



CS 563 Advanced Topics in Computer Graphics Stereoscopy

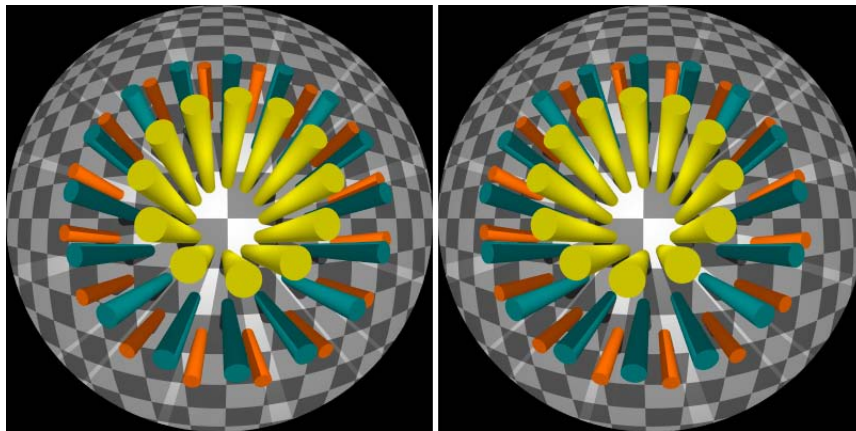
by Sam Song

- Introduction
- Parallax
- Camera
- Displaying and Viewing
- Results

- Stereoscopy
 - What is it?
 - seeing in three dimensions
 - creates the illusion of depth in images
 - What causes it?
 - Binocular disparity
 - Difference between images in left and right retinas causes stereo effect
 - What is it used for?
 - Recreational
 - 3D Movies & Games
 - Research in visualization
 - medical imaging
 - aviation simulation
 - geographical data

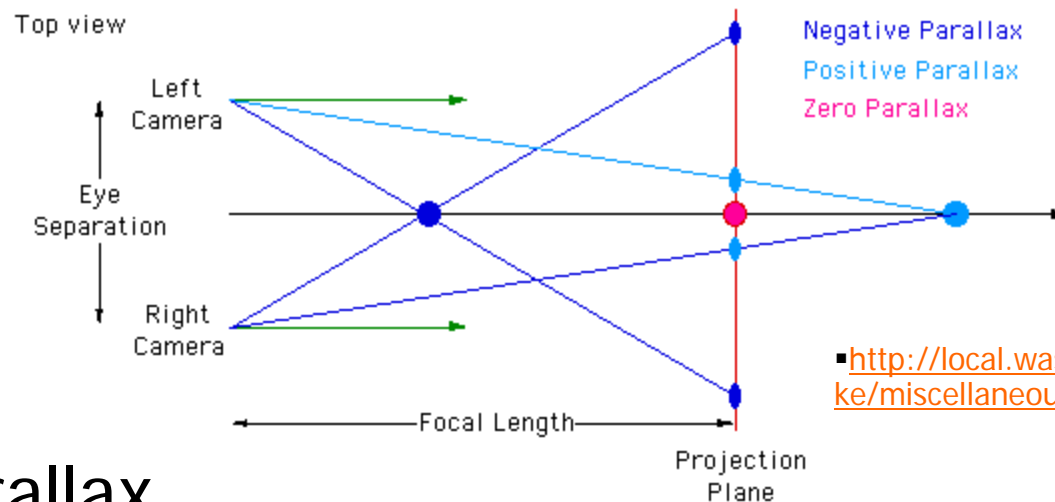
- How do we see depth?
 - Combination of Visual Clues
 - We can tolerate some inconsistency in clues
- Visual Clues
 - Binocular disparity (dominant depth cue)
 - Lighting & Shadows
 - Object occlusion
 - Perspective viewing
 - Detail
 - Size of known objects
 - Motion of objects with head movement
 - Accommodation
 - Focal length to focus at a particular depth
 - Convergence
 - Eye rotation so it is facing the focal point

- Stereo pairs



- Viewed such that our visual cortex will fuse them
- Convergence
- Binocular disparity
- No accommodation

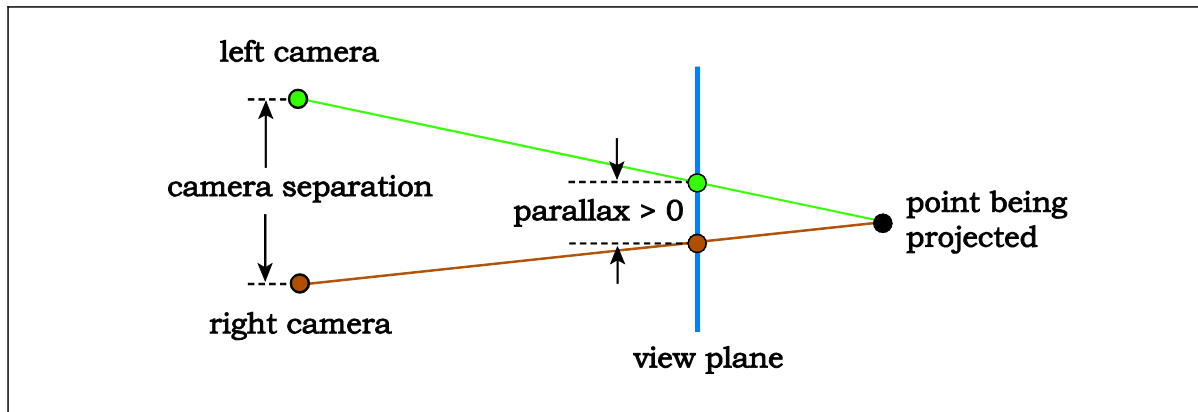
- Create Left and Right Cameras
 - Camera separation: distance between cameras



