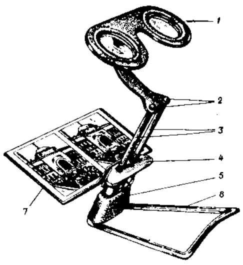
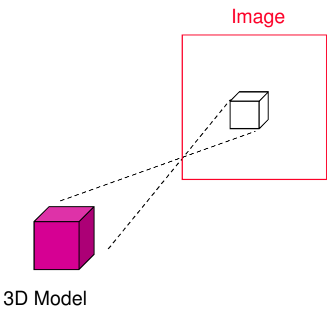
Stereo

Viewing Stereo
Stereograms
Autostereograms
Depth from Stereo



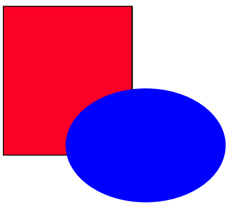
3D (Depth) from 2D

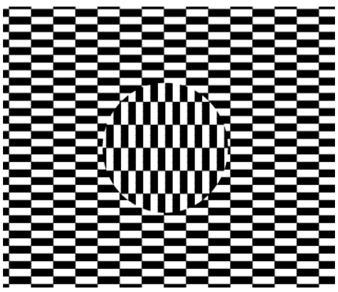
- 3D information is lost by projection.
- How do we recover 3D information?



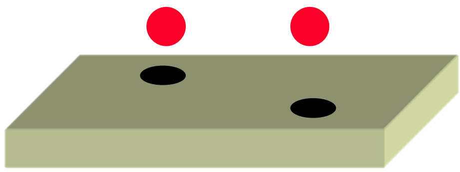
Depth Cues

Occlusions:

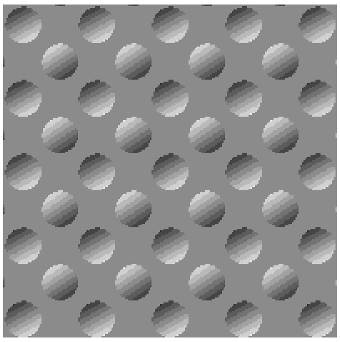


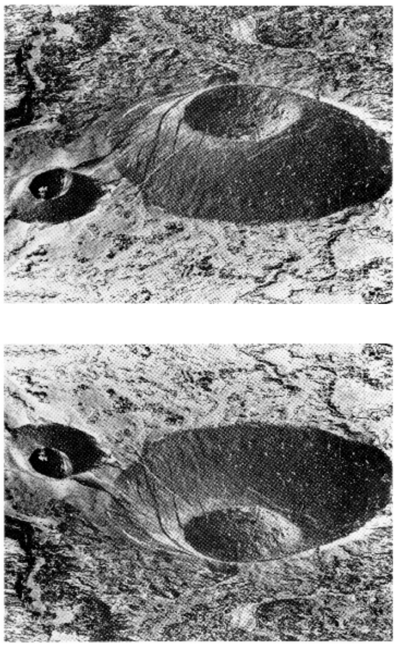


Shadows:

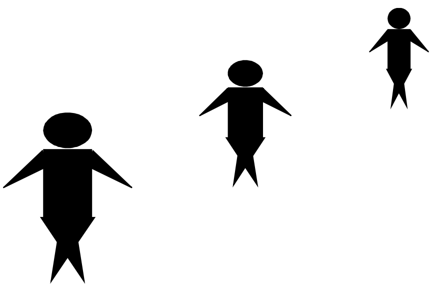


Shading:

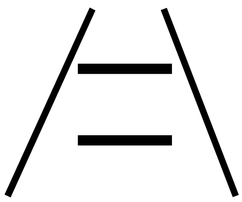


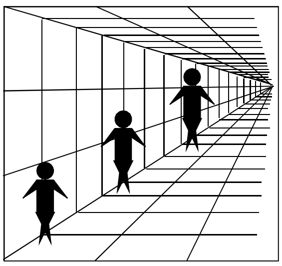


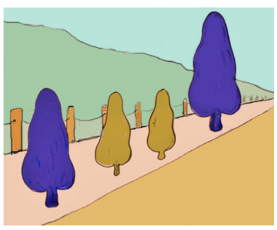
Size Constancy (perspective):



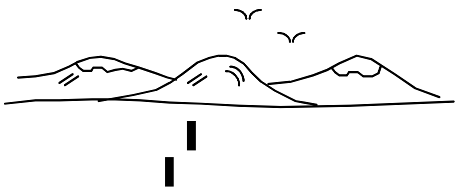
Perspective Illusions



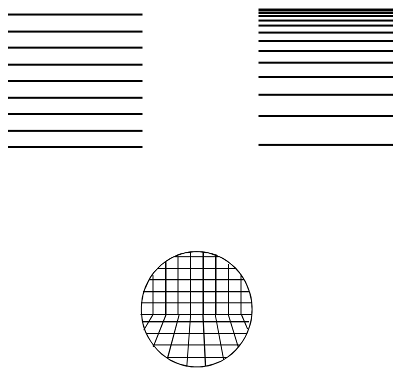




Height in Plane:



