

3D Game Programming Virtual Reality

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Goal


- ✍ Stereo displayer
- ✍ Human Interface Device
- ✍ XR(VR, AR, MR)

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Depth perception

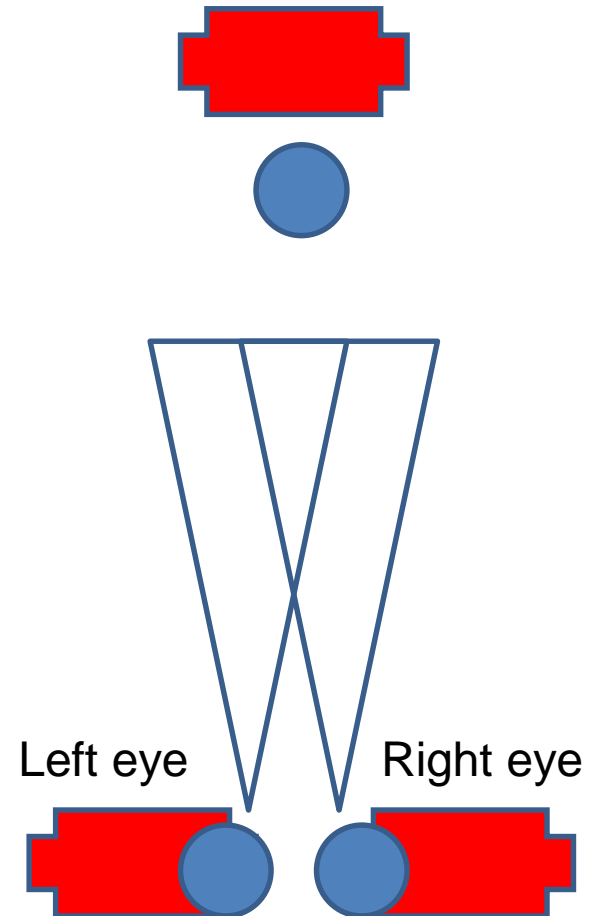
- 
- Depth sensation** is the ability to move accurately, or to respond consistently, based on the distances of objects in an environment
- binocular cues
 - monocular cue

Binocular cues

 Stereopsis or retinal(binocular)
disparity

 Convergence

 Shadow Stereopsis



Monocular cues

- ✎ Motion parallax
- ✎ Depth from motion
- ✎ Perspective
- ✎ Relative size
- ✎ Occlusion



Stereoscopic

- ❏ Stereoscopic technology provides a different image to the viewer's left and right eyes.



View of [Boston](#), c. 1860



Brewster-type
stereoscope, 1870

Categories of 3D viewer technology

With glasses

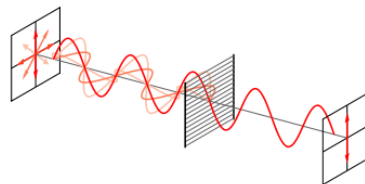
Active

- Liquid crystal shutter glasses



Passive

- polarized glasses
- Complementary color anaglyphs



Others

- Head-mounted display

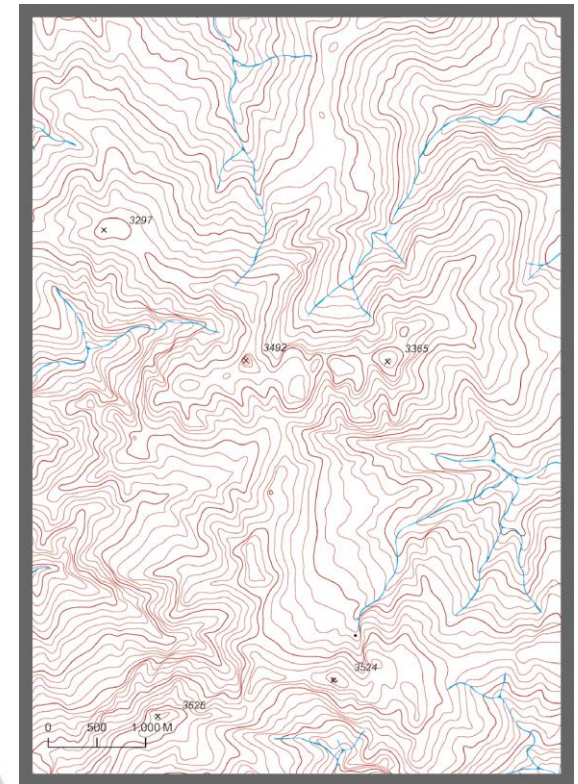
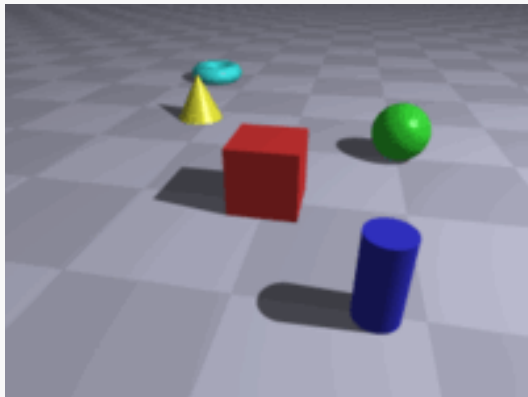


