Maximizing User Comfort & Immersion

A game designers guide to 3D displays

Jens Ogniewski
Information Coding Group
Linköpings University

LiU expanding reality

Background / Motivation

Est. 1982

Background / Motivation

- In recent months, several 3D display have been introduced to the mass-market (NVIDIA 3D Vision, Playstation 3D, Nintendo 3DS, 3D capable Android phones, ...)
- Gimmick or not?
  - Examples show that hardware is ready

=> It is up to the game designer to use their full potential!

- 3D-display not about gameplay, but immersion
- Main tasks: Heighten comfort and immersion
- Not always contradicting goals

Display systems

- Many different systems exist, here we will concentrate on:
  - Glass-based systems
  - Autostereoscopic displays
- Similar limitations
- All devices available on the consumer market fall in this categories

Display systems (glass-based)

- Shutter glasses: time multiplex
- Needs synchronization with display system
- expensive glasses due to synchronization logic, glasses battery powered
- due to “black period” for each eye: flicker (if displayrate is too low) possible
- Display comparable cheap, partly compatible to existing solutions

Display systems (glass-based)

- Polarized-glasses-based systems
- Use (circular) polarization filter to separate the two views
- Cheap glasses, but more expensive display
  - Display needs twice the resolution of each view

Display systems (autostereoscopic)

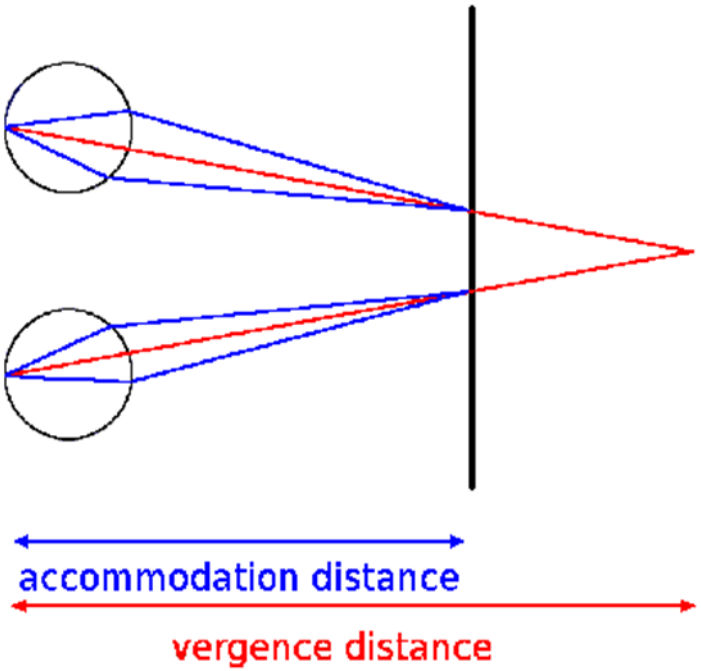
- Optical elements (lenticules, lenses) direct light in different directions
- No glasses needed
- But beholder needs to sit in sweetspot
- Displays need (at least) twice the resolution of the views

Display systems

- All displays: crosstalk
  - Light leakage between the views
  - Shutter-glasses: switching speed of display, bad synchronization
  - Polarized-glasses: manufacturing accuracy, light leakage of the LEDs
  - Autostereoscopic display: if not exactly in sweetspot, light leakage of the LEDs
- All displays: illumination reduction
  - Shutter-glasses: black period
  - Polarized-glasses: optical filter; but is included in most LEDs display anyway
- Trade-off illumination vs. crosstalk

Eyestrain

- Basically: Overexertion of the visual system
  - Can happen with any kind of monitor, but...
- Stereoscopic displays especially prone for it
  - Due to vergence / accomodation conflict



