Virtual and mixed reality : an introduction

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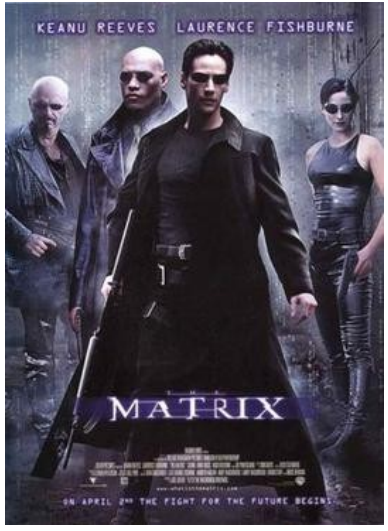
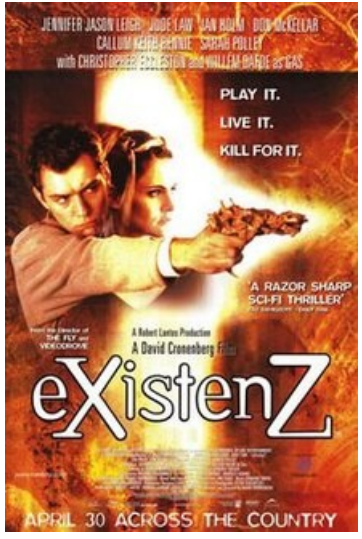
So many examples in pop culture …





Virtual Reality

Definition :

Virtual reality (VR) is a simulated experience that can be similar to or completely different from the real world. Applications of virtual reality include entertainment (e.g. video games), education (e.g. medical or military training) and business (e.g. virtual meetings).

(wikipedia – 19.09.2021)

Virtual reality, but not only …

2 different concepts, with different applications and hardware …

- **Virtual Reality**

- **Mixed Reality**

Source : Wikipedia

Sensory modalities

Vision :

Helmet, HUD

Google glass

HTC vive

Microsoft Hololens

Stereovision or mono
60 FPS … often more (Motion sickness …)
Sensors : Accelerometers, inclinometers

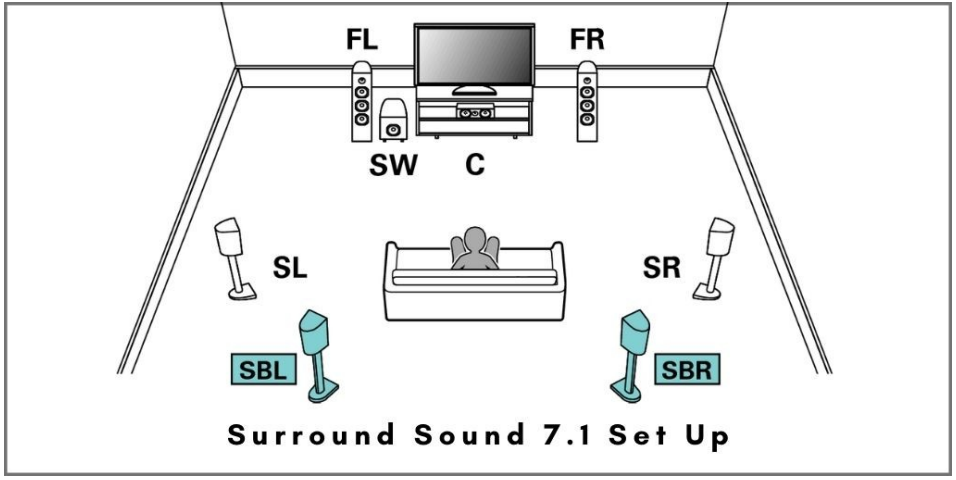
Sensory modalities

Vision :

Helmet, HUD

Sound :

Stereo, immersive … (5.1, 7.1, etc ...)



Sensory modalities

Vision :

Helmet, HUD

Sound :

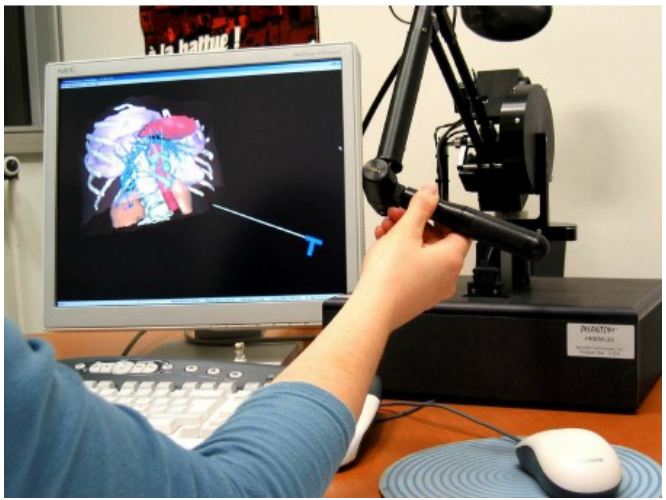
Stereo, immersive … (5.1, 7.1, etc ...)

Touch :

Vibrations

Haptic feedback

3DOF, 6DOF, etc.



Phantom Device – 6 DOF

High Refresh Rate : 1KHz !!!!
Simple Physics model

Sensory modalities

Vision :

Helmet, HUD

Sound :

Stereo, immersive … (5.1, 7.1, etc ...)

