matfyz

POCKET VIRTUALITY

Computer Graphics Charles University

Augmented reality with HoloLens

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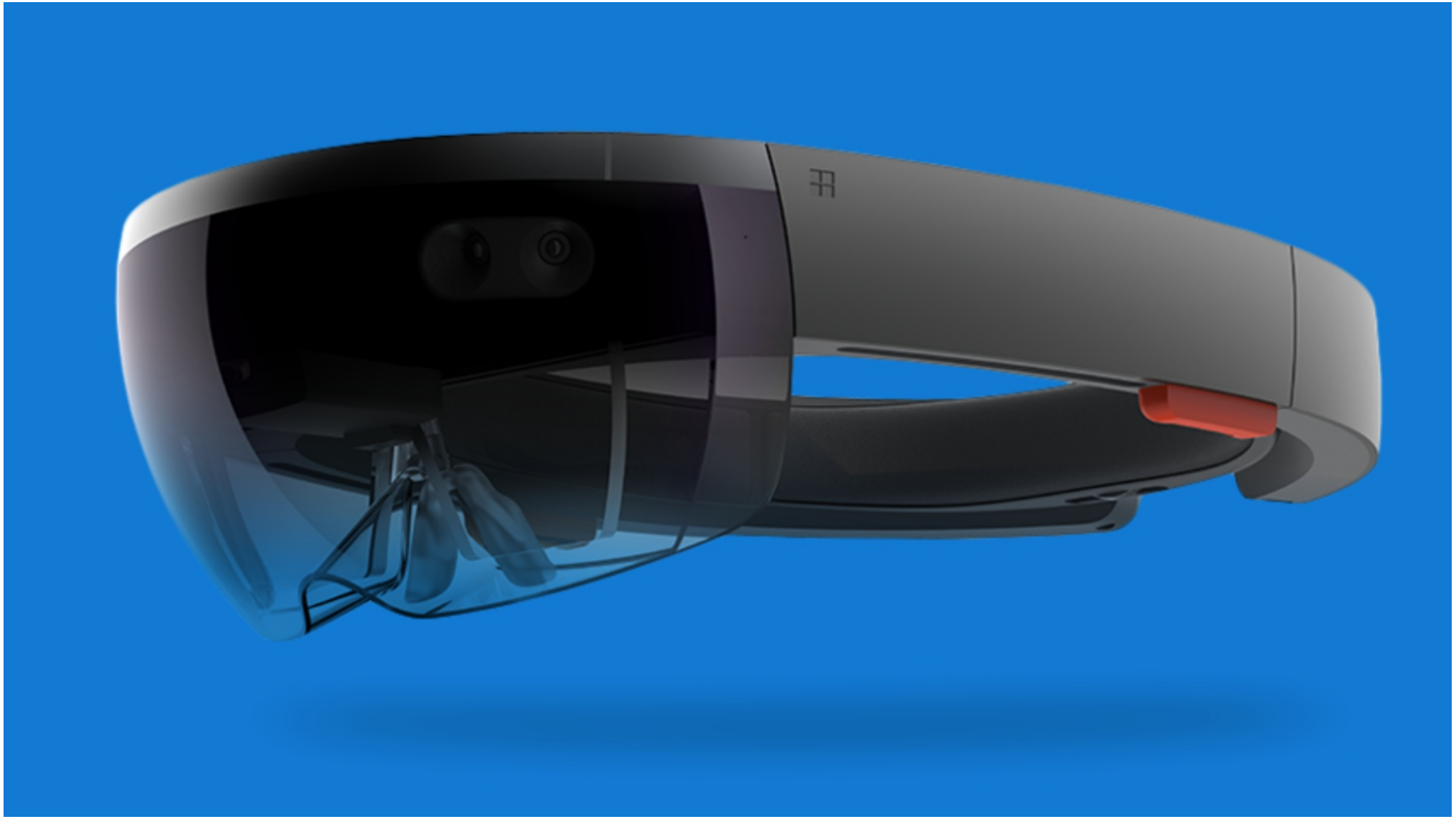
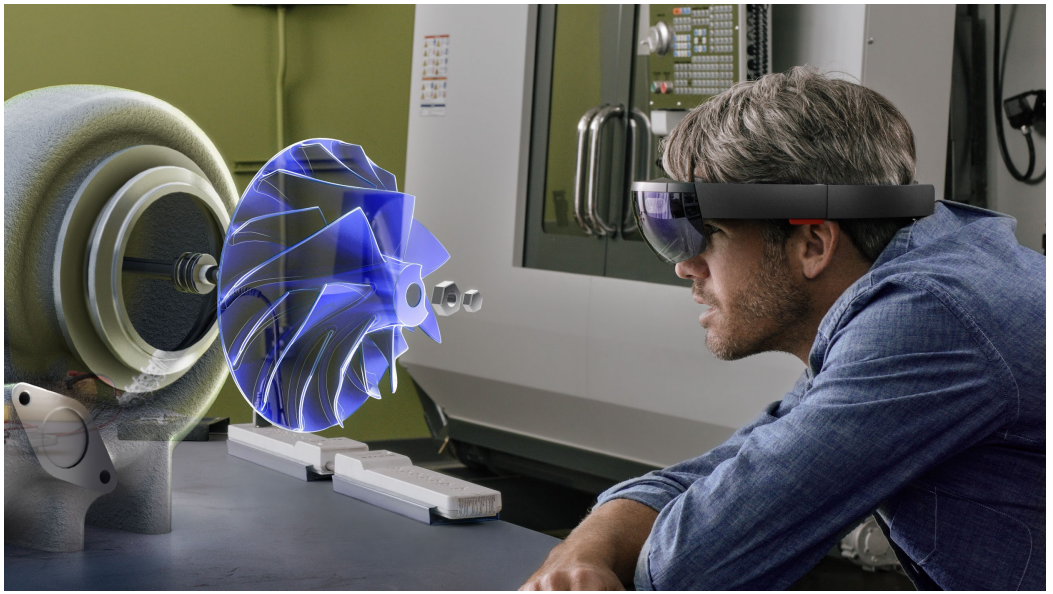
Microsoft HoloLens



Augmented vs. Virtual reality



AR is **not** just VR + CG layer!