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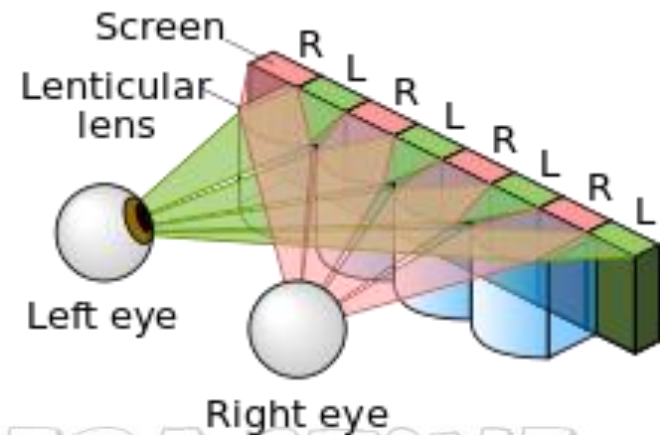
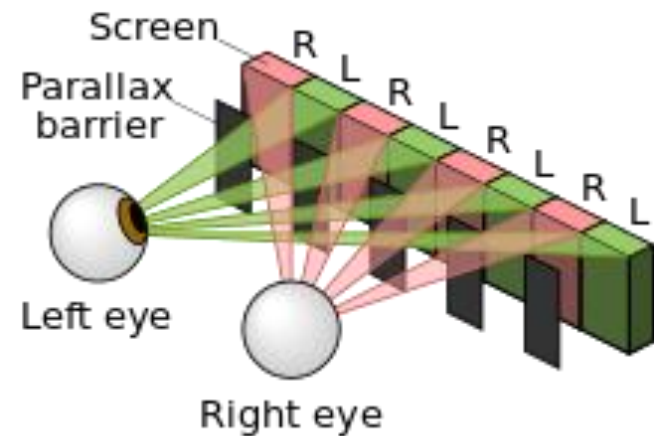
Without glasses

- Wiggle stereoscopy



Without glasses

- Autostereoscopy
 - Parallax barrier
 - Lenticular lens






[youtube](#)

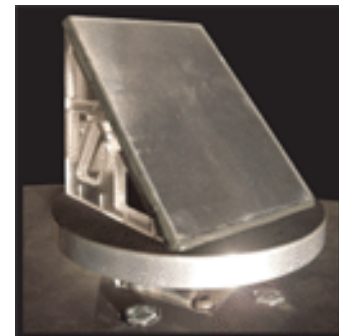
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Holography

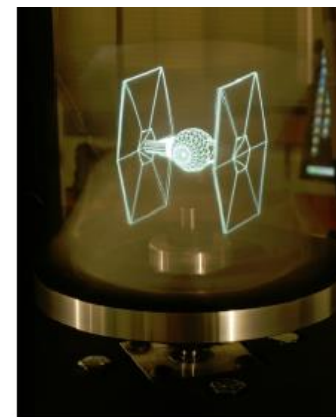
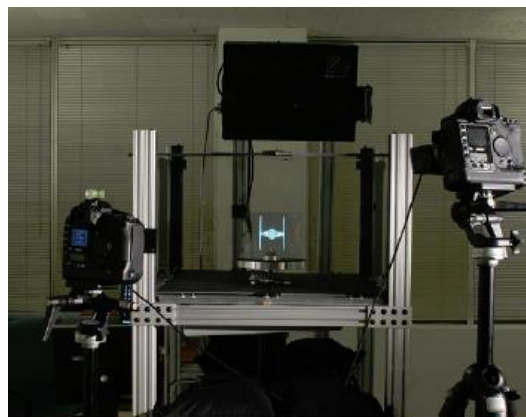
-  Holography is a technique that allows the light scattered from an object to be recorded and later reconstructed so that it appears as if the object is in the same position relative to the recording medium as it was when recorded.

Light field display

Andrew Jones *et al* proposed an autostereoscopic light field display able to present interactive 3D graphics to multiple simultaneous viewers 360 degrees around the display, in 2007,

