

Issues and Challenges of 3D User Interfaces

Effects of Distraction

Leslie Klein
Kleinl@in.tum.de
TU München

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Department of Informatics | Technische Universität München

Time-Critical 3D User Interfaces



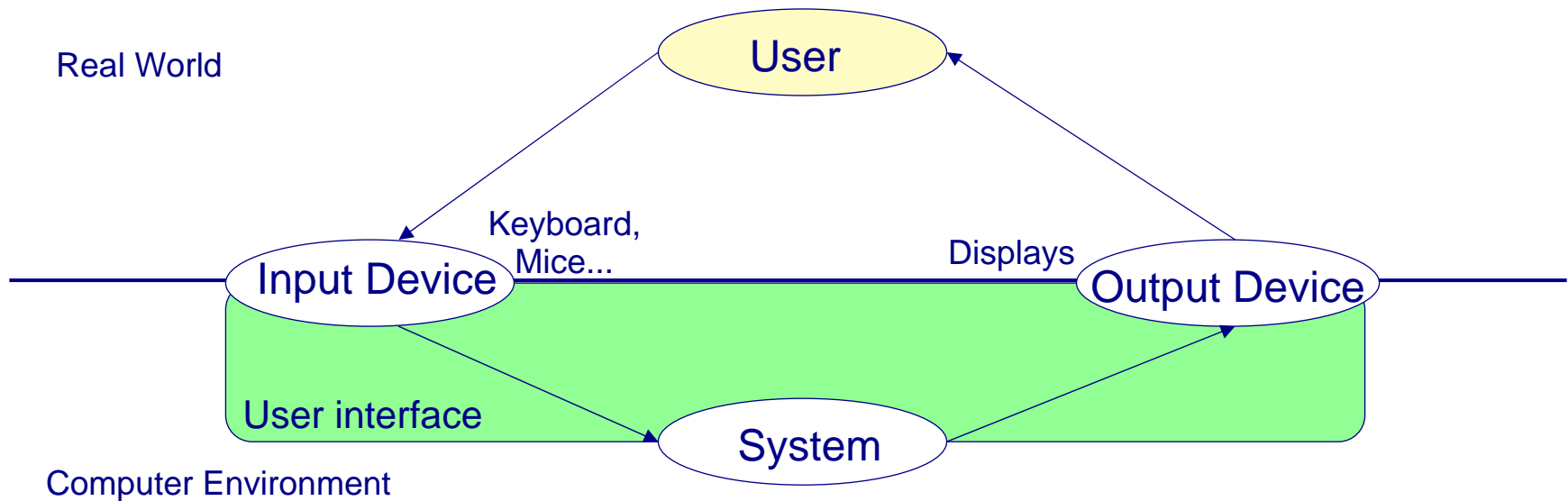
Overview

- 3D user interfaces
 - Input
 - Output
 - Interaction techniques
- Time-critical tasks
- Challenges & problems
- Summary & outlook

2D User Interfaces

Definition of Terms

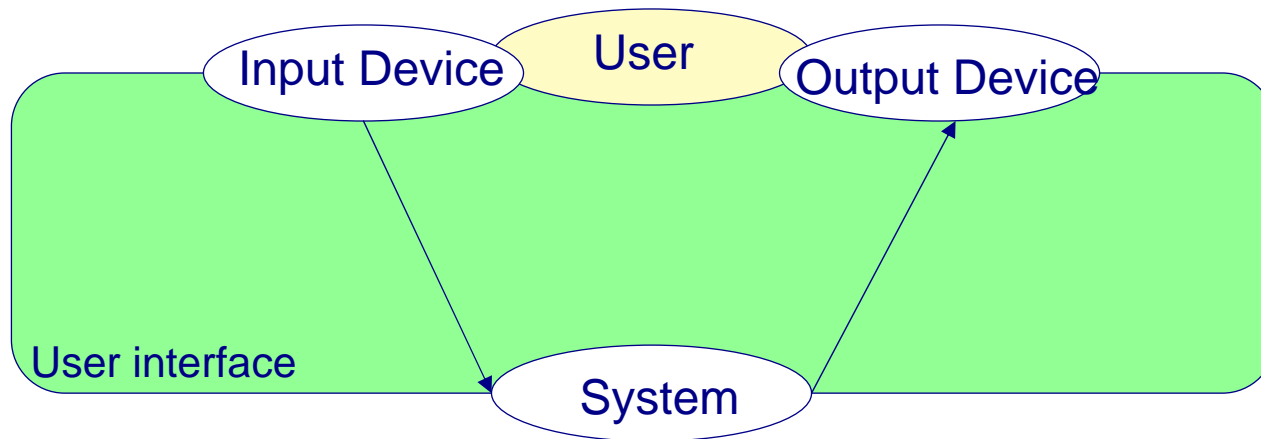
- Human-computer interaction (HCI)
- 2D user interfaces
- Interaction techniques



