Lecture 12: Beyond WIMP

WIMP interfaces

- WIMP = Windows, Icons, Menus, Pointers
  - they’re everywhere!
  - in fact, after circa 1983, the vast majority of interfaces are based on the WIMP paradigm
    - e.g., think about Windows vs. Macintosh vs. UNIX-based window managers
    - some exceptions...
      - e.g., text terminals, game systems
  - ... but generally, WIMPs rule!

Beyond WIMP

- WIMP has been around a while, and probably will remain on the scene for a long time.
- But let’s think forward.
  What’s the next step?
    - Nielsen: “virtual realities, head-mounted displays, sound and speech, pen and gesture recognition, animation and multimedia, limited artificial intelligence, and highly portable computers with cellular or other wireless communication capabilities” (?!)
    - increasing computing power makes this possible
    - but can all this be in a single interface? maybe not... that’s yet another difference!
    - interfaces may become more task/user specific
**Functional vs. Object-Oriented**

- “Old-school” interfaces are functional in requiring specification of entire function
  - uses a “verb-noun” syntax
  - e.g., “rm foo”, “emacs file.java”
- Current GUIs are object-oriented
  - uses a “noun-verb” syntax
  - e.g., select icon, drag to trash / select “Open”
- What seems to be coming on the horizon?
  - “syntax-free” interfaces
  - well, at least syntax-flexible
  - can specify noun-verb, or verb-noun, or something radically different... just like communication w/ people

**One step forward...**

- Thought exercise
  - imagine you have access to a movie database
  - database = info about films, actor/actresses, etc.
  - how can you answer questions like...
    - In what films did Harrison Ford star between 1980-90?
    - In what films did Julia Roberts and Richard Gere costar?
    - What are the most popular Sci Fi movies of 1993?

**Non-command interfaces**

- Idea: user and computer interact not through a dialogue of commands and responses, but through a complex, dynamic, continuous interaction
- Huh? What’s that?
- Nielsen’s 12 “interaction characteristics” for next-generation, non-command software
  - not all applications will incorporate all 12
  - rather, it is expected that many applications will incorporate a significant subset of the 12
1. User focus

- Interaction feels like “using a computer”, not working on a task (according to Nielsen)
- With NC interfaces, focus = task... features come for free implicitly
- Example: Portholes system
  - update every 5min
  - implicit awareness

2. Computer’s role

- Old: “Do what you’re told”
  New: “Do what I mean!”
- Great idea... but why is this hard?
- Example: Intelligent tutoring
  - monitor what the student knows
  - interrupt with instruction when necessary
- Example: Model tracing / “Mind tracking”
  - infer student knowledge, or disabled user’s intentions, or driver’s intentions...

3. Interface control

- Old: User controls computer
  New: Computer controls interaction
- Examples: warn user of incoming email, infer current writing task and provide template, etc.
- BUT this is very hard to do well
  - must avoid interrupting the user
  - guesses / inferences had better be right!

4. Syntax

- Old: Rigid interaction “syntax”
  New: No / little syntax
- Example: deleting files
  - way #1: select and delete (noun-verb)
  - way #2: say “remove all *.java files” (verb-noun)
  - can we integrate multiple methods?
- Example: writing math expressions
  - try not to require top-down or bottom-up
5. Object visibility

- Old-school interfaces with “direct manipulation” require visible objects
- New interfaces could manipulate objects implicitly through higher-level interactions, or with hidden agents
- Might this be dangerous?
  - user doesn’t know about manipulation
  - can be good, can be bad

6. Interaction stream

- Old: Single-threaded input / output
- New: Multi-threaded, multimodal
- Example: “Put that there!”
  - point to display wall at object
  - say “Put that”... point to destination... “there”
- Example: eye-driven window interface

7. Bandwidth

- Old: Low input bandwidth (keys, mouse)
- New: Very high bandwidth
- Systems may incorporate motion tracking, virtual reality, speech, “peripheral” input
- Difficulties
  - requires lots of processing power, both for accepting input and interpreting it
  - lags are unacceptable!
    (e.g., motion sickness in virtual environments)

8. Tracking feedback

- Old: Feedback only after completed input
- New: Continuous feedback on-the-fly
- Example: Emacs search (sort of)
- Example: movie database
- Interface should react like the real world
  - again, input-output lag is an issue
  - again, processing power is an issue
9. Turn-taking

- Old: First user, then computer, then user...
  New: Continuous stream for both
- Closely related to feedback... computer is always responding, so there's never a “turn”
- How does this map onto the real world?
  - when we interact with the inanimate world?
    - e.g., walking through the park, playing basketball
  - when we interact with the animate world?
    - e.g., talking to someone, interacting with a pet
  - we sometimes take turns in the real world...
    - why not in a user interface?

10. Interface locus

- Old: Computer on the desk
  New: Computers everywhere
- Ubiquitous computing from...
  - smaller, lighter “computers”
    - e.g., PDAs, calculators, watches
  - computers built into everyday objects
    - e.g., ovens, cars, shopping carts
  - computers built into not-so-everyday objects
    - e.g., pet dog robots
- Good for awareness, “telepresence”; dangerous for privacy?