Texture Gradient:

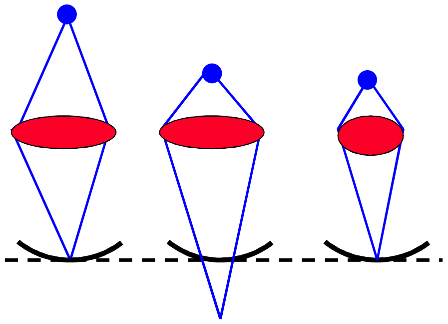


3D from 2D +

- Accommodation (Focus)
- Eye Vengeance
- Motion.
- Stereo

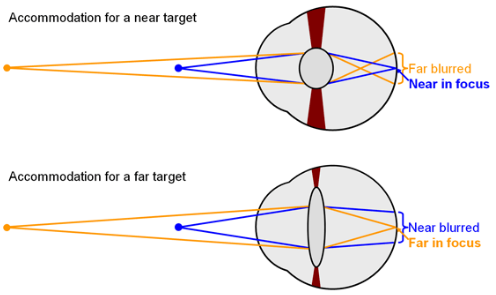
Accommodation

- Change in lens curvature according to object depth.
- Effective depth: 20-300 cm.



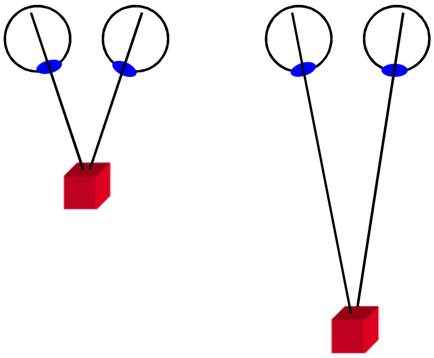
Accommodation

- Change in lens curvature according to object depth.
- Effective depth: 20-300 cm.

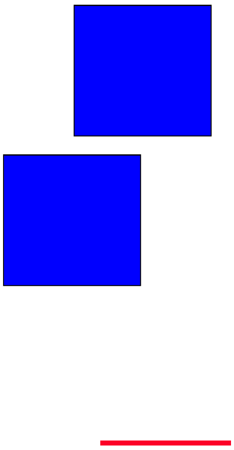


Eye Vergence

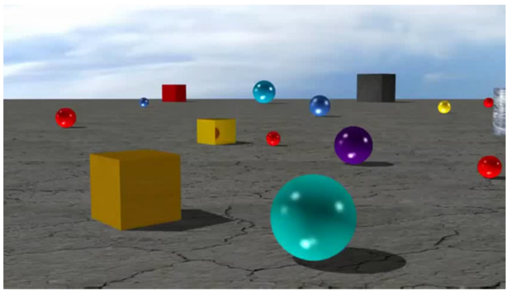
- Change in lens curvature according to object depth.
- Effective depth: up to 6 m.



Motion:



Motion:

