3D User Interface from Minority Report

https://www.outerplaces.com/science/item/16688-minority-report-user-interface-augmented-reality

3D User Interface from Iron Man

https://www.youtube.com/watch?v=P5k-4-OEuTk&t=9s

3D User Interfaces Guidelines

based on the slides from Bowman

http://people.cs.vt.edu/~bowman/3dui.org/course_notes/chi2009/guidelines.pdf

previously…

. Introduction to 3D user interfaces

. Concept of usability, user experience, and accessibility

2D is better than 3D

Jakob Nielsen, 1998 https://www.nngroup.com/articles/2d-is-better-than-3d/

The screen and the mouse are both 2D devices, so we don't get true 3D unless we strap on weird head-gear and buy expensive bats (flying mice)

It is difficult to control a 3D space with the interaction techniques that are currently in common use since they were designed for 2D manipulation (e.g. dragging, scrolling)

Users need to pay attention to the navigation of the 3D view in addition to the navigation of the underlying model: the extra controls for flying, zooming, etc get in the way of the user's primary task

Poor screen resolution makes it impossible to render remote objects in sufficient detail to be recognizable; any text that is in the background is unreadable

The software needed for 3D is usually non-standard, crash-prone, and requires an extra download (which users don't want to wait for)

Bad uses of 3D?

Most **abstract information spaces** work poorly in 3D because they are non-physical...

...**navigation through a hyperspace** (such as a website) is often very confusing in 3D, and users frequently get lost. 3D navigation looks very cool in a demo, but that's because you are not flying through the hyperspace yourself ...

Avoid **virtual reality gimmicks** (say, a virtual shopping mall) that emulate the physical world...

Jakob Nielsen, 1998 https://www.nngroup.com/articles/2d-is-better-than-3d/

Good uses of 3D?

When you **visualize physical objects** that need to be understood in their solid form. Examples include:

- surgeons planning where to cut a patient: the body is 3D and the location of the tumor has a 3D location that is easier to understand from a 3D model than from a 2D X-ray
- mechanical engineers designing a widget that needs to fit into a gadget
- chemistry researchers trying to understand the shape of a molecule
- planning the layout of a trade-show booth...

...**entertainment applications** and some educational interfaces can benefit from the fun and engaging nature of 3D,... Note that 3D works for games because the user does not want to accomplish any goals beyond being entertained....

Jakob Nielsen, 1998 https://www.nngroup.com/articles/2d-is-better-than-3d/

Links e leituras recomendadas

3D User Interfaces, by Doug Bowman.

https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/3d-user-interfaces

Chapter 3: 3D User Interfaces: Theory and Practice, 2nd Ed.

https://www.pearson.com/us/higher-education/program/La-Viola-3-D-User-Interfaces-Theory-and-Practice-2nd-Edition/PGM101825.html

Outline

Application areas for 3D UI's
Challenges for 3D UI's
- input
- output
- human

Guidelines for 3D UI's

3D UI
APPLICATIONS

3D Window Managers

Kwin WM with Xfce
thelinuxrain.com

Ubuntu Buzz: enabling 3D Desktop Cube
ubuntubuzz.com

- Objective: Manage 2D & 3D applications
  Basically a means for "navigation" among apps, files, etc
  Setting: Desktop
  Users: single users, novice to experts

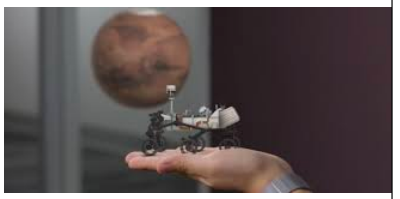
Games

Examples: beat saber, resident evil, zelda
Objective: diversão, treinamento, **social**
Settings: Console, desktop, celular, sentado em casa com joystick x keyboard mouse
Users: jovens, acostumados com tecnologia x casual, single x multiple users

CAD: computer aided design

Examples: arquitetura
engenharia, design gráfico
Objective: visualização
modelo, definição
Settings: desktop,
escritório,
Users: treinamento (expert), single x multi user,

3D UI in AR/VR



Examples:
. treinamento,
. beat saber (game)
. google maps
Objective:
. diversão, imersão, treinamento
. visualização, acessibilidade
Settings: óculos, holograma,
Users:

Interaction

Main Challenges

How to interact?
- input devices
- output devices
- human issues

Input: Desktop 3D devices

- Spaceball
- Phantom
- Leap motion

Issues

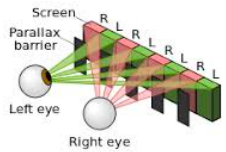
. Very sensitive
. Limited motion
. Desk clutter

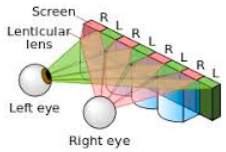
Input: Game controllers

Input: free-space 3D devices

Output: Mono x Stereo displays

auto stereoscopic, glasses, HMD (head mounted displays)





Output: display issues

- AR glasses for user with glasses
- heavy frames and thick lenses
- Small field of view, small resolution displays
- 3D graphics hardware is more expensive
  - 3D text is significantly less readable due to perspective distortion, aliasing (blurring), and limited pixel resolution
- Therefore: less information density in 3D!

3D UI

HUMAN ISSUES

We live in a 3D world but…

We are not used to full 3D
- astronauts, divers, fight pilots, …
  . requires extensive training

No “natural” mapping for full 3D rotations
- except bimanual operation
  . needs tracking of hands and fingers
    - with high precision and haptic feedback

human issues

- People interact with visible objects
  . strong preference
- Limited depth perception

- Navigation
  . 3D spatial memory not much better than 2D
  . Easier/faster to teleport/search
    . Google Earth

human issues

- Latency / lag
  . Latency is detrimental on performance
    . Jitter in latency is much worse
  . Noise is not good either
    . Smoothing introduces latency

- User interface mappings
  . UI very often just a thin layer above math
    . e.g.: handles, wireframe, ortho view, etc.
  . Most humans don’t understand these easily

how to fix?

- User studies
  - . observe novices
    - . no bias!
- Use know results from
  - . Perception (stereo, hand-eye coord., …)
  - . Kinesiology (study of body movement)
  - . AR/VR research
  - . 2D UI
  - . 3D games

3D UI

GUIDELINES

Objectives

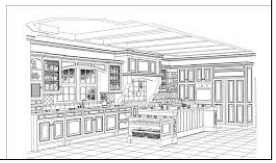
- present a list of guidelines for good 3D user interfaces
- help for designers
  - . some well known in various communities
    - . add theoretical/experimental underpinning
  - . directions for future work

Guidelines: objects

1. contact assumption
   - . floating objects exception in real world
     - . but often default in 3D UI's
     - . training is required to deal with floating objs
2. objects should not interpenetrate each other
   - . confusing visual display, can't manipulate, …
     - . real-time collision avoidance easy
     - . enables also sliding contact

guidelines: select & display

3. interact only with visible objects
    . users navigate for occluded objects
        . 2D view manifold
            . ray-casting [Bowman99]
                - 3D selection with 2D devices
4. Perspective and occlusion are the strongest depth cues [Wickens & Hollands, 2000]
    . with no floating objects, these 2 are sufficient to judge 3D position
        . stereo is not really necessary!



guidelines: position & rotate

5. show entire area of visual overlap for object positioning
    . not only “cursor" position
    . area based techniques are better
        . perceptual evidence
6. full 3D rotations not always required
    . objects in contact are constrained
        . simpler UI

guidelines: input & cognition

7. 2D devices are more precise/less latency than 3D/6D
    . resolution 10-100 times better
    . latency 40-50 ms more than mouse
    . latency and jitter matter a lot [theater]
        . surprisingly, effect of hand support is less important
8. 2D/2.5 D tasks cognitively simpler than 3D
    . almost all real world tasks are 2D or 2.5D

guidelines: general & navigation

9. simulate reality only if necessary
    . bad if objects fall down and roll under table
    . “stacks" are important
        . manipulate base obj for whole stack

10. navigation is rarely 6 DOF
    . walking = 2.5 + 2 DOF -> 0.5 is jump/crouch
    . flying = 2 + 2 DOF -> inertia makes it simpler
    . full 6 DOF only with training!

summary: two ‘worlds'

2D & constrained 3D

. most human tasks

. lots of experience

. common in AR/VR

. polygonal models

. UI can be simplified

. easy to use

“full" 3D

. few human tasks

. training required!

. challenge for VR

. volumetric models

. needs complex UI

. training required

Conclusions

Choose right approach for domain

. e.g. personal interaction panel x gloves

Goal: 3D UI’s close to 2D performance

. similar ease-of-use, ease-of-learning

. will greatly enhance adoption of 3D UI’s