11. User programming

- That is, programming for end users
- Old: (Usually) hard-core macro languages
  New: Smooth adaptation of objects
- Example: object-oriented customization
  - “take your basic” <object> “but make the” <subobject> “behave like this…”
  - if possible, can specify with state transitions
    - like storyboards, or like SILK’s behaviors
- BUT in the end, complex programs require complex languages
  - hard (for me) to envision huge successes here

12. Software packaging

- Old: Application-centered approach
  New: System-wide, OO approach
- Example: spell checkers
  - should be only one for your entire system
  - does Microsoft have this right??
    - integrated across Word, Excel, PowerPoint, email
    - easier to do for a single vendor, and has the unfortunate side effect of monopolization
    - open source, open standards — but can we really arrive at a true standard?
Sample noncommand interface domains

- **Interface agents**
  - provide active help, reminders, etc.
- **Embedded help**
  - actually show the process, guiding the user’s “hand” to the right places
- **Computer music**
  - computer listens, plays along, harmonizes, etc.

HC“Eye”

- **Human --> machine communication...**
  - keyboard, mouse
  - speech, handwriting, gestures
  - poking (*CRL Kiosk*), tickling (*Tickle-Me Elmo*)!!
- **Gaze-based interfaces (GBIs)**
  - users control the interface using gaze / eye movements
  - typical focus on disabled users
  - gaze is often the *only* (primary) input

Gaze-Added Interfaces (GAIs)

- Users control the interface using gaze and/or other inputs
- Gaze added to basic/existing input instead of replacing it
- **Users can...**
  - employ only basic inputs
  - employ only gaze input
  - employ any combination of basic / gaze

Case Study: IGO
Gaze-Added Input

• Gaze focus: background highlight

• Gaze button: (keyboard) key
• Gaze control analogous to mouse
  - click for select
  - double-click for open
  - hold for drag

Intelligent Interpretation

• All GBIs must interpret gaze - i.e., assign gaze to intended object
  - assign gaze to underneath / nearest object

Intelligent interpretation
  - assign gaze to most likely object
  - use probabilistic model of behavior

Intelligent Interpretation

• Find object that maximizes
  \( \Pr (\text{gaze} | \text{object}) \cdot \Pr (\text{object} | \text{history}) \)

  - Gaussian distribution of gaze location \((x,y)\) around object center
  - Distribution of object probabilities given some action history

  - File .20 .40 .10
  - .30
  
Intelligent Interpretation

  - Normal
  - After Icon Select

  - Edit
  - Copy
  - Paste
Evaluation Study

• Training Stage (8 blocks of 10 trials)
  - gaze only or mouse only
• Free Stage (2 blocks of 10 trials)
  - gaze and/or mouse as desired
• Trial = one of five tasks (5-10 s)
  - select icon, close window, open window (double-click), select menu (drag),
    move icon (drag)
• Ten users with no GBI experience

Task Times

• No difference between gaze and mouse

Task Errors

• More errors with gaze than mouse
• Errors in free stage -> gaze use

Free Stage Gaze Use

• Overall gaze use = 67%
• Correlated to (gaze–mouse) times (R=.70)
Gaze Use by Action Type

- Less complex actions -> more gaze use

![Gaze Use by Action Type Chart]

Intelligent Interpretation

- Comparison of correctness with...
  - intelligent interpretation
  - “no-context” interpretation: assign gaze to nearest object
  - “basic” interpretation: assign gaze to underneath object

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Intelligent</th>
<th>No-Context</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>83%</td>
<td>65%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Lessons Learned

- Gaze nicely complements other inputs
  - users quickly adapt to gaze input
  - users successfully interleave gaze, mouse
- Common difficulties
  - “leave before click”
  - gaze dragging
  - handling two “cursors”
- Intelligent interpretation helps
  - eye trackers will improve, but variability will remain
  - better eye tracking -> greater usability

Thought question...

- Ok, let’s try to put all this to use.
- We know how a typical web browser looks
- Can we design a new one “beyond WIMP”?
On Beyond GUI:
Wearable, Heterogeneous, Adaptive

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Wearable

- Cursorless
- Eyes-free

Corners of watch bezel serve as “tactile landmarks” to guide user’s finger


Wearable

- Cursorless
- Eyes-free

Heterogeneous

- Coordinated use of different displays and interaction devices
  - Multiple displays
    - Projected desktop
    - Handheld
    - High-res monitor
    - See-through head-worn
  - Multiple interaction devices
    - Multi-touch table
    - Tracked hands/heads
    - Speech

Adaptive

- Change user interface in response to environment
  - Modify layout of virtual objects to avoid overlap in AR

Heterogeneous

- Coordinated use of dimensionalities
  - “Pull” 2D image into 3D model
  - “Push” 3D model into 2D image

Adaptive

- Change user interface in response to environment
  - Modify transparency to reveal important content on desktop
Three Themes for Future UIs

• Wearable
  - Cursorless → Eyes free, glanceable,…

• Heterogeneous
  - Mix of users, displays, devices, dimensionalities,…

• Adaptive
  - Dynamically modified in response to changes in environment, tasks,…