Übung zur Vorlesung Mensch-Maschine-Interaktion

e3: Advanced Interface Technologies

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Advanced Interface Technologies - Introduction

- What's wrong with mice and keyboards?
- What are advanced interface technologies?
- When can we benefit from their usage?
- How can we classify them?
- What is important when designing with and for such devices?

Übersicht

- WIMP User Interfaces
- Advanced Input Devices
- Advanced Output Devices
- Interactive Surfaces
- Tangible User Interface (TUI)
- Taxonomy

There is More Than Just WIMP

- WIMP (**W**indows **I**cons **M**enus **P**ointers)
  - Classical concept of GUIs
  - WIMP user interfaces use standardized controls (since the 80s)
    - » Mouse
    - » Keyboard
    - » Monitor
    - » Speakers / Headphones
  - covered in the lecture
- Are mice and keyboards the ultimate input devices? **[Video]**
- In real live we use a magnitude of tools and controls that have evolved over much longer time.
  - Screwdriver, pliers, saw
  - Knobs, levers, buttons
  - …
- These tools serve a specific need and are often highly specialized.

What Is Wrong With Mice and Keyboards?

- Through interactive graphics we can metaphorically rebuild (almost) every real device (or its controls) in software.
  - Trash bin on desktops
  - Phone dialing pads in VoIP software
  - Calculator
  - Volume controls
  - Professional audio / video editing (e.g. Premiere)
- Are there any limitations / drawbacks?

„real device“: mixer

software: metaphorical rebuild

Basic Problem With Single Pointing Device

- With mice (and keyboards) some sort of multiplexing is required for complex interactions
  - Input multiplexing (key combination + point-and-click)
  - Time multiplexing (several click operations after each other)
- Several application domains have properties that are hard to match with standardized input / output technologies:
  - Complex machinery (e.g. music instruments, planes)
  - 3D modeling / manipulation (e.g. CAD)
  - 3D navigation (e.g. games, high dimensional data sets)
  - Playful applications (e.g. exertion interfaces)
  - Mobile applications (e.g. navigation, maintenance, field studies)
  - Special experience (e.g. museum, exhibitions, trade fare)
  - Integrated communication / collaboration

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3D Mouse

- Also called Spacemouse or Spaceball
- Object (e.g. Ball) is elastically mounted
- Pressure, pull, torsion are measured
- Dynamic positioning

Spaceball (http://www.alsos.com/)

3DConnexion SpaceNavigator

Data Glove

- Up to 6 DOF
  - X, Y, Z
  - Roll-Pitch-Yaw (describe rotations)
    - Roll: rotation about the X-axis
    - Pitch: rotation about the Y-axis
    - Yaw: rotation about the Z-axis
  - Bending of fingers
  - Sometimes absolute position (external tracking)
- Data is used for gesture recognition

Multi DOF Armatures

- Mechanical armatures
- Hybrid between flying-mouse and stationary device
- Advantages
  - Not susceptible to interference
  - Less delay: usually better response than flying mouse
  - Can be configured to stay put
- Drawbacks
  - Fatigue (as with flying mouse)
  - Constrained operations due to the armature
- Can be equipped with force feedback

Other Controllers

Game Controllers

Music Input Devices

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Stereoscopic Imaging

- Stereoscopic imaging is any technique capable of recording three-dimensional visual information or creating the illusion of depth in an image.
- Technologies
  - Head-Mounted Display (HMD)
  - Head-Coupled Display (HCD)
  - 3D Glasses
  - 3D Display
  - Volumetric 3D Display
  - Immersive Projection Display (IPD)
  - ...

Head-Mounted Displays (HMD)

- Separate displays for each eye
- Highly immersive
- Panoramic vision (wide field-of-view)
- LCD
  - Light-weight
  - Low resolution
- CRT
  - Heavy-weight
  - High resolution

HMD
i-glasses

Head-Coupled Displays (HCD)

- Displays are fixed to an armature
- Comparing HCD to HMD:

	HMD	HCD
Pros	• Highly immersive • Free movement • No infrastructure required	• Attention shifts: User can shift attention to the real world and back
Cons	• Additional weight	• Limited movement • Less immersive

