Basics of Stereoscopic Displays

Presented

by

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The Goals of this Presentation

- **Primary**
  - Enumerate the principle means of producing electronic, 3D, moving images.
  - Briefly explain the configuration and principles of operation of each 3D technology.

- **Secondary**
  - Summarize the characteristics, advantages and disadvantages of each technology.
  - List the applications for which each technology is best suited.
  - Present representative values of key specifications for each type of display.

Consider the Various Means to Produce a 3D Image

1. Stereoscopic

An independent image is presented to each eye through the use of some means of separation.

- Polarization of light
- Spectrum of light
- Spatial
- Temporally

Consider the Various Means to Produce a 3D Image

2. Volumetric

Volume filling. Each voxel emits visible light from the region in which it appears.

- Multiplanar systems
- Rotating systems
- Vibrating systems
- Other

Consider the Various Means to Produce a 3D Image

3. Holographic

Produces a free standing image.

4. "Hologram Like"

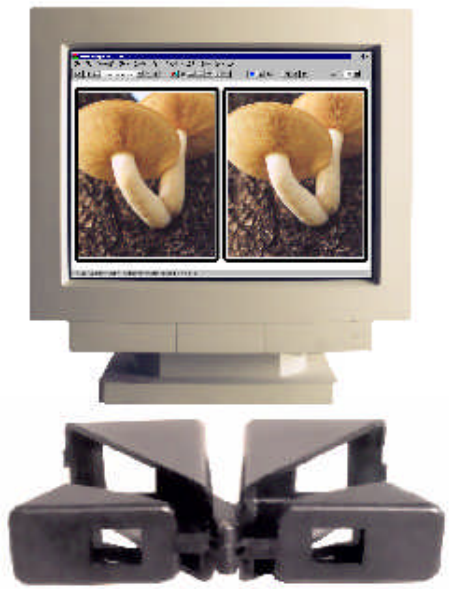
There are technologies that describe themselves and the image they produce as hologram like.

STEREOSCOPIC

Direct View

Two Direct View Displays - Physical Separation

Graphic Media Research
PokeScope Pocket Stereoscope



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DISPLAY INTELLIGENCE™

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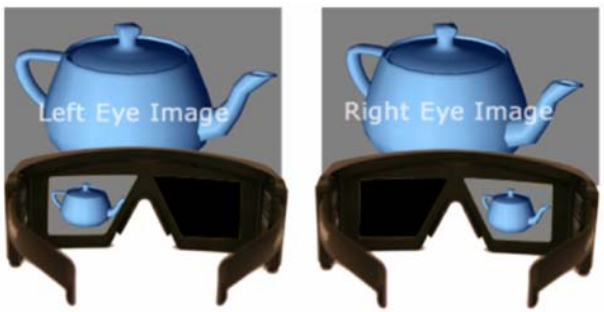
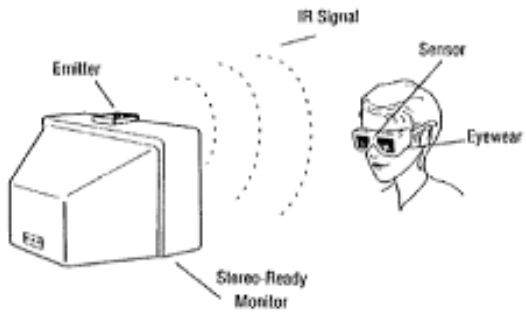
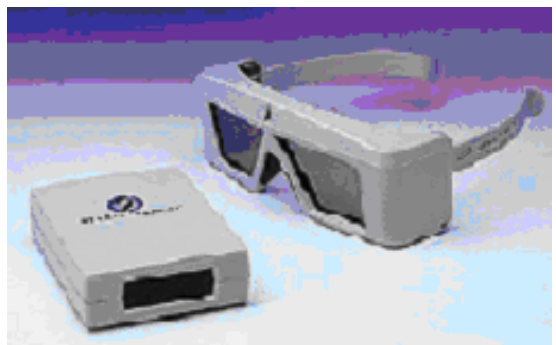
Direct View

One Direct View Display - Active Gasses

- Two different eye perspectives are time sequentially presented on a direct view 2D display.
- The viewer wears “active” glasses in which the lenses are shutters.







STEREOSCOPIC

Direct View

One Direct View Display - Active Gasses

- The lenses switch between transmitting or blocking light.
- Lenses are usually some type of LCD.
- The opening and closing of the lenses is synchronized with the imagery.
- Glasses synchronized to display by IR link or can be tethered.

STEREOSCOPIC

Direct View

One Direct View Display - Active Gasses

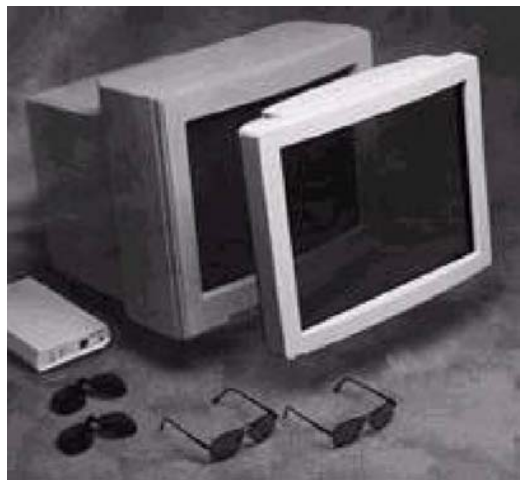
Stereoscopic - Direct View - One Direct View Display - Active Glasses	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Wide field of view • Compatible with headtracking • Allows for limited number of multiple viewers • System can be switched to 2D eliminating the need for glasses
Disadvantages of the technology	• Sophisticated glasses are required • Potential exists for flicker in some system designs • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Reduced image brightness • Provides only horizontal parallax
Principle applications	• Computer monitors
Example product Company	• CrystalEyes • StereoGraphics Corp.
Key specifications of example	• Glasses field Rate: 80 - 160 fields/second • Glasses transmittance: 16% • Glasses dynamic range: 1500:1 • Emitter range: ~20 feet

STEREOSCOPIC

Direct View

One Direct View Display with Active Polarization Switch - Passive Polarizing Glasses

- Two different eye perspectives are presented time sequentially on a direct view 2D display.
- A polarization switch is placed on the front of the 2D display screen.
- Output can be linearly or circularly polarized.



STEREOSCOPIC

Direct View

One Direct View Display with Active Polarization Switch - Passive Polarizing Glasses

- The polarization of the transmitted image is switched synchronously with the imagery.
- Viewers wear passive polarizing glasses.
- CRT based - technology is disappearing.

STEREOSCOPIC

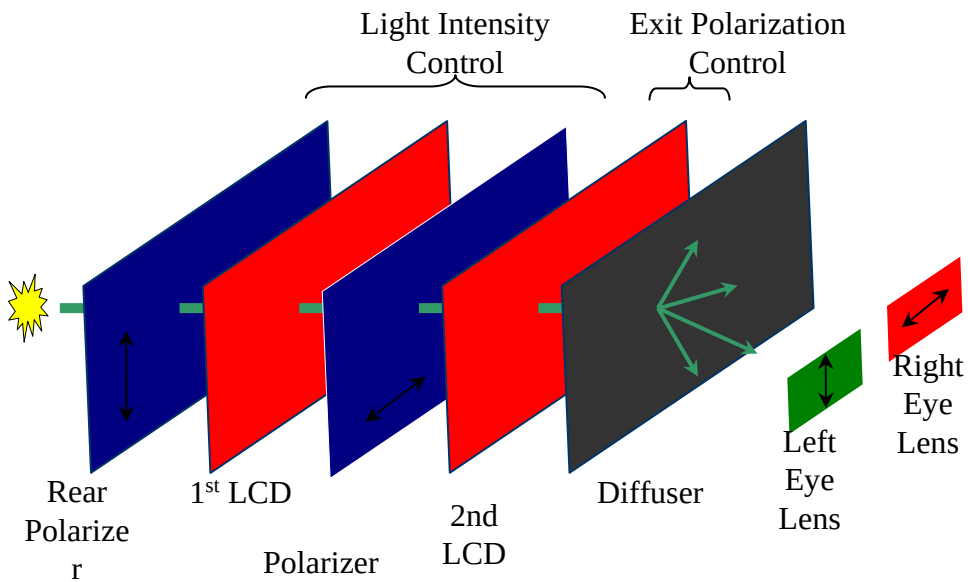
Direct View

One Direct View Display with Active Polarization Switch - Passive Polarizing Glasses

Stereoscopic - Direct View - One Direct View Display with Active Polarization Switch - Passive Polarizing Glasses	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Adequate field of view • Allows for limited number of multiple viewers • System can be switched to 2D eliminating the need for glasses
Disadvantages of the technology	• Simple glasses are required • Potential exists for flicker in some system designs • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Reduced image brightness • Provides only horizontal parallax
Principle applications	• Computer monitors
Example product Company	• Monitor Z-Screen • StereoGraphics
Key specifications of example	• Light transmission: 16% including eyewear • Field rate: 40Hz to 200Hz

Stacked LCD Displays

- Rear LCD panel controls the luminance. Includes two standard linear polarizers.
- Front LCD panel controls the polarization angle. No polarizers.



STEREOSCOPIC

Direct View

Dual LCDs - Passive Polarizing Glasses

•Voltage on front panel is adjusted on a pixel-by-pixel basis to control polarization and, thus, direct correct light to correct eye. Viewer wears passive polarizing glasses.

•Two panels are aligned to a sub-pixel accuracy with ~1mm gap.

