

# Mixed Reality and Tangible Interfaces

## 3D Mixed and Augmented Reality



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1. Brief recap
2. Reality ? What Reality ?
3. AR prospective: Denno Coil.

**Augmented reality** (AR) is a term for a live direct or indirect view of a physical, real-world environment whose elements are *augmented* by computer-generated sound, video, graphics, haptic or GPS data.

Augmentation is conventionally in *real-time* and in semantic context with environmental elements, such as sports scores on TV during a match.

With the help of advanced AR technology (computer vision and object recognition) the information about the surrounding world becomes interactive, e.g. artificial information about the environment can be overlaid.

Augmented reality was coined by Thomas Caudell, working at Boeing, in 1990.



Caudell at Boeing (1990)

*“Reality is merely an illusion, albeit a very persistent one.” – Albert Einstein*

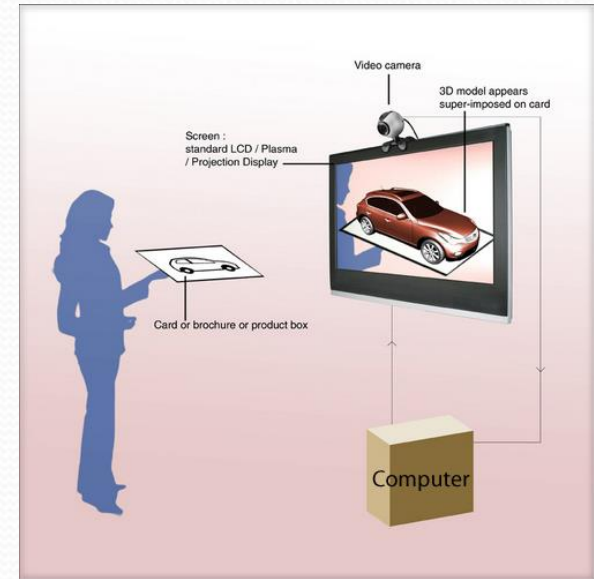
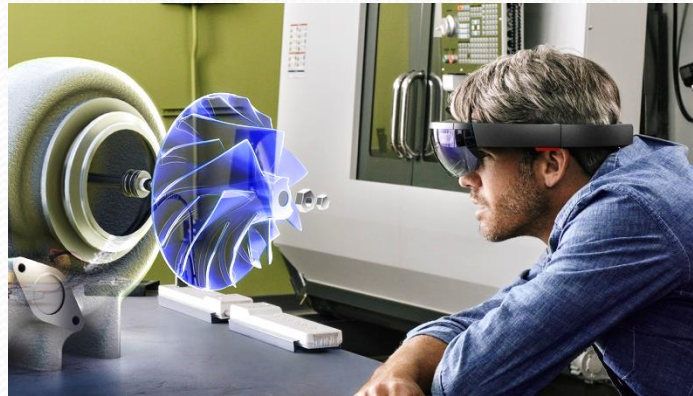
How do we know Reality is a consensus ? We don't !

Doesn't pose too many problems until ... we start fiddling with perception !

*“Everything you see or hear or experience in any way at all is specific to you. You create a universe by perceiving it, so everything in the universe you perceive is specific to you.” – Douglas Adams*

Reality is (accessible only by) what we perceive

AR is a NEW way of accessing “reality”. Augmenting the senses = augmenting reality