- Did not prevail

HCD

3D Glasses

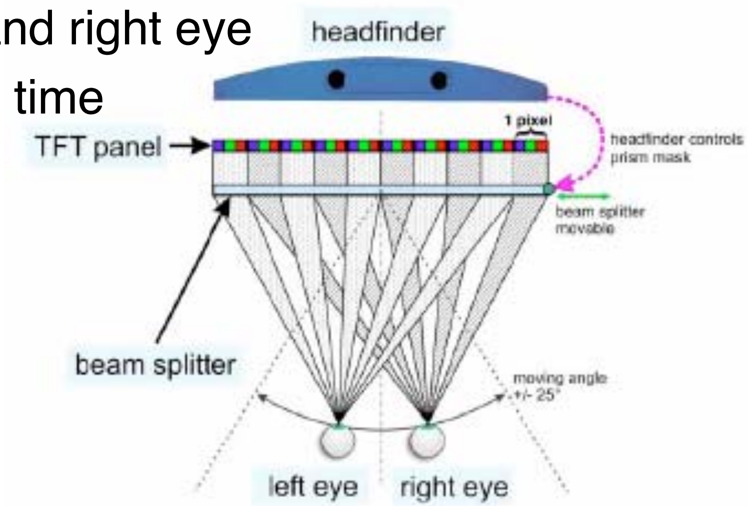
- Two seperate views of the same scene (one for the left and one for the right eye)
- „Active Stereo“: Polarized 3D Glasses
  - 2 projectors with polarized lenses
  - Lenses are polarized at an 45° angle
- „Passive Stereo“: Shutter Glasses
  - Screen displays alternating views for left and eye at a high rate.
  - Viewer wears electronically-switched liquid crystal lenses
  - Lenses pass or block light for one of the eyes (at the same frequency)
  - Infrared emitter is placed at the monitor and broadcasts synchronization information to the eyewear.

Polarized 3D Glasses

Shutter Glasses: CrystalEyes

3D Display

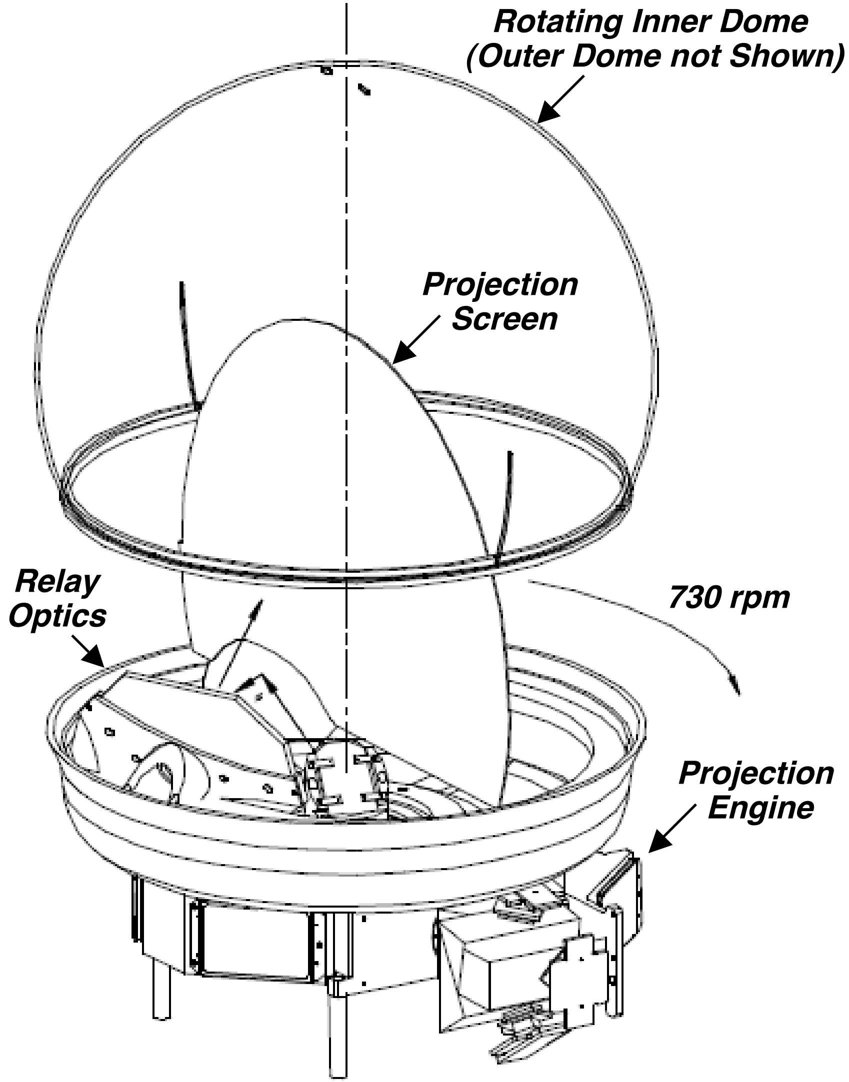
- Auto stereoscopic display
- No special glasses
- High resolution and full brightness
- User‘s position is tracked
  - Camera of infrared
  - Allows user to move naturally while working without using the 3D effect
- Moveable prism provides two views
- Alternating columns for left and right eye
- Only one viewer at the same time