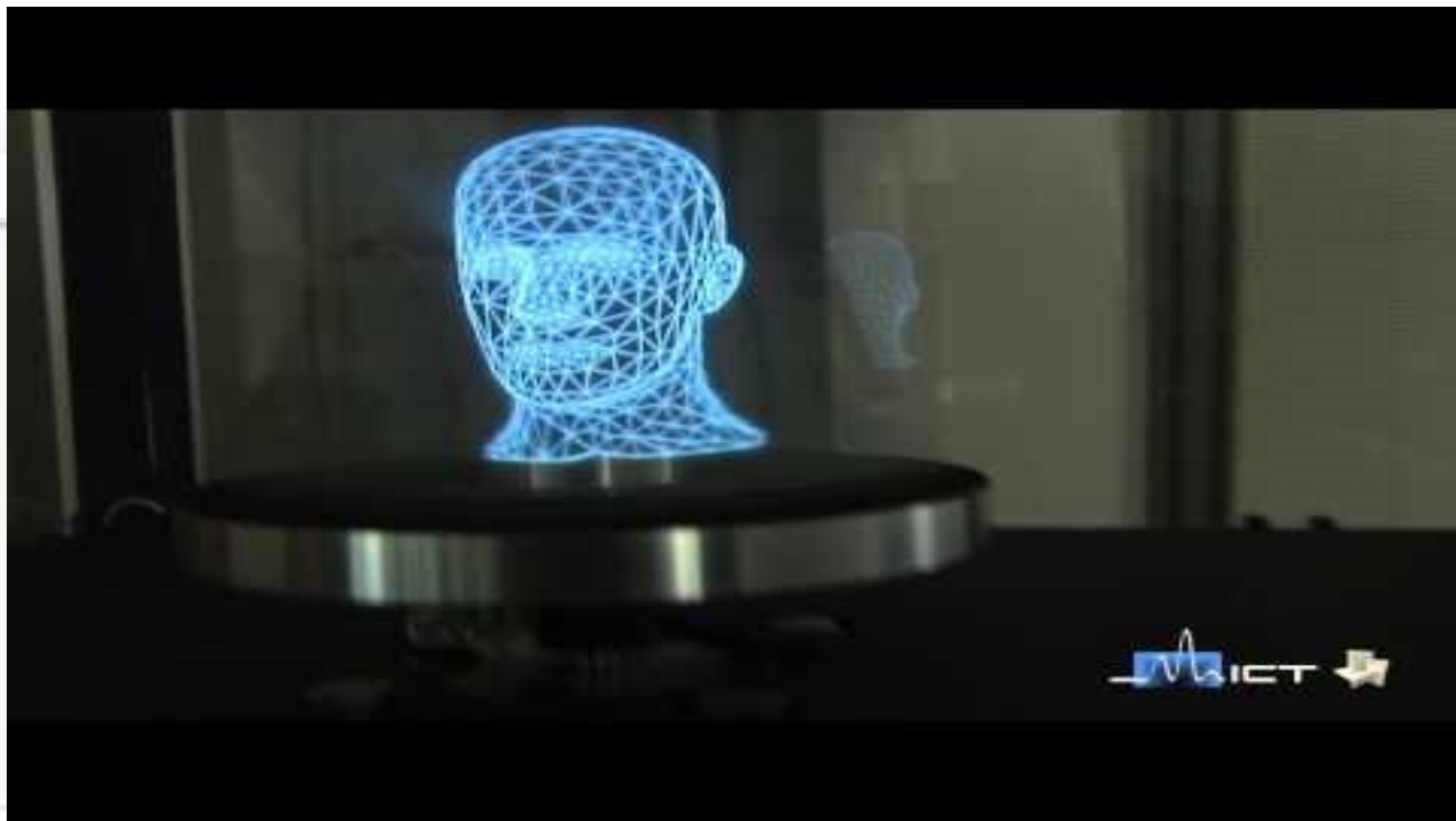


Anisotropic spinning mirror

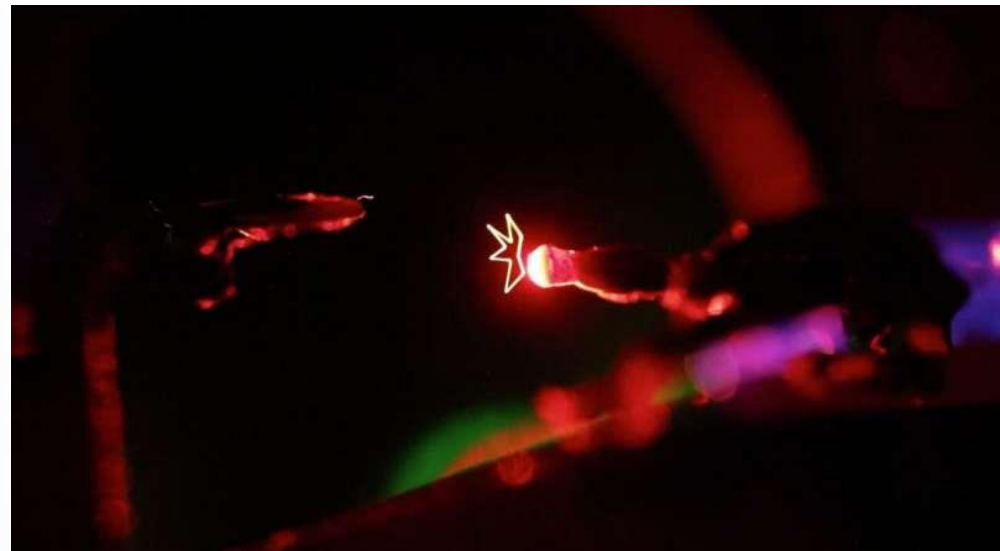
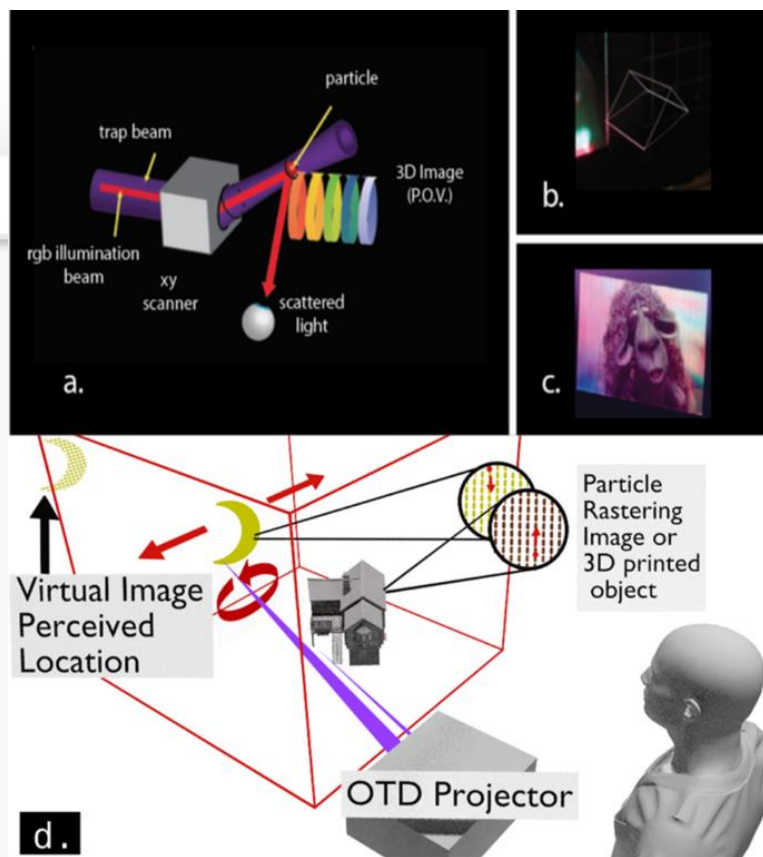


