

XR = VR/AR/MR

---

# XR Basics

王銓彰

墨匠科技 BlackSmith  
Digital Content Institute  
2019-2020

---

# Contents

---

Introduction to XR (XR簡介)

Virtual Reality (虛擬實境)

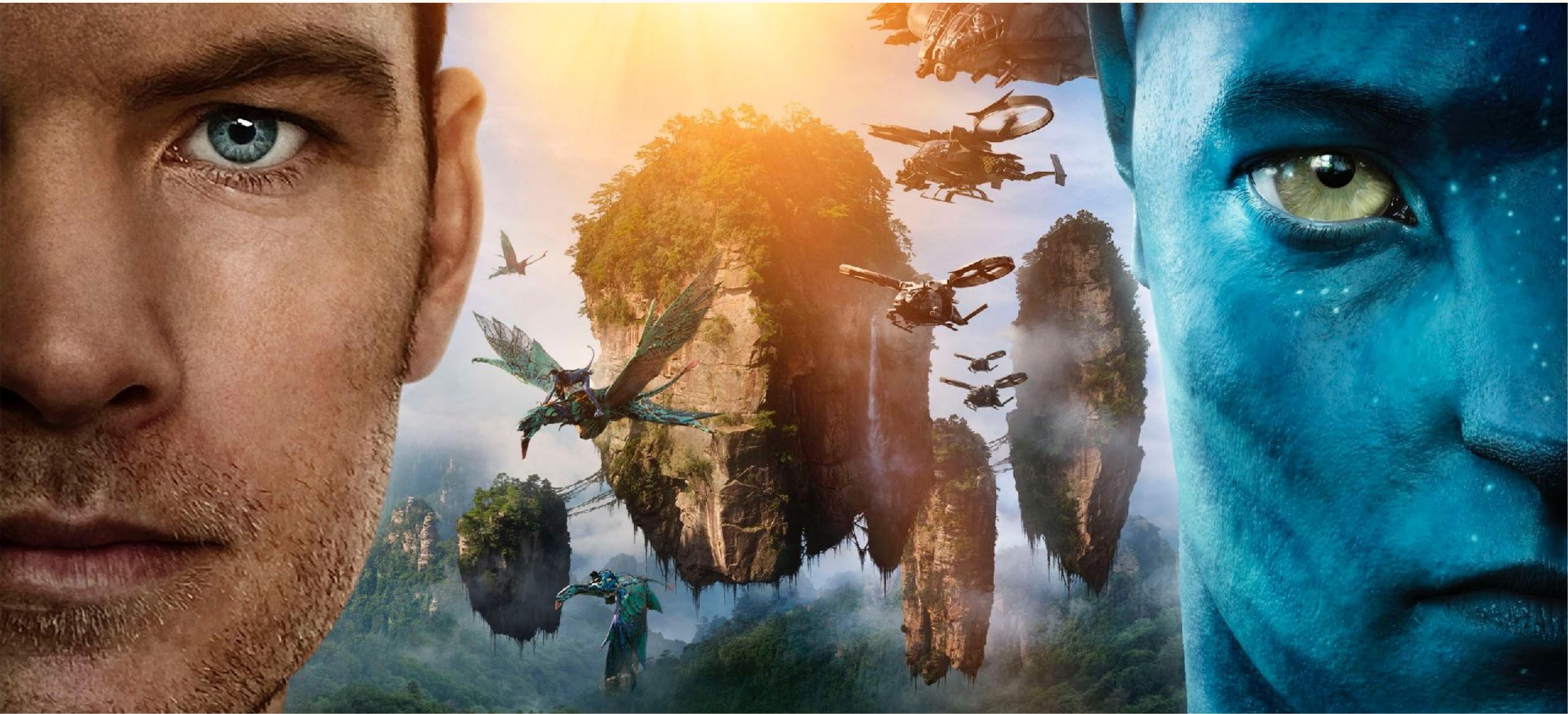
Augmented Reality (擴增實境)

Motion Sickness (動暈症)

XR Applications (XR的應用範例)

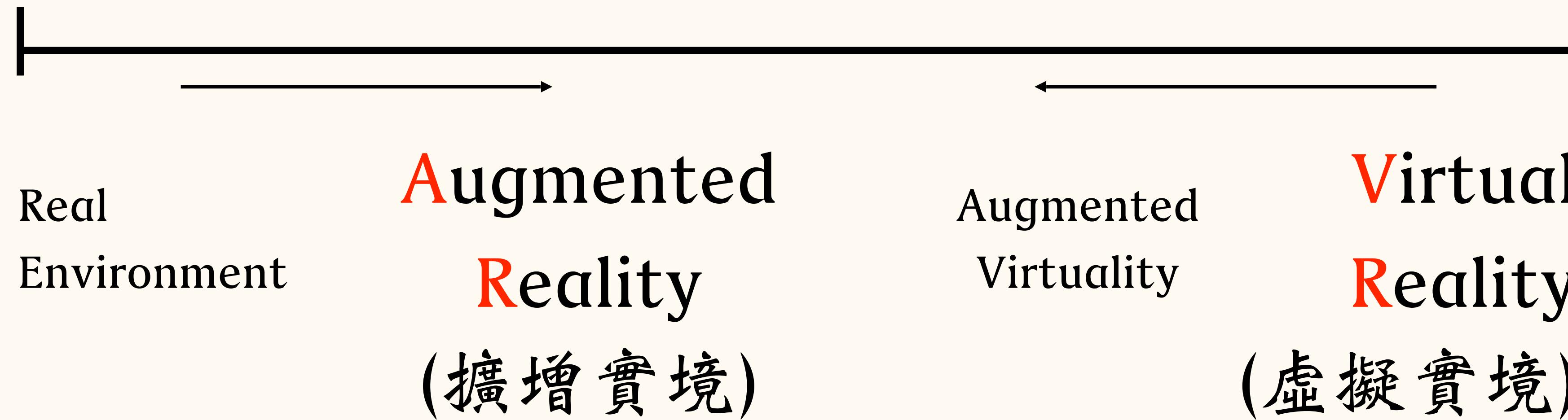
XR in the Near Future (即將到臨的XR)

# Reality vs Virtuality



# Reality–virtuality Continuum

## Mixed Reality (混合實境)



# What is the XR

We're making mobile XR a reality for everyone.

Today, extended reality (XR) experiences are more accessible for mainstream users than ever. Qualcomm® Snapdragon™ platforms, including the Snapdragon XR2 and XR1 Platform and the Snapdragon 865, Snapdragon 855, Snapdragon 845, Snapdragon 835, and Snapdragon 820 Mobile Platforms, combine intelligent augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) features that meet the growing needs of the XR ecosystem—powering mobile devices that deliver immersive audio, visuals, and interaction across entertainment, gaming, education, industrial applications, and more.

Qualcomm Snapdragon is a product of Qualcomm Technologies, Inc. and/or its subsidiaries.

(Quote from **Qualcomm Technologies Inc.**)

What is the XR (My Point-of-view)

**VR AR 5G MR**

# Virtual Reality

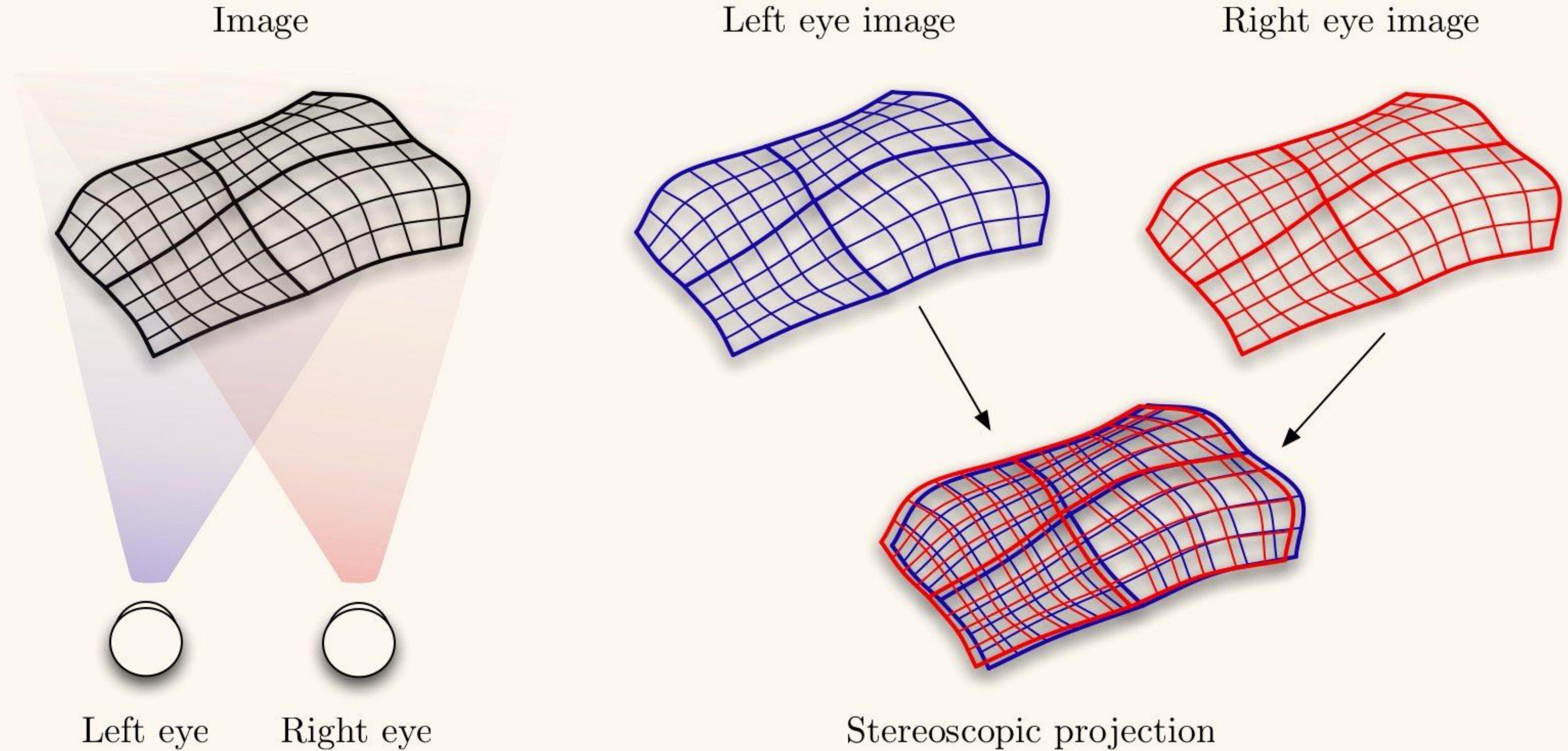
VR = 3D Computer Graphics +  
Stereoscopy +  
Interaction +  
Immersive



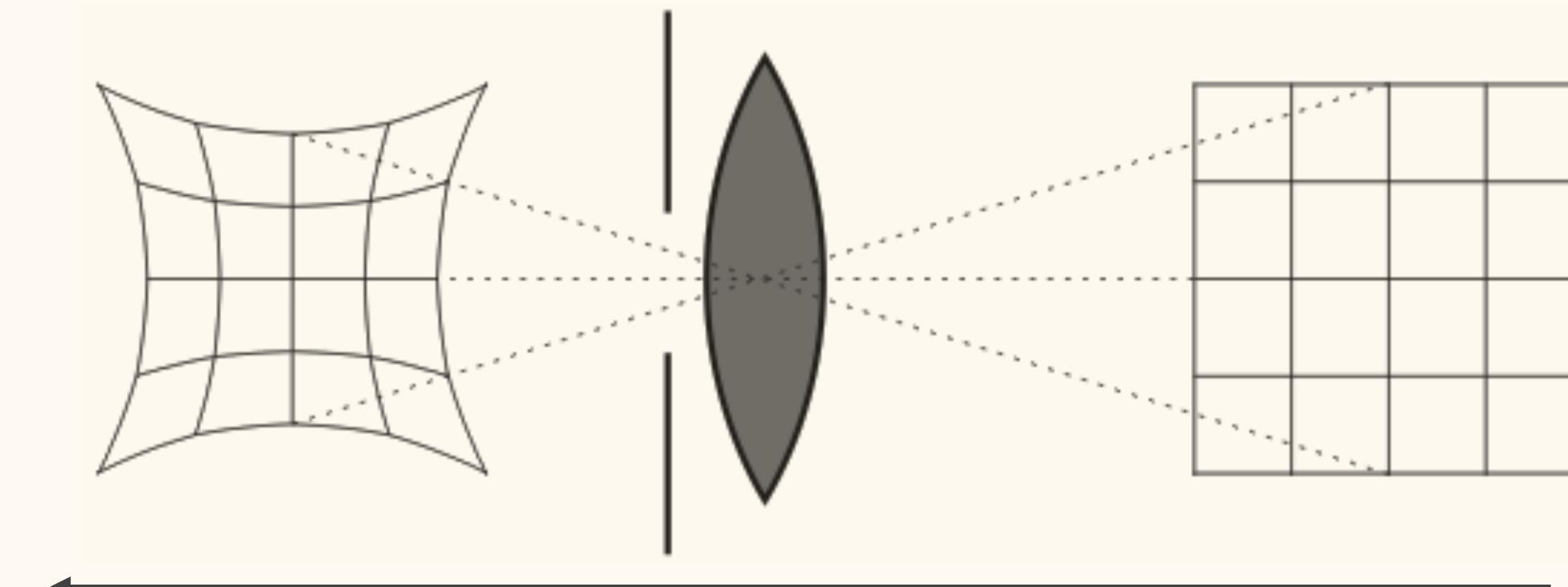
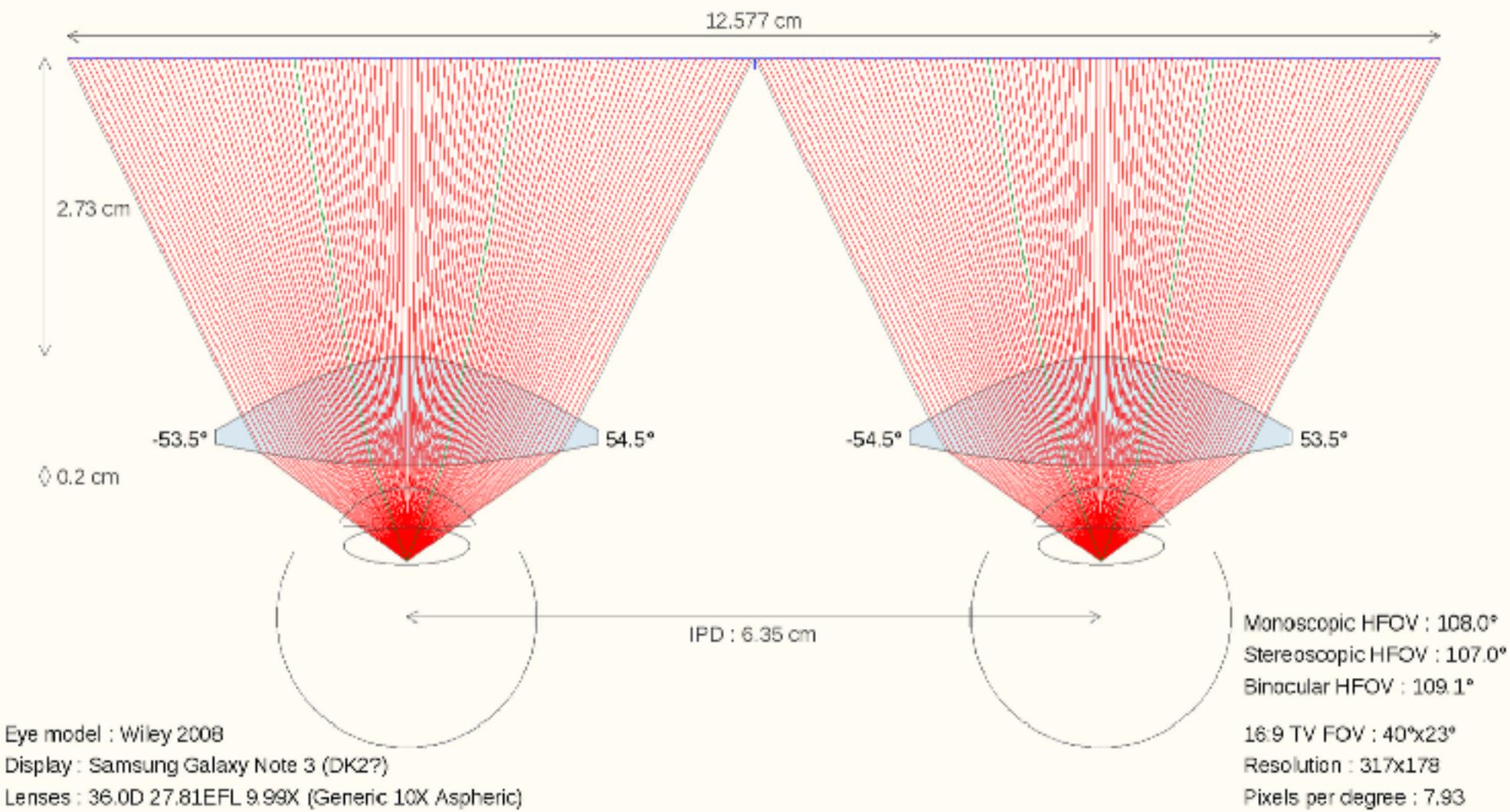
# Head Mounted Display (HMD)