AR has extra:

- multifocal rendering
- understanding of environment topology
- inside out tracking, anchors
- lighting

AR is a new computation/presentation platform

Microsoft HoloLens (2016-)

Holographic visualization (GPU, stereo)

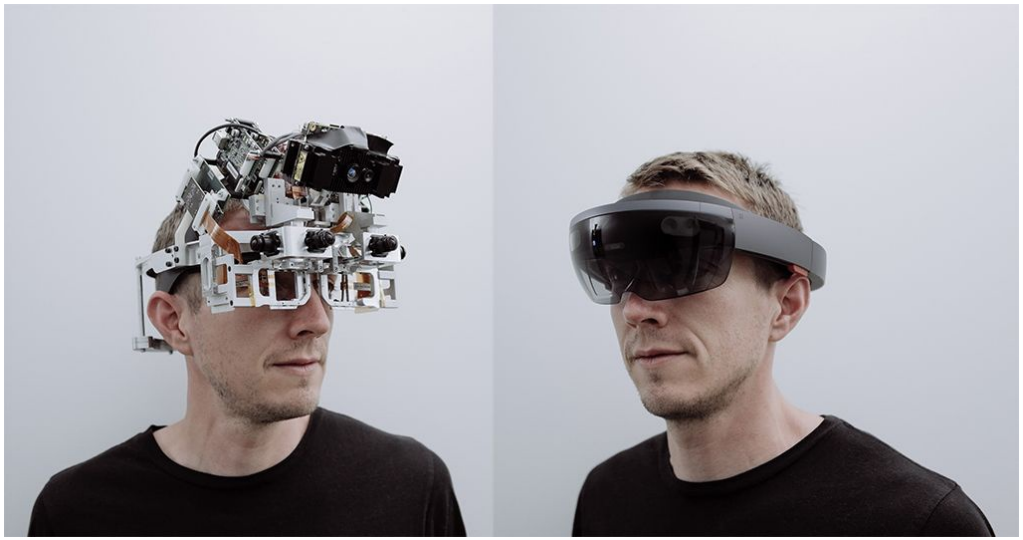
Wireless: Bluetooth, WiFi

Voice commands, hand gestures

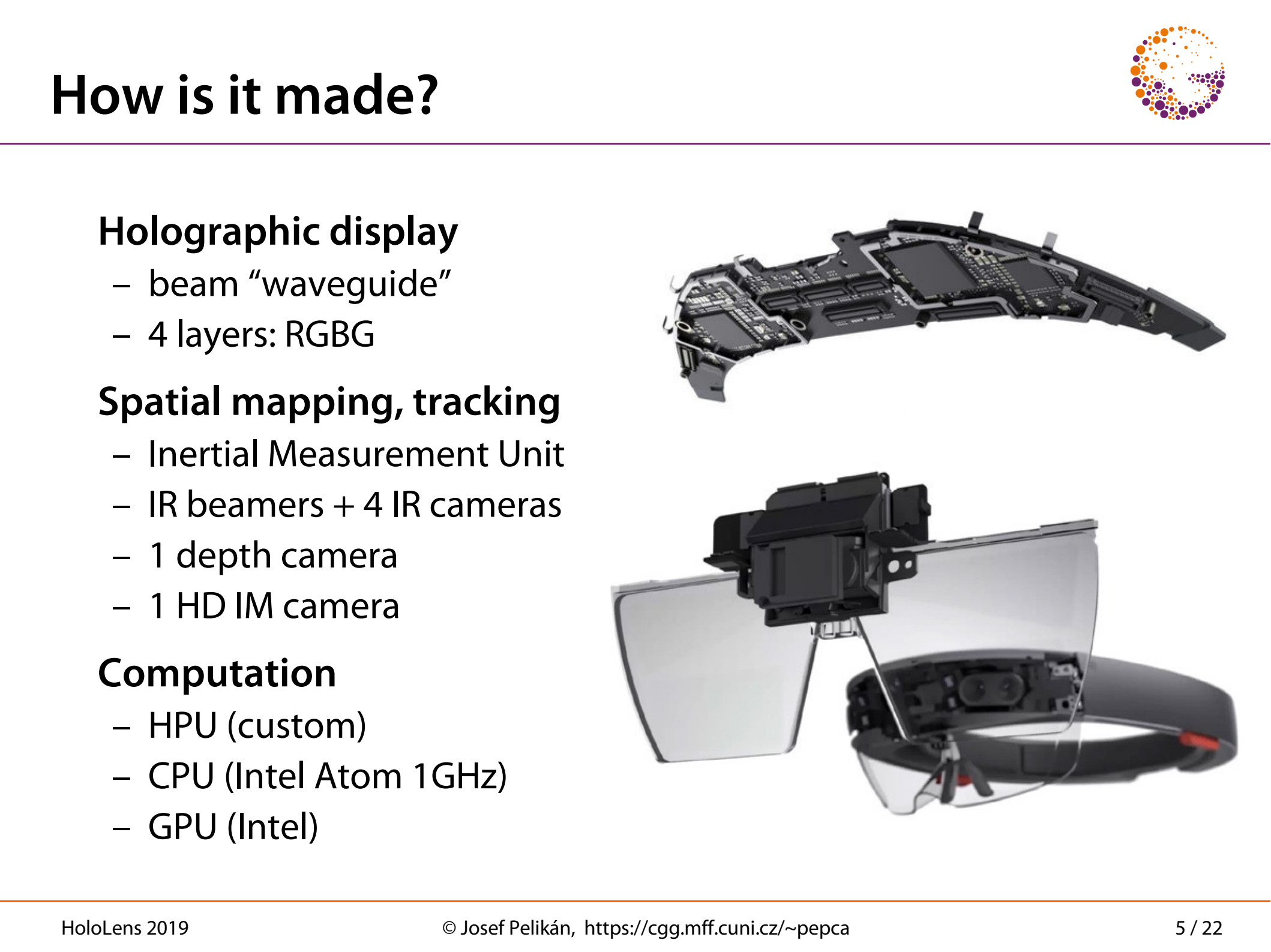
Real-time spatial mapping (to understand the current environment)

Precise 6DOF tracking & sharing (anchors)

- 4 environment cameras



How is it made?



Holographic display

- beam “waveguide”
- 4 layers: RGBG

Spatial mapping, tracking

- Inertial Measurement Unit
- IR beamers + 4 IR cameras
- 1 depth camera
- 1 HD IM camera