3D display

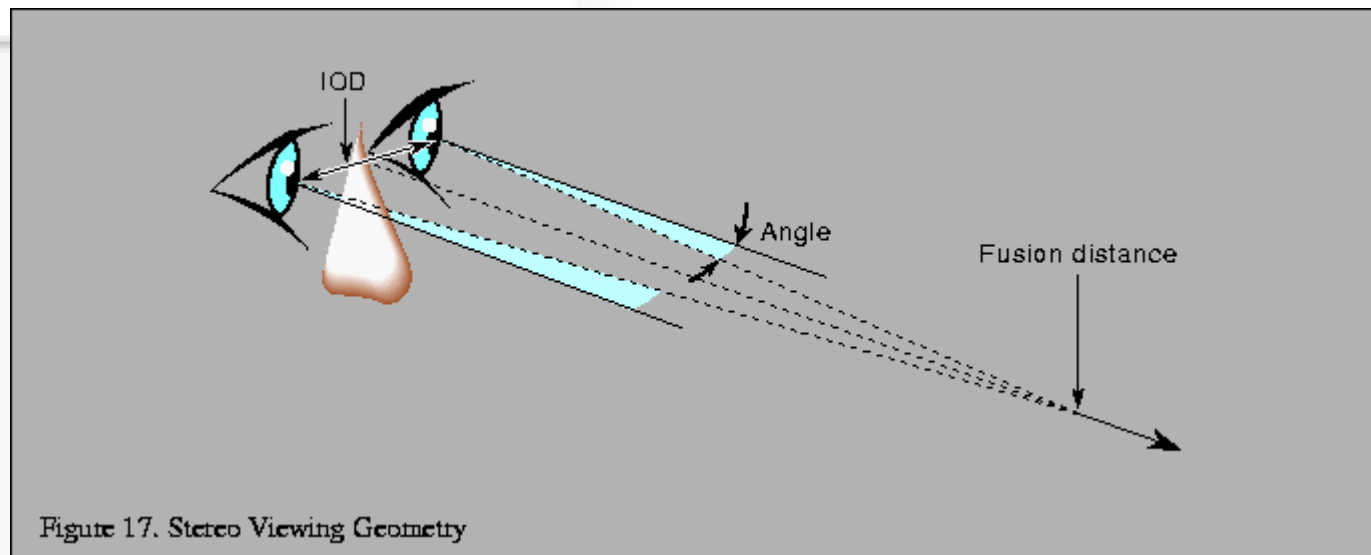
USC Institute for Creative Technologies



optical trap displays



Wesley Rogers et al, Simulating virtual images in optical trap displays, *Scientific Reports* (2021). DOI: [10.1038/s41598-021-86495-6](https://doi.org/10.1038/s41598-021-86495-6)



SIGGRAPH 99 coursenote

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OpenGL Quad buffer

```
glClear();  
glMatrixMode(GL_MODELVIEW);  
glLoadIdentity(); /* the default matrix */  
glPushMatrix();  
glDrawBuffer(GL_BACK_LEFT);  
gluLookAt(-IOD/2.0, 0.0, EYE_BACK,  
0.0, 0.0, 0.0,  
0.0, 1.0, 0.0);  
<viewing transforms>  
<modeling transforms>  
draw();
```

```
glClear();  
glPopMatrix();  
glPushMatrix()  
glDrawBuffer(GL_BACK_RIGHT);  
gluLookAt(IOD/2.0, 0.0, EYE_BACK,  
0.0, 0.0, 0.0,  
0.0, 1.0, 0.0);  
<viewing transforms>  
<modeling transforms>  
draw();  
glPopMatrix();  
  
glutSwapBuffer();
```

Anaglyphs Using OpenGL

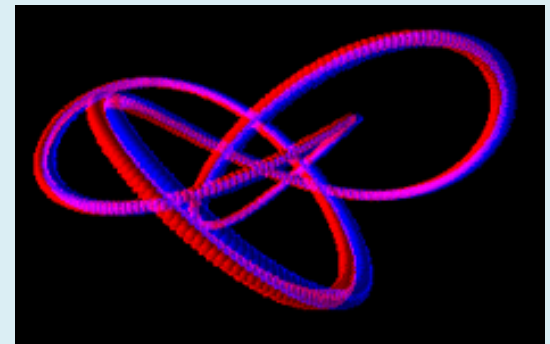
```
glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);  
glColorMask(GL_TRUE, GL_FALSE, GL_FALSE, GL_TRUE);  
// set camera for blue eye, red will be filtered.  
// draw scene
```

```
glClear(GL_DEPTH_BUFFER_BIT);  
glEnable(GL_BLEND);  
glBlendFunc(GL_ONE, GL_ONE);  
glColorMask(GL_FALSE, GL_FALSE, GL_TRUE, GL_TRUE);  
// set camera for red eye, blue will be filtered.
```

