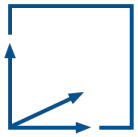
Module IN 2018

3D User Interfaces
- Dreidimensionale Nutzerschnittstellen -

Prof. Gudrun Klinker



Interaction Techniques: System Control

SS 2023

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System Control

1. Definition and Classification
2. Graphical Menus
3. Voice Commands
4. Gestural Commands
5. Tools
6. Multimodal System Control Techniques
7. Design Guidelines

1. Definition and Classification

1.1 General Issues

1.2 Factors of Successful System Control Techniques

1.3 Classification

1.1 General Issues

- System commands are issued in order to
  - Request the system to perform a particular function
  - Change the mode of interaction
  - Change the system state
- Different from selection, manipulation and travel tasks (*how,* but not *what*)
- Typical control widgets (WIMP): *interaction styles*
  - Menus (pull-down, pop-up)
  - Toolboxes
  - Palettes
  - Toggles
  - Radio buttons
  - Checkboxes

1.2 Factors of Successful System Control Techniques

- Human factors
  - Usability and performance depends on user‘s
    - physical characteristics
    - training
    - experience level
  - Other factors:
    - shape and size of controls
    - visual representation and labeling
    - methods of selection
    - underlying control structures
- Availability of input devices
- System- and application-level factors

1.3 Classification

Basic metaphors

System control method	Technique
Graphical menu	- Adapted 2D menu - 1-DOF menu - 3D widget - TULIP menu
Voice command	- Speech recognition - Spoken dialogue system
Gestural command	- Gesture - Posture
Tools	- Physical tool - Virtual tool

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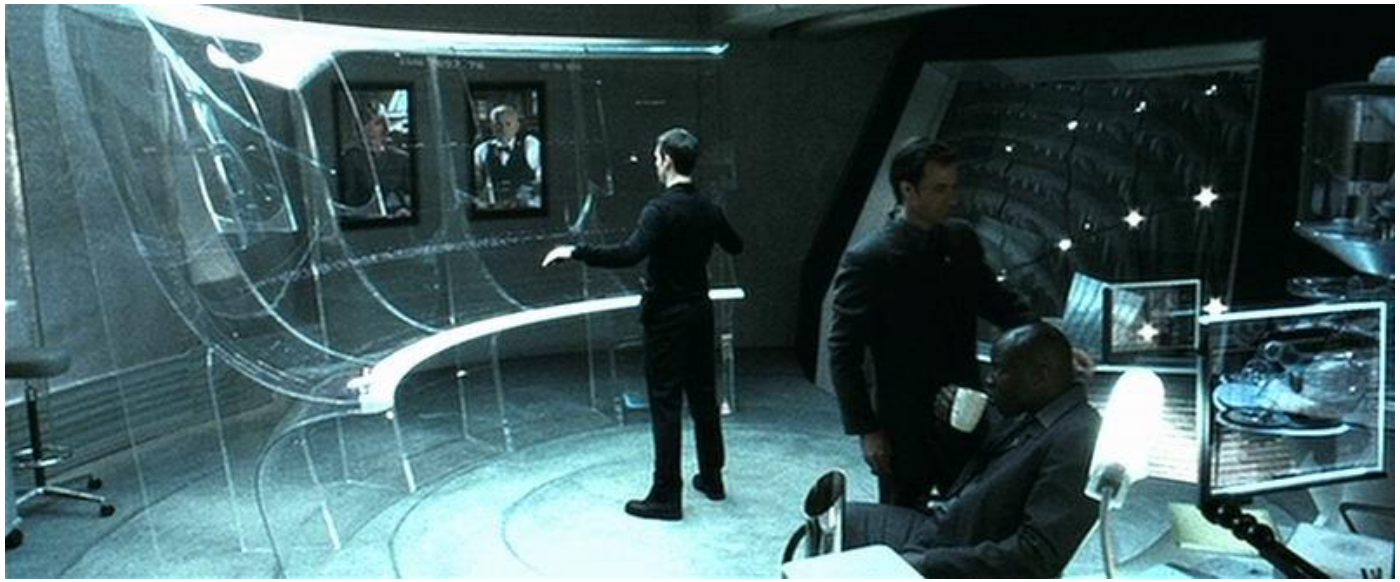
Overview

2. Graphical Menus

- 2.1 Techniques
- 2.2 Design and Implementation Issues
- 2.3 Practical Application



[https://www.ted.com/speakers/john_underkoffler] [Minority Report]

