Input/Output (HCI)

Computer Science and Engineering - University of Notre Dame

Explicit Input/Output

explicit input → Context-Aware System → *explicit* output

Context:
• state of the user
• state of the physical environment
• state of the computing system
• history of user-computer interaction
• ...

Computer Science and Engineering - University of Notre Dame

Natural/Implicit Interfaces

- Keyboard/Mouse/Screen/Speakers
- Pen input
- Touch
- Speech/Audio/Sound
- Gesture, eye movement
- Tangible interfaces
- Augmented Reality
- Wearable Computing
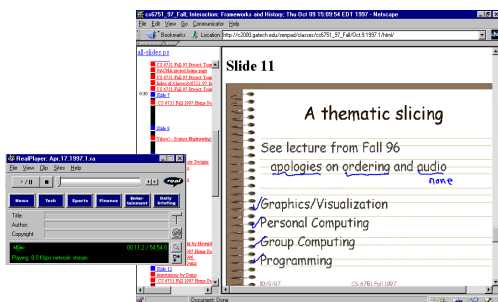- Multi-modal Interactive Interfaces: more than just one input/output channel

Automated Capture
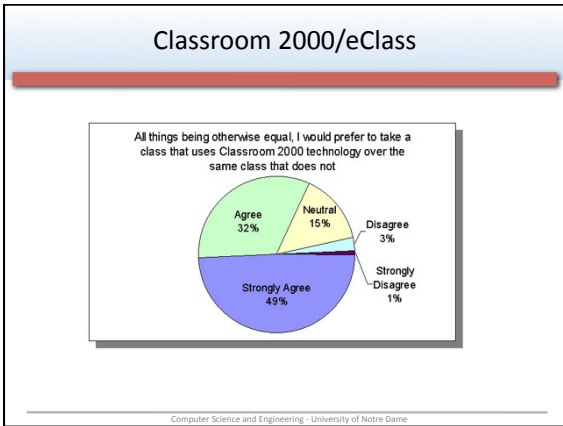
- Motivation
  - Record-taking is hard
  - Multiple streams of information need to be captured
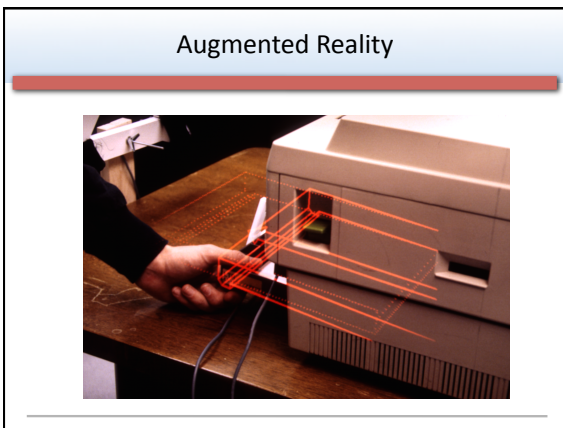 - Machines are better at some of these things than we are

LiveBoard

Classroom 2000/eClass

Classroom 2000/eClass

All things being otherwise equal, I would prefer to take a
class that uses Classroom 2000 technology over the
same class that does not

Agree 32%
Neutral 15%
Disagree 3%
Strongly Disagree 1%
Strongly Agree 49%

Computer Science and Engineering - University of Notre Dame

Augmented Reality


Augmented Reality

– Virtual sightseeing
  • Superimposition of text, images and videos on real images using a fixed device

Computer Science and Engineering - University of Notre Dame

Augmented Reality

– Dynamic augmented reality
  • YDreams has developed a technology that enables the insertion and control of virtual elements in a real scene:
    – One can be a virtual actor in a real movie scene
    – One can participate in a car race driving a virtual car against real cars
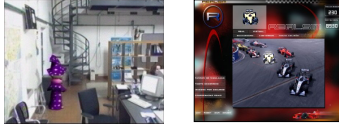
Computer Science and Engineering - University of Notre Dame

Gesture Pendant

Pins and Super Cilia Skin

Super Cilia Skin is a multi-modal interactive interface, conceived as a computationally enhanced membrane coupling tactile-kinesthetic input with tactile and visual output. An array of individual actuators (cilia) use changes in orientation to display images or physical gestures as physical or tactile information.
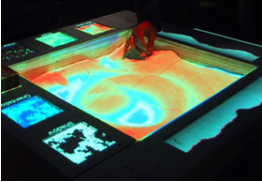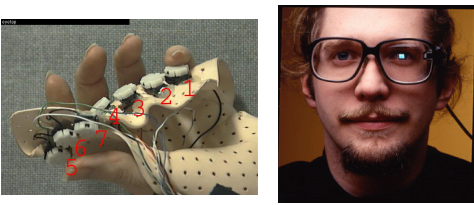
Workbenches

SandScape

SandScape is a tangible interface for designing and understanding landscapes through a variety of computational simulations using sand. Users view these simulations as they are projected on the surface of a sand model that represents the terrain. The users can choose from a variety of different simulations that highlight either the height, slope, contours, shadows, drainage or aspect of the landscape model. The users can alter the form of the landscape model by manipulating sand while seeing the resultant effects of computational analysis generated and projected on the surface of sand in real-time.
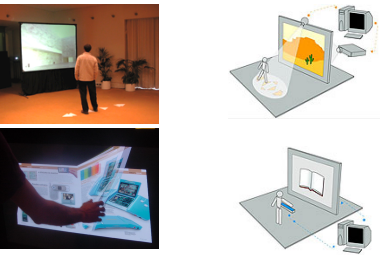