STEREOSCOPIC

Direct View

Dual LCDs - Passive Polarizing Glasses

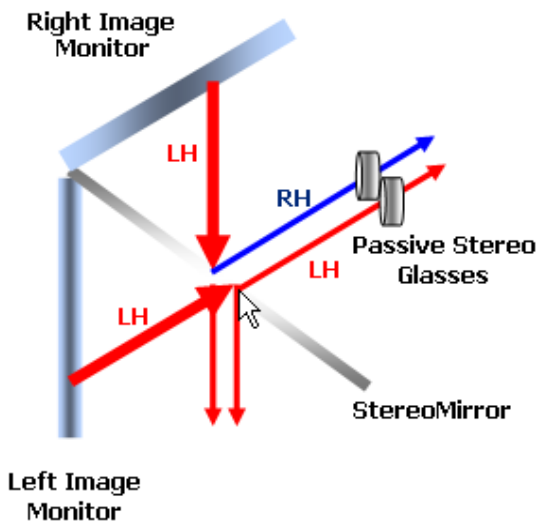
Stereoscopic - Direct View Dual LCDs - Passive Polarizing Glasses (Stacked LCDs)	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Wide field of view • Compatible with headtracking • Allows for limited number of multiple viewers • System can be switched to 2D eliminating the need for glasses
Disadvantages of the technology	• Requires simple glasses • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Provides only horizontal parallax
Principle applications	• Computer monitors for games
Companies	• iZ3D (Example is one product from this product line) • Polaris • MacNaughton • Chi Mei Optoelectronics
Key specifications of example	• LCD size: 22“ • Display resolution: 1680 x 1050 • Viewing angle: 120/90 • Response time: 5 ms • Brightness: 250 nit • Contrast: 700:1

STEREOSCOPIC

Direct View

Dual LCDs - Passive Polarizing Glasses

- Utilizes two identical direct view displays (set up to produce polarized light - LCDs).
- The screens are oriented at an angle to each other with their pixel arrays accurately aligned.



STEREOSCOPIC

Direct View

Dual LCDs - Passive Polarizing Glasses

- One screen displays a right eye perspective image, the other the left eye perspective image.
- A half silvered mirror is inserted between the two display screens bisecting the angle.
- The stereo mirror reflects one polarization and transmits the other.
- The viewer wears passively polarized glasses and sees a stereoscopic 3D image.

STEREOSCOPIC

Direct View

Dual LCDs - Passive Polarizing Glasses

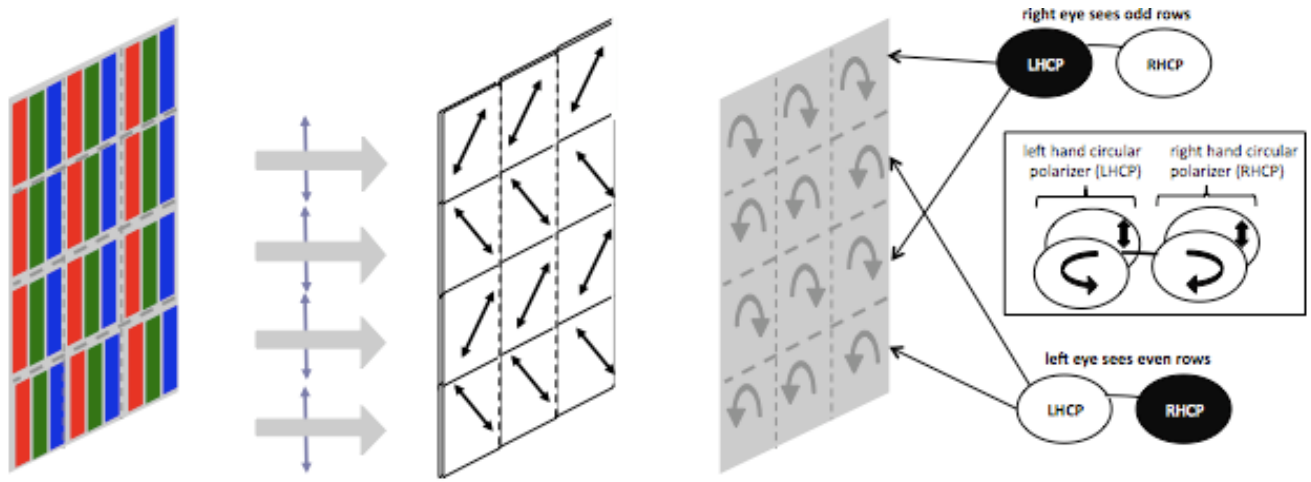
Stereoscopic – Direct View Dual LCD - Passive Polarizing Glasses (StereoMirror)	
Advantages of the technology	• All solid state system - no moving parts • Full 2D display resolution, color pallet and contrast • Flicker free • Multiple viewers possible - limited by physical space
Disadvantages of the technology	• Requires passive glasses • Large form factor
Principle applications	• Satellite/aerial photogrammetry; medical imaging; computational chemistry; complex modeling visualization
Companies	• SD2320W • Planar Systems (Example drawn from this product line.) • SevenData • Omniatec
Key specifications of example	• Display resolution: 1920 x 1200 • Palette: 16 million colors • Stereo luminance: 150 cd/m^2 (through glasses) • Response time: 12 ms (3 ms rise, 9 ms fall) • Refresh rate: 60 Hz

STEREOSCOPIC

Direct View

One LCD with µPol Technology – Passive Polarized Glasses

- The right eye perspective image is presented on a flat panel LCD using the odd pixel rows.
- The left eye perspective image is presented on a flat panel LCD using the even pixel rows.



STEREOSCOPIC

Direct View

One LCD with µPol Technology – Passive Polarized Glasses

- The “usual” LCD front polarizer sheet is replaced by a special polarizer sheet.
- It consists of an array of pixel wide polarizers stripes.
- The polarization states of alternate stripes are orthogonal to each other.
- The polarizer stripes are placed in careful alignment with the pixel rows.
- The viewer wears passive polarized glasses.

STEREOSCOPIC

Direct View

One LCD with µPol Technology – Passive Polarized Glasses

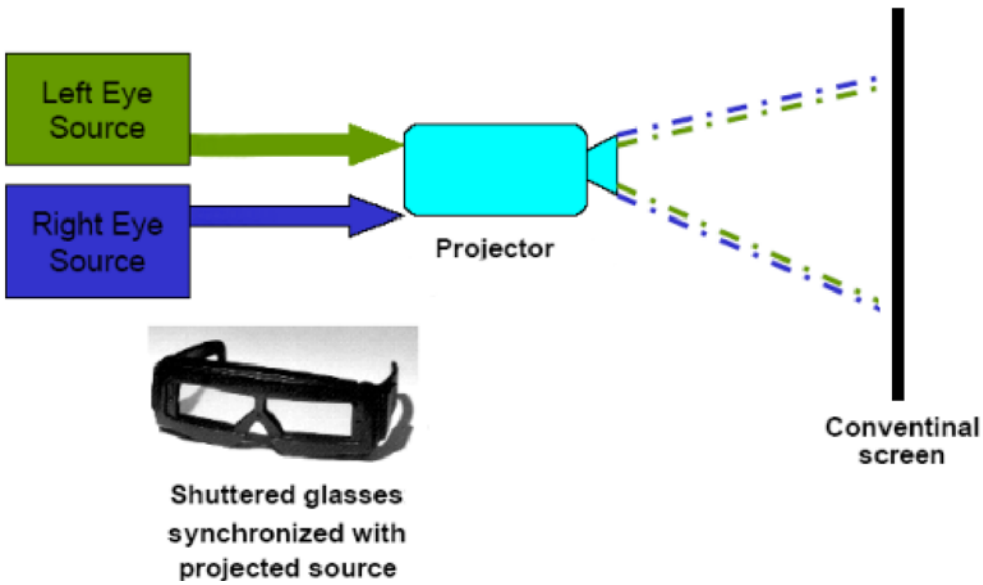
Stereoscopic Direct View - One LCD with µPol Technology - Passive Polarized Glasses	
Advantages of the technology	• Adequate field of view • Allows for limited number of multiple viewers • System can be switched to 2D eliminating the need for glasses
Disadvantages of the technology	• Image resolution reduced by a factor of 2 compared to 2D image • Simple glasses are required • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Reduced image brightness • Provides only horizontal parallax
Principle applications	• Computer monitors • Television
Companies	• Pavonine • SpectronIQ 3D • Zalman • Hyundai (One model used in the example below.)
Key specifications of example	• 22 inch diagonal • WSXGA+ resolution (1,680x1,050) • Brightness level of 300cd/m² • Contrast ratio of 1,000:1 • Response time of 5ms

STEREOSCOPIC

Projection

Single Projector - Active glasses

- The display source is a single projector with a single lens.
- Sequential frames in the projected image alternate between right eye and left eye perspectives.



STEREOSCOPIC

Projection

Single Projector - Active glasses

- The projected image is unpolarized.
- The viewer observes the image on a conventional screen - does not need to preserve polarization.
- Viewers wear active glasses.

STEREOSCOPIC

Projection

Single Projector - Active glasses

- Most single 3D projectors are DLP based.
- 3D digital projectors based on LCOS microdisplays are also available.
- A single DLP projector can be used to produce a 3D rear projection TV.

