3D Game Programming Virtual Reality

Ming-Te Chi
Department of Computer Science,
National Chengchi University

Goal

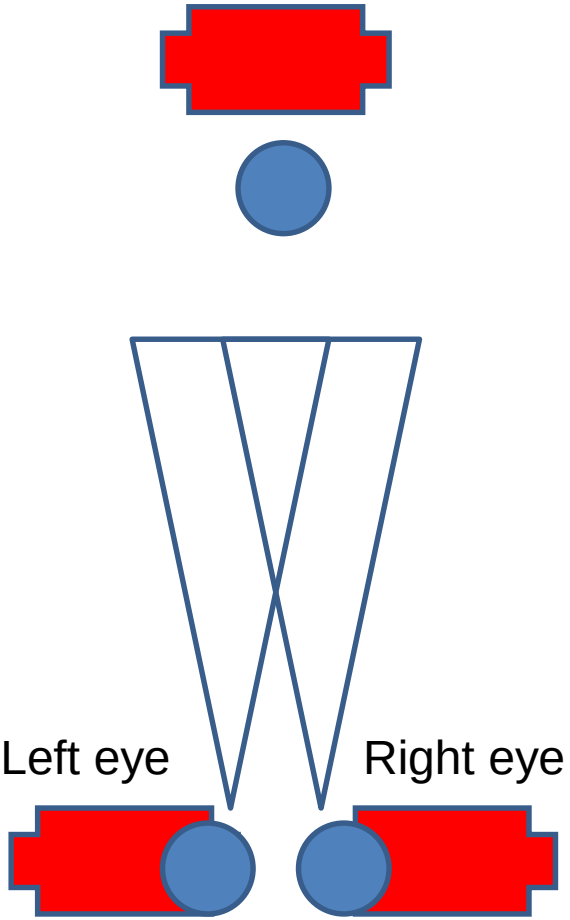
- Stereo displayer
- Human Interface Device
- XR(VR, AR, MR)

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

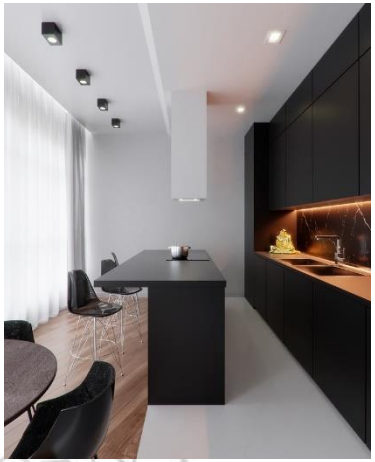
Binocular cues

- 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.

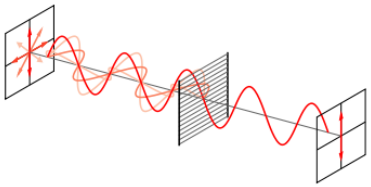
View of Boston, c. 1860

Brewster-type stereoscope, 1870

Categories of 3D viewer technology

With glasses

- Active
  - Liquid crystal shutter glasses

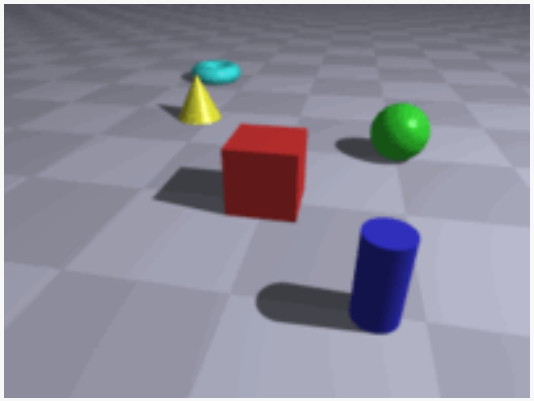


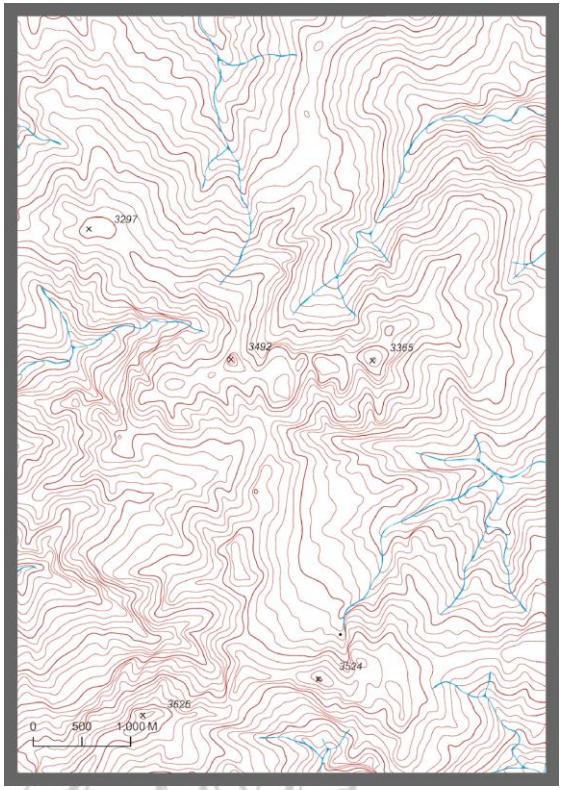
- Passive
  - polarized glasses
  - Complementary color anaglyphs