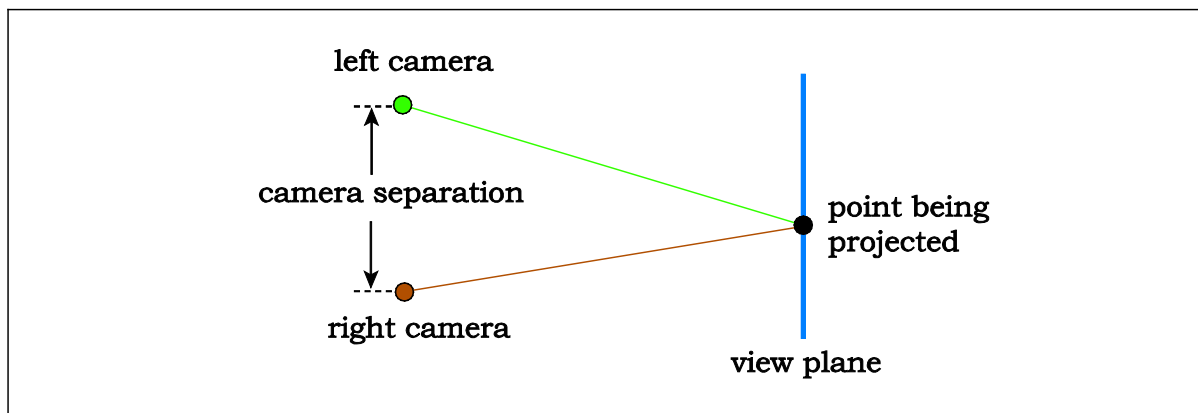
■ <http://local.wasp.uwa.edu.au/~pbourke/miscellaneous/stereographics/>

- Parallax
 - Displacement of a point being projected onto the view plane by the two cameras
 - Determines apparent distance
 - Size
 - Sign

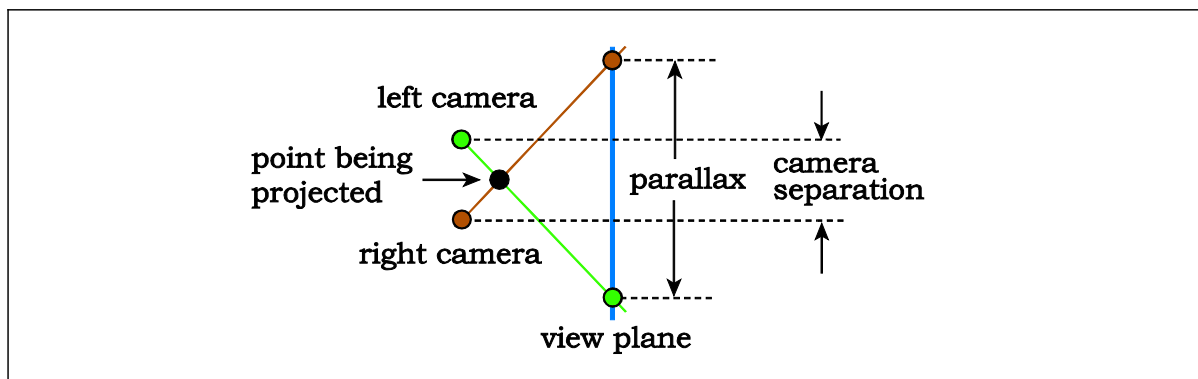
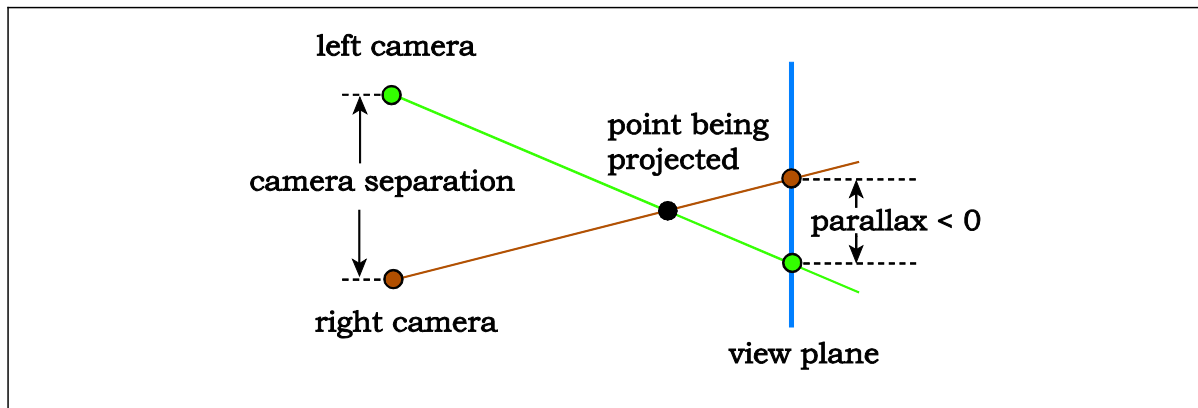
- Positive Parallax - Point behind the screen