STEREOSCOPIC

Projection

Single Projector - Active glasses

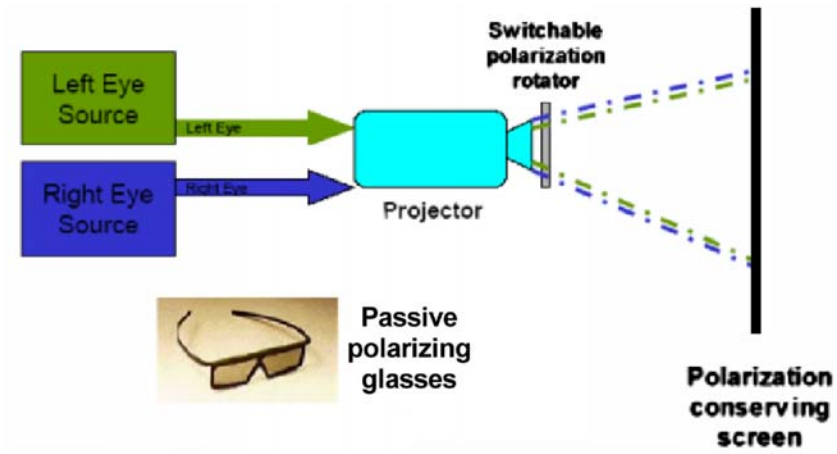
Stereoscopic – Projection - Single Projector - Active Glasses	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Allows for multiple viewers • System can be switched to 2D eliminating the need for glasses • Large field of view
Disadvantages of the technology	• Sophisticated glasses are required • Potential exists for flicker in some system designs • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Reduced image brightness • Provides only horizontal parallax but, in likely applications, not a problem
Principle applications	• Large venue presentation such as movies and conference room settings
Companies	• Galaxy product line • Christie • Barco
Typical key specifications	• Contrast ratio: 500:1 • Transmission: 16% including glasses

STEREOSCOPIC

Projection

Single Projector with Active Polarization Switch - Passive Polarizing Glasses

- The display source is a single projector with a single lens.
- Sequential frames in the projected image alternate between right eye and left eye perspectives.
- A polarization switch is positioned at the output of the projection lens.



STEREOSCOPIC

Projection

Single Projector with Active Polarization Switch - Passive Polarizing Glasses

- Synchronously with the imagery, the linear (or circular) polarization of the transmitted image is switched.
- The screen must preserve the polarization of reflected light.
- The viewers wear passive polarizing glasses.

STEREOSCOPIC

Projection

Single Projector with Rotating Polarization Switch – Passive Polarizing Glasses

- Similar principle but the polarization switch is two segment mechanical rotating filter.

STEREOSCOPIC

Projection

Single Projector with Active Polarization Switch - Passive Polarizing Glasses

Stereoscopic - Projection Single Projector with Active Polarization Switch - Passive Polarizing Glasses	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Allows for multiple viewers • System can be switched to 2D eliminating the need for glasses • Large field of view
Disadvantages of the technology	• Simple glasses are required • Potential exists for flicker in some system designs • Potential exists for ghosting in some system designs • Inconsistent accommodation and convergence cues • Reduced image brightness • Special polarizing conserving screen is required • Provides only horizontal parallax but, in likely applications, not a problem
Principle applications	• Large venue presentation such as movies and conference room settings
Companies	• RealD • NEC • Christie • Masterimage • Barco
Typical key specifications	• Contrast ratio: 100:1 • Transmission: 16% including glasses

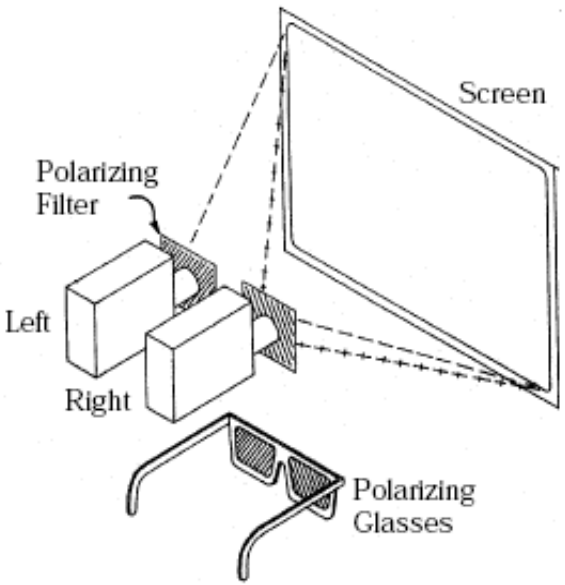
STEREOSCOPIC

Projection

Dual projector - Passive Polarizing Glasses

- Two projectors: one produces the left hand perspective imagery, the other the right hand imagery.

- Filters are positioned on the projectors so that they output linearly (or circularly) polarized light.



STEREOSCOPIC

Projection

Dual projector - Passive Polarizing Glasses

- The projector producing right hand imagery has (for example) a vertical axis of linear polarization.
- The projector producing the left hand imagery has a horizontal axis of linear polarization.
- The screen must preserve the polarization of reflected light.
- The viewers wear passive polarizing glasses.

STEREOSCOPIC

Projection

Dual projector - Passive Polarizing Glasses

Stereoscopic – Projection - Dual Projector - Passive Polarizing Glasses	
Advantages of the technology	• Image resolution not reduced compared to 2D image • System can be switched to 2D eliminating the need for glasses • Good field of view • Supports multiple viewers
Disadvantages of the technology	• Simple glasses are required • Special polarizing conserving screen is required • Potential exists for ghosting in some system designs • Image brightness is reduced • Inconsistent accommodation and convergence cues • Potential exists for imperfect synchronization and alignment of images
Principle applications	• Large venue presentation such as movies and conference room settings
Example product Company	• Barco • Mechdyne • NEC • IMAX • Panasonic • Fakespace • Sony • Christie • JVC
Key specifications of example	• Contrast ratio: 100:1 • Transmission: 19% including glasses

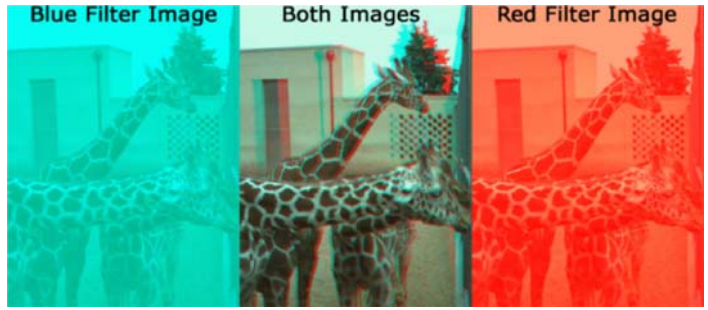
STEREOSCOPIC

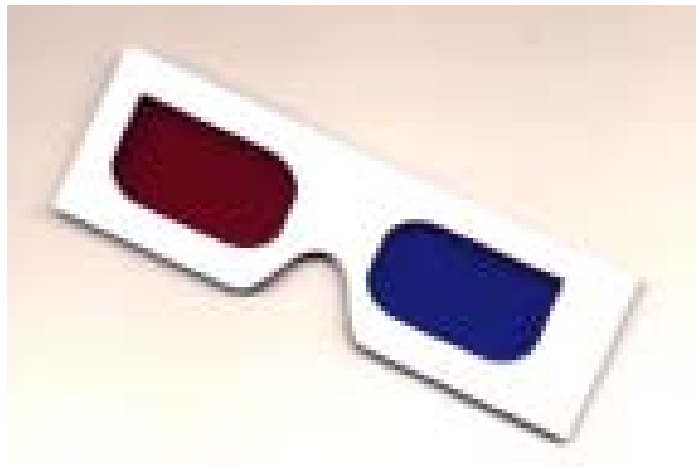
Direct View

Passive Chromatic Glasses

Anaglyphic

- The 2D display presents sequential frames that contain, for example, first a blue left eye image and then a red right eye image.
- The viewer wears glasses with passive red/blue lenses.
- Compatible with existing display systems.





ColorCode 3-D

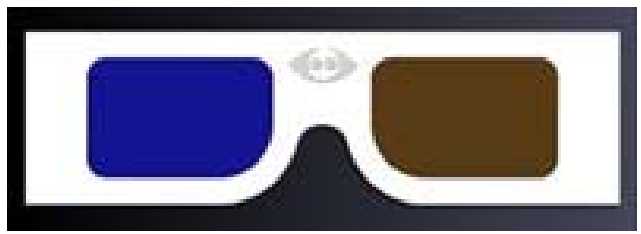
- Red and Green (Yellow) to one eye. Blue to the other eye.
- A horizontal displacement is introduced between the red and blue images.
- The viewer wears passive yellow/blue glasses.

STEREOSCOPIC

Direct View

Passive Chromatic Glasses

- Allows the use of any color at any depth plane in the system. Essentially, the system creates a nearly full color image for one eye and a shifted monochrome image for the other eye.



Eclipse 3D

- Full color image to one eye and a monochrome image to the other eye.
- Monochrome image can be red or yellow, but must be spectrally distinct from full color image.
- The images are viewed with colored filter glasses.
- When one eye views the full-color image and the other eye views the monochrome image, the mind perceives a full-color 3D image.

STEREOSCOPIC

Direct View

Passive Chromatic Glasses

- The color comes from the full-color image. The depth comes from the monochrome image.
- Can be done with a 4-segment color wheel. (BrilliantColor with narrow band yellow instead of the broadband yellow.)
- 4 different color LEDs.
- Approach is not backward compatible with either the transmission channels or current display technology.