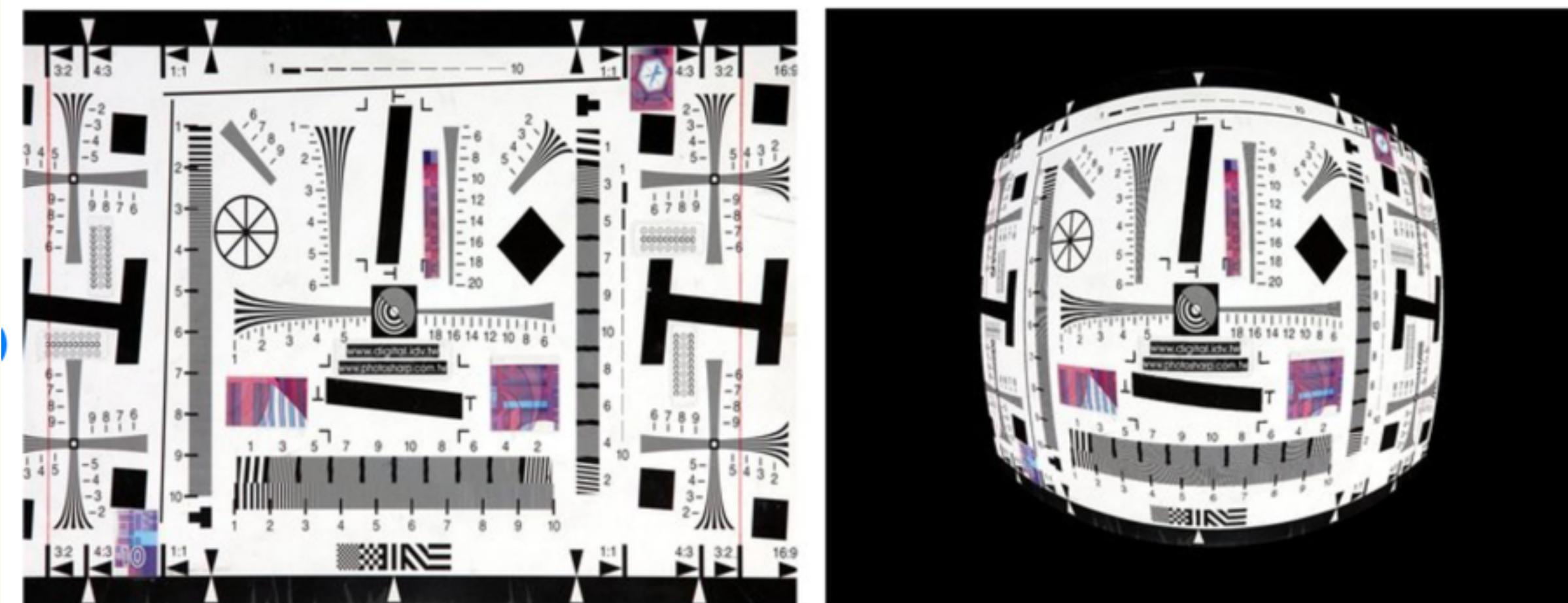
# 3D Stereoscopy



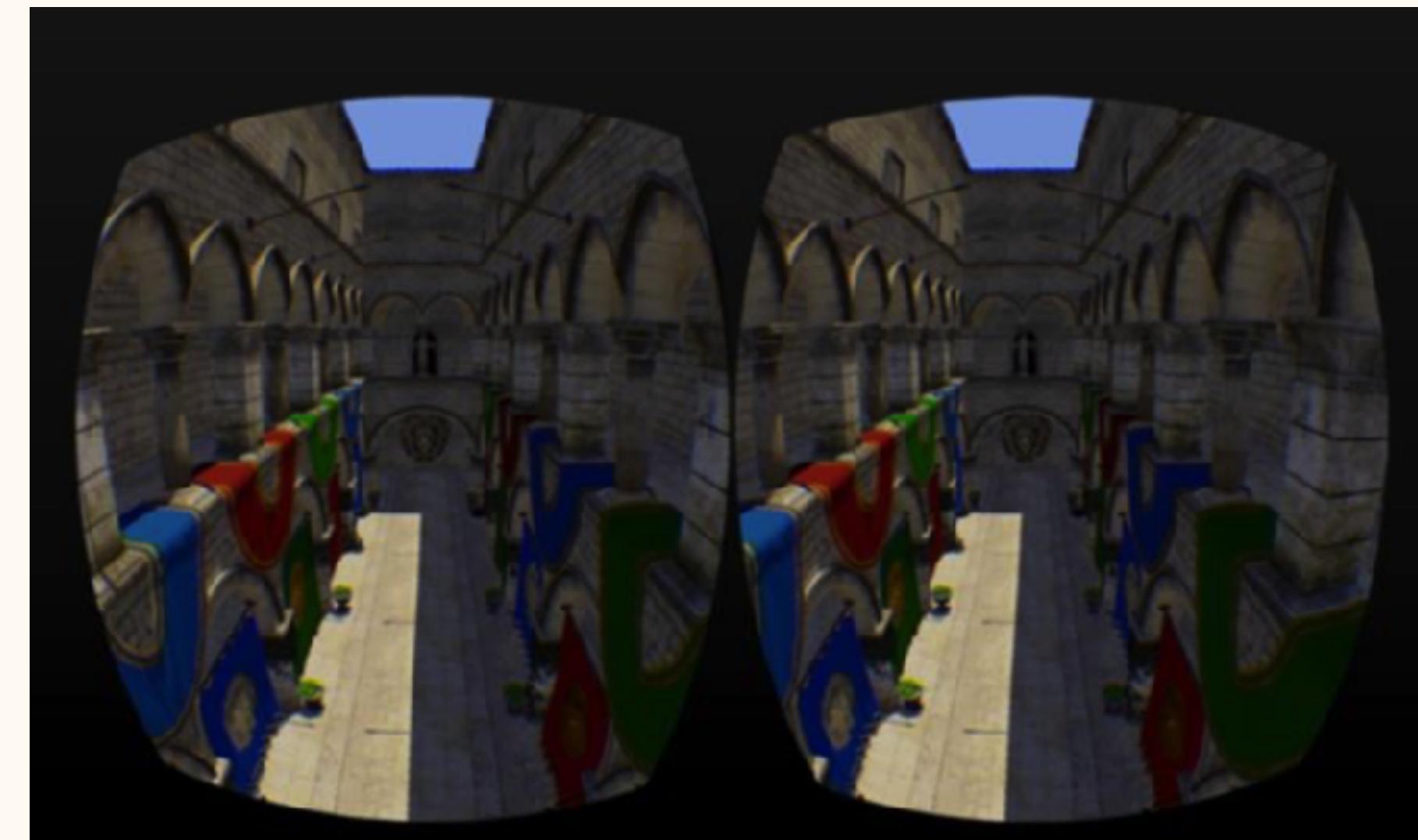
# VR Lens Design



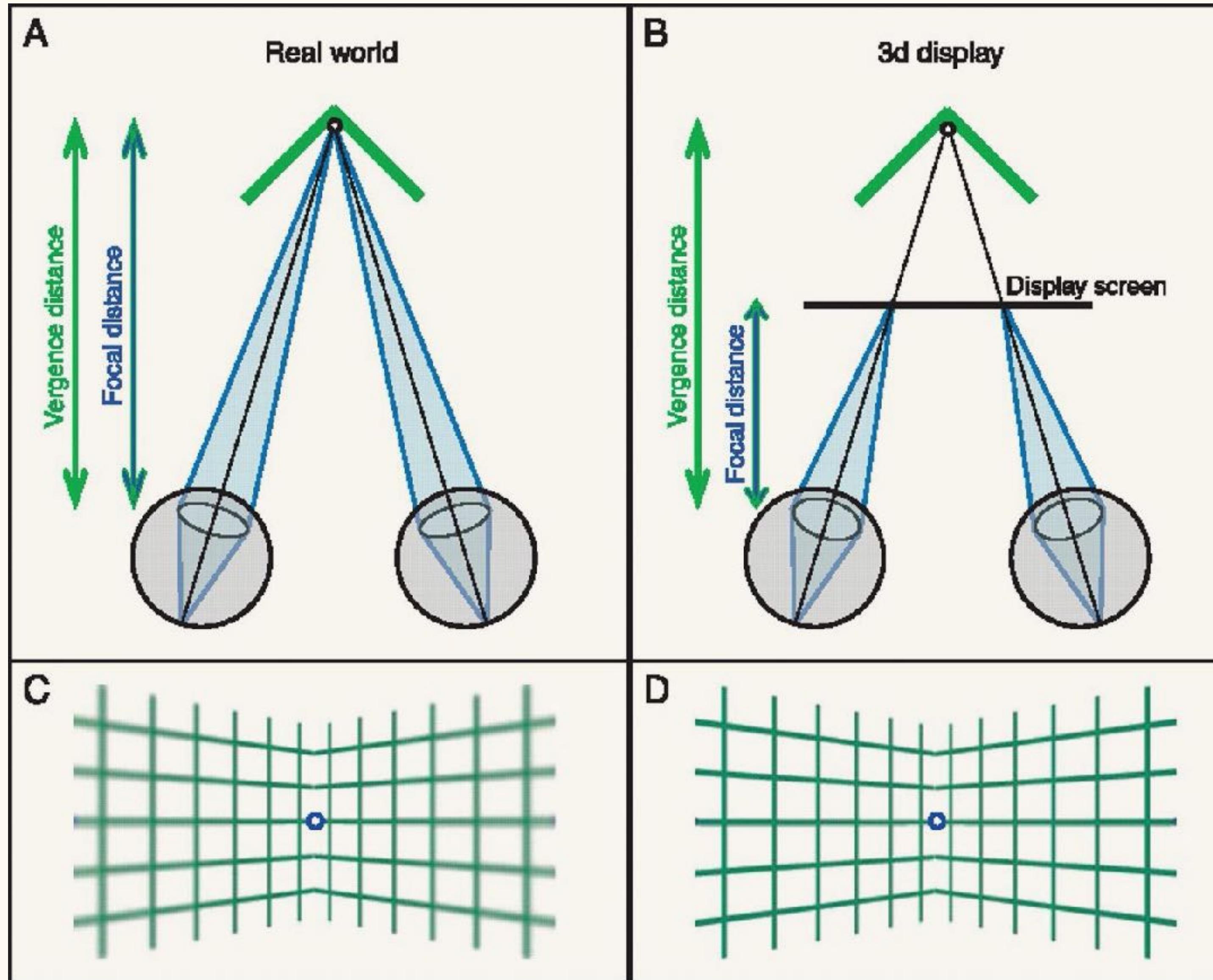
Pincushion Distortion of the Lens



Pre-distortion of VR Image (Barrel Distortion)



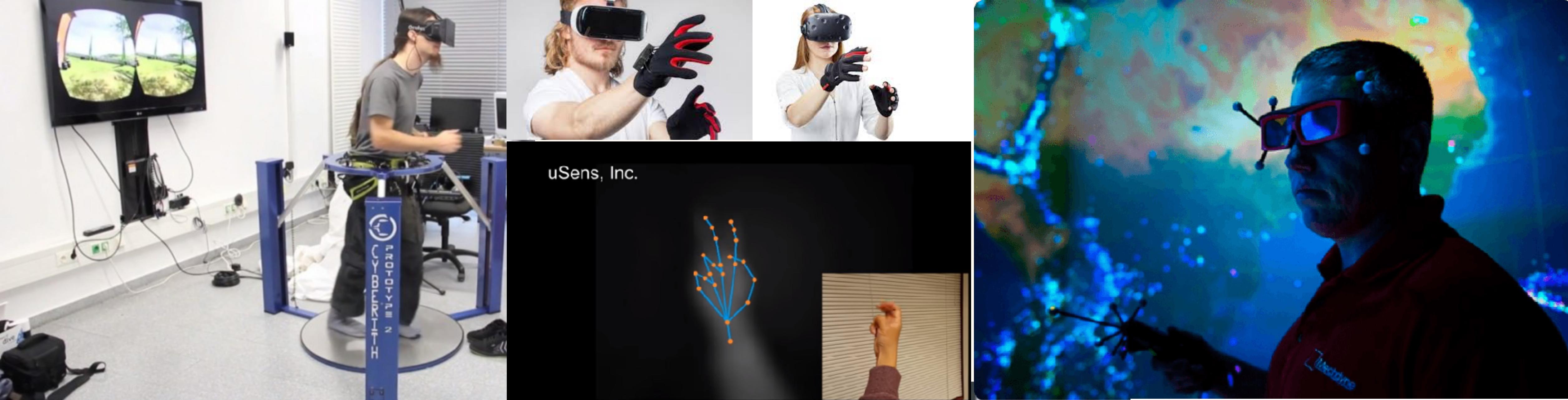
# Vergence-Accommodation Conflict (VAC)



VAC is a problem against  
human viewing.

This is an unsolved problems!

