



PA201 Virtual Environments

Lecture 5

Virtual Reality User Interface Design

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User Interface Design



What is User Interface Design?



- The process of designing effective and user friendly interfaces for software systems and applications
 - Applies in all computer science
 - Other disciplines as well
 - i.e. Hardware design



The User Interface



- Users usually judge a software application based on its interface rather than its functionality
 - A poorly designed interface can cause a user to make catastrophic errors
 - Poor user interface design is the main reason why so many software systems are never used



Many Types of Interfaces



- Command
- Speech
- Data-entry
- Form fill-in
- Query
- Graphical
- Web
- Pen
- Augmented reality
- Gesture



Graphical User Interfaces (GUIs)



- GUIs allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation
 - Opposed to text-based interfaces, typed command labels or text navigation
- GUIs can be found in hand-held devices and many applications exist
 - i.e. Augmented reality



GUI Characteristics



| Characteristic | Description |
|----------------|---|
| Windows | Multiple windows allow different information to be displayed simultaneously on the user's screen. |
| Icons | Icons represent different types of information. On some systems, icons represent files; on others, icons represent processes. |
| Menus | Commands are selected from a menu rather than typed in a command language. |
| Pointing | A pointing device such as a mouse is used for selecting choices from a menu or indicating items of interest in a window. |
| Graphics | Graphical elements can be mixed with text on the same display. |

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GUI Advantages



- They are easy to learn and use
 - Without experience can use the system quickly
 - Can switch quickly from one task to another
 - Can interact with several different applications
 - Information remains visible in its own window when attention is switched
- Fast, full-screen interaction is possible with immediate access to anywhere on the screen

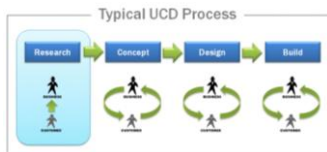
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User-Centred Design



- In user-centred design the needs of the user are paramount and where the user is involved in the design process
- User interface design always involves the development of prototype interfaces



User Interface Design Principles

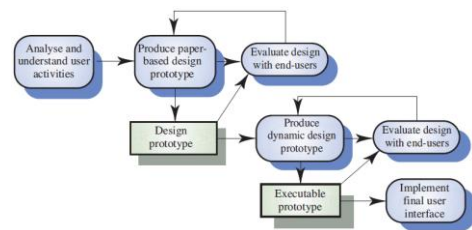


- User interface design must consider the needs, experience and capabilities of the system users
 - Principles underlie interface designs although not all are applicable to all designs
- Designers should:
 - Be aware of people's physical and mental limitations (e.g. limited short-term memory)
 - Recognise that people make mistakes

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User Interface Design Process



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User Interface Design Principles .



| Principle | Description |
|------------------|---|
| User familiarity | The interface should use terms and concepts which are drawn from the experience of the people who will make most use of the system. |
| Consistency | The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way. |
| Minimal surprise | Users should never be surprised by the behaviour of a system. |
| Recoverability | The interface should include mechanisms to allow users to recover from errors. |
| User guidance | The interface should provide meaningful feedback when errors occur and provide context-sensitive user help facilities. |
| User diversity | The interface should provide appropriate interaction facilities for different types of system user. |

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Design Principles



- User familiarity
 - The interface should be based on user-oriented terms and concepts rather than computer concepts
 - i.e. An office system should use concepts such as letters, documents, folders etc. rather than directories, file identifiers, etc.
- Consistency
 - The system should display an appropriate level of consistency
 - Commands and menus should have the same format, command punctuation should be similar, etc.
- Minimal surprise
 - If a command operates in a known way, the user should be able to predict the operation of comparable commands

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Design Principles .