...

```
// draw scene
```

....



libgls

```
glsClear(ctx);
```

```
// ... clear and render left view ...
```

```
glsSubmitView(ctx, GLS_VIEW_LEFT);
```

```
// ... clear and render right view ...
```

```
glsSubmitView(ctx, GLS_VIEW_RIGHT);
```

```
glsDrawSubmittedViews(ctx, GLS_MODE_RED_CYAN_DUBOIS,  
GL_FALSE);
```

```
// ... swap buffers ...
```

Unity XR Toolkit

OpenXR Plugin Release

Unity Technologies

Version 1.3.1 - December 02, 2021

Registry Unity

[View documentation](#) • [View changelog](#) • [View licenses](#)

OpenXR is an open, royalty-free standard developed by Khronos that aims to simplify AR/VR development by allowing developers to target

Project Settings

Adaptive Performance

Audio

Editor

Graphics

Input Manager

Input System Package

Memory Settings

Package Manager

Physics

Physics 2D

Player

Preset Manager

Quality

Scene Template

Script Execution Order

Services

Ads

Cloud Build

Cloud Diagnostics

Collaborate

In-App Purchasing

Legacy Analytics

Tags and Layers

TextMesh Pro

Time

Timeline

UI Builder

Version Control

XR Plug-in Management

OpenXR

XR Plug-in Management

Initialize XR on Startup ☒

Plug-in Providers ⓘ

☐ Oculus

☒ OpenXR

☐ Unity Mock HMD

Information about configuration, tracking and migration can be found below.

[View Documentation](#)

Package Manager

+ Packages: In Project Sort: Name ↓

▼ Packages - Unity

▶ JetBrains Rider Editor	3.0.12 ✓
▶ OpenXR Plugin	1.3.1 ✓
▶ Test Framework	1.1.29 ⓘ
▶ TextMeshPro	3.0.6 ✓
▶ Timeline	1.6.4 ✓
▶ Unity UI	1.0.0 ✓
▶ Version Control	1.15.12 ⓘ
▶ Visual Studio Code Editor	1.2.5 ✓
▶ Visual Studio Editor	2.0.14 ✓
▼ XR Interaction Toolkit	2.0.0 ✓
Currently installed	2.0.0 R
	1.0.0-pre.8 Pre

XR Interaction Toolkit **Release**

Unity Technologies

Version 2.0.0 - February 21, 2022

Registry Unity

[View documentation](#) • [View changelog](#) • [View licenses](#)

A high-level, component-based, interaction system for creating VR and AR experiences. It includes a set of components, and an Interaction Manager that ties these two types of components together.

▼ Samples

Starter Assets 92.88 KB	Import
XR Device Simulator 41.13 KB	Import

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HUMAN INTERFACE DEVICE

(HID)