# VR Interactive By Tracking Technologies



3Glasses S1

---

VR HMD Tracking

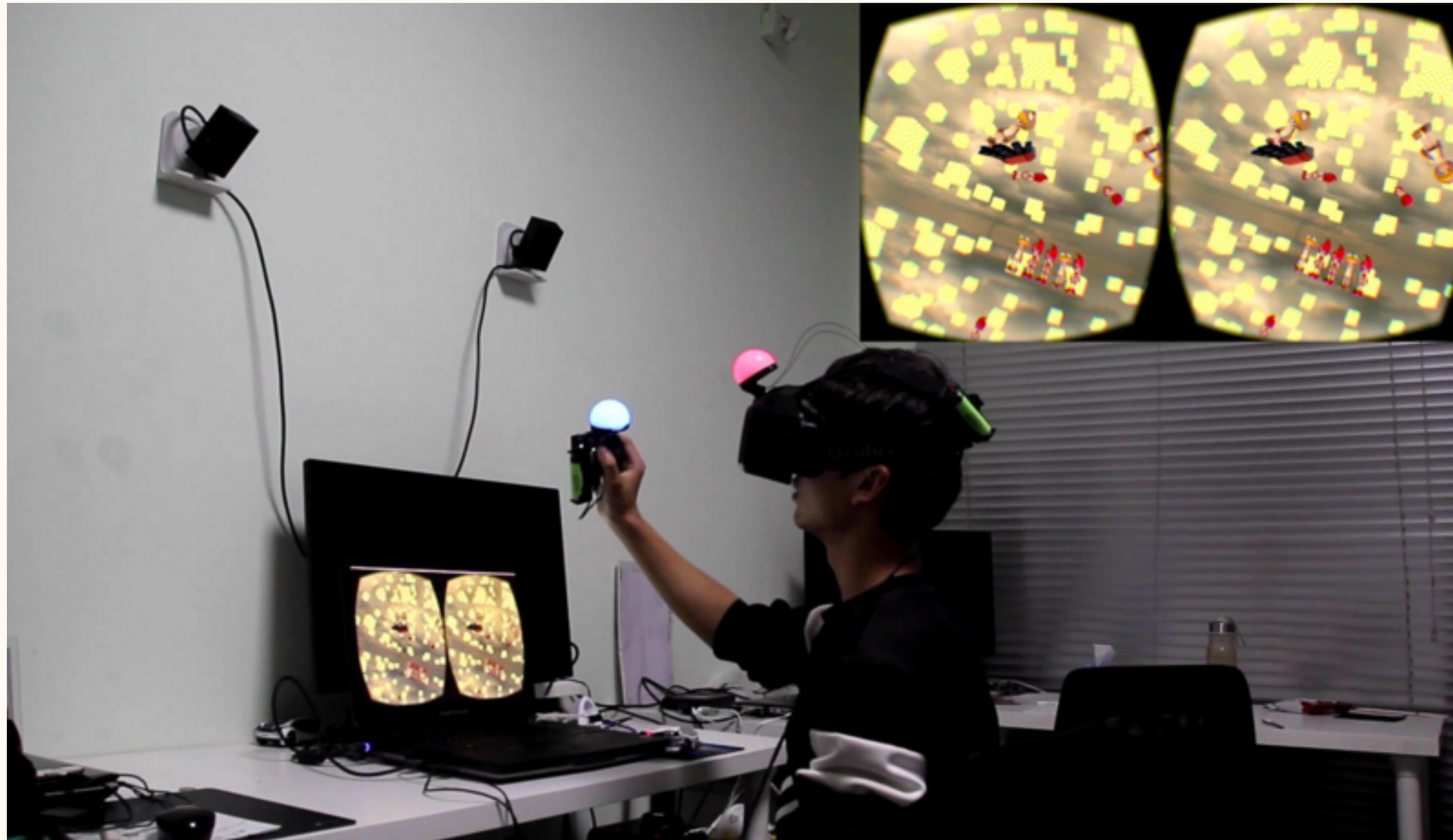
---

Outside-In

vs

Inside-Out

# Outside-In Tracking



# Outside-In Tracking



# Outside-In Tracking



VIVE

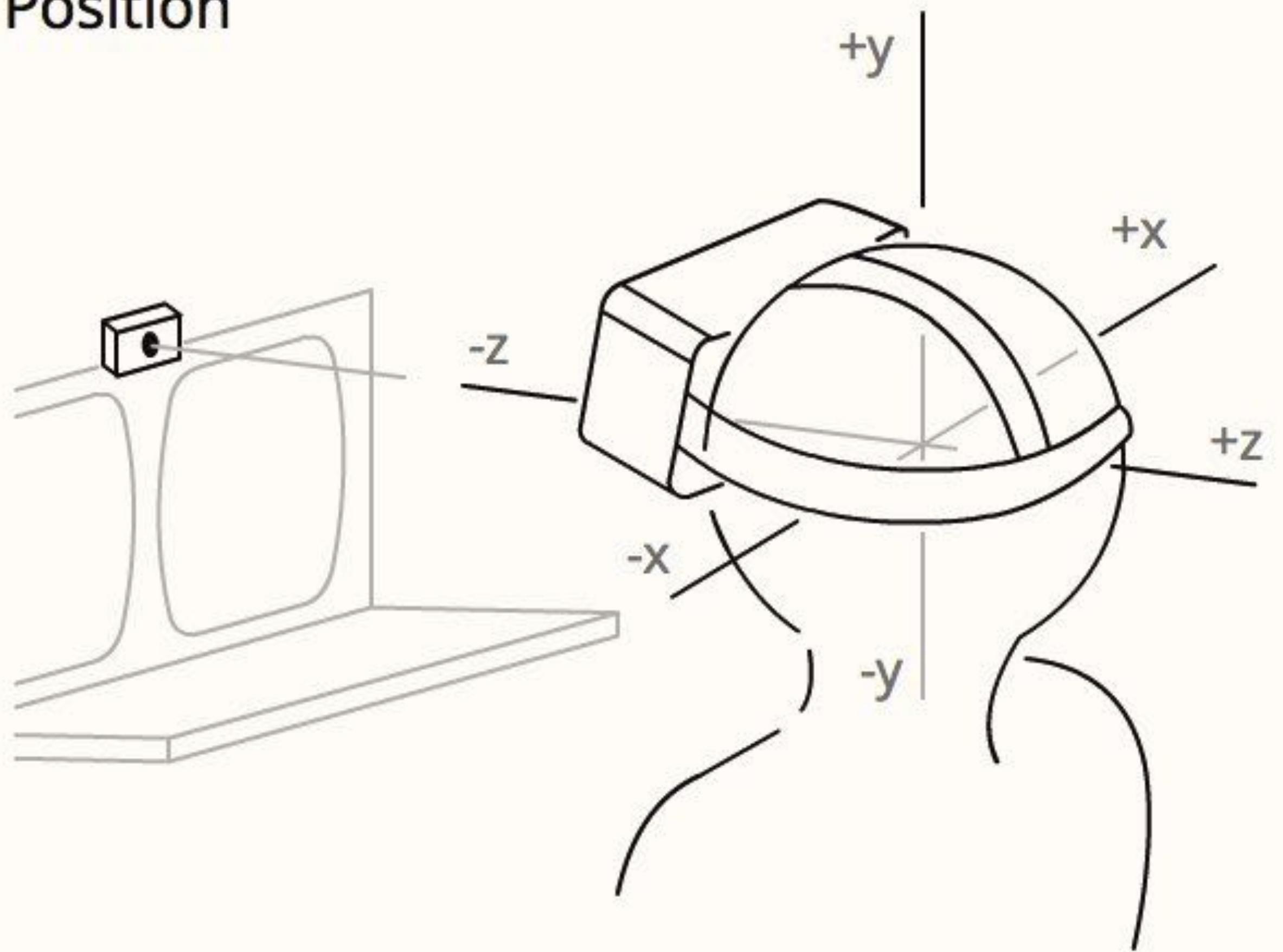
htc | steam<sup>®</sup> VR

# Outside-In Tracking

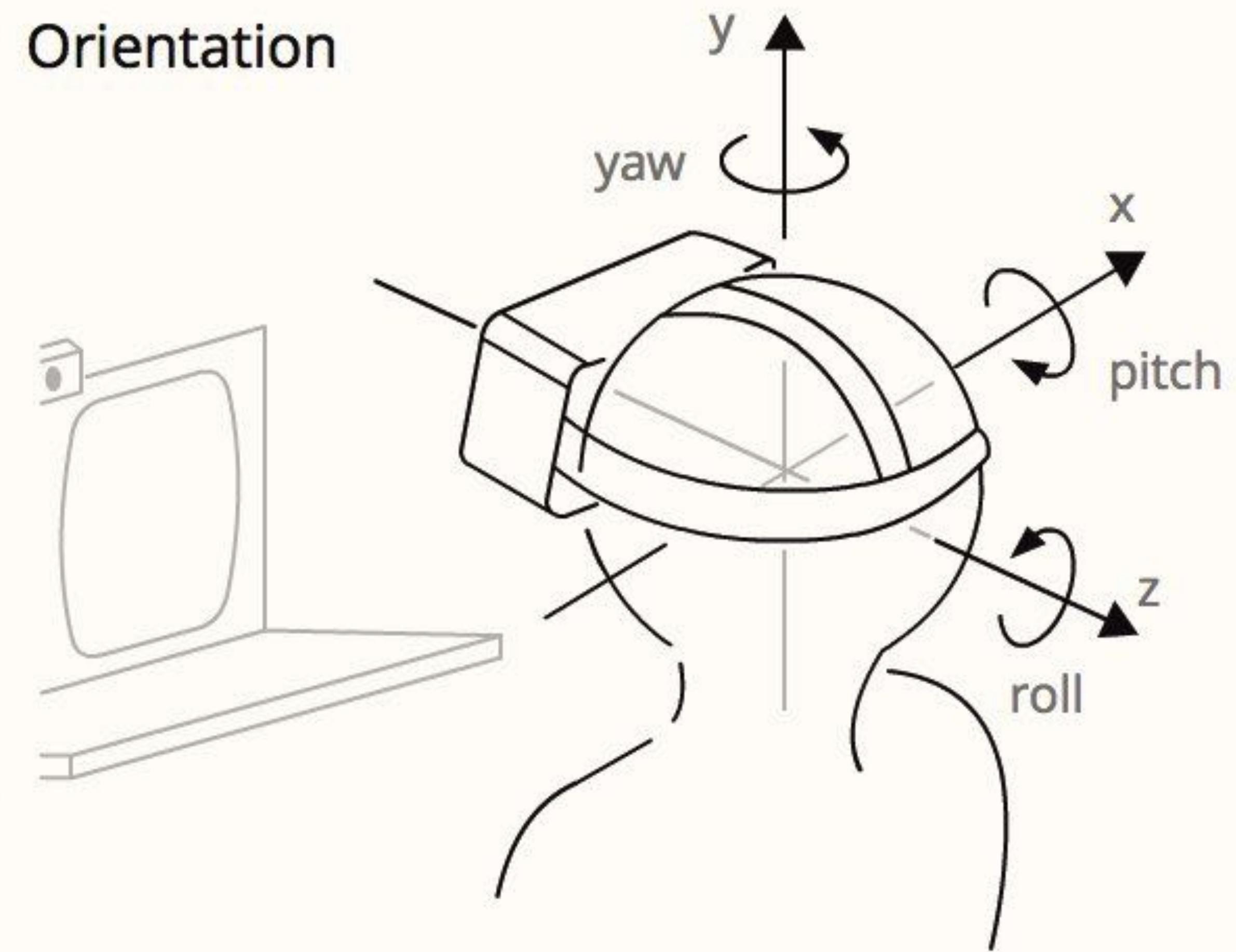


# 6-DOF HMD

Position



Orientation



---

# Inside-Out Tracking

---



# Inside-Out Tracking



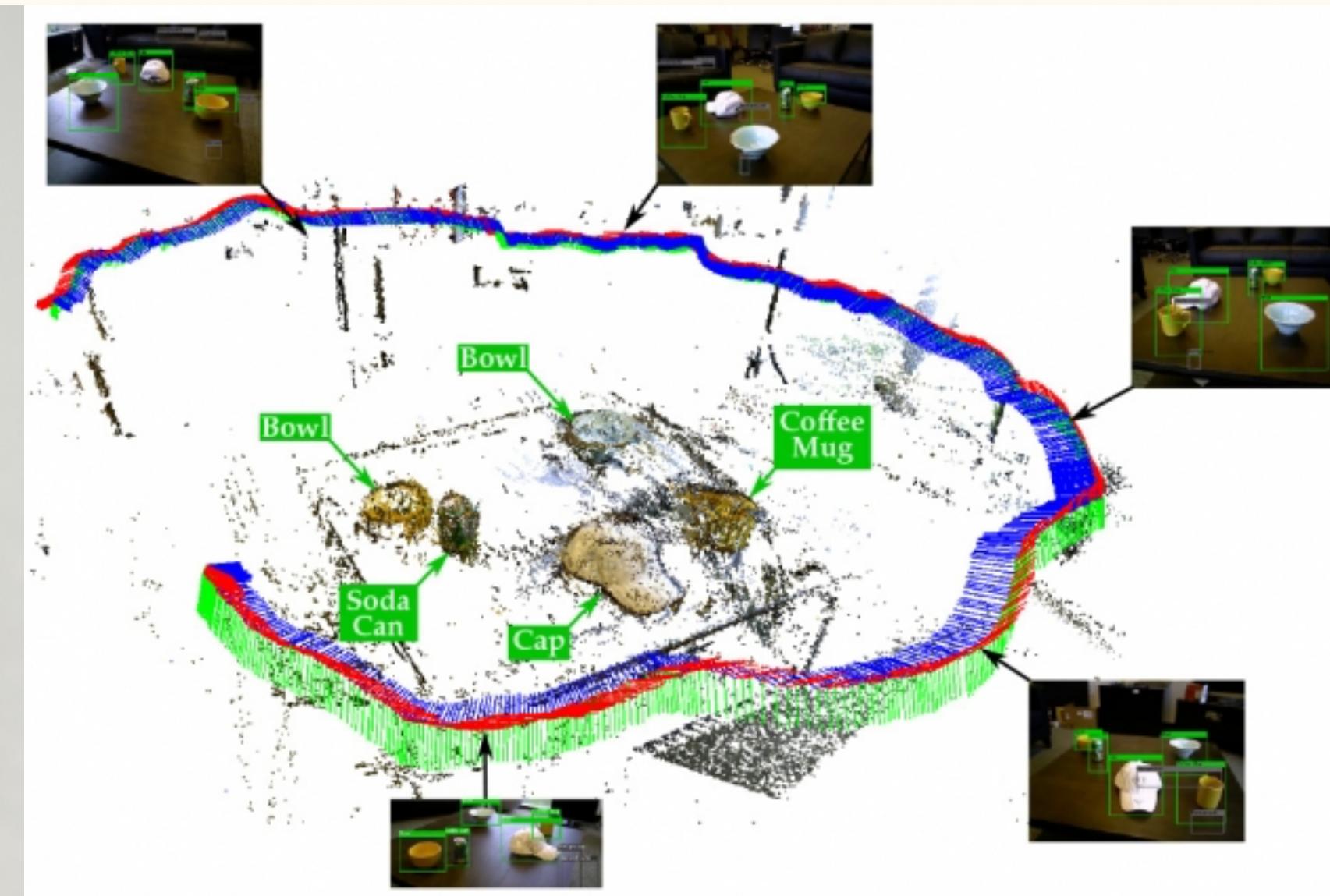
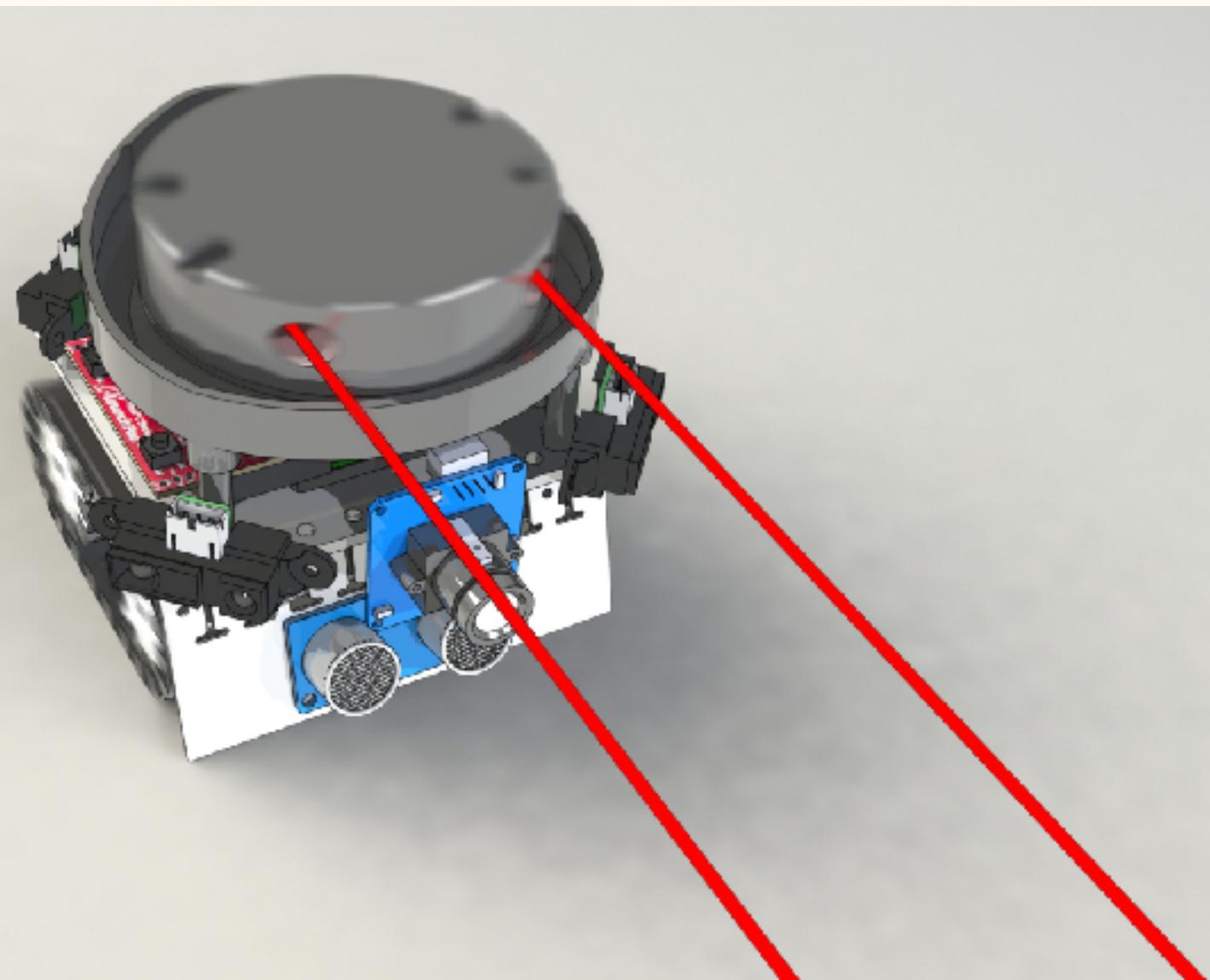
PC

# Inside-out Tracking By SLAM

## Simultaneous Localization and Mapping

A Technology from Robotic Mapping

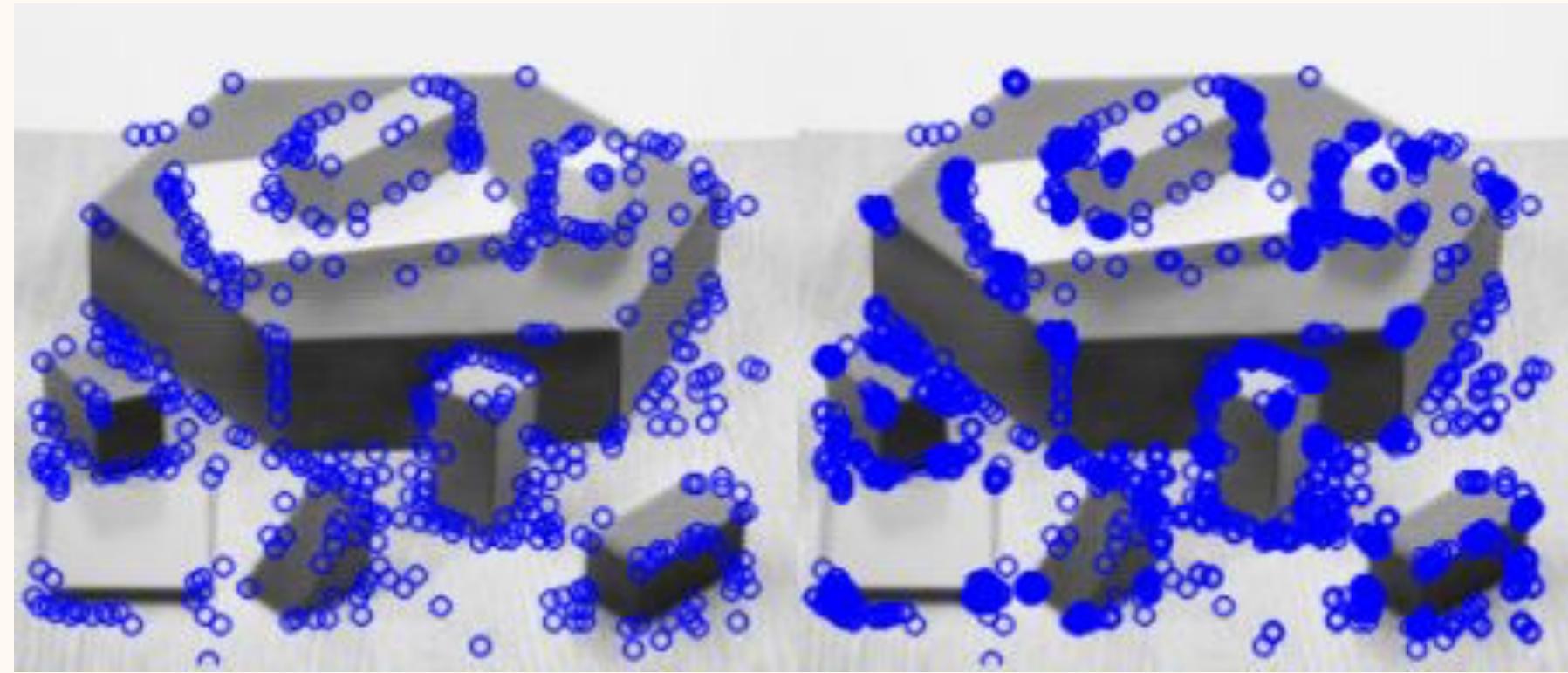
For an Autonomous Robot to Construct a Map to Localize Itself in It



