

# LABORATORIO DI REALTÀ AUMENTATA

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# Introduction to AR

# What does Augmented Reality mean?

- Give your definition!
- To define Augmented Reality (AR) we will start from another notion: Virtual Reality (VR)

# Virtual Reality

- Virtual Reality refers to a simulated environment, in which the user can interact with the virtual world
- Sensorial experience is artificially generated (most often involves sight and hearing, but can be extended to other senses)
- Different possible immersion levels

# Examples

- First-person video games could be seen as an example of VR (\*). The user “lives” in a virtual world, which can sense both with sight and hearing. The immersion level is typically low (computer screen)



(\*) Although the term “virtual reality gaming” is generally used to denote a specific type of games

# Examples

Other senses can be involved. Haptic systems give tactile feedback to the user (e.g. haptic steering wheels for video games, force feedback joysticks, haptic devices for remote surgery...)



# Examples

- Immersion levels: low (e.g. PC monitor), partial (e.g. wide surrounding monitors), fully immersive (HMD, head-mounted displays)



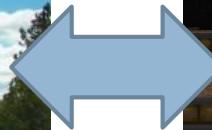
A drive simulator

Samsung Gear VR



# Reality vs. Virtuality

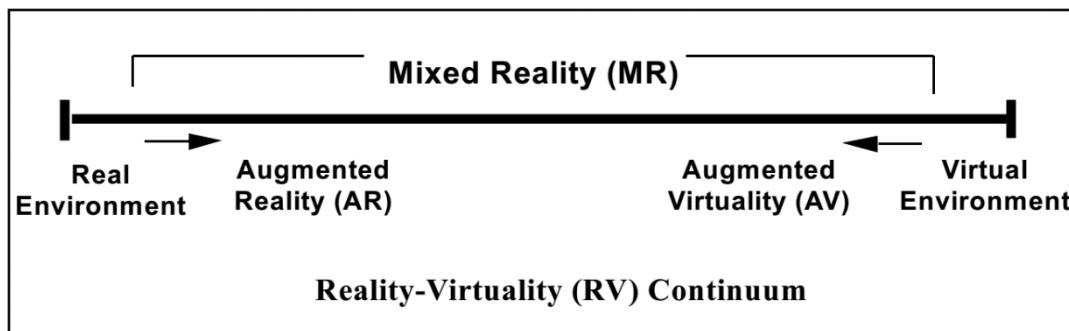
- Two extrema: real world and virtual world



(being a picture mediated by a computer, this is not actually the real world... look around you ☺)

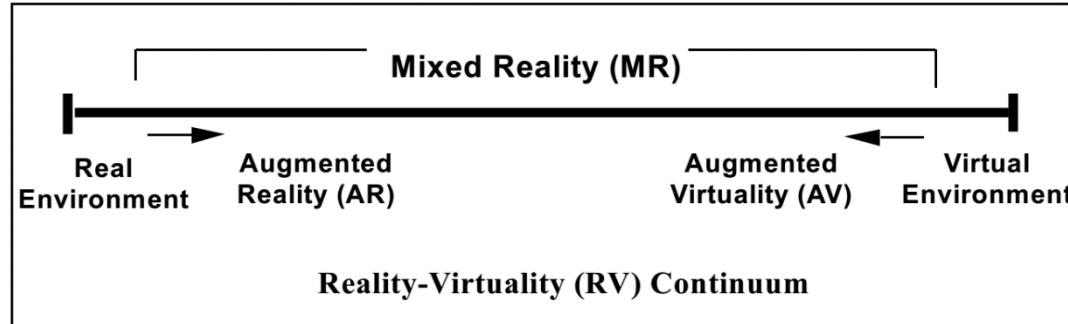
# The virtuality continuum

- Between the two extrema, there is a whole range of possibilities, where the real and virtual worlds mix. This is the “virtuality continuum” as first defined by Milgram et al. in 1994



P. Milgram; H. Takemura; A. Utsumi; F. Kishino (1994). "Augmented Reality: A class of displays on the reality-virtuality continuum". Proceedings of Telemanipulator and Telepresence Technologies. pp. 2351–34.

# Milgram's virtuality continuum



- The environments between the real and virtual ones are generically called “Mixed reality”
- Among mixed realities, we identify Augmented Reality (reality plus some virtual elements) and Augmented Virtuality (virtuality plus some real elements)
- “Augmented” means that something is **added** to the basic real or virtual environment

# Mixed reality

- In the last years, the term “mixed reality” has been used to denote an advanced form of AR, but the definition is still unclear and not shared by everyone. E.g. check this definition by intel:

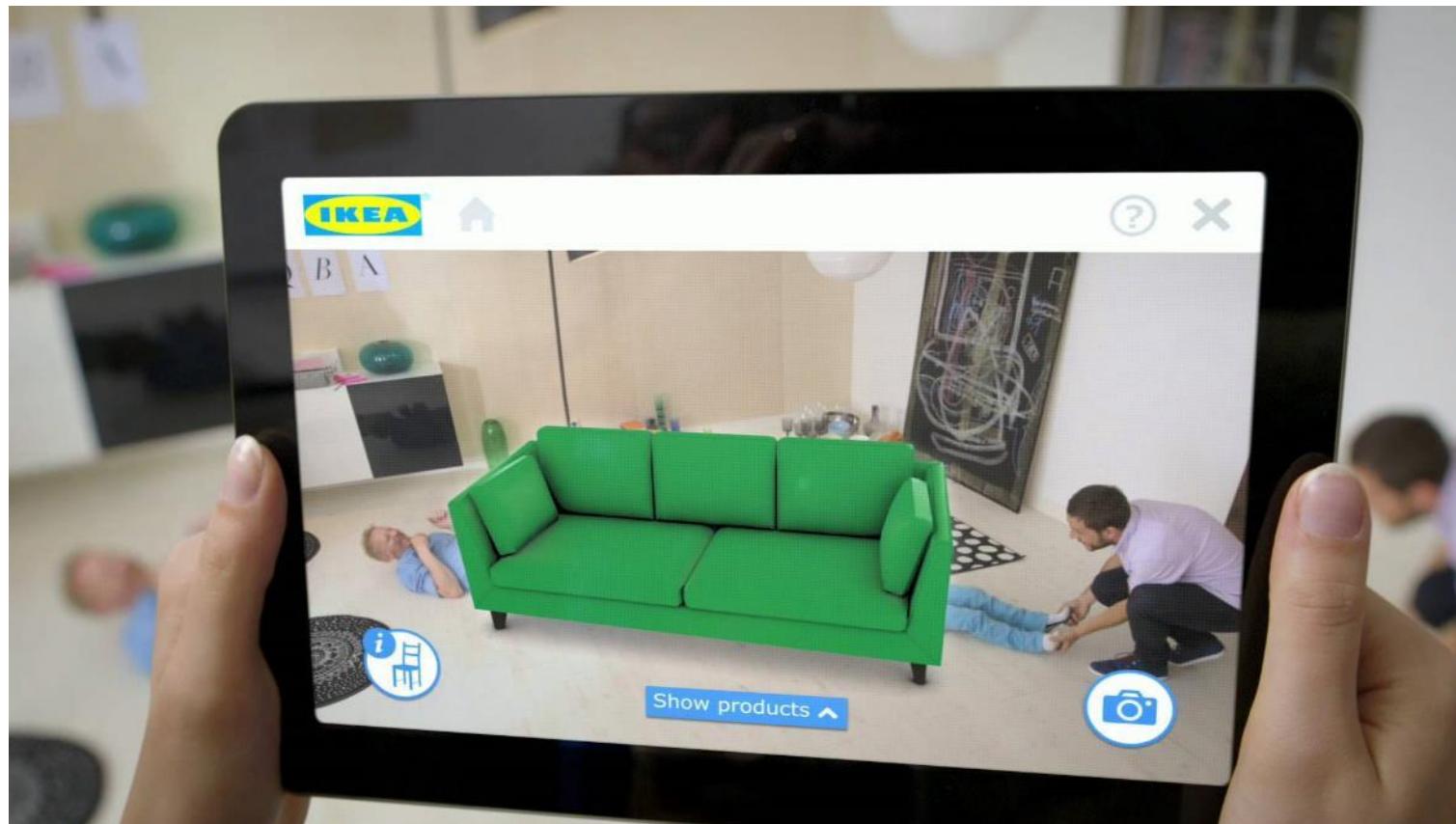
## Mixed Reality

MR brings together real world and digital elements. In mixed reality, you interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. Mixed Reality allows you to see and immerse yourself in the world around you even as you interact with a virtual environment using your own hands—all without ever removing your headset. It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary, offering an experience that can change the way you game and work today.

