Vorlesung
Mensch-Maschine-Interaktion

Input devices & technologies

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http://www.medien.informatik.uni-muenchen.de/

Table of Content

- Input Devices
- Degree of Freedom

Basic Input Operations

- Text Input
  - Continuous
    - Keyboard and alike
    - Handwriting
    - Spoken
  - Block
    - Scan/digital camera and OCR
- Pointing & Selection
  - Degree of Freedom
    - 1, 2, 3, 6, <more> DOF
  - Isotonic vs. Isometric
  - Translation function
  - Precision
  - Technology
  - Feedback
- Direct Mapped Controls
  - Hard wired buttons/controls
    - On/off switch
    - Volume slider
  - Physical controls that can be mapped
    - PalmPilot buttons
    - "internet-keyboard" buttons
    - Industrial applications
- Media capture
  - Media type
    - Audio
    - Images
    - Video
  - Quality/Resolution
  - Technology

Complex Input Operations

- Examples of tasks
  - Filling a form = pointing, selection, and text input
  - Annotation in photos = image capture, pointing, and text input
  - Moving a group of files = pointing and selection
- Examples of operations
  - Selection of objects
  - Grouping of objects
  - Moving of objects
  - Navigation in space

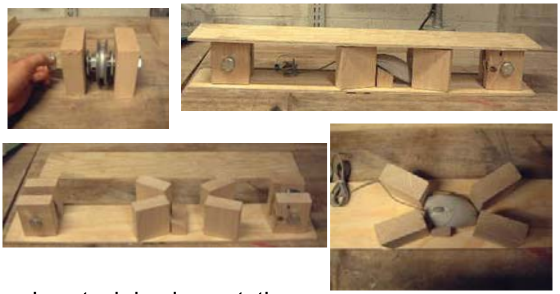
1D Pointing Device
Example: Computer Rope Interface

- Interface to move up and down
- Visualisation of Rainforest vegetation at the selected height
- Exhibition scenario
- Users: kids 4-8

http://web.media.mit.edu/~win/Canopy%20Climb/Index.htm

Example: Computer Rope Interface

Example: Computer Rope Interface



- Low tech implementation
- Mouse scrolling

Rope Interface Video

- http://web.media.mit.edu/~win/Canopy%20Climb/Rope%20Interface%20Export2.avi
- http://web.media.mit.edu/~win/Canopy%20Climb/Treemovie.avi

Pointing Devices with 2DOF

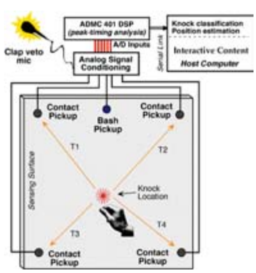
- Pointing devices such as
  - Mouse
  - Track ball
  - Touch screen
  - (See last week)
- Off the desktop other technologies and methods are required
  - Virtual touch screen
  - Converting surfaces into input devices
  - Human view

Virtual Touch Screen

- Surfaces are converted into touch screens
- Image/video is projected onto the surface
- Using a camera (or other tracking technology) gestures are recognized
- Interpretation by software
  - simple – where is someone pointing to
  - complex – gestures, sign language
- application
  - Kiosk application where vandalism is an issue
  - Research prototypes …

Example: Window Tap Interface

- locates the position of knocks and taps atop a large sheet of glass.
- piezoelectric pickups
  - located near the sheet's corners
  - record the structural-acoustic wavefront
  - relevant characteristics from these signals,
    - amplitudes,
    - frequency components,
    - differential timings,
  - to estimate the location of the hit
  - simple hardware
  - no special adaptation of the glass pane
  - knock position resolution of about s=2 cm across 1.5 meters of glass



http://www.media.mit.edu/resenv/Tapper/

Example: Window Tap Interface

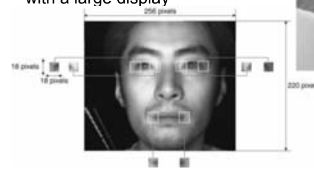
http://www.media.mit.edu/resenv/Tapper/

Example: Window Tap Interface

- http://www.media.mit.edu/resenv/Tapper/

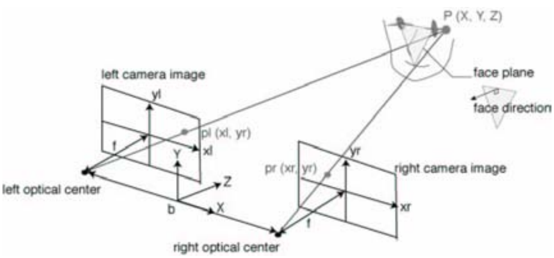
Example: Vision-Based Face Tracking System for Large Displays

- stereo-based face tracking system
- can track the 3D position and orientation of a user in real-time
- application for interaction with a large display



http://naka1.hako.is.uec.ac.jp/papers/eWallUbicomp2002.pdf

Example: Vision-Based Face Tracking System for Large Displays



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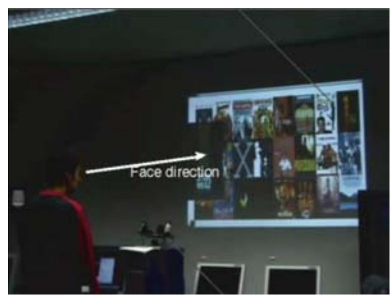
Example: Vision-Based Face Tracking System for Large Displays