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Input device



Mouse



Keyboard



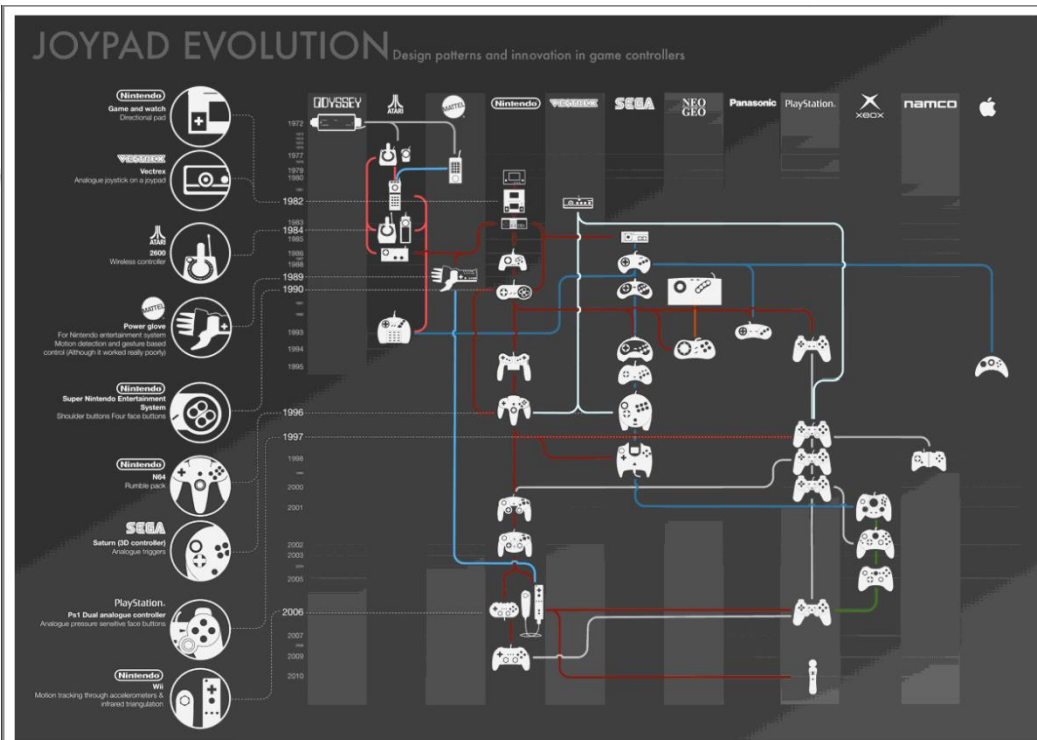
Gamepad



Immersed
control



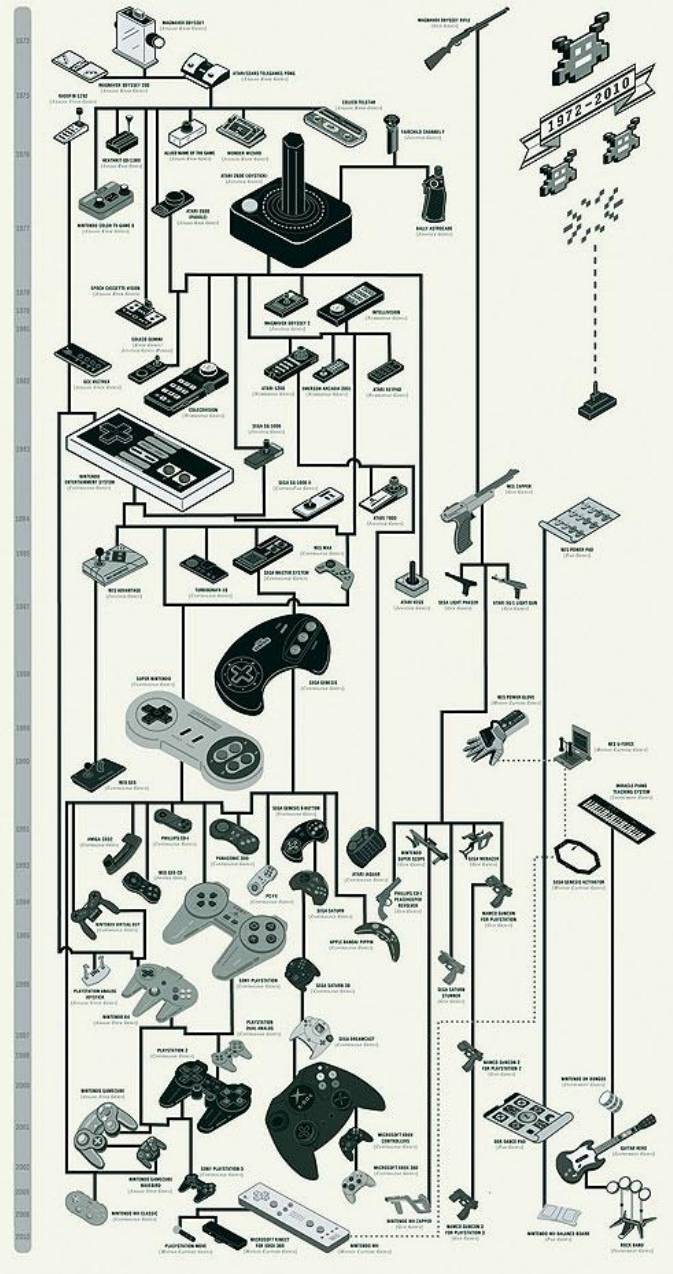
Controllers



The Evolution of

CONTROLLERS

GENEALOGY



<http://www.bitrebels.com/geek/the-evolution-of-video-game-controllers-infographic/>



Gif made by [Christian Tailor](#).

Type of inputs



Digital buttons



Analog axes and buttons



Relative Axes

Accelerometer (加速度儀)

- ✍ An accelerometer is a device that measures proper acceleration.
- ✍ Especially useful to identify the gravity force

Gyroscope(陀螺儀)

- ✎ A gyroscope is a device for measuring or maintaining orientation, based on the principles of conservation of angular momentum.

Touch user interface (觸控介面)

 A touch user interface (TUI) is a computer-pointing technology based upon the sense of touch (haptics).



An touch based interface example.

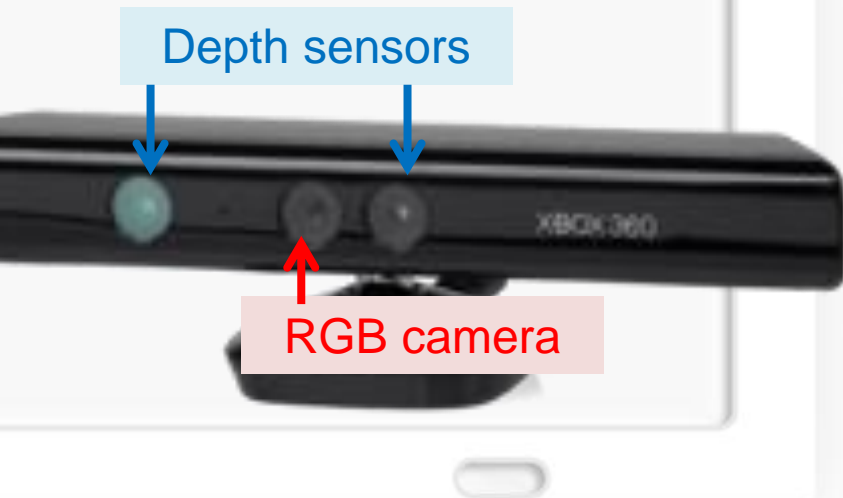
**As-Rigid-As-Possible Shape
Manipulation**

