Experimental User Interfaces

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http://www.cs.hut.fi/~tta/
Contents

- Why experimental interfaces?
- Towards common methodology
- Cases from research experiments
- Trends for future
1. Why experimental UI?

- dominant design now
- gestural 2D interfaces: mouse / touch
- sensory limitations in current UI, new devices
- missing established methodology
Current dominant paradigm

- **Basic features**
  - 2D visual display + point & click device (mouse)
  - direct manipulation
  - hierarchical window structure
  - virtual devices (widgets)
    - menu
    - button
    - text box
    - scroll bar
  - event-based control loop
    - window manager
    - device handlers
  - gestural interaction techniques
    - drag & drop
    - selection by "sweeping"
    - opening by double click

\[\text{WIMP} = \text{Windows} - \text{Icons} - \text{Menus} - \text{Pointers}\]
Isn't this enough?

- "A Personal Computer for Children of All Ages"
  
  (Alan Kay's Dynabook vision, 1968)

using iPad today, after 40 years of development
Natural interaction is...

not just a notebook, but

- multisensory / multimodal
  - different concurrent devices / kinds of use
  - image, sound, video...
  - graspable / movable objects (tangible UI)
  - wearable computing
  - smart environment watching the user

- continuous (non–discrete) control
  - no command dialogue, but continuous flow
  - computer may act as an initiative agent

- tied to the real environment, "physical computing"
## Use of senses in current interfaces

<table>
<thead>
<tr>
<th></th>
<th><strong>input (to computer)</strong></th>
<th><strong>output (display)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>sight</strong></td>
<td>webcam</td>
<td>UI (widgets) and content (text, images, video, etc.)</td>
</tr>
<tr>
<td></td>
<td>offline images</td>
<td></td>
</tr>
<tr>
<td><strong>hearing</strong></td>
<td>speech recognition</td>
<td>alert signals (UI)</td>
</tr>
<tr>
<td></td>
<td>content recording</td>
<td>soundtracks (content)</td>
</tr>
<tr>
<td><strong>smell</strong></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>taste</strong></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>touch</strong></td>
<td>keyboard</td>
<td>force feedback</td>
</tr>
<tr>
<td></td>
<td>mouse / finger</td>
<td>(in some game consoles)</td>
</tr>
</tbody>
</table>

- very asymmetric: tactile input + visual output; sound underutilised
- exception: multimedia content (sound and images in and out)
- NOTE: the fifth "feel" sense actually covers several different senses
New input devices

- current standard devices: keyboard + mouse
  - recently being replaced by touch pad

- available but less used
  - pen/stylus, joystick, track ball
  - 3D trackers
  - force/torque handles
  - speech recognition

- new potential
  - image capture
  - non-speech sound
  - motion sensors (accelerometer)
  - positioning (GPS)
  - biosensors (EMG)
  - chemical sensors, smell/taste
  - etc.
'Put That There' (Bolt 1980)

- pointing gestures
- speech commands
- large screen display
- multi-user interface

Why these still aren't standard features of a UI?
2. Towards methodology in software

- Computer graphics standardization
- Model-View-Controller framework
- Device abstractions
- A mental experiment
CG standardization

- drawing in device independent coordinates
- input part not well established

official: GKS (1985)
de facto: OpenGL (1992)
The MVC conceptualization

- often used in web applications
- works well with common widgets
  - also with hierarchical structure
- may become difficult in more general use
  - the controller may become very complex
Input device abstractions

- A useful framework for conceptualization and generalization

- What information is transferred from human to machine?
  - State or its change (on/off) → boolean
  - One from a set of alternatives → integer [enumeration]
  - Text → character [string]
  - Continuous numeric value → float
  - Location (2D/3D) → vector [x,y]
  - Reference to a pointed object → id (name/address/number)

- May be implemented in many ways by different devices
  - Switch, function key, alphanumeric key, slider, cursor on screen (indicator of mouse), drawing tablet, 3D tracker, camera, speech recognizer ...