Dresdener 3D Display

Volumetric 3D Display

- Auto stereoscopic
- Volume Image
- Supports multiple simultaneous viewers (multiple viewpoints)



Immersive Projection Display (IPD)

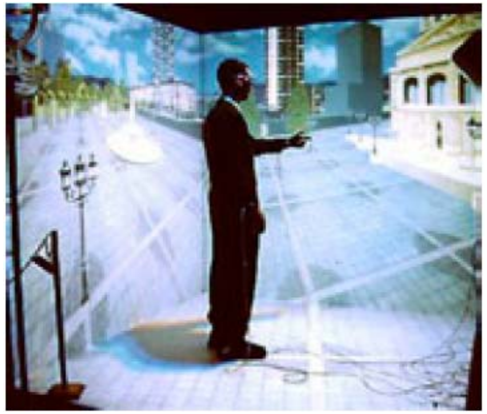
- Similar to movie theaters
- 1 - 6 projection screens:
  - Powerwall: 1 wall
  - Curved Screen
  - Workbench: 1 horizontal display
  - CAVE: 3 - 6 projection screens

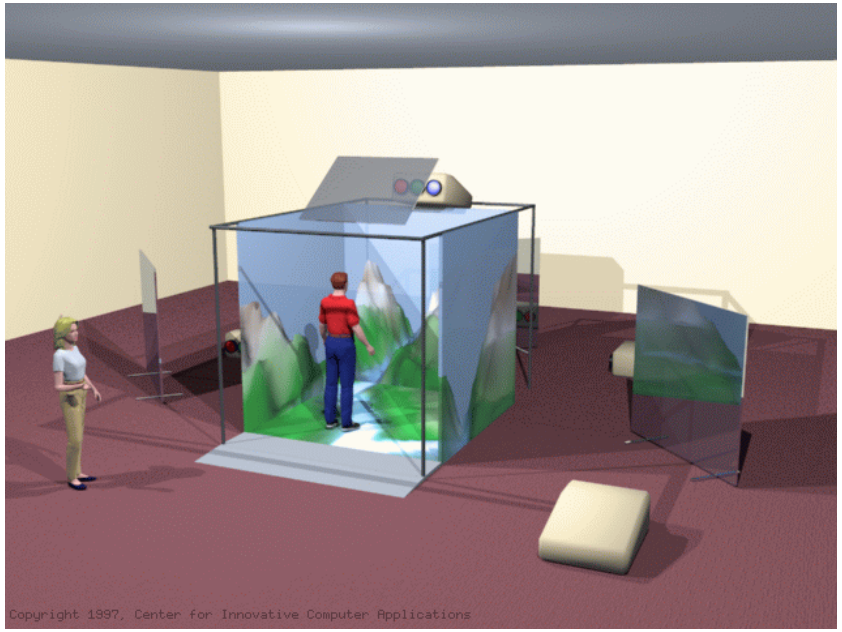
Powerwall (front-projection)

Powerwall (rear-projection)

CAVE

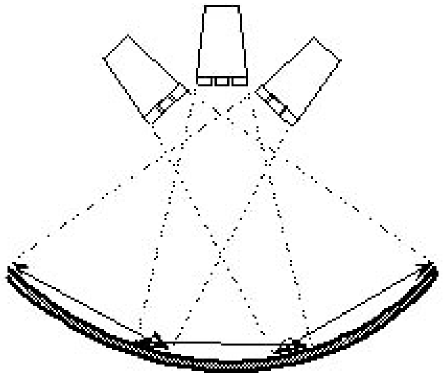
- One of the first IPDs
- 3 - 6 projection screens, typically:
  - 3 rear-projection screens on the walls
  - 1 down-projection screen on the floor
- Stereo image
- Viewers wear shutter glasses



