CSE 190: Virtual Reality Technologies

LECTURE #5: DISPLAYING 3D IMAGES

Announcements

Homework project 1 due this Sunday, April 19th at 11:59pm

Relaxed requirements for app presentation: any VR headset is allowed (not just smartphone compatible apps)

Next Monday: Discussion homework project 2

Today's App Presentation

Jason Wang: Half-Life: Alyx

- https://store.steampowered.com/app/546560/HalfLife_Alyx/

Stereo Imaging: Concept

General concept: each eye sees a slightly different image

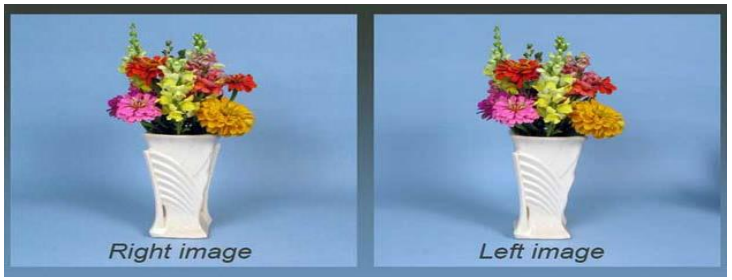
Example: Viewmaster

- Slide reels with 7 image pairs

Stereo Imaging: Side-by-Side

Stereo can be seen by fusing images: converge eyes in front or behind the actual image plane

Eyes converge behind image plane

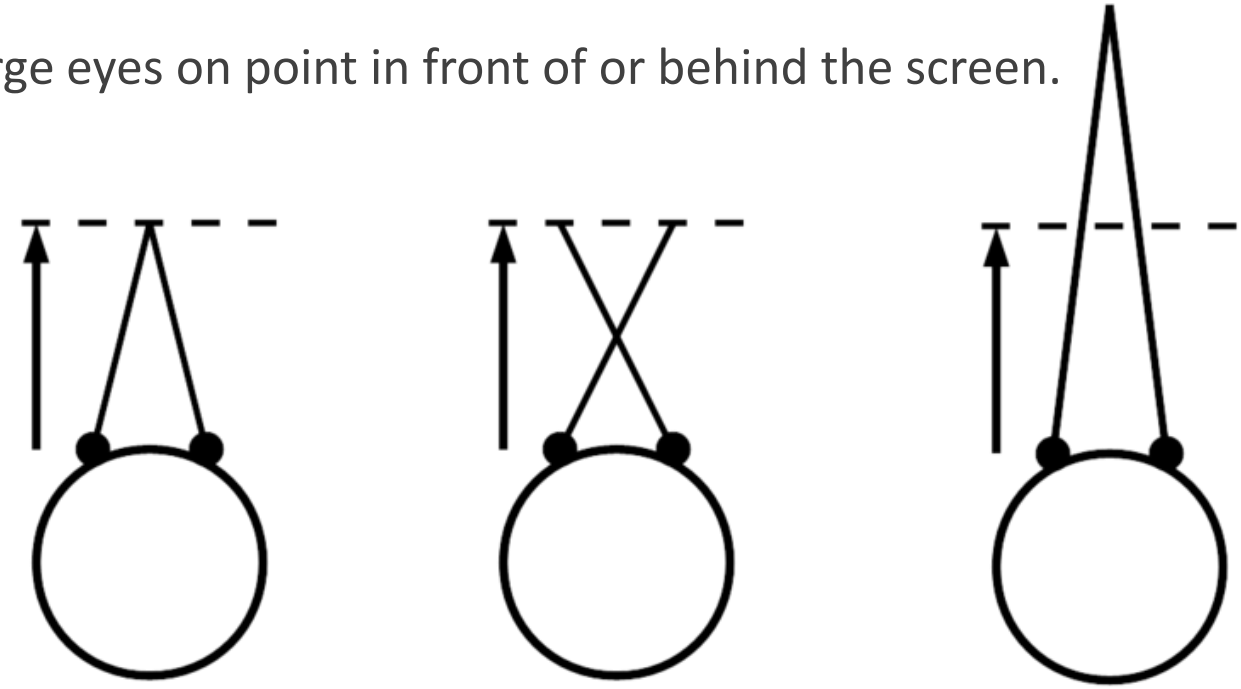


Eyes converge in front of image plane

Single Image Stereogram (SIS)

No glasses required

Converge eyes on point in front of or behind the screen.