Touch :

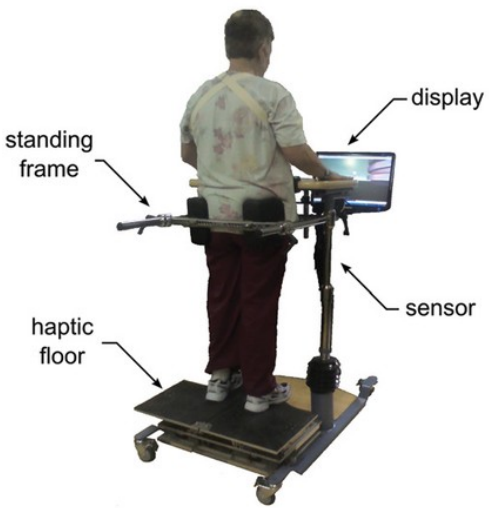
Vibrations

Haptic feedback

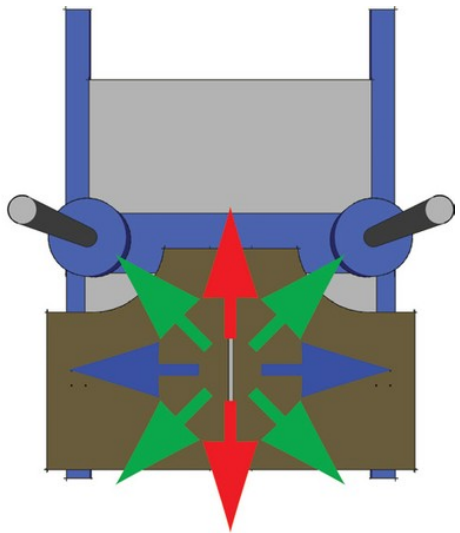
3DOF, 6DOF, etc.

Balance :

Haptic floor



a

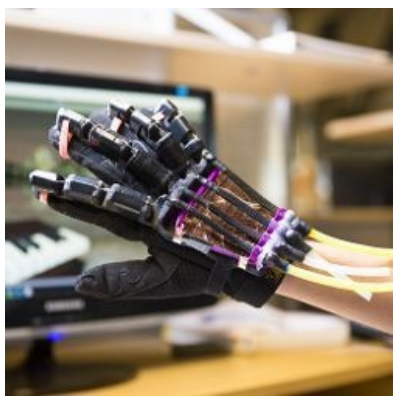


b

Inputs

Gloves / Controllers :

6 DOF, measures of the hand and fingers position, haptic feedback ?



Inputs

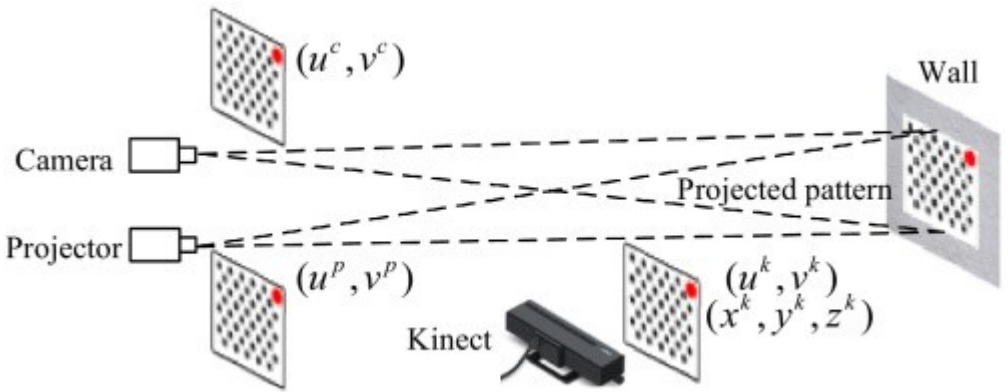
Gloves / Controllers :

6 DOF, measures of the hand and fingers position

Body :

Sensor-less approach (kinect)

Sensor-based approach (motion capture suit)



Kinect V1 – Structured light

Inputs

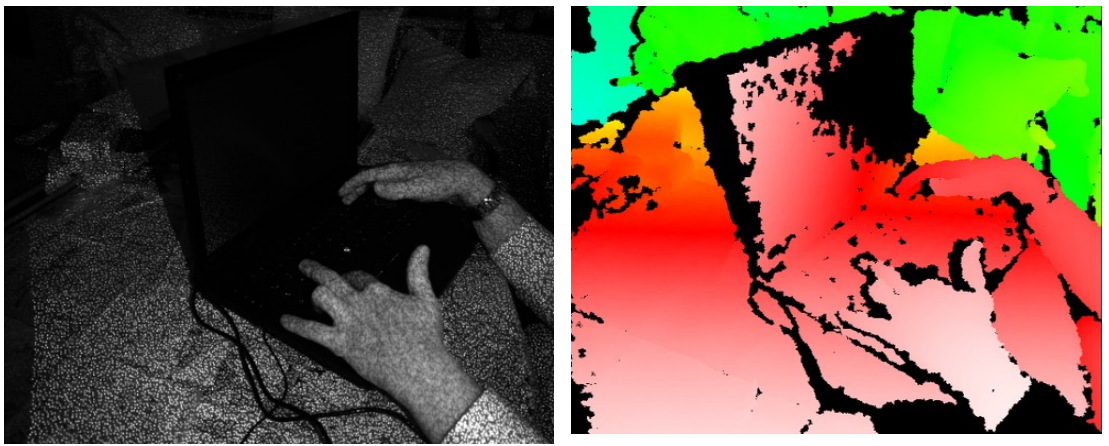
Gloves / Controllers :

6 DOF, measures of the hand and fingers position

Body :

Sensor-less approach (kinect)

Sensor-based approach (motion capture suit)



Kinect V1 – Structured light

Inputs

Gloves / Controllers :

