Work Modelling
   - Prototyping
3. Evaluation Methods
   - Overview
   - Cognitive Walkthrough
   - Heuristic Evaluation

Forward: Technology

1. Ubiquitous User Interfaces
2. Context-Aware Computing
Today

Interaction Paradigms
- Ubiquitous Computing
- Metaphor
- Direct manipulation
- Action vs Language
- Multimodal Interaction

What is an interface?
The Human – Perception and Communication Channels
Ubiquitous User Interfaces – Challenges and Examples
Learning Goals and Motivation

After today’s lecture you should

– Understand the concepts
  • Metaphor-based interaction
  • Direct manipulation
  • Action-based vs language-based interaction

– Understand different communication channels that are relevant for humans (and hence in HCI)

– Understand challenges for designing ubiquitous user interfaces

– Know classes of ubiquitous use interfaces

– Be able to give examples for systems that make use of different communication channels, or constitute different UUI classes

Helps you to systematically think through options when you design a new application!
What is an interface?
Interface

Interface: Boundary between 2 Actors
Interactive Systems: Humans and Computers
  – Traditionally: 1 Human, 1 Computer
  – Increasingly: x Humans, x Computers (CSCW)
  – UbiComp: 1 Human, n Computers – x Humans, m\times x Computers

Communication mediated by interface
Actors have channels for communication (input/output may blur, e.g., eyes/signt)
What is a Paradigm?
Example Paradigm Shifts

- Batch processing
- Timesharing
- Networking
- Graphical display
- Microprocessor
- WWW
- Ubiquitous Computing

A symbiosis of physical and electronic worlds in service of everyday activities.

User Interface Paradigms

Metaphor
Direct manipulation
Language vs. Action
UI Paradigm: Metaphor

Relating computing to other real-world activity is effective teaching technique
- LOGO's turtle dragging its tail
- file management on an office desktop
- word processing as typing
- financial analysis on spreadsheets
- virtual reality – user inside the metaphor

Problems
- Users understand the metaphor but not the system (what happens when a file is moved?)
- Metaphors may prevent the implementation and understanding of inherently new functionality
- Cultural bias

Reference List: Metaphorical Contexts

- **Desk**: Drawers, files, folders, papers, paper clips, stick-on note sheets
- **Document**: Books, chapters, bookmarks, figures; newspapers, sections; magazines, articles; newsletters forms
- **Photography**: Albums, photos, photo brackets/holders
- **Television**: Programs, channels, networks, commercials, viewer guide
- **Music**: Compact disk, cassette, record, tracks, jukeboxes
- **Deck of cards**: Cards, piles
- **Games**: game rules, game pieces, game boards
- **Film**: Rolls, slide trays, shows, reels, movies, theaters
- **Containers**: Shelves, boxes, compartments
- **Tree**: Roots, trunk, branches, leaves
- **Maps**: Networks, diagram, map: nodes, links, landmarks, regions, labels, base (background), legend
- **Cities**: Regions, landmarks, pathways, buildings, rooms, windows, desks

http://dl.acm.org/citation.cfm?id=153670
Reference List: Functions

- **Move** (purposeful traversal): navigate, drive, fly
- **Browse** (low goal-oriented review of options): Rapid replacement, scanning text lines, window shopping, thumbing through books,
- **Scan** (very rapid browsing): fast review of scrollable items, fast review of buildings, objects, people, billboards on highway at high speed
- **Locate**: point, touch, encircle item(s)
- **Select**: touch item, poke item, grab item, lasso item, place finger on item and slide
- **Create**: add (new), copy
- **Delete**: throw away, destroy, lose, recycle, shred. Delete (temporary or permanent) sometimes consists of dragging a file icon to a trash can, garbage can, refuse truck, black hole, or a goat.
- **Evaluate**: Rotate knob, slide pointer, twist, spin
- **Pour, flow**: water (pipelines, rivers), electricity.
UI Paradigm: Direct manipulation

Direct manipulation (Shneiderman, 1982)
- visibility of objects
- incremental action and rapid feedback
- reversibility encourages exploration
- syntactic correctness of all actions
- replace language with action

The interface is a world in which the user can act
UI Paradigms: Language versus Action

Direct Manipulation – interface replaces underlying system -> user carries out “actions” on objects

Language paradigm
- User tells computer what to do (e.g., search, programming)
- The more intelligent interpretation of user input needs to be, the more this goes towards agent-based interfaces (e.g., natural language based questions)

Ubiquitous User Interfaces
What’s new?