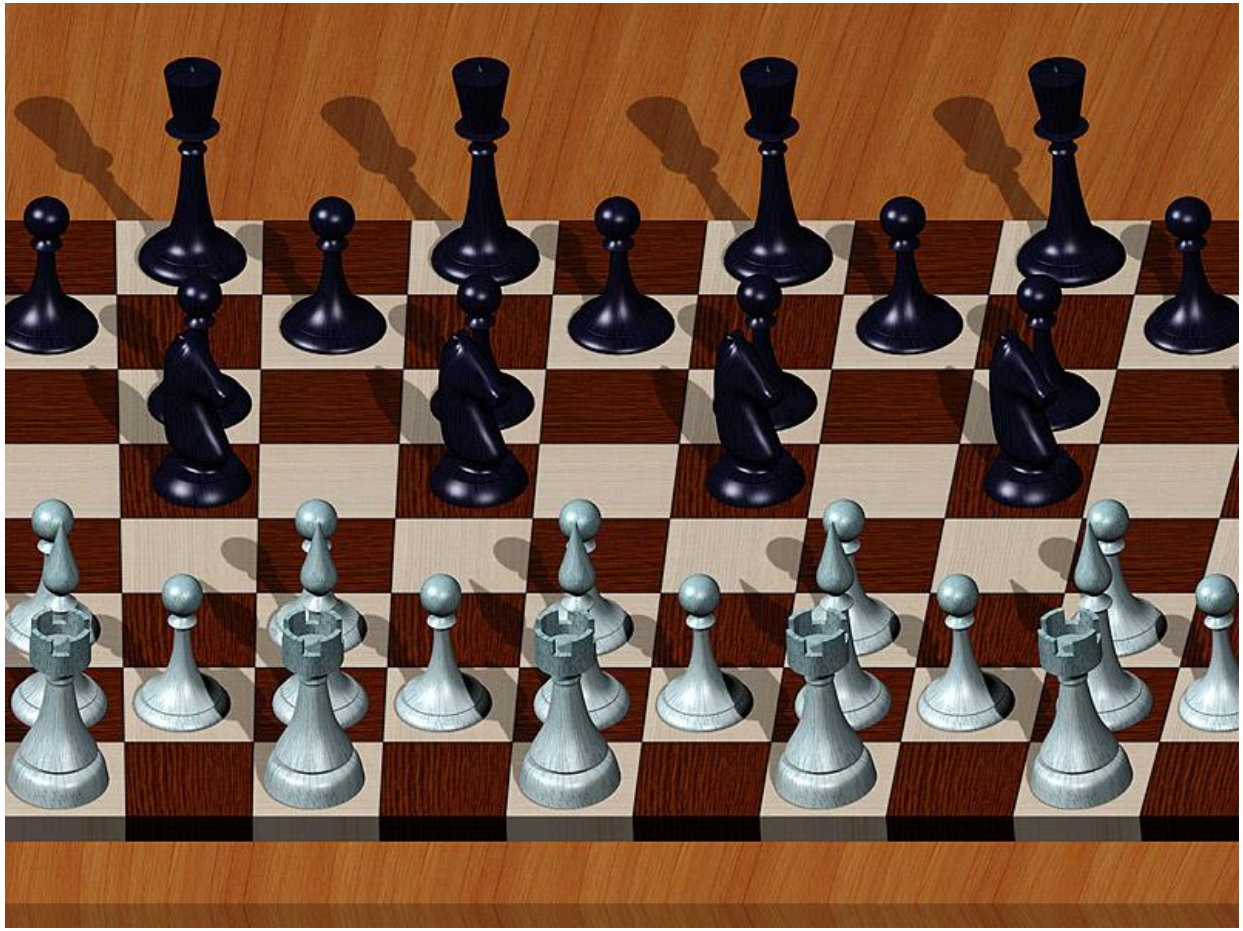


Aligned vergence and accommodation (normal viewing)

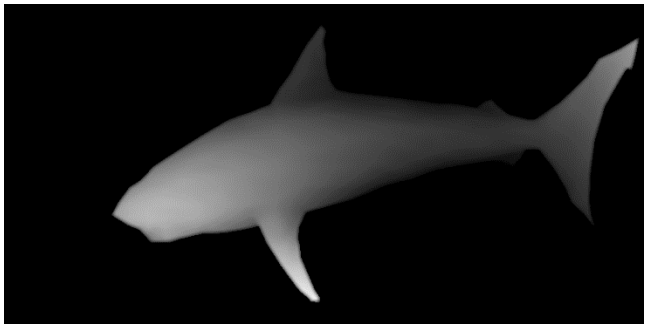
Cross-eyed vergence.
Arrow: accommodation

