3D User Interfaces

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Some example interfaces

Navigation

Introduction

Navigation involves two different tasks:

- **Travel** : motor component (actions to move the user to a new target location or in the desired direction)
- **Wayfinding** : cognitive component (process of defining a path through a environment).

Travel tasks

Types of travel tasks according to user's goal:

- Exploration
  - No explicit goal.
  - Typically used at the beginning of the interaction with a VE.
- Search
  - The user is looking for some target.
  - Naïve search: the user doesn't know where the target is or how to get there.
  - Primer search: the user has knowledge about target location.
- Maneuvering
  - Involves small, precise movements (e.g. position the viewpoint more precisely; examine an object from different angles).

Travel techniques

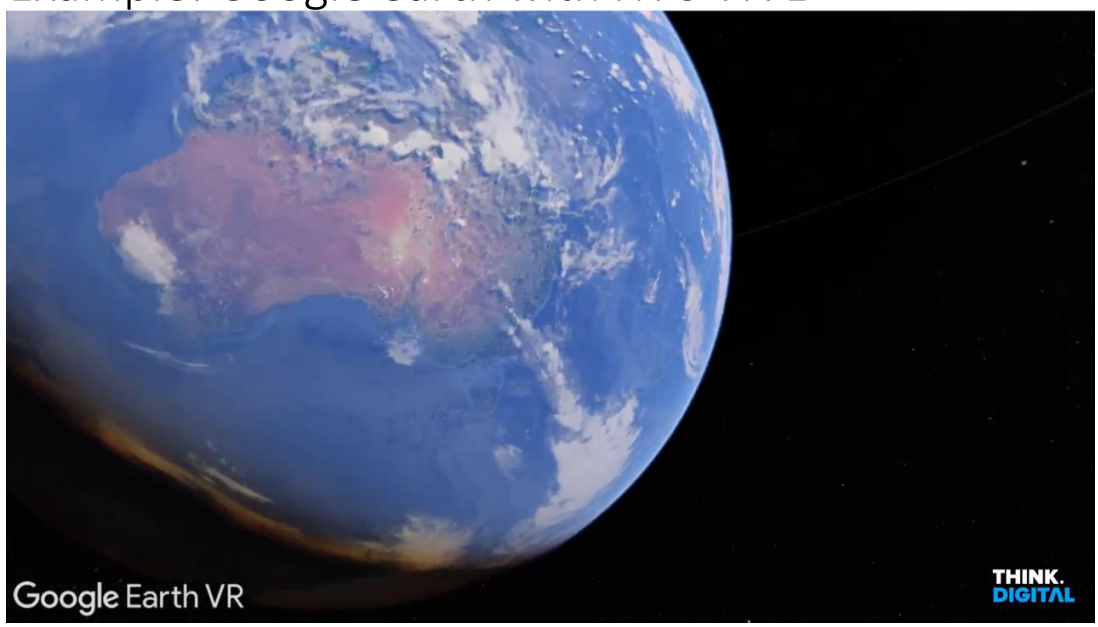
- Exploration
  - The user must be able to change the target at any moment (continuous control of the viewpoint).
  - Little cognitive load → user can focus on information gathering.
- Search
  - Techniques can be goal-oriented (e.g. specify the final location on a map) provided that the target is explicitly represented in the map [Bowman, Johnson, Hodges 99].
- Maneuvering
  - Use physical motion of head/body.

Travel tasks

Additional travel characteristics [Bowman et al 2004]:

- Distance to be traveled
  - Short-range: using natural physical motion only.
  - Medium-range: virtual travel technique, but no speed control.
  - Large-range: speed control & quick jumps.
- Visibility of the target from the start
- DOFs required for the movement (walk vs fly)
- Required accuracy
- Other primary tasks that take place during the travel (e.g. shot enemies)

Example: Google earth with HTC VIVE



Travel techniques

- Active: viewpoint movement is controlled by the user.
- Passive: viewpoint movement controlled by the system.
- Active and passive: route planning
  - Users plan the path and then the system follows it.

Travel techniques

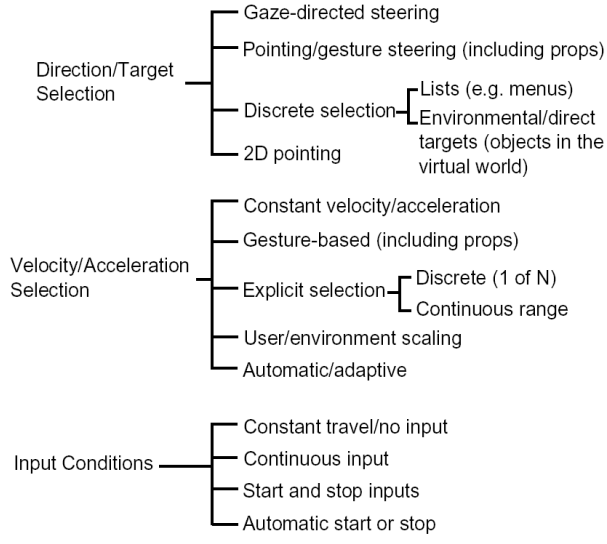
- Physical travel: mimic motions in the real world
  - User's body physically translates or rotates.
  - Requires tracking. Effective within a very limited space.
- Virtual travel: virtual vehicle
  - User's body remains stationary.
  - Provides visual motion cues, not vestibular cues.