- Others
  - Head-mounted display

Without glasses

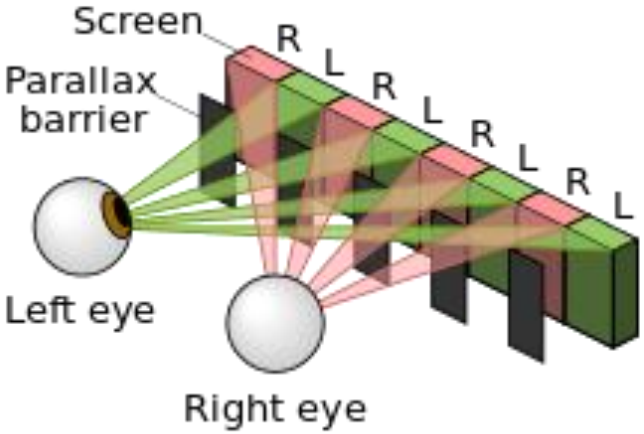
- Wiggle stereoscopy

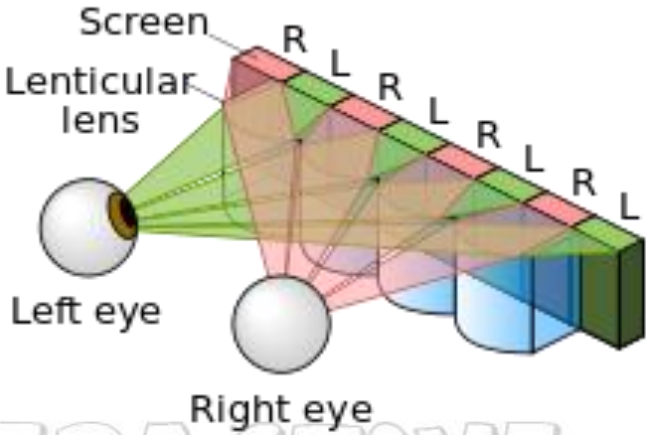




Without glasses

- Autostereoscopy
  - **Parallax barrier**
  - **Lenticular lens**





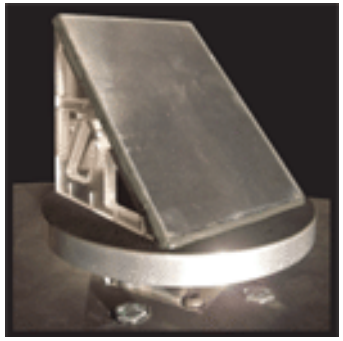
youtube

Holography

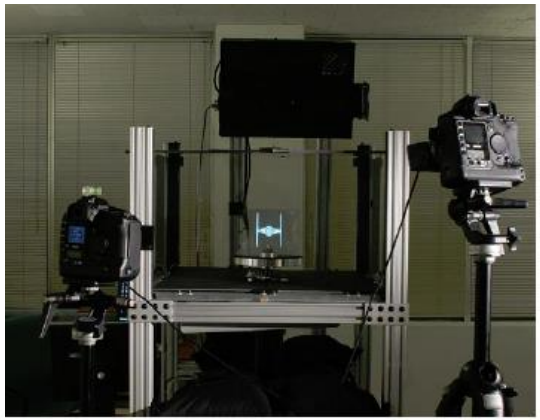
- **Holography** is a technique that allows the light scattered from an object to be recorded and later reconstructed so that it appears as if the object is in the same position relative to the recording medium as it was when recorded.