- Recoverability
 - The system should provide some resilience to user errors and allow the user to recover from errors
 - This might include an undo facility, confirmation of destructive actions, 'soft' deletes, etc
- User guidance
 - Some user guidance such as help systems, on-line manuals, etc. should be supplied
- User diversity
 - Interaction facilities for different types of user should be supported
 - i.e. Accessibility

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User-System Interaction



- Two problems must be addressed in interactive systems design
 - How should information from the user be provided to the computer system?
 - How should information from the computer system be presented to the user?
- User interaction and information presentation may be integrated through a coherent framework such as a user interface metaphor

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Interaction Styles



Interaction Styles



- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

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Pros and Cons



| Interaction style | Main advantages | Main disadvantages | Application examples |
|---------------------|---|---|---|
| Direct manipulation | Fast and intuitive interaction Easy to learn | May be hard to implement. Only suitable where there is a visual metaphor for tasks and objects. | Video games CAD systems |
| Menu selection | Avoids user error Little typing required | Slow for experienced users. Can become complex if many menu options. | Most general-purpose systems |
| Form fill-in | Simple data entry Easy to learn Checkable | Takes up a lot of screen space. Causes problems where user options do not match the form fields. | Stock control, Personal loan processing |
| Command language | Powerful and flexible | Hard to learn. Poor error management. | Operating systems, Command and control systems |
| Natural language | Accessible to casual users Easily extended | Requires more typing. Natural language understanding systems are unreliable. | Information retrieval systems |

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Direct Manipulation Advantages



- Users feel in control of the computer and are less likely to be intimidated by it
- User learning time is relatively short
- Users get immediate feedback on their actions so mistakes can be quickly detected and corrected

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Direct Manipulation Disadvantages



- The derivation of an appropriate information space model can be very difficult
- Given that users have a large information space, what facilities for navigating around that space should be provided?
- Direct manipulation interfaces can be complex to program and make heavy demands on the computer system

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Menu Systems



- Users make a selection from a list of possibilities presented to them by the system
- The selection may be made by pointing and clicking with a mouse, using cursor keys or by typing the name of the selection
- May make use of simple-to-use terminals such as touch screens

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Menu Systems Advantages



- Users need not remember command names as they are always presented with a list of valid commands
- Typing effort is minimal
- User errors are trapped by the interface
- Context-dependent help can be provided
 - The user's context is indicated by the current menu selection

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Menu Systems Disadvantages



- Actions which involve logical conjunction (and) or disjunction (or) are awkward to represent
- Menu systems are best suited to presenting a small number of choices
 - If there are many choices, some menu structuring facility must be used
- Experienced users find menus slower than command language

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Command Interfaces



- User types commands to give instructions to the system
 - i.e. UNIX
- May be implemented using cheap terminals
- Easy to process using compiler techniques
- Commands of arbitrary complexity can be created by command combination
- Concise interfaces requiring minimal typing can be created

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Command Interfaces Disadvantages

- Users have to learn and remember a command language
 - Unsuitable for occasional users
- Users make errors in command
 - An error detection and recovery system is required
- System interaction is through a keyboard so typing ability is required

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Command Languages

- Often preferred by experienced users because they allow for faster interaction with the system
- Not suitable for casual or inexperienced users
- May be provided as an alternative to menu commands
 - i.e. Keyboard shortcuts
- In some cases, a command language interface and a menu-based interface are supported at the same time

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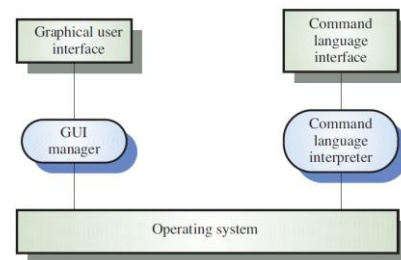
Natural Language Interfaces

- The user types a command in a natural language
- Generally, the vocabulary is limited and these systems are confined to specific application domains
 - i.e. Timetable enquiries
- NL processing technology is now good enough to make these interfaces effective for casual users
 - But experienced users find that they require too much typing