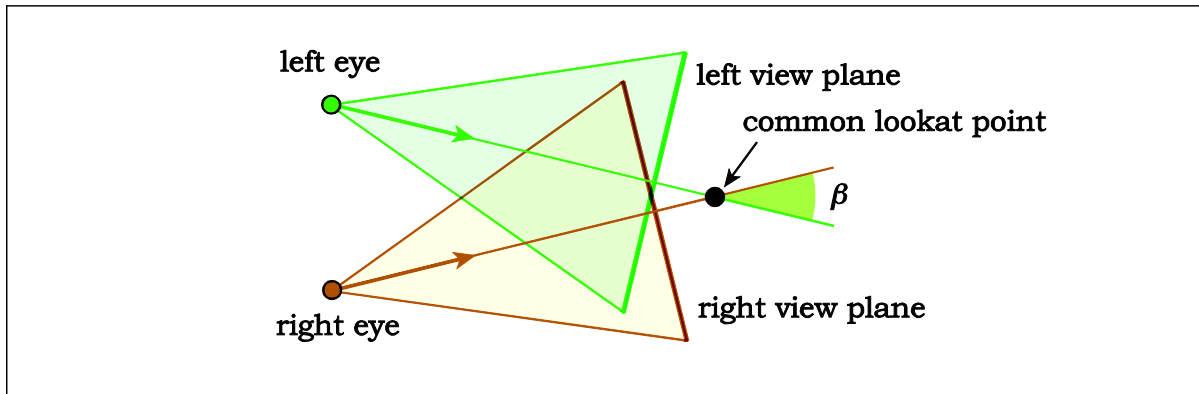
- Zero Parallax – Point on the screen



- Negative Parallax – Point in front of the screen

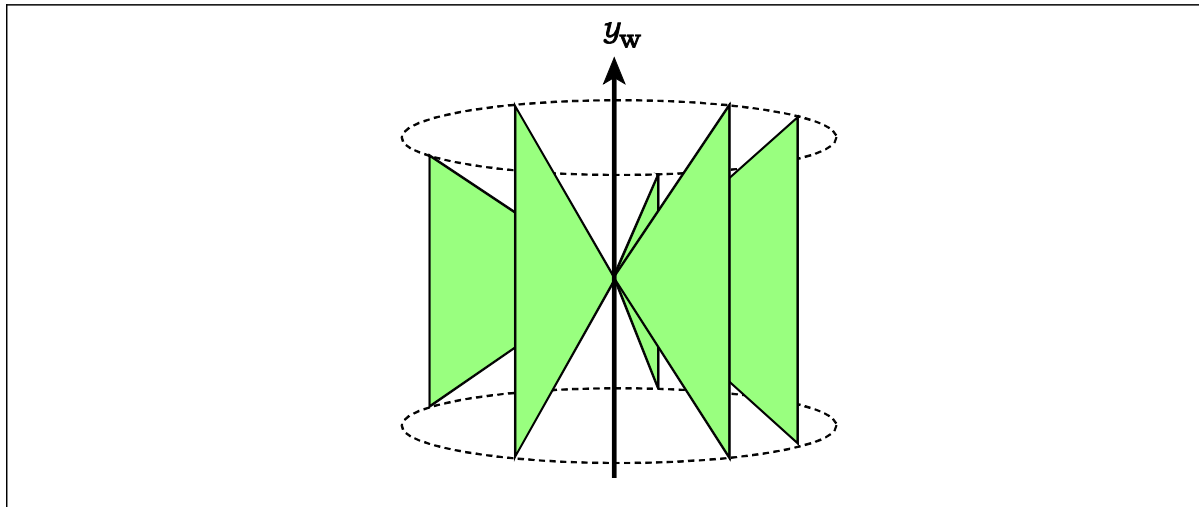


- How do we arrange the left and right cameras?
- Convergence may suggest both cameras use the same look at point
- Toe-in Camera Arrangement