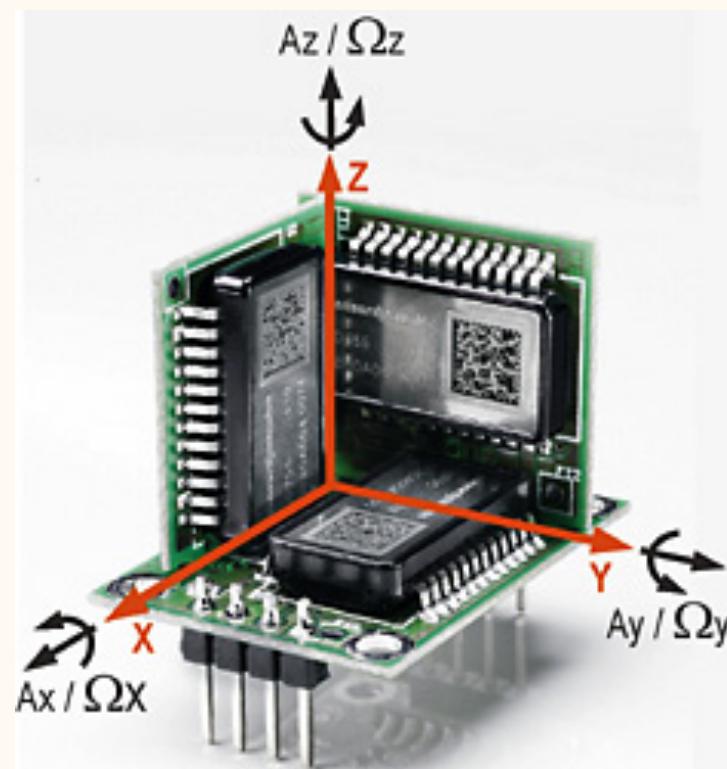
# Feature Detection



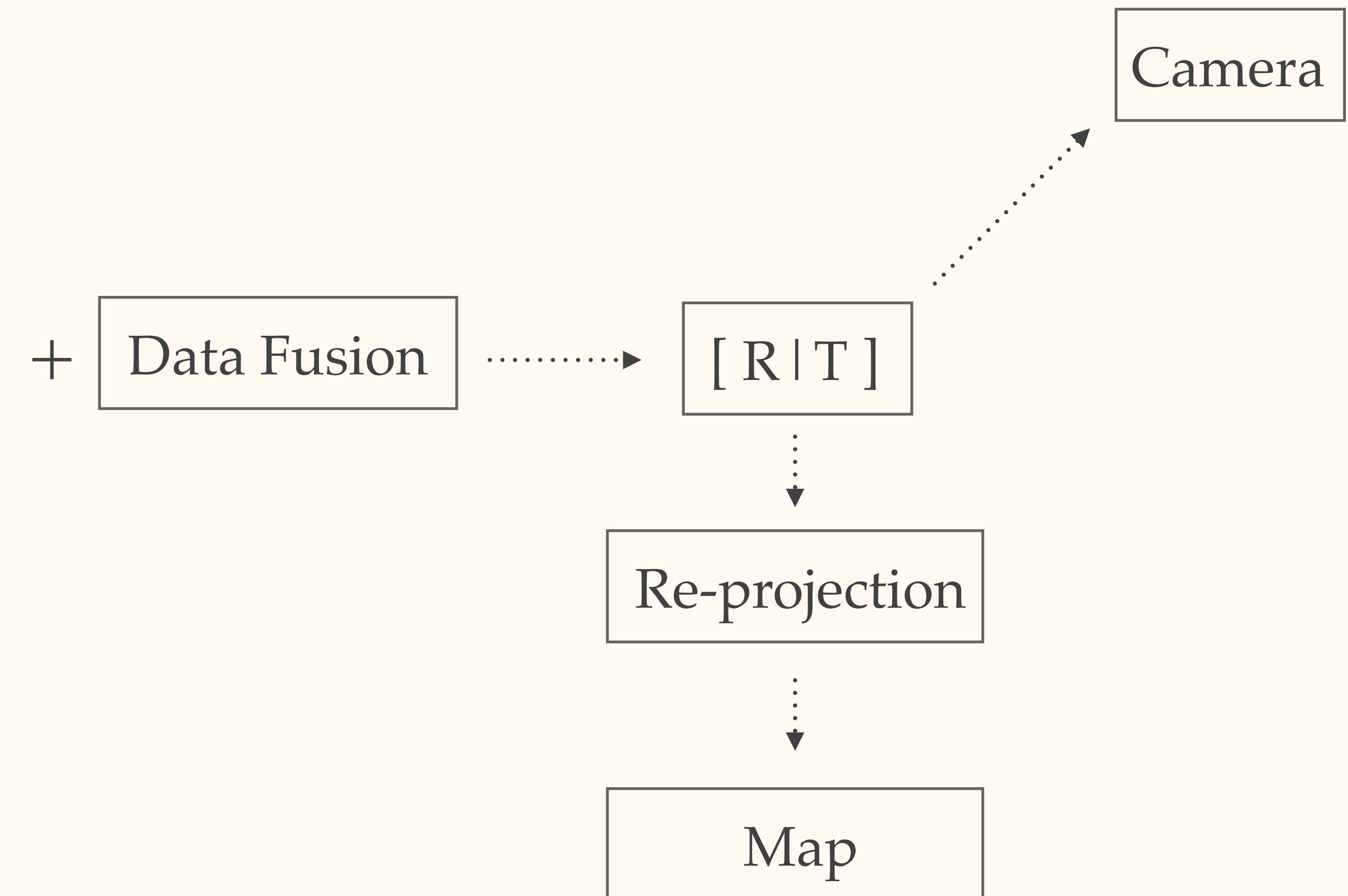
# Visual SLAM



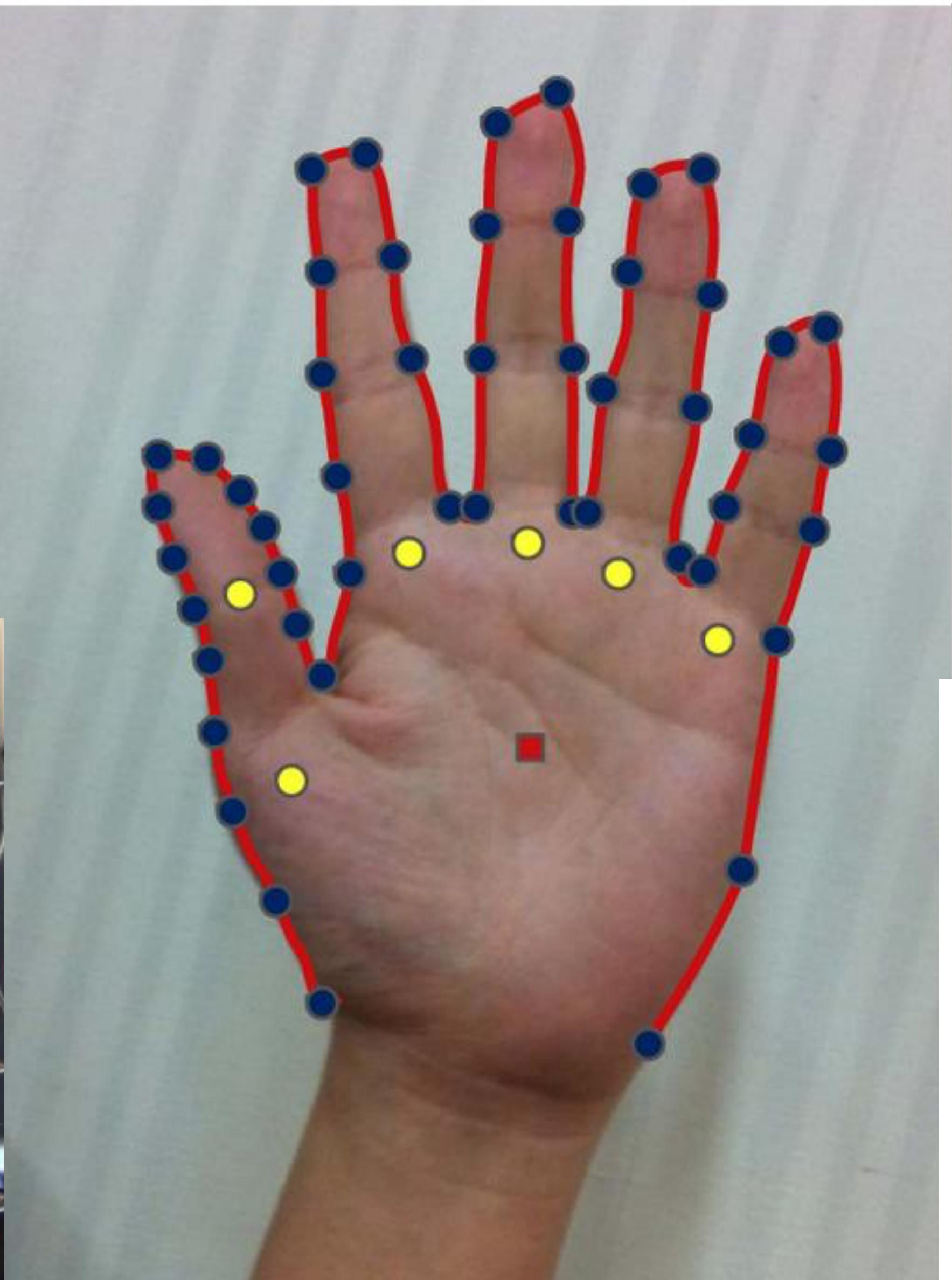
Feature Detection and Correspondence



3-axis IMU



# Hand Gesture Tracking



# Summary about Tracking

---

**(VR + Tracking) is a “Must” !**

**2016 is the Year of “Outside-In” Tracking**

HTC Vive, Oculus Rift, 3Glasses are key players.

6-DOF HMD & Controllers Tracking

**2017 & after is the Years of “Inside-Out” Tracking**

Microsoft HoloLens, Windows 10 Mixed Reality, Google Project Tangle, Oculus Quest

**SLAM is the key technology.**

6-DOF HMD Tracking in Indoor Environment

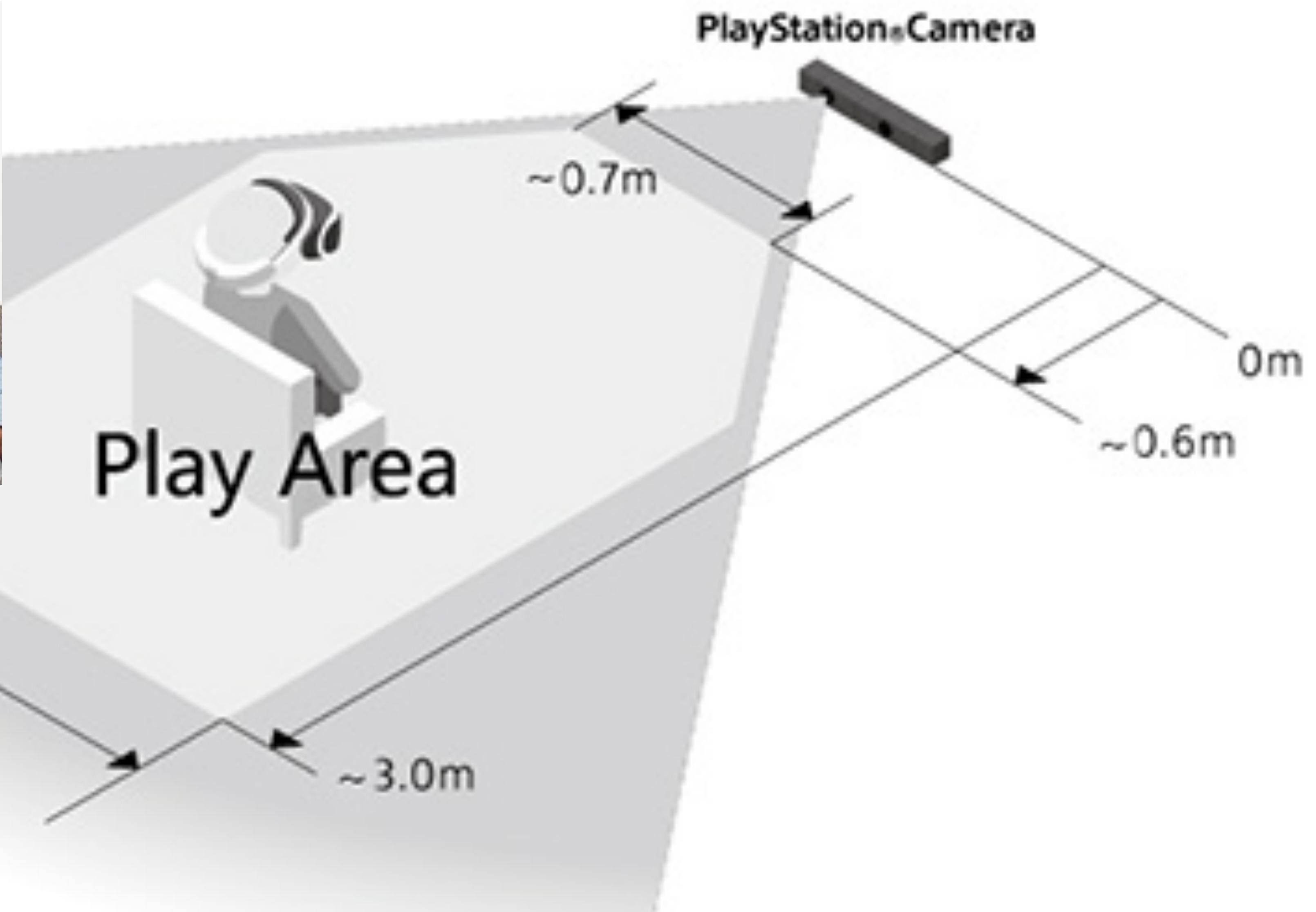
Hand Tracking (Gesture)

VR Area

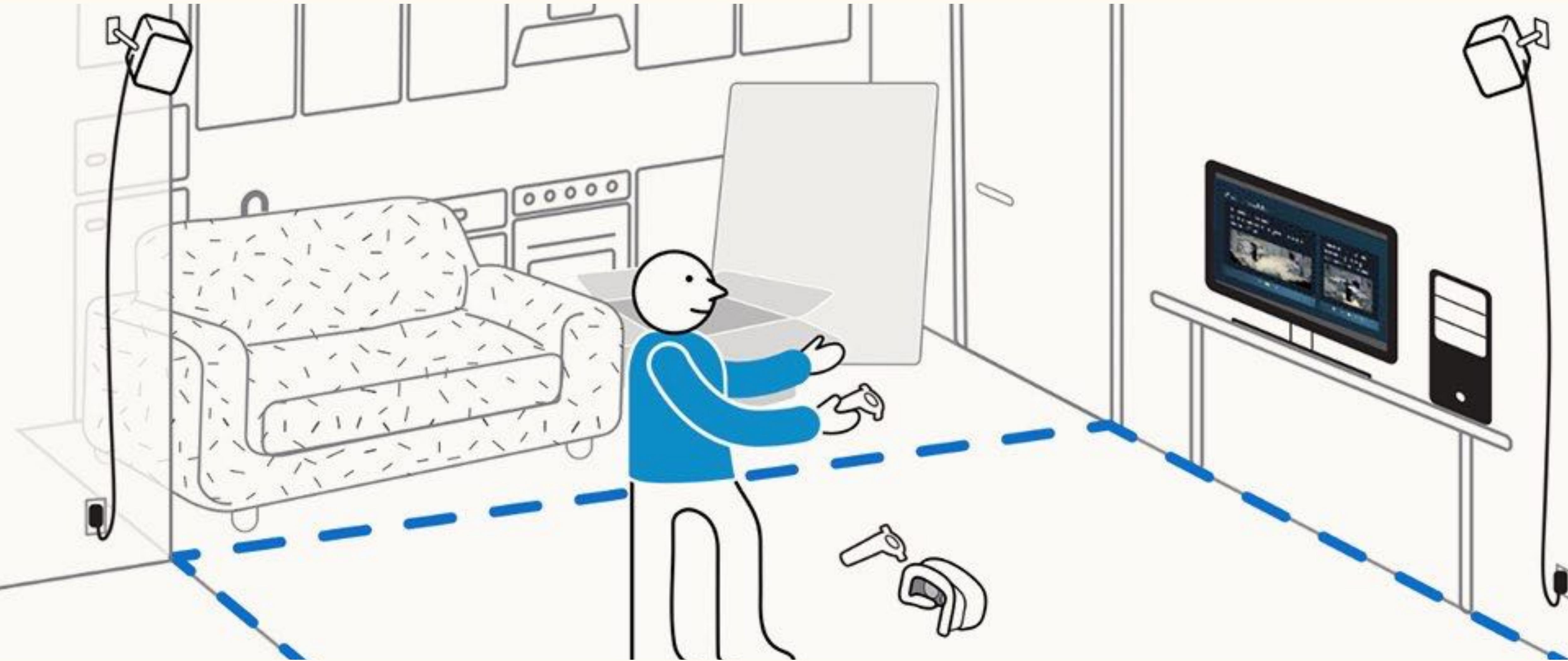
# Mobile VR - Google Cardboard/Daydream - 3DOF



# Seated VR

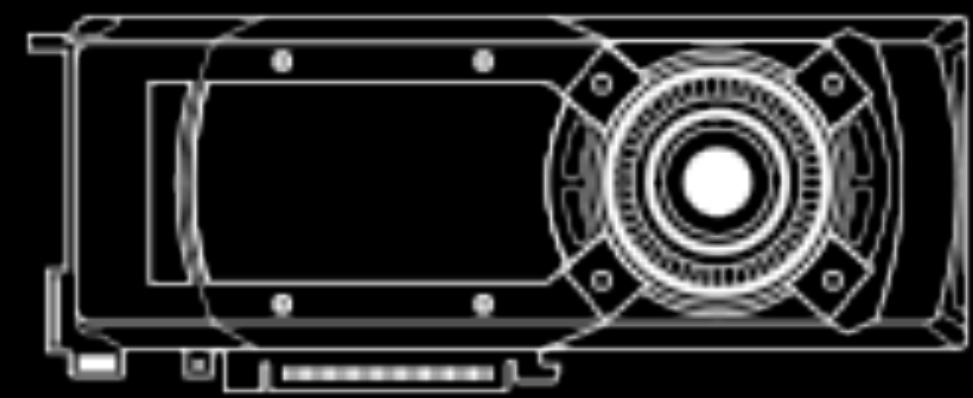


# Room-scale VR



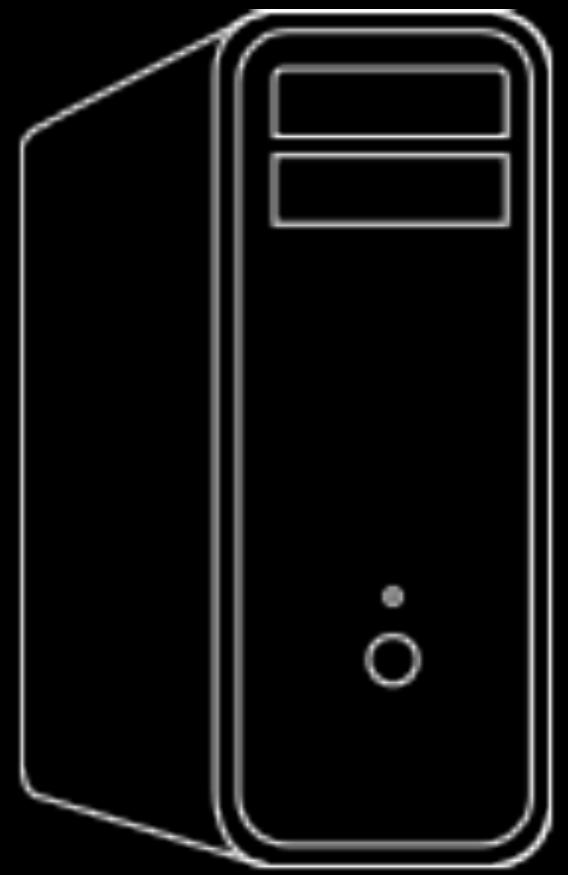
# Types of VR HMD

# PC VR



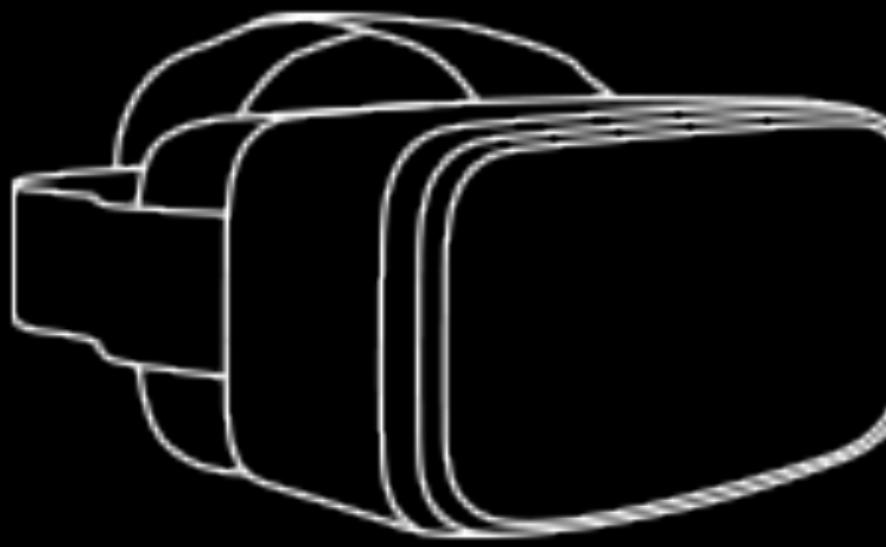
GPU

GeForce GTX 1060 or greater



PC

With 3x USB 3.0



HMD

Head Mounted Display  
HTC Vive, Oculus Rift,  
Windows Mixed Reality

# Wired



# PC VR



SLASH GEAR

# Mobile VR



A VR Case for Smart Phone  
With Lens and 3DOF controllers  
Running on Android OS  
Based on Google Cardboard SDK (mostly)