STEREOSCOPIC

Direct View

Passive Chromatic Glasses

Stereoscopic - Direct View - Direct View - Passive Chromatic Glasses (ChromaDepth)	
Advantages of the technology	• Multi viewer • Wide field of view • 2D compatible
Disadvantages of the technology	• Color can not be arbitrary when conveying a specific depth position • Limited to 3 depth planes on most electronic displays • Requires glasses, although they are simple and low-cost • Color fringing
Applications best suited to the technology	• Applications where attention getting is more important than image quality. • Works best in print and film, can also be used on electronic displays
Principle companies developing the technology	• American Paper Optics (Purchased Chromatek in 2003.) • nWave (ColorCode)
Potential for system performance improvements	Use of multiple primary color displays
System pricing	Disposable glasses are low cost (under $1 each in low volume as low as an estimated $0.10 in a volume of 10’s of millions)

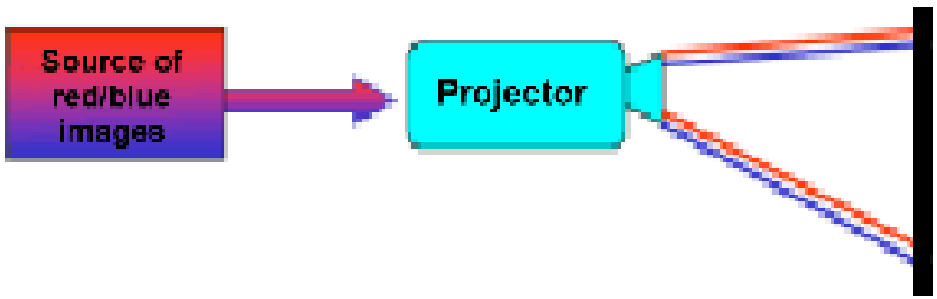
STEREOSCOPIC

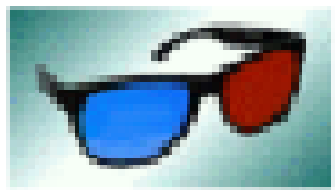
Single Projector

Passive Chromatic Glasses

Anaglyphic

- One projector produces sequential frames that contain, for example, first a blue left eye image and then a red right eye image.
- The viewer wears glasses with passive red/blue lenses.





Glasses with red and blue lenses

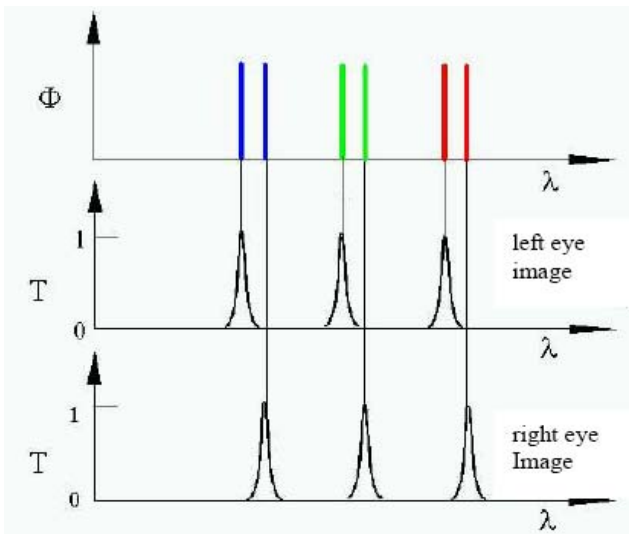
STEREOSCOPIC

Single Projector

Passive Chromatic Glasses

Infitec/Dolby approach

- Rotating mechanical filter has two areas.
- Spectrum transmitted by one filter (R1, G1, B1) differs slightly from that transmitted by the other filter (R2, G2, B2).



STEREOSCOPIC

Single Projector

Passive Chromatic Glasses

- Full color image produced for both eyes.
- A horizontal displacement is introduced between the images.
- The viewer wears passive glasses.

STEREOSCOPIC

Dual Projector

Passive Chromatic Glasses

Anaglyphic

- One projector produces, for example, a blue left eye image and the other projector produces a red right eye image.
- The viewer wears glasses with passive red/blue lenses.

STEREOSCOPIC

Dual Projector

Passive Chromatic Glasses

Infitec

- One projector produces a right eye image with a spectrum (R1, G1, B1)
- The second projector produces a left eye image with a spectrum R2, G2, B2.
- Both eyes see full color images. They are slightly different and this is digitally corrected.
- The viewer wears passive Infitec filter glasses.

STEREOSCOPIC

Dual Projector

Passive Chromatic Glasses

Stereoscopic – Dual Projector - Dual Projectors - Passive Chromatic Glasses (Infitec)	
Advantages of the technology	• Image resolution not reduced compared to 2D image • System can be switched to 2D eliminating the need for glasses • Good field of view, allows head tipping • Supports multiple viewers • No special screen required – allows display mobility • Flicker free
Disadvantages of the technology	• Requires simple but expensive glasses • Image brightness slightly reduced • Potential problem in producing balanced, full color images • Inconsistent accommodation and convergence cues • Potential exists for imperfect synchronization and alignment of images in 2 projector systems
Principle applications	• Large venue presentation such as movies and conference room settings
Companies	• Galaxy + Infitec product line • Barco
Typical key specifications	• Contrast ratio: 10,000:1 • Transmission: 13% including glasses for two 3-microdisplay DLP projectors

STEREOSCOPIC

Head Mounted

- When operated in the 3D mode, each eye is exclusively presented a single perspective image.
- Head gear is available based on variety of microdisplay technologies.

I-O Display Systems
i-Theater (HTPS)

I-Glasses
PC HR (LCOS)

eMagin
Z800 3DVisor
(OLED)

STEREOSCOPIC

Head Mounted

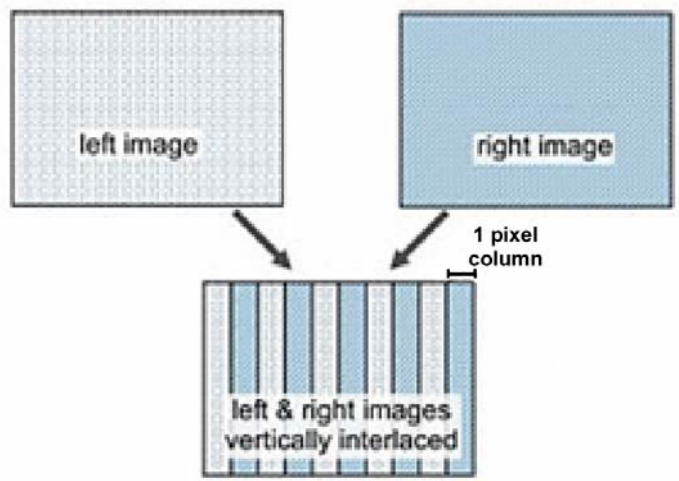
Stereoscopic - Head Mounted Displays	
Advantages of the technology	• Image resolution not reduced compared to 2D image • Wide field of view • Compatible with headtracking • System can be switched to 2D
Disadvantages of the technology	• “Cumbersome” eyewear required • Potential for ergonomic problems
Principle applications	• Virtual reality • Video games
Example product Company	• I-Glasses PC HR • I-O Display Systems
Key specifications of example	• Resolution: 800 x 600 • Field of view: 26 degrees diagonal • Refresh rate: 100 Hz • Virtual image size: 70 inches at 13 feet • Color depth: 24 bit input

STEREOSCOPIC

Multiview

Parallax Barrier

- The right eye perspective image is presented on a flat panel display utilizing (for example) only the odd pixel columns.
- The left eye perspective image is presented on the even pixel columns.
- Resolution is cut in half.



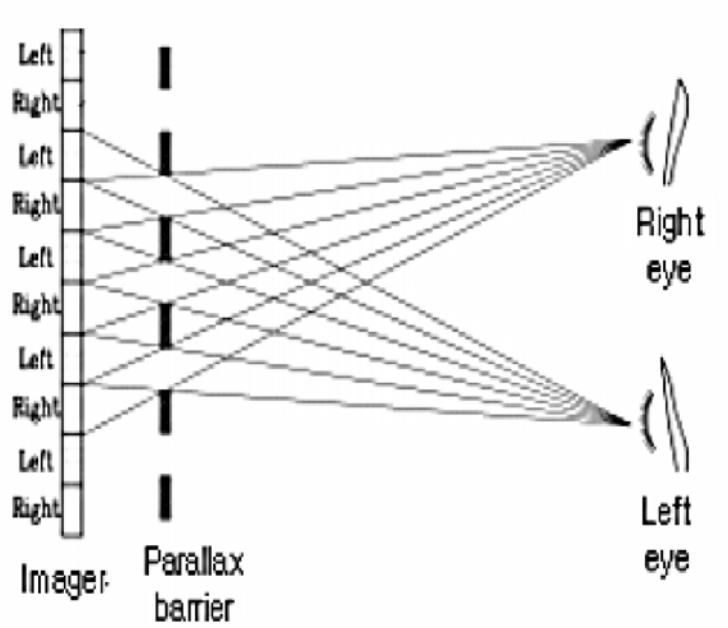
STEREOSCOPIC

Multiview

Parallax Barrier

- A clear sheet containing a series of narrow, linear, opaque stripes - a parallax barrier - is placed in front of the display.

- The “geometry” is such that a viewer sees the right eye pixel columns with the right eye from some viewing angles but not from others. The same is true for the left eye pixel columns.