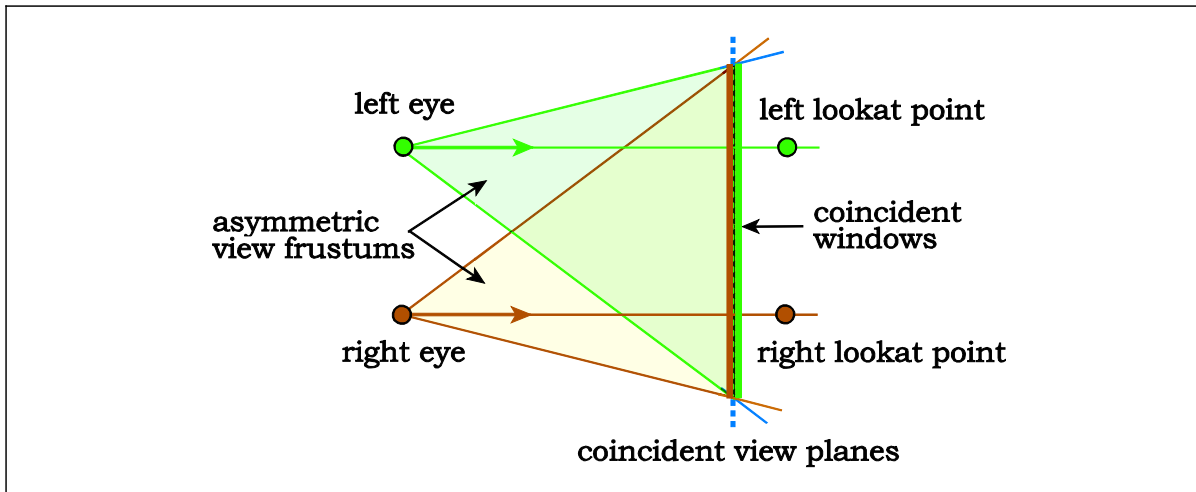
- same look at point
- different view planes
- symmetric view frustums

- How will the views of the left and right camera differ?
 - An Object centered at the look at point will be rotated by some angle β
- Vertical Parallax



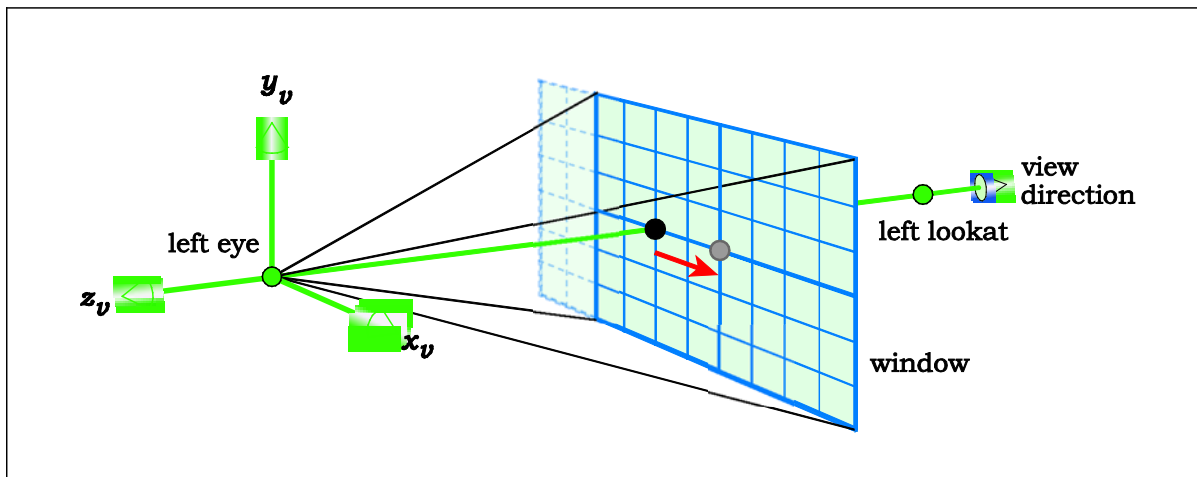
- Images with vertical parallax are more stressful to fuse

■ Parallel Camera (Off-axis)

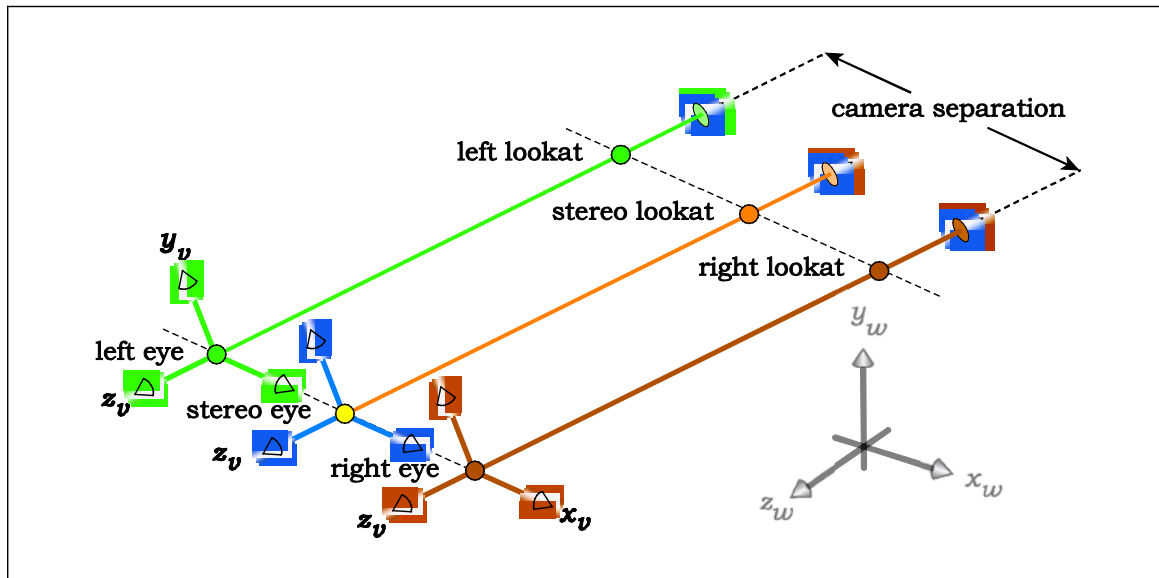


- Cameras has own look at point
- Cameras have asymmetric view frustums
- Parallel view planes
- Not supported in all rendering packages