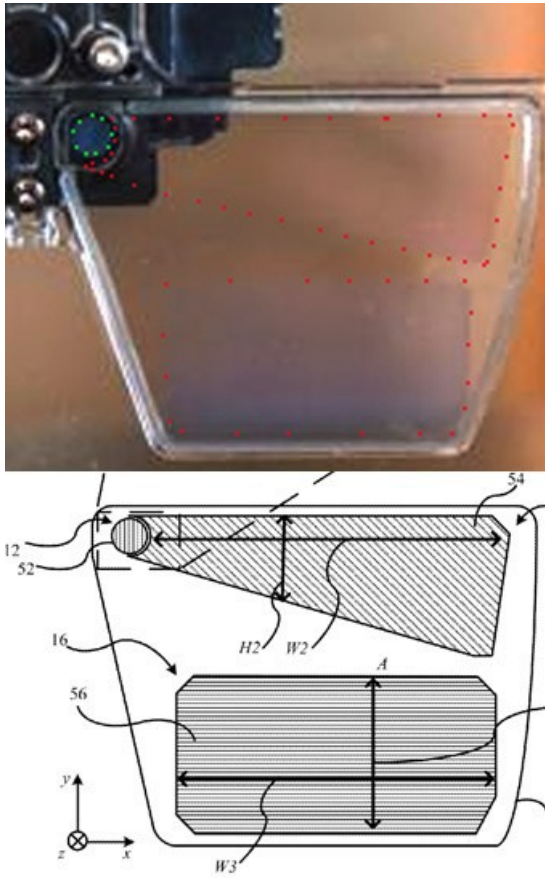
Computation

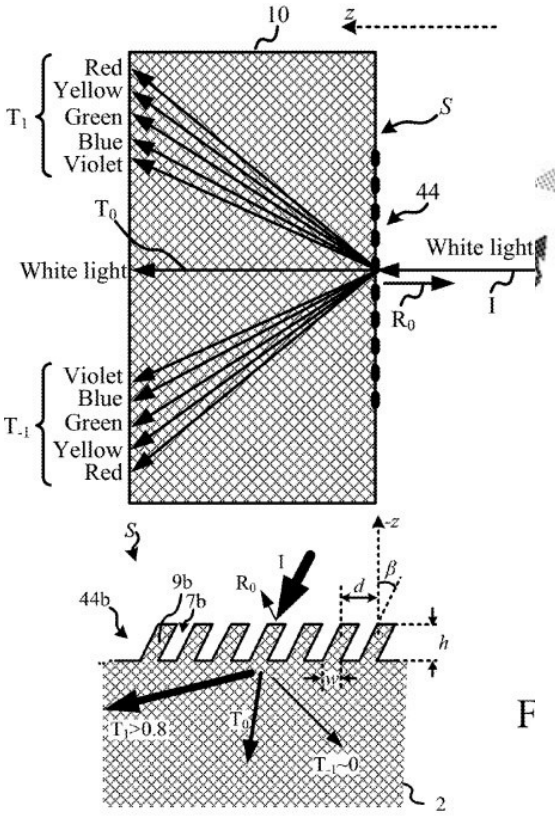
- HPU (custom)
- CPU (Intel Atom 1GHz)
- GPU (Intel)

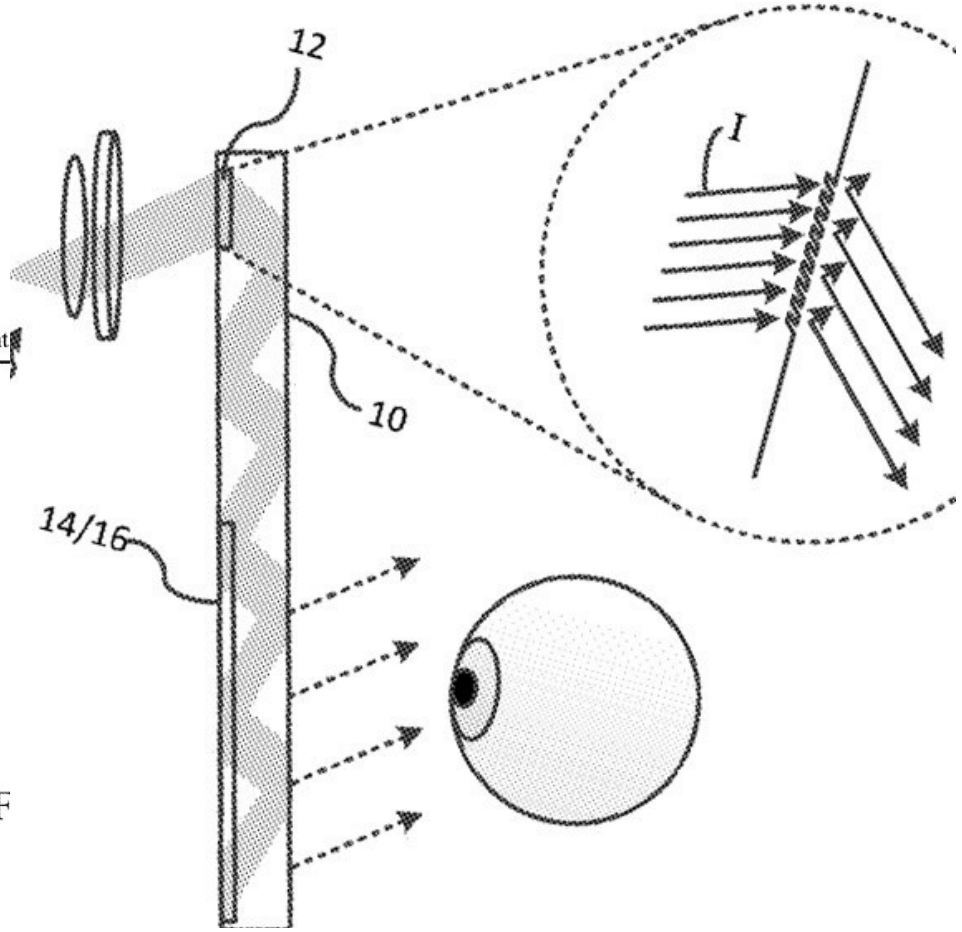
AR light combining system

Patent US 2016/0231568 (based on Nokia research)

– very small structures (~wavelength), TIR







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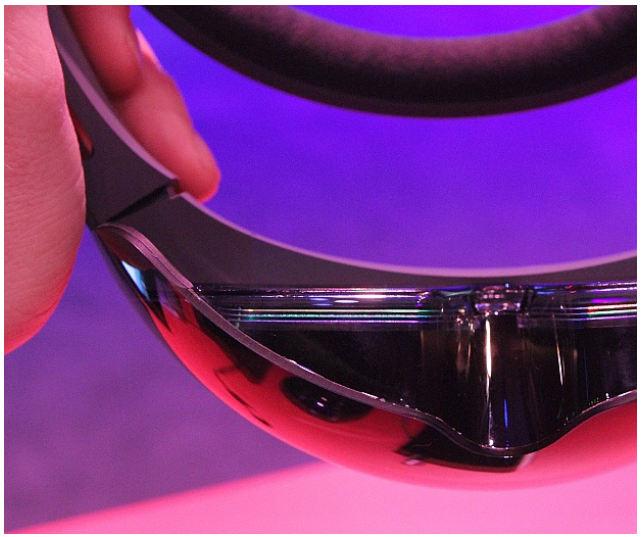
Details

