User Interface Engineering – FS 2013

Brief History of HCI & Research Overview
The birth of the UI – The Mouse

- When was the mouse invented?
  - A) 1954
  - B) 1963
  - C) 1978
  - D) 1984
  - E) 1991
The birth of the UI

[The Mouse. Engelbart and English. Stanford University. 1963]
The birth of the UI
The mother of all demos

Control Devices
The birth of the UI part II

[Xerox Alto. Thacker, Kay, Lampson et al. 1972]
XEROX 8010 Star Information System

Star provides integrated text and graphics. A variety of type sizes and styles may be used.

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink</td>
<td>$0.30</td>
</tr>
<tr>
<td>Beige</td>
<td>$0.50</td>
</tr>
</tbody>
</table>

This is some text in a text frame.

Form Field

Button
From Mainframe to Ubiquitous Computing


Mainframe
Personal Computing
Ubiquitous Computing
~ $10^6$ Times more powerful than the Xerox Alto
How we see the computer

How the computer sees us
2000s – The Touch (Re)volution

- iPhone 2007
- iPad 2010
2006 – Motion Based Gaming

Nintendo Wii vs Sony Playstation 2
(R)evolution of the User Interface – Research Perspective
1985: Multi-Touch Tablet

- Touch sensing tablet
  - Arbitrary number of simultaneous contact points
  - Pressure sensing (approximated by contact area)
- Capacitive sensor (same as in modern smartphones)
- Developed in the same year the first Macintosh came out

[Lee, Buxton, & Smith. U Toronto (ACM CHI 1985)]
1991: Digital Desk

- A classic paper in the literature on augmented reality.
- Front projection tablet top system
  - Optical and acoustic techniques to sense both hands/fingers as well as objects
- Demonstrated multi-touch concepts
  - Two finger scaling and translation of graphical objects, using either a pinching gesture or a finger from each hand

[Wellner, P. Xerox PARC. ACM UIST (1991)]
2002: SmartSkin

- Capacitive sensor array
- Recognizes multiple hand positions and precise shape
- Can estimate distance from surface (hover)
- Demonstrates use of capacitive tags

[Rekimoto, J. Sony CSL. ACM CHI (2002)]
Robust vision based technique to detect multi-touch input
Based on frustrated total internal reflection (FTIR) used previously in fingerprint scanning

[Han, J. Y. NYU. ACM UIST (2005)]
1999-2005 Fingerworks

- Range of capacitive touch tablets
- Extensive work on gesture recognition, palm rejection and touch typing
- Acquired in 2005 by Apple Inc.

[Westermann, W. U Delaware. PhD (1999)]
VideoPlace

- Vision based system that enabled multiple fingers, hands, and people to interact using a rich set of gestures.
- Different configurations, including table and wall.
- Essentially “wrote the book” in terms of unencumbered (i.e., no gloves, mice, styli, etc.) rich gestural interaction.
- More than a decade ahead of its time and hugely influential.

[Krueger, Gionfriddo, Hinrichsen, ACM CHI (1985)]

Recommended Reading:
XWand

- Wireless sensor package
  - Vision based position recovery
  - Accelerometers, Gyroscope and Magnetometer used to recover orientation
- Used to control “smart environments” by pointing at objects and performing gestures

[Wilson, A. MSR. ACM CHI (2003)]
The Kinect pose estimation pipeline

capture depth image & remove bg

infer body parts per pixel

cluster pixels to hypothesize body joint positions

fit model & track skeleton
Hinckley Smartphone

- First exploration of sensors on a mobile device as interaction method.
- Demonstrates context sensitive or “smart” behavior now commonplace in mobile phones.