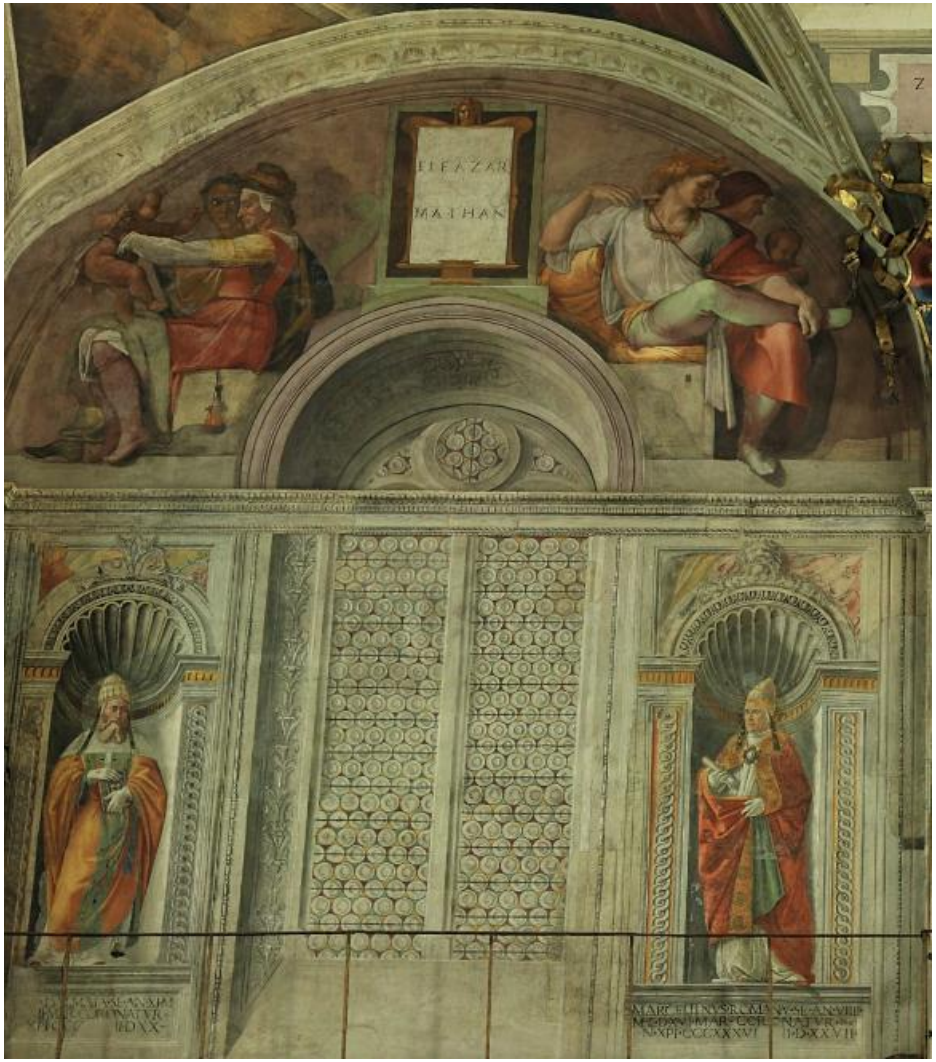
General rules

- Make it as easy for the eyes as possible
- Keep the scene as simple (in terms of number of object, depth variation, motion etc.) as possible
- Keep the scene as realistic (especially concerning the depths as well as artifacts) as possible
- Give the user the possibility to control the 3D effect, and to turn it off
- Don’t overdo it!
  - Don’t heighten depth effect artificially, don’t place objects too far behind / in front of the screen

Comfort rules

- Keep scene inside the comfort area
- Make focusing easier (especially don't make it harder by e.g. using focus blur)
- Avoid dark scenes, since most 3D displays have only limited illumination
- Avoid fast motions, especially in depth, since they heighten eye strain