Windows 10
- limited multitasking
- UWP, DirectX 11.1

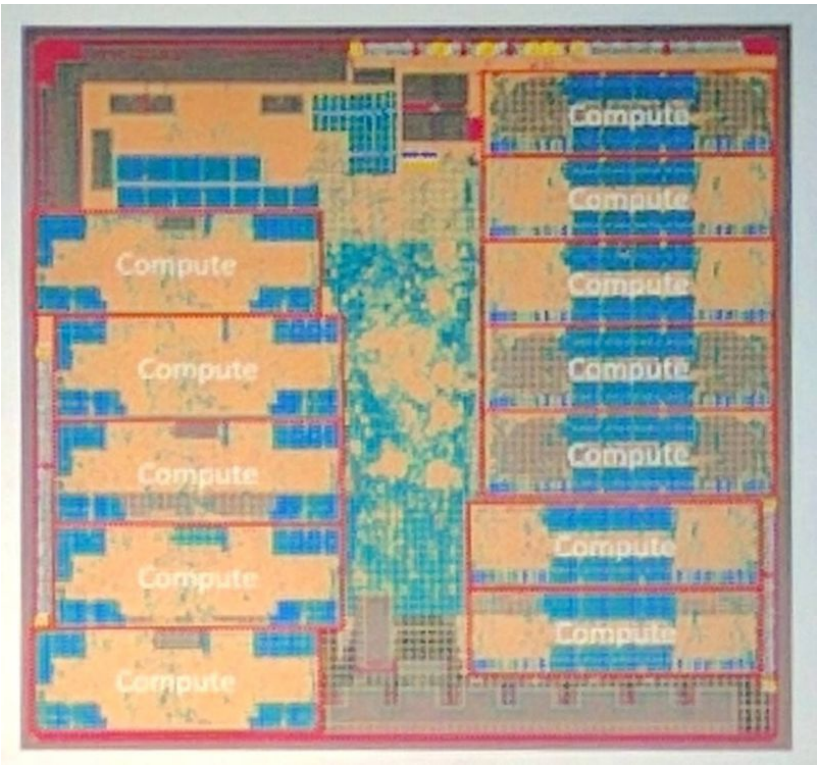
Memory
- 2GB RAM
- 64GB Flash



RGB camera
- 1280×720, 45° horizontal

Optics
- 2 HD 16:9 light engines
- Holo resolution: 2.3M total light points
- Holo density: >2.5k radiants (light points per radian)

HPU – Holographic Processor Unit



24 Tensilica DSP cores

1GB internal DDR3 DRAM

FPGA (i.e. “custom”)

300 special custom instructions

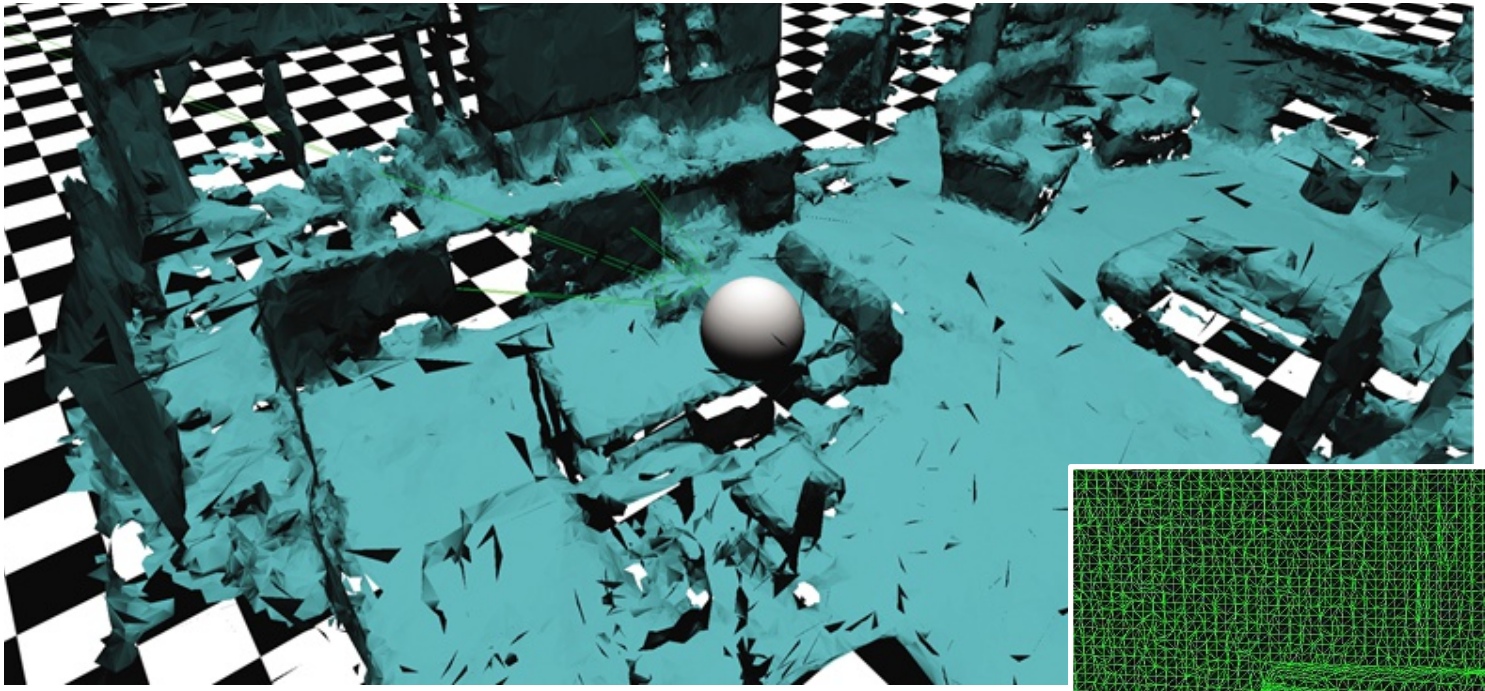
65M logic gates

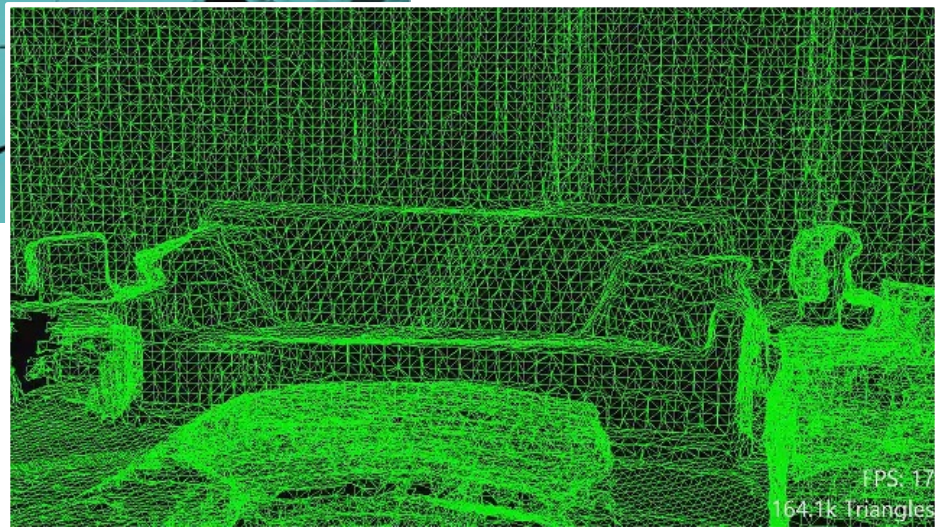
8MB static RAM

cadence

tensilica

Spatial mapping





Based on “Time of Flight”

– similar to lidar systems

Energy efficient, compact

Allows multiple users to work simultaneously!