2.1 Techniques

2.1.1 Adapted 2D menus

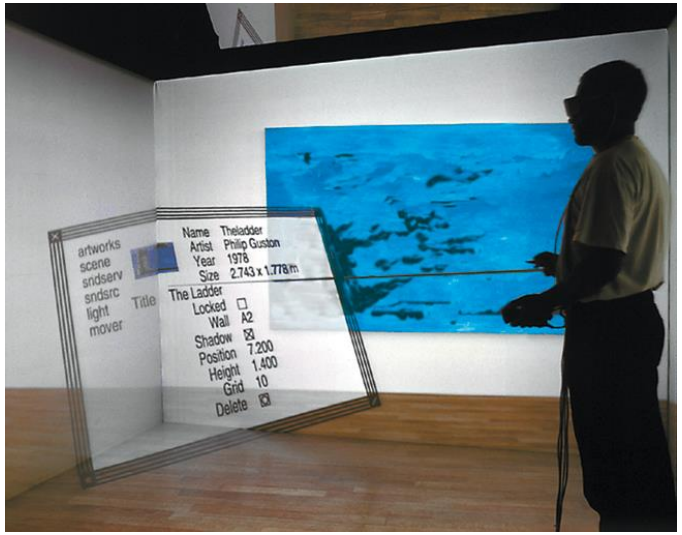
2.1.2 1-DOF menus

2.1.3 TULIP menus

2.1.4 3D widgets

2.1.1 Adapted 2D Menus

- Principle: Simple adaptations from 2D
  - Same behavior
  - Opaque or semi-transparent
  - Attachment to various coordinate systems
    - Screen-based
    - Head-based
    - Object-based (e.g.: a tablet or a marker)
  - Interaction via 3D selection technique
- Advantage
  - Well-known interaction metaphors
- Disadvantages
  - Widgets may occlude important parts of the 3D environment
  - Users may have to search for menus within the 3D environment



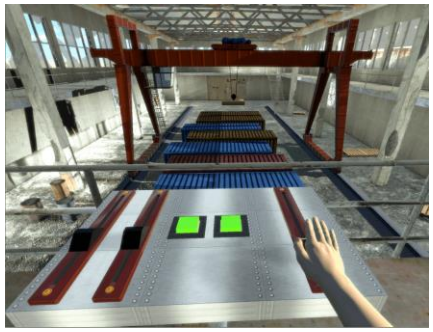
[Pick et al 2013]

2.1.2 1-DOF-Menus

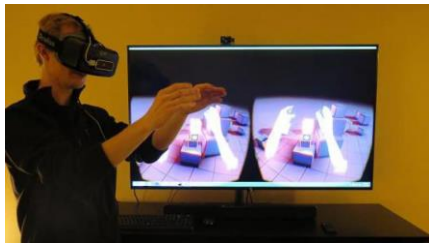
- Principle: 1 DOF list of options constrained 3D user motion
  - *Ring menu*: circular menu around a user‘s wrist
  - Linear hand motion (up-down, left-right)
  - *Handheld widgets*: relative hand positions (distance between hands)
- Advantages
  - Easy to use
  - Rapid access and use (strong placement cue)
- Disadvantage
  - Works only for short lists

[minority report]


[www.icido.de]


[AN Games Studio]

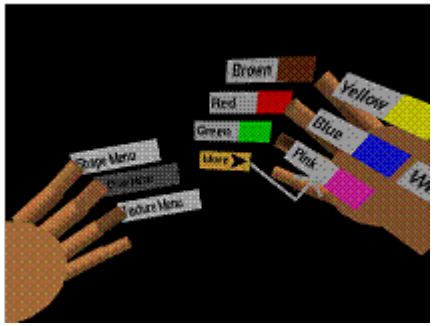

[minority report]


[AN Games Studio]

2.1.3 TULIP Menus

Three-Up, Labels In Palm

- Principle:
  - Interaction via pinch-gloves
    - Labels attached to fingers
    - Selection with thumb
    - 2 level menus (two hands)
  - Three-Up:
    - 3 fingers for „real labels“
    - 1 finger for „more“
  - Labels In Palm (for long lists)
    - 3 labels available for selection
    - Further labels (in sets of three) are shown in palm
- Advantages
  - Moderately efficient, comfortable, easy to use
- Disadvantages
  - Requires special hardware

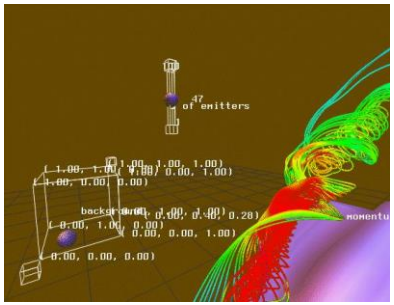


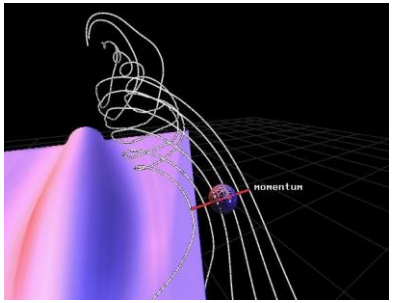
[Bowman and Wingrave 2001]