Depth cues

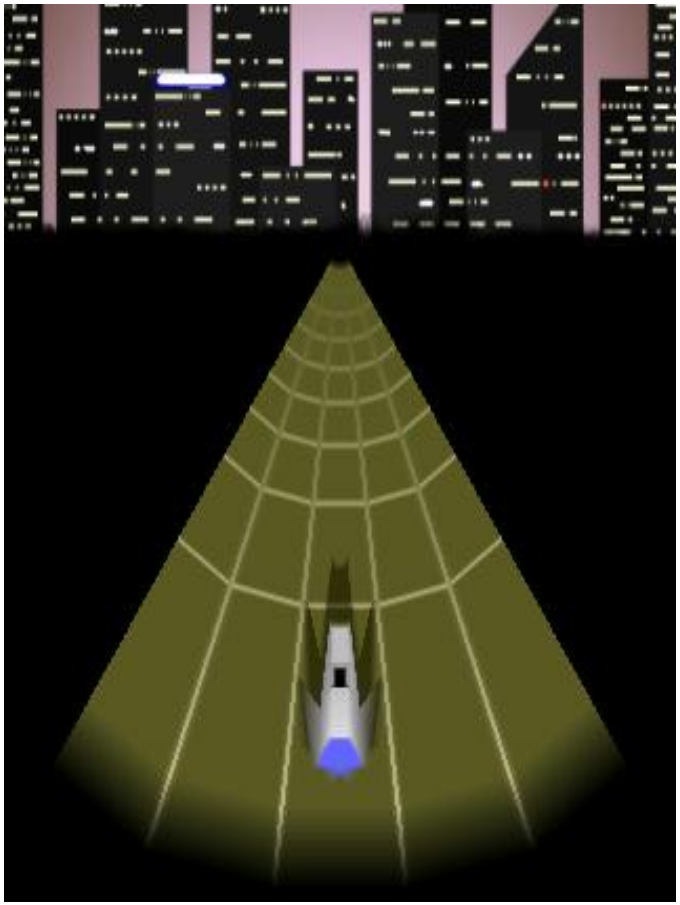


Depth cues

- Used by artists for centuries
- Basically all means that heightens depth perception of a picture, video etc.
- Most important ones for our purposes:
  - **Stereoscopy**
  - Occlusion
  - Shadows
  - Distance blur
  - Motion parallax (more on that later)
- Avoid contradicting depth cues!
- But: correct depth cues can make it easier for the eyes of the beholder

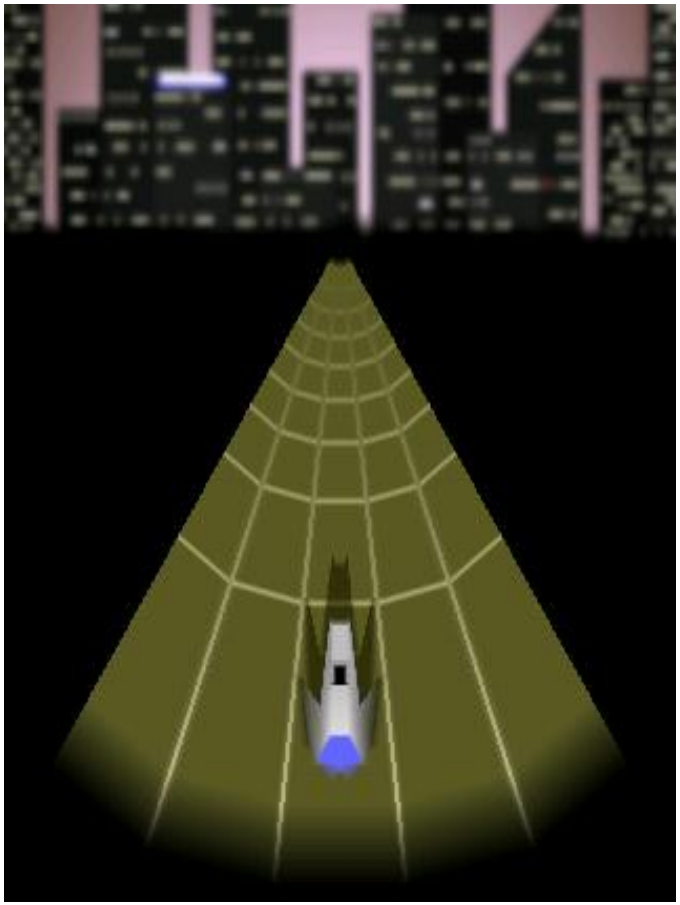
Depth cues

- Example:



Depth cues

- Example:



Motion parallax

- The effect of changing the perspective of a scene according to the movement of its beholder
- Related: Parallax Scrolling (since 1982)

Motion parallax

- The effect of changing the perspective of a scene according to the movement of its beholder
- Especially important for objects far away from the beholder
- Can be used solely to construct 3D displays
- Can be introduced via user tracking
  - Gyroscope
  - Visual head-/eye-tracking

In front / behind the screen?