# All-in-One VR

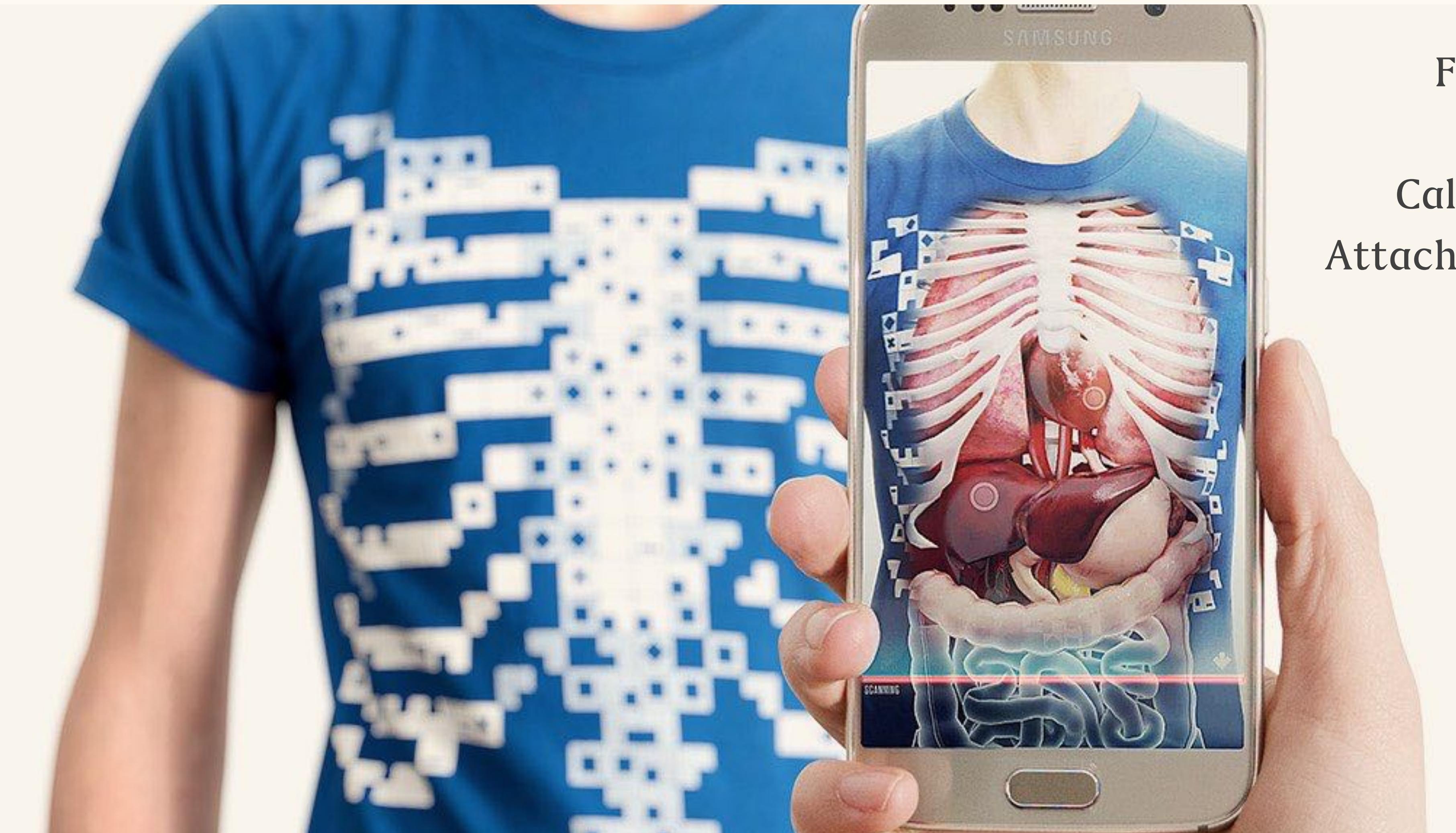


Use Smartphone Architecture (Qualcomm CPU mostly)

All-in-One : CPU/GPU, VPU, Tracking System, Lens, OS, Modem, Power Supply

# Augmented Reality (Mixed Reality)

# Augmented Reality in the Past



Use Camera  
Find Features in Image  
Identify the Pattern  
Calculate the Camera Pose  
Attach 3D Models on the Pattern

# Augmented Reality in the Past



# Augmented Reality Now



Use Camera

Find the Planes by SLAM  
(Features + Homography)

Calculate the Camera Pose

Attach 3D Models on the Pattern

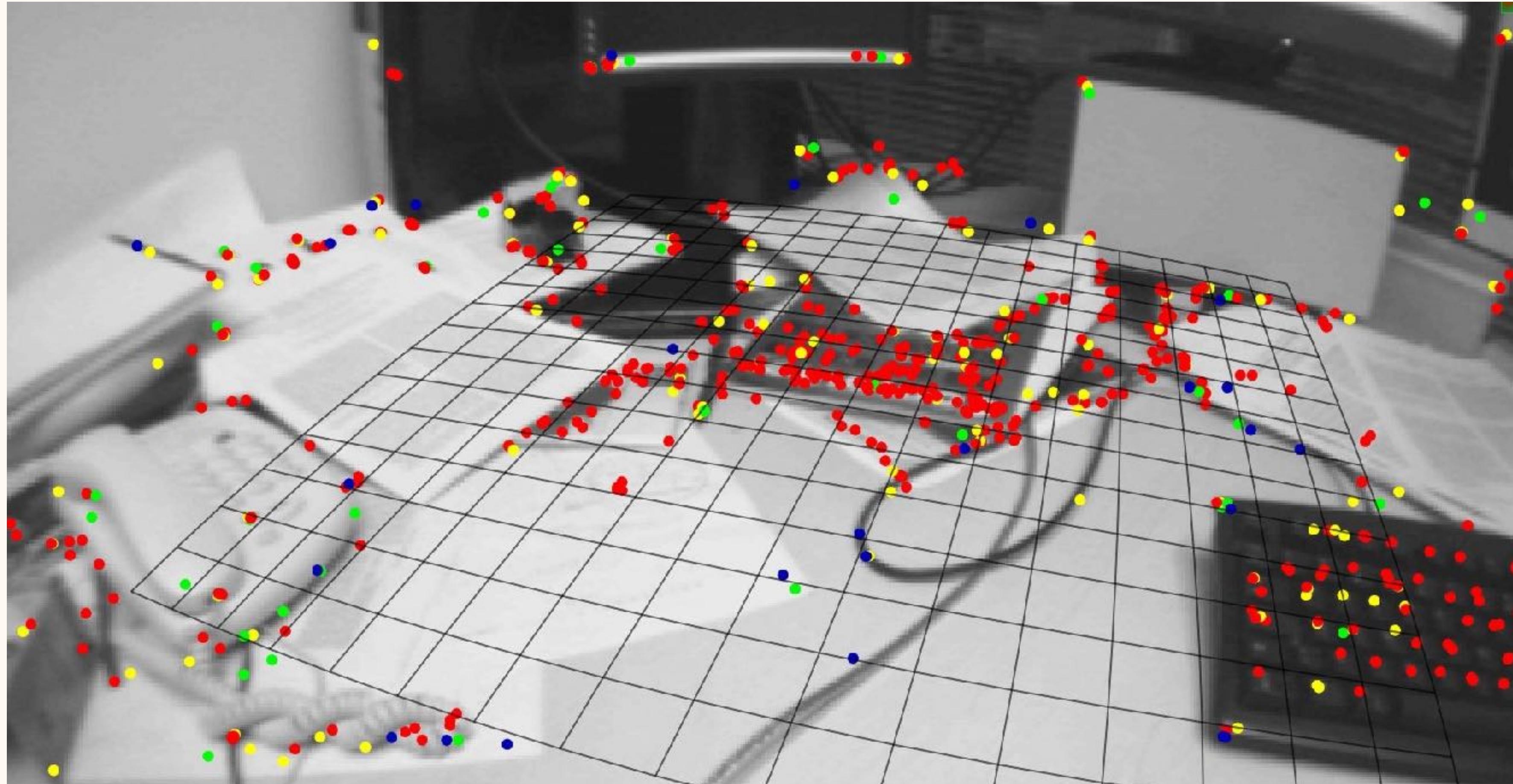
# MR / AR



# MR / AR



# SLAM for Tracking



Keywords :

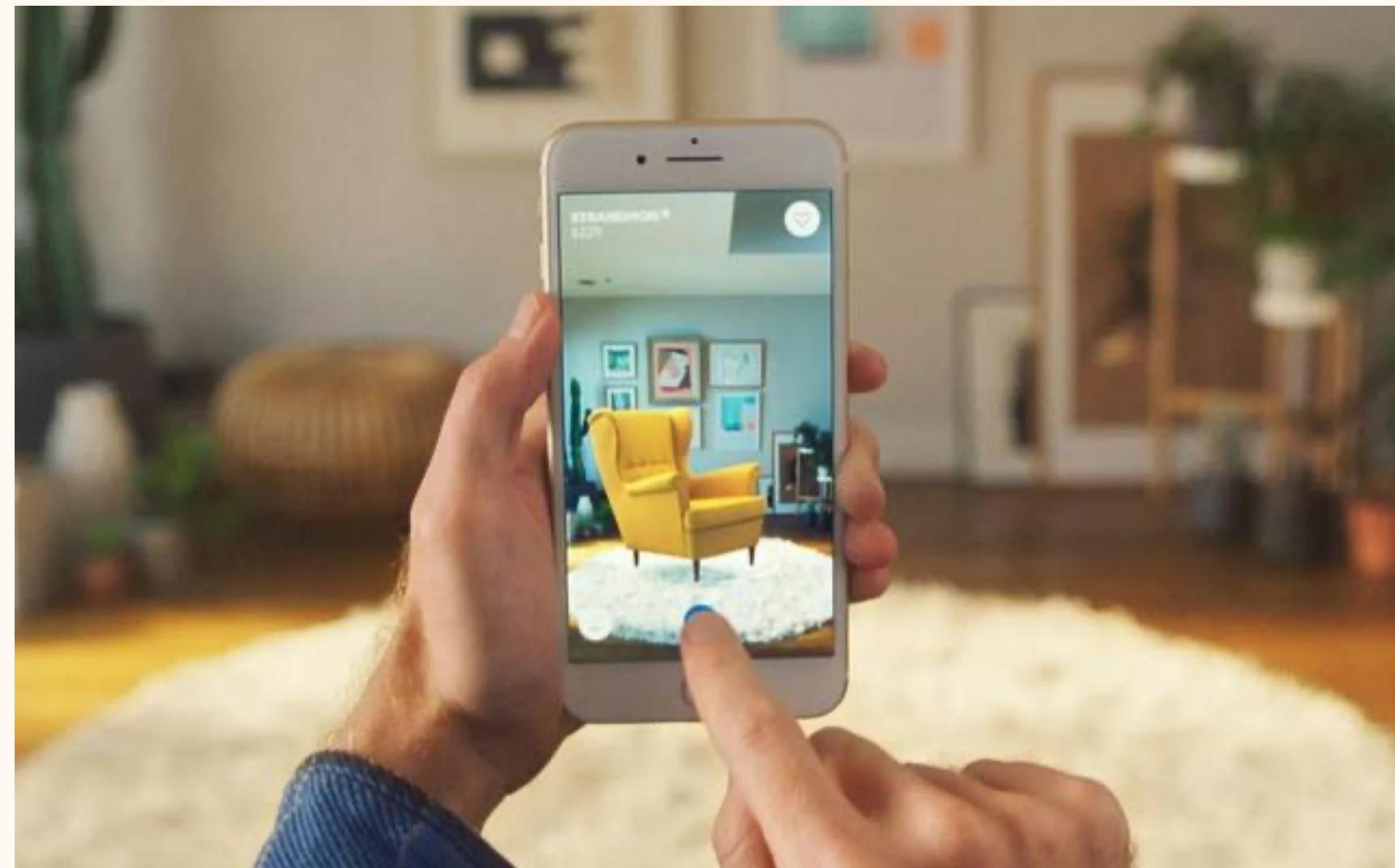
Feature Detection & Matching  
Homography