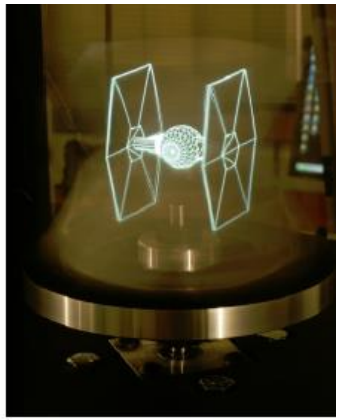
Light field display

- 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,



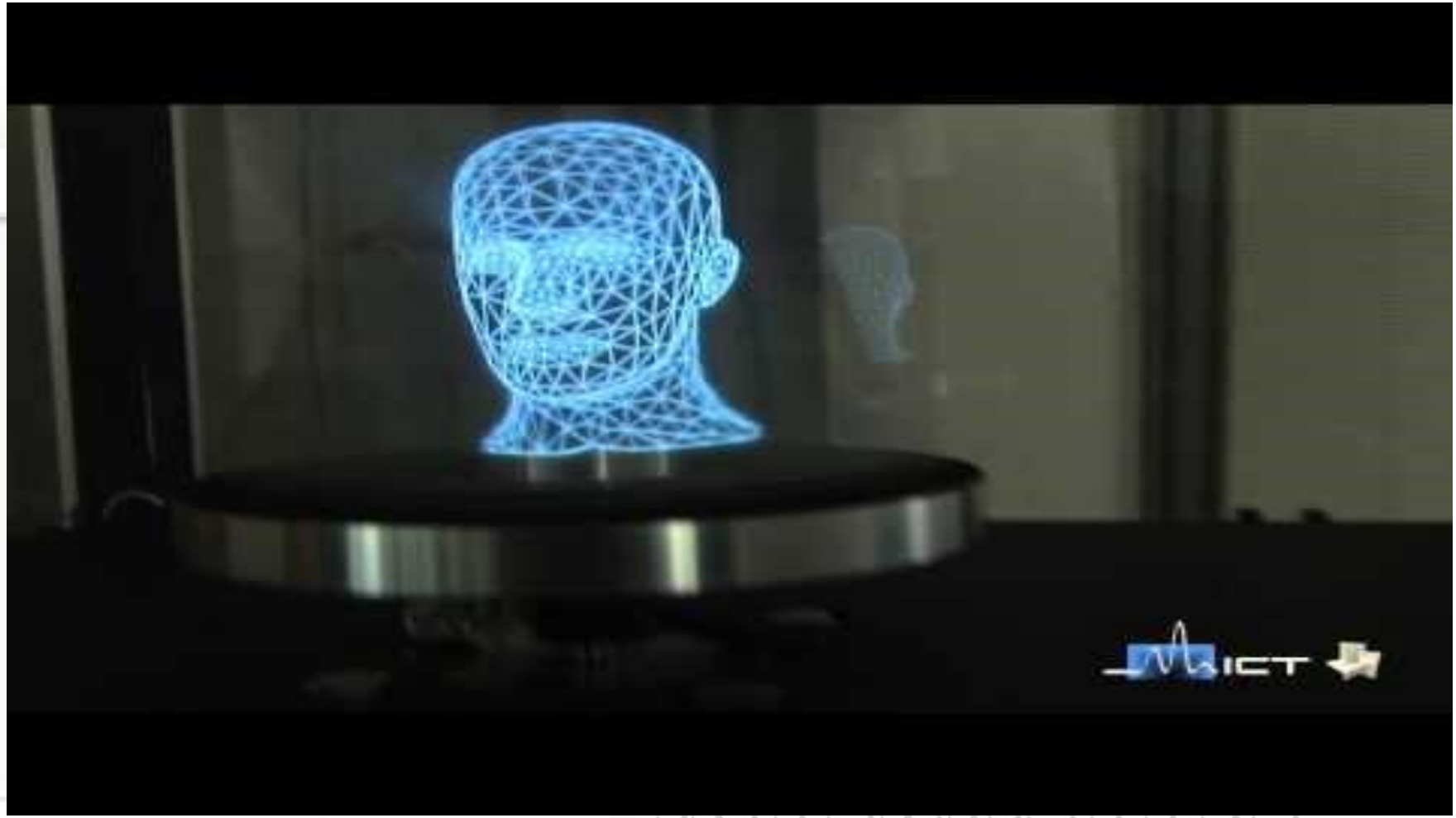
Anisotropic spinning mirror



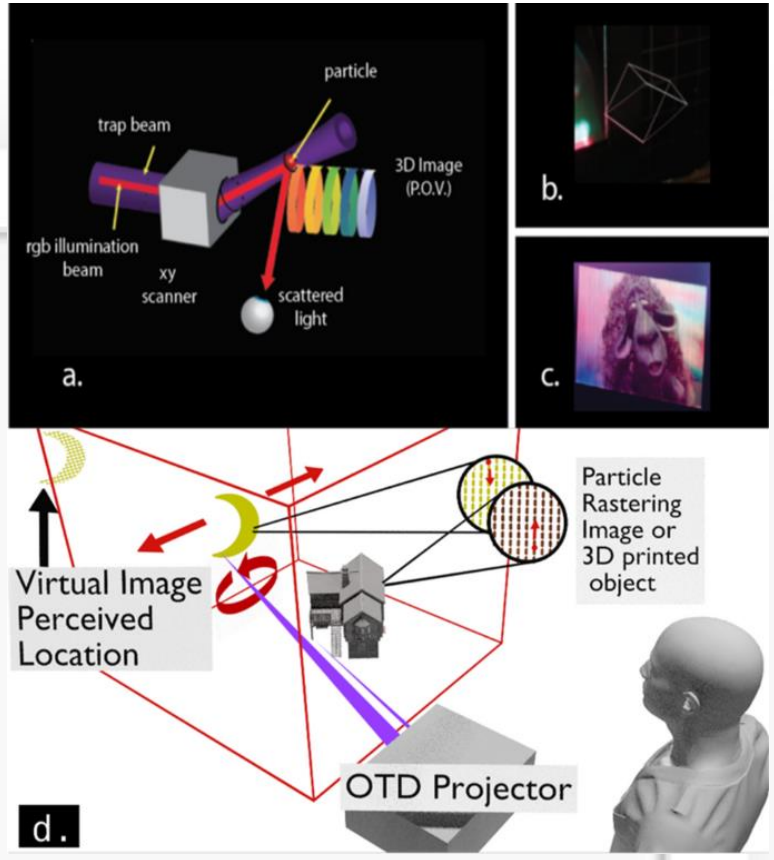


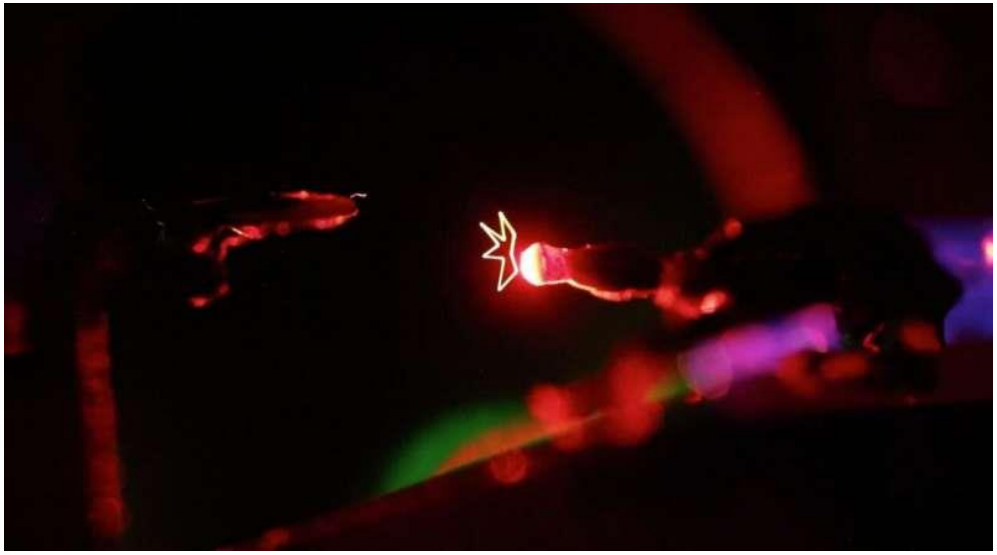
3D display

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

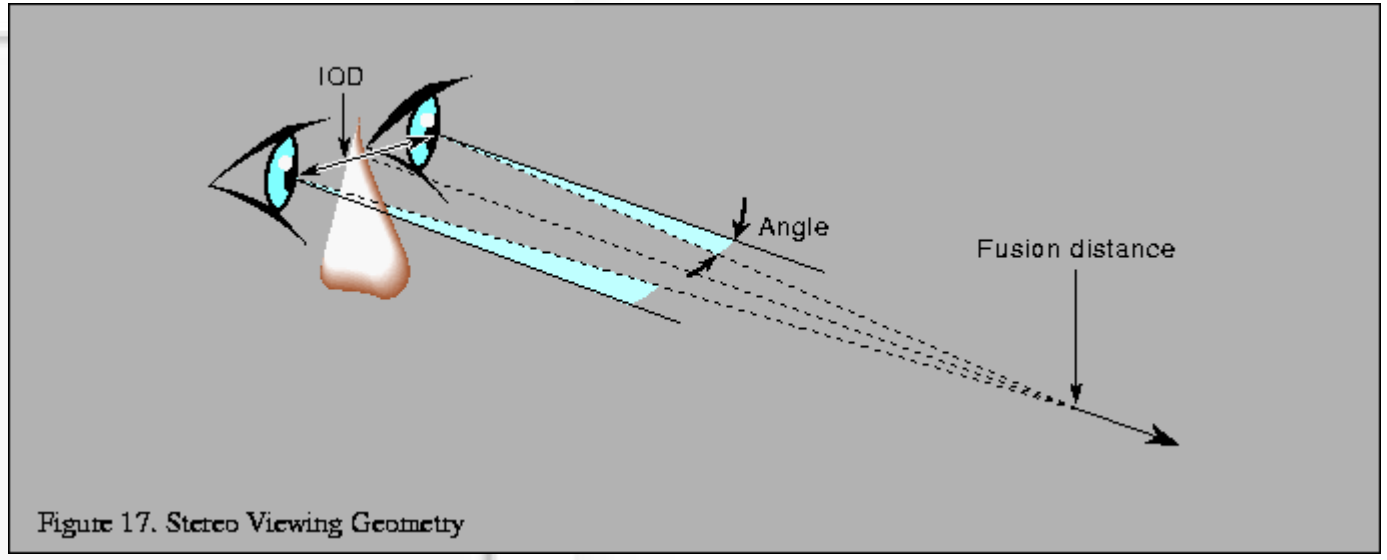