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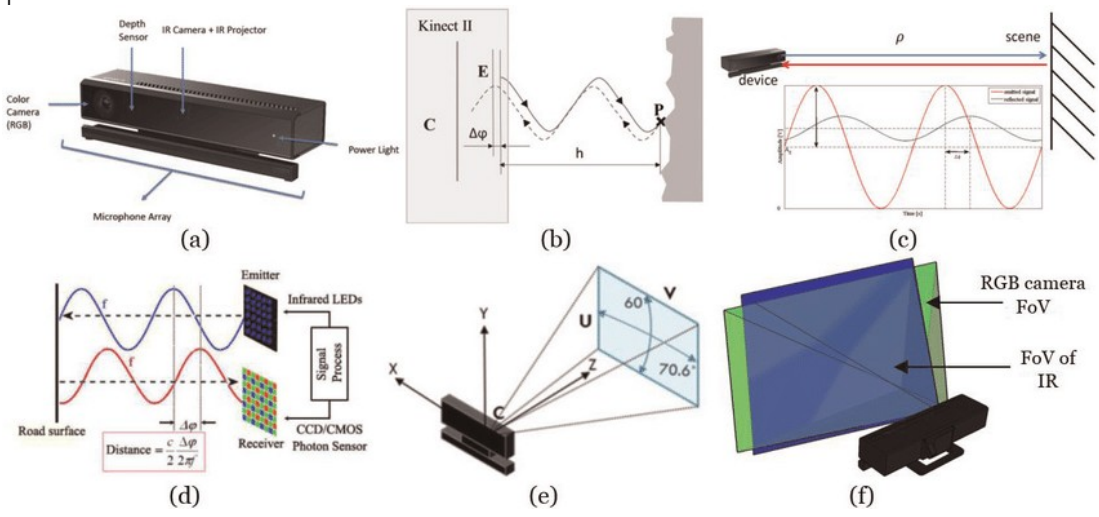
Body :

Sensor-less approach (kinect)

Sensor-based approach (motion capture suit)



Kinect V2 – Time of flight (V2)

Inputs

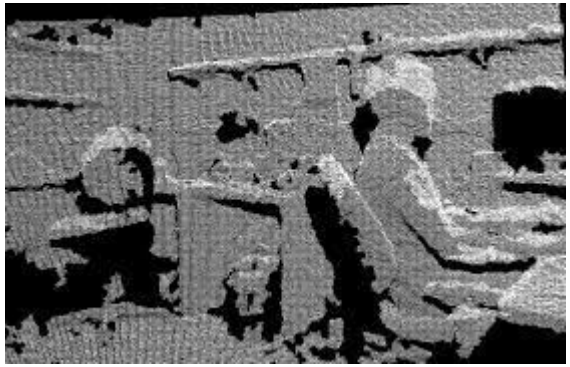
Gloves / Controllers :

6 DOF, measures of the hand and fingers position

Body :

Sensor-less approach (kinect)

Sensor-based approach (motion capture suit)



Partial model (occultations, reflections)
Unstructured (point cloud)

Inputs

Gloves / Controllers :

6 DOF, measures of the hand and fingers position

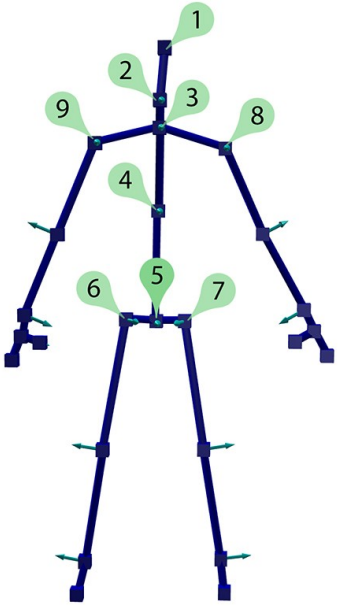
Body :

Sensor-less approach (kinect)

Sensor-based approach (motion capture suit)

Parametric model fitting

1 Head
2 Neck
3 Spine_Shoulder
4 Spine_Mid
5 Spine_Base
6 Hip_Right
7 Hip_Left
8 Shoulder_Left
9 Shoulder_Right



Inputs

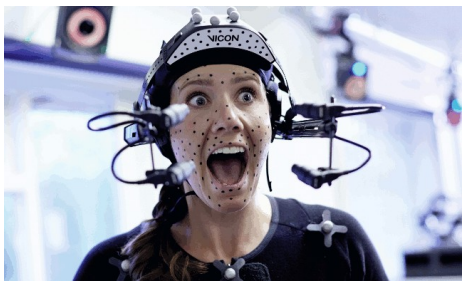
Gloves / Controllers :

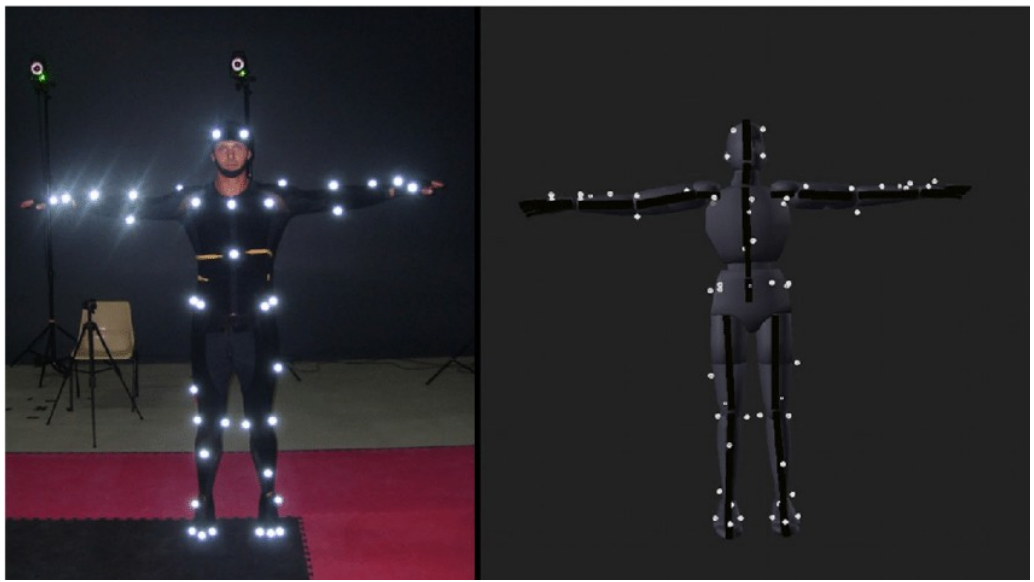
6 DOF, measures of the hand and fingers position