2.1.4 3D Widgets

- Principle: Use truly 3D widgets
  - Context-sensitive (co-located)
    „The combination of geometry and behavior“ [Conner et al 92]
    - Widgets attached to 3D objects
    - Menu functionality tuned to objects
    - Menus only available when relevant

    “diegetic interfaces”
  - Non-context-sensitive
    - Novel 3D menus
    - Fixed appearance and functionality
    - Interaction via pointer and buttons





[Bryson, NASA]

[Dead Space]

Overview

2. Graphical Menus

2.1 Techniques

→ 2.2 Design and Implementation Issues

2.3 Practical Application

2.2 Design and Implementation Issues

- Placement
  - Easy accessibility vs. occlusion
  - Reference points: world, head, body (hand), device (screen) [Feiner 93]
- Selection (mismatch: 2D menus, 3D interaction)
  - Reduce useless degrees of freedom by constraining interpretation of user motions (e.g. pointing) to their intersections with planar surfaces (e.g.: ray casting)
- (Visual) representation and structure
  - Size and distances matter! (Avoid small objects and distances)
  - Structure the interface by using
    - Functional grouping
    - Sequential grouping
    - Context-sensitive menus
  - Style concepts (guides) for colors, shapes, surfaces, textures, dimensions, positions, texts, and symbols (icons)

Overview

2. Graphical Menus

2.1 Techniques

2.2 Design and Implementation Issues

→ 2.3 Practical Application

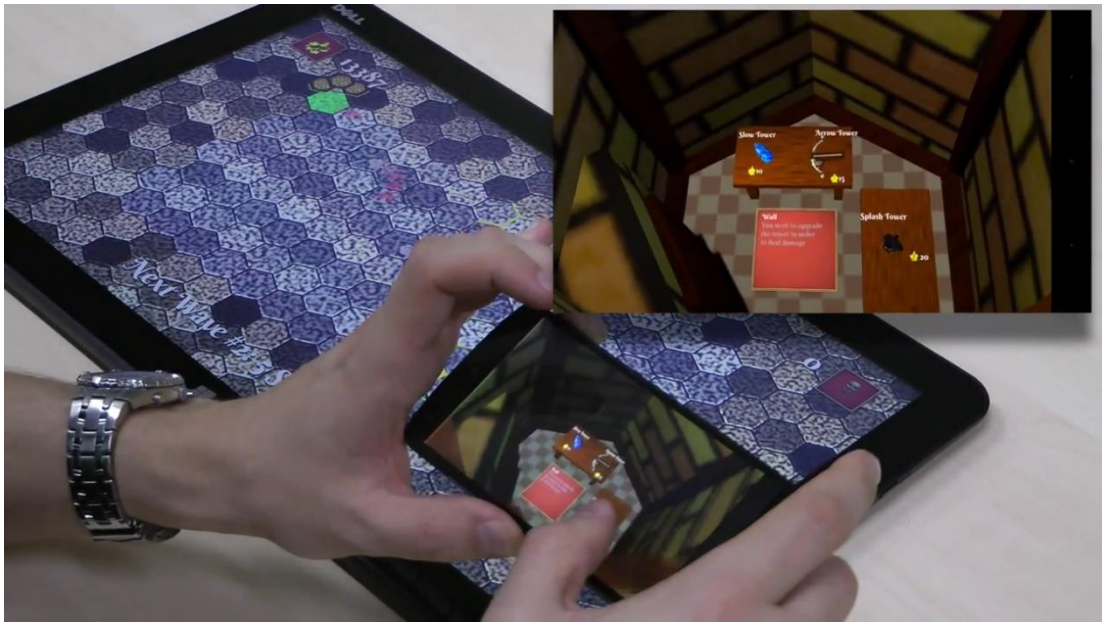
2.3 Practical Application

- Menus are good for 3D applications
  - With large number of functions
- But
  - Menus shouldn‘t overlap too much with the 3D workspace
- Extension
  - Remote menus on a dedicated 2D device (PDA, tablet PC)

2.3 Practical Application

AR Games (TUM-Games Engineering)

- Towering Defense:
  Information spread across multiple displays



https://youtu.be/KYAbeQ602o4

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3. Voice Commands

3.1 Techniques

3.2 Design and Implementation Issues

3.3 Practical Application

3.1 Techniques

- Technical foundation: speech recognition engine
  - Factors influencing the recognition rate:
    - Variability among speakers
      - Speaker-dependent (initial training)
      - Speaker-independent
    - Size of vocabulary
    - Background noise
  - Often used in combination with other input modalities

- Technical options
  - Simple speech recognition
    - For issuing single commands to the system
  - Spoken dialogue
    - To promote a discourse between user and system
      - Spoken interaction in a „relatively“ natural manner
      - Vocabulary dynamically adaptable to flow of discourse