Figure 17. Stereo Viewing Geometry

SIGGRAPH 99 coursenote

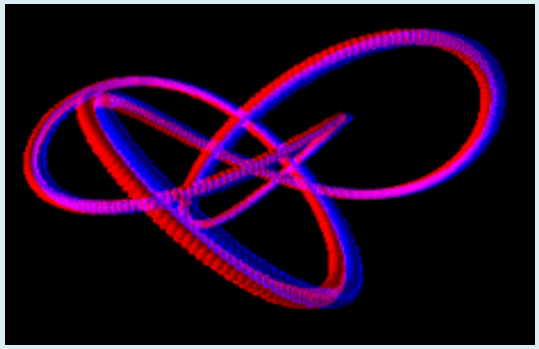
OpenGL Quad buffer

```
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

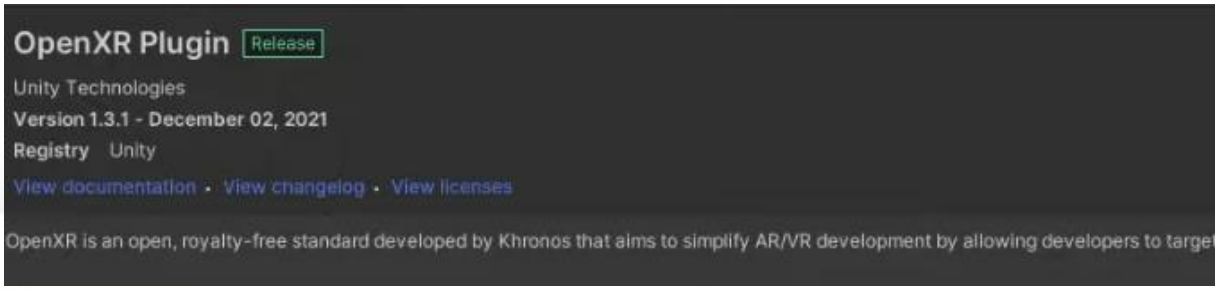
```
glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
glColorMask(GL_TRUE, GL_FALSE, GL_FALSE, GL_TRUE);
// set camera for blue eye, red will be filtered.
// draw scene