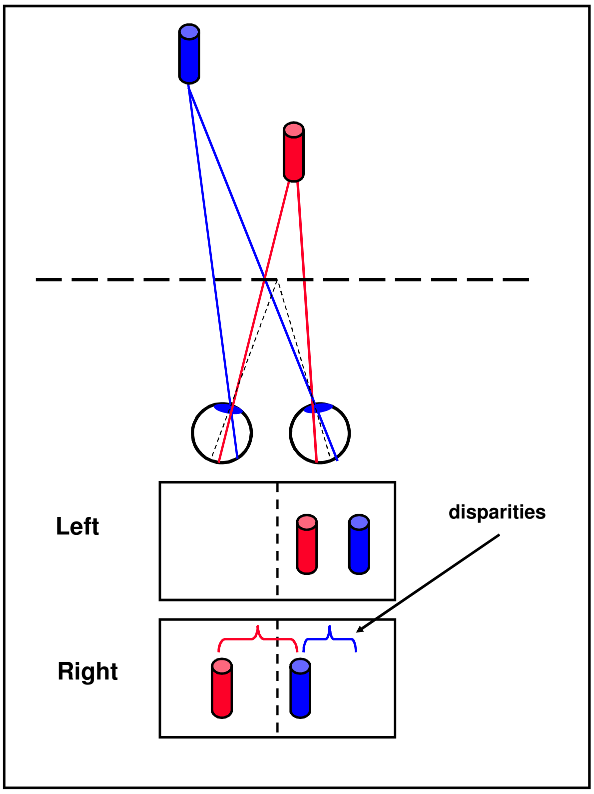


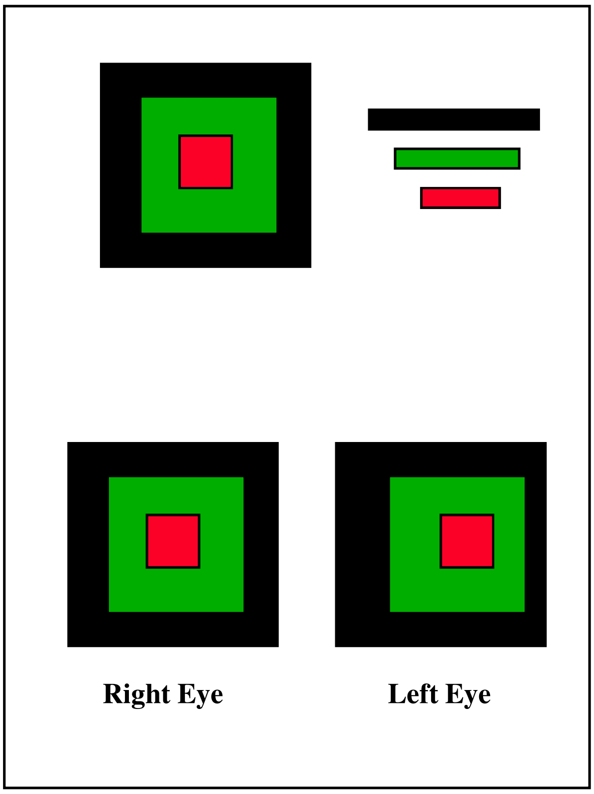
Stereo Vision

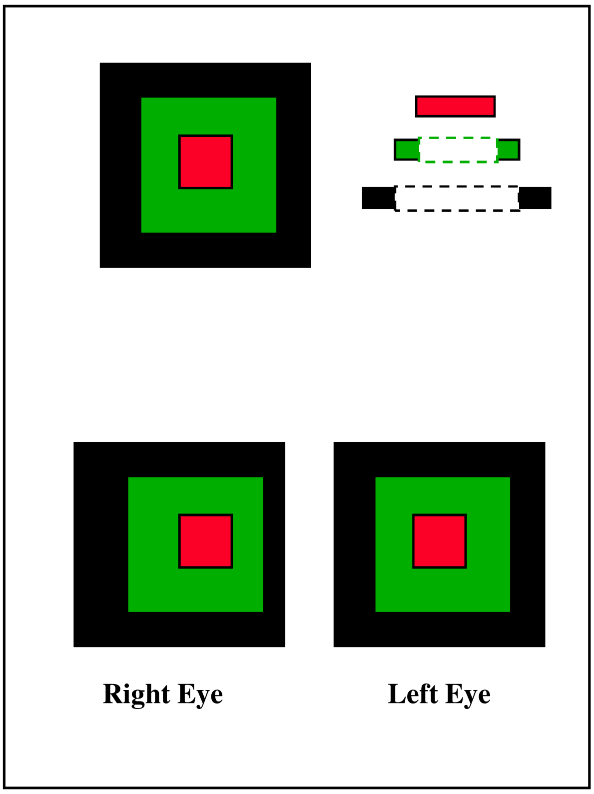
- In a system with 2 cameras (eyes), 2 different images are captured.
- The "disparity" between the images is larger for closer objects:

$$\text{disp} \propto \frac{1}{\text{depth}}$$

- "Fusion" of these 2 images gives depth information.







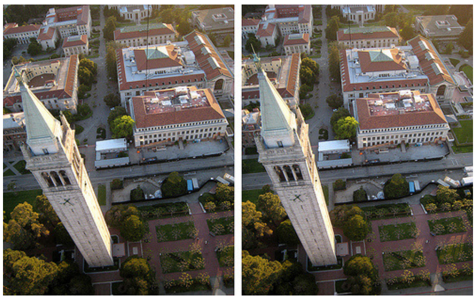
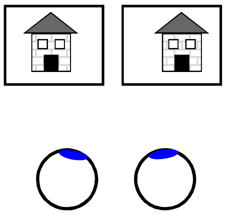


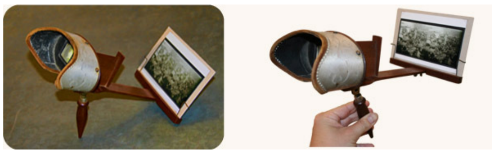
Image Separation for Stereo

- Special Glasses
- Red/green images with red/green glasses.
- Orthogonal Polarization
- Alternating Shuttering



Optic System

Parlor Stereo Viewer 1850



Viewmaster
1939

ViduTech
2011

Optic System

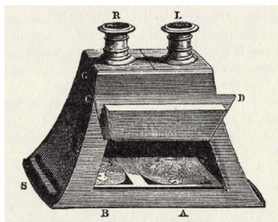


Fig. 6: The lenticular Brewster stereoscopic viewer

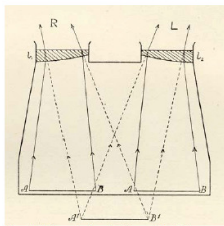
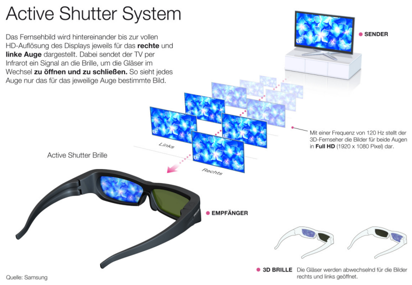