Famous Solutions :  
PTAM  
ORB-SLAM

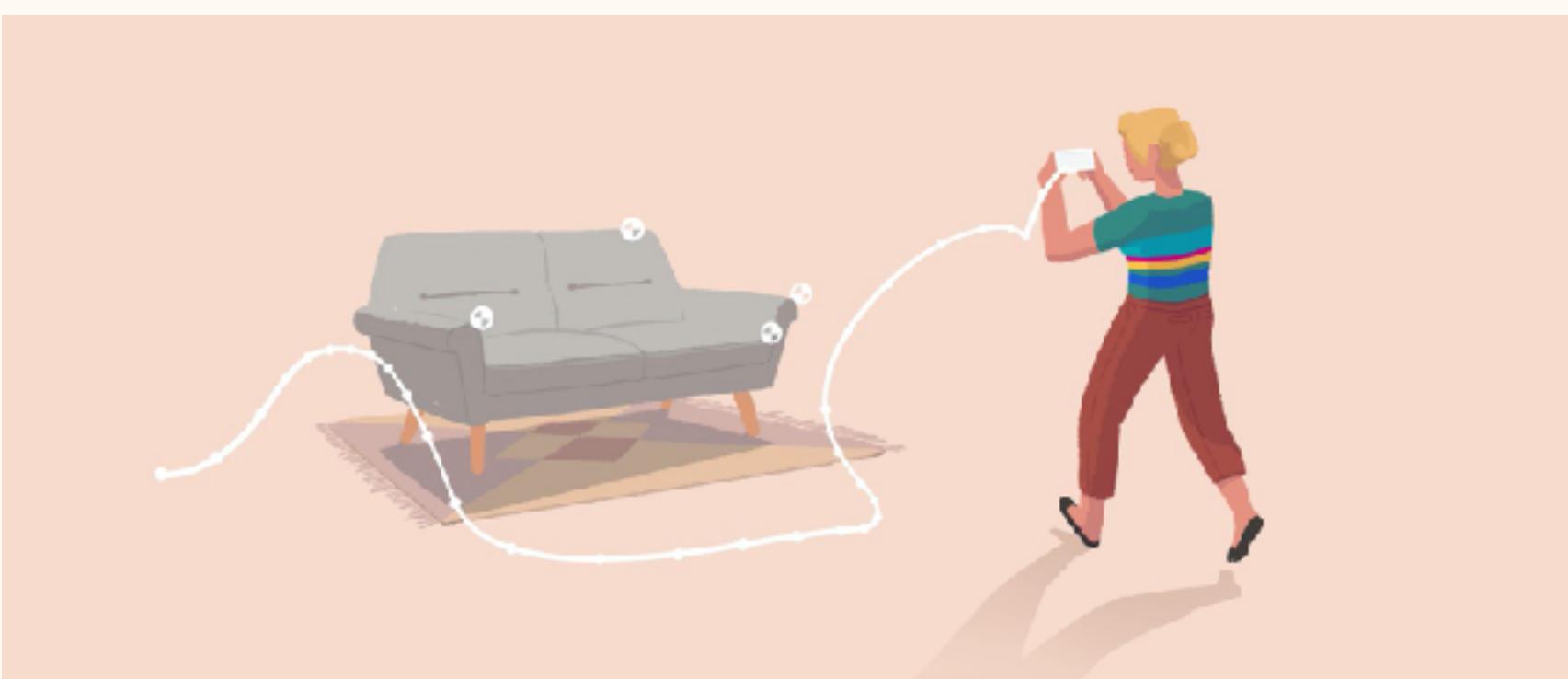
# AR Platforms

# Hand-held AR

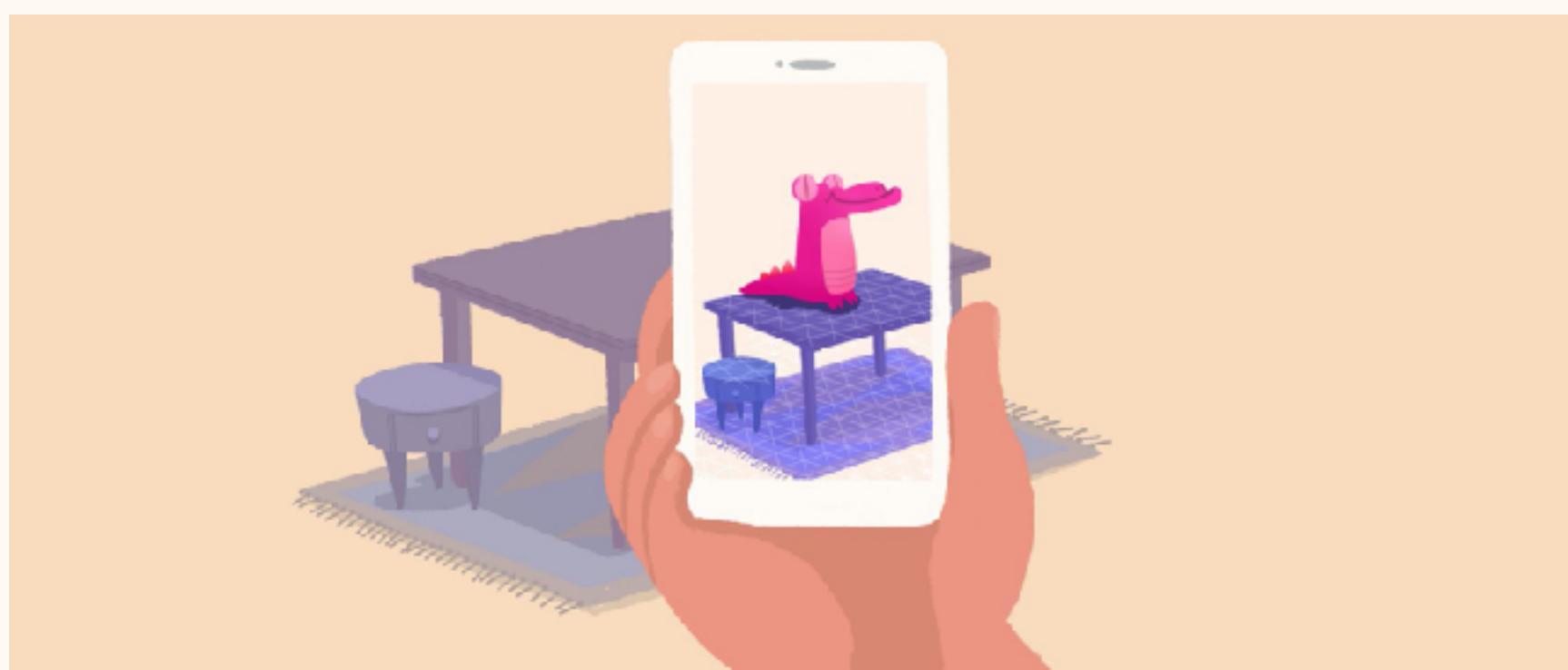
Smartphones



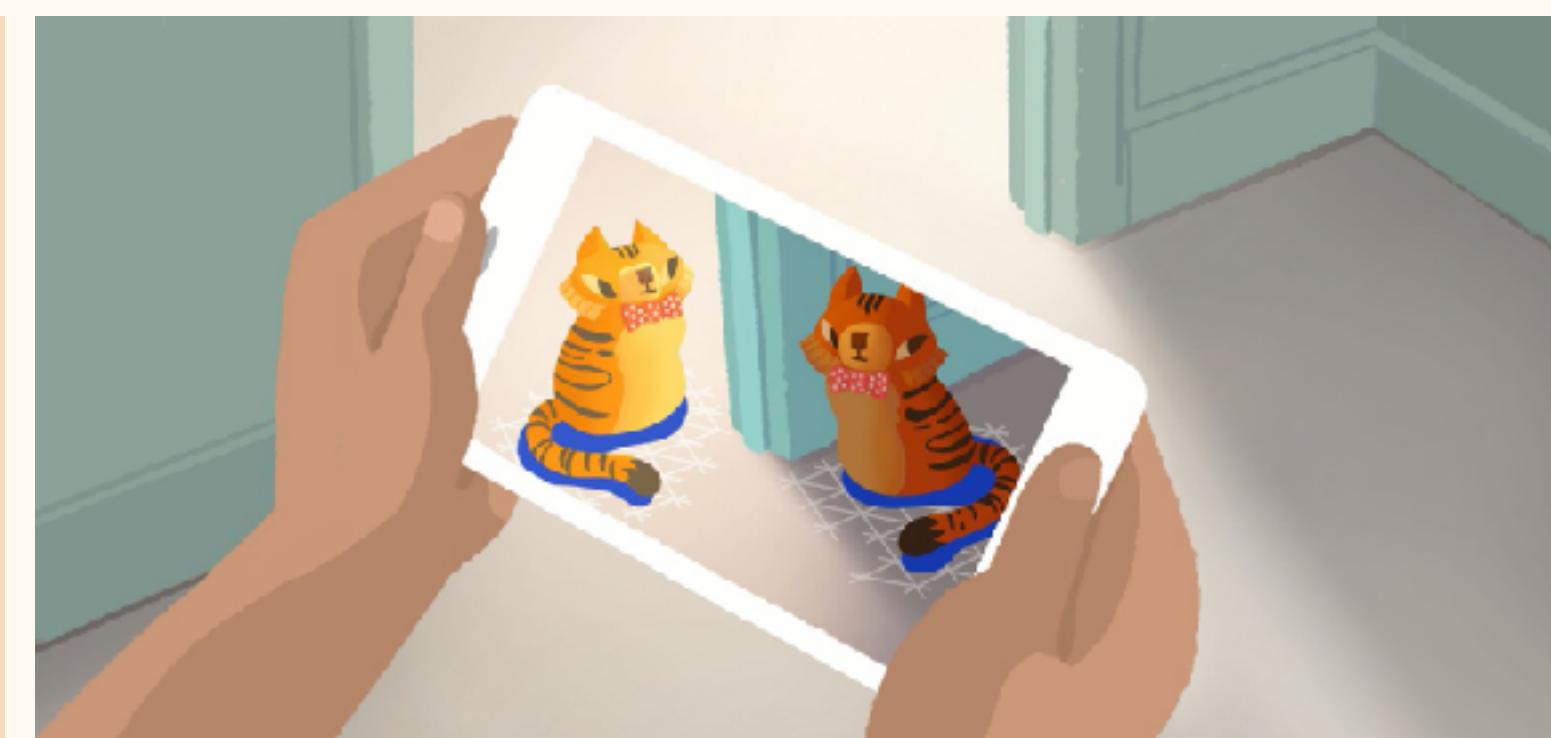
Pads



Motion Tracking



Environment Understanding



Light Estimation

# Smart Glasses vs AR Glasses



# Microsoft HoloLens 1



All-in-One AR  
Best SLAM in the World  
World-scale AR  
Hand Gestures  
Microsoft MR Platform

# Microsoft HoloLens 2

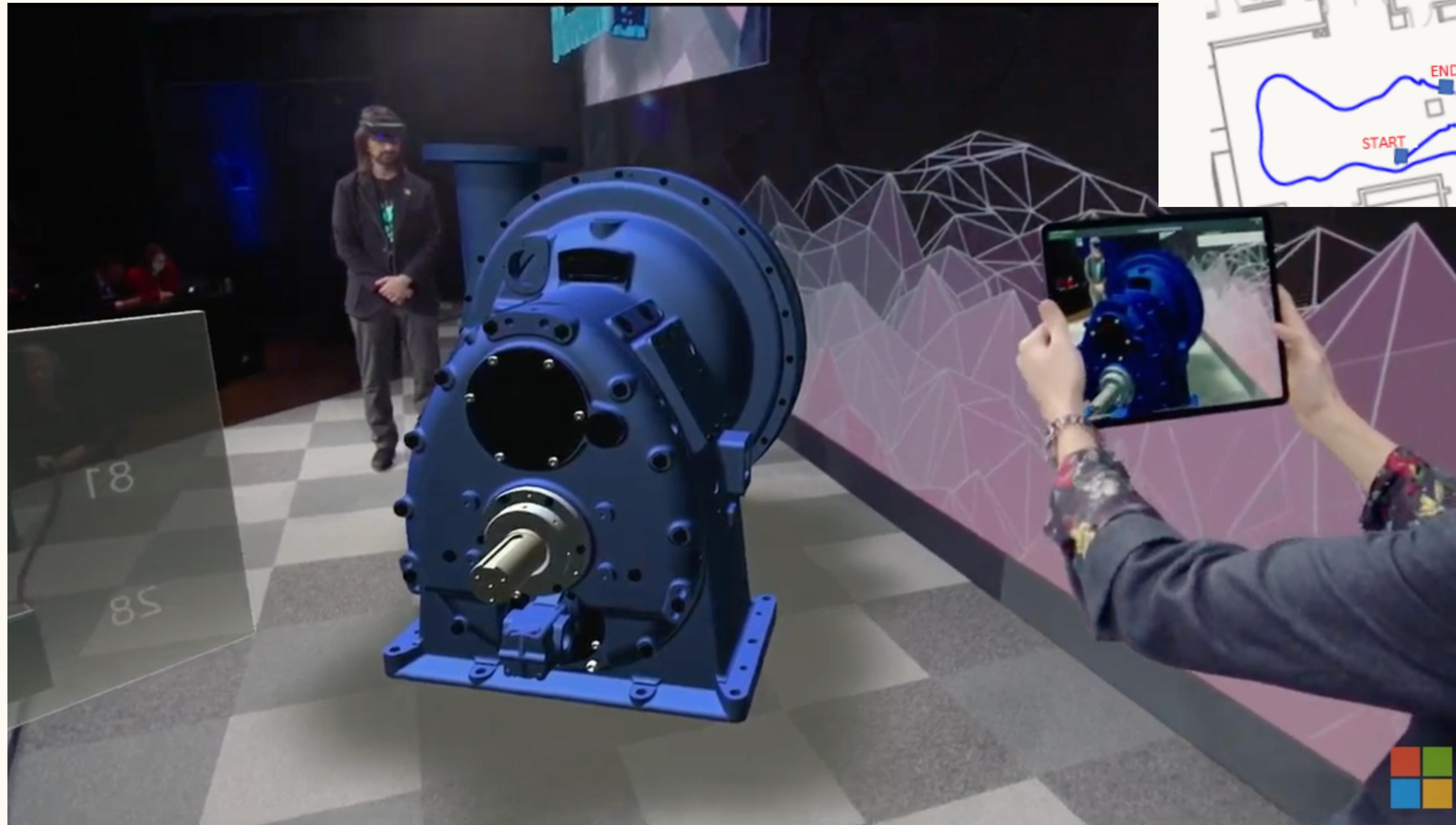


# Magic Leap

Join us



# World-scale AR



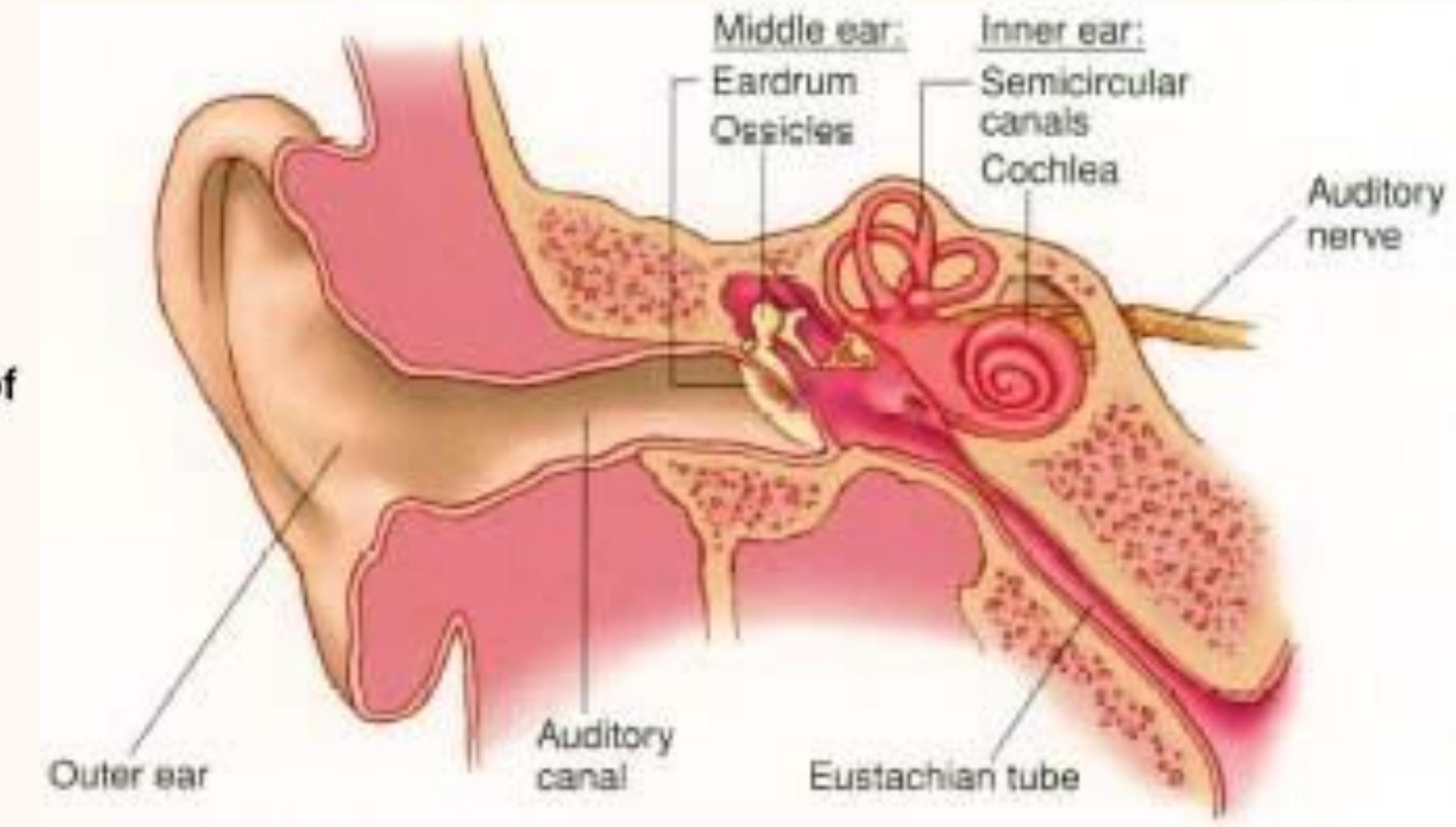
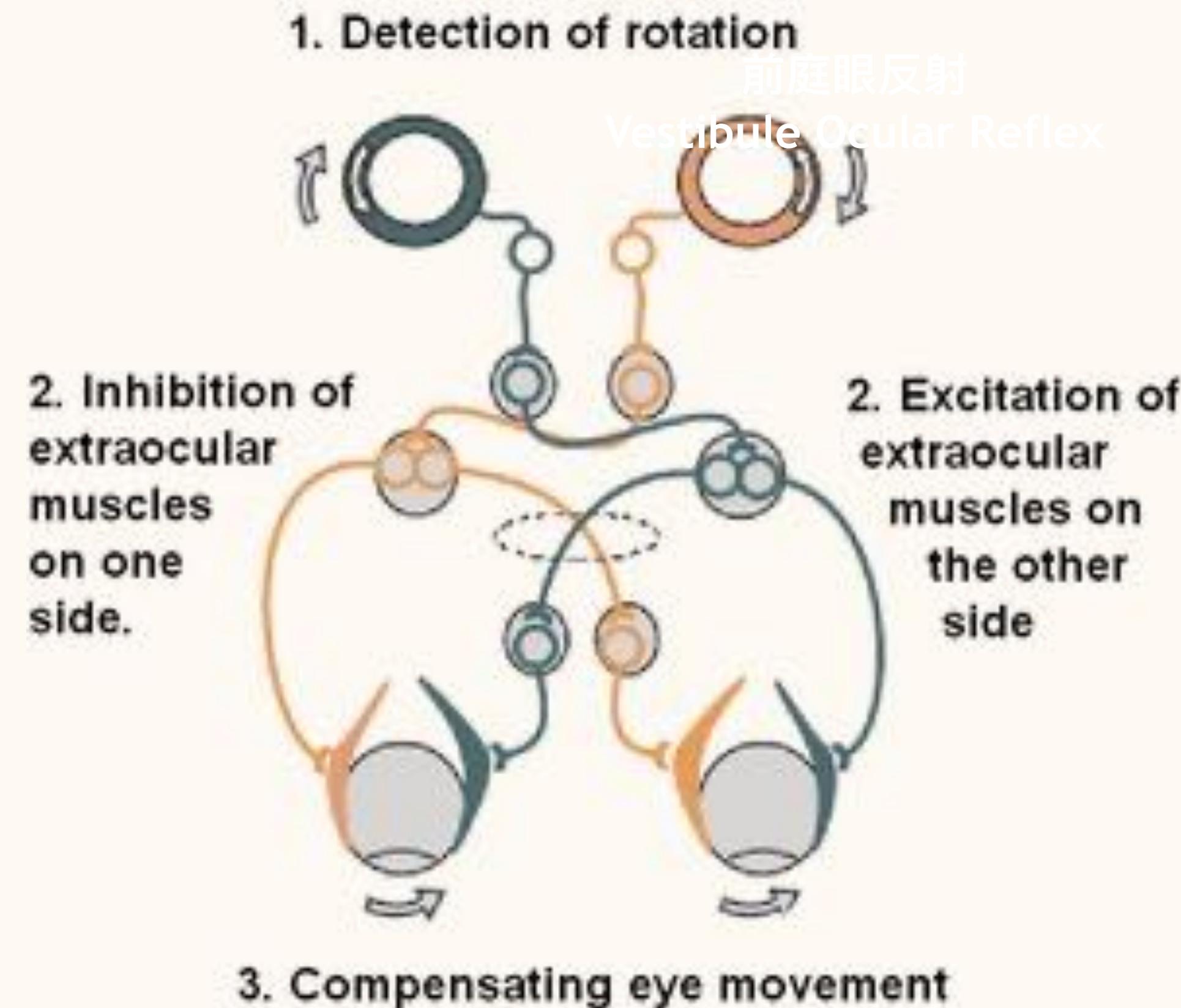
# Smart Glasses