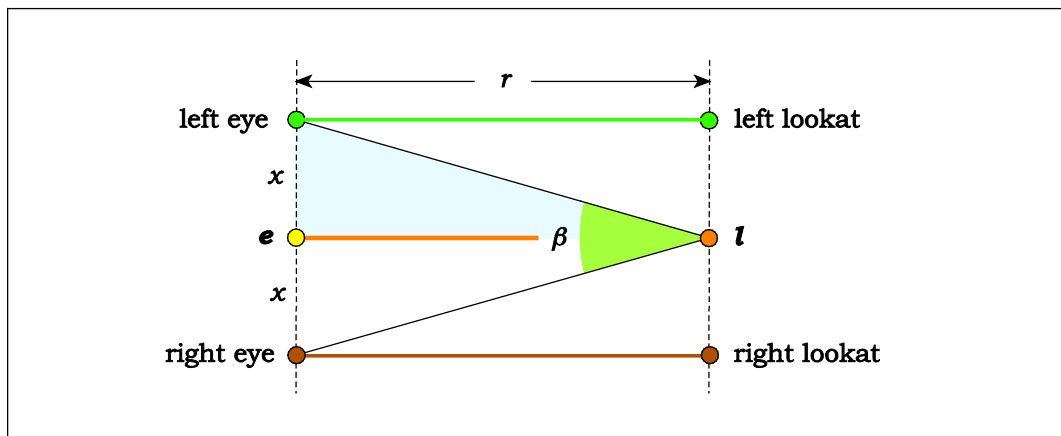
- Requires non symmetric camera frustum
- We need to change the symmetric frustum to an asymmetric function
 - Translate the window over the view plane in the x direction by half the camera separation



- Left camera - translate in positive direction
- Right camera – translate in negative direction



- $R = || e - l ||$
- $X = r \tan(\beta / 2)$



Displaying and Viewing

- Various techniques to display the correct image to each eye
 - Shutter glasses
 - Unassisted
 - Stereoscope
 - Anaglyph
- Shutter glasses
 - Glasses synchronized with computer display
 - Limited viewers

Displaying and Viewing

- Unassisted

- Side-by-side on computer screen or print
- Difficult to fuse images



- Parallel viewing vs transverse viewing

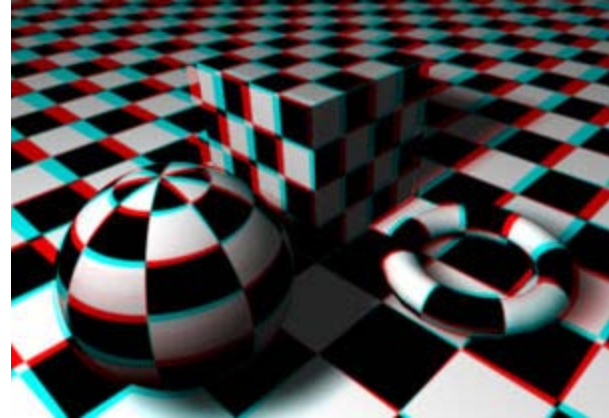
- Parallel viewing limited to 5 cm across
- Transverse no size restrictions

Displaying and Viewing

- Stereoscope
 - Uses parallel viewing
 - model determines max image size
- Anaglyph projection
 - Projectors with polarized filters
 - Viewers wear passive polarized glasses
 - Mass viewing (movie theaters)
 - Special hardware required