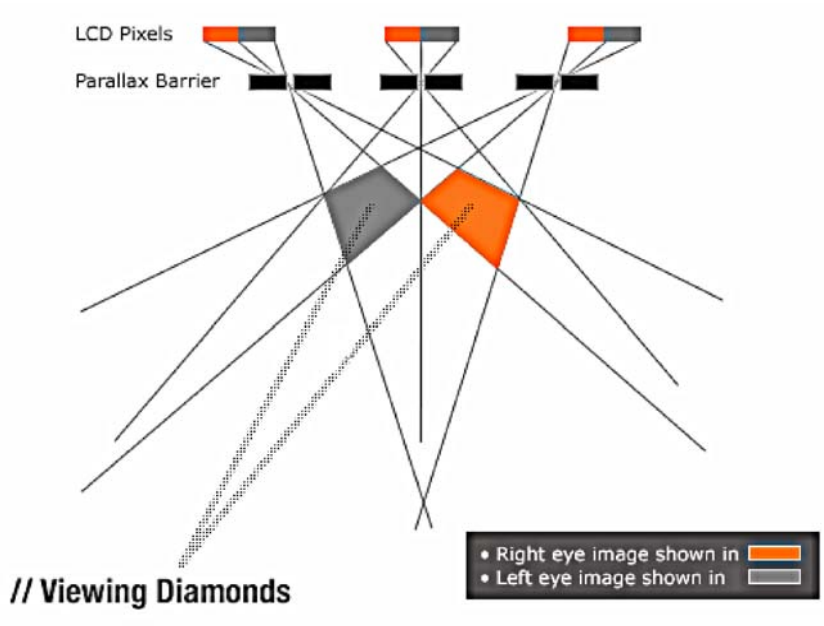


STEREOSCOPIC

Multiview

Parallax Barrier

- The horizontal distance between right eye and left eye diamond areas corresponds to the spacing between human eyes, about 2½”.
- When properly positioned within the viewing zone, the right eye of a viewer will see only the right eye pixel columns and a right eye perspective. The left eye will see only the left eye pixel columns and a left eye perspective.
- Provides a single viewer 3D “sweet spot”.



STEREOSCOPIC

Multiview

Parallax Barrier

- Two-view products available from Pavonine, Tridelity, Dimension Technologies
- Multi-view products available from Spatial View, NewSight, Tridelity.

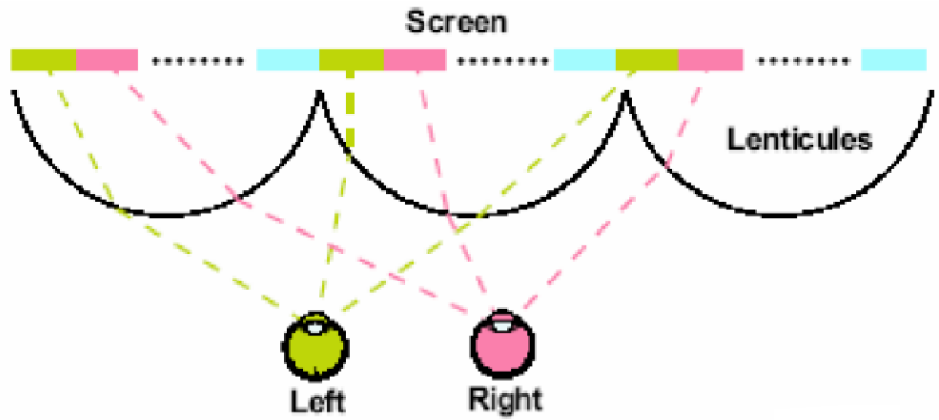
STEREOSCOPIC

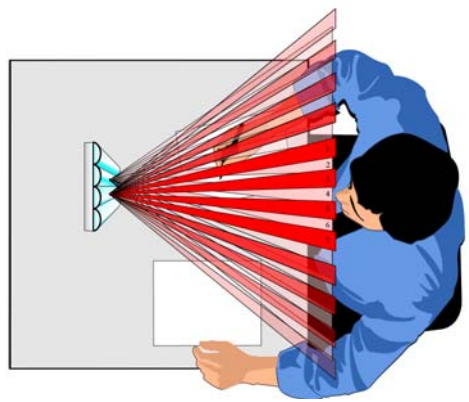
Multiview

Lenticular

- A lenticular sheet contains a linear array of narrow cylindrical lenses is placed in front of the LCD.

- The lenses direct light from the image to different areas in the viewing zone.





STEREOSCOPIC

Multiview

Lenticular

- Two view products available from Spatial View/SeeFront
- Multi-view products available from Philips 3D, LG Electronics, NEC, Samsung, Alioscopy

STEREOSCOPIC

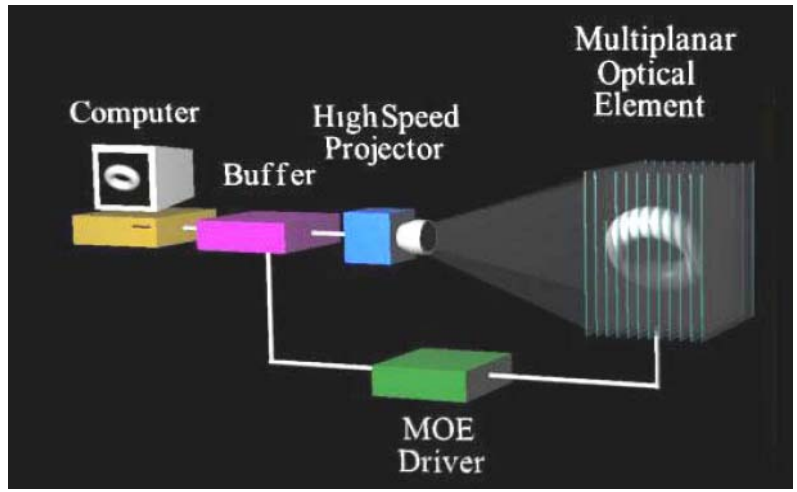
Multiview

Parallax Barrier

Stereoscopic – Multiview - Parallax Barrier (Sharp Switchable)	
Advantages of the technology	• All solid state systems - no moving parts • Viewable by a limited number of simultaneous users • System can be switched to 2D • Autostereoscopic – no glasses required
Disadvantages of the technology	• Restricted head box • Cross talk can degrade image quality • Only provides horizontal parallax • 3D resolution is reduced from 2D resolution • Text distorted in 3D mode
Principle applications	• Advertising • Monitors, TV
Example product Company	• LL-151-3D monitor • Sharp
Key specifications of example	• Contrast ratio: 500:1 • Response time: 23 ms • Resolution: 1024 x 768 • Viewing angle: 130^{o} horizontal, 115^{o} vertical (to CR 10:1) • Brightness: 370 cd/m^2 (2D mode), 140 cd/m^2 (3D mode)

VOLUMETRIC
Multiplane

- A 3D view is created by imaging a series of 2D image slices into a 3D projection volume.
- The projection volume is composed of a physically deep stack of independently addressable layers.
- At any instant in time, one layer displays a 2D image and all other layers are transparent.
- Since each image slice is produced in the display volume at the correct depth, a 3D image is produced.

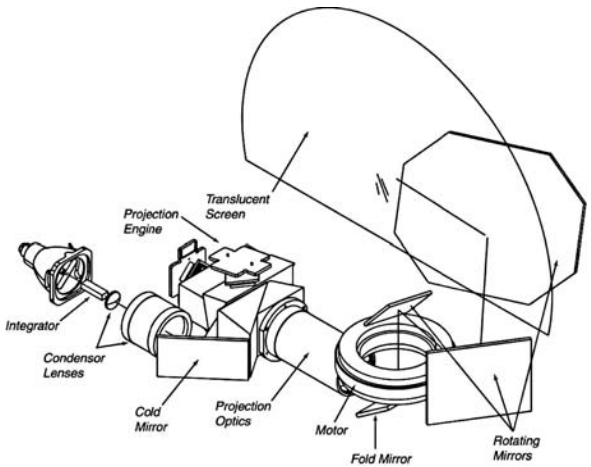


VOLUMETRIC
Multiplane

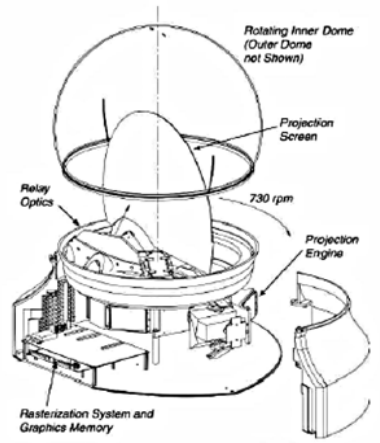
Volumetric – Multiplane - DepthCube	
Advantages of the technology	• All solid state system - no moving parts • Autostereoscopic • No headtracking required • Viewable from an arbitrary distance • Viewable by a limited number of simultaneous viewers • Parallax can be produced in both X and Y
Disadvantages of the technology	• Response time limited, not truly suitable for virtual reality. • Field of view restricted to front only • Slight residual haze from transparent layers • “Translucent” image
Principle applications	• Computer aided engineering and computer graphics
Example product Company	• DepthCube z1024 3D • LightSpace Technology, Inc.
Key specifications of example	• 15.7” x 11.8” x 4.0” deep image volume (19.6” front diagonal) • 90° field of view • 15.3 million voxels • 1024 x 748 transverse pixels x 20 depth planes • 32,768 colors (15 bits) • 50 Hz refresh rate (100 Hz interlaced) • >20 Hz 3D image update rate

Projection on to a Rotating Plane

- A sequence of 2D image “slices” are projected onto each side of a rotating, semi-transparent diffuser screen.



Layout of projector and optical assembly



Schematic

Perspecta 1.9 display

VOLUMETRIC

Rotating

•The spatial position of the emanating voxel is determined by the momentary location of the light beam's intersection with the rotating, screen.

•The projector is based on a 3 chip DLP light engine.