<https://www.intel.it/content/www/it/it/tech-tips-and-tricks/virtual-reality-vs-augmented-reality.html>

# Augmented reality example

## IKEA virtual furniture placement



Uses the IKEA catalog as a reference marker

# Augmented virtuality examples

Meeting rooms in virtual worlds (Second Life, OpenSim)



Reference:

- <http://blog.inf.ed.ac.uk/ataste/2011/09/15/i-room-a-virtual-space-for-intelligent-interaction/>
- Tate, A., Potter, S. and Dalton, J. (2009), “I-Room: a Virtual Space for Emergency Response for the Multinational Planning Augmentation Team”, International Conference on Knowledge Systems for Coalition Operations

# Augmented virtuality examples

## Newscasters in virtual studios



# Augmented virtuality examples

Reality Virtual Studio  
IBC 2016

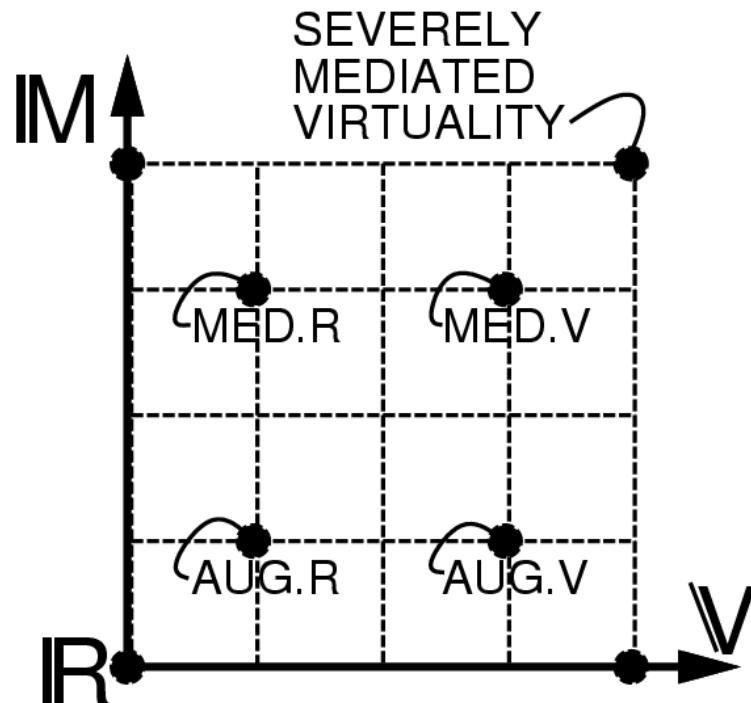


[https://www.youtube.com/watch?v=pEeN\\_4h1DYQ](https://www.youtube.com/watch?v=pEeN_4h1DYQ)

# Mediated reality and virtuality

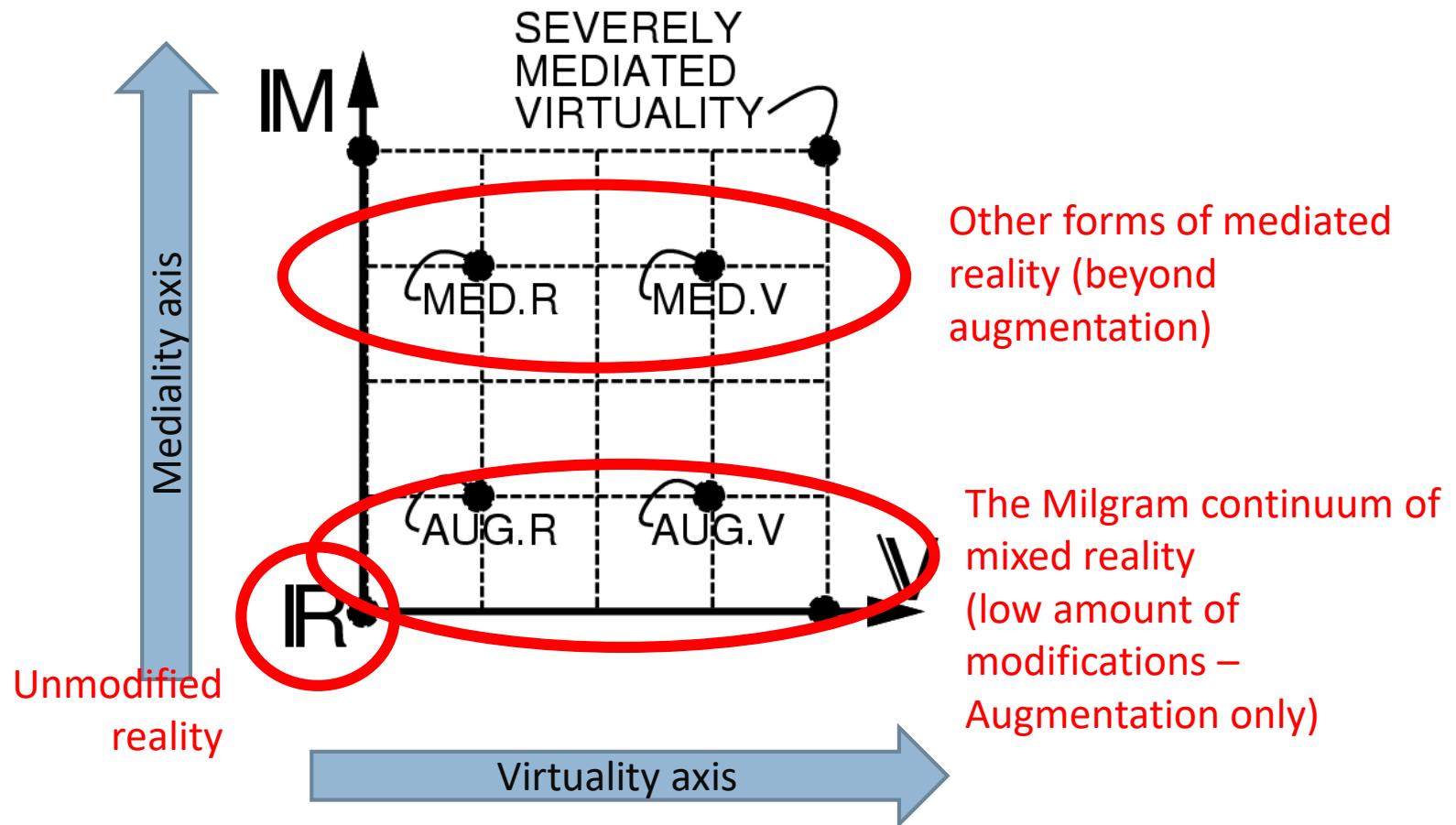
- The Milgram continuum models only augmentation of real/virtual environments
- It fails to model other types of modifications, e.g. removal of elements (diminished reality) or more generic alterations (modulated reality)
- In 2002 Mann extended the Milgram model adding a second dimension, the “mediality”, denoting the amount of modifications
- The entire framework is called **mediated reality**