[Hinckley, Pierce, Sinclair, Horvitz. ACM UIST (2000)]
The (R)evolution of the User Interface

- Bringing **physical interaction** to the computer
- Giving the computer a **sense of space**
- Embracing **3D interfaces**
- Enabling rich **natural interaction in mobile scenarios**
Overview of (Own) Research
[Izadi, Kim, Hilliges, Molyneaux, Newcombe, Kohli, Shotton, Hodges, Freeman, Davison, Fitzgibbon. UIST '11]

[Newcombe, Izadi, Hilliges, Molyneaux, Kim, Davison, Kohli, Shotton, Hodges, Fitzgibbon. ISMAR '11 (Best Paper Award)]
Interplay of Physical and Digital Ubiquitous Sensing
HoloDesk
Direct 3D Interactions with a Situated See-Through Display

[Hilliges, Kim, Izadi, Weiss. In CHI ’12]
System Setup
Digits
Freehand 3D Interactions Anywhere
Using a Wrist-Worn Gloveless Sensor

[Kim, Hilliges, Izadi, et al. In UIST ’12]
Freehand 3D Hand Interactions
System Overview

- IR Laser Line Generator
- IR diffuse LEDs
- IR Camera
- Inertial Measurement Unit
Image Processing

Image Capture

3D Laser Triangulation

Background Subtraction

CCL & Tracking

Hand Pose Recovery

Hand Pose Recovery
Natural Flex Hand Pose Recovery
Application: Non-Visual User Interfaces
Augmented Projectors

Augmented Projectors. Pervasive’12 (Best paper)
Steerable Augmented Reality with the Beamatron

Andy Wilson, Hrvoje Benko and Shahram Izadi
Microsoft Research, 2012
Class Overview and Preview - Next week
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Title</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18.9.</td>
<td>Introduction</td>
<td>Introduction to class contents, HCI research field, admin</td>
</tr>
<tr>
<td>2</td>
<td>25.9.</td>
<td>Input Fundamentals I</td>
<td>Buttons, switches, sliders. Keyboards &amp; Mice, Textinput</td>
</tr>
<tr>
<td>3</td>
<td>02.10.</td>
<td>Interactive Surfaces &amp; Gestural Interfaces</td>
<td>Overview of post-WIMP Interfaces and Interaction Techniques (image processing for vision based touch screens)</td>
</tr>
<tr>
<td>4</td>
<td>09.10.</td>
<td><em>No Class (ACM UIST)</em></td>
<td>Work on homework assignments / Project ideas</td>
</tr>
<tr>
<td>5</td>
<td>16.10.</td>
<td>Camera based input I</td>
<td>Techniques &amp; algorithms for touch detection on interactive surfaces (tracking, filtering etc.)</td>
</tr>
<tr>
<td>6</td>
<td>23.10.</td>
<td>Advanced Input Devices &amp; Techniques</td>
<td>Touchscreen technologies. Resistive / Capacitive</td>
</tr>
<tr>
<td>7</td>
<td>30.10.</td>
<td>Camera based input II</td>
<td>Techniques &amp; algorithms for the analysis of motion and shape based interaction (mostly Optical Flow)</td>
</tr>
<tr>
<td>8</td>
<td>06.11.</td>
<td>Discrete gesture recognition</td>
<td>Algorithms to recognize discrete, symbolic gestures.</td>
</tr>
<tr>
<td>9</td>
<td>13.11.</td>
<td>Continuous and motion based gesture recognition</td>
<td>Algorithms to recognize continuous, dynamic motion and gestures over time.</td>
</tr>
<tr>
<td>10</td>
<td>20.11.</td>
<td>Introduction to body and hand pose estimation</td>
<td>Basic introduction to body (and particularly hand) pose estimation (mostly Random Forests)</td>
</tr>
<tr>
<td>11</td>
<td>27.11.</td>
<td>Augmented Reality I</td>
<td>Overview of AR. Systems, Tracking and Display technologies.</td>
</tr>
<tr>
<td>12</td>
<td>04.12.</td>
<td>Augmented Reality II</td>
<td>Camera tracking, scene reconstruction.</td>
</tr>
<tr>
<td>13</td>
<td>11.12.</td>
<td><em>Guest Talk (tbc)</em></td>
<td>Joint class with HCI (BSc) watch out for room changes</td>
</tr>
<tr>
<td>14</td>
<td>18.12.</td>
<td>Review &amp; Project presentations</td>
<td>Exercise groups present their projects prototypes</td>
</tr>
</tbody>
</table>
Further Reading


- Also watch: The Mother of all Demos: [http://www.youtube.com/watch?v=JflgzSoTMOs](http://www.youtube.com/watch?v=JflgzSoTMOs)
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