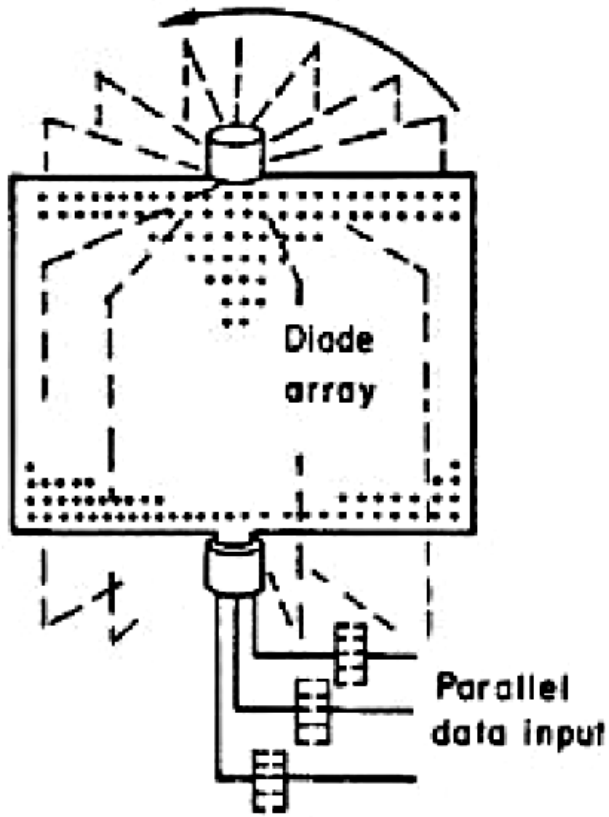
VOLUMETRIC
Rotating

Volumetric – Rotating - Projection on to a Rotating Plane (Perspecta)	
Advantages of the technology	• Convergence and accommodation consistent • No glasses required • Multi viewer capable • Full motion parallax • 360º view ability
Disadvantages of the technology	• Mechanical system • “Haze” from the rotating screen • “Translucent” image • Limited color bit depth
Principle applications	• Medical imaging, the earth sciences (oil and gas), and consumer electronics
Example product Company	• Prespecta 1.9 • Actuality Systems, Inc.
Key specifications of example	• Image size: 10” diameter spatial 3D imagery • Field of view: 360º horizontal, 270º vertical • Resolution: 198 slices, 768 x 768 pixels/slice

VOLUMETRIC
Rotating

Rotating LED Array

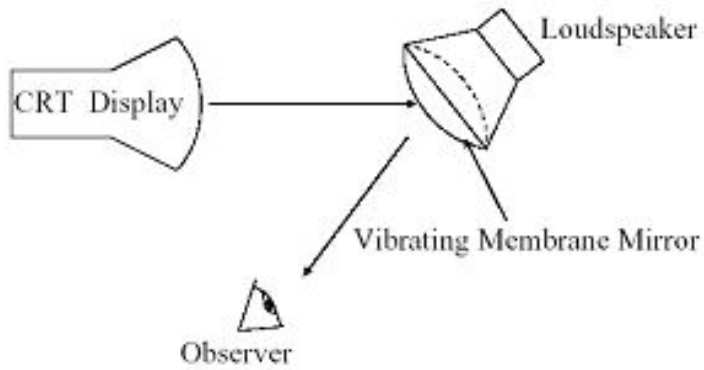
- An XY array of LEDs is rotated about a vertical axis.
- The screen is invisible to viewers because of its' high rotation speed.
- The position in which the LEDs are activated and the LEDs luminescence and duration are computer controlled.
- Low resolution versions of this type of display are currently used in toys, clocks and as "attention getters."



VOLUMETRIC

Vibrating

- An example of this approach was the SpaceGraph 3D Display.
- Note that varifocal techniques are not strictly volumetric in as much as they produce virtual images.
- A thin aluminised mirror film is set into vibration by a loudspeaker.

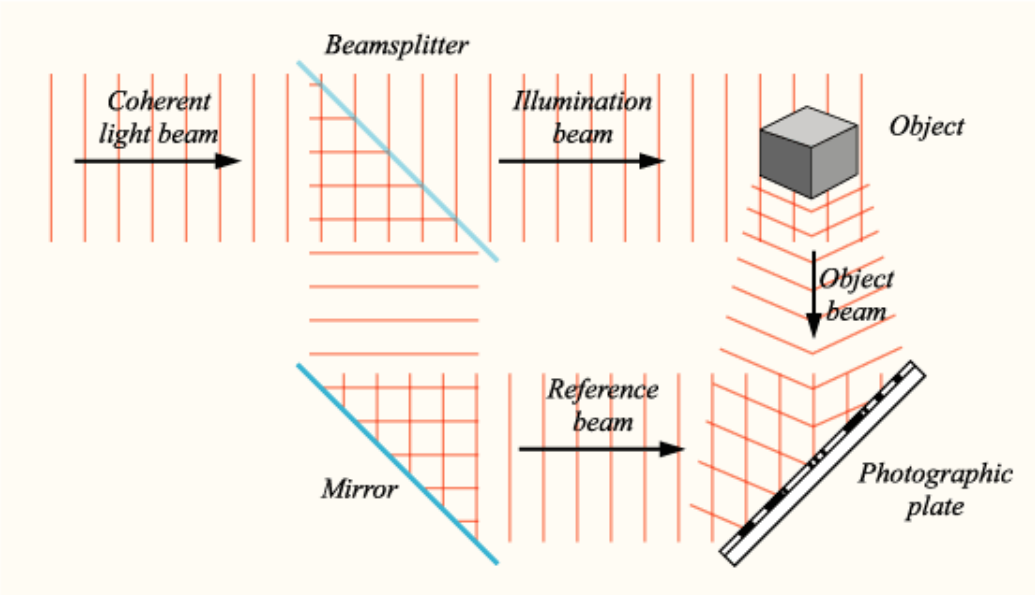


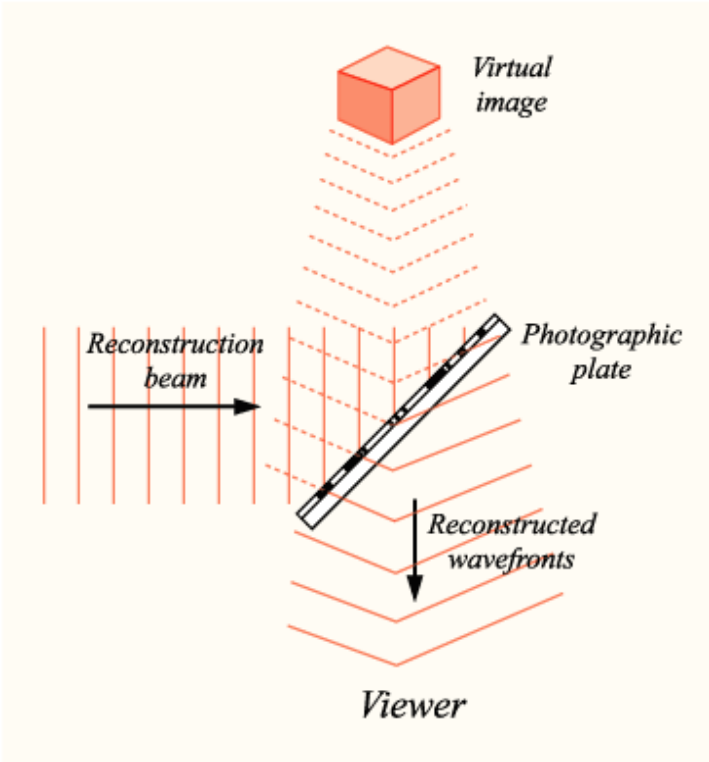
VOLUMETRIC

VIBRATING

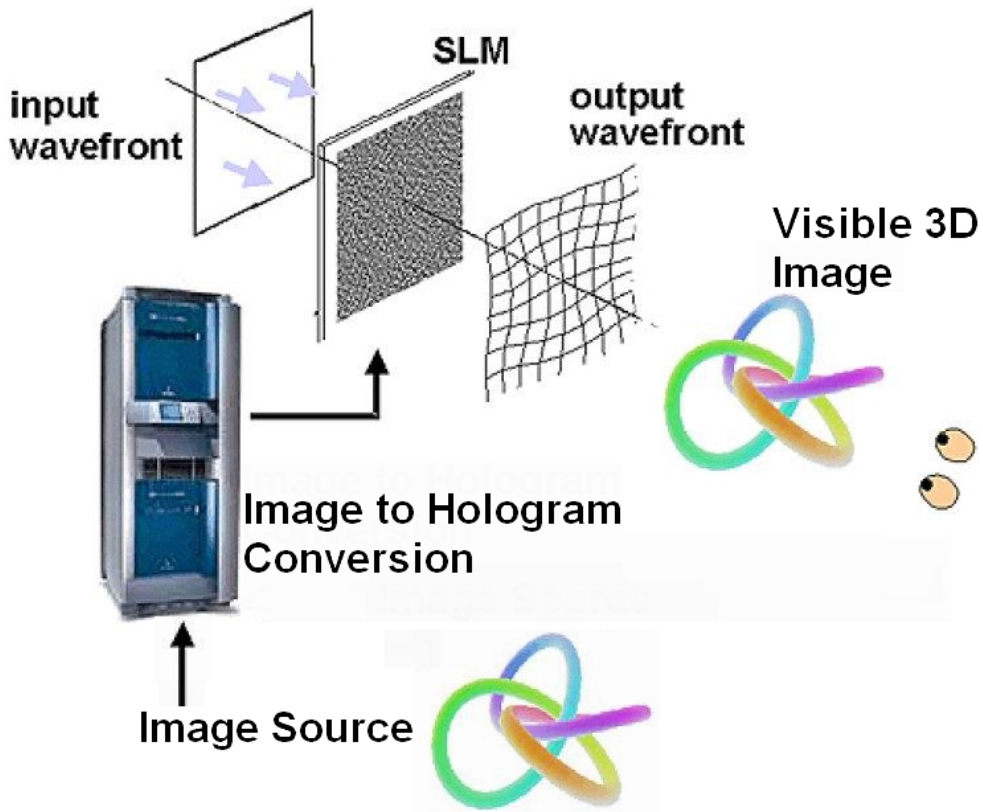
- The surface of the mirror is essentially a sphere with a continuously changing curvature.
- When an observer views the face of a CRT by reflection in the mirror, the changes in curvature cause a corresponding change in the position of the reflected image.
- The result is an autostereoscopic image that is essentially a transparent stack of 2D images.