# Mediated reality



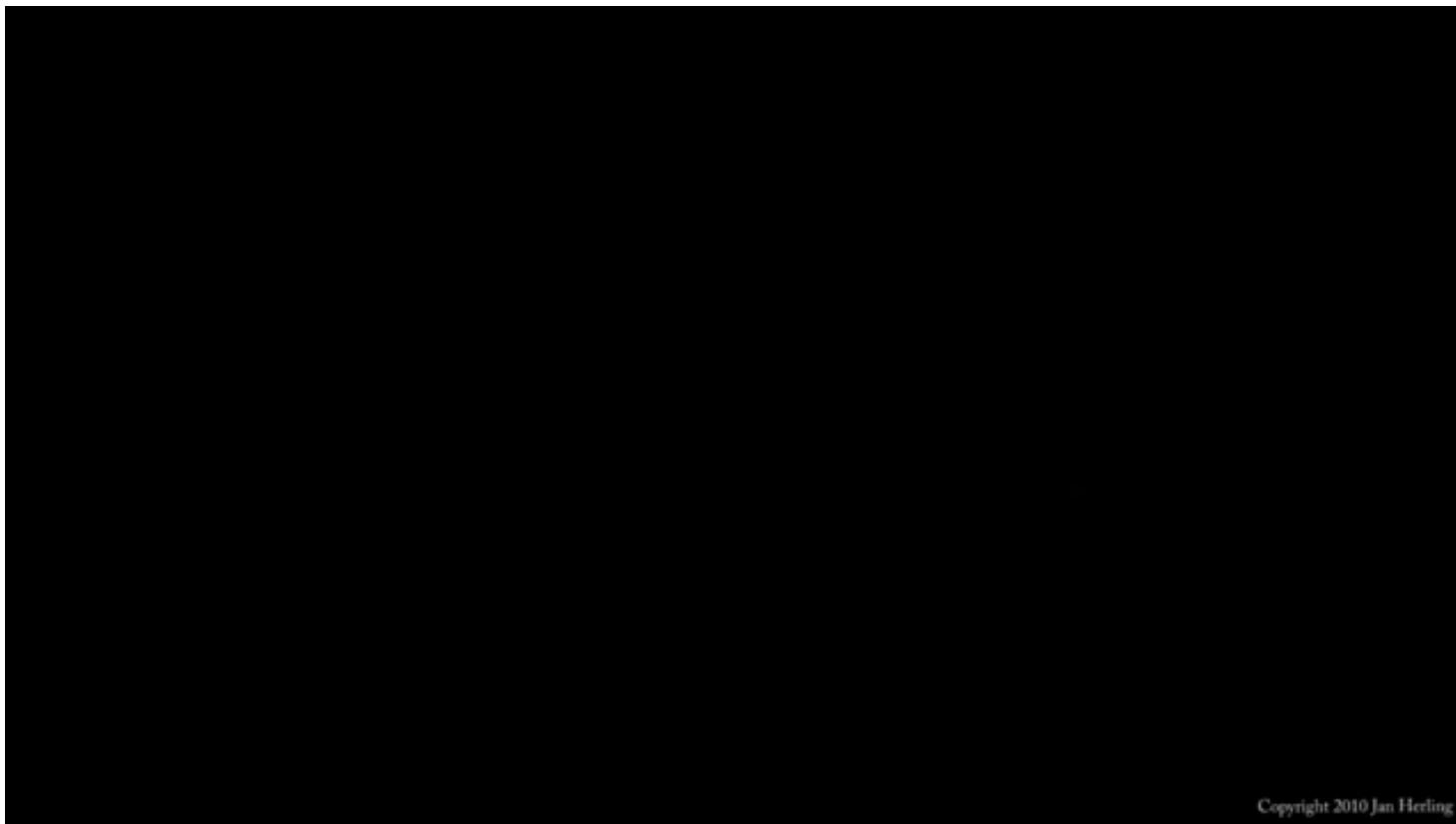
- [http://wearcam.org/presence\\_connect/](http://wearcam.org/presence_connect/)
- Mediated Reality with implementations for everyday life, 2002 August 6th, Presence Connect, the on line companion to the MIT Press journal PRESENCE: Teleoperators and Virtual Environments, MIT Press

# Mediated reality



# Mediated reality examples

- Diminished reality: remove unwanted components from the environment



Copyright 2010 Jan Herling

Source: <https://youtu.be/FgTq-AgYITE>

Herling, J. and Broll, W.: Advanced Self-contained Object Removal for Realizing Real-time Diminished Reality in Unconstrained Environments. Proceedings of the International Symposium on Mixed and Augmented Reality 2010 (ISMAR' 2010), Seoul, South Korea, October 2010, 207 - 212.

# Diminished reality applications

- Privacy protection (e.g. Google StreetView)
- Advertisement removal
- ... any other ideas? Share your thoughts
- Possible misuses: censorship?



Nikolai Yezhov next to Iosif Stalin. Removed after his execution in 1940.

Images from: [https://en.wikipedia.org/wiki/Censorship\\_of\\_images\\_in\\_the\\_Soviet\\_Union](https://en.wikipedia.org/wiki/Censorship_of_images_in_the_Soviet_Union)

# Mediated reality

- Another example of mediation: wearable visors substituting visual information with infrared or thermal data