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
....
```

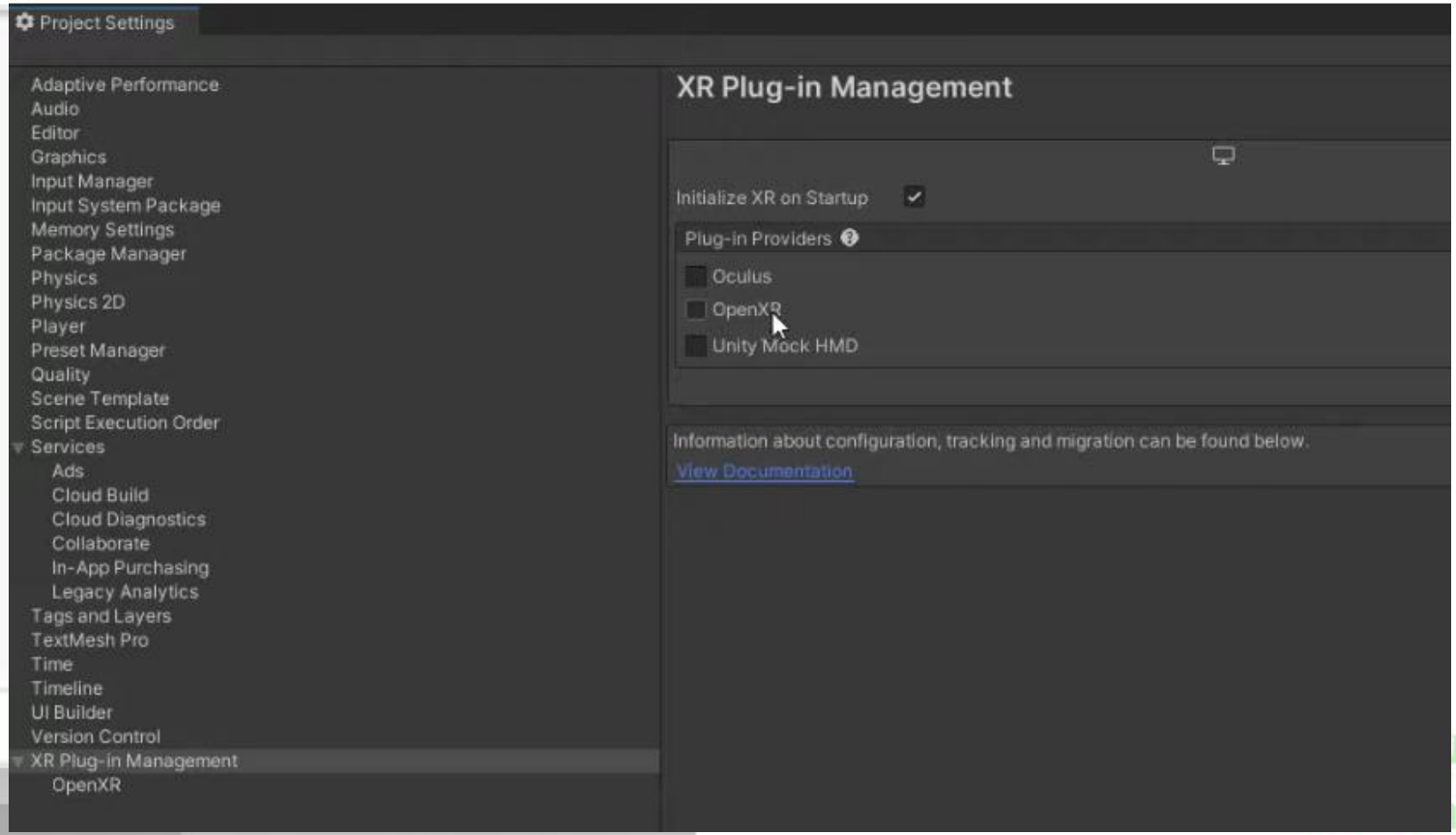


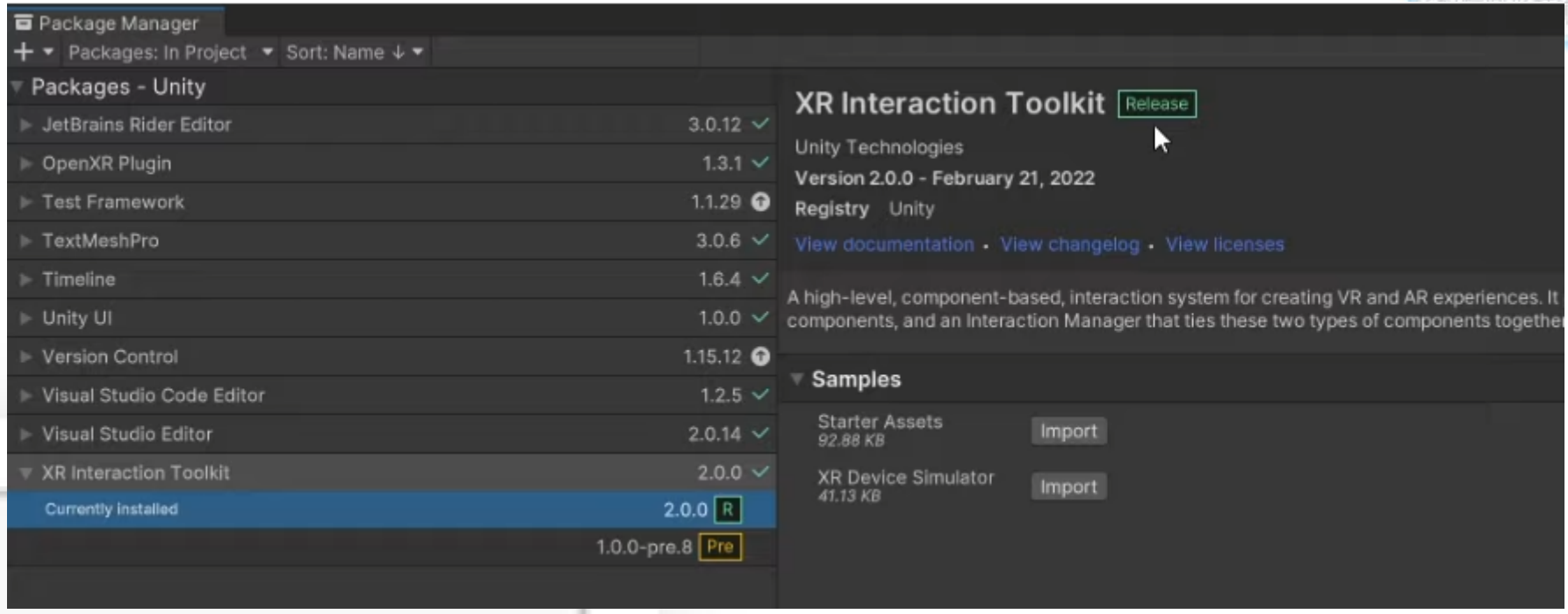
libgls