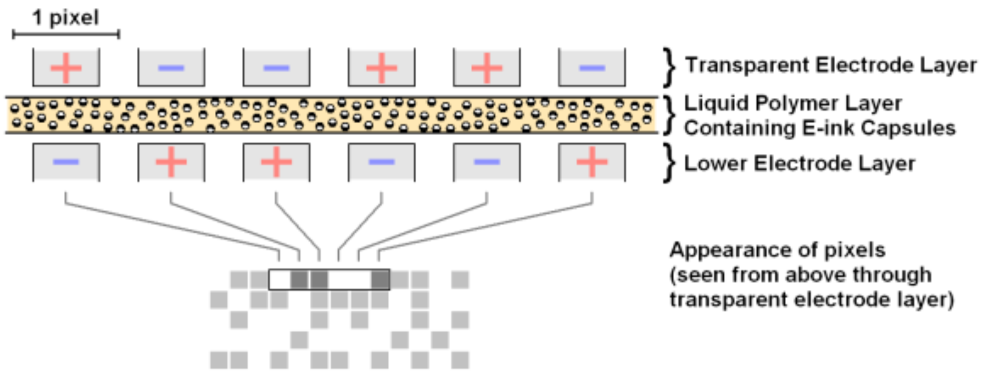


Curved Screen

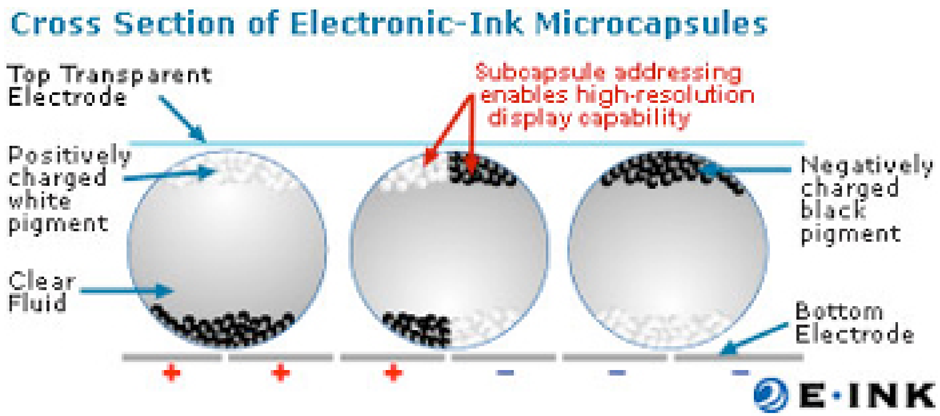
- Panoramic display
- Front projection
- Multiple projectors oriented towards different directions
- Edge blending
  - Necessary for smooth transitions between the overlapping images
  - Control of brightness in the outer image areas



Electronic Paper Display (EPD)

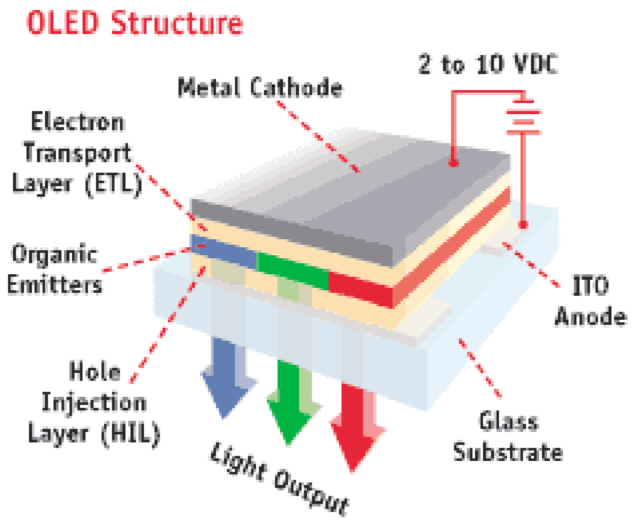


- E-Ink Technology
- Millions of tiny microcapsules
- Each microcapsule contains
  - A clear fluid
  - Positively charged white particles
  - Negatively charged black particles suspended in a clear fluid
- Only particles on the top are visible
- Electronic field determines if white or black particles move to the top
- Minimal energy consumption needed to paint an image
- No energy needed to maintain images
- High contrast
- Sunlight readable



OLED

- Organic LED (Light Emitting Diode)
- Paper-thin flat panel displays
- Thin layers of halfconducting, organic material
- Structure similar to LEDs
- Advantages
  - Cheap
  - Large field of view (up to 160°)
  - Thin and flexible
  - Short reaction time
  - High contrast
  - Sunlight readable
- Disadvantage
  - Short life time of organic material
  - Less light efficient than LEDs
- Very new technology → not yet fully developed
- High potential → might replace E-Ink and even TFTs in the future