*Other means ?*

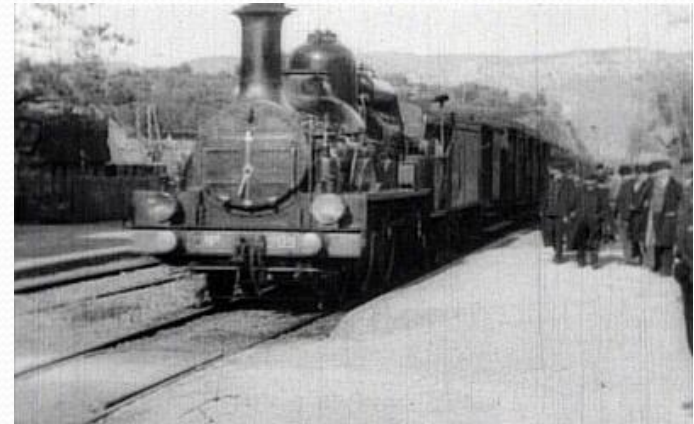


## *Other means ?*

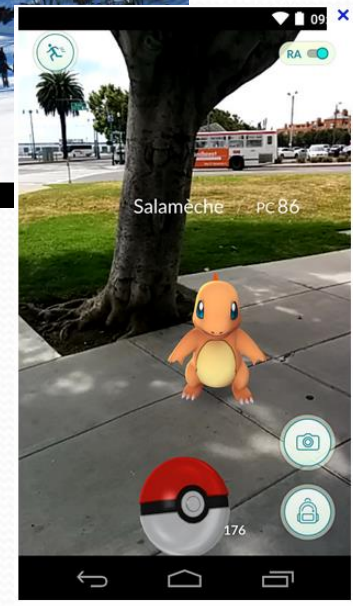
Trompe l'œil



Théâtre de la Flèche



L'entrée en gare de la Ciotat (1895)



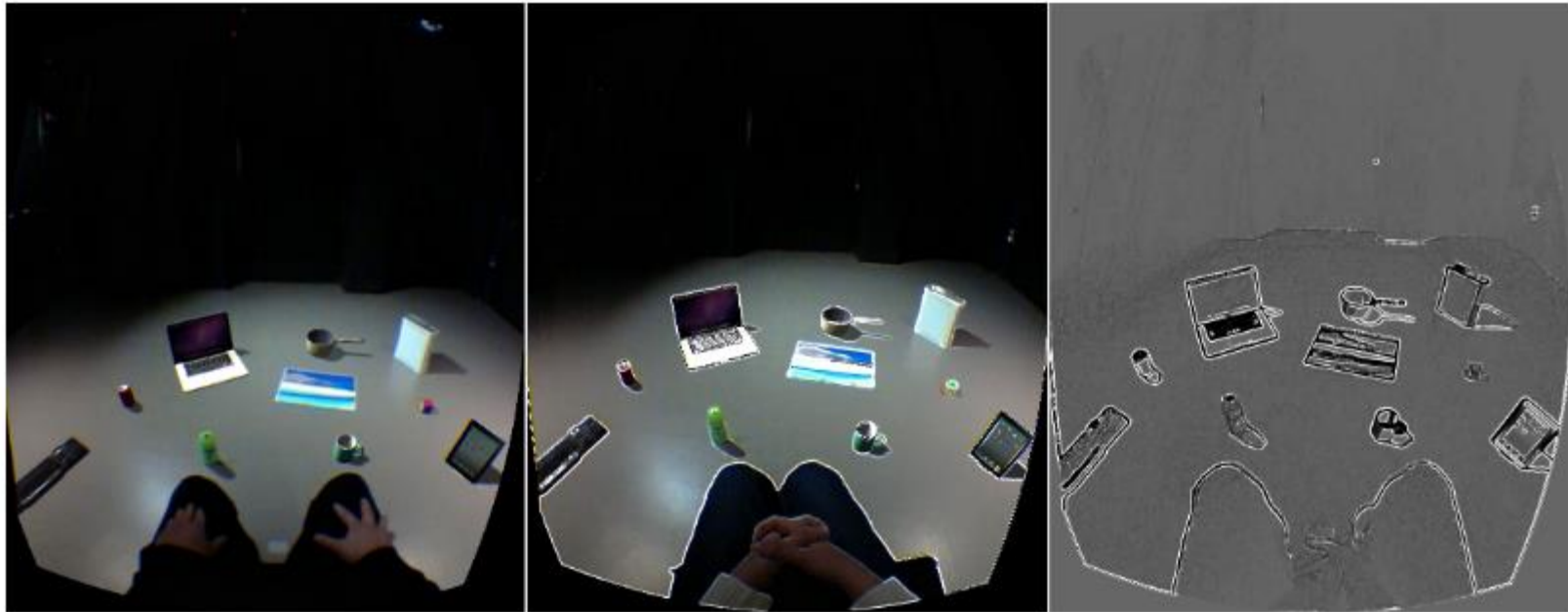
# AR: a glimpse into the future



Denno Coil (2007) by **Mitsuo ISO**.  
26 installments.  
Let's see EPISODE 1 together !