```
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







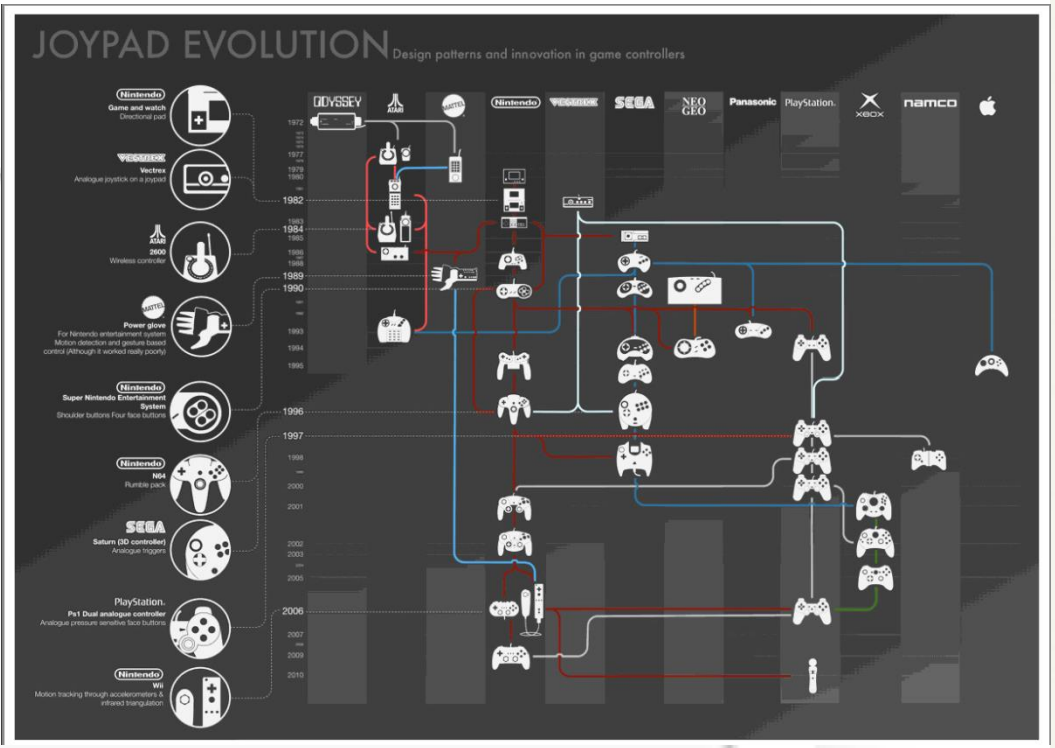
HUMAN INTERFACE DEVICE

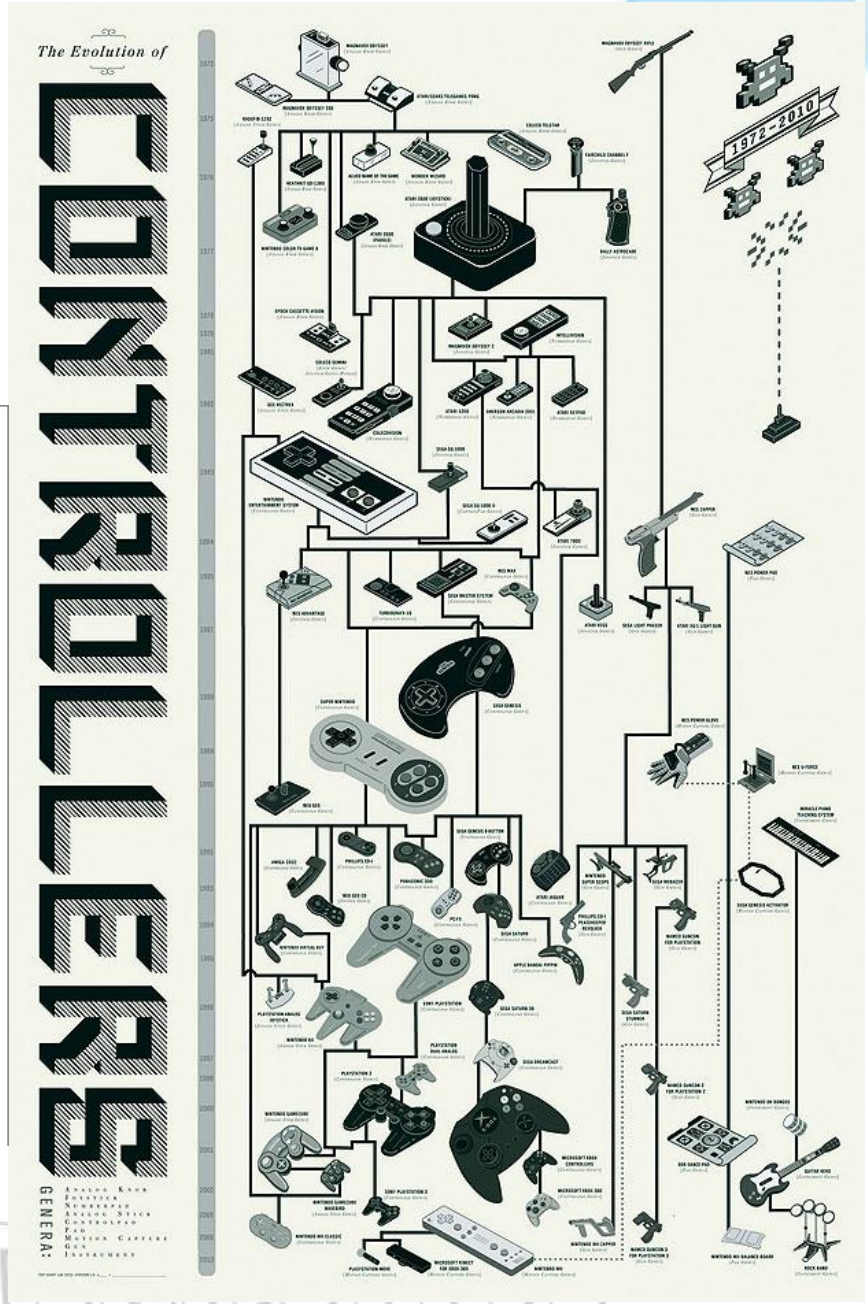
(HID)

Input device

- Mouse
- Keyboard
- Gamepad
- Immersed control

Controllers





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.

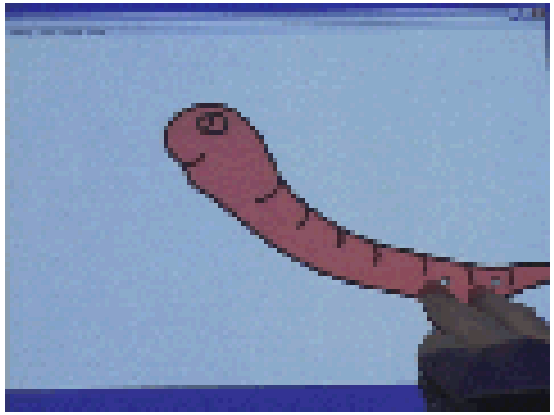
- Especially useful to identify the gravity force

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)

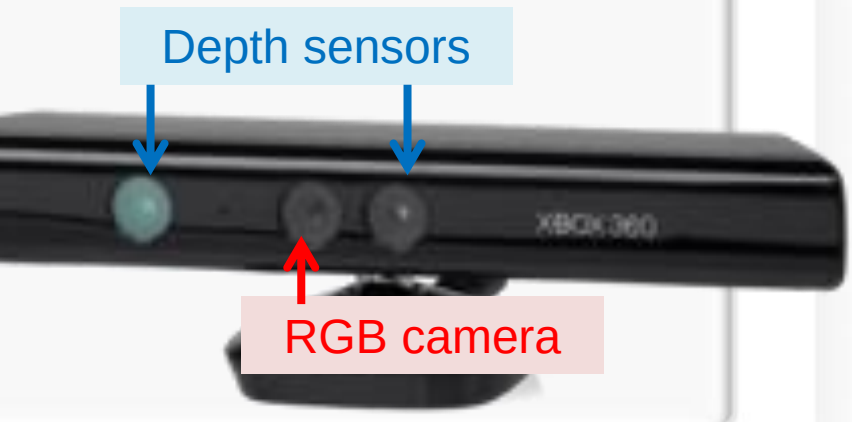
- A **touch user interface** (TUI) is a computer-pointing technology based upon the sense of touch (haptics).



