Chapter 3: Interactive Tabletops and Surfaces

Vorlesung „Mensch-Maschine-Interaktion II”
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(slides today partly courtesy of Dr. Otmar Hilliges)
Chapter 3: Interactive Tabletops and Surfaces

• Motivation, Vision
  – the FTIR hype
  – the SUN Starfire Video

• Early Research
  – The MIT MetaDesk
  – Pierre Wellner‘s Digital Desk

• Hardware for Interactive Surfaces
  – displays
  – input sensing
Interactive Surfaces before the FTIR hype

• Interactive Tabletops in research since early 1990ies
  – cumbersome setups, expensive technology
  – commercial prototypes early 2000s
    • e.g., “Roomware“ 2001, photo below from Fraunhofer IPSI
  – did not really catch on at a large scale

• Interactive walls also in the 90ies
  – became commercial products as interactive whiteboards
  – front or back projection
  – sensing of one or multiple pens
  – affordable and widespread today
  – use for presentation, teaching, ...
Jeff Han and the FTIR Hype

• Jefferson Y. Han (NYU): work on a cheap multi touch sensing scheme ([http://cs.nyu.edu/~jhan/ftirtouch/](http://cs.nyu.edu/~jhan/ftirtouch/))
• Spin-off company „perceptive pixels“
• „FTIR Hype“ started probably with a TED talk, Feb. 2006
• many refinements and DIY projects followed
Interactive Tabletops and Surfaces Today

• Rapidly growing research field
• conference ITS 2009 in Banff, Canada:
  – started in 2006 as IEEE tabletop workshop
  – ~150 participants, 30 papers, conference status
  – 2010 will be in Germany (more submissions in 2009 from Germany than from USA)

• Commercial interest since „Perceptive Pixels“ and the Microsoft Surface
• Multi Touch also popularized by the iPhone
SUN Starfire - an early vision

- concept video produced in 1992
- only shows existing or almost existing technology
- features a curved high resolution interactive surface
- multimodal interaction with the system
You are about to see an engineering vision of an advanced network based multi-media computer system called Starfire.

It is not “science fiction.” Its key technologies are all running in the laboratory today.
Historic Interactive Surfaces

• read http://www.billbuxton.com/multitouchOverview.html!
• early experiments with multi touch in the 1980ies
• For this lecture: 2 prominent historic examples:
  – Pierre Wellner‘s Digital Desk
  – MIT MetaDesk
Pierre Wellner‘s Digital Desk

- Working prototype in 1991
- Regular table with top projection
- Overhead camera to detect fingers
- Camera can also scan paper on the desk
- Interaction with printed paper and digital applications on the same surface
Working prototype 6/91
The MIT MetaDESK

• Platform for exploring Tangible UIs (Ullmer & Ishii, 1997)
• Also uses top projection
• Various projects built on top of it
Interactive Surface Hardware

• (Visual) output: Display
  – quite well understood
  – simple solution: projection: front or back (or side ;-) 
  – screens built into tables
  – modification of screen hardware

• Input: Sensing
  – much less well understood
  – many concurrent approaches, each with its drawbacks
  – categories: resistive, capacitive, optical, ...
  – wide field of ongoing research
Display: Front Projection

• what we are doing here in class
• simplest way to produce visual output on any surface

• pro:
  – cheap, simple
  – even light distribution
  – no additional space needed
  – space for legs under the table

• contra
  – interacting hand and person cast a shadow
  – only feasible for table tops when firmly mounted

image source: http://www.rosco.com/
Display: Rear Projection

• Pro:
  – projector is hidden, space in front empty
  – no shadowing of the surface

• Contra:
  – Can only be done with space behind
  – complex mirror construction for tabletops
  – can create „hot spot“ with cheap screen

image source: http://www.rosco.com/
Display: Projection from the side ;-)

- PlayAnywhere, Andy Wilson (Microsoft Research), 2005
- Uses commercial short throw projector for front projection at an angle of 40 degrees
- Uses cameras for sensing
  - mounted off axis from the projection
  - can see shadows caused by front projection
  - can recognize fingers and markers
- Turns any flat surface (e.g., table) into an interactive surface
The vision
Display: Screens

• What we initially used in our tabletop research @LMU
  – High resolution and contrast + great color
  – Insensitive to ambient light
  – Can be bought with touch overlay for sensing
Screen with integrated sensing: ThinSight

- Izadi (Microsoft Research), 2007
- Shines IR light through LCD from the back
- Measures Reflection from objects or fingers
- Low resolution prototype
- Senses simple gestures
- Could turn display into a scanner/camera
Sensing

• Embedded sensors
  – Capacitive
  – Resistive
  – Optical

• Camera Infrared
  – FTIR
  – Diffuse Illumination

• Others
Classical touch screen
[http://de.wikipedia.org/wiki/Touchscreen]

- Two sheets of conductive, transparent material
- Connected by finger or pen pressure
- Resistance measurements
  - Between X electrodes
  - Between Y electrodes

\[
U_{y3} = U_{y4} = U_x + \frac{(U_{x1} - U_{x2}) \times R_2}{R_1 + R_2} = 0V + 5V \times \frac{1}{3} = 1.66V
\]
Capacitive Sensing

- Layer of conductive material holds charge
- Finger approaching the surface changes the amount of charge
- requires grid of driving and sensing lanes
- OR individual electrodes embedded in one layer

[Dietz Leigh'01]  [Rekimoto'02]
Figure 3: Interactive table with an $8 \times 9$ SmartSkin sensor: A sheet of plywood covers the antennas. The white squares are spacers to protect the wires from the weight of the plywood cover.
Capacitive Sensing: Sony SmartSkin

- finger only changes capacitive coupling in grid
Capacitive Sensing: MERL DiamondTouch

- finger acts as one electrode of the capacitor
- connection e.g., through the chair
- different users send different signals
- finger identification solved!!
Optical Sensing - FTIR

FTIR - Frustrated Internal Reflection

Projection surface
Silicone Rubber
Plexiglass
Total Internal Reflection
IR LED

IR Camera
http://iad.projects.zhdk.ch/multitouch/
Optical Sensing - DI

http://iad.projects.zhdk.ch/multitouch/
TouchLight

- Andy Wilson, ICMI 2004
- Projection onto Holofilm (transparent projection screen)
- Imaging through the screen ==> funny effects possible
Optical tracking from the side: SmartTech SmartBoard DViT

- 4 cameras, 100FPS
- can be overlaid to screens, projection surfaces etc..
- theoretically 4, practically 2 (narrow) contact points
Optical Tracking twisted: Fiberboard
Multitouch DIY project for the weekend!