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Multiple User Interfaces



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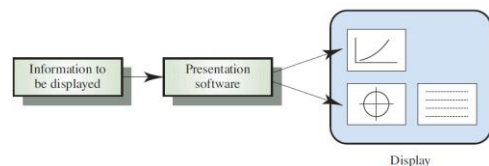
Information Presentation

- Information presentation is concerned with presenting system information to system users
- The information may be presented directly (e.g. text in a word processor) or may be transformed in some way for presentation (e.g. in some graphical form)
- The Model-View-Controller approach is a way of supporting multiple presentations of data

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Information Presentation .



https://www.ics.uci.edu/~taylor/ics52_f01/USlides.pdf



Types of Information



- Static information
 - Initialised at the beginning of a session
 - Does not change during the session
 - May be either numeric or textual
- Dynamic information
 - Changes during a session and the changes must be communicated to the system user
 - May be either numeric or textual

https://www.ics.uci.edu/~taylor/ics52_f01/USlides.pdf



Information Display Factors



- Is the user interested in precise information or data relationships?
- How quickly do information values change?
- Must the change be indicated immediately?
- Must the user take some action in response to a change?
- Is there a direct manipulation interface?
- Is the information textual or numeric? Are relative values important?

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VR Interaction Styles



Types of VR Apps



- Generally speaking from a designer's perspective, VR applications are made up of two types of components:
 - Environments
 - Interfaces
- You can think of an environment as the world that you enter when you put on a VR headset — the virtual planet you find yourself on, or the view from the rollercoaster that you're riding
- An interface is the set of elements that users interact with to navigate an environment and control their experience

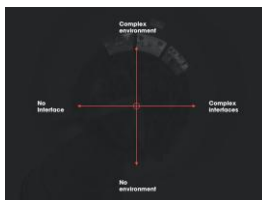
<https://www.smashingmagazine.com/2017/02/getting-started-with-vr-interface-design/>



Types of VR Apps .



- All VR apps can be positioned along two axes according to the complexity of these two components



<https://www.smashingmagazine.com/2017/02/getting-started-with-vr-interface-design/>



A Process For VR UI Design



- Whereas most designers have figured out their workflow for designing mobile apps, processes for designing VR interfaces are yet to be defined
- Designing for VR should not mean transferring 2D practices to 3D, but finding a new paradigm

<https://uxdesign.cc/design-practices-in-virtual-reality-800f933826d8#5c5671f>



A Process For VR UI Design .

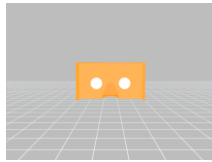
- Designers should expand their expertise to different fields, such as psychology, architecture, sound design, lighting design and physics, in order to be able to create fully controlled experiences, guiding users in VR by shaping the virtual environment in such way

https://uadesign.cz/design-practices-in-virtual-reality-900f9335826#_af56571f



Role of the Ground

- Users can find themselves in such situation in poorly designed VR experiences, causing inevitable motion sickness
- The ground to horizon relationship is as important in VR
 - Similar to our physical reality



https://uadesign.cz/design-practices-in-virtual-reality-900f9335826#_af56571f



VR Design Solutions



Atmosphere

- Atmospheric (aerial) perspective can help users to understand the scale of the virtual environment, therefore making the experience more natural
 - The gradual fading of the landscape is a clear cue for depth and distance



Masaccio using atmospheric perspective to create the illusion of depth

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Terrain Features

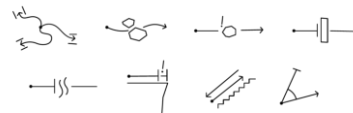
- Ground is rarely an open environment
- A path affords pedestrian motion from one place to another, between other terrain features
- An obstacle is an animal-sized object that affords collision
- A barrier is a specific kind of obstacle that is usually blocking vision as well as movement
- A water margin prevents pedestrian locomotion
- A brink, the edge of a cliff
- A step is a layout of adjacent steps which afford both descent or ascent
- A slope may or may not afford pedestrian locomotion dependent on the angle and texture of the ground

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Terrain Features .