3D User Interfaces

Definition of Terms

- Human-computer interaction
- 3D user interfaces
- Interaction techniques



Input

- Input vs. Interaction
 - Many interaction techniques can be mapped onto any input device
 - Mapping must be naturally, efficiently and appropriately
- Input devices
 - Discrete input device
 - Continuous input device
 - Hybrid device

Input - Hardware

- Desktop Input device
 - Windows, Icons, Menus, Pointer (WIMP)
 - Keyboards
 - 2D Mice & trackballs
 - Joystick

- Tracking device
 - Motion tracking
 - Eye tracking
 - Data Gloves

- Direct human input
 - Speech



Cooling Station Keyboard



Cybercollege



Data Glove 5 Ultra



Overview

- 3D user interfaces
 - Input
 - **→ Output:**
 - Interaction techniques
- Time-critical tasks
- Challenges & problems
- Summary & outlook

Output

- Visual Displays
- Auditory Displays
- Haptic Displays
- Olfactory Displays
- Gustatory Displays

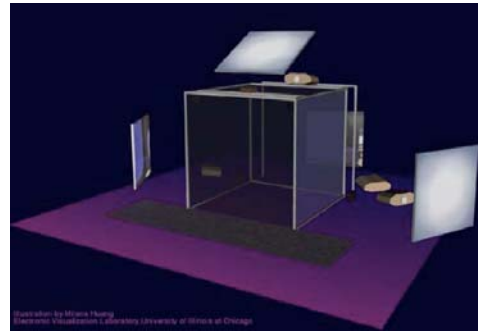


Output - Visual Displays

- Component to present information to the user
 - Information must be generated by computer
- Fully-immersive visual displays
 - Stereoscopic projection display
 - Surround-screen display



BARCO



NCSA-EVL CAVE



FhG-IMK

Output - Visual Displays

- Semi-immersive visual displays: Head-up display(HUD)
 - Real world is augmented with virtual objects or symbolic information



HUD on C-130J,
U.S. Air Force



HUD in BMW Series

Output - Visual Displays

- Semi-immersive and fully-immersive visual display
 - Head-mounted display (HMD)



Sim Eye XL 100a



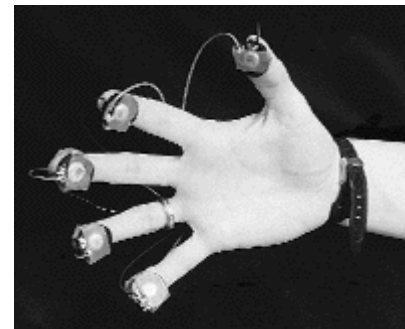
ARTHUR System

Output - Auditory Displays

- Informational or alarm signals
- Interface goals
 - Localisation: Spatially encoded sounds
 - Useful for way finding
 - Locating objects in environment
 - Sonification: Transforming information into sounds
 - Substitution for another sensory modality like touching

Output - Haptic and Multimodal Displays

- Haptic or tactile output
 - Provides a sense of force, a sense of touch or both
 - Physical connection to user => Input and output
- Types of haptic output
 - Ground-referenced haptic device
 - Body-referenced haptic device
 - Haptic device on user's body
=> more freedom of motion
- Multimodal Displays: Overcome individual weakness



Robotics Institute, Carnegie
Mellon University

Overview

- 3D User Interfaces
- Input
- Output
- **➔ Interaction Techniques**
- Time-Critical Tasks
- Challenges

Interaction Techniques

Interaction techniques are methods used to accomplish a given task via the interface

- Categorization of techniques provide guiding principles for interaction design
- Intuitive and easy-to-use
 - Metaphors: pictorially transference to substitute one thing for the other
 - Metaphors form mental models of a techniques
 - Mental models: Internal representation of external reality

Interaction Techniques

- Navigation: Travel & way finding
- Selection & manipulation
- System control
- Symbolic input

Interaction Techniques - Navigation

- Task: Movement in and around the environment
- Travel and way finding
 - Travel: Executive component to control position and orientation of viewpoint and conditions of movement
 - Way finding: cognitive component, thinking, planning related to user's movement