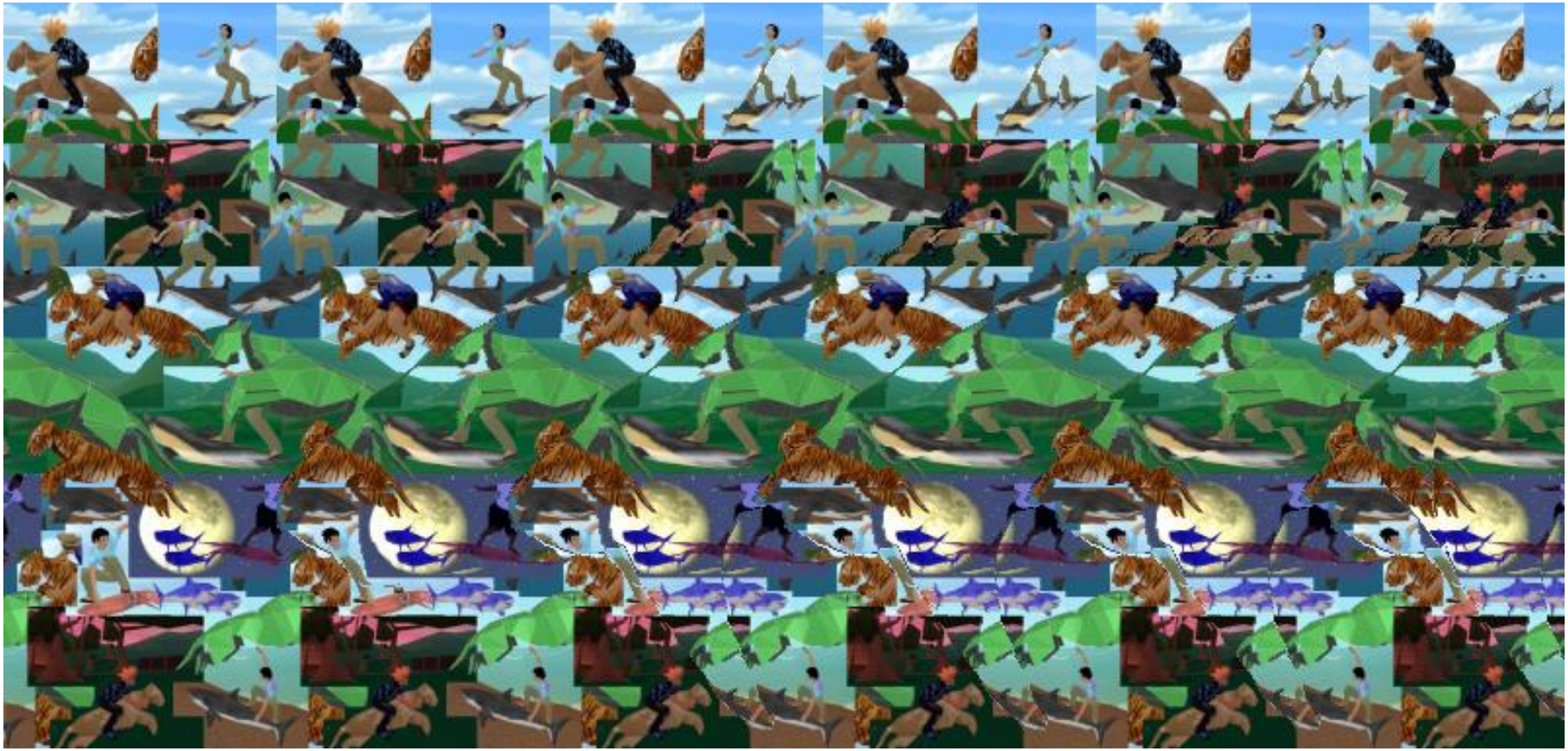
Wall-eyed convergence

SIS: Chessboard



SIS: Shark





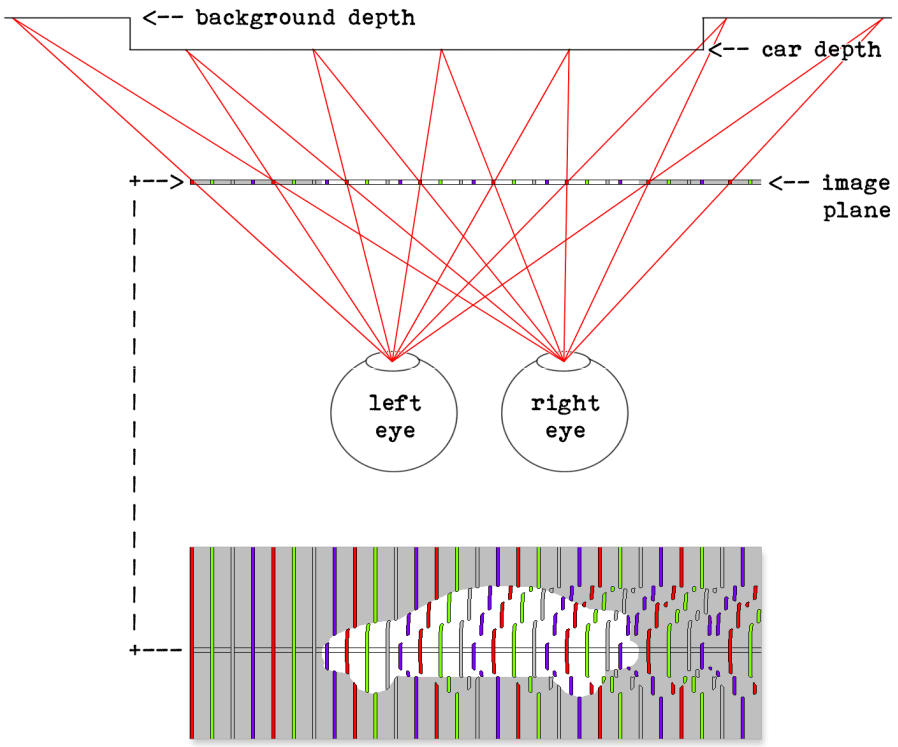

Stereogram by 3Dimka

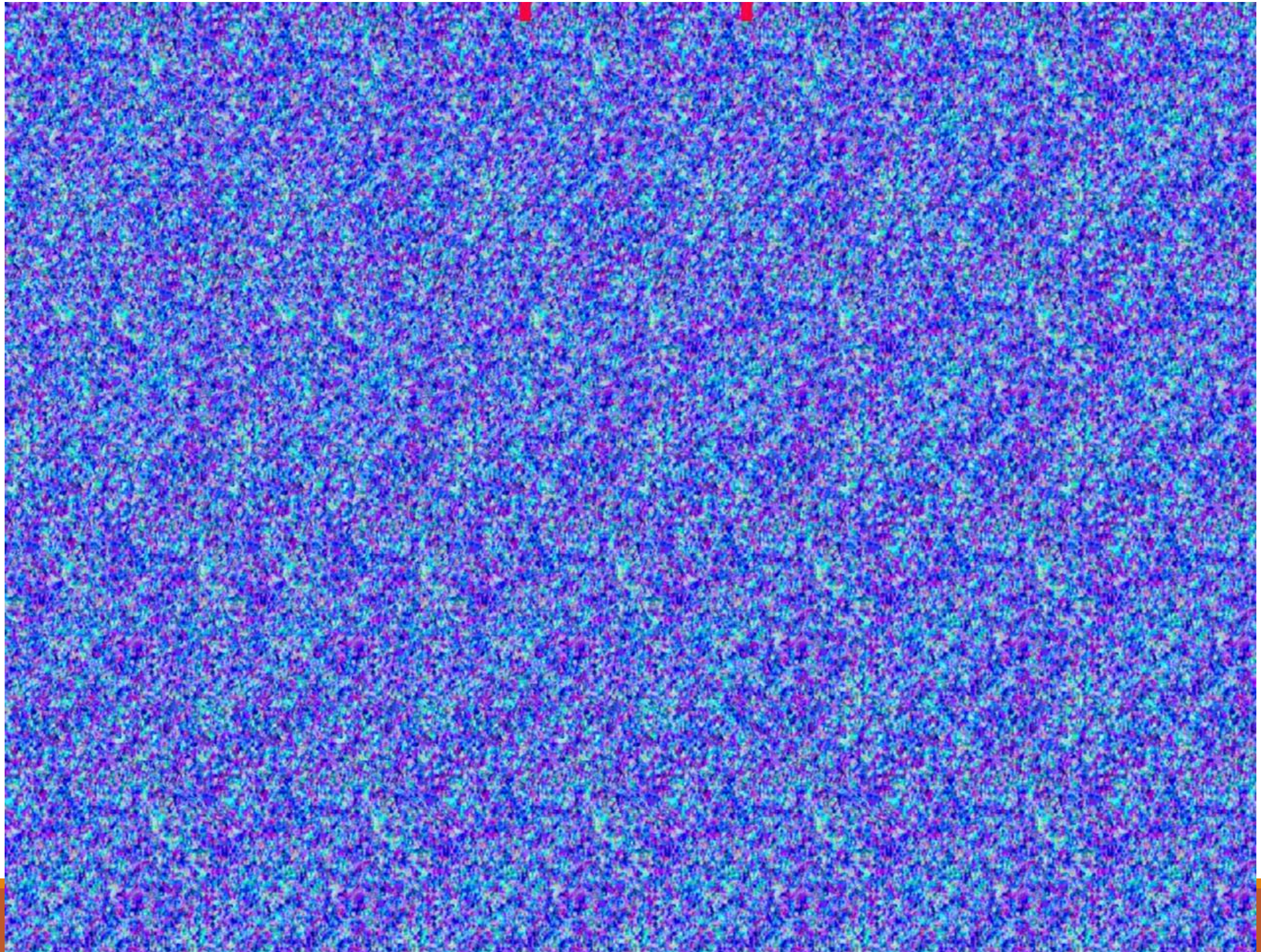
SIRDS:
Single Image Random Dot Stereogram

A SIRDS encodes a 3D scene into an image in such a way that both eyes look at slightly distorted copies of the same (noisy) pattern.

The distortion of these copies is specifically crafted to encode the depth of each pixel in a rendered virtual 3D scene.

SIRDS use random dots instead of regular patterns to hide artefacts that could distract the viewer from the illusion.





Autostereoscopic Displays

Light sent separately to each eye from a monitor

No headgear required

Can be head-tracked (dynamic) or non-tracked (static, head assumed in sweet spot)

Approaches:

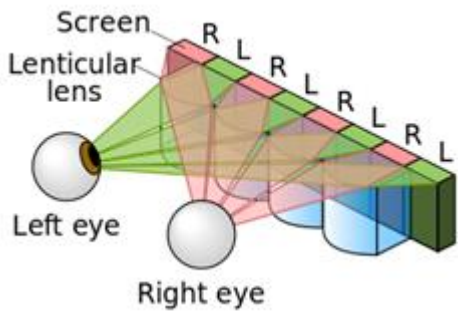
- lenticular screen
- barrier screen

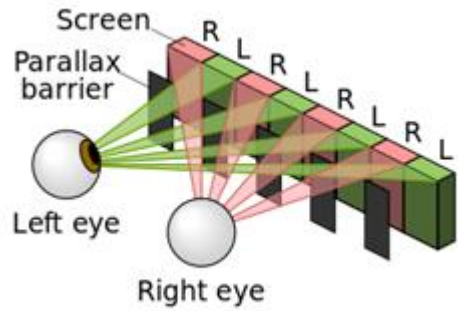
SeeReal display

Nintendo 3DS

Autostereo

Lenticular screen





Parallax barrier

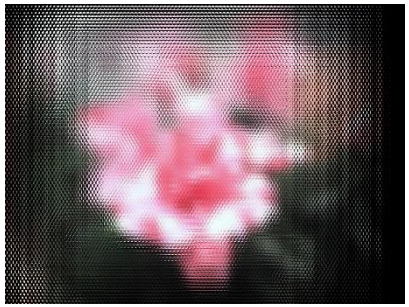
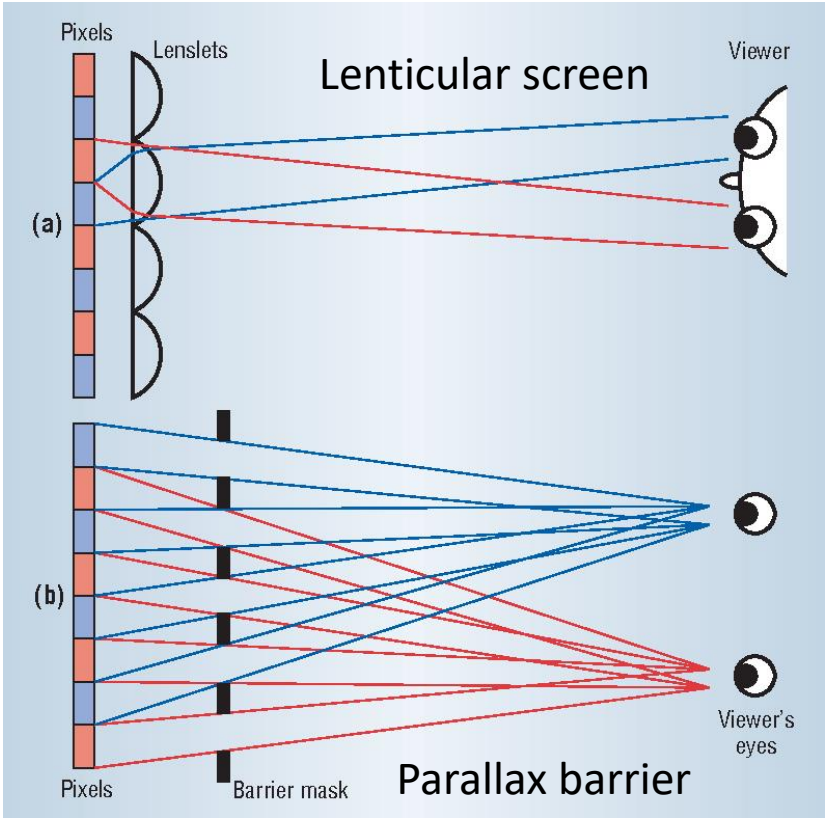


Image without autostereo filter



Stereo with 3D Glasses

Two options:

- Passive stereo: unpowered glasses with optical filters
- Active stereo: powered glasses with LCD shutters

Polarized sunglasses

Active LCD 3D Shutterglasses

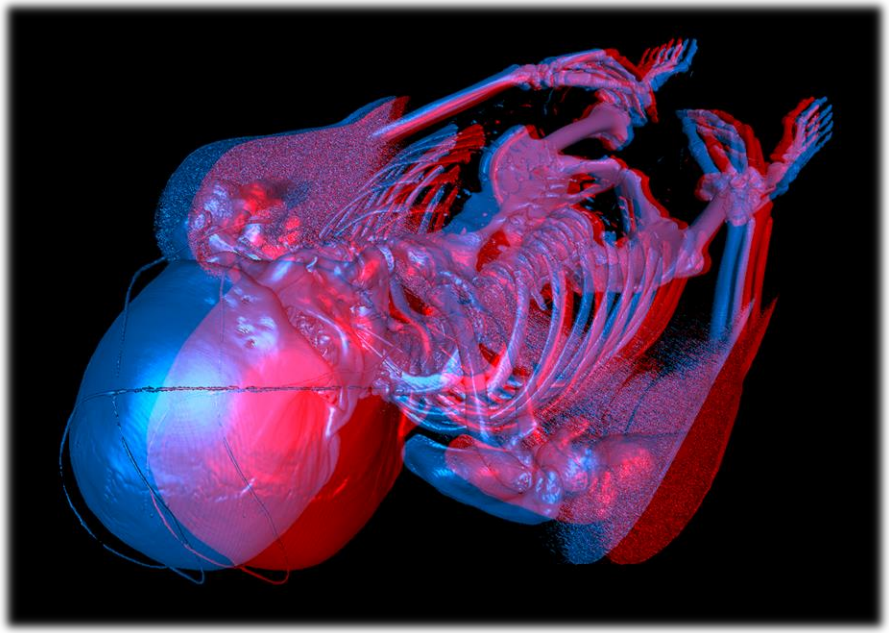
Passive Stereo in Anaglyph 3D

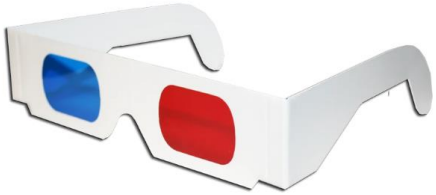
Requires anaglyph red/blue or red/green glasses

- Available in cardboard (~$0.50) or plastic (~$5)

Color is diminished (but not entirely lost)

Example below: view with which of the glasses on right?