Travel techniques

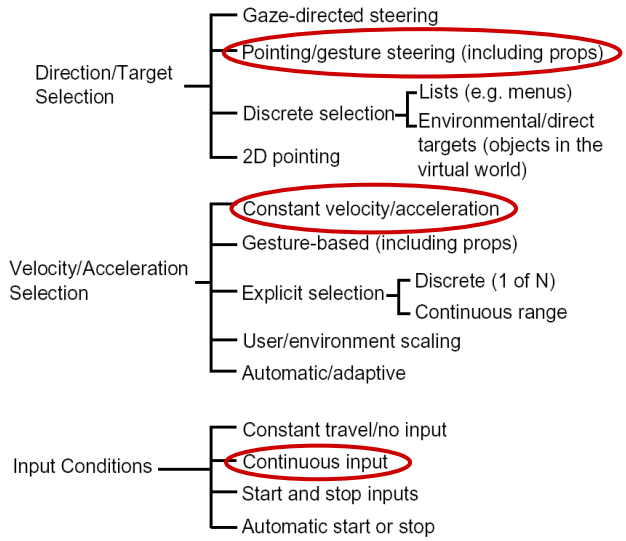
Task decomposition [Bowman, Koller, Hodges 97]:

- Direction or target selection: where to move.
- Velocity/acceleration: how fast.
- Conditions of input: how travel is initiated, continued and terminated.

Travel techniques



Travel techniques



Travel techniques

Metaphor [Bowman et al 2004]:

- Physical locomotion techniques
- Steering techniques
- Route-planning techniques
- Target-based techniques

Physical locomotion

- Mimics a natural method of locomotion in the real world.
- Examples: Walking, Walking in place, Bicycles…

Walking

- Provides vestibular cues → better spatial understanding.
- Suitable for short-range distances.
- Size of the real environment and range of tracking >= size of VE.
- Cables are an important issue.
- When users are allowed to walk and use a virtual travel technique, they often use only the later (less effort).

Walking in place

- Feet move; the body remains stationary.
- No need a large physical environment.
- Not as effective as real walking [Usoh et al 1999]
- Two different approaches:
  - User moves feet up and down (only trackers, no special device)
  - Devices simulating walking.

Walking in place

Devices simulating walking

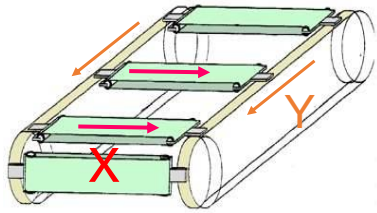
- Simple treadmill → requires another device to turn

Walking in place

Devices simulating walking

- Omnidir Treadmill [Darken et al 1997]
- GaitMaster [Iwata 2001] video

Serious safety issues (if users lose their balance)



Walking in place

Omnidirectional Treadmill

- Infinadeck

http://infinadeck.com/#introduction

Walking in place

VR treadmills: Virtuix Omni and Cyberith

- Passive approach by using low-friction surfaces to facilitate locomotion rather than moving parts

http://www.virtuix.com/products/

http://cyberith.com/product/

http://www.virtuix.com/

Bicycles

Travel techniques

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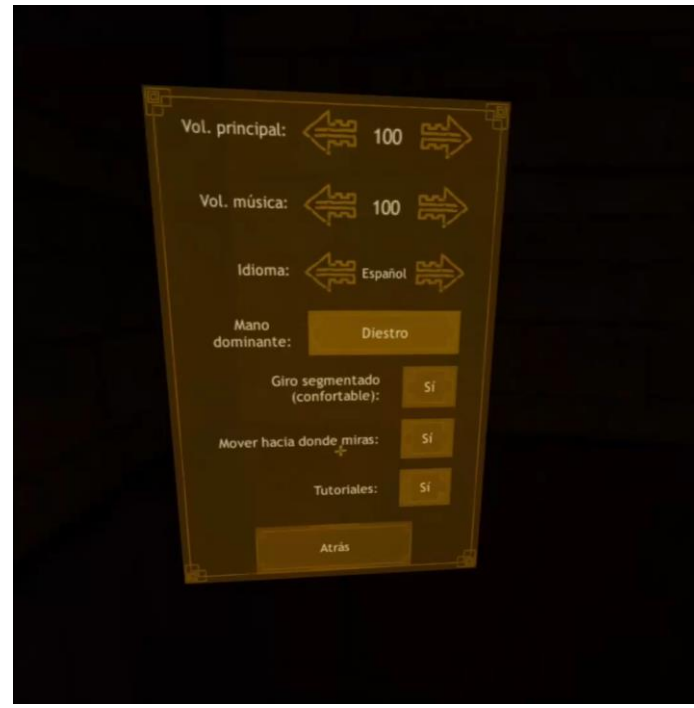
Steering techniques

Steering → continuous control of the direction of motion by the user.