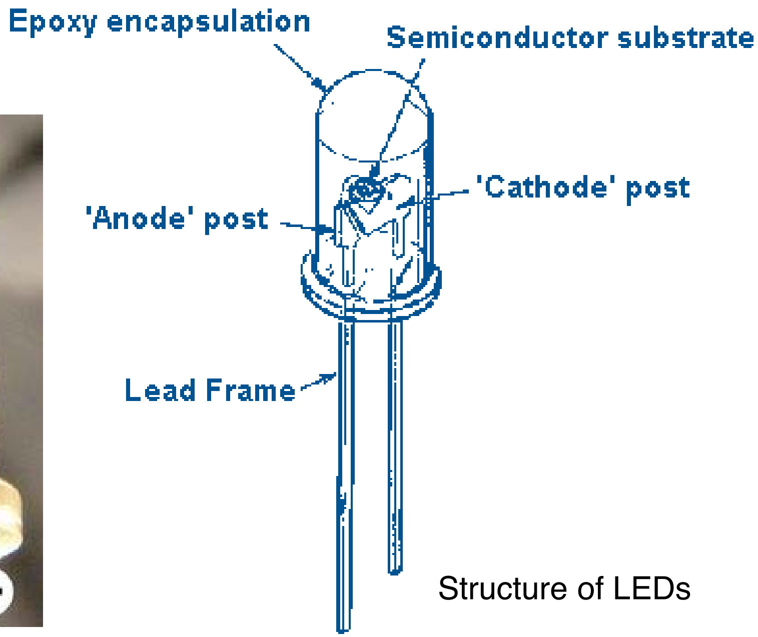


LED

- Semiconductor layers
- Current flow through diode → Light emission
- Color of light depends on the semiconductive material
- Applications:
  - Lights
  - Information Displays
  - Laser pointer
- Advantage (compared to lightbulbs)
  - Cheap
  - Low energy consumption
  - Long life time
  - LEDs do not get hot

Lightbulb

LED



Structure of LEDs

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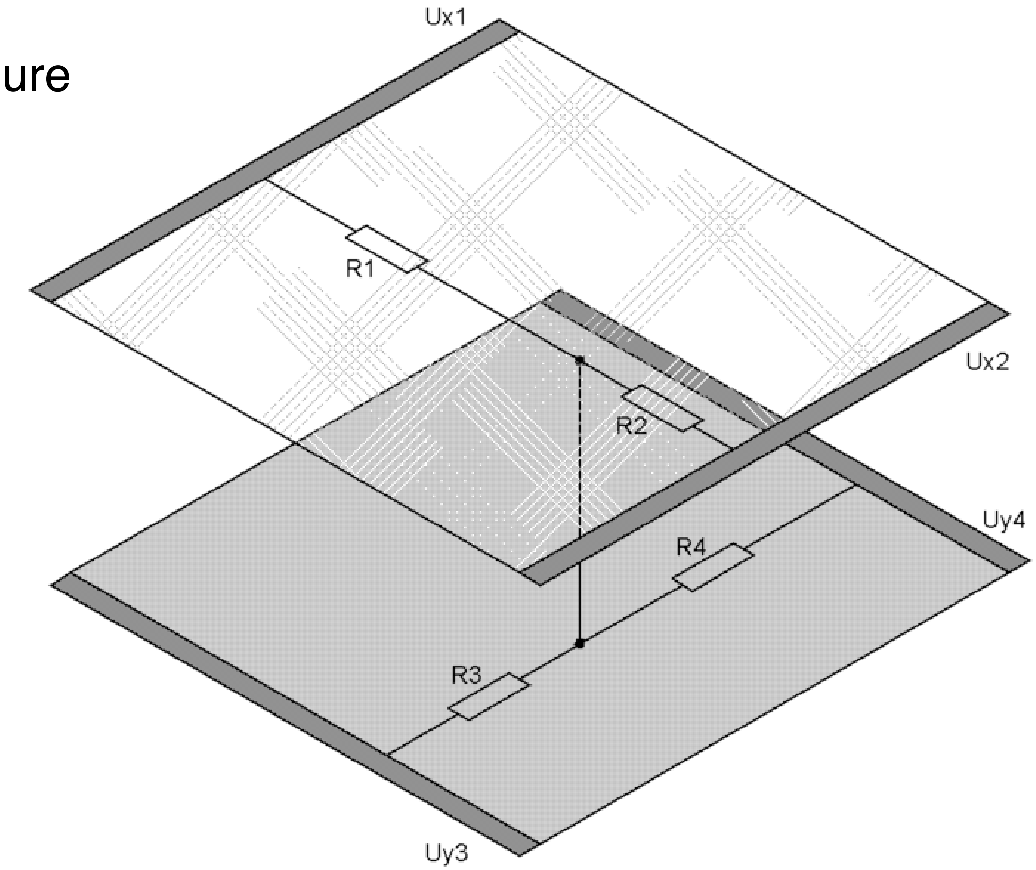
Touch Screen

- Two sheets of conductive, transparent material
- Connected by finger or pen pressure
- Resistance measurements
  - Between X electrodes
  - Between Y electrodes
- Cheap and robust technology
- **Only one point** can be tracked
- Direct manipulation equivalent to standard mouse.