Inside-out tracking

Tracking position and orientation of the helmet
- passive (observing the environment)

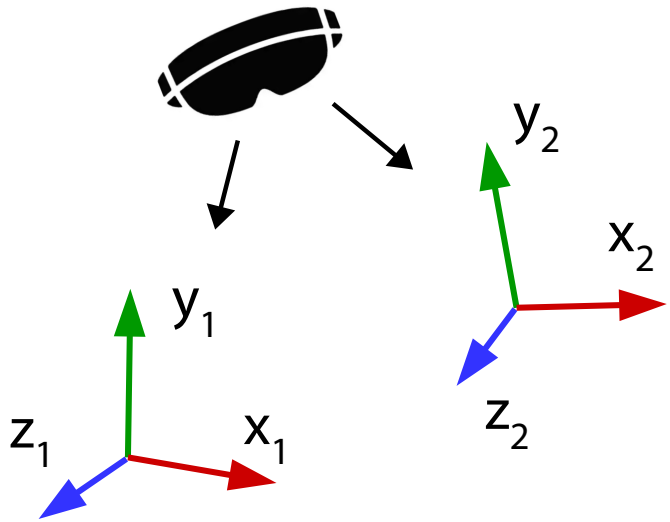
Markerless!

Allows multiple users

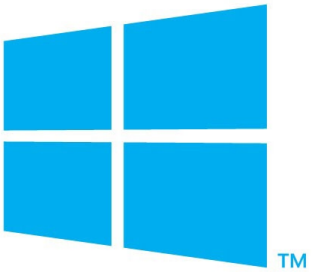
Transform of coordinate systems

"Anchor"
- significant part of 3D scene
- 3D maps + textures

Limitations:
- exteriors
- big space
- how to track controllers?



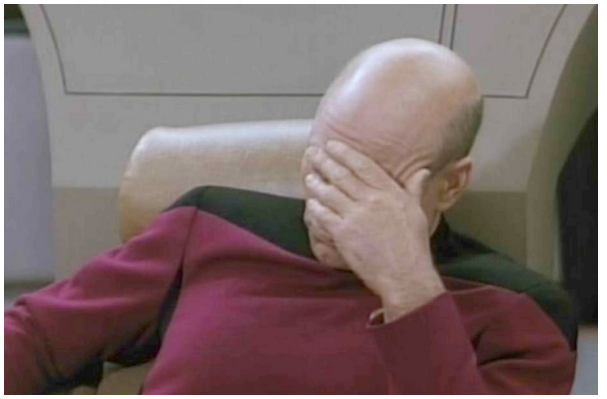
Programming



Layers, API

0. hardware
1. driver & Microsoft layer
2. HL API, Win10 UWP (C++)
3. Unity, Vuforia, OpenCV (C#, C++)

Limitations of HoloLens 1 (2▸)



Limited field of view
- 30 × 17.5° only ▸

IR spatial mapping
- sunlight, limited distance, 3cm detail

No GPS ▸?, no GSM ▸?
- not intended for outdoors

No chance to **dim incoming light**

Turning around ⇒ losing orientation?
- rear camera?

Intel Atom CPU (performance)
- will be replaced ▸ (Snapdragon 850)

Typical applications

Medicine

Engineering

Military

Architecture

B2B applications

- … whenever artificial 3D data layers are needed

Fata Morgana

Real-time streaming of reconstructed environment to distant VR operators

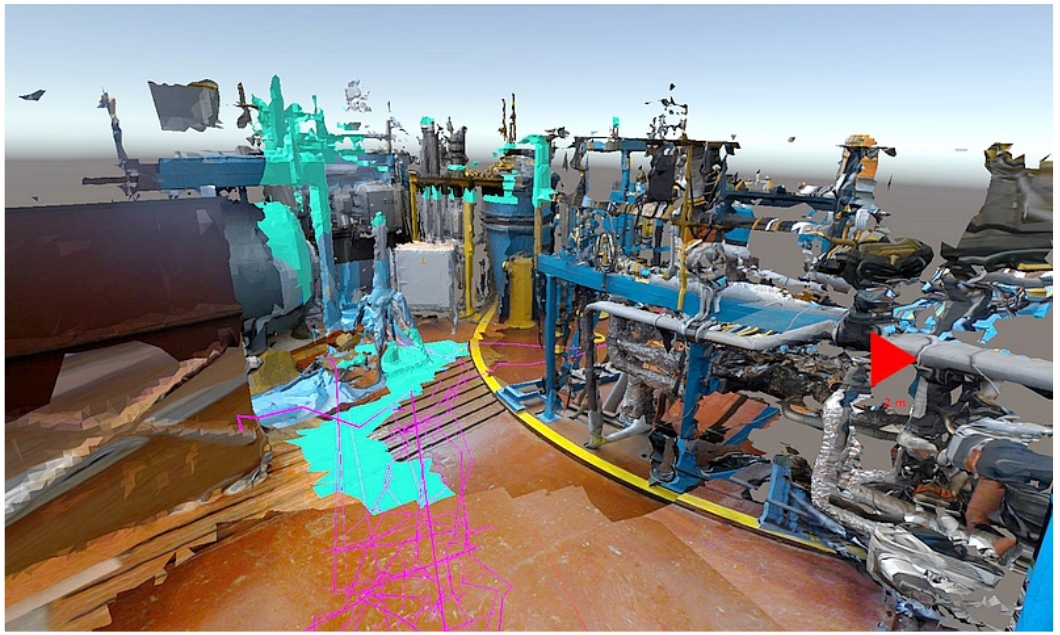
- comments
- navigation
- communication
- object classification
- measurements, environment analysis

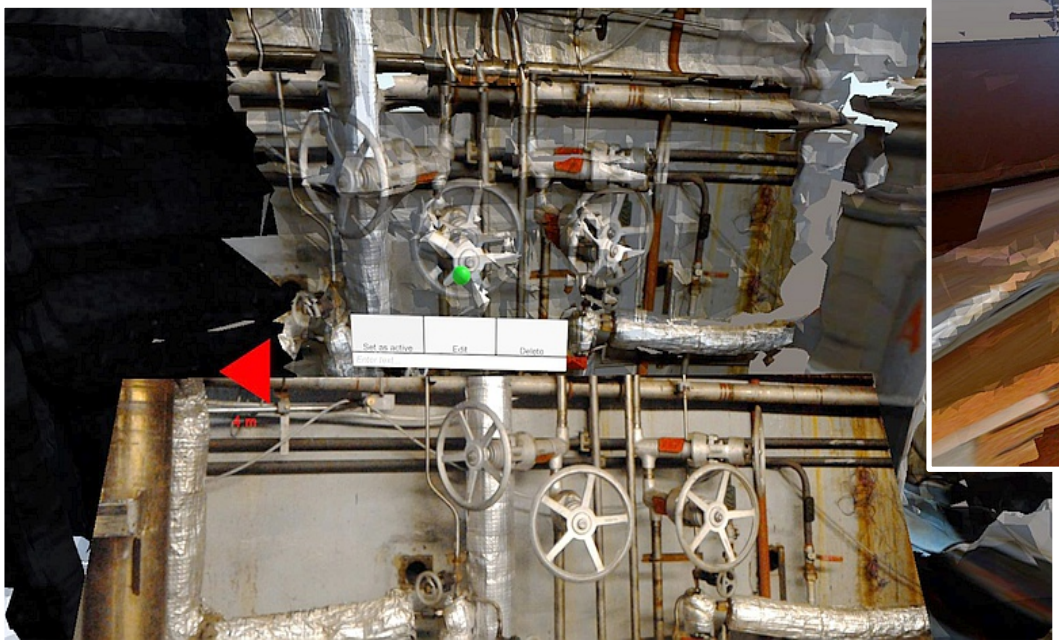
Additional sensor system

Fata Morgana in Temelín

Pocket Virtuality + ŠKODA JS a. s.