Body :

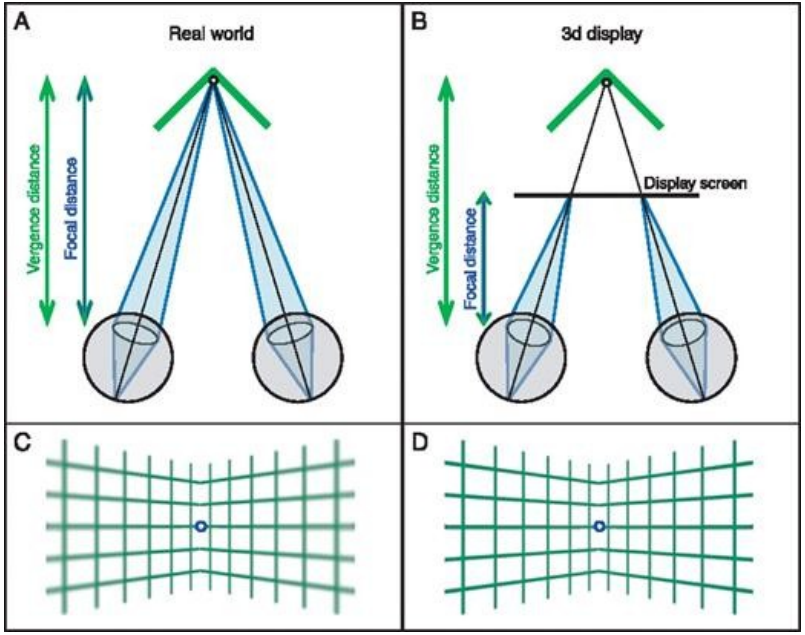
Sensor-less approach (kinect)

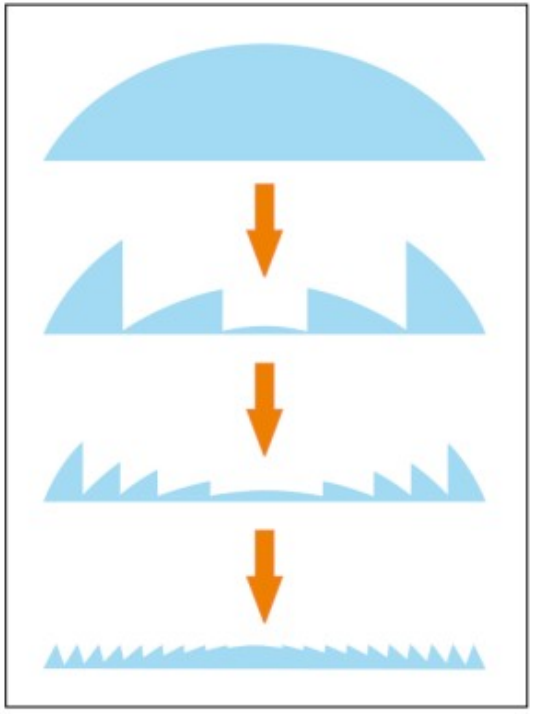
Sensor-based approach (motion capture suit)