Multi-User Touch Screen

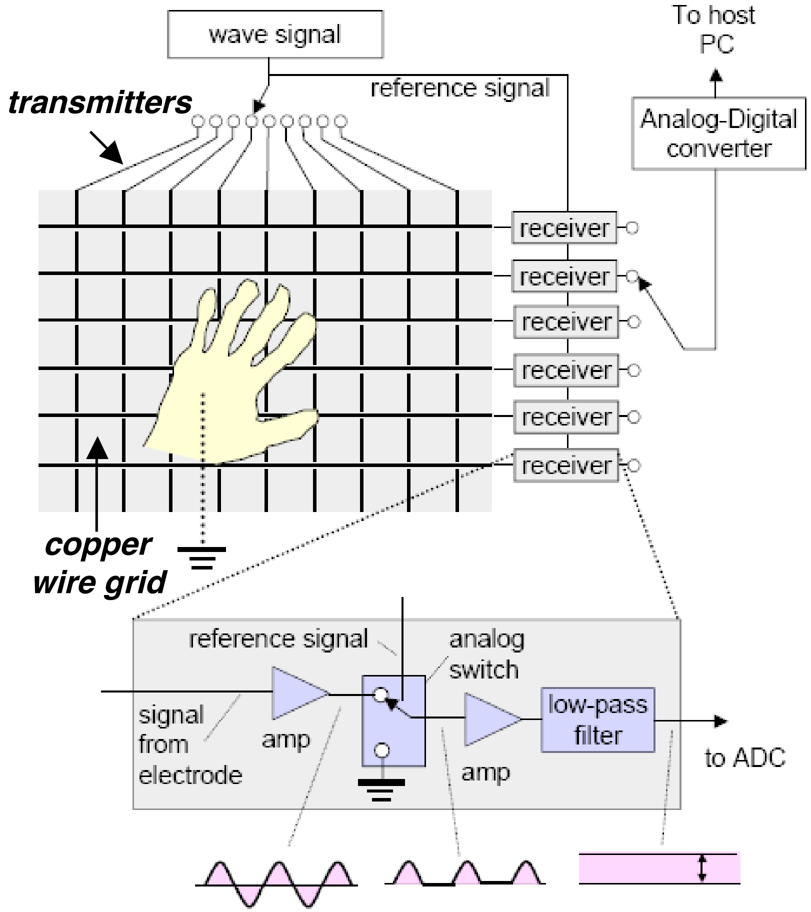
- E.g. Mitsubishi DiamondTouch [P. Dietz, D. Leigh, UIST 2002]
- Array of antennas embedded in touch surface
- Each antenna transmits a unique signal
- Separate receiver for each user connected capacitively, typically through the user's chair.
- Sequence of actions:
  1. User touches surface
  2. Signal is transmitted from antenna through the user‘s body to receiver
  3. Touch coordinates are determined by the unique signal
- Distinguishes between
  – Simultaneous inputs from multiple users
  – Multiple touches by a single user (e.g. two handed touch gestures)

Mitsubishi DiamondTouch

[Video]

Interactive Surfaces Using Capacitive Sensing

- E.g. Sony SmartSkin [Jun Rekimoto, CHI 2002]
- Recognizes multiple hand positions and shapes
- Calculates the distance between hand and surface
- Sequence of actions:
  1. Vertical wires transmit wave signal
  2. Crossing points acts as capacitor
  3. Conductive and grounded object (e.g. user's hand) approaches crossing point
  4. Electrodes are capacitively coupled
  5. Horizontal wires receive signal
  6. Signal strength depends on capacitance



[Video]

Interactive Surfaces Based on Cameras

- E.g. SmartTech SmartBoard DViT:
  http://www.smarttech.com/dvit/index.asp
- Vision based: cameras in each corner
- Nearly on any surface
- More than one pointers
- No special pen required