AR Viewer  
Low Cost  
Limited Tracking Features  
Connect to Smartphone

# Understanding Motion Sickness

# Our Brain and Eyes



VOR  
Vestibule Ocular Reflex

Human Body will Try to Stabilize  
the Image We Seeing

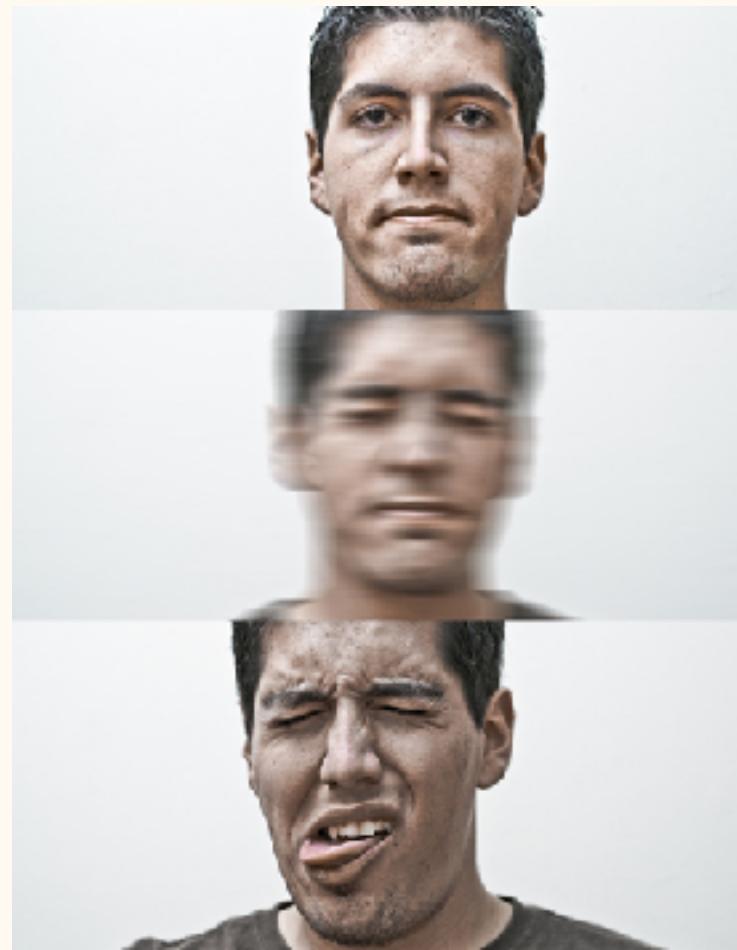
# Motion Sickness Case 1



# Motion Sickness Case 2

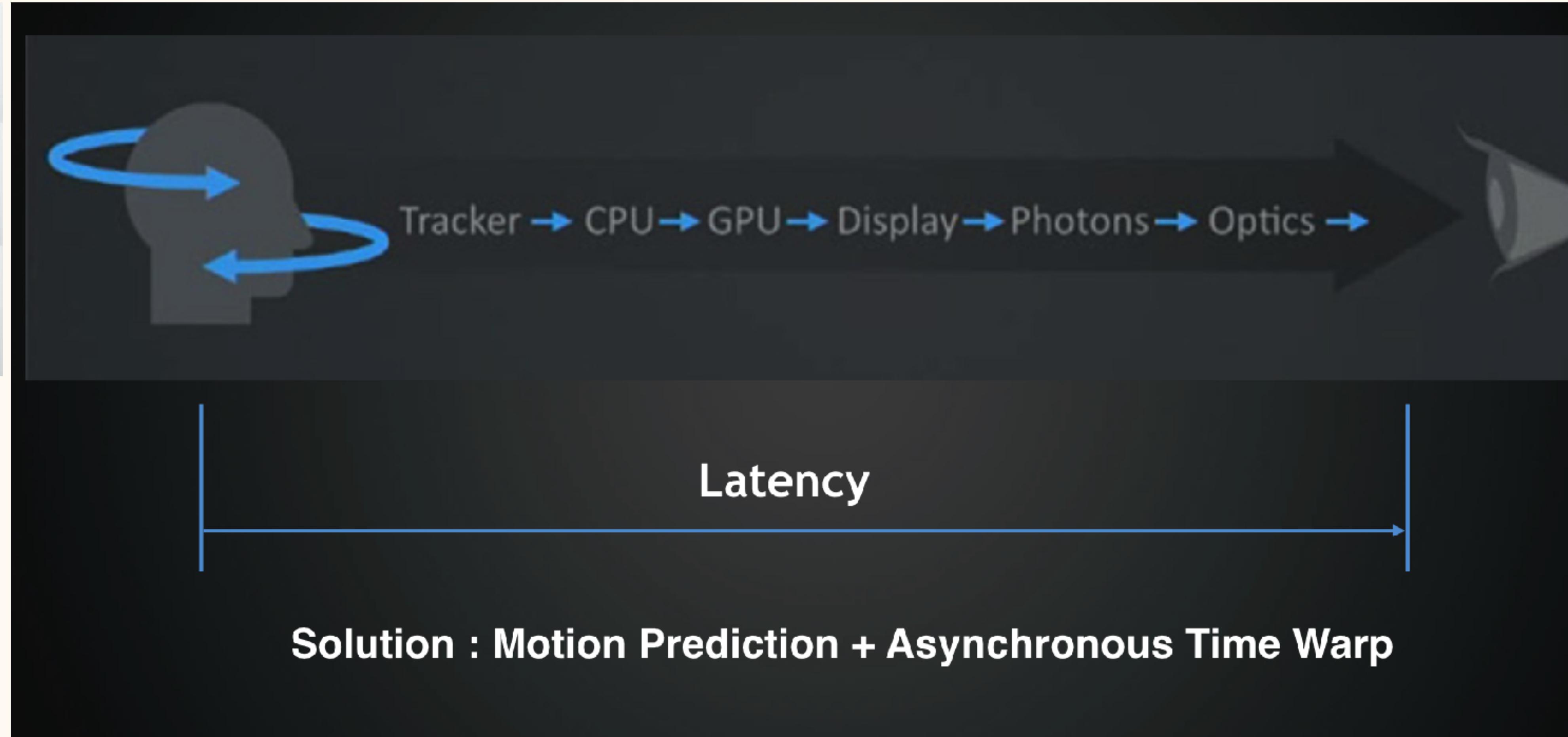
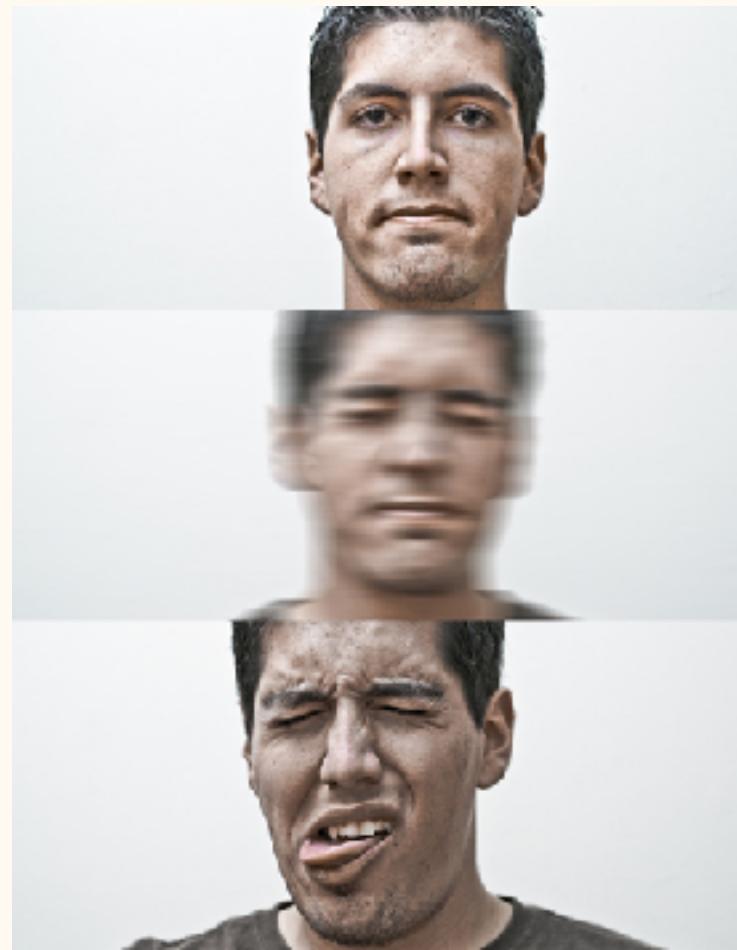


# Motion Sickness Due to Display Persistence



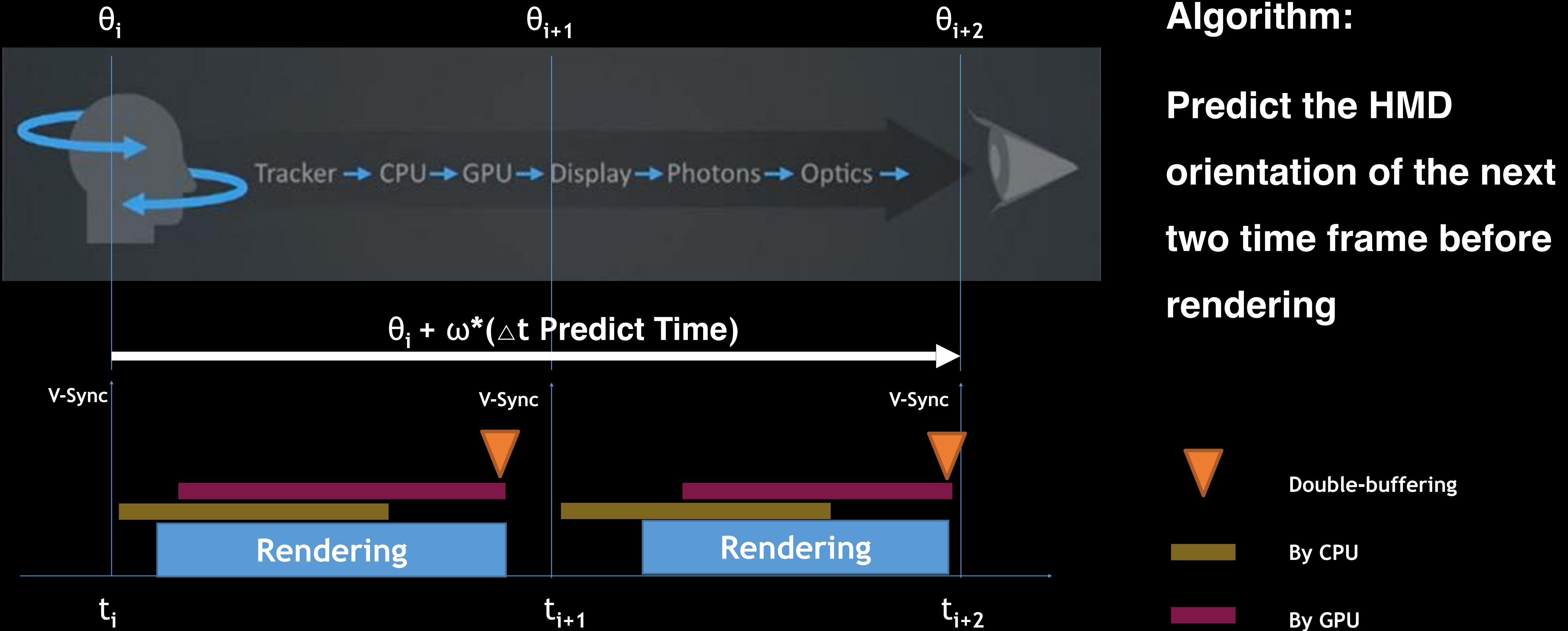
OLED vs Traditional TFT

# Motion Sickness Due to Rendering Latency

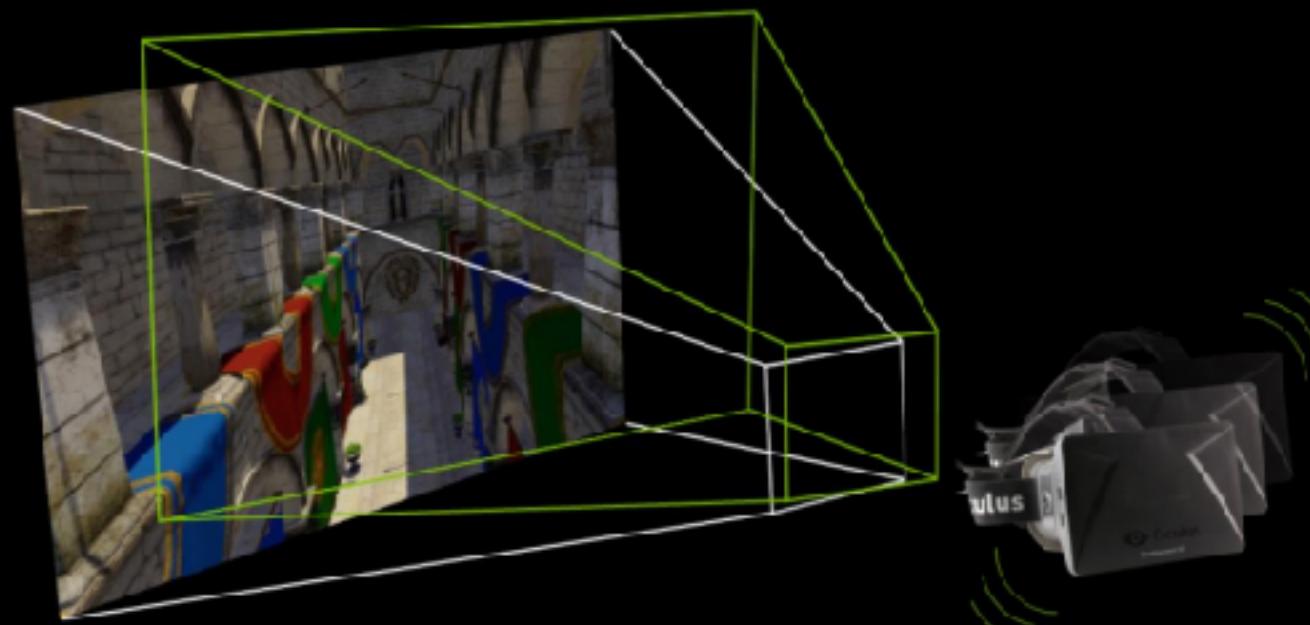


Speedup the 3D Rendering Performance + Head Motion Prediction +  
Asynchronous Time Warp (ATW) + Single-buffer Rendering

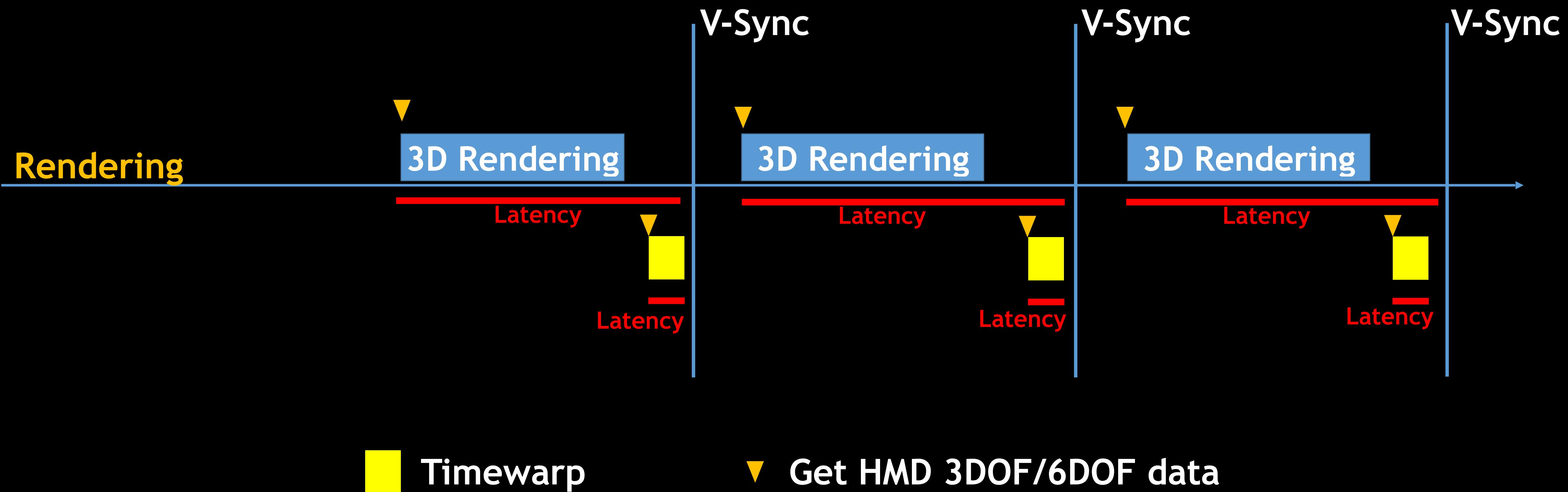
# Motion Prediction



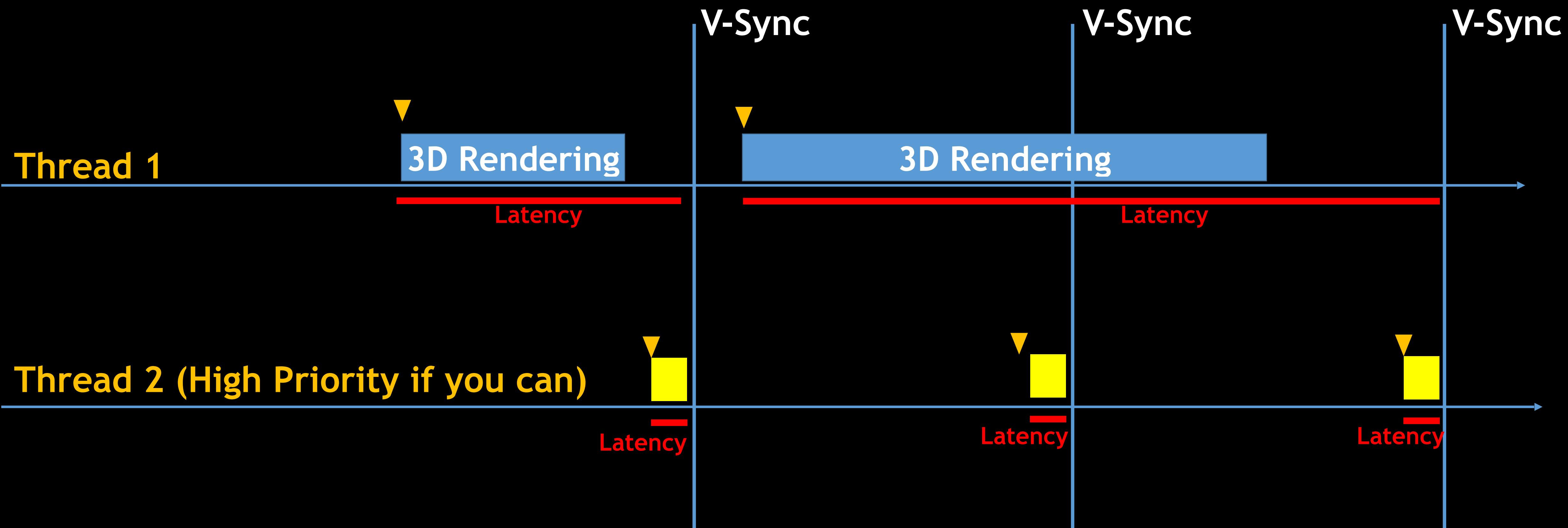
**TIMEWARP**



# Timewarp



# Asynchronous Timewarp



# To Prevent From Motion Sickness

---

What You See Is What You Feel  
Vision Is Synchronized with Sensing

Don't Challenge the Limitation of Human Beings

Fit It into Real-world Sense of Space/Size/Cognition  
(空間感、尺寸、認知)

Select Proper Hardware

---

# Popular VR/AR Content Formats

---

3D Graphics + Interaction

360 Video

Stereo 180 Video

# 3D Graphics + Interaction



# 3D Graphics + Interaction

---

Based 3D Game Technology

Must up to 60-90 FPS Performance

(Due to Stereoscopy : 120-180 FPS/Frame)

6-Time-Faster Than Traditional 3D Games

Unity & Unreal Capable of VR Packages

Highly Interaction

Computer-generated Images

---

# 360 Video

---



# 360 Video Limitations

---

8K Resolution Is a Limit Recently  
(Due To the Network Bandwidth, Camera System, etc)

But You Only “See” 1/8 Portion of the 360-image

Only One Camera View , No Immersion

3 DOF (Degree-of-Freedom) Only

Very Limited Interaction

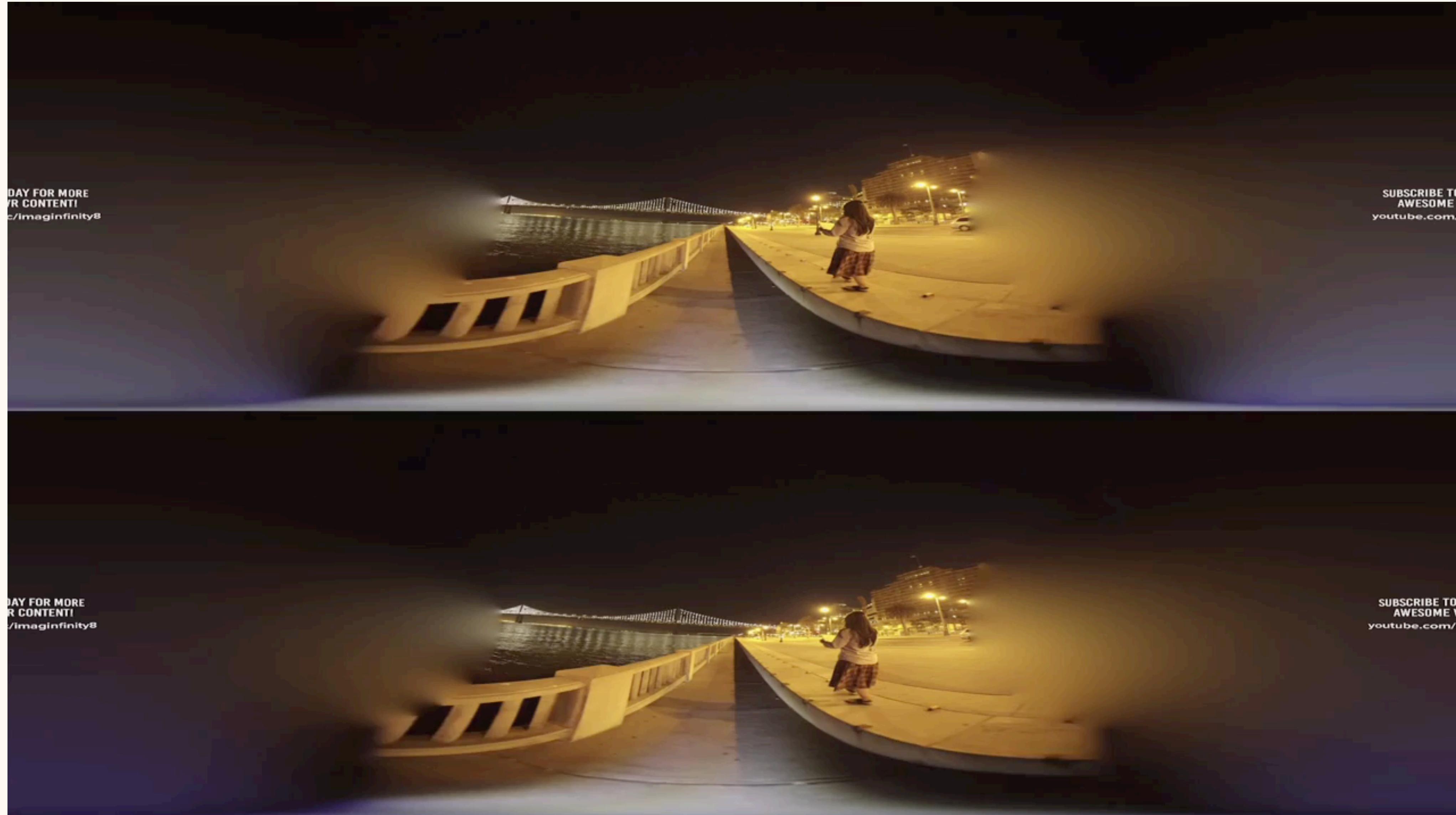
---

# 360 Video + 3D Objects + Image-based Lighting

---



# Stereo 180 Video



DAY FOR MORE  
VR CONTENT!  
[youtube.com/c/imagininfinity8](https://www.youtube.com/c/imagininfinity8)