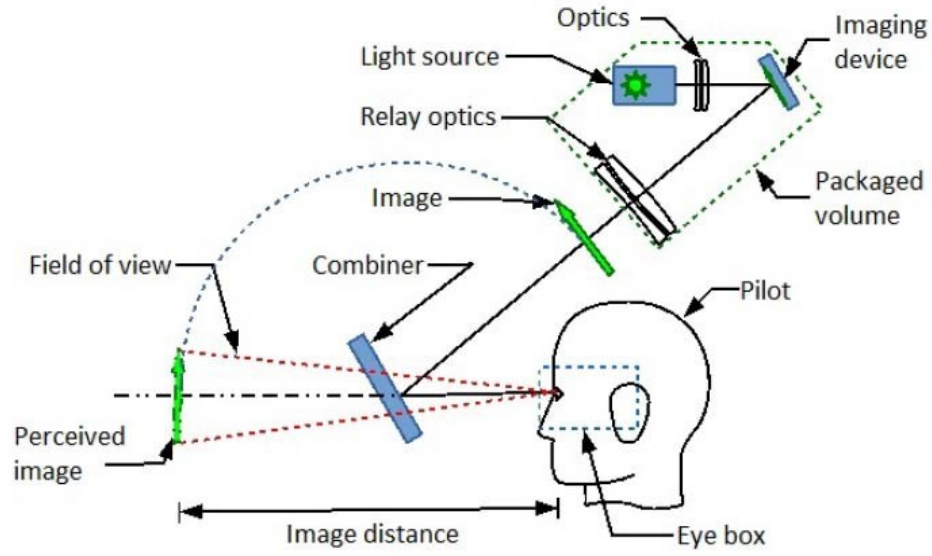
Anatomy of a VR headset





Fresnel Lens

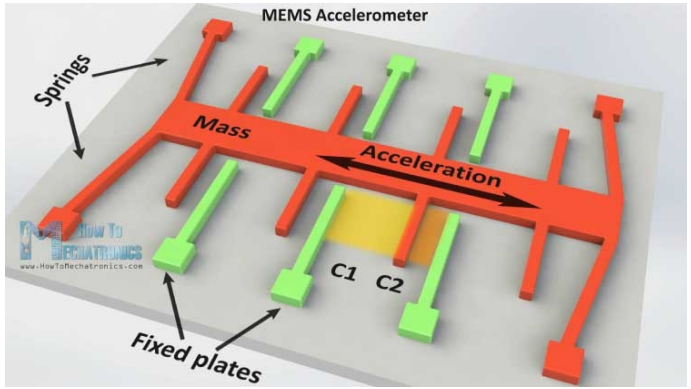
Anatomy of a mixed reality headset

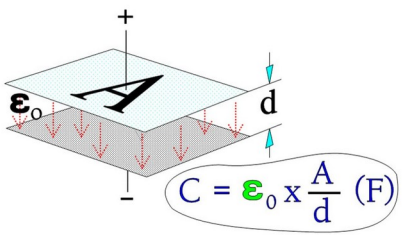


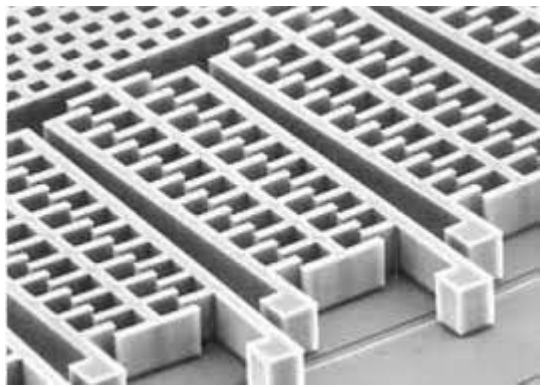
Accelerometers …

Based on MEMS (Micro electro-mechanical systems)

- Very low cost
- Very common







Gyrometers (aka tilt sensors)

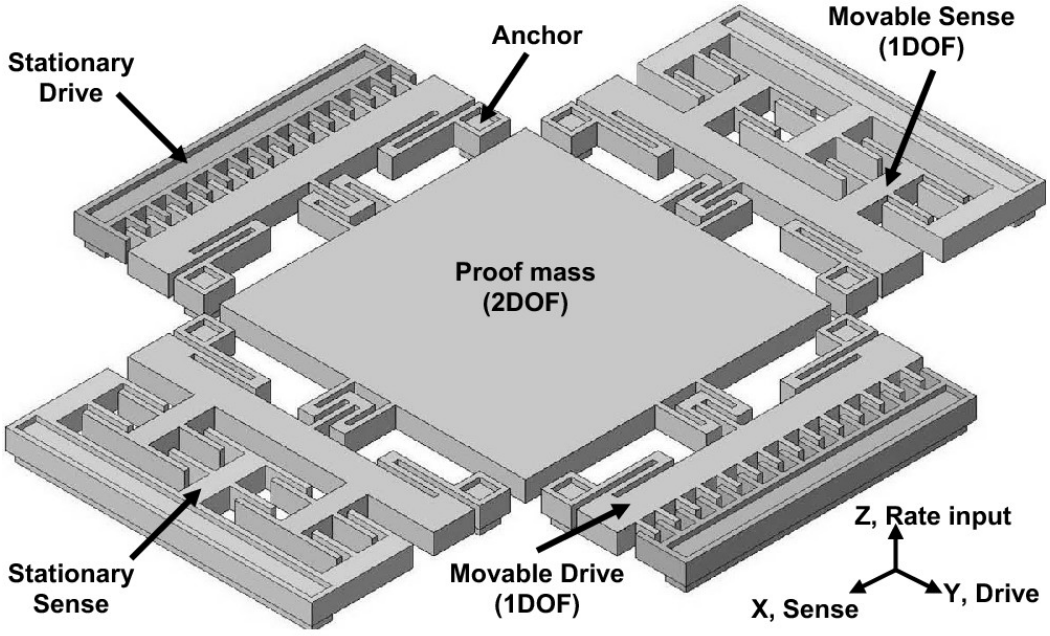


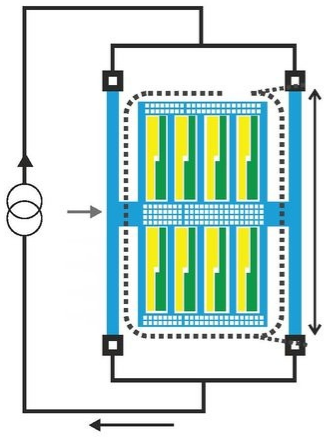
Figure 1: Perspective view of the improved symmetrical and decoupled gyroscope.

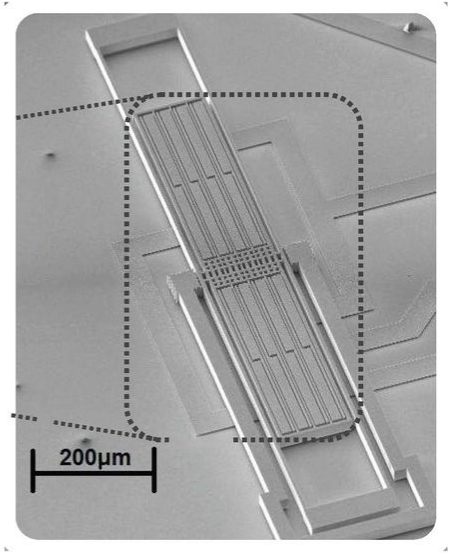
Magnetometers

Yet another MEMS ...