3.2 Design and Implementation Issues

- Designers must carefully analyze the task to define the size of the vocabulary
- Voice interfaces are invisible to the user
  - Users don‘t have a menu, they make mistakes
  - System-side verification of user input is essential!
    - Error correction by semantic and syntactic filtering
    - Formal discourse model
- „All at once“ approach towards initialization, selection and issuing of a command
  - Push-to-talk techniques simplify initialization problem
  - Separate human-human communication from human-computer interaction
    - Distinction via syntactic differences between personal communication and system interaction

3.3 Practical Application

- Voice input is powerful because it is hands-free and natural
- But: it is tiring and cannot be used in every environment
  - User needs to learn and memorize which voice commands are available (works well for only a small set of functions)
- Use of voice control has been studied in many applications, e.g.:
  - Voice control via telephone
  - Alexa, Siri, …

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4. Gestural Commands

4.1 Techniques

4.2 Design and Implementation Issues

4.3 Practical Application

4.1 Techniques

- Classification
  - Posture: static configuration of the hand
  - Gesture: dynamic movement
- Typical gestures of humans:
  - Mimic gestures
    - Describe an object or concept (e.g., sweeping motion to outline a 3D object)
  - Sweeping (Marking-menu techniques)
  - Symbolic gestures (e.g., „thumbs up“)
  - Sign language
    - Pre-specified set of postures and gestures
  - Whole-body interaction
  - Speech-connected hand gestures
    - Deictic gestures to indicate a referent (“Put that there”)
  - Surface-based gestures

4.2 Design and Implementation Issues

Major gesture input techniques

- Glove-based recognition
  - Recognition algorithms: hidden Markov models, neural networks
  - Gesture models: button, valuator, locator, pick device
  - Devices:
    - Pinch gloves: only limited postures
    - DataGloves: postures and gestures
- Camera-based recognition (such as leap motion, kinect)
  - Computer vision: hand/gesture recognition
- Surface-based recognition
  - Touch screens, pen-based interaction

4.2 Design and Implementation Issues

Problems / Issues:

- Gestural interaction depends heavily on input device
- Gesture recognition is still not always reliable
- When a menu is accessed via a gestural interface, the lower accuracy of gestures may lead to the need for larger menu items
- Gesture-based system control shares many of the characteristics of speech input discussed in the previous section
  - Combines initialization, selection, and issuing of the command
  - Gestures should be designed to have clear *delimiters* that indicate the initialization and termination of the gesture (“Push-to-gesture”?)
- Users may need to discover the actual gesture or posture language

4.2 Design and Implementation Issues

Recommendations:

- Use limited number of gestures
- System has to provide adequate feedback when a gesture is recognized

4.3 Practical Application

See our classes (based on Kinect input device)

- Tanz und Schauspiel im virtuellen Studio
- Active SportGames

https://www.youtube.com/watch?v=YURjuWRYS-w

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5. Tools

5.1 Techniques

5.2 Design and Implementation Issues

5.3 Practical Application

5.1 Techniques

- Classification
  - Physical tools („props“)
    - Space-multiplexed
    - Time-multiplexed
  - Virtual tools
    - Tool belt
- Technical option
  - Tangible user interfaces (TUIs) [Ishii et al]
    Combination of representation and control
    - Physical representations are computationally coupled to underlying digital information
    - Physical representations embody mechanisms for interactive control
    - Physical representations are perceptually coupled to actively mediated digital representation
- Examples
  - Physical pen selecting items of a virtual menu
  - Transparent physical tablet as a basis for a virtual menu

5.2 Design and Implementation Issues

- Function of a prop is communicated by its form
  - Imitate traditional control design (e.g.: machinery design)
  - Duplicate everyday tools
- Compliance between real and virtual worlds
  - Some prop-based interfaces require a clutching mechanism
- Possible: blind operation (merely by touch)
  - Props must be designed for tactile interaction
- Issue: Where are props placed when they are not needed?

5.3 Practical Application

- Public installations of VEs can greatly benefit from tools
  - Visitors can use tools without much (or even any) learning effort
- By definition, each tool has limited applicability
  - What can be done for applications with large sets of functionality?
    - Tool switching?

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6. Multimodal Techniques

- Combined use of multiple input channels to control a system
- Advantages
  - Decoupling
  - Error reduction and correction
  - Flexibility and complementary behavior
  - Control of mental resources
- Examples:
  - „Put-that-there“ [Bolt 80] (gesture and speech)
  - „Marking menus“ (gesture-based shortcuts for items in menus)

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7. Design Guidelines

- Avoid disturbing the flow of action of an interaction task
- Prevent unnecessary changes of the focus of attention
- Avoid mode errors
- Use an appropriate spatial reference frame
- Structure the functions in an application
- Consider multimodal input

Thank you!