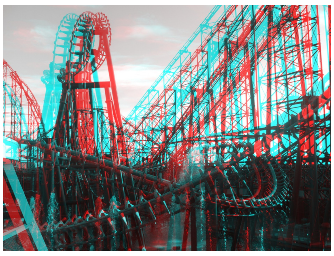
Fig. 7: The optical reduction of the distance between the plates inside a Brewster viewer

Active Shutter System

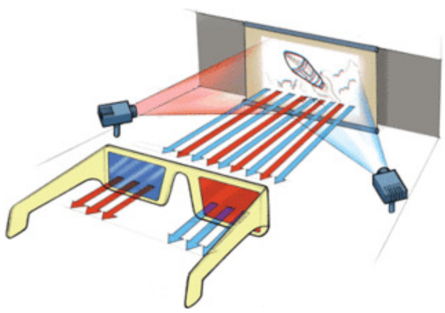


Red/Green Filters

Anaglyphs



Anaglyphs How they Work



Orthogonal Polarization

Linear Polarizers:

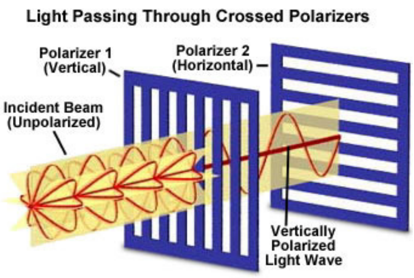


Figure 1

Orthogonal Polarization

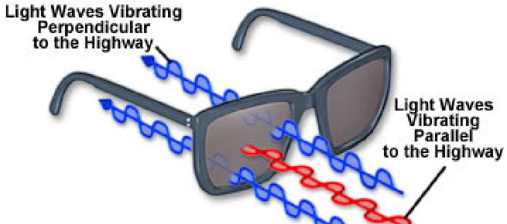
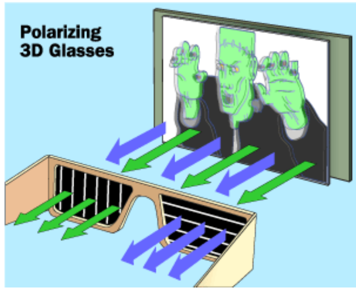


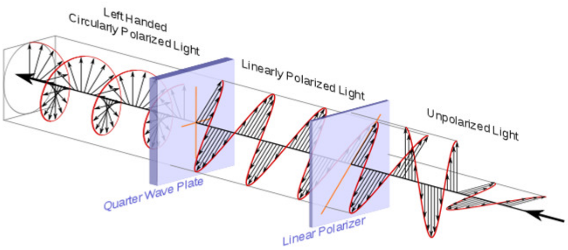
Figure 2



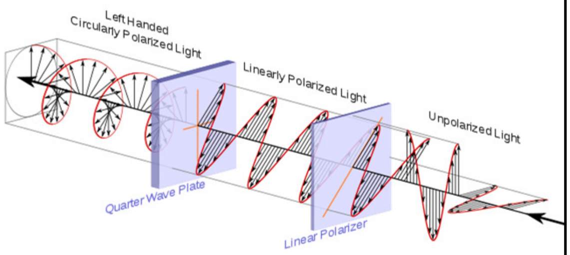
2 polarized projectors are used
(or alternating polarization)

Orthogonal Polarization

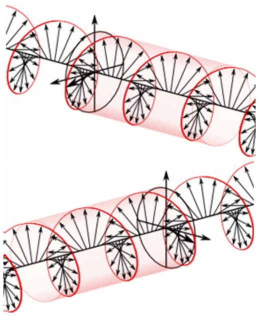
Circular Polarizers:



Orthogonal Polarization



Circular Polarizers:

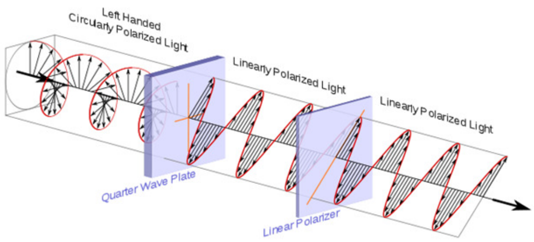


Left handed

Right handed

Orthogonal Polarization

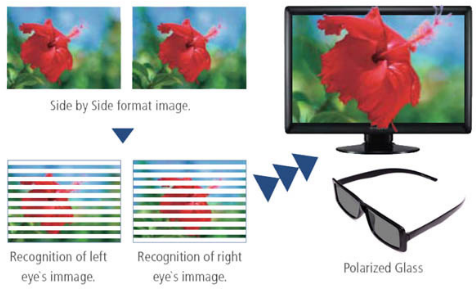
Circular Polarizer Glasses:



Same as polarizers – but reverse light direction

TV and Computer Screens

Polarized Glasses



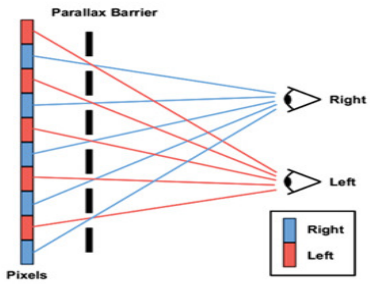
Glasses Free TV and Computer Screens

Parallax Stereogram

Glasses Free TV and Computer Screens

Parallax Stereogram

Parallax Barrier display

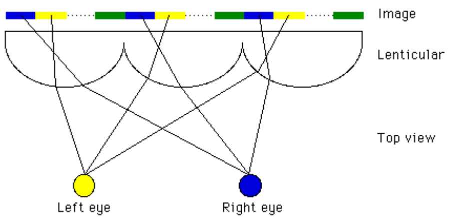


Uses Vertical Slits

Blocks part of screen from each eye

Glasses Free TV and Computer Screens

Lenticular lens method

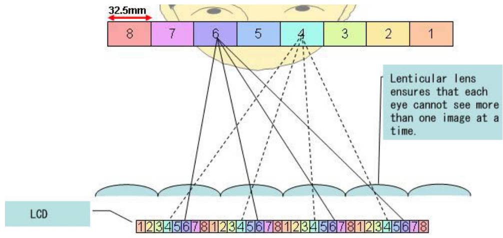


Uses lens arrays to send different Image to each eye.

Eyes must be in "sweet spots"

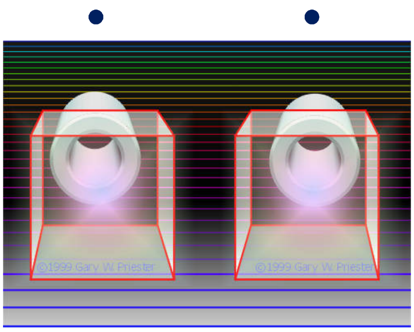
Glasses Free TV and Computer Screens

Lenticular lens method

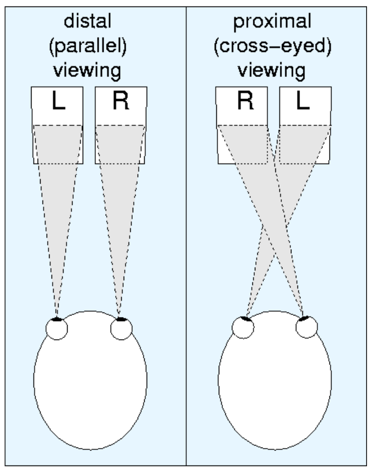


Multiple "sweet spots"