Can be based on :

- Voltage sensing
- Frequency shift sensing
- Optical sensing





Inertial Motion Unit

IMU =

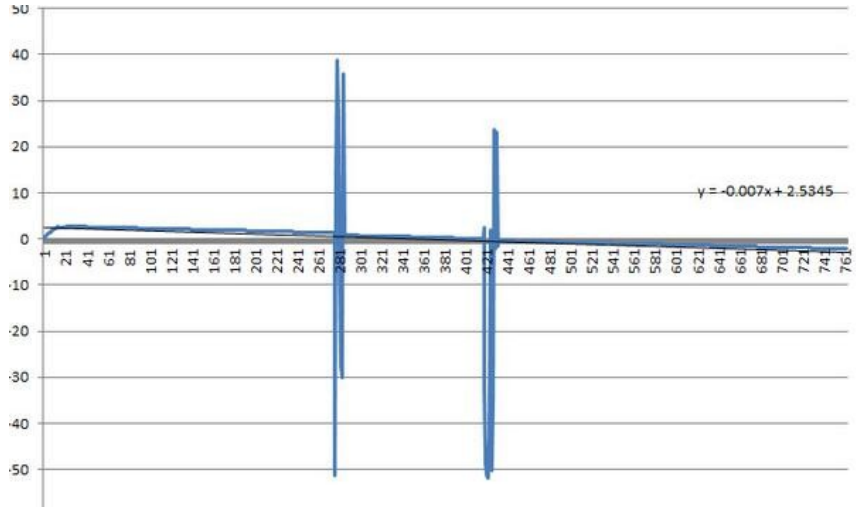
- 3 DOF accelerometer
- 3 DOF tilt sensor
- 3 DOF Magnetometer

Inertial Motion Unit

IMU =

- 3 DOF accelerometer
- 3 DOF tilt sensor
- 3 DOF Magnetometer

But drift is huge …



MPU6050 Roll Drift

Vive Lighthouse

60 pulses per second (Infrared)

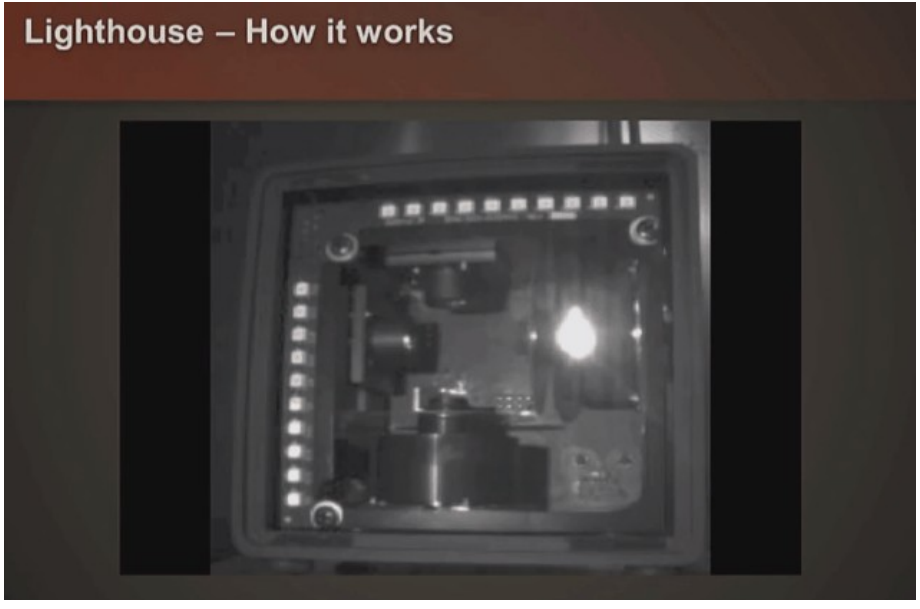
- One flash
- One vertical swipe
- One horizontal swipe

Sensors on the headset and controllers

Vive Lighthouse

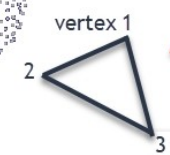
(Video 1 : principle)

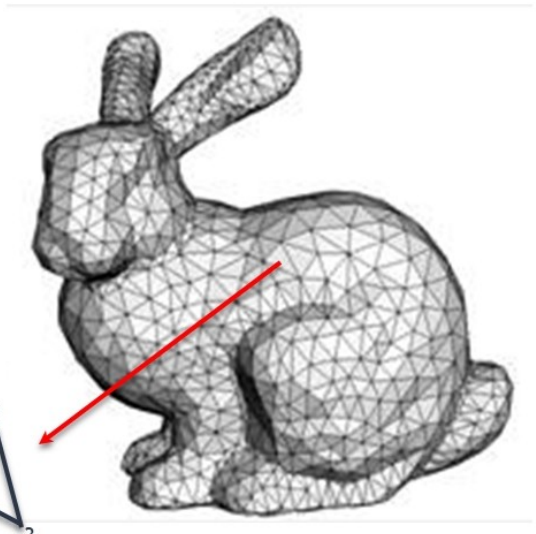
(Video 2 : slow motion)