Interaction Techniques - Navigation

- Travelling tasks
 - Exploration
 - Search
 - Maneuvering
- Travelling techniques categorized
 - Active and passive
 - Physical and virtual
- Travelling metaphors
 - Physical movement
 - Manual viewpoint manipulation
 - Steering
 - Target-based travelling
 - Route planning

Interaction Techniques - Navigation

- Way finding tasks
 - Exploration
 - Search
 - Maneuvering
 - Specified trajectory movement

- Using and acquiring spatial knowledge to build up a cognitive map
- Important to provide spatial information
- Local versus global awareness



Interaction Techniques - Selection/Manipulation

- Manipulation
 - In real world: Handling physical objects with one or two hands
 - Close relationship to properties of input device
 - Virtual hand simulates real-world interaction
- Manipulation Tasks
 - Selection
 - Positioning
 - Rotating



Interaction Techniques - System Control

Commands to change state of system or mode of interaction

=> Similarities to object selection, but different

- Typical control widgets
 - Graphical menus (visual representation of commands)
 - Voice commands (menus accessed via voice)
 - Gestural interaction (command sets accessed via gestures)
 - Tools (virtual objects with an implicit function or mode)



Interaction Techniques - Symbolic Input

Humans use symbolic communication everyday:

Language and mathematics

- Symbolic input tasks
 - Alphanumeric input: Alphabetic, numbers, symbols
 - Editing alphanumeric symbols: Insert, delete
 - Markup input: Use formatting style
- In 3D symbolic input for
 - Communication
 - Annotation
 - Labelling
 - Markup
- Input techniques: keyboard-, pen-, gesture- or speech-based

Interaction Techniques

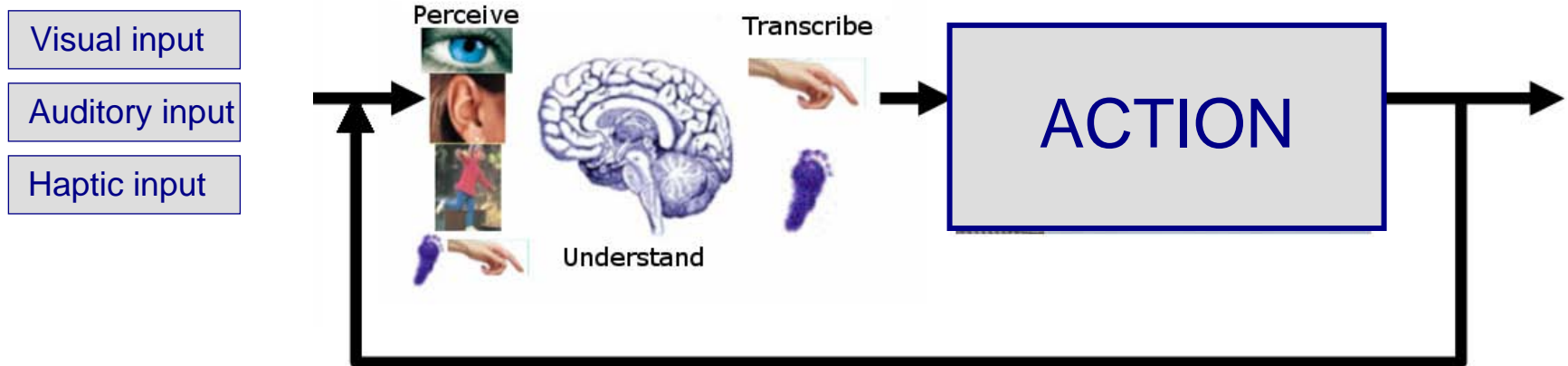
- Design of 3D user interface is depending on requirements of particular application
- Which tasks needs to be supported by 3D UI?
- Which interaction techniques are appropriate?
- Which input devices map these techniques best?

Overview

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- Interaction Techniques
- → **Time-Critical Tasks**
- Challenges & Problems

Time-Critical Tasks

- Interactivity within time-critical tasks



- Complex task that needs a significant amount of the user's attention
- Attention capturing amount of supplementary systems
 - ➔ Constraints to 3D UI Design

Time-Critical Tasks - Constraints

- Supplementary systems must provide support and no distraction
- Input and interaction:
 - Intuitive and with no learning phase
 - Require little visual attention
 - Interruptible
- Output:
 - Not distract the cognitive skills
 - Support the user

Overview

- 3D User Interfaces

- Input
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- Interaction Techniques
- Time-Critical Tasks
- **➔ Challenges & Problems**

Challenges & Problems

- Information overload
- Change blindness
- Occlusion & depth perception
- Perceptual tunneling
- Cognitive capture