- Objects in front of the screen more eyecatching
- But experience indicates that objects in front of the screen are more straining
- Wandering off problem

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In front / behind the screen?

- If display is used as input device:
  - Input elements should be placed on the screen (i.e. not above or below)
  - Otherwise confusing, lessens immersion
  - Should not be occluded
  - But no false occlusion either => objects have to be placed behind the screen

In front / behind the screen?

- Suggestion: place objects behind the screen
- Place in front of screen for shock effects
  - Higher effect if used sparsely
  - Place objects which are in front in the middle to avoid “wandering off” problem
  - Example: Pole truncating windshield after car crash

Technical Aspects

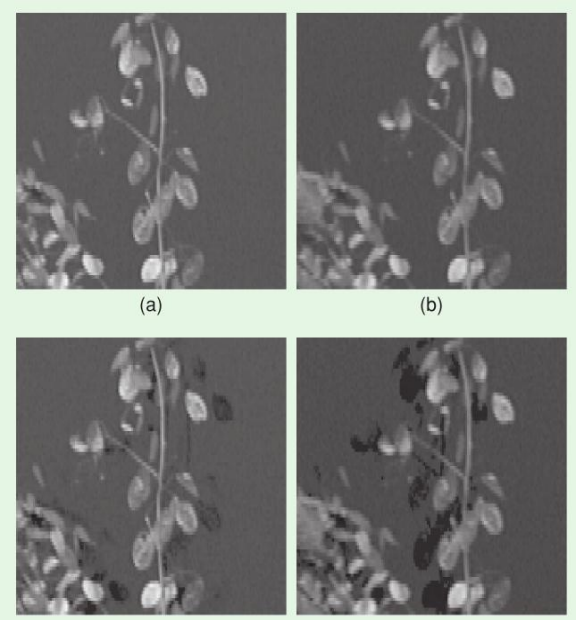
- Autostereoscopic displays: need to sit in sweet spot
  - Display with user-tracking exists, move either the optical element or the screen itself
  - Instead possible: use user tracking, adjust which pixel should be seen by which eye accordingly, best even the different color channels of the pixels (since they are produced with different diodes)
  - Can also be used to introduce motion parallax
  - Also beware of using a gyro attached to an autostereoscopic display as input device

Technical Aspects

- Use Anti-Aliasing
  - Alias especially confusing if different for each eye
  - Distance blur might help, since many alias effects are introduced by fine structures far away from the users
  - Pixel-mask from autostereoscopic displays may introduce alias effects (since irregular masks are used in most cases)
  - Anti-alias step and the blending of the two images in autostereoscopic and polarized-glasses-based displays can be combined

Technical Aspects

- Deal with ghosting” (i.e. pixels that are seen by the wrong eye, visible crosstalk artifacts)
  - Avoid high contrast in neighboring pixels
  - Calculate “antighosts” if possible



  - Need to know display parameter
  - Not possible for all ghosts

Technical Aspects

- Graphic programming:
- Beware of algorithms that “cheat depth”
- Avoid billboards
  - Billboard clouds can work
- Be carefull with 2D effects
  - HDR effects like blooming
  - Particle effects
  - Bump mapping
- Skyboxes: place as far in the distance as possible
  - Again, distance blur might help
- Use realistic geometry as much as possible

Conclusion

- Make the most of 3D displays!
- Ease the strain on the eyes wherever possible
- Heighten perceived depth wherever possible (by using correct depth cues etc.)
- Learn from the video community (which has much more articles on user comfort and 3D displays)
- Find out which 2D techniques work in 3D and which not
- Not all games are suitable for 3D, others may profit from it (other than by a higher immersion)

Questions?


Thank you very much!
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