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

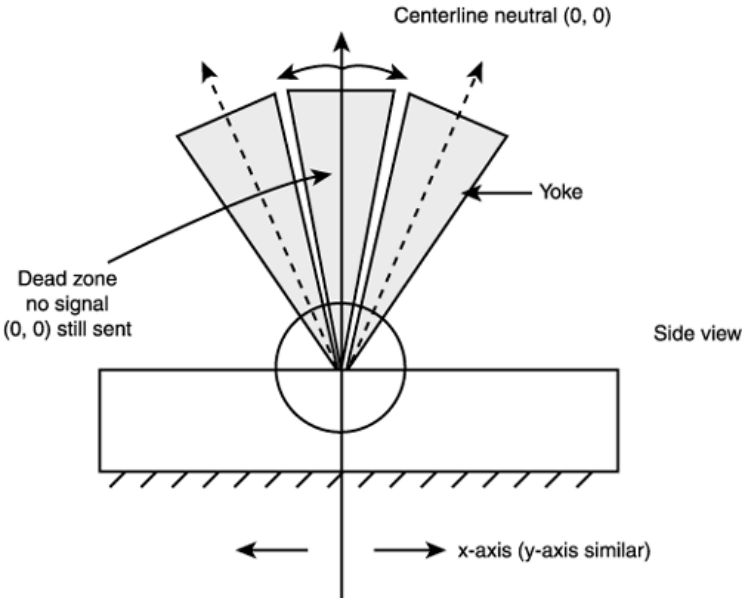
DualSense

觸覺回饋、動態自適應扳機以及內建麥克風

14:25

HID process

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

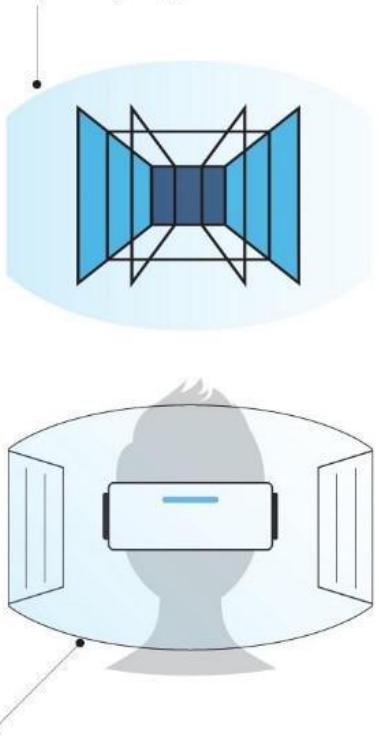


The "joystick deadzone" is the area around the center of a joystick that does not respond to movement. It is designed to cut down on accidental movement caused by "jitter".

Extended Reality

VIRTUAL REALITY (VR)

Completely digital environment



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

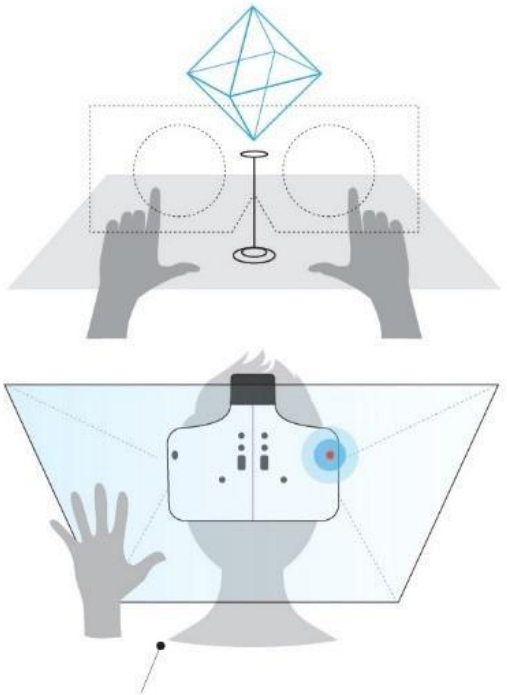
AUGMENTED REALITY (AR)

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

Head-Mounted Displays

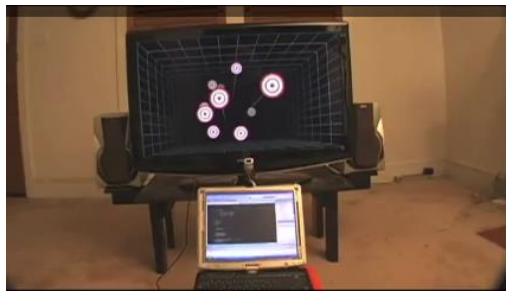
Consider carrying two displays around on your head.

+ Stereopsis is a strong 3D queue
+ 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