Steering techniques

- Gaze-directed steering [Mine 95a]
- Pointing
- Torso-directed
- Camera in-hand [Ware & Osborne 90]
- Physical steering props
- Virtual Motion Controller (pressure sensors) [Wells et al 96] (→)

Steering techniques



Travel techniques

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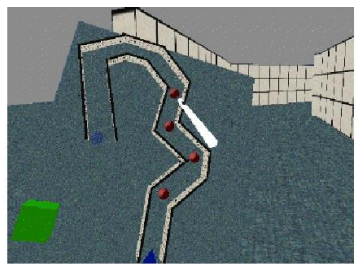
Route planning

- Drawing a path
- Marking points along the path
- User representation:
  - A human figure in WIM.
  - A user icon in a 2D map.



Travel techniques

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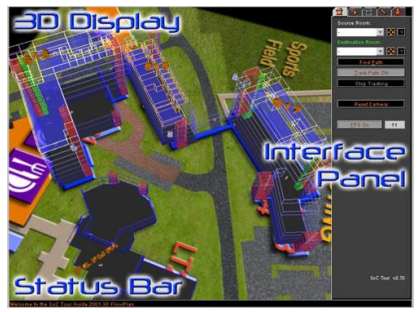
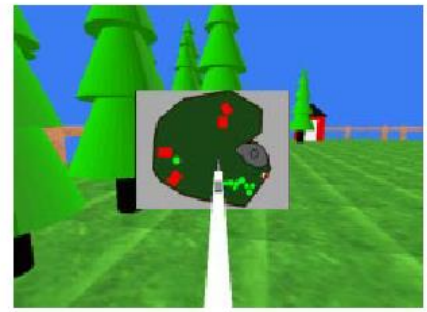
Target-based techniques

Example: Map-based or WIM-based target specification





Target-based techniques

Grabbing the air

The entire world is viewed as an object to be manipulated

Navigation through thoughts

Brain computer interface inside a CAVE

Motion Sickness

- Sensory conflict – a mismatch between the visual data coming in and the information that a human receives through their vestibular system.
- This happens when a user is moving in VR, but does not move in real life.

Reducing motion sickness

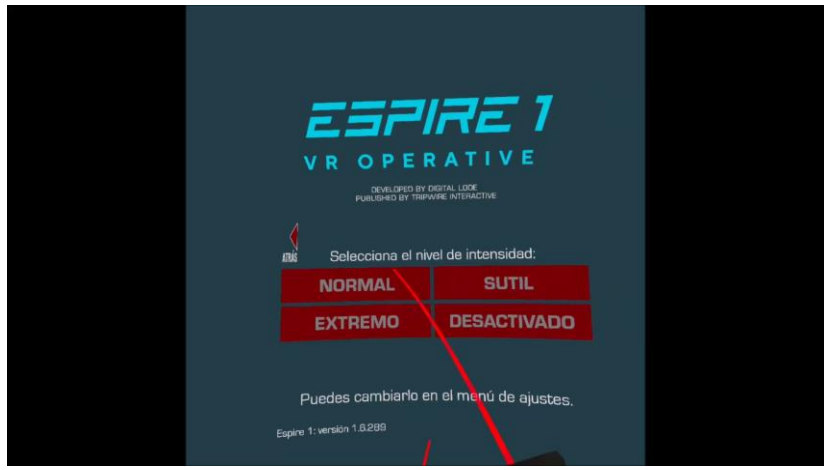
Teleportation

Reducing motion sickness

Low speed changes

Reducing motion sickness

Constraint optical flow to a part of the user's fov



Reducing motion sickness: GVS

Trick the inner ear using electrical impulses to simulate that your body is physically moving

https://www.youtube.com/watch?v=_17xalkzG1k

Adding Proprioceptive Feedback to Virtual Reality Experiences Using Galvanic Vestibular Stimulation*

Extended Abstract†

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Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems
https://doi.org/10.1145/3290605.3300905

More on Motion Sickness

https://vrscout.com/news/avoid-motion-sickness-developing-for-vr/

Locomotion Vault: the Extra Mile in Analyzing VR Locomotion Techniques

https://www.microsoft.com/en-us/research/publication/locomotion-vault-the-extra-mile-in-analyzing-vr-locomotion-techniques/