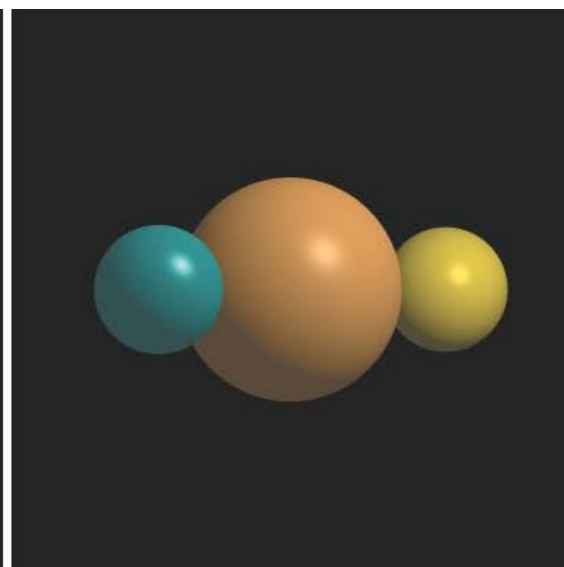
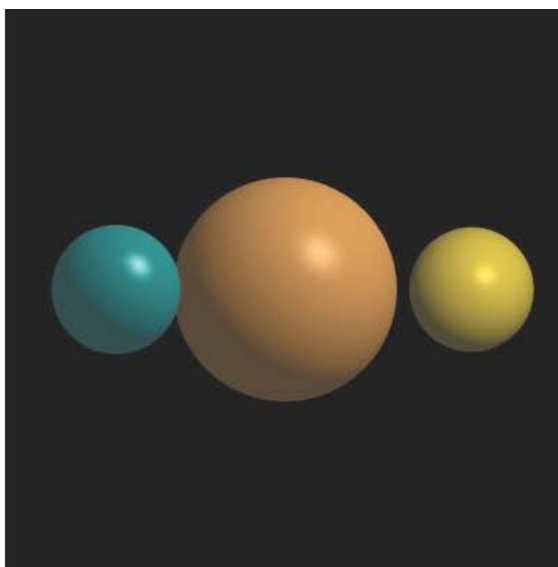
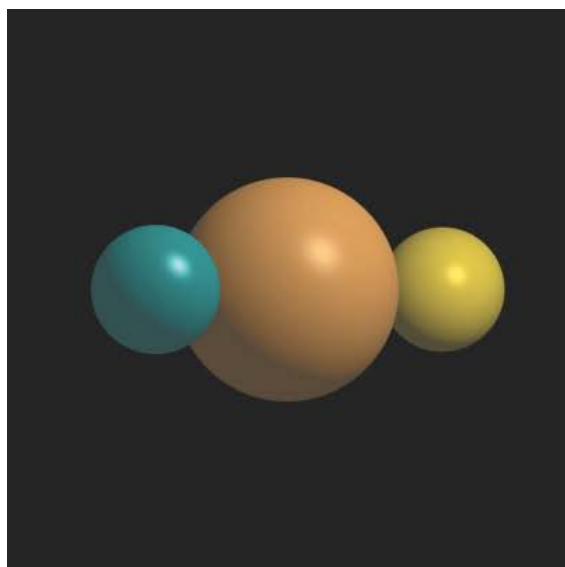
Displaying and Viewing

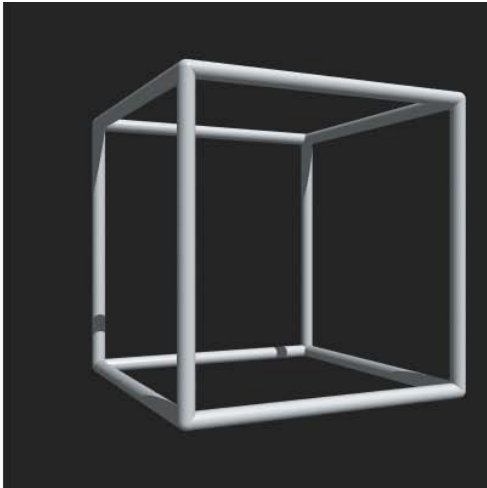
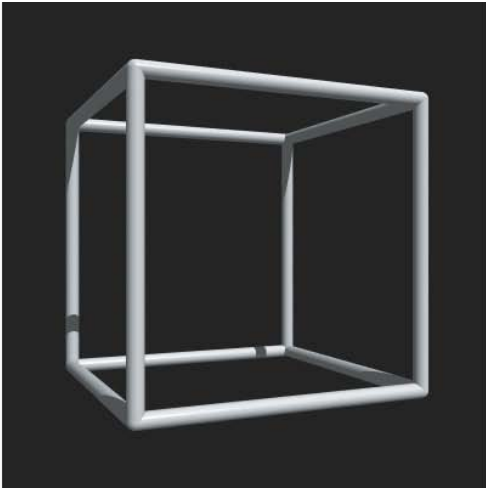
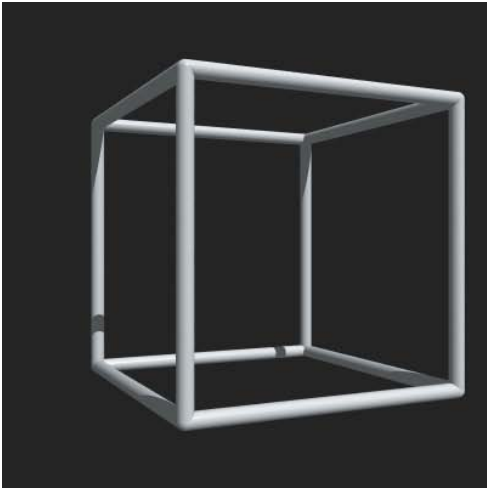
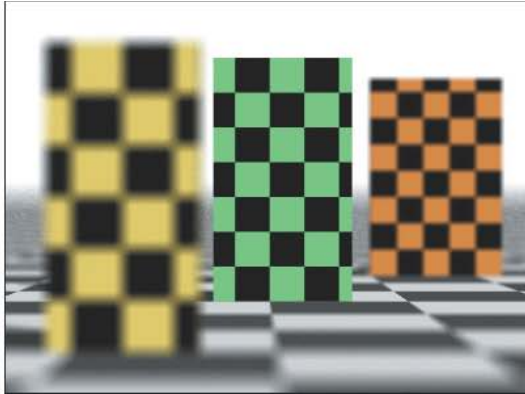
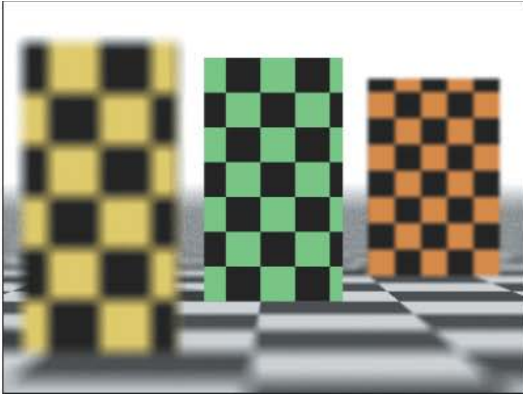
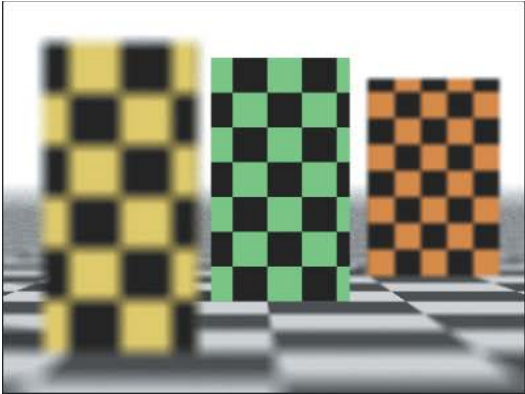
- Anaglyph images
 - Two color filtered images combined together
 - Red and Cyan
 - Images offset to create depth effect