Vision based interface

Get user input through the computer vision technique

Wii remote contains a IR camera

Kinect



Types of HID outputs



Rumble pack

- Simulating the turbulences or impact



Force-Feedback

- Steering wheel



Audio

DualSense

觸覺回饋、動態自適應扳機以及內建麥克風

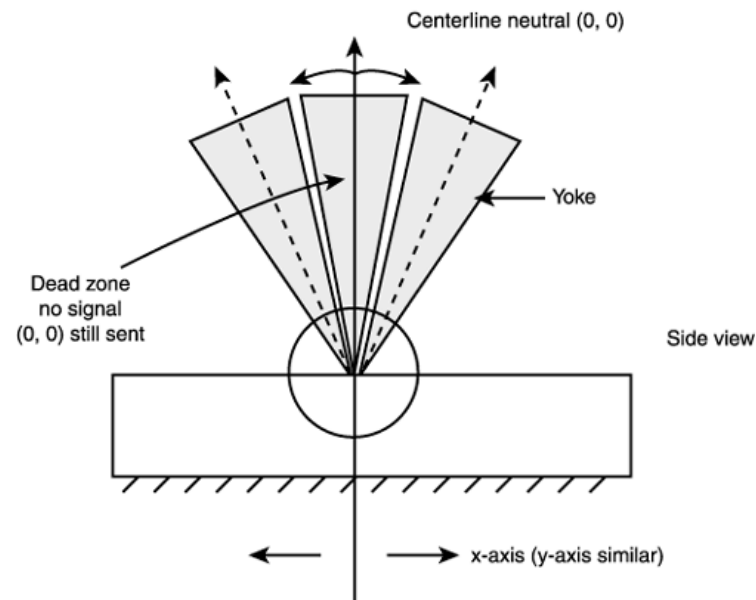


14:25

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HID process

- Dead zones
- Analog signal filtering
- Event detection
- Button sequences and multiple player
- Gesture detection
- Controller input re-mapping



The "joystick deadzone" is the area around the center of a joystick that does not respond to movement. It is designed to cut down on accidental movement caused by "jitter".

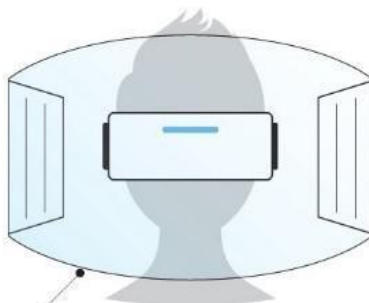
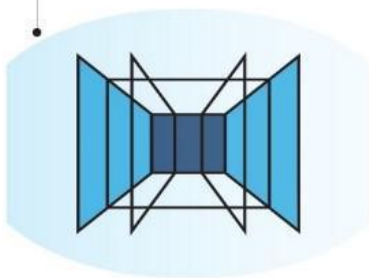
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Extended Reality

VIRTUAL REALITY (VR)

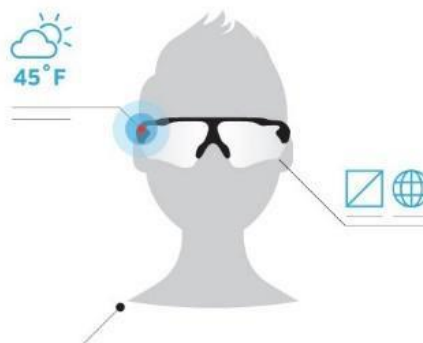
Completely digital environment



Fully enclosed, synthetic experience with no sense of the real world.

AUGMENTED REALITY (AR)

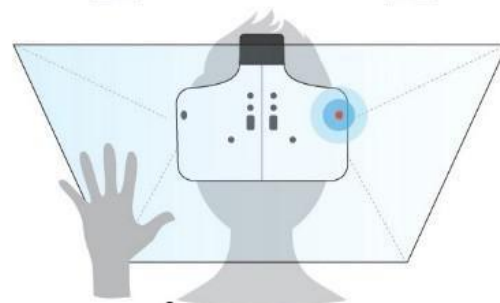
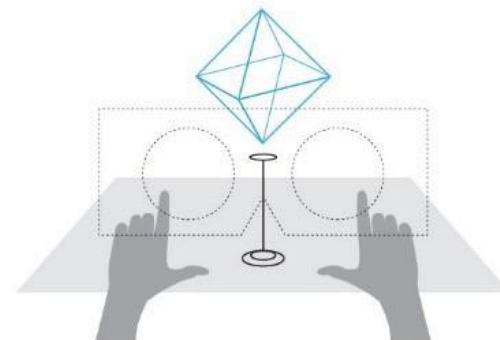
Real world with digital information overlay



Real world remains central to the experience, enhanced by virtual details.

MERGED REALITY (MR)

Real and the virtual are intertwined



Interaction with and manipulation of both the physical and virtual environment.

Cave

Cave Automatic Virtual Environment

- An immersive virtual reality environment where projectors are directed to three, four, five or six of the walls of a room-sized cube.



Star wars battle pod



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Head-Mounted Displays



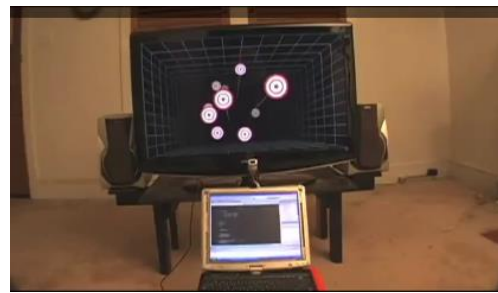
Consider carrying two displays around on your head.