Geometric model

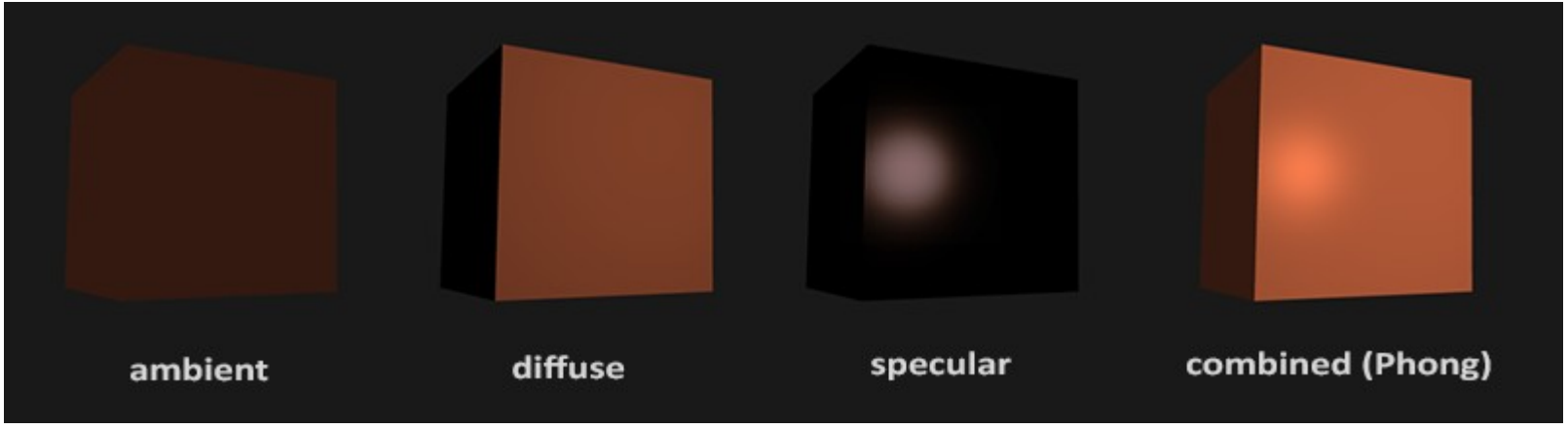
Point Cloud



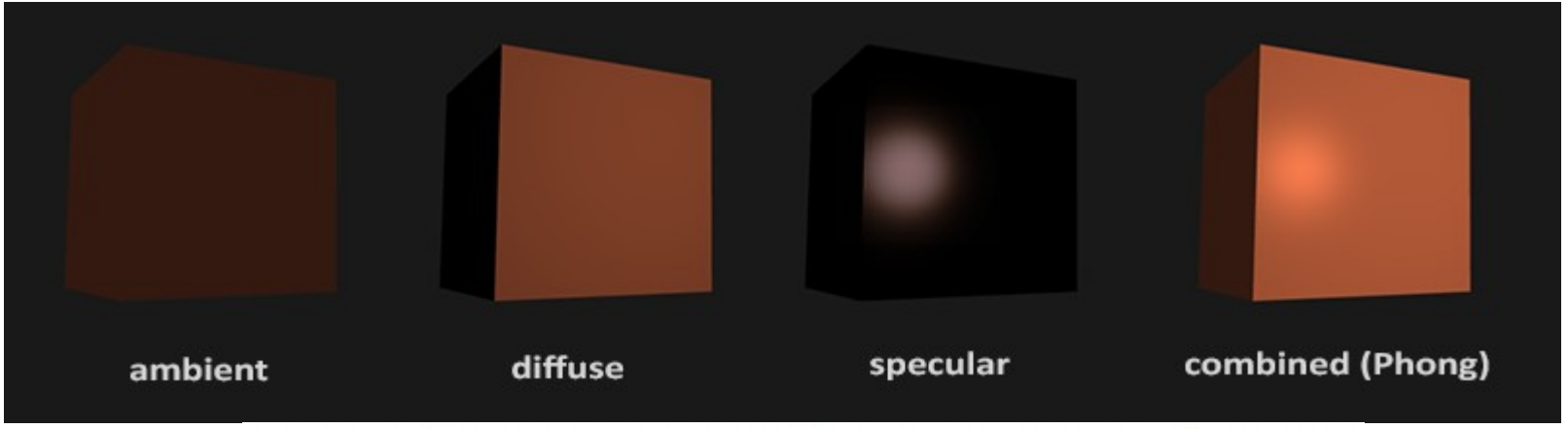


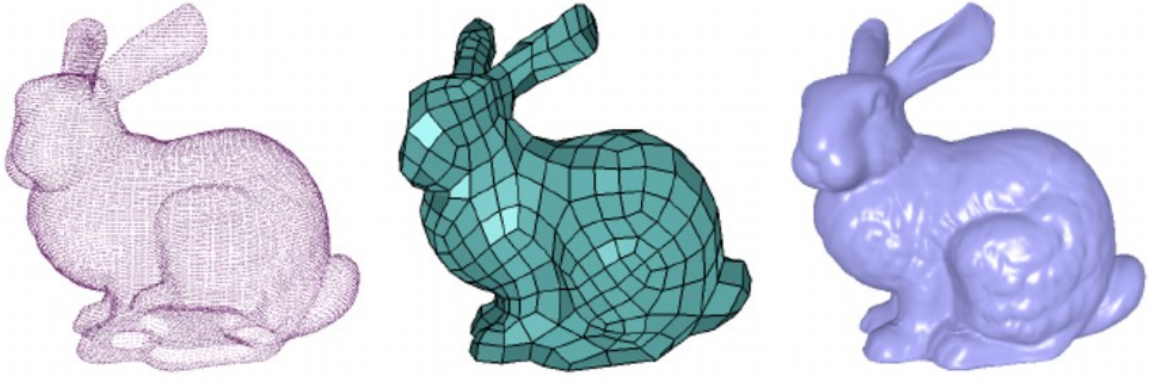
Mesh (shaded)