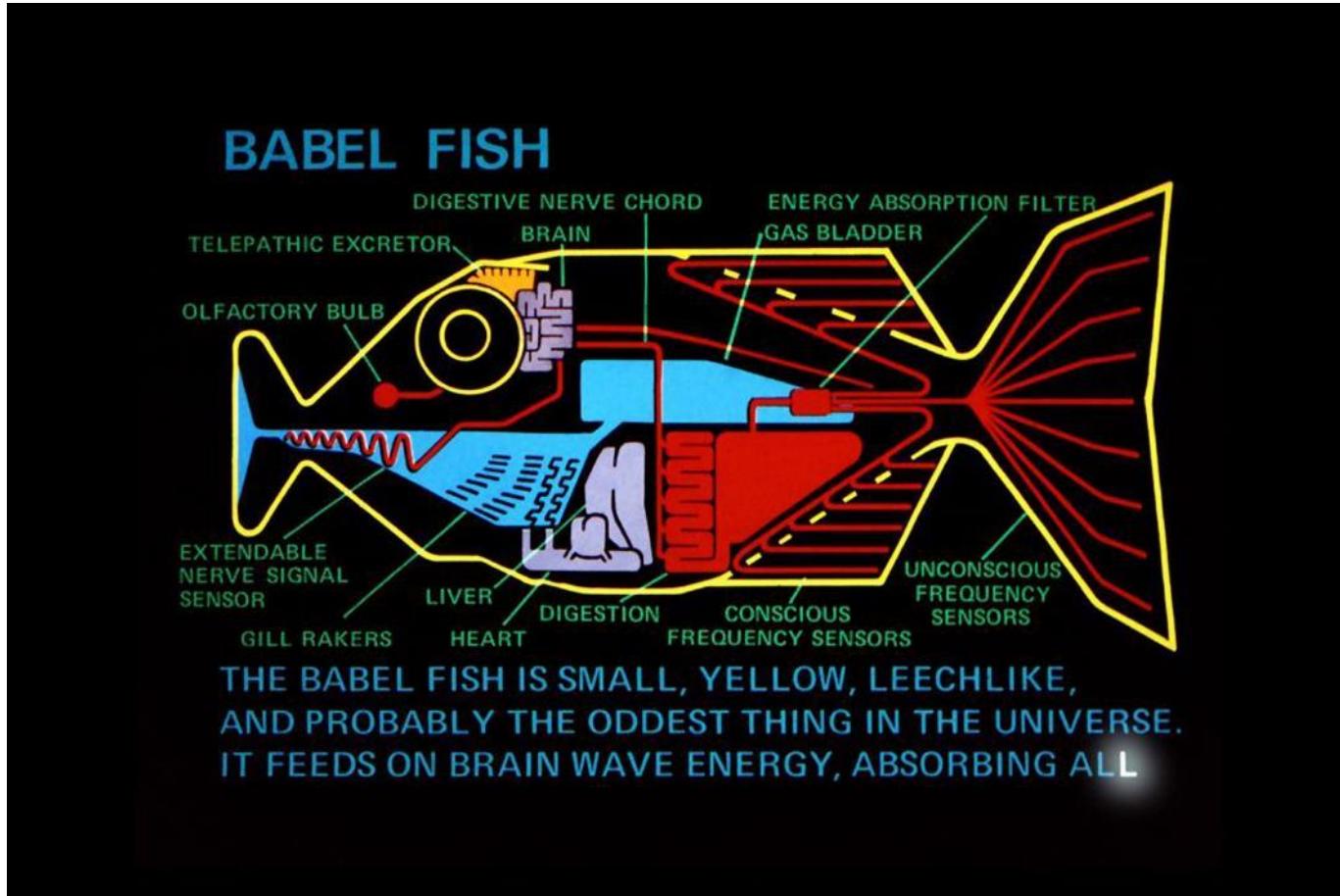


Near-infrared nocturnal vision  
(requires IR illuminator)



Far-infrared (thermal) vision

# Mediated reality for audio signals



From Douglas Adams' "The Hitchhiker's Guide to the Galaxy"

# Mediated audio

“Audio Augmented Reality (AAR) is a new selective noise cancellation / enhanced ambient awareness technology for headphones that gives users the ability to cancel certain sounds while amplifying others to create safer and more enjoyable experiences”



# Now becoming real...



## Come posso utilizzare la funzione Cancellazione Attiva dei Rumori su Galaxy Buds Live?

I Galaxy Buds Live sono ideali nella vita quotidiana, perché riducono le interferenze superflue ma ti fanno sentire ciò che davvero conta: voci delle persone e gli annunci. La Cancellazione Attiva dei Rumori, o ANC (Active noise cancellation), per design Open Type ti permette di ascoltare la musica che vuoi senza deconcentrarti.

### Cancellazione attiva del rumore e modalità Trasparenza in AirPods Pro e AirPods Max

Gli AirPods Pro e le AirPods Max prevedono tre modalità di controllo del rumore: cancellazione attiva del rumore, modalità Trasparenza e non attivo. Puoi passare da una modalità all'altra, in base a quanto vuoi sentire l'ambiente che ti circonda.

### Cosa sono la cancellazione attiva del rumore e la modalità Trasparenza?

Con la cancellazione attiva del rumore, uno o più microfoni rivolti verso l'esterno rilevano i rumori ambientali, i quali vengono cancellati dagli AirPods Pro o dalle AirPods Max generando un segnale opposto prima che tu li possa sentire. Un microfono rivolto verso l'interno rileva i suoni indesiderati che arrivano dentro l'orecchio: anche questi vengono eliminati dagli AirPods Pro o dalle AirPods Max con un segnale opposto.

La modalità Trasparenza lascia entrare i suoni esterni, permettendoti di sentire l'ambiente circostante. La cancellazione attiva del rumore e la modalità Trasparenza funzionano meglio se [gli AirPods Pro si adattano perfettamente al tuo orecchio](#).



# AR definition

- Let's go back to AR to give a better definition

**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

(adapted from Wikipedia)

- Key element: **live**, meaning that real-time processing is a fundamental requirement. This leads to the possibility of ***interaction*** with the augmented world

# AR: Real-time

**Augmented reality (AR)** is an **interactive**, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

Real-time processing to enhance live perception of reality is mandatory.

For example, VFX (visual effects) in movies are not AR, despite augmenting real footage with computer-generated graphic content



# This is not AR!



Source: <https://www.youtube.com/watch?v=QXe4T1RoJTc>

# This is AR



[https://youtu.be/XPv6\\_pxrvzw](https://youtu.be/XPv6_pxrvzw)  
Iphone measurement app



<https://youtu.be/E9uzxWFxk00>  
Lego hidden side

# AR: Direct view

**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

The world is seen either directly or indirectly. Direct view examples:



Microsoft Hololens



Airplane HUDs  
(head-up display)



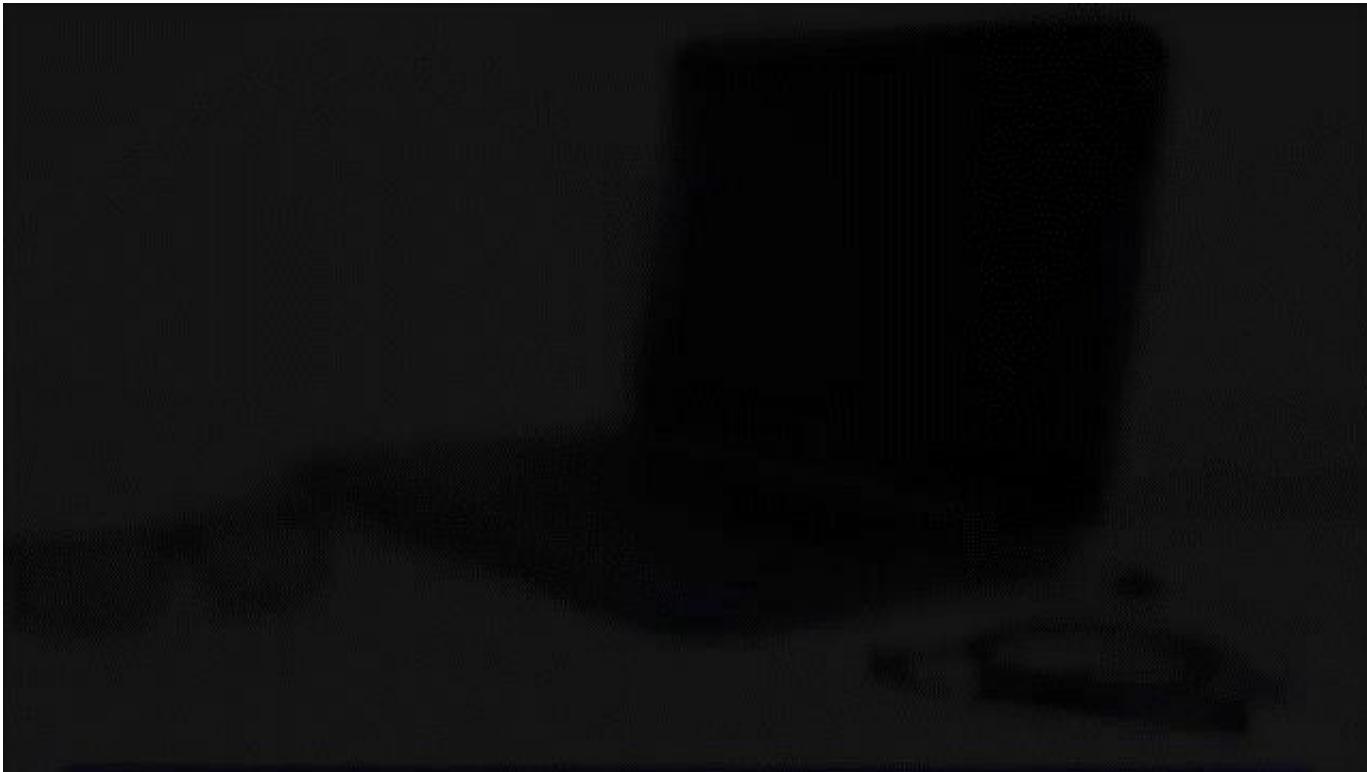
# AR: Indirect view

**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

The world is seen either directly or indirectly. Indirect view examples:



# Viewing devices



A full device for AR and VR applications:  
<https://zspace.com/>

# AR: Real world

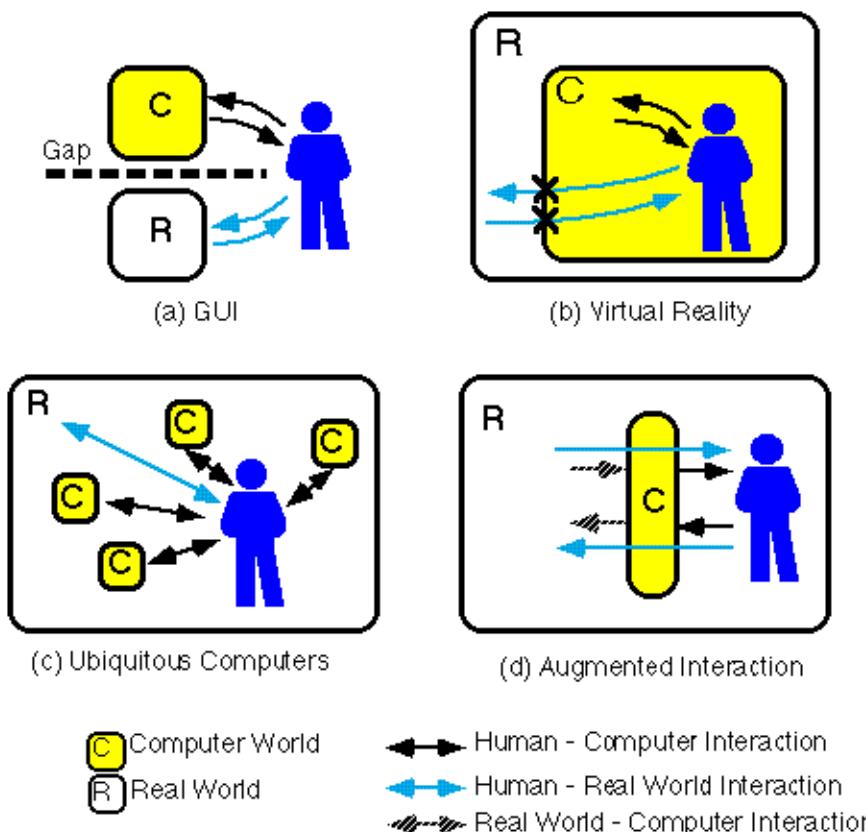
**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

Don't forget that AR is about augmenting *reality*. If the world itself is simulated, it's virtual reality, not augmented reality



# Relationship between real and augmented worlds

**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.



J. Rekimoto, K. Nagao. "The world through the computer: Computer augmented interaction with real world environments", Proceedings of the 8th annual ACM symposium on User interface and software technology, 29-36, 1995

# AR: augmenting what?

**Augmented reality (AR)** is an interactive, direct or indirect experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

Which information is augmented? Typically visual (and audio) information. But other possibilities exist. We have already seen an example of haptic AR in surgery



# AR: augmenting what?

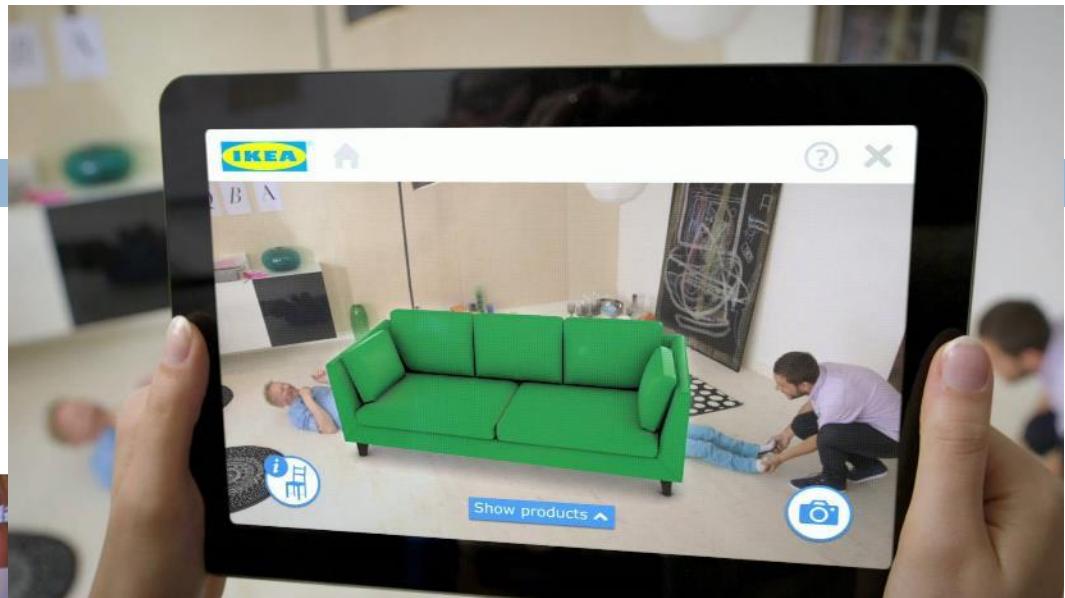
Augmenting visual information using positional and orientation sensors available in modern smartphones



# AR application fields

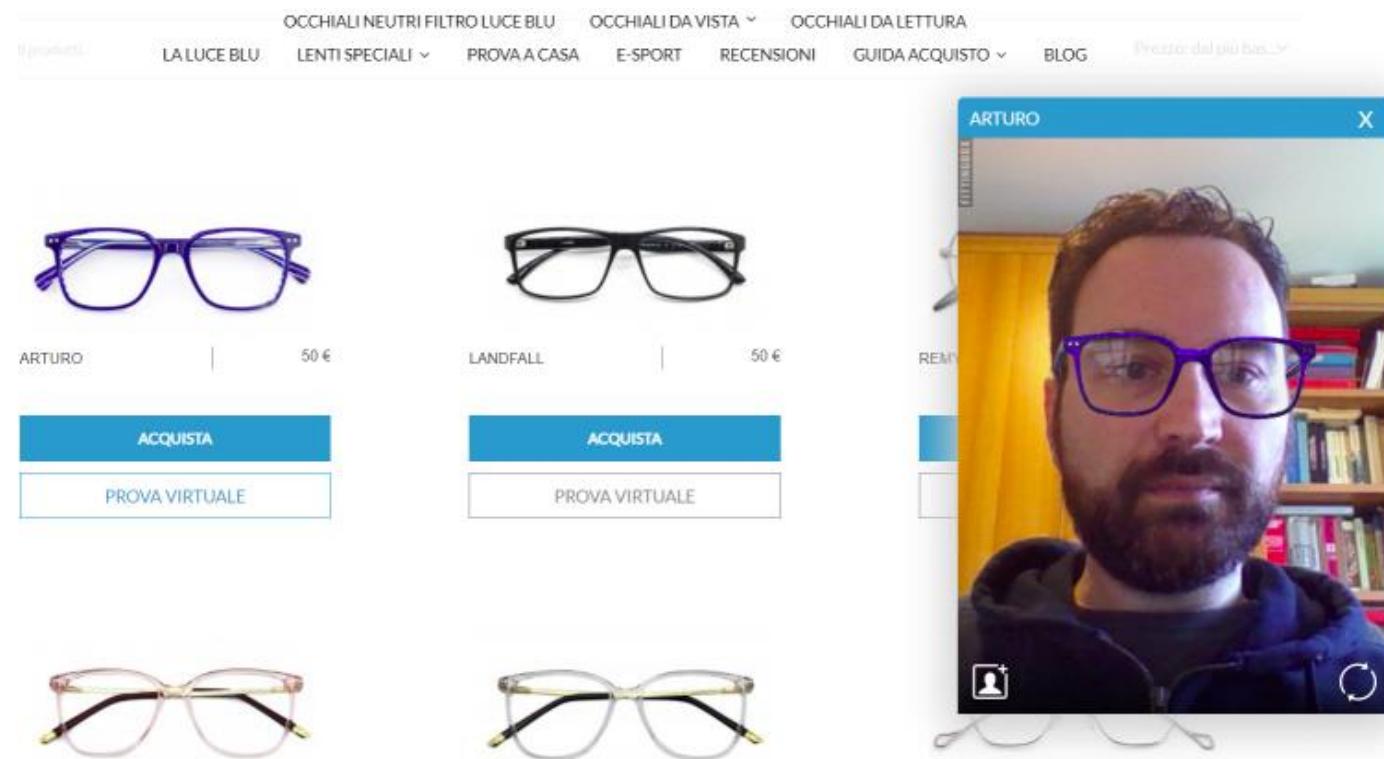
- Applications for augmented reality are limitless
- Share your thoughts!
- Let's see some examples...