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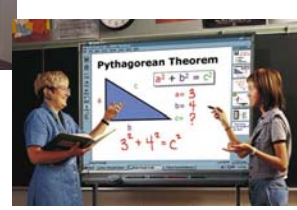
Example: Vision-Based Face Tracking System for Large Displays

http://naka1.hako.is.uec.ac.jp/papers/eWallUbicomp2002.pdf

Smart-Board

- Large touch sensitive surface
- Front or back projection
- Interactive screen



Smart-Board
DViT (digital vision touch)

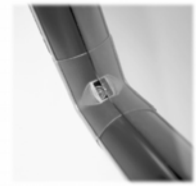


Figure 1: DViT Technology Camera

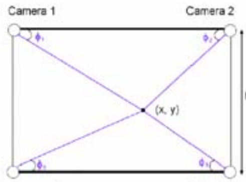


Figure 2: Camera Identification of a Contact Point

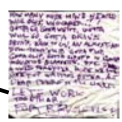
- Vision based, 4 cameras, 100FPS
- Nearly on any surface
- More than one pointers
- http://www.smarttech.com/dvit/index.asp

Capture Interaction

- Mimio
  - Tracking of flip chart makers
  - Capture writing and drawaing on a large scale
- PC Notes Taker
  - Capture drawing and handwriting on small scale

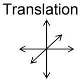
Photo Capture

- Write on traditional surfaces, e.g. blackboard, white board, napkin
- Capture with digital camera

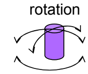


3D Input
6 DOF Interfaces

Translation



rotation

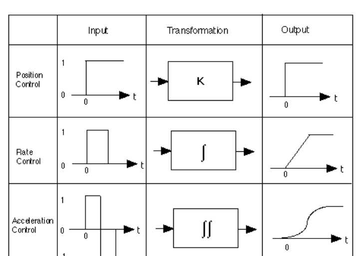


- 3D input is common and required in many different domains
  - Creation and manipulation of 3D models (creating animations)
  - Navigation in 3D information (e.g. medical images)
- Can be simulated with standard input devices
  - Keyboard and text input (6 values)
  - 2DOF pointing device and modes
  - Gestures
- Devices that offer 6 degrees of freedom
  - Criteria
    - Speed
    - Accuracy
    - Ease of learning
    - Fatigue
    - Coordination
    - Device persistence and acquisition
  - Little common understanding

6DOF

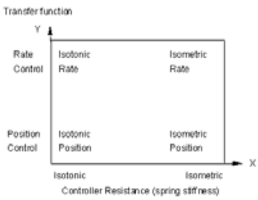
- Transfer function
  - Position control
    - Free moving (isotonic) devices – device displacement is mapped/scaled to position
  - Rate control
    - Force or displacement is mapped onto cursor velocity
    - Integration of input over time -> first order control
- Controller resistance
  - Isotonic
    - Displacement of device is mapped to displacement of the cursor
  - Elastic
  - Isometric
    - Force is mapped to rate control

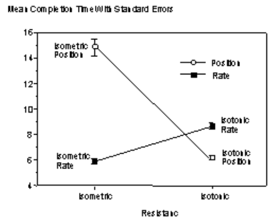
Analysis of Position versus Rate Control



http://vered.rose.utoronto.ca/people/shumin_dir/papers/PhD_Thesis/Chapter2/Chapter23.html

Performance depends on transfer function and resistance





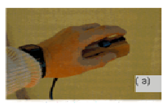
http://www.siggraph.org/publications/newsletter/v32n4/contributions/zhai.html

Controller resistance

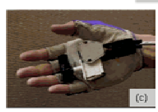
- **Isotonic**
  - pressure devices / force devices
  - Infinite resistance
  - device that senses force but does not perceptibly move
- **Isometric**
  - displacement devices, free moving devices or unloaded devices
  - zero or constant resistance
- **Elastic**: Device's resistive force increases with displacement, also called spring-loaded
- Viscous: resistance increases with velocity of movement,
- Inertial: resistance increases with acceleration

Flying Mice (I)

- a mouse that can be moved and rotated in the air for 3D object manipulation.
- Many different types…
- flying mouse is a free-moving, i.e. *isotonic* device.
- displacement of the device is typically mapped to a cursor displacement.
- Such type of mapping (transfer function) is also called *position control*.


(a)


(b)


(c)

http://www.almaden.ibm.com/u/zhai/papers/siggraph/final.html

Flying Mice (II)

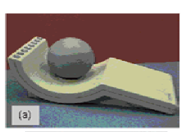
- The advantages of these "flying mice" devices are:
  - Easy to learn, because of the natural, direct mapping.
  - Relatively fast speed
- disadvantages to this class of devices:
  - Limited movement range. Since it is position control, hand movement can be mapped to only a limited range of the display space.
  - Lack of coordination. In position control object movement is directly proportional to hand/finger movement and hence constrained to anatomical limitations: joints can only rotate to certain angle.
  - Fatigue. This is a significant problem with free moving 6 DOF devices because the user's arm has to be suspended in the air without support.
  - Difficulty of device acquisition. The flying mice lack persistence in position when released.