SUBSCRIBE TO  
AWESOME V  
[youtube.com/c/imagininfinity8](https://www.youtube.com/c/imagininfinity8)

DAY FOR MORE  
VR CONTENT!  
[youtube.com/c/imagininfinity8](https://www.youtube.com/c/imagininfinity8)

SUBSCRIBE TO  
AWESOME V  
[youtube.com/c/imagininfinity8](https://www.youtube.com/c/imagininfinity8)

# Stereo 180 Video

---

Only 180-degree of Vision

Using Side-by-side Format To Combine Two Views

Immersion

3 DOF only

Limited Interaction

---

# VR/AR Applications

---

Games

B2B Applications

---

# VR Game Platform

---

SONY Playstation VR

Steam VR Platform

Etc

# SONY PSVR

SONY Playstation 4 Game Console



**PlayStation®VR**  
豪華全配包



Closed System

Developing Contents Need to Be Authorized

Games Mostly

Seated VR

# Steam VR

Based on Stream Platform  
VR App Store By Valve

Open Platform for VR on PC/Mac/Linux/Mobile  
Supported Most of VR HMDs



---

# B2B Applications

---

Education

Entertainment

Medical Application

Training

Simulation

Travels

...









---

# VR/AR in the Near Future

---

Using in anytime and anywhere

All-in-one Hardware

Wireless

5G + Edge Computing

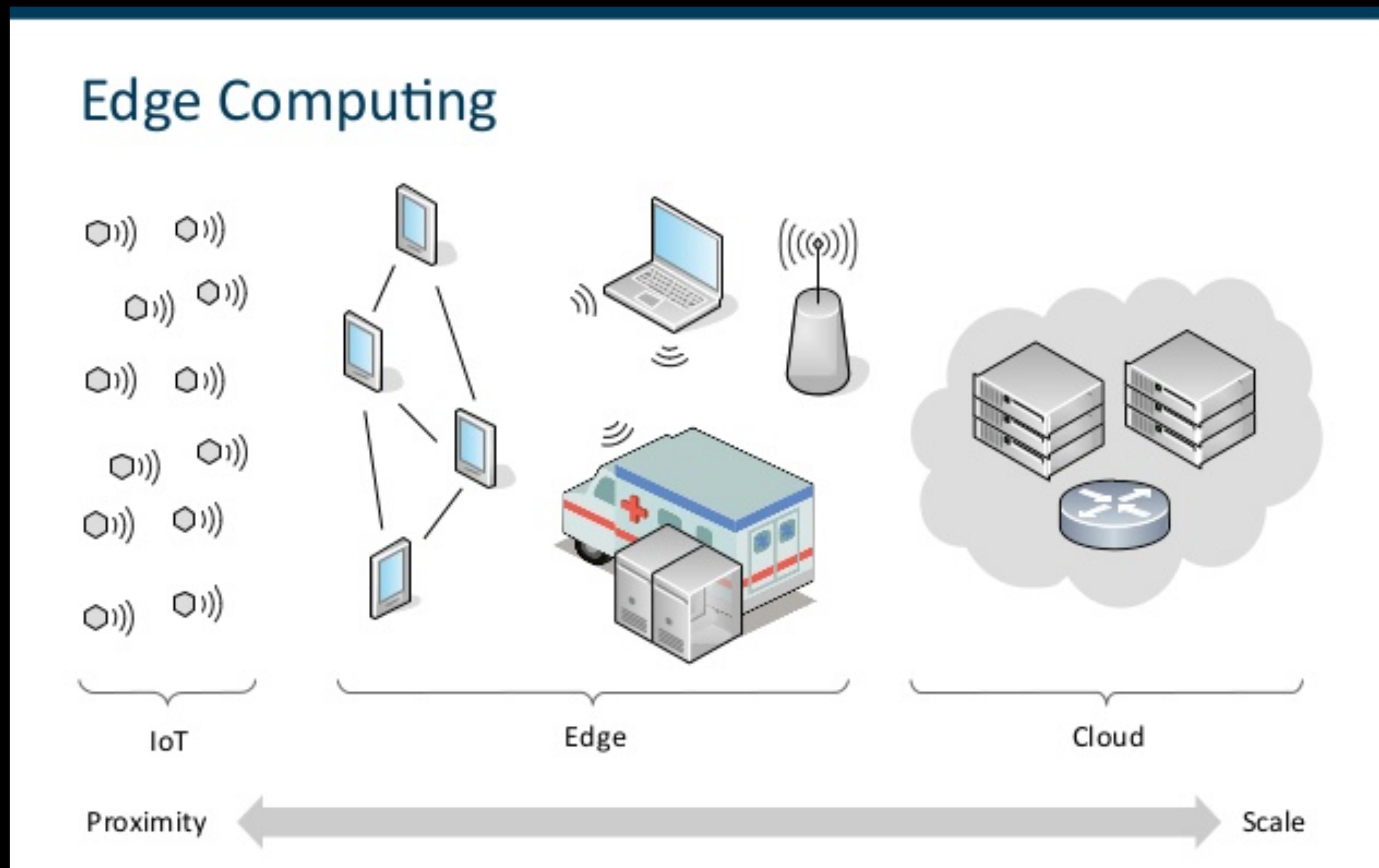
World-scale

Social VR/AR

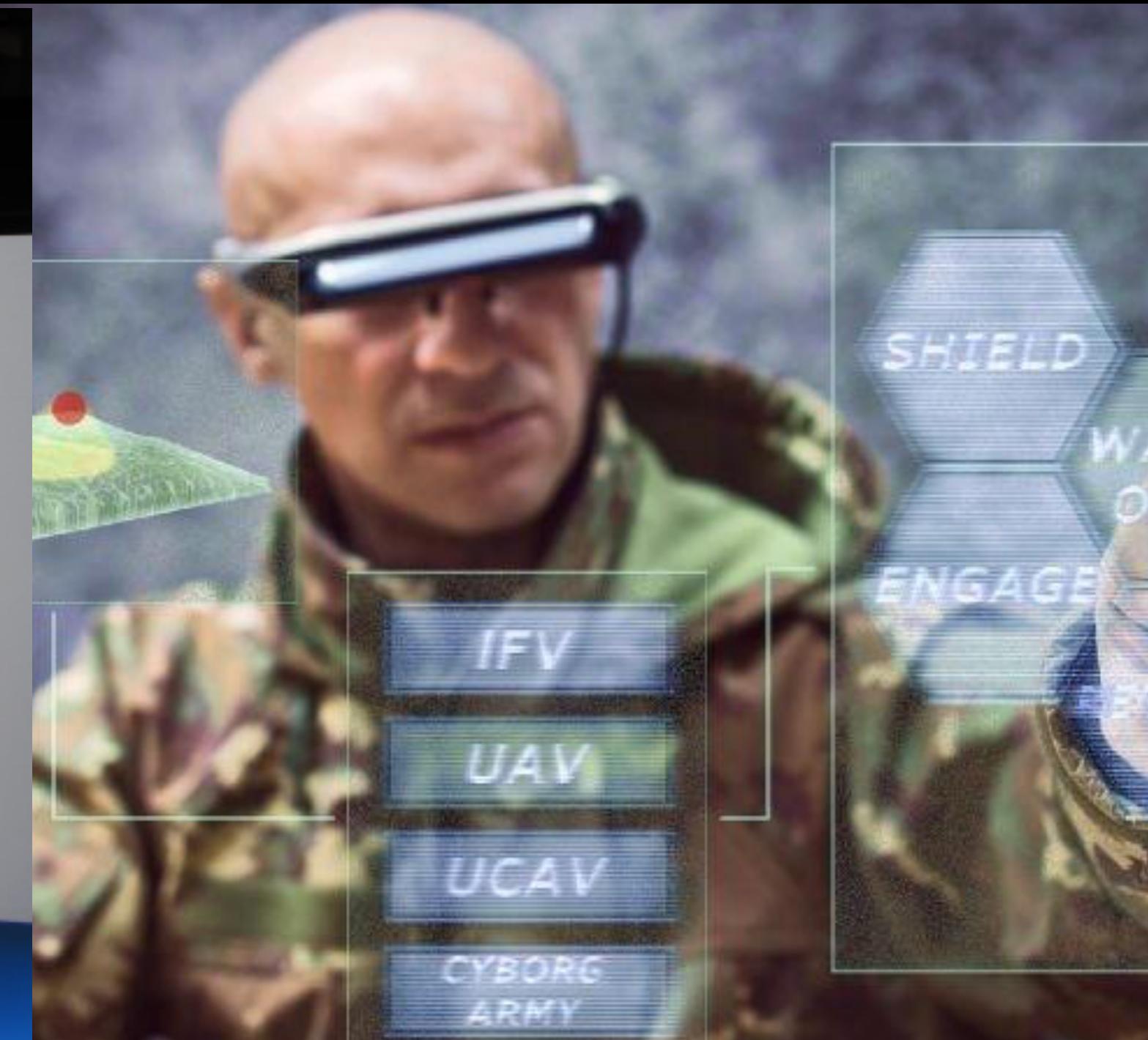
# All-in-One

CPU + GPU  
Tracking System  
VPU  
OS  
Modem  
Power Supply

# 5G + Edge Computing



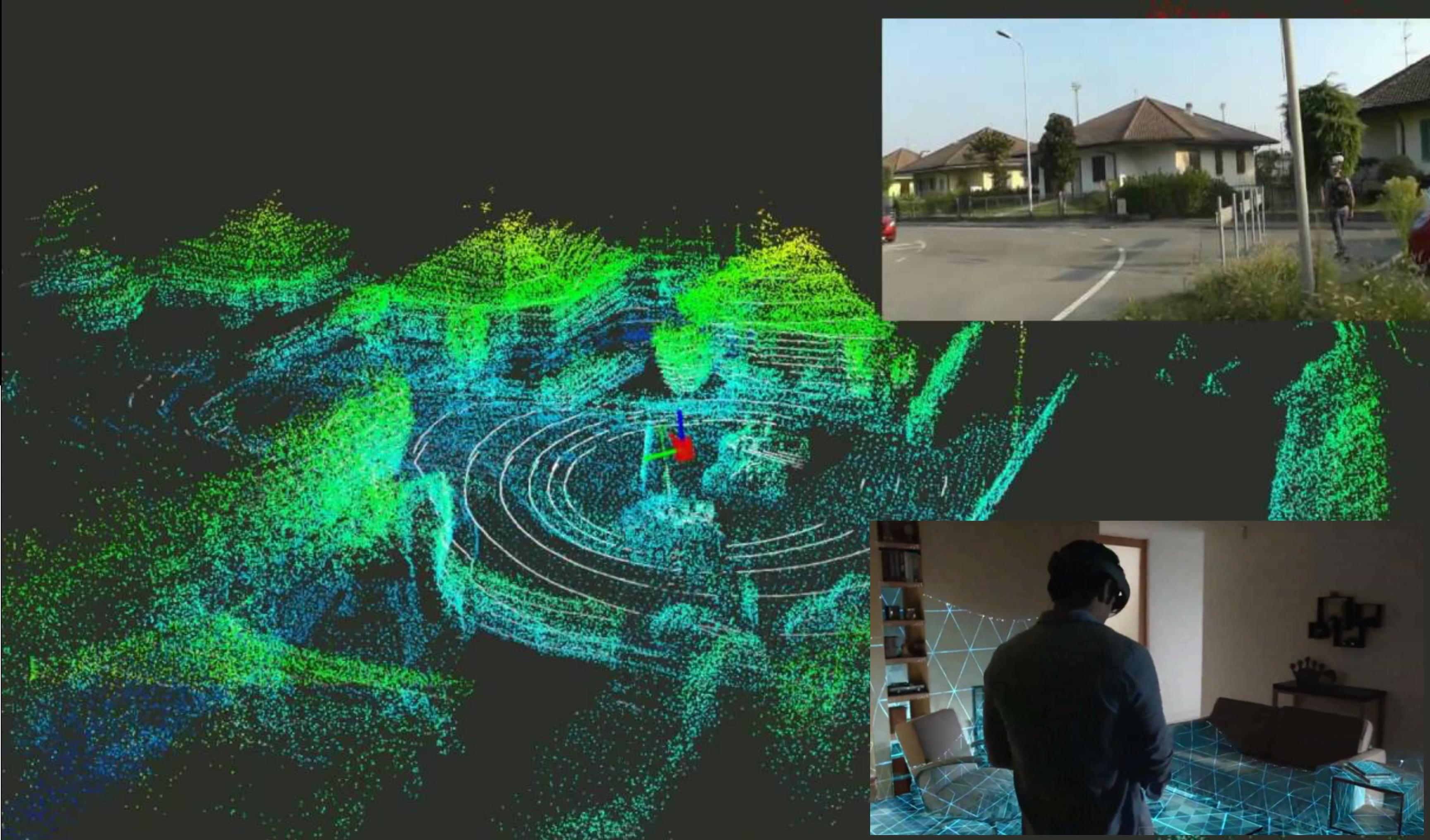
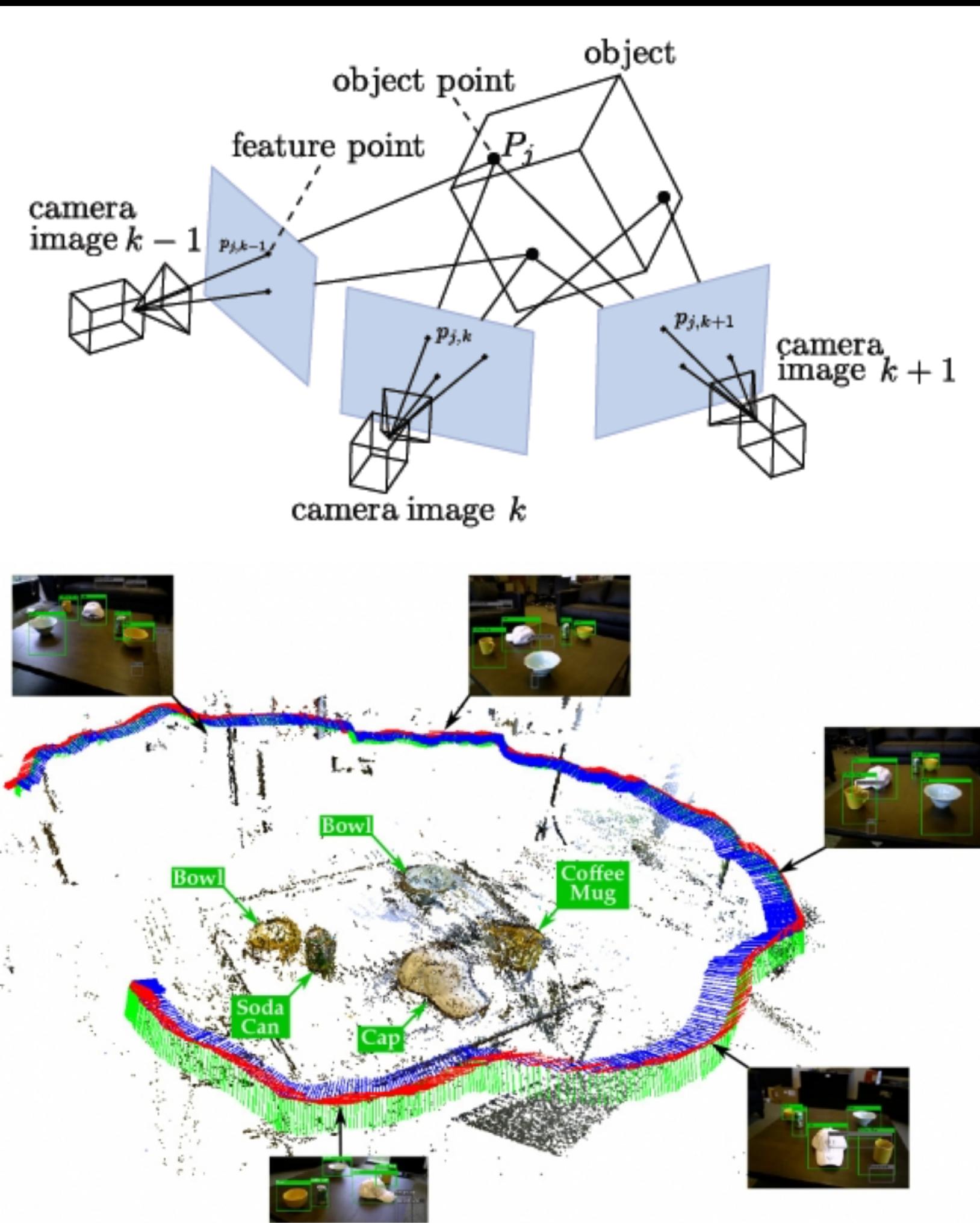
# Small & Light



# Hand Free



# World-scale



# Social VR/AR



Bring People Together

---

# Thank You

---



[cwang001@blacksmis.com](mailto:cwang001@blacksmis.com)