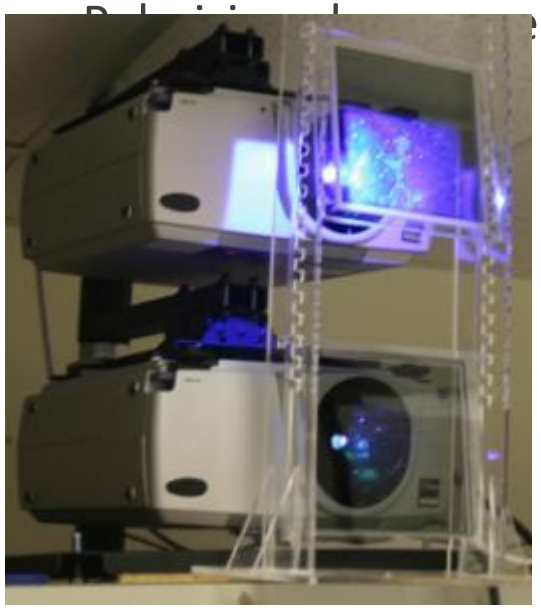


Passive Stereo with Polarized Light

Two options:

- Linear polarization
- Circular polarization: creates circularly polarized light by adding a quarter-wave plate after a linear polarizer

inexpensive (~$2-10)