- + Stereopsis is a strong 3D cue
- + Existing Technology
- + Personal Display
- Obtrusive
- Narrow FOV (Tunnel Vision)
- Low Resolution
- Tracking

Currently the most popular 3-Dimensional (VR) display

Head Tracking

- Head Tracking is an important to obtain position and orientation for pose determination and recognition of simple gestures such as nodding and head shaking.



Head Tracking for Desktop VR Displays using the Wii Remote

[Johnny Chung Lee](#)

Using (left) a head mounted sensor bar (two IR LEDs) and light a wii remote .

Head-Mounted Displays



Oculus Rift



Sony
PlayStation VR



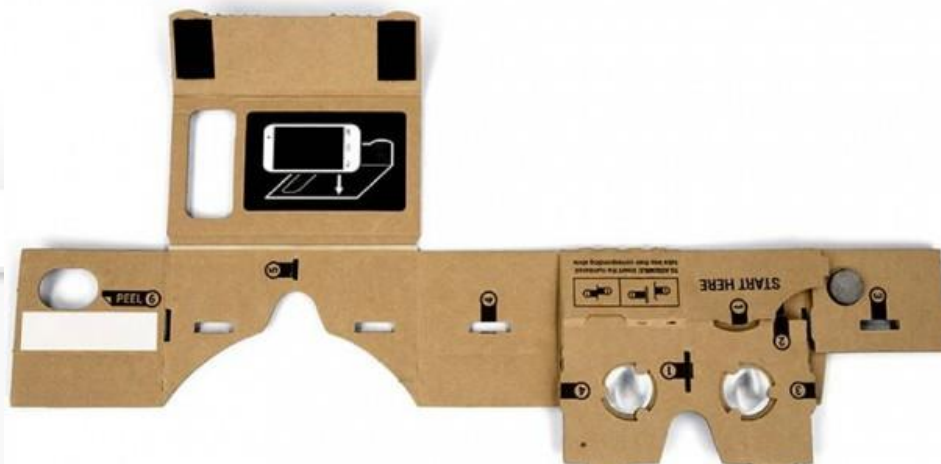
Htc vive

Inside oculus rift DK2



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google cardboard



HTC vive



VIVE控制器

- 專為VR設計
- 直覺性的操作與手勢偵測
- 真實高解析的觸覺回饋

VIVE基地台

- 360°全區追蹤定位覆蓋
- 無線同步技術
- 使用標準規格螺紋，安裝簡易

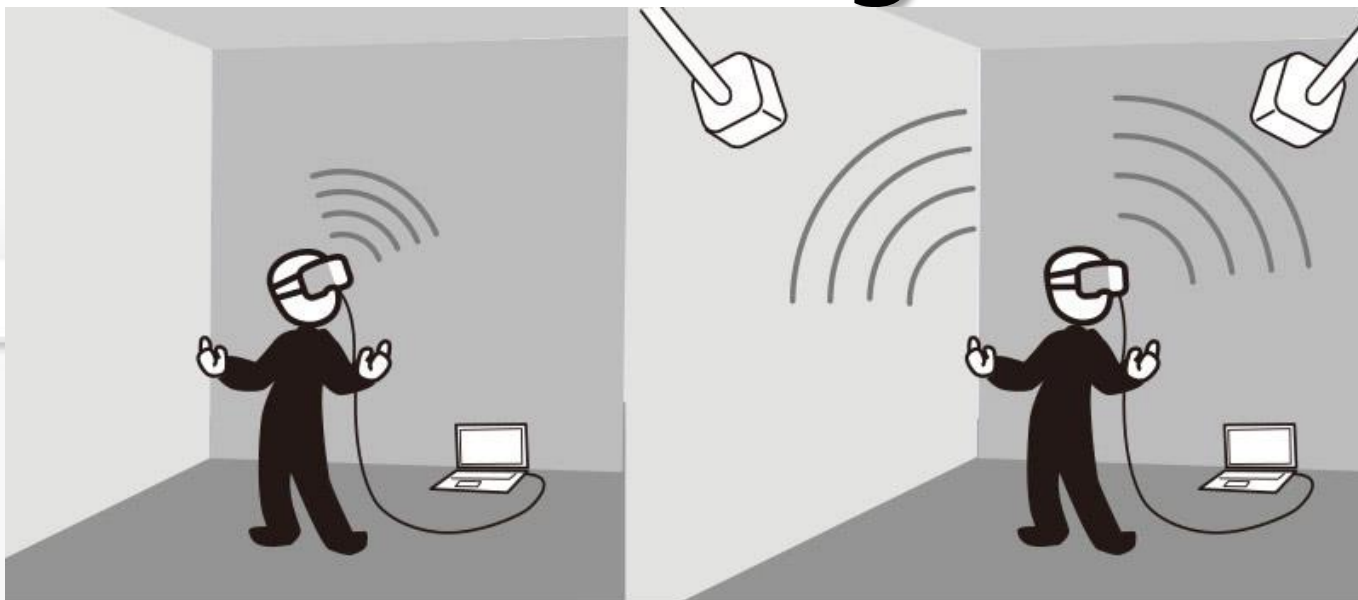


Room scale VR



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Inside-out tracking



Inside-Out Tracking

Outside-In Tracking



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Spatial Computing



Reference



立體顯示技術簡介



Creating And Viewing Anaglyphs



Head Tracking for Desktop VR Displays
using the Wii Remote

- <http://johnnylee.net/projects/wii/>