- The form factor of devices has a significant impact on the pointing performance. E.g. Fingerball vs. glove

http://www.almaden.ibm.com/u/zhai/papers/siggraph/final.html

Stationary devices (I)

- devices that are mounted on stationary surface.
- Have a self-centering mechanism
- They are either *isometric* devices that do not move by a significantly perceptible magnitude or *elastic* devices that are spring-loaded.
- Typically these devices work in *rate control* mode, i.e. the input variable, either force or displacement, is mapped onto the velocity of the cursor.
- The cursor position is the integration of input variable over time.


(a)


(b)


(c)

Stationary devices (II)

- isometric device (used with rate control) offers the following advantages:
  - Reduced fatigue, since the user's arm can be rested on the desktop.
  - Increased coordination. The integral transformation in rate control makes the actual cursor movement a step removed from the hand anatomy.
  - Smoother and more steady cursor movement. The rate control mechanism (integration) is a low pass filter, reducing high frequency noises.
  - Device persistence and faster acquisition. Since these devices stay stationary on the desktop, they can be acquired more easily.
- isometric rate control devices may have the following disadvantages:
  - Rate control is an acquired skill. A user typically takes tens of minutes, to gain controllability of isometric rate control devices.
  - Lack of control feel. Since an isometric device feels completely rigid

Multi DOF Armatures

- multi DOF input devices are mechanical armatures.
- the armature is actually a hybrid between a flying-mouse type of device and a stationary device.
- Can be seen as a are near isotonic - with exceptional singularity positions - position control device (like a flying mouse)
- has the following particular advantages:
  - Not susceptible to interference.
  - Less delay: response is usually better than most flying mouse technology
  - Can be configured to "stay put", when friction on joints is adjusted and therefore better for device acquisition.
- drawbacks:
  - Fatigue: as with flying mouse.
  - Constrained operation. The user has to carry the mechanical arm to operate, At certain singular points, position/orientation is awkward.
- This class of devices can also be equipped with force feedback, see later Phantom Device

Technology Examples
Data Glove

- Data glove to input information about
  - Orientation, (roll, pitch)
  - Angle of joints
  - Sometimes position (external tracking).
- Time resolution about. 150...200 Hz
- Precision (price dependent):
  - Up to 0,5 ° for expensive devices (> 10.000 €)
  - Cheap devices (€100) much less

Technology Examples
3D-Mouse

- Spacemouse und Spaceball:
  - Object (e.g. Ball) is elastically mounted
  - Pressure, pull, torsion are measured
  - Dynamic positioning
- 6DOF

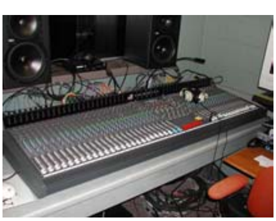
http://www.alsos.com/Products/Devices/SpaceBall.html

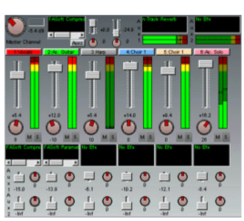
Technology Examples
3D-Graphic Tablet

- Graphic tablets with 3 dimensions
- Tracking to aquire spacial position (e.g. using Ultrasound)

Basic Problem with a single 2DOF Pointing Device

- With 2DOF most often time multiplexing is implied!
- One operation at the time (e.g. slider can be only be moved sequentially with the mouse)





Interactive Modelling (Merl)

http://www.merl.com/papers/TR2000-13/

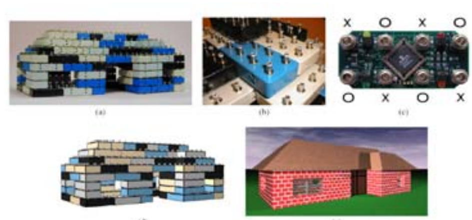


Figure 1: (a) a physical block structure comprising 98 blocks; (b) a close-up of the blocks; (c) a bottom view of the circuit board inside each block; and renderings of the virtual model recovered from the structure, one literal (d) and one interpreted (e). The literal rendering uses associated shapes and colors to render the blocks. The virtual model is augmented automatically for the interpreted rendering.

Interactive Modelling (Merl)

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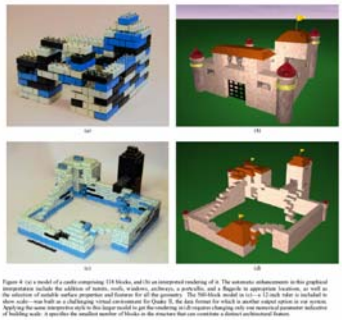
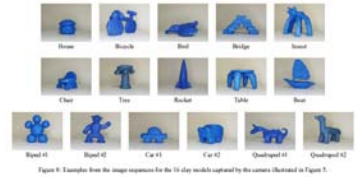


Interactive Modelling Cont. (Merl)



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