Multi-modal: Multiple communication channels
  - Increased focus on input via speech, gaze, body movement
  - Increased focus on output via

Implicit / invisible interaction: Context-aware, intelligent systems
Challenges

Novel interfaces: Outside known “interface language” (metaphors, icons, terminology…)

Disappearing interfaces: How to interact with an invisible system?

Technology Driven Design: Beyond being cool, what existing problem is solved?

Costs: How expensive will a widespread use of the system be?
The Human
Human Perception

Five senses
- Sight (fast, most accurate in the center of focus, sensitive to movement in the periphery)
- Sound (fast, effective in the background, e.g., selective hearing, noticing changes)
- Touch – temperature, pressure, pain (slow, different body parts have different sensitivity/resolution of receptors)
- Smell (slow)
- Taste (slow)

Other
- Equilibrium
- Kinaesthetic sense (relative position of body parts)
Communication Channels

Visual (Eyes - Text, Icons, Images, Movies, Gestures)

Acoustic (Ears – Mouth, Spoken Language, Music, Noise)

Chemical (Taste, Smell - ???)

Tactile (Touch, Temperature, Kinaesthetic, Balance, Pain – Vibrating Devices, Haptic Interfaces)
…. A view on Communication Channels fro Biology
Examples: Tactile

Mobile phone vibrations
Braille
ActiveBelt:

- For navigation
- For making users aware of ubicomp information
- For reminding users of valuables left behind
- For moving in sync with music, or transmitting rhythmic vibrations to others

Example: Meta-Cookie as Pseudo-Gustatory Display

UUI Classes
Tangible User Interfaces

1. User manipulates a physical object
2. System senses this
3. … and provides some feedback
TUI Example
Tangible User Interfaces

**Embodiment**: How far is the output from the object the user manipulates? (input=output, output is near, around or far from the user)

**Metaphor**: How is the object related to the real-world (not at all, the object’s look, the interaction gesture, both, object=physical system)
Surface User Interfaces

Self-illuminated surface via which computation is controlled

- Smartphones, tablets, ambient interactive displays
- Input device: stylus, fingers…
- Often similar interaction paradigms than in traditional GUIs
- Via smartphones, touch-based interfaces have become very widespread, and a touch-gesture language has appeared (tap, double-tap, swiping, zooming)
Ambient User Interfaces

… are ignoreable or glanceable

… don’t always incorporate input and output – or input may be very implicit
Other

Audio Interfaces, both input and output (e.g., Memento – audio input)

Gestures as input

Sensors as implicit input (e.g., FitBit)
## Communication Channels and UI Classes

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<th>Acoustic</th>
<th>Chemical</th>
<th>Tactile</th>
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<td>Sensors as Input</td>
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<td>Gestures as Input</td>
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CONCLUSION
Recap

- Interaction Paradigms: Metaphors, Direct Manipulation, Action vs. Language based, multimodality
- Communication channels and their usage in ubicomp systems (visual, acoustic, tactile, olfactory)
- User interface classes and input modalities (tangible, surface, ambient, audio/speech, gestures, implicit/sensor-based)
Readings

Key readings:

– Dix et al., Human-Computer Interaction, Chapter 1 “The Human” and Chapter 4 “Paradigms for interactions”
  www.hcibook.com
– Krumm, Ubiquitous Computing Fundamentals, Chapter 6 “From GUI to UUI: Interfaces for Ubiquitous Computing”

Others:

– Human Information Processing Capacity: Miller’s number (7±2) - http://www.musanim.com/miller1956/