Wearable Computing

- Computation devices accompany you, rather than you seeking them out

Movement Recognition

Seven Design Principles

1. Equitable use
   – same means for all users, do not segregate/stigmatize users, make design appealing

2. Flexibility in use
   – provide choice of methods & adapt to user's pace

3. Simplicity and intuitiveness of use
   – support user's expectations
   – accommodate different languages and literacy skills
   – provide prompting and feedback

Seven Design Principles

4. Perceptible information
   – redundancy of information: use different forms/modes
   – emphasize essential information

5. Tolerance for error
   – minimize impact caused by mistakes
   – remove potentially dangerous situations
   – hazards should be shielded by warnings

Seven Design Principles

6. Low physical effort
   – comfort; minimize fatigue and effort;
   – repetitive or sustained actions should be avoided

7. Size and space for approach and use
   – placement of system should be reachable by all users
   – consider line of sight for standing and sitting user
   – allow for variation in hand size
   – provide room for assistive devices

Multi-Modal Interaction

- Provides access to information through more than one mode of interaction

- Sight is predominant and most interactive systems use visual channel as primary presentation
   – graphics
   – text
   – video
   – animation

Multi-Modal Interaction

- Sound important
   – keeps us aware of surroundings
   – provides clues and cues to switch our attention
   – music - also auditory
     • convey and alter moods
     • conjure up visual images
     • evoke atmospheres
- Touch
   – tactile feedback to operate tools
   – hold and move tools, instruments, pens

Multi-Modal Interaction

- Taste and smell
  - less appreciated
  - check food if bad, detect early signs of fire, …

Multi-Modal Interaction

- Human-human everyday interaction multi-modal
- Each sense provides different information to make whole
- Want human-computer interaction to be multi-modal
  - visual channel can get overloaded
  - provide richer interaction
  - provide redundancy for an equivalent experience to all

Sound in the Interface

- Contributes to usability
- Audio confirmation
  - changes in key clicks
  - error occurrences
- Provide information when visual attention elsewhere
- …or environment has visual limitations
- Dual presentation through sound and vision supports universal design
  - enables access to visual and hearing impaired
- Two kinds: speech and nonspeech

Sound in the Interface: Speech

- Speech recognition
  - Useful when hands are occupied
  - Alternative means of input for users with visual, physical and cognitive impairment
  - single-user systems; require training
  - barriers
    - background noise
    - redundant and meaningless noise ('uh')
    - variations between individuals and regional accents
  - Examples
    - speech-based word processors
    - telephone-based systems
    - interactive systems that give feedback

Sound in the Interface: Speech

- Speech Synthesis
  - Complementary to speech recognition
  - Problems
    - monotonic - doesn't sound natural
    - canned messages
    - spoken output cannot be reviewed or browsed easily
    - intrusive (more noise or equipment)
  - Application areas
    - blind or partially sighted
      - accessible output medium (screen readers)
    - assist those with disabilities affecting their speech
      - predefined messages can be stored

Sound in the Interface: Non-Speech Sound

- Assimilated quickly
- Learned regardless of language
- Require less attention
- Uses:
  - indications of changes or errors in interactive system
  - provide status changes
  - sound representation of actions and objects
  - provide confirmation
  - give redundant information
- Two Kinds - auditory icons and earcons

## Sound in the Interface: Non-Speech Sound

- Auditory icons
  - Use natural sounds to represent types of objects and actions

  - Example: Mac's SonicFinder
    - crumpling paper when putting file in wastebasket

  - Problem: Some objects or actions don't have a natural sound

Sound in the Interface: Non-Speech Sound

- Earcons
  - use structure- combinations of notes (motives) to represent actions and objects
  - vary according to rhythm, pitch, timbre, scale and volume
  - hierarchically structured
    - compound earcons - combine motives
      - 'create' and 'file'
    - family earcons - 'error' family
    - makes learning easier
  - even lack of musical ability has little effect on ability to remember earcons

Touch in the Interface

- Touch both sends and receives information
- Touch in the interface is haptic interaction
- Two areas:
  - cutaneous - tactile sensations through skin
    - vibrations against skin; temperature, texture
  - kinesthetics - perception of movement and position
    - resistance or force feedback
- Entertainment or training
- Tactile devices
  - electronic braille display
  - force feedback devices in VR equipment
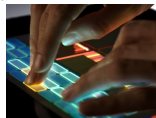
Handwriting Recognition

- Handwriting provides textural and graphical input
- Technology for recognition
  - digitizing tablet
    - sampling problems
  - electronic paper - thin screen on top
- Recognizing handwriting
  - variation among individuals (even day-to-day)
  - co-articulation - letters are different next to others
  - cursive more difficult

Gesture Recognition

- Subject in multi-modal systems recently
- Involves controlling computer with movements
  - put that there
- Good situations
  - no possibility for typing (VR)
  - supports people with hearing loss (sign language)
- Technology expensive
  - computer vision
  - data glove (intrusive)