- Try it out: implement devices by each other 😊
Exercise: fill the empty slots

<table>
<thead>
<tr>
<th>Information for the computer:</th>
<th>Physical device:</th>
<th>keyboard</th>
<th>slider</th>
<th>function keys</th>
<th>drawing tablet</th>
<th>camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text string (char)</td>
<td>native</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Real number (float)</td>
<td>?</td>
<td>native</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Choice (one out of few alternatives)</td>
<td>?</td>
<td>?</td>
<td>native</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>2D position (x,y)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>native</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>
Conclusion (for today)

- Real life communication too complex to be standardized
  - attempts in early 80's to do the same for interaction as for graphics, with limited success
  - works for limited applications and modalities, e.g. the desktop/notebook metaphor

- However, abstractions help to keep it simpler
  - software modularity: separate data manipulation from action control, if possible

- Be ready for very different paradigms in the future
Paradigm changes in UI software

Current
- single-threaded I/O
- discrete tokens
- precise tokens
- sequence, not time
- explicit user commands

Future
- parallel, asynchronous dialogues; may be interrelated
- continuous inputs and responses (plus discrete)
- probabilistic input, not easily tokenized
- real-time requirements, deadline-based
- passive monitoring of the user

source: Butler, Jacob & John  CHI’98
3. Sample cases

- Musical applications
- New art forms
- Motion based games
- Eyes-free interfaces
DIVA virtual orchestra

- animated musicians playing MIDI encoded music
  - automatically computed grips on the instruments
  - physically based sound synthesis
  - sound reverberated according to virtual concert hall

- music conducted with a baton
  - neural networks trained to follow the motion
  - mapping from motion samples to relative timing between beats
  - also recognition of conductor’s emotional intent

- performance at Siggraph’97 Electric Garden
Virtual instruments

- new user interfaces for synthesized sound
- more degrees of freedom than with a keyboard
- mappings to control parameters of physically based synthesis algorithms
- free configurability ➔ build your own instrument

examples:
- xylophone
- drum plate
- virtual air guitar
  (became a media success and later spinned off a game company)
Drawing in the air

- Fine motoric interaction methods for immersive free-hand expression
- A new art medium
- Experiments with artists
  - exhibition at the Kiasma museum of modern art (2005)

Mäkelä, Reunanen, Takala 2004
Art installations (student work)

- Experience design
- "Tranquil interaction"

prisoned dancer

the village

Tommi Ilmonen 2007
Motion-based entertainment and games in VR

- hand gestures and sound effects
  - virtual aquarium
  - virtual snow fight

- camera based tracking of full body movements
  - children's game *QuiQui's Giant Bounce*
  - fighting game *Kick Ass Kung-Fu*

Perttu Hämäläinen
Eyes-free interfaces

- gestural menu selection
- spatialized (3D) auditory display
- use cases when sight is reserved (e.g. while driving) or missing

Raine Kajastila 2013

Concept of free-hand controlled circular auditory interface
4. Current research and trends

- Embodied "enactive" interfaces
- Emotions in motion
- Active virtual agents
- Excergames – motion based activities
- Variability and commoditization
- Different thinking in software design
'Enactive media' as research approach

- direct and implicit human-machine communication by embodied activity, without symbolic abstractions inbetween

- aiming at natural interaction with human-like companions
  - “not using, but living with computers”

- topics:
  - affective computing (emotions)
  - virtual agents

Meeri Mäkäräinen 1996
Interaction with captured motion

- analyzing activities and styles by motion descriptors
- animated responsive character programmed with behavioral rules
- may simulate virtual personalities

Klaus Förger et al. 2011
Classification and synthesis of motion

- motion samples observed and characterized by words (human)
- resynthesis by selecting samples from a data base (computer)
- goal: directing animated characters by verbal instructions
ExcerGames

- studying psychological/perceptual aspects of games
  - what affects player's motivation to move?
- presenting captured human motion in a different context
- sample: trampoline as game controller
Commoditization

- basic devices getting cheaper
  - webcam
  - game consoles and controllers (Wii, PSMove, etc)
- large number of special devices available
  - sensors
  - interface hw/sw platforms (e.g. Arduino)
- development by hobbyists and open communities
From expensive VR to open platforms

Cave installation [http://eve.hut.fi](http://eve.hut.fi)

a light-weight cave "Upponurkka"

RUIS platform
Cases

- RUIS (Reality-based User Interface System)
  - open source platform for affordable VR
  - see demo on Vimeo

- Using customer level 3DUI for designing
  - combining Blender modeling software with RUIS UI
  - demo video: Will it Blend?
5. Final notice

- Open your mind for creativity
  - interdisciplinarity, human studies
  - art and entertainment

- Just do it – be bold, but patient
  - experiment, prototype, and learn
  - "The best way to predict the future is to invent it." (Alan Kay)

- KISSS principle in interface design
  - Keep it simple and stylish, stupid
Thank you!