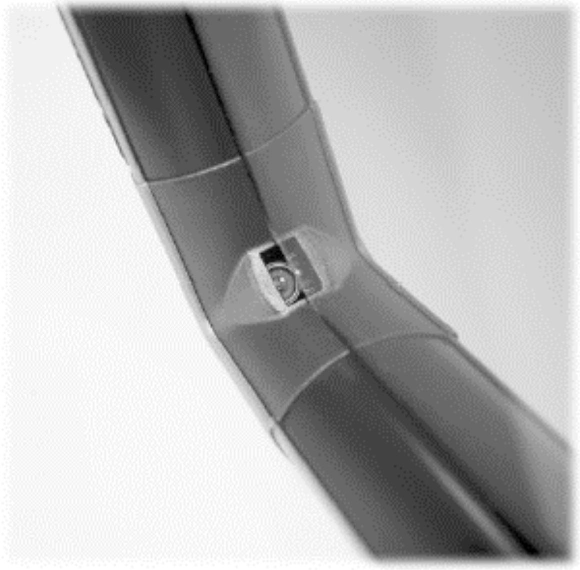


Figure 1: DViT Technology Camera

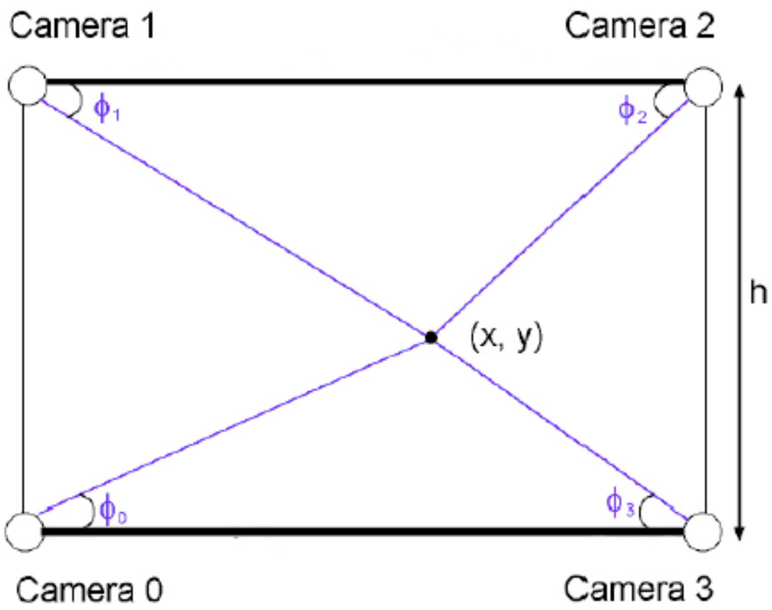
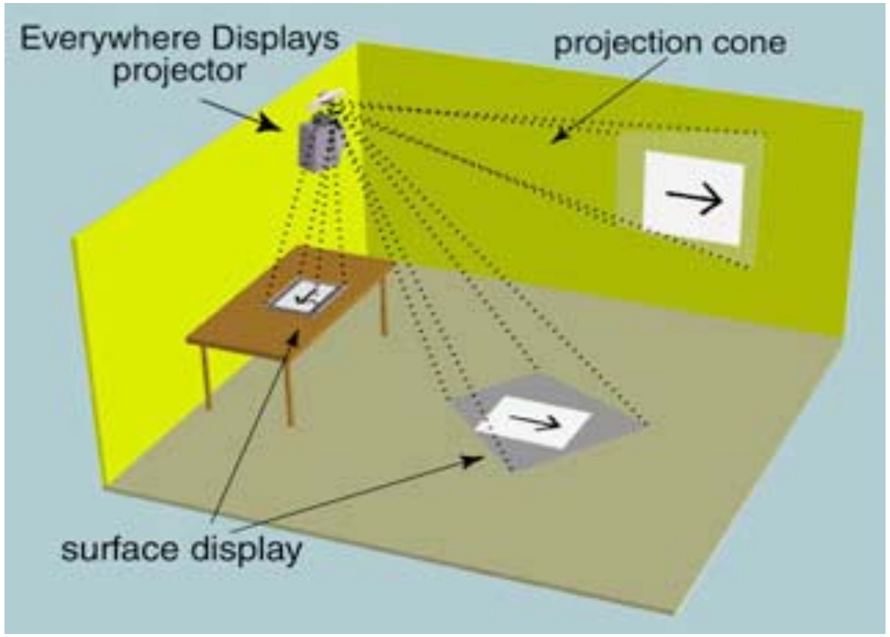


Figure 2: Camera Identification of a Contact Point

Everywhere Display

- Allows any surface to be transformed into a projected touch screen
- Combination of LCD, pan / tilt mirror and camera
- Mirror deflects the projected image to surfaces
- Camera detects hand or body activity
- Image needs to be processed to compensate for the perspective distortion
- No glasses, no wired surface



[Video]

Continuous Information Spaces

Share information between different information spaces, e.g. drag something from table to wall.

[Video]

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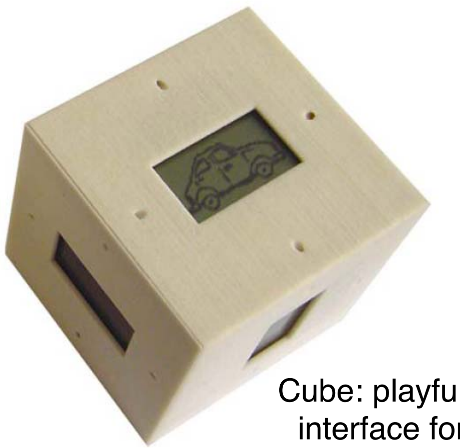
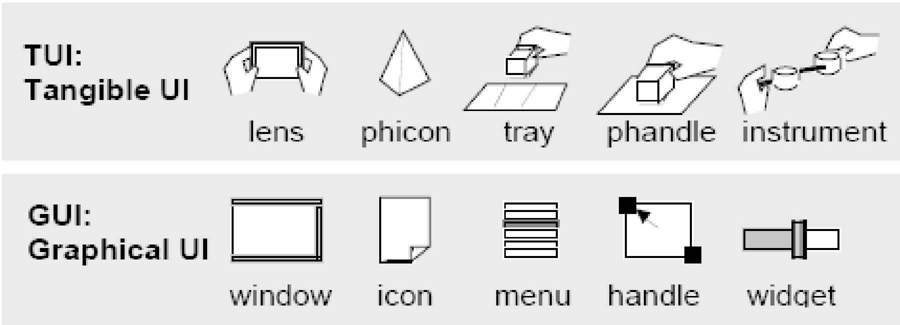
Tangible User Interfaces