- service support in a nuclear power-plant
- reduce the dose of radiation
- better assistance





HoloObserver

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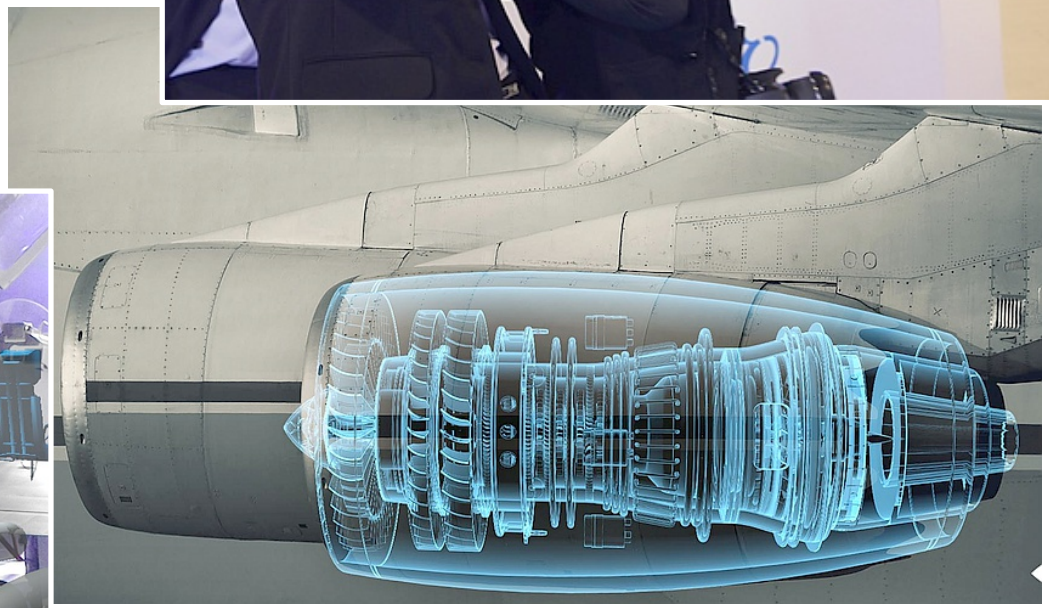
Shows artificial 3D model on a real object

Server-client

- multiple user support
- guide mode (Visitor)

Object recognition and automatic alignment



Holotable

Horizontal big **touch-screen** (table)

Synchronized 3D content

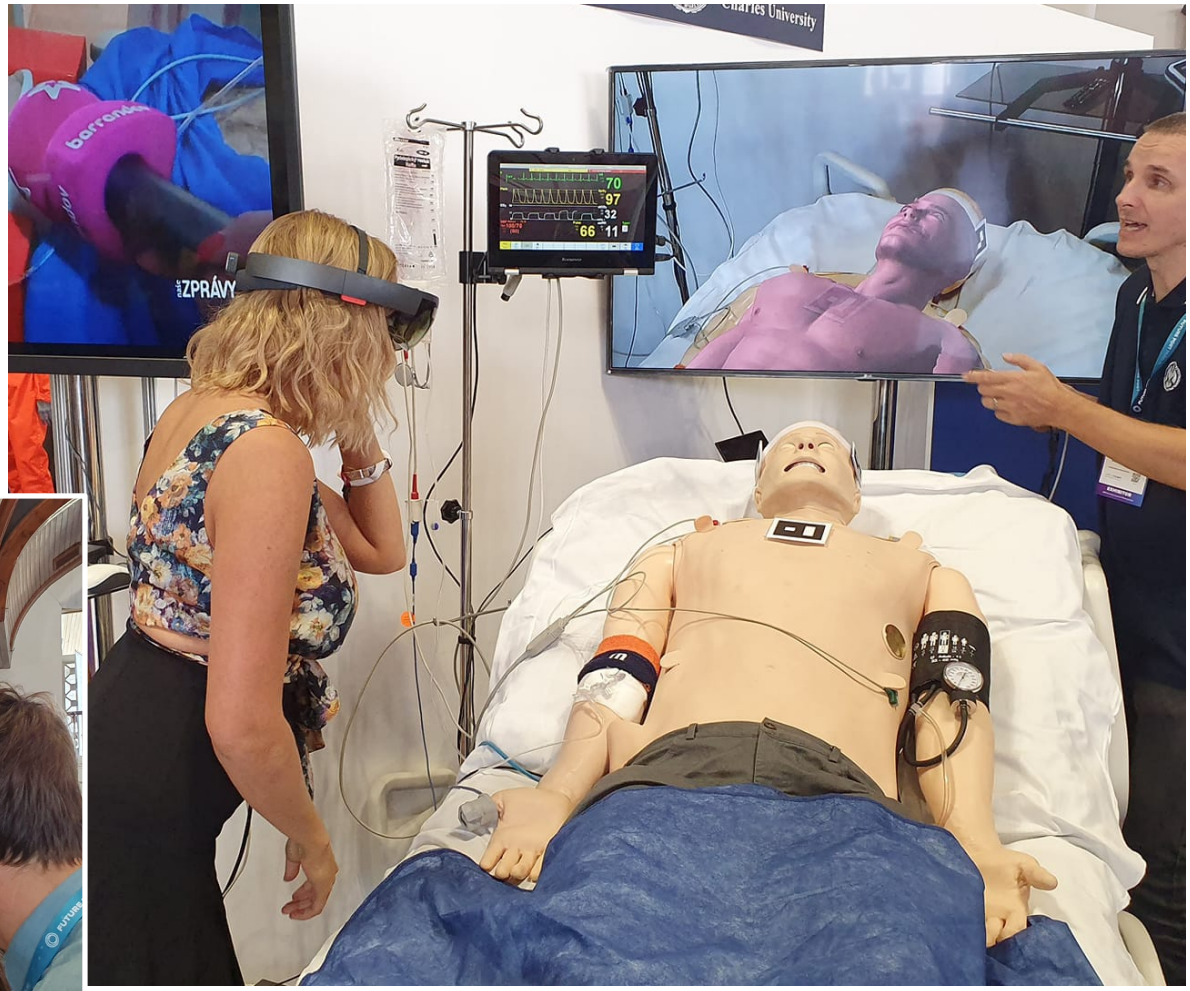
Clients with HoloLenses (1+)