Depends on observation condition and activity !



73%

56%

36%

“degraded reality”

*Presence and Discernability in Conventional and Non-Photorealistic Immersive Augmented Reality.*

Steptoe, W. and Julier, J. and Steed, A. (2014)



Jan Herling and Wolfgang Broll - Ilmenau University of Technology (2010)

What is needed:

- Ego-centric object (or 2D zone) tracking
- Photoshopping-out algorithm in Real-time
- Manual initialization

The "Retro-reflective Projection Technology, Optical Camouflage" cloak from TachiLab





Tower infinity (South Korea), 2030  
 a.k.a. "Cheongna City Tower" or "Ecoprism  
 Tower" or "Crystal Top Tower".

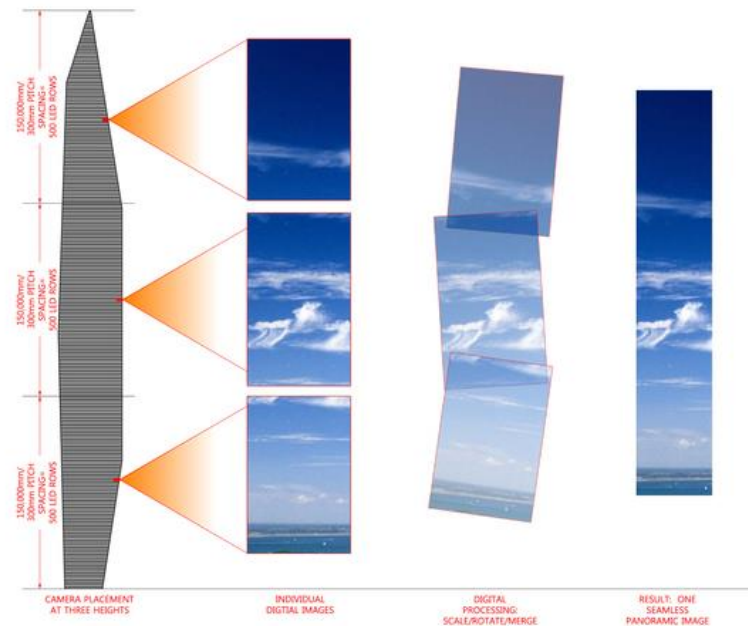


IMAGE CAPTURE + PROCESSING



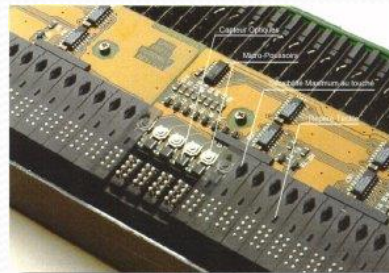
- Bidirectional !
- Two types of feedback : Tactile vs. Force