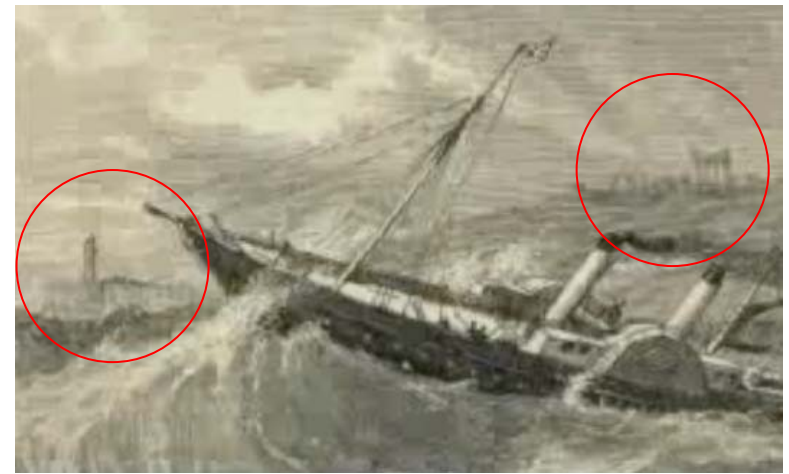
Information Overload

- Too much information to detect important ones



Change Blindness

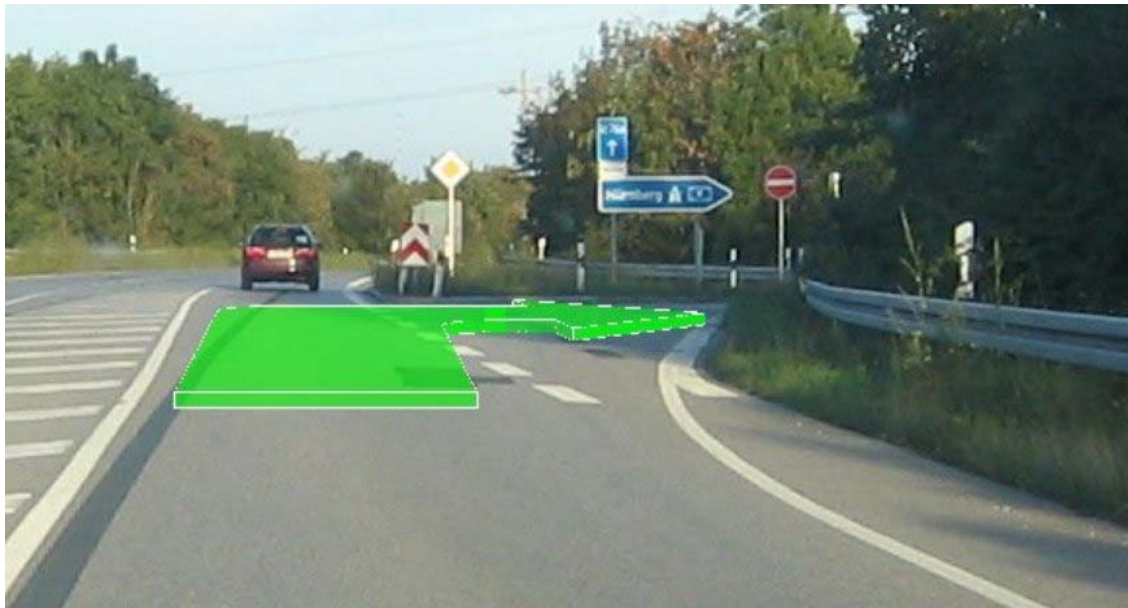
- Failure to detect obvious visual change
=> Information change must be displayed explicitly



Depth Perception

Example Navigational arrows

- Reduces cognitive load of way finding or interpretation of bird's eye maps and distance
- Driver does not need to turn head away of street-scenery



Occlusion, Depth Perception

Example Navigational arrows

- Occlusion of a certain field of environment
- Reversed visual presentation impairs depths cue perception



Perceptual Tunneling

User focus on one stimulus by neglecting attention to other important information

- Phenomenon in aviation
- Animated warning schemes can encourage distraction



V.Novak, C.Sandor, G.Klinker AR Workbench for Experimenting with Attentive User interfaces

Cognitive Capture

- Totally lost in thought and loss of situational awareness



Summary & Outlook

3D user interface

- Gain more capabilities
- Promising new possibilities for time-critical tasks
- But new challenges and problems
- New devices , new techniques, new metaphors: No standards
- Design is an interdisciplinary field of study of research
 - Physical and psychological situation of the user
 - Cognitive phenomena have to be considered and to be tested by usability tests

Thank you for your attention!!