# Commerce



# Commerce

- Example: virtual mirrors for eyeglasses
- <https://vimeo.com/204856469>
- <https://www.nowaveofficial.com/it/31-occhiali-neutri>



# Entertainment

Lasciati ispirare!



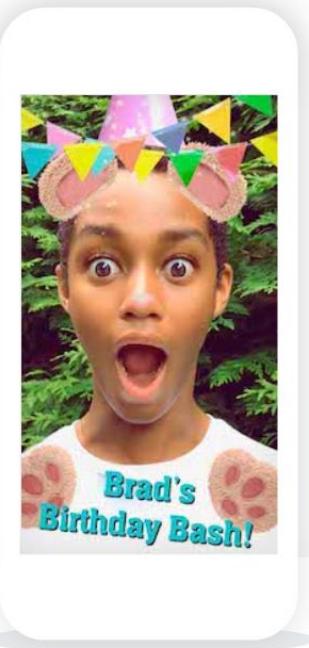
Community



Filtri



Lenti

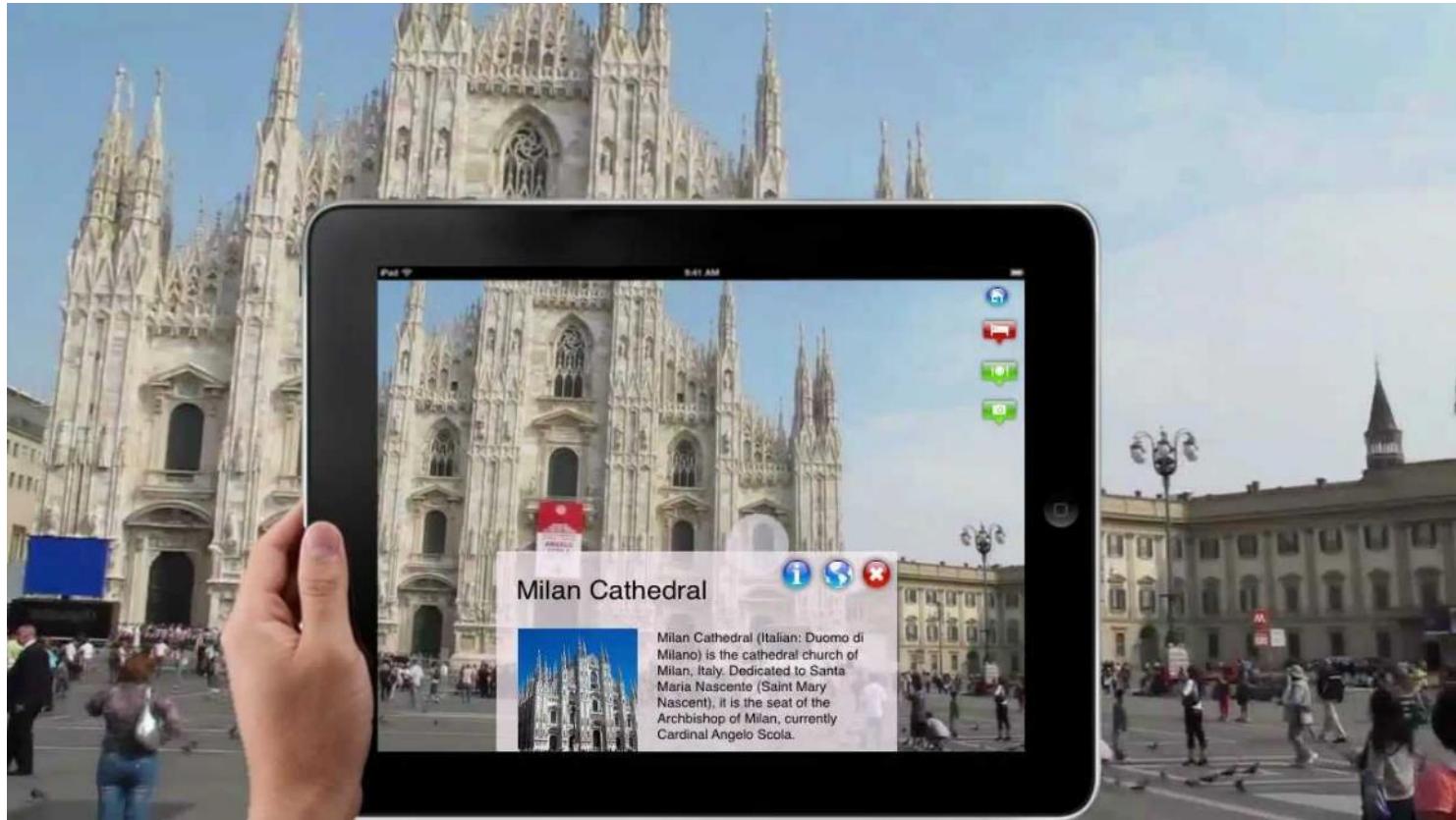


Snapchat lenses

# Architecture



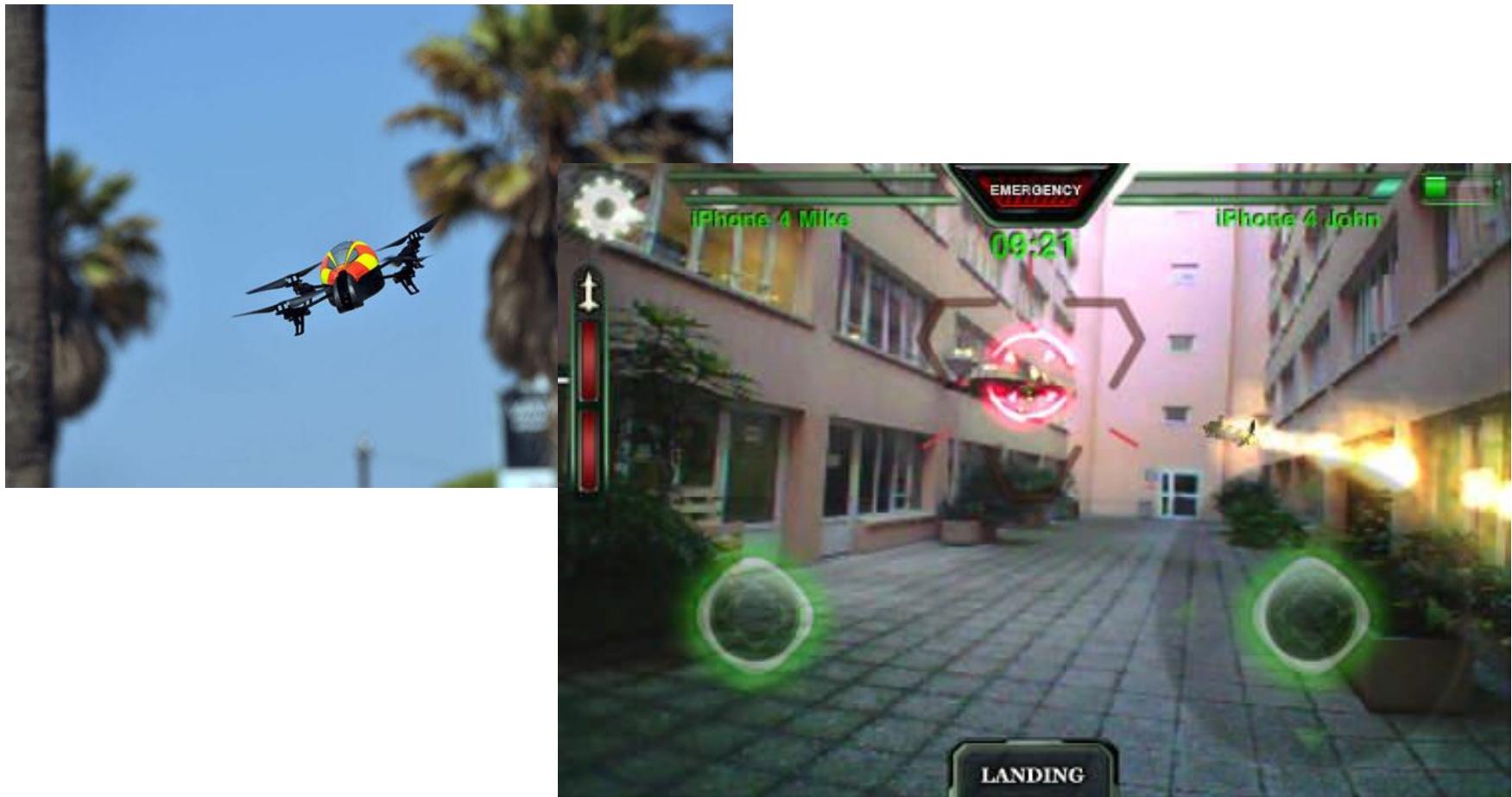