- <http://www.captain3d.com/stereo/html/tutorial.html>

Results





Results



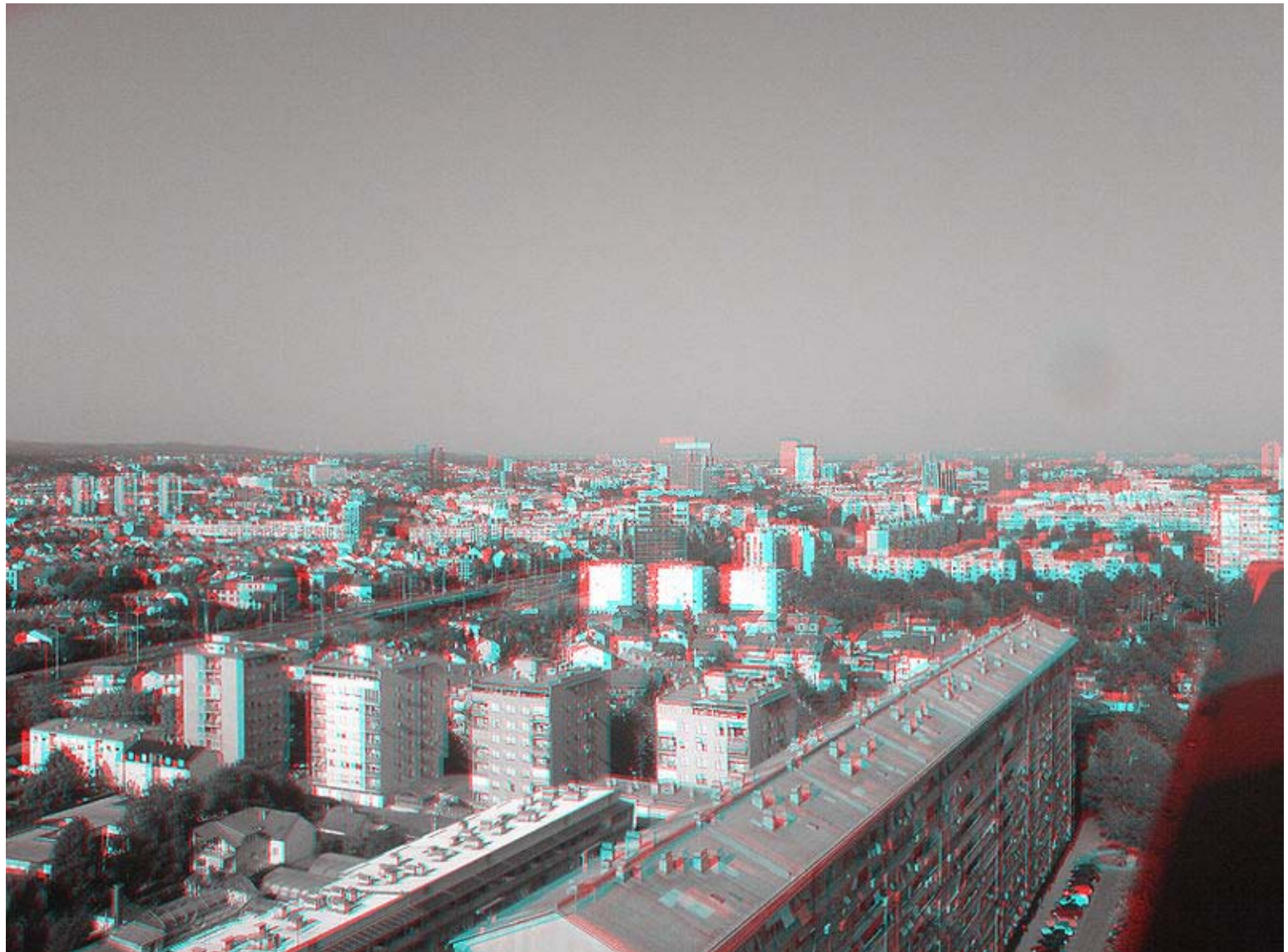
- <http://www.captain3d.com/stereo/html/tutorial.html>