- Using these features in a controlled manner, as the building blocks when designing the virtual environment, will result in (natural) VR experiences guided by human intuition



https://uadesign.cz/design-practices-in-virtual-reality-900f9335826#_af56571f



User and Soundscapes

- In virtual reality changing the environment entirely is effortless
 - Although for the user these sudden and overwhelming changes can cause sickness and confusion
- A gentle introduction to the new environment can be achieved by fading-in the ambient soundscape of the place at first, then the image
- This allows to build a mental image of the environment via sound
 - Lowering the shock factor

<https://uadesign.cz/design-practices-in-virtual-reality-900f935826#.d5o5671f>



Video

- <https://player.vimeo.com/video/138951063>



Guiding the User with Objects

- Navigating the user via a certain path in a cluttered environment can be difficult without using conventional wayfinding UI elements
- The usage of these elements could break the immersion of the experience
 - However subtle changes in the environment, such as growing flowers at the openings of a field in order to draw the users attention to the correct path, could still maintain the genuineness of the place



Red flowers in Firewatch guiding the player towards the correct direction

<https://uadesign.cz/design-practices-in-virtual-reality-900f935826#.d5o5671f>



Contextual Reticle

- In non-tracked VR reticles are used in order to show the user the specific point where they gaze
 - e.g. Gear VR, Google Cardboard
- It helps to orient in space by showing the centre of focus
- It is also used for movement and interacting with objects
- These specific tasks demand different reactions from the reticle

<https://uadesign.cz/design-practices-in-virtual-reality-900f935826#.d5o5671f>



Contextual Reticle .

- Idle state
 - The idle state reticle should be as minimal as possible, giving only a hint where the centre is
- Movement
 - The reticle should be activated when the user looks at any place that is approachable
 - When doing so, the reticle should transform into a larger pointer, highlighting the selectable area with a circle projected over it from the user's perspective

<https://uadesign.cz/design-practices-in-virtual-reality-900f935826#.d5o5671f>



Contextual Reticle ..

- Interacting with objects
 - When the user turns his/her attention to an interactive object the reticle should react accordingly
- Reticle colouring
 - The reticle should adapt its colour to the brightness level of its background, by switching between light and dark modes in order to stay visible in all lighting conditions
- Objects as reticle
 - Replacing the reticle with specific 3D items can be an easy cue for the interaction
 - e.g. a key as the reticle whilst opening a lock

<https://uadesign.cz/design-practices-in-virtual-reality-900f935826#.d5o5671f>



Interactive Objects



- If not all objects are interactive, users should be hinted which objects they can interact with
- The contextual reticle can be a help in this case, but in some cases, in order to avoid confusion, the interactive objects should change, too
- This could be a minor change in the shading of the object or even a subtle sound describing its behaviour whilst looking at it
 - e.g. subtle click in case of light switches

<http://uxdesign.cc/design-practices-in-virtual-reality-900f59158264#5e5871f>

VR Design Patterns



Introduction to VR Design Patterns



Curved Design



- UX experts used to design forms, websites and smartphone applications
 - Now they need to re-learn the trade to design interfaces and interactions in virtual reality
- Many of the traditional UI elements simply do not work in VR, and a significant part of the existing UX toolkit is simply inappropriate
- To begin with, designing for a flat surface - our laptop or phone screens - is very different from designing for a spherical world with the user at its centre
 - Luckily there are people researching UI and UX in VR, and there are a few tried and tested patterns

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>

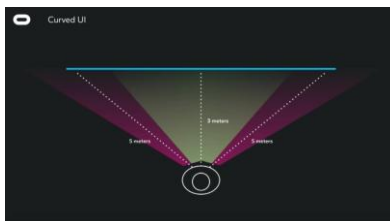
<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Curved Design .