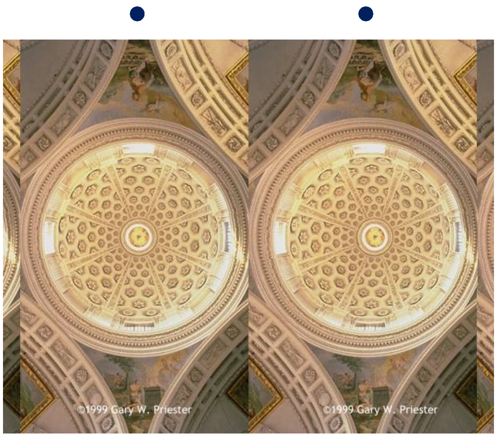
Cross-Eyed Viewing



Cross-Eyed Viewing

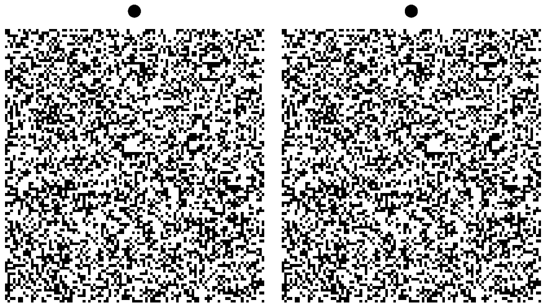


Cross-Eyed Viewing

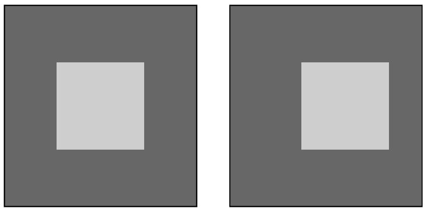


Cross-Eyed Viewing

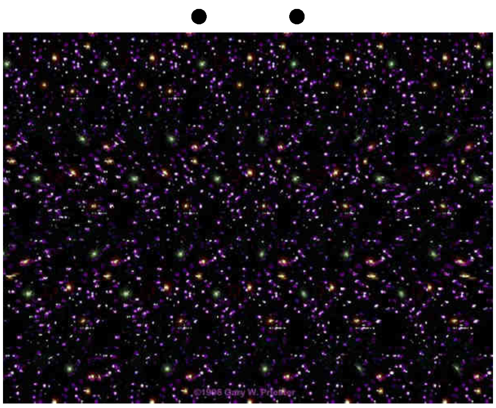
Random Dot Stereogram



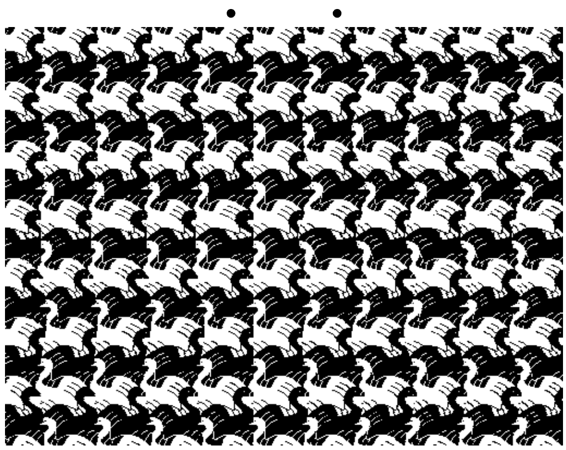
(Bela Julesz - 1971)

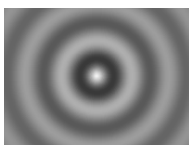


AutoStereograms

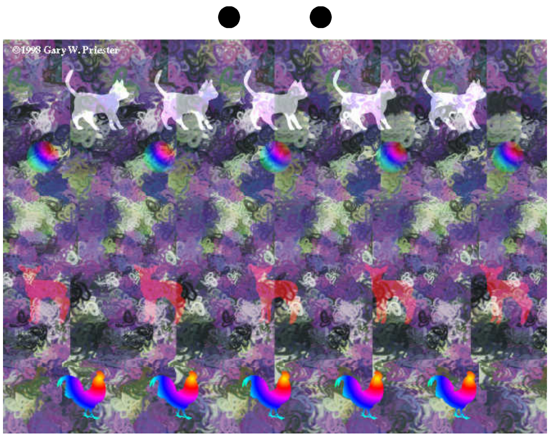


AutoStereograms

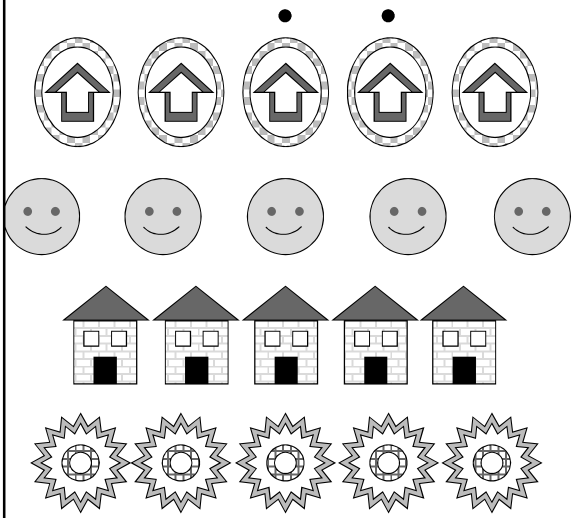




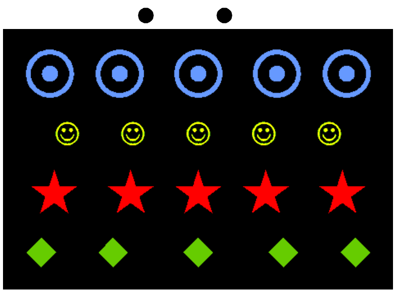
AutoStereograms



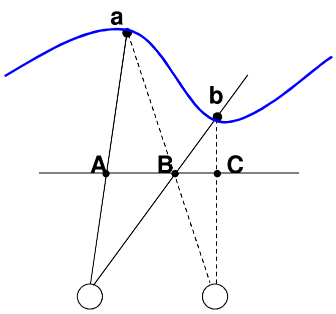
AutoStereograms



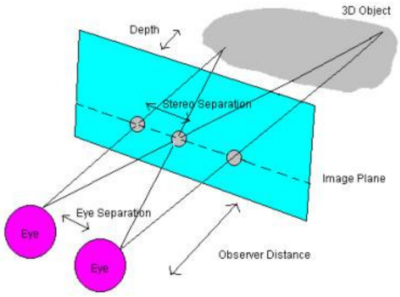
AutoStereograms



Autostereograms



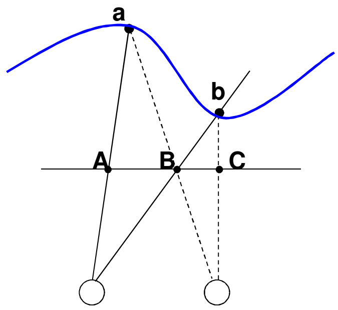
Autostereograms



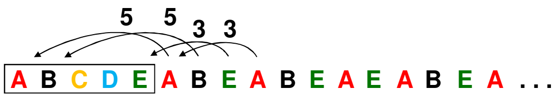
Stereo Separation/depth =
eyesep/(depth+observer_dist)