- Digital information is coupled to everyday physical objects and information
- User manipulates digital information through the physical environment
- Different types of physical objects:
  - Tools: manipulate digital information
  - Tokens: access stored information
  - Containers: move information between devices of platforms



Cube: playful learning interface for children [Kranz, UbiComp '05]



[Video]

[Ishii H, Ullmer B, CHI'97] [Holmquist et al., HUC'99]

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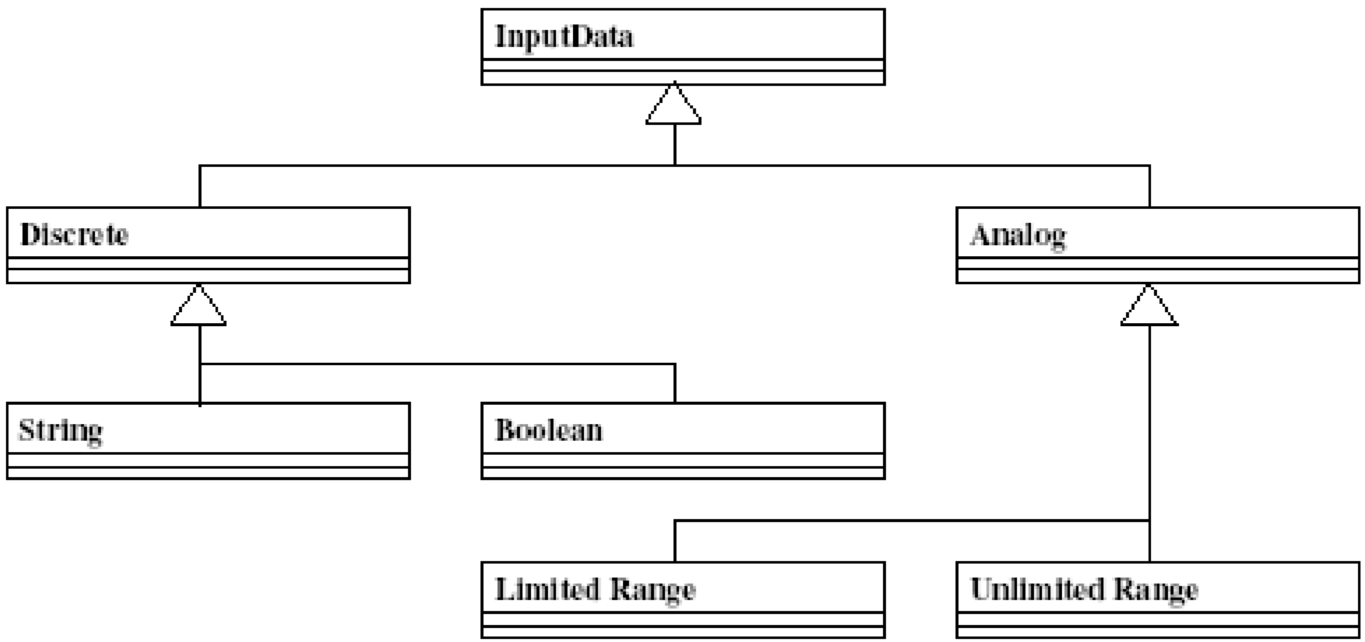
Device Taxonomy

- Can we deal with all these devices systematically?
- What are possible dimensions of a taxonomy?
  - Input vs. output
  - Continuous vs. discrete
  - Parameters measured (e.g. position, pressure, temperature)
  - Number of dimensions
  - Agent of control (e.g. hand, foot, voice, eyes)
- Several taxonomies (for input devices) exist.
- Often incomplete because of new devices being developed

Semantic Input Taxonomy

- Instead of classifying every possible device one can classify the data emitted.
- Thus application programming becomes independent from the actual device.



Taxonomy for Output Devices

- Discriminate between media types:
  - Graphics
  - Acoustics
  - Haptics
- Which devices can be exchanged which can't?
  - Laptop monitor vs. power wall?
  - Spoken text vs. written text?
  - Dynamic vs. static behavior?
  - 3D vs. 2D capabilities?
- The receiver of information is human
  - Perceptive and cognitive system is very complex
  - Very hard to predict how information is decoded
  - Almost impossible to come up with equivalency relations between different modalities.