Narrowing the Field



- In VR placing any meaningful control element to the periphery of the field of vision is a bad idea
 - It's simple biology: your vision is simply not sharp enough on the edges.
- We are used to think in a landscape or portrait format on the web, and on smartphones
- Neither work particularly well in VR, as they force the user to tilt their head too much
 - Instead, controls should be placed inside a 1:1 rectangle area

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>

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Narrowing the Field .



<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Using Z Zones and Depth

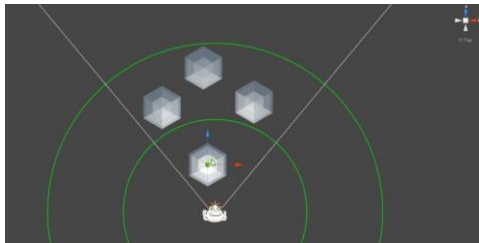


- Objects that are too close to your eyes will get blurry
- Just raise your hand and start moving it towards your face - you simply can't maintain focus when it's closer than a few inches
- Objects, and especially controls should never be placed too close to the user
- On the other hand people are much better in telling the distance between two objects in close distance, than between two objects far away
- If the distance is important from an interaction point of view, the objects should be placed reasonably close to the user's eyes

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Using Z Zones and Depth .



<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Motion Flow



- In virtual reality the camera is mapped to the player's head, with it's focus being at the centre (unless you use eye tracking)
- This means you never ever should change the environment against the head movements, or force the user turn their head involuntarily
 - Both leads to motion sickness, and being nauseated
- Of course sometimes you want to guide the user through the user interface, towards the direction where something is happening
 - This is where subtle tools like motion flow comes into play
 - Pressing a button can trigger the button to extend, or slowly start moving, gently guiding the user to turn their head
 - We are implying a direction, guiding their eye to the next point of interest

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Moving Interface



- It's the opposite of motion flow, when we don't urge the user to look in a specific direction, but rather move the new elements directly to the field of view
- Standing the centre of a sphere means you don't see, and you don't know about UI elements changing behind your back
- Sometimes it's better to put them right in the front of the user

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Capturing Attention



- The long evolution of the Homo Sapiens trained us to pay attention to lights and movement
 - This evolutionary skill is perfect to capture focus in a virtual reality environment
- A great example is the game demo Lost by Oculus
 - They use fireflies in a dark forest to lead the eyes of the user
- We expect to see more subtle, clever plays on light and shadow in VR applications and games

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Capturing Attention .



<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Anchor Objects



- Virtual reality causes dizziness for a lot of people
- Chances are if you had a bad experience with VR you won't try it again
 - And definitely won't try it the third time
- We are used to standing or sitting still while the world is moving around us, a good example being driving
- It's not causing nausea, because we have a visual anchor, the car dashboard
- Establishing such an anchor object in the virtual space is something interface designers should consider
- Research suggests even a virtual nose can help

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Anchor Objects .



<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Holophonic Sound



- Holophonic means 3D sound
- The idea is that with listening through the right equipment you can tell if the sound is coming from above, below, or from behind your back
 - And not just left and right, as with the stereo systems
- Holophonic sounds are amazing in games, but they very well might be used for VR control interfaces
 - Imagine a video start playing outside of your view, and you will hear 'exactly' where the sound comes from

<http://realityshift.io/blog/ui-ux-design-patterns-in-virtual-reality>



Conclusions



- Virtual reality and user interface design are emerging as a new medium with the potential of having as strong an impact in society
- Nowadays can build the foundations of interface, experience and interaction design specific for this medium
 - Without taking already existing solutions for granted



Videos



- VR Interface Design Pre-Visualisation Methods
 - <https://www.youtube.com/watch?id86HeV-Vb8>
- UI/UX design for WebVR
 - <https://www.youtube.com/watch?v=ZOaOYTOPwyM>
- Google I/O 2015 - Designing for virtual reality
 - <https://www.youtube.com/watch?v=Qwh1LBzz3AU>
- Designing For Virtual Reality
 - <https://www.youtube.com/watch?v=hM1AnOgaE-w>



Questions