**Tactile:** part of *somatosensory system* (temperature, touch, pain)

**Mechanoreceptors : touch , texture**



Vibration

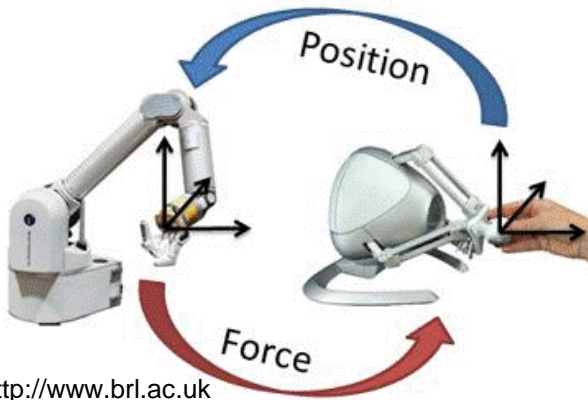


Braille Reader



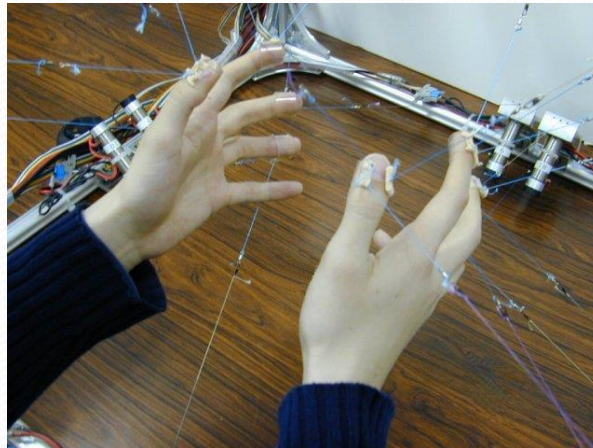
Ultrasonic Tactile Display  
(Ultrahaptics – joined Leap Motion in 2019)

## Force: skin+ muscles + articulations



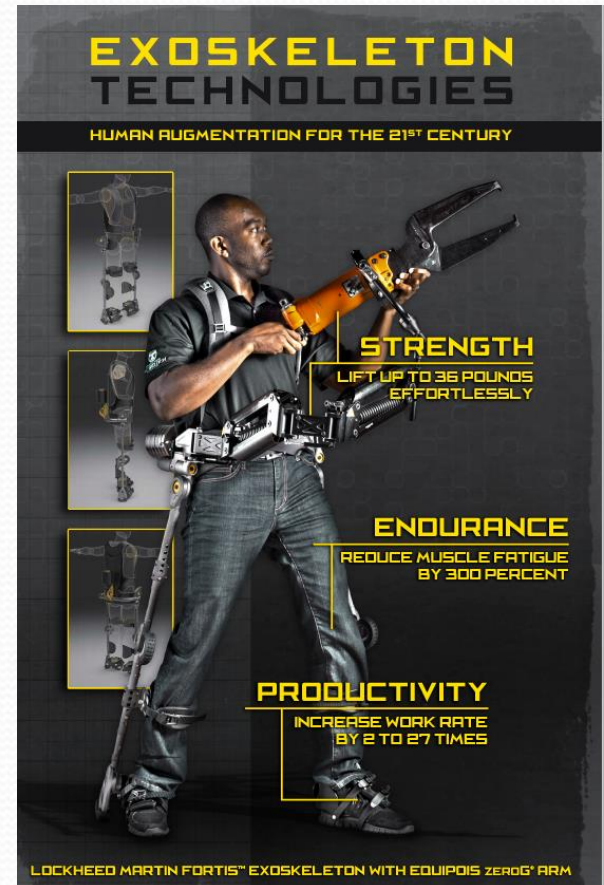
Haptic arm

<http://www.brl.ac.uk>



Spidar

## Exoskeleton



## Exosquelette MATE XT (Comau)

- Système passif, sans moteur
- 3kg
- + 56 % d'endurance statique, + 27 % de précision et de qualité, + 10 % de rapidité et – 30 % d'efforts musculaires.
- €4,995.00