HOLOGRAPHIC





Real-time Holographic Display

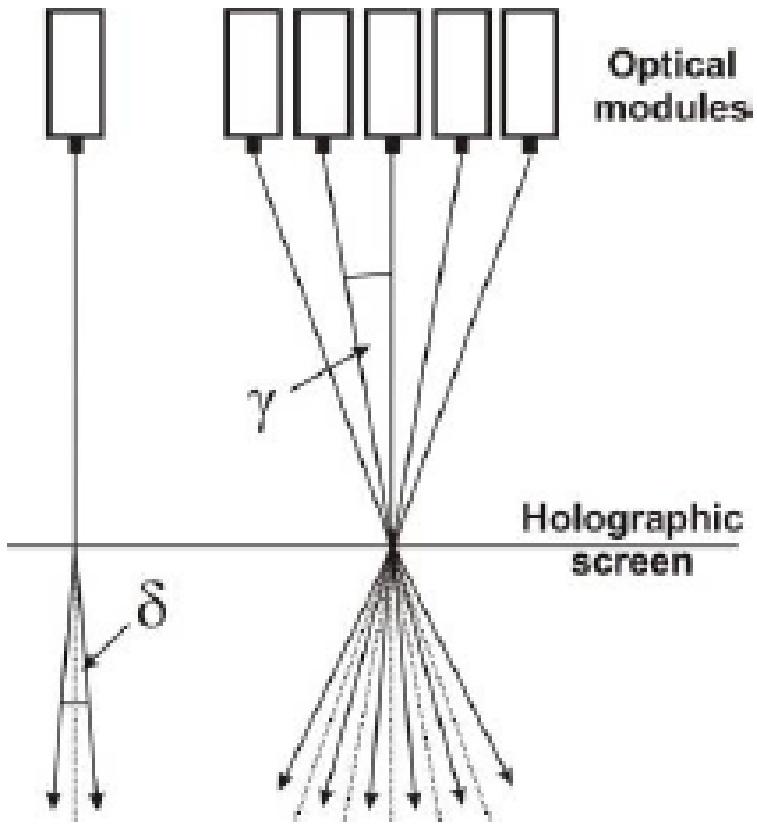


HOLOGRAPHIC

- It is possible to replace film as the image recording medium with a 2D digital display.
- By illuminating the display, the holographic image can be created and, ultimately, animated.
- The extent of the computation required to convert a 3D scene into a hologram is very substantial.
- The state of the art is such that it is possible to commercially produce still images.
- High quality, real time holographic video is not yet commercially viable.

HOLOGRAPHIC “LIKE”

- The display reconstructs the light field of 3D scene instead of views.
- An array of projector modules is arranged behind a holographic screen.
- The image produced by a module is not a 2D view of the final image
- Rather, the light beams produced by the projection modules are determined by geometry.



HOLOGRAPHIC “LIKE”

- Each point on the screen is always contributed by many modules.
- Each point of the holoscreen is able to emit light beams of a different color and intensity in different directions.

HOLOGRAPHIC "LIKE"

Holographic "Like" 3D Display	
Advantages of the technology	• No glasses needed • Motion parallax • Multi viewer • No positioning or head tracking applied
Disadvantages of the technology	• Complex • Expensive
Principle applications	• Medical, CAD, air traffic control, simulation, security, gas and oil exploration, entertainment, theme parks, scientific visualization.
Example product Company	• HoloVizio product line 620 RC • Holografika
Key specifications of example	• Aspect ratio:16:9 • Screen size: 72" diagonal • Resolution: 50.3 Mpixel • Viewing angle: 50^{o}-70^{o} • Colors: 16M (24 bit RGB)

OTHER TECHNOLOGIES

Direct View or Projection

Pulfrich

- Retinal sensors require a minimum number of light photons to send a signal to the visual system.
- One eye is covered with a neutral density filter.
- Light from a scene will be slightly time delayed to the covered eye.
- Within a scene, the eye with the filter cover will see the position of an object in motion later than the uncovered eye.

OTHER TECHNOLOGIES

Direct View or Projection

Pulfrich

- It follows that images perceived by the left and right eyes will be slightly different.
- The visual system will interpret the result as a stereo pair.
- Compatible with existing displays and transmission systems.

OTHER TECHNOLOGIES

Direct View or Projection

Pulfrich

Pulfrich Based 3D Display	
Advantages of the technology	• Multi viewer • Wide field of view • 2D compatible
Disadvantages of the technology	• Requires simple/cheap glasses • Motion required for 3D effect
Principle applications	• TV • Movies

OTHER TECHNOLOGIES

Projection

Vibrating Slit

- A shutter is placed in front of the projector lens.
- The shutter consists of a series of individually addressable, vertical stripes.
- The shutter is made black except for a single, clear slit.
- The clear slit is electronically moved back and forth in the horizontal plane.
- The imagery alternates between right and left eye perspectives and is synchronized with the motion of the slit.

OTHER TECHNOLOGIES

Projection

Vibrating Slit

- A series of full resolution images are projected into space.
- Position in the viewing zone determines the pair of images seen by the viewer.
- This approach allows for:
  - 3D motion parallax
  - Side-by-side viewers to simultaneously watch different 3D programs.
- Products based on this technology are offered by Deeplight

OTHER TECHNOLOGIES

Stereoscopic

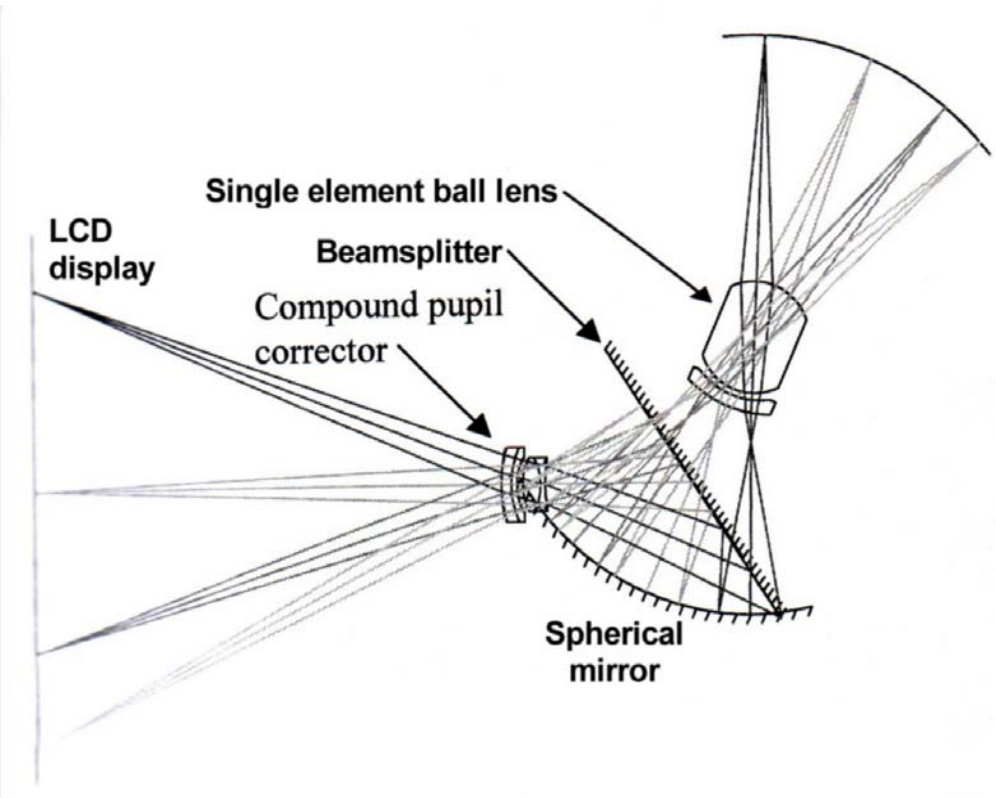
Monocentric

- The main virtue claimed of this design approach is that it enables an autostereoscopic display with both a large viewing pupil and a wide field of view.
- The system has two independent optical paths sharing a single, large spherical mirror.
- The viewer looks into two "floating balls of light" that provide each eye a magnified virtual image of the systems two 17 inch LCDs image sources.