Augmented patient

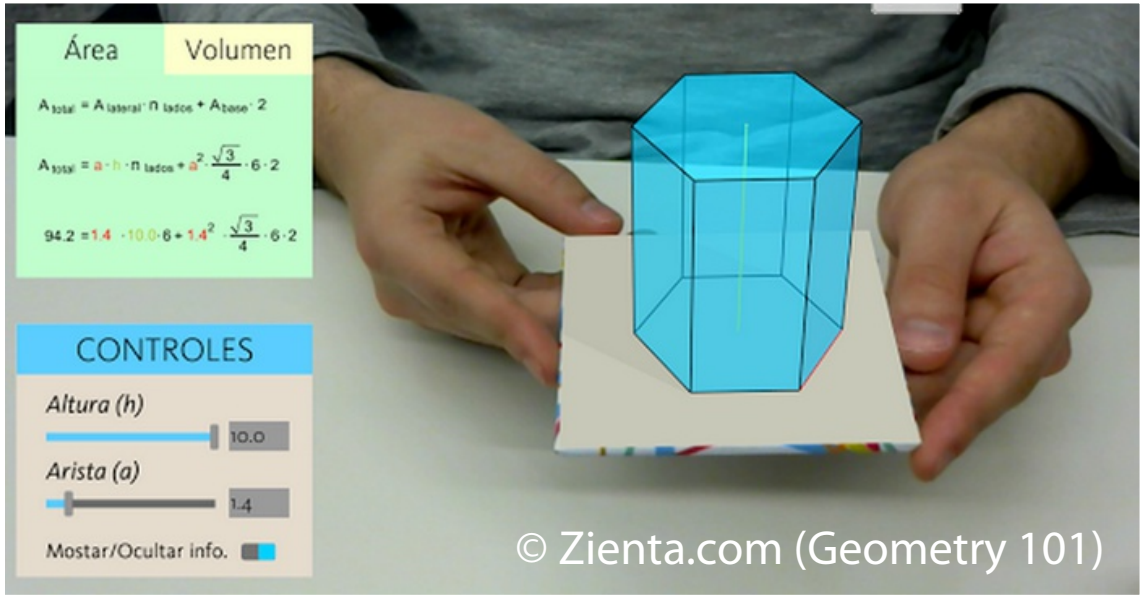
Physical figurine

– tracking (even limbs!)

Augmented graphics in HoloLens



AR in education

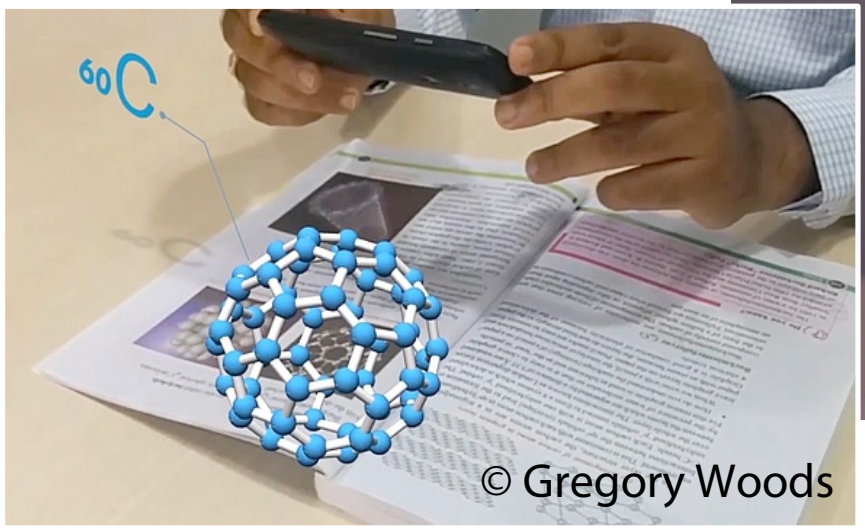


Math (geometry)

Chemistry

Biology

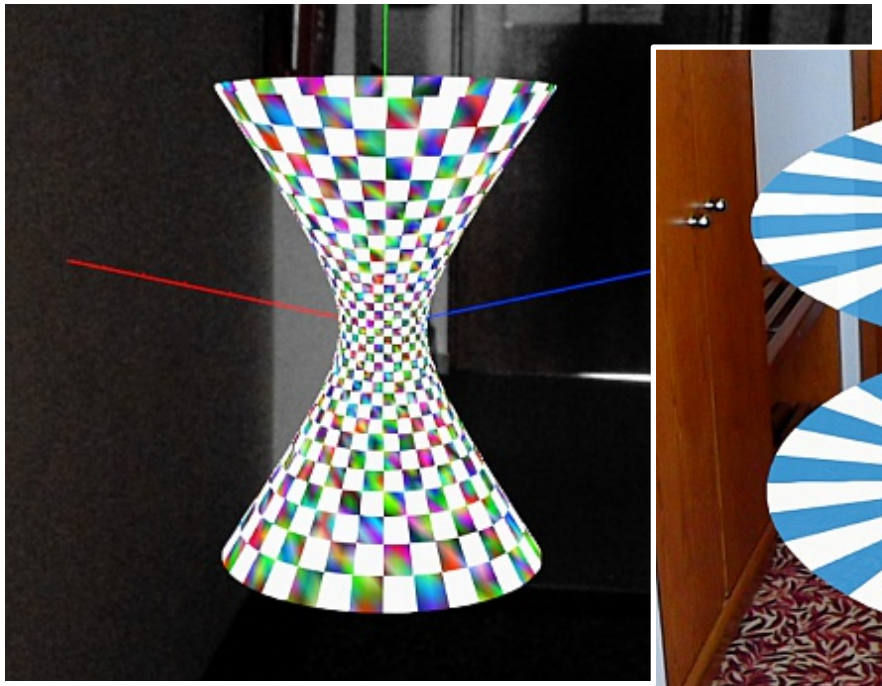
…

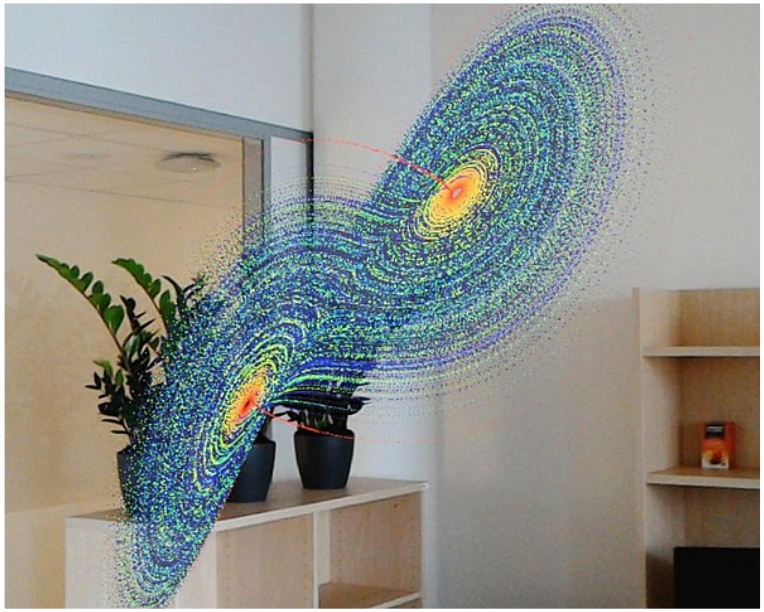


AR in science

Exploration of 3D objects in real space
- user is able to select best viewpoints

Visualization
- + “steering” (dynamic control)