Lighting models

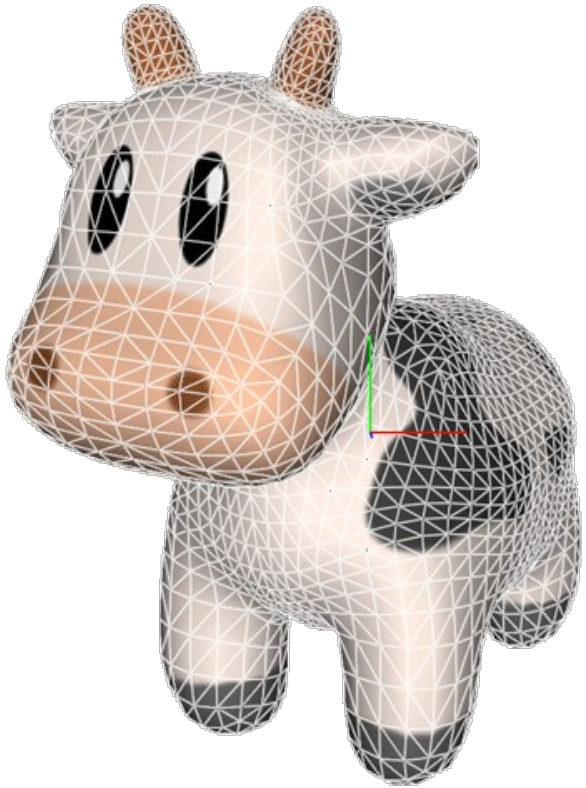


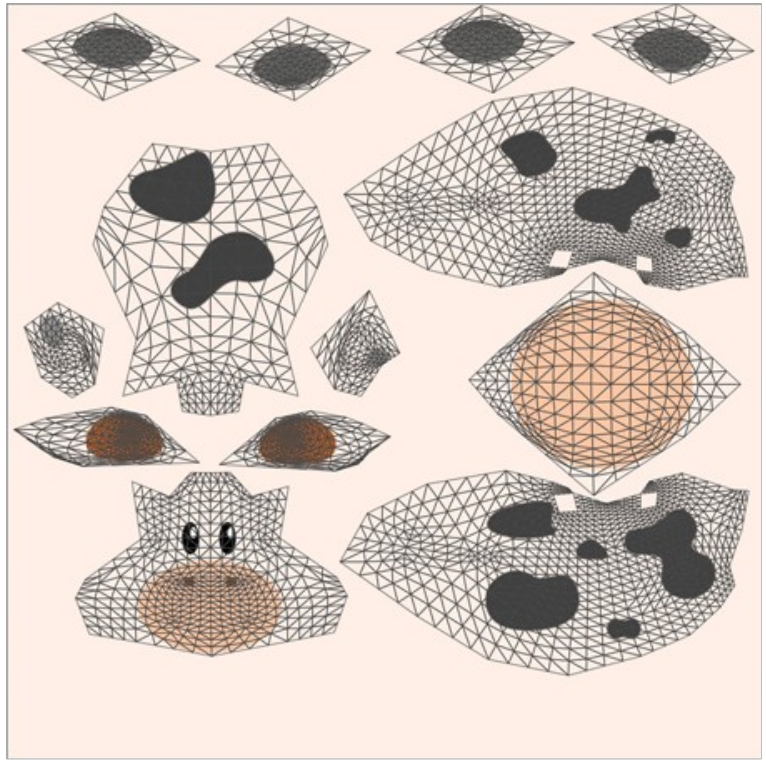
Lighting models





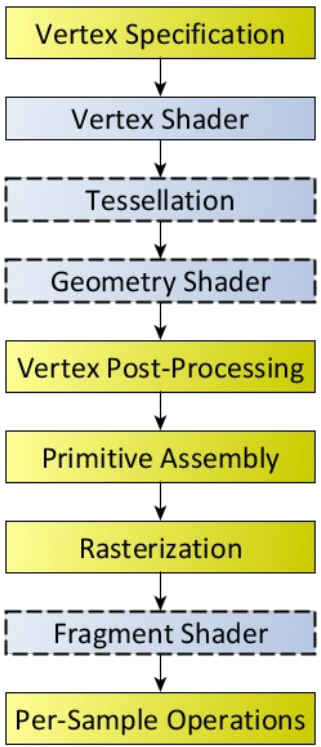
Texture mapping (aka uv mapping)

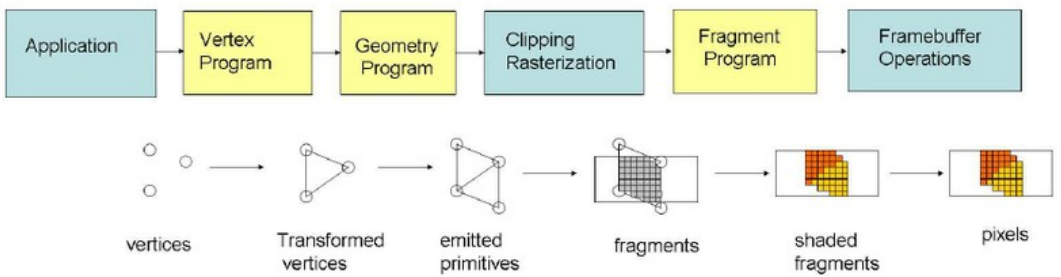




Texture mapping

OpenGL processing pipeline





Game engine

Higher level :

- Data structures (hides all the dirty bits …)
- (Very) approximated physic models (« game physics »)
- Multi-resolution
- Scriptable behaviours
- Multiple plateforms
- Etc.

Useful for data visualization
DO NOT USE FOR ROBOTICS SIMULATION

Game engine

Features	Unity	Unreal Engine	CryEngine	Godot	Panda3D
Languages	C#	C++	Lua, C++, C#	GDScript, C++, C#	Python, C++
VPL	Unity ECS	Blueprints	Flow Graph	Visual Script	- // - // - // -
Community	123k+	42,6k	10,2k+	24,7k+	2,5k+
Source Modify	Yes - Paid	Yes - Royalties	Yes - Royalties	Yes - Free	Yes - Free
Platforms	PC, GC, WEB, MD, XR	PC, GC, WEB, MD, XR	PC, GC, WEB, MD, XR	PC, GC, WEB, MD, XR	PC, WEB, MD, XR
Assets Store	AssetStore	MarketPlace	MarketPlace	Asset Library	- // - // - // -
License	EULA	EULA	EULA	MIT	BSD
Developer's	Unity Technologies	Epic Games	Crytek	SFC & PLC	Disney & CMU
Year	08.06.2005	28.04.1997	02.05.2002	14.01.2014	XX.01.2002

PC - Personal Computer's / GC - Game Console's / WEB - Browser's / MD - Mobile Device's / XR - Extended Reality