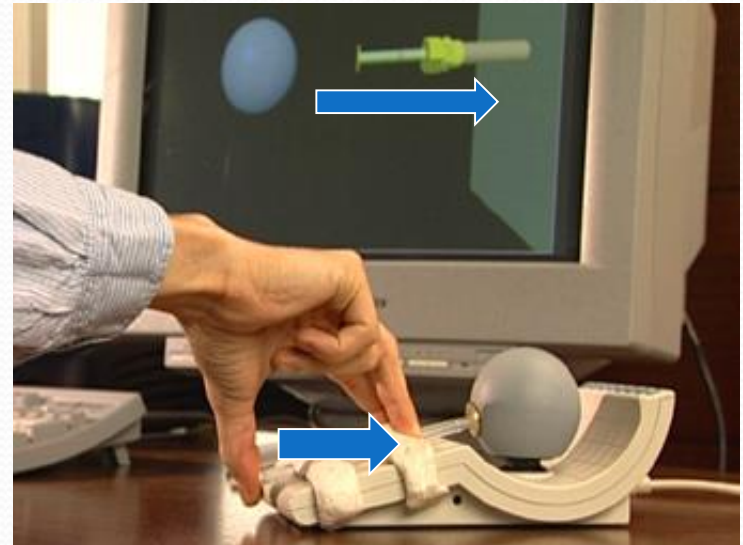


Haptics not an agile technology (yet)

→ Pseudo haptics = haptic illusion

"Trick" one modality to modify another (crossmodality)

Ex: visuo-haptics



Lecuyer [2000]

→ Alter perception of: stiffness, friction, mass, texture...

Origin: 1975 (Gerzon).

Coder/decoder for (3D) sound recording/rendering independent of speaker location  
→ 3D rendering = recreate the soundfield at the listening spot/area

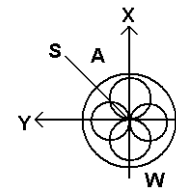
Technique: Weighting of microphones/ loudspeakers

- Encode the soundfield in spherical harmonics.

4 channels:  $W$ ,  $X$ ,  $Y$  and  $Z$ .

$W$  = sound pressure  
pressure gradient =  $(X, Y, Z)$

- Decode dependent of speaker position relative to user.



Encoding:

$$W = S, X = \cos A \cdot S, Y = \sin A \cdot S$$

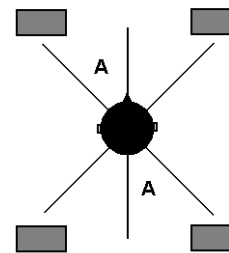
Decoding:

$$L_b = \frac{1}{2} (W - \sqrt{2} \sin A \cdot X + \sqrt{2} \cos A \cdot Y)$$

$$L_f = \frac{1}{2} (W + \sqrt{2} \sin A \cdot X + \sqrt{2} \cos A \cdot Y)$$

$$R_f = \frac{1}{2} (W + \sqrt{2} \sin A \cdot X - \sqrt{2} \cos A \cdot Y)$$

$$R_b = \frac{1}{2} (W - \sqrt{2} \sin A \cdot X - \sqrt{2} \cos A \cdot Y)$$





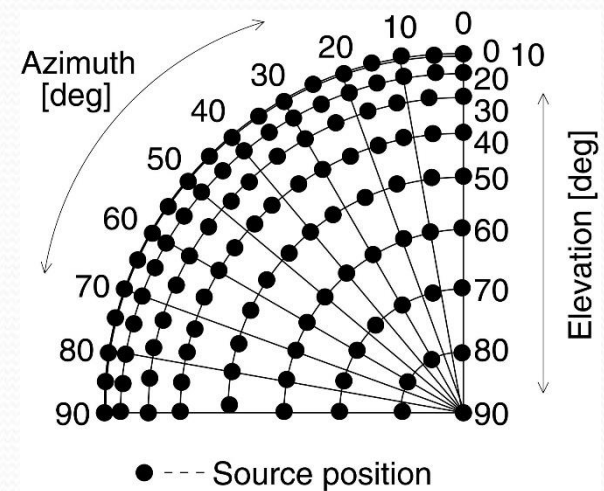
Record sound with two microphones located on dummy → replay them in sync.

Binaural recording starts in 1881 (Théâtrophone)

Two main cues:

1. Interaural Time Difference (ITD)
2. Interaural Level Difference (ILD)

→ Combined in  
→ **Head Related Transfer Function (HRTF)**  
+ **dephasing**



See Mikko Peltola : "Augmented Reality Audio Applications in Outdoor Use"

<http://www.vrgeeks.org/>

<http://www.augmented.org>

<https://www.augmented-reality.fr/>

<https://www.euroxr-association.org/>