# Tourism



# Museums



# Gaming



AR.FlyingAce for Parrot drones

# Gaming

- <http://father.io/>



[https://www.youtube.com/watch?v=Y\\_TZTnxgD1I](https://www.youtube.com/watch?v=Y_TZTnxgD1I)

# Gaming



# Gaming



Minecraft + Hololens

<http://dai.ly/x2uacxa>

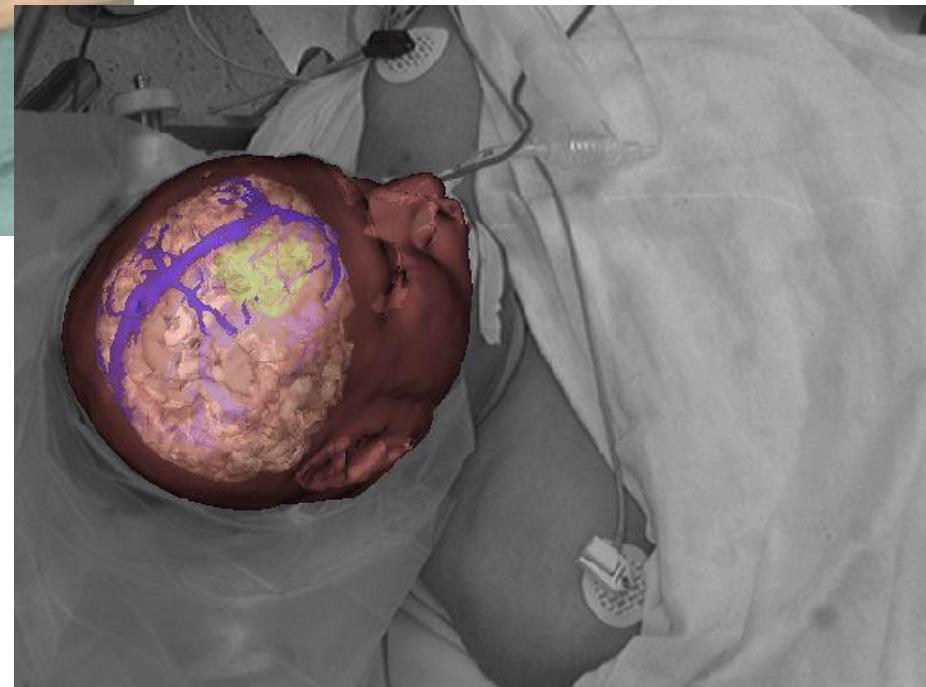
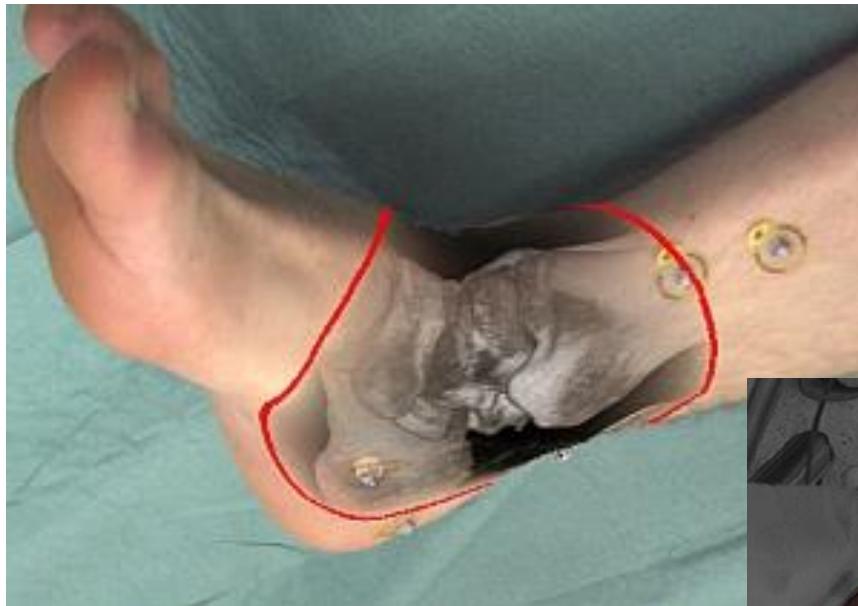
# Gaming