OTHER TECHNOLOGIES

Stereoscopic

Monocentric



OTHER TECHNOLOGIES

Stereoscopic

Monocentric

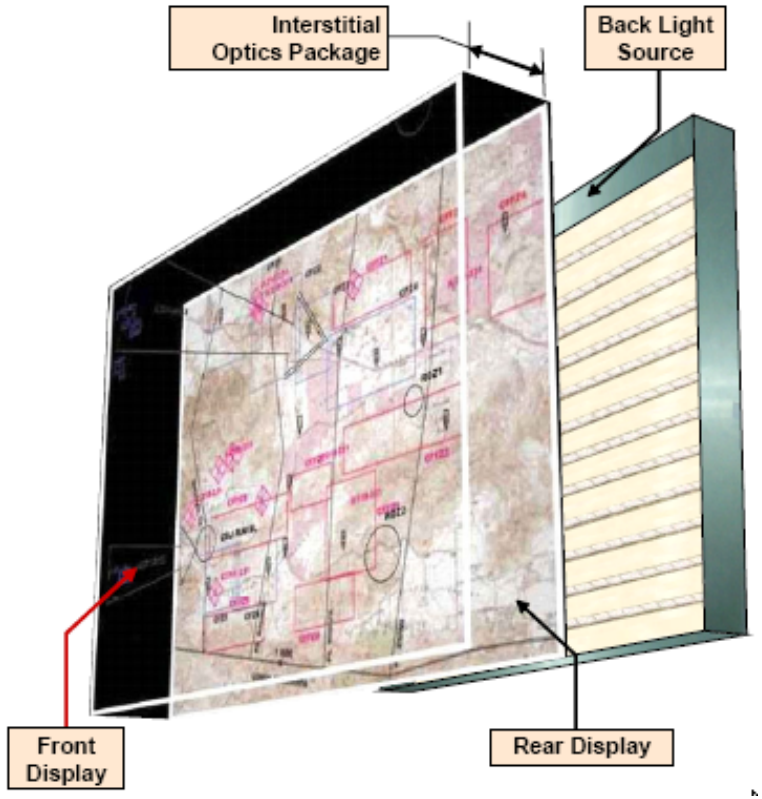
Other Technologies – Stereoscopic - Monocentric	
Advantages of the technology	• Autostereoscopic • Large viewing pupil • Large field of view
Disadvantages of the technology	• Physical form factor
Principle applications	• Intensive visualization tasks • Oil and gas exploration, molecular modeling, CAD, medical imaging.
Example product Company	• Prototype only • Kodak
Key specifications of example	• Field of view that measures 43º by 34º • Resolution of 1280 x 1024 pixels. • 40 mm viewing pupils • Image brightness is about 125 nits

OTHER TECHNOLOGIES

Direct View

Multi Layer LCDs

- Not true autostereoscopic 3D
- Comprised of two (or more) distinct layers of LCD panels of any size stacked on top of each other and sharing a common backlight.
- Each LCD receives independent control signals, through the coordination of the displayed images, a multi-layer visual display is presented.

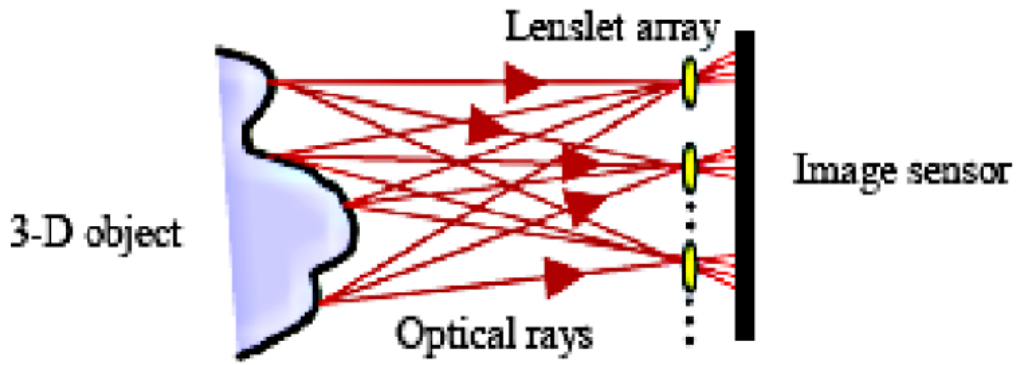


OTHER TECHNOLOGIES

Integral Imaging

To record a 3D image

- A lenslet array is used to sample light rays coming from a scene.
- The result is a tremendous number of closely packed but distinct micro images.
- Each micro image contains information on the direction and intensity of the spatially sampled light.

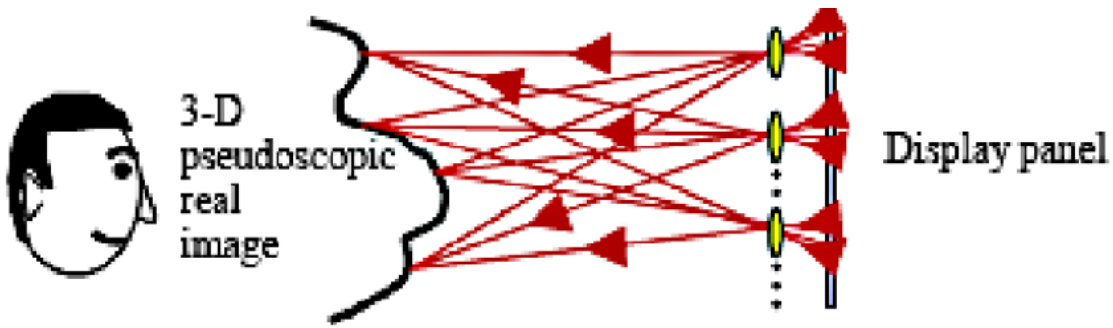


OTHER TECHNOLOGIES

Integral Imaging

To reconstruct the 3D image

- The set of 2D micro images are displayed in front of a lenslet array using a 2D display panel.
- There is one lenslet for every micro image in the integral image.
- Rays from the micro images travel through the lenslet array and converge to form a 3D real image.

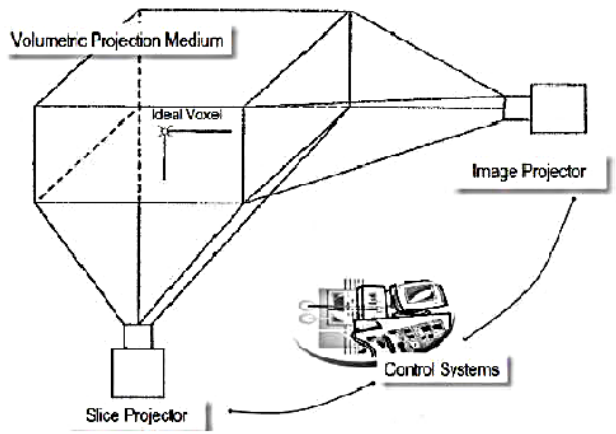


OTHER TECHNOLOGIES

Volumetric - Projection

Dual laser

- Two DLP projectors.
- Two infra red lasers having different wavelengths.
- Up-converting medium.
- Scanning is synchronized.



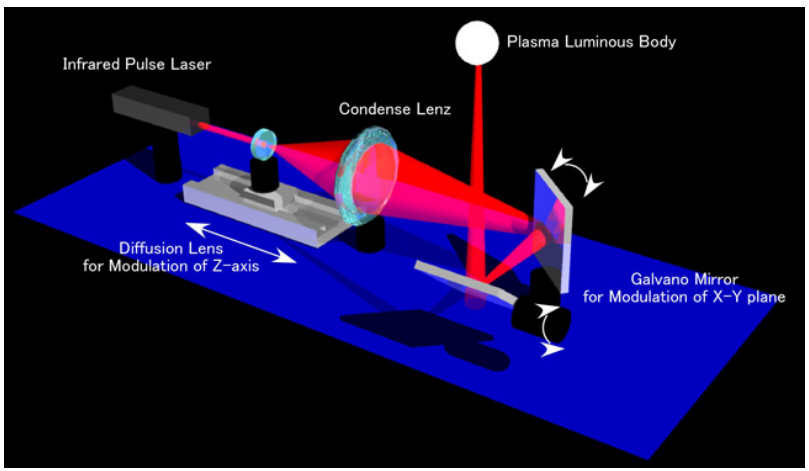
OTHER TECHNOLOGIES

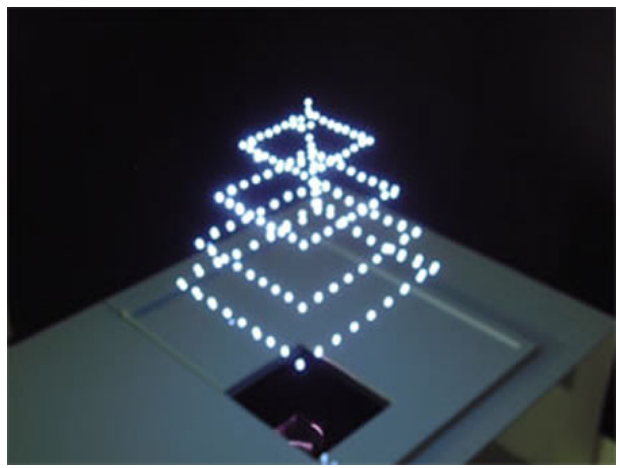
Volumetric - Projection

Free Space, Laser - Plasma 3D Display

- When a laser beam is strongly focused, plasma emission can be induced from the air near the focal point. This is called free space emission and is of one color.

- The laser produces nanosecond-long pulses of infrared light from a NdYAG laser at a wavelength of 1,064 nm.





OTHER TECHNOLOGIES

Volumetric - Projection

Free Space, Laser - Plasma 3D Display

- One pulse is used for each dot in the image.
- By synchronizing the timing of the laser pulses with the direction of the focal point, an image consisting of 100 dots per second can be drawn in a 2D plane.
- Changing the focal point allows producing points in the third dimension.
- Galvanometric mirrors are used to direct the laser beam along the x and y directions.

CONCLUSIONS

- There are a lot of companies developing 3D technology.
- There are a lot of different types of 3D technologies.
- There are a lot of different types of 3D products.
- Each technological approach has a different set of advantages and disadvantages.

CONCLUSIONS

- Taken in conjunction with the fact that there are a wide range of 3D applications:
- The result is that there is not a single best approach to 3D but, rather, approaches that are better for given applications.
- Looking forward, business opportunities exist for many 3D companies and technologies.

THANK YOU!


Ευχαριστώ
Благодаря
ขอบคุณ
متشكرم
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