Stereo projectors

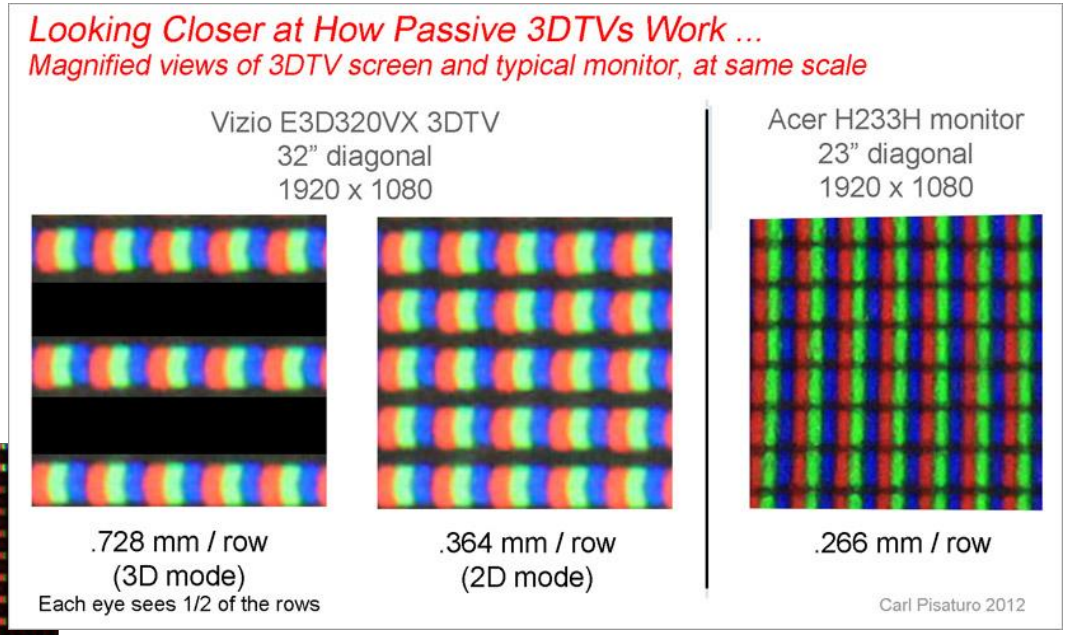
Polarizing glasses

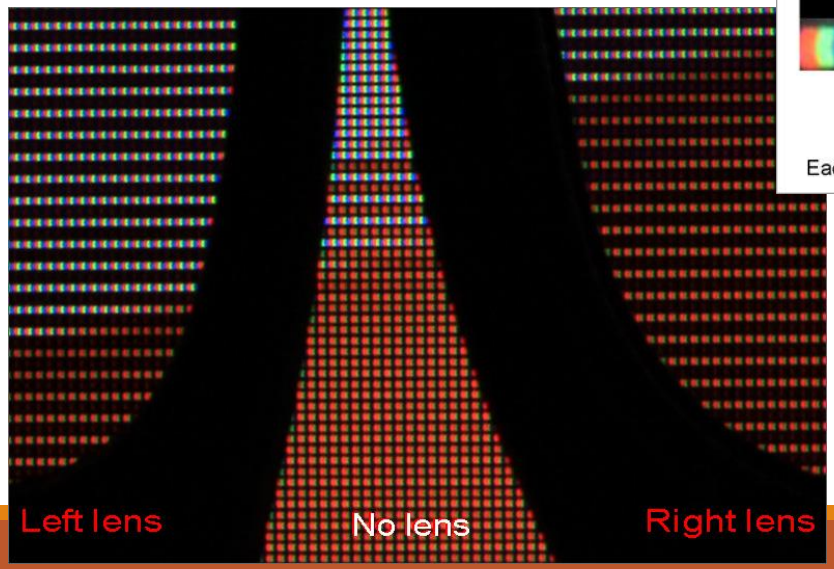
Passive Stereo Monitors

Filter on monitor polarizes alternating pixel rows clockwise/counter-clockwise

Best view point is on-axis

Off-axis viewers see ghosting



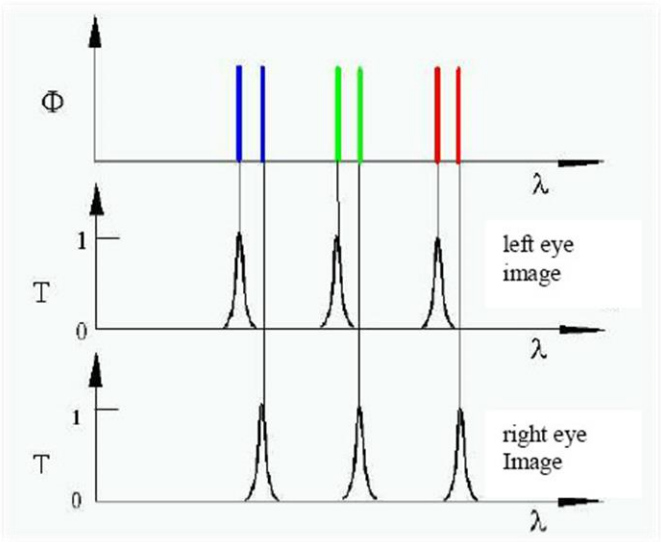


Interference Filters

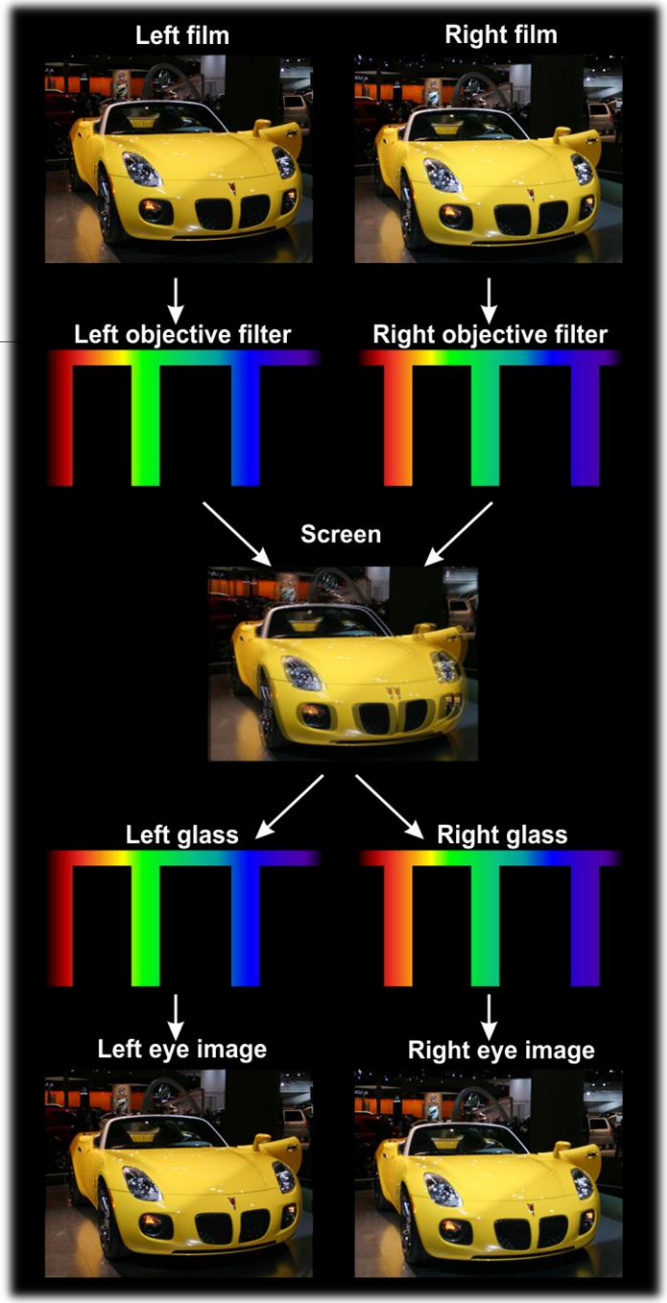
Uses specific wavelengths of red, green and blue for the right eye, and different wavelengths of red, green and blue for the left eye. Example: Dolby 3D

Dolby 3D glasses

Stereo projectors with filters



Stereo projectors with filters



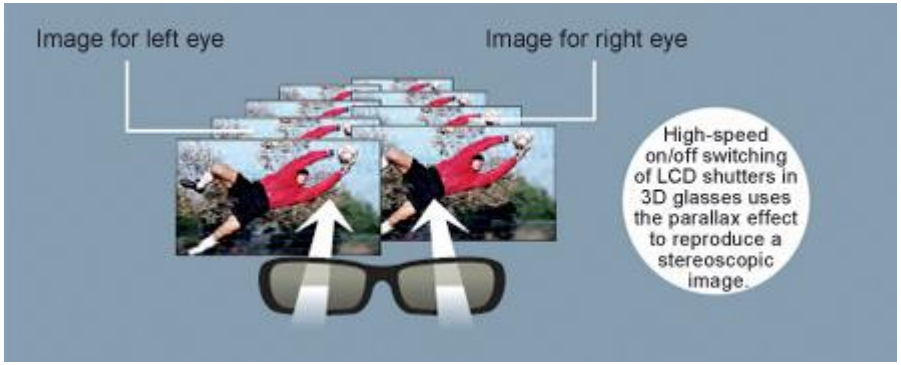
Active Stereo with Shutter Glasses

Display alternates between images for left and right eyes at 120+ Hz

Shutter glasses:

- synchronized to display refresh rate
- more expensive than passive glasses (~$30+)
- require batteries

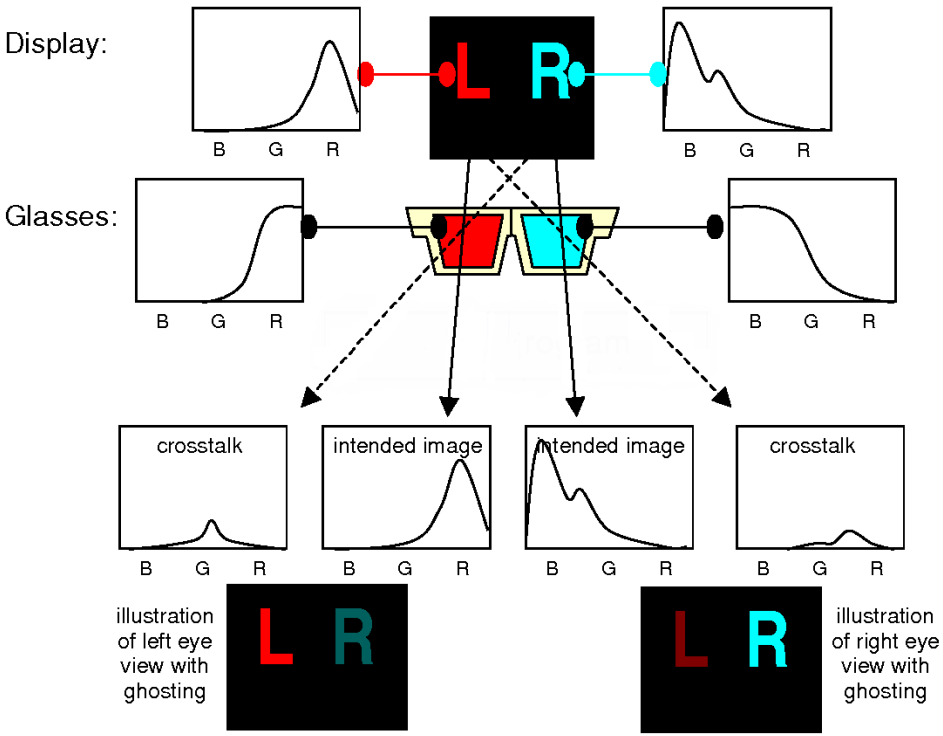
3D shutter glasses



3D Crosstalk – Ghosting

Ghosting is when a **secondary** "ghost" image can be seen along with the primary image.

On stereo displays, the ghost image is the image displayed for the other eye, visible because of **insufficient filtering** by the stereo glasses.



Example: ghosting with anaglyph 3D

Ghosting

Which 3D stereo techniques are prone to ghosting?

Ghosting

Which 3D stereo techniques are prone to ghosting?

All filter-based techniques:

- Autostereo displays
- Anaglyph 3D
- Passive stereo
- Interference filters
- Active stereo

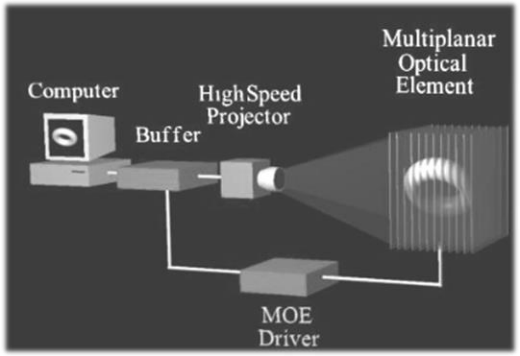
Volumetric Displays

Display a true 3D image

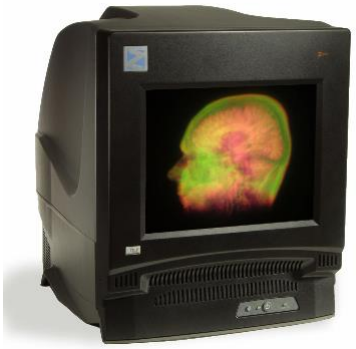
- Looks correct for multiple users
- Each user has correct perspective

Techniques:

- Rotating projected screen
- Rotating LED arrays
- Multi-layered projected screen



https://www.youtube.com/watch?v=4N31Wfi3hdk&feature=emb_rel_end



DepthCube: 20 layers

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

Separate Displays for Each Eye

Stereo created by showing physically separated displays to each eye.

Requires head-worn 3D display

Examples:

- Viewmaster
- Gaming VR headsets
- Google Cardboard
- AR headsets

3D headsets with physically separated displays