Results



▪ http://upload.wikimedia.org/wikipedia/commons/d/d7/Art_Institute_of_Chicago_Lion_Statue_%28anaglyph_stereo%29.jpg

Results



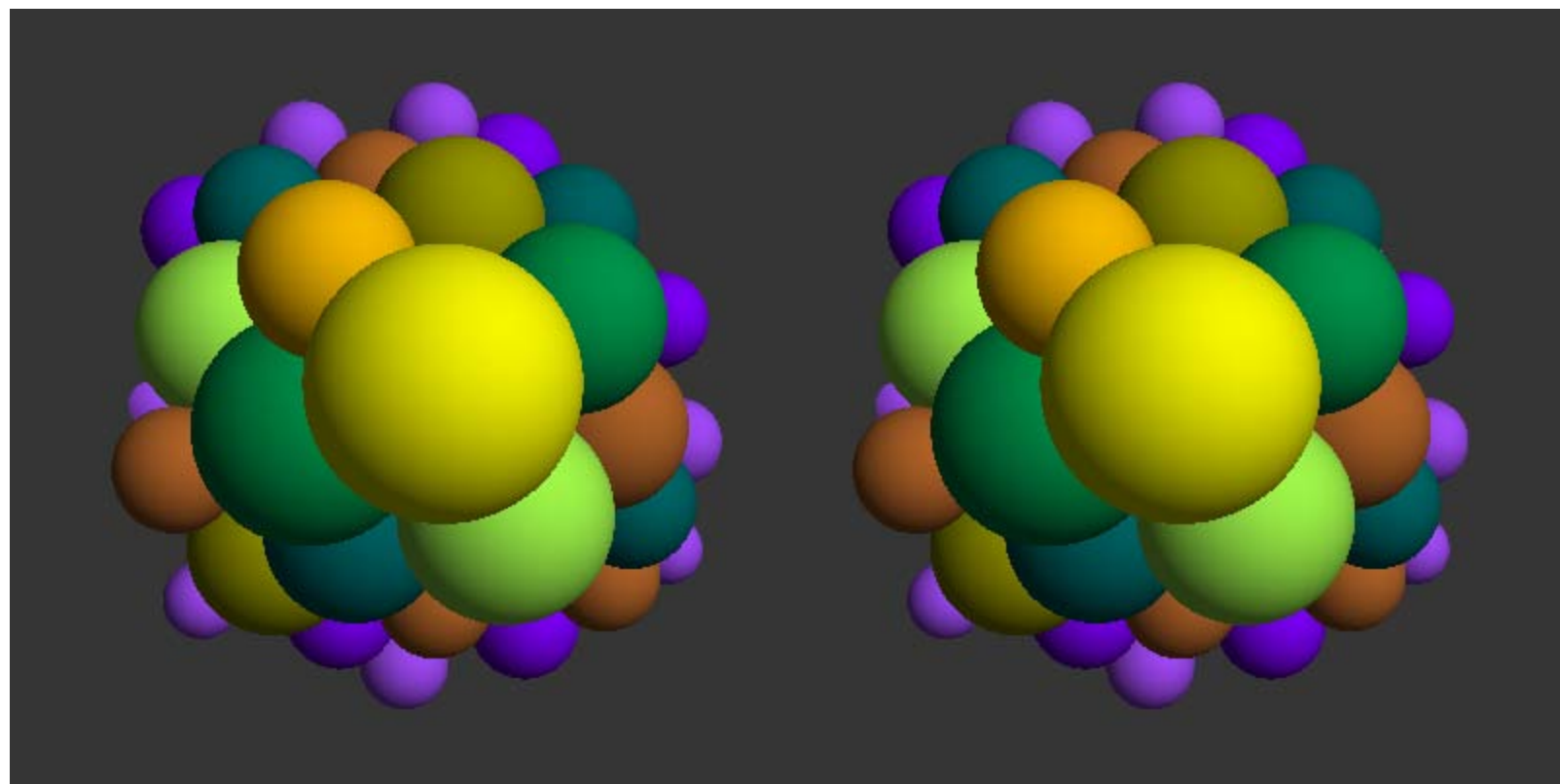
▪ <http://en.wikipedia.org/wiki/File:3D.jpg>

Results



▪ http://en.wikipedia.org/wiki/File:Dusk_on_Desert.jpg

Results



- Questions?

- <http://www.raytracegroundup.com>
- Suffern, Kevin (2007). Ray Tracing from the Ground up. Pp. 197-216 Wellesley, MA: A K Peters, Ltd.
- <http://local.wasp.uwa.edu.au/~pbourke/miscellaneous/stereographics/>
- <http://www.captain3d.com/stereo/html/tutorial.html>