Stereo Separation =
(eyesep*depth)/(depth+observer_dist)

Autostereograms

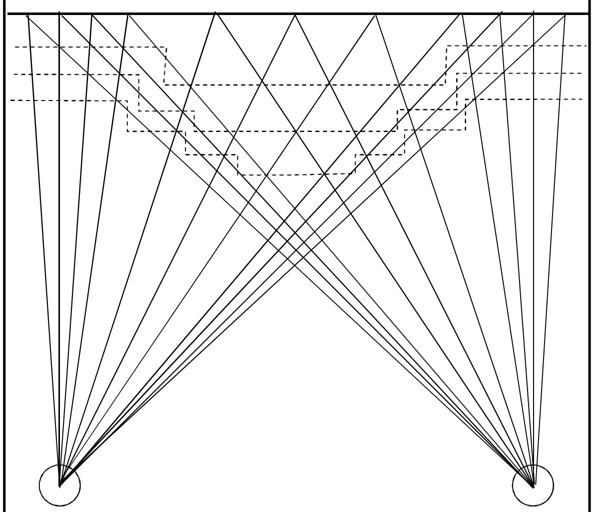


Depth Map

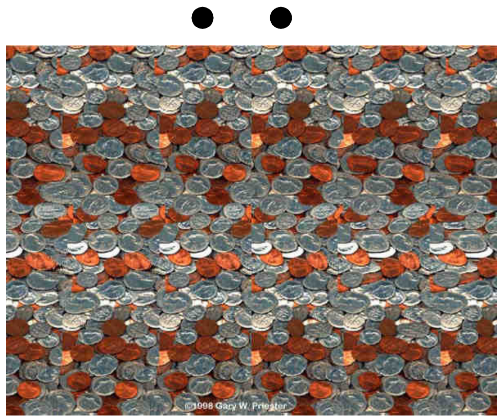


Texture Patch

Multiple Depth Planes

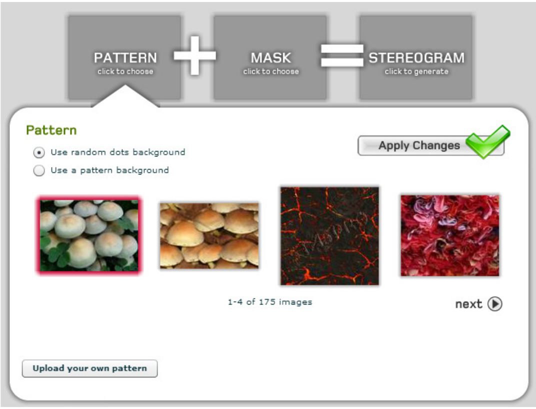


AutoStereograms



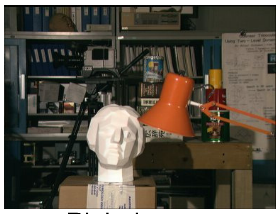
Autostereograms

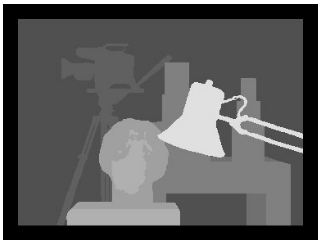
http://www.easystereogrambuilder.com
/3d-stereogram-maker.aspx



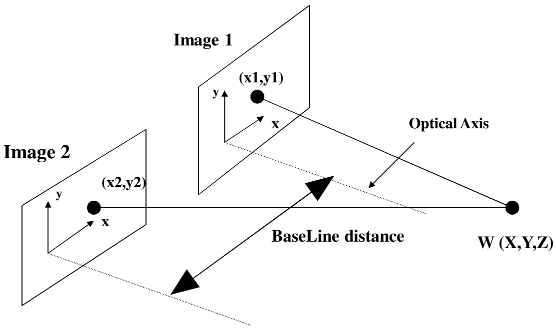
Determining depth from Stereo Image Pairs


Left image


Right image

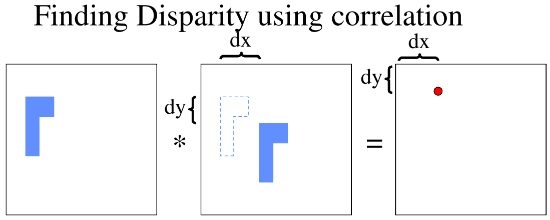

Depth Map
Disparity Map

Determining depth from Stereo Image Pairs

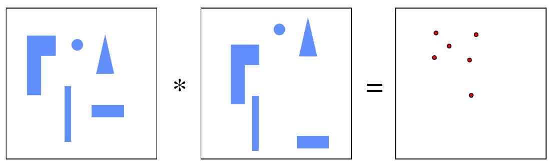


Determining depth from Stereo Image Pairs

Finding Disparity using correlation



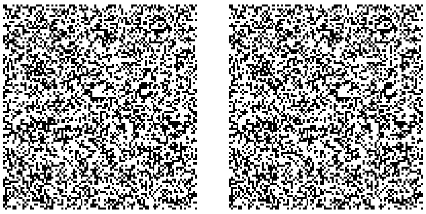
Problem: when there are numerous objects at various distances:



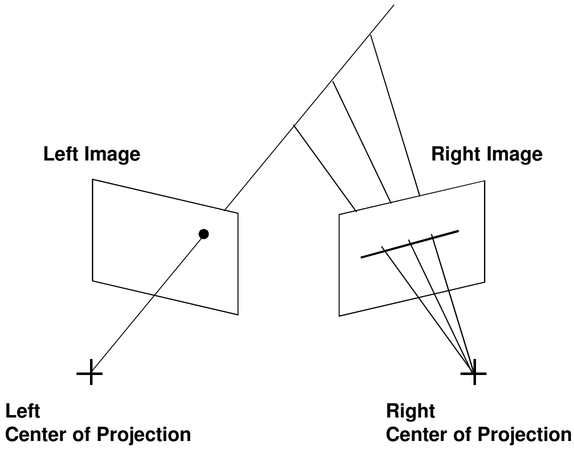
Solution: divide image into windows and correlate each window separately.

Determining depth from Stereo Image Pairs

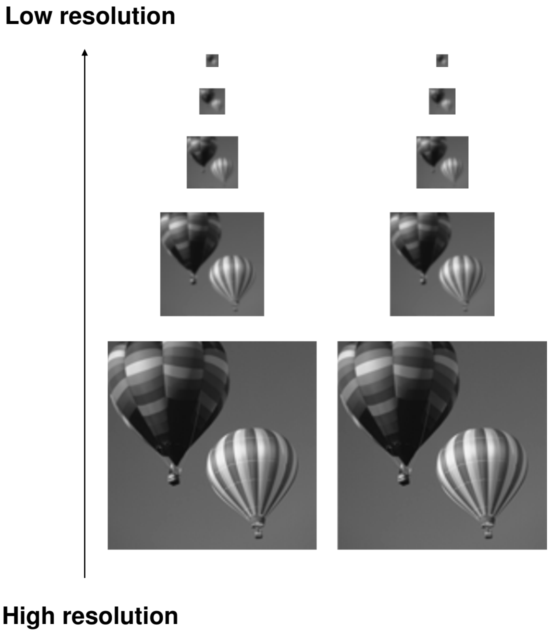
- **Problem**: A very expensive search problem.
  Multiple matches.
- **Solutions**: Constrain search space
  - Epipolar constraint
  - Coarse to fine
  - Depth smoothness



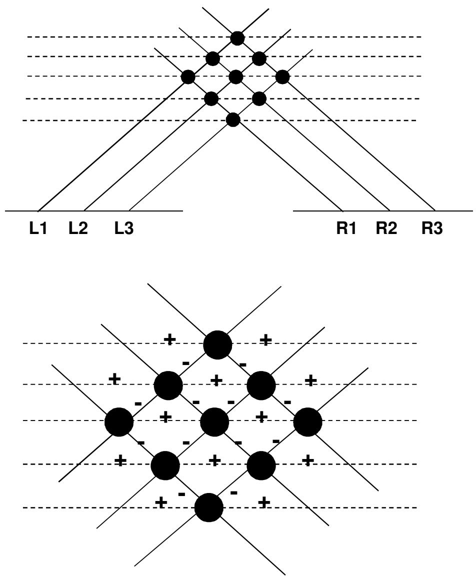
Epipolar Constraint



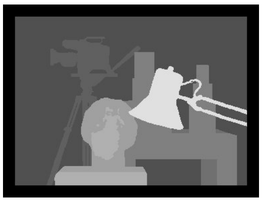
Coarse to Fine



Depth smoothness



Determining depth from Stereo Image Pairs

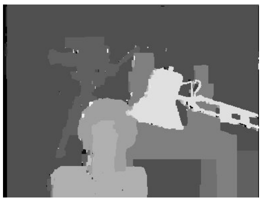


True Depth

SSD

SAD

Dynamic Programming



Graph Cut

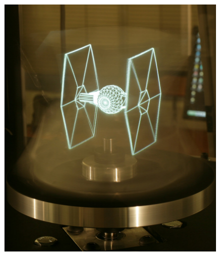
http://3dstereophoto.blogspot.co.il/2011/06/depth-maps-from-stereo-pairs.html

3D Display

Volumetric display

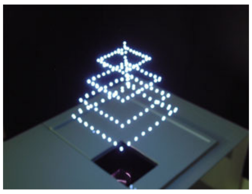
Holographic displays

Integral imaging



Spinning mirrors, high-speed DLP Projections (USC)

Laser Plasma 3D Display



Io2 – on sheet of water mist

Holodust – laser on dust