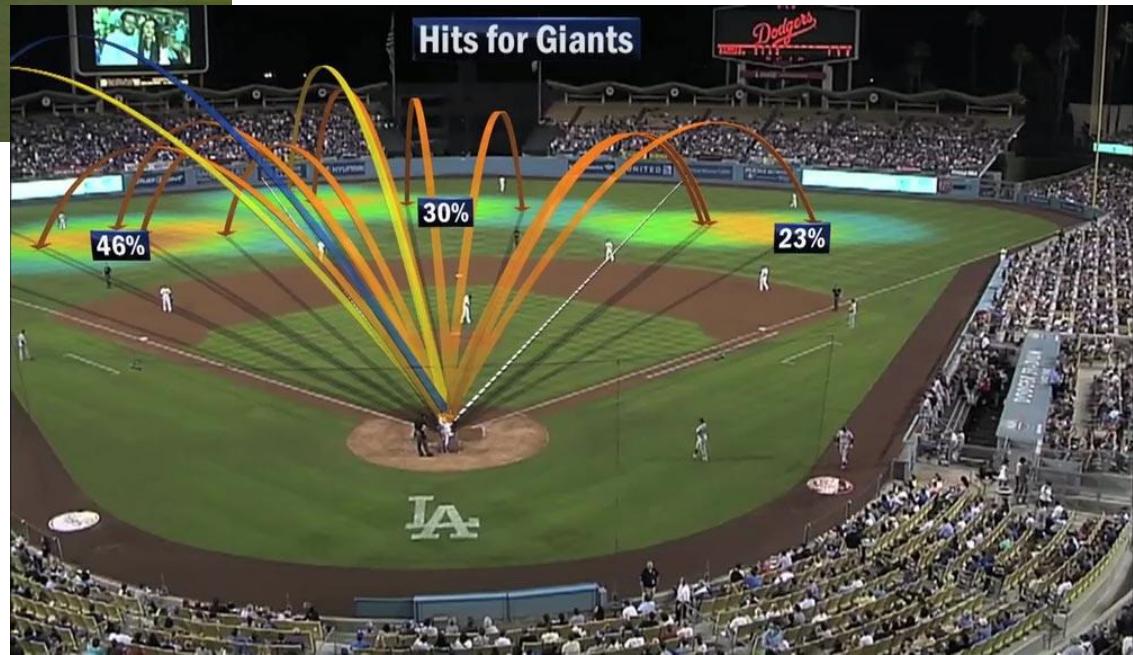
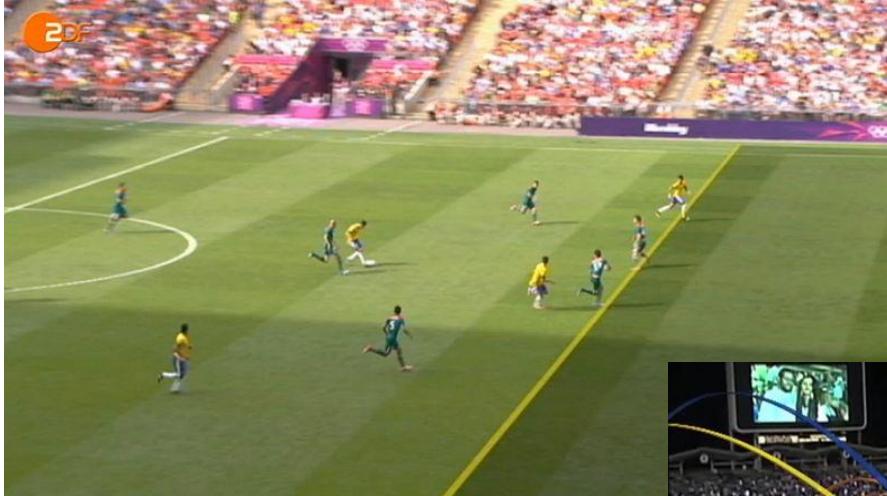
<https://youtu.be/JoXiu-2NsPw>

Knightfall AR

# Medical



# Sports



# Navigation



<https://www.punto-informatico.it/ios-2019-google-maps-realta-aumentata/>

# Navigation



<https://www.kickstarter.com/projects/eyeride/eyeride-hud-make-your-helmet-smart>

# Task support



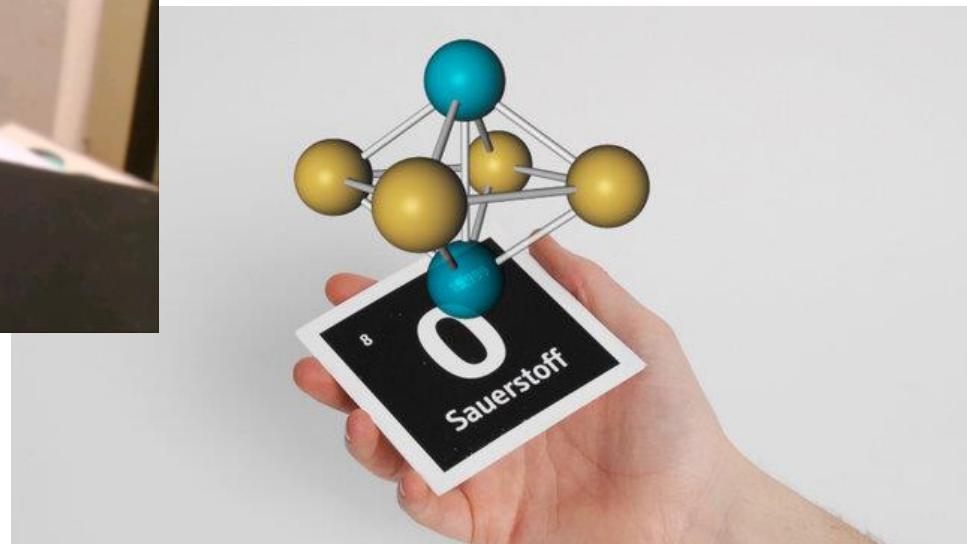
# Virtual teachers



See videos at:

<http://uploadvr.com/teomirn-mixed-reality-app-teaches-play-piano/>

# Education

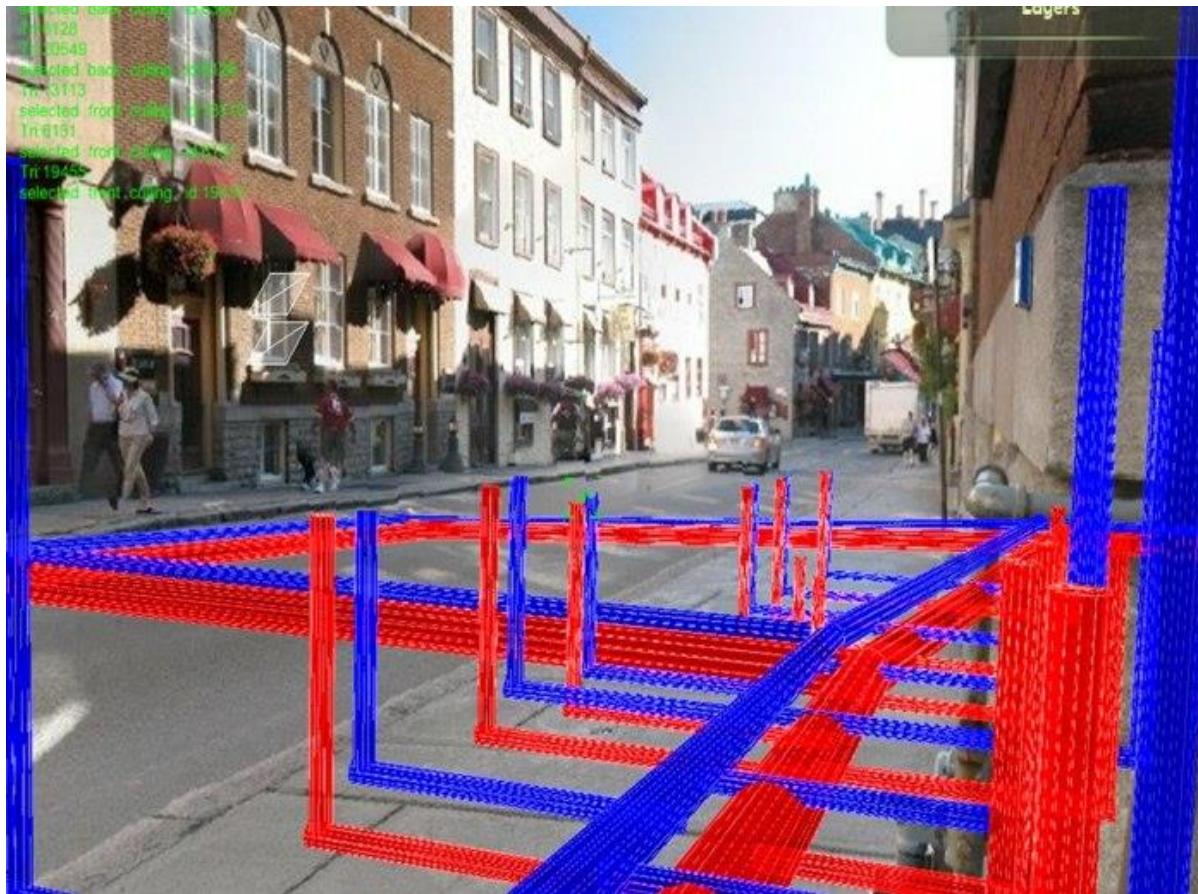


# Education



<https://youtu.be/j9JXtTj0mzE>

# Constructions



# Military



# A provocation on the future of AR: nothing can go wrong?

- Hyper-reality video:

- <https://vimeo.com/166807261>
  - <https://youtu.be/YJg02ivYzSs>

- Black mirror