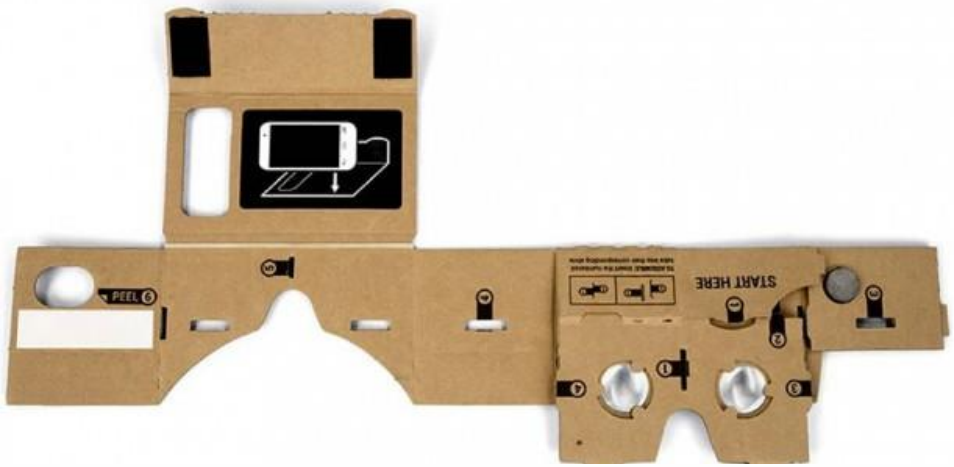
Sony
PlayStation VR

Oculus Rift

Htc vive

Inside oculus rift DK2

google cardboard



HTC vive

VIVE控制器

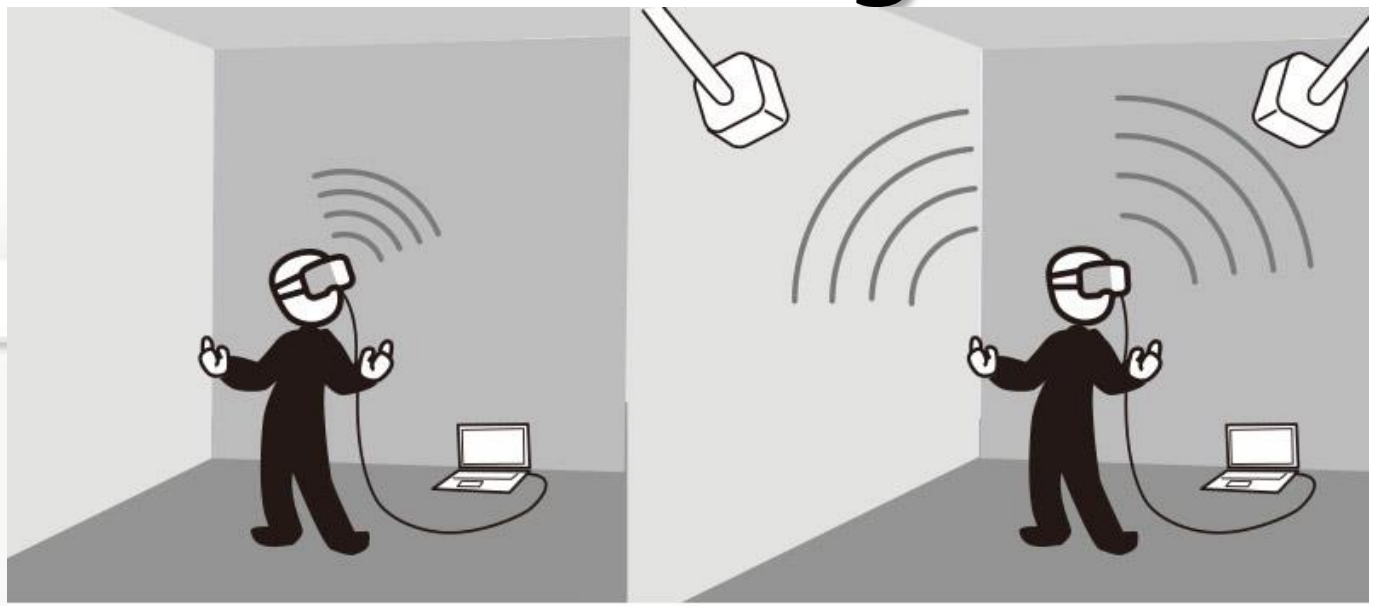
- 專為VR設計
- 直覺性的操作與手勢偵測
- 真實高解析的觸覺回饋

VIVE基地台

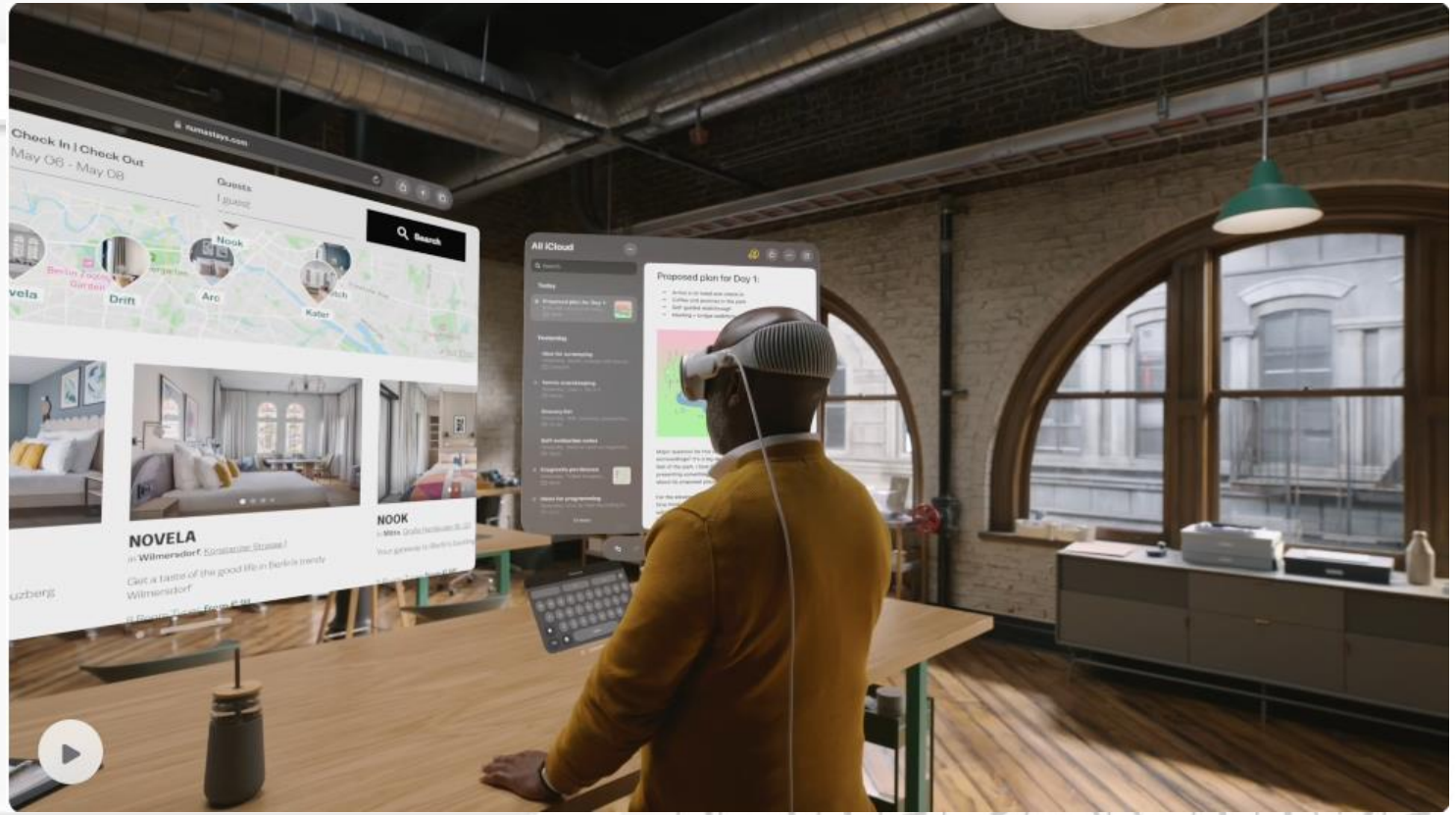
- 360°全區追蹤定位覆蓋
- 無線同步技術
- 使用標準規格螺紋，安裝簡易

Room scale VR

Inside-out tracking



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/