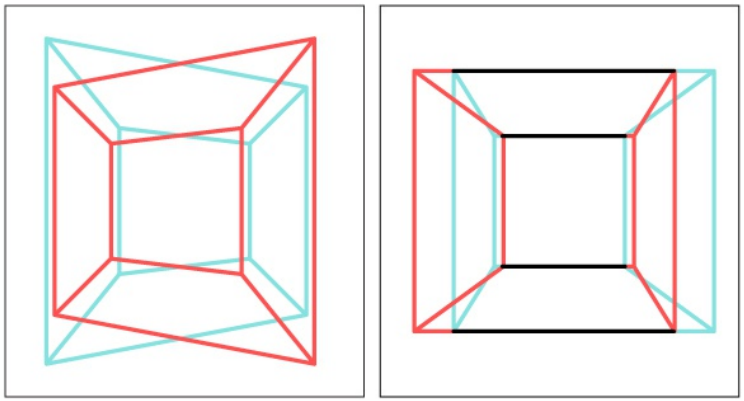
Mixed Reality API (DirectX 11+)

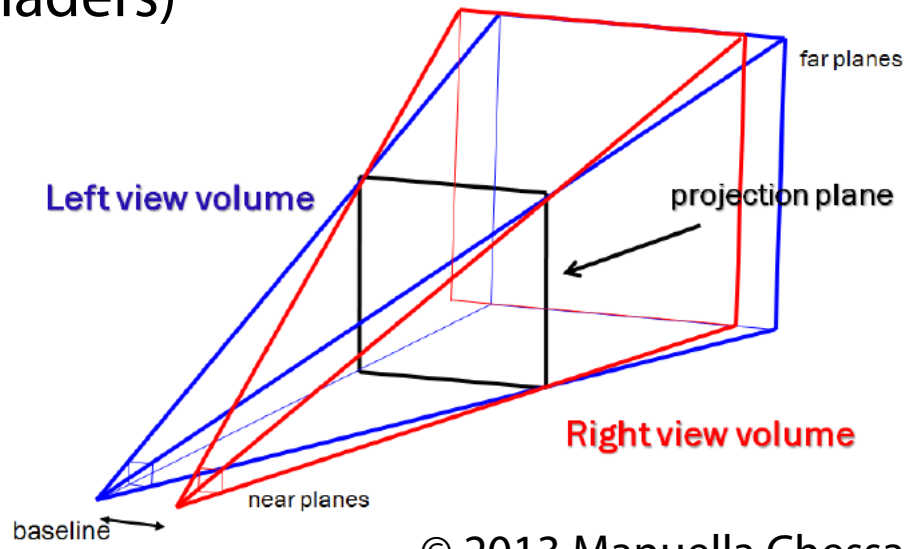
HolographicFrame

- **prediction** of future headset position and orientation

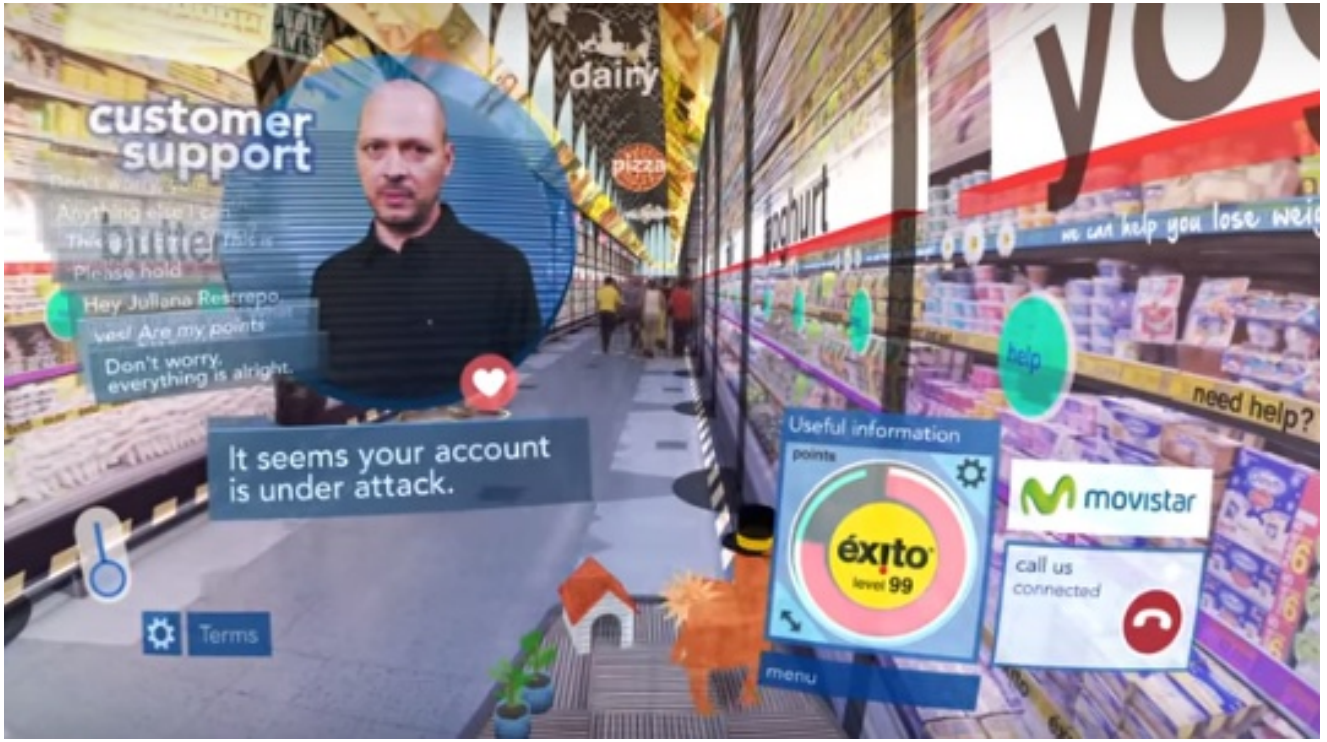
Stereo rendering

- transparent dual-render-target using **instancing**
- custom instancing can be preserved
- tuple of View-Projection matrices (small modifications of vertex/geometry/tesselation shaders)





Future will be augmented!



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