Ciências ULisboa | Informática

Animação e Ambientes Virtuais 2018/2019

Mestrado em Engenharia Informática
Mestrado em Informática
e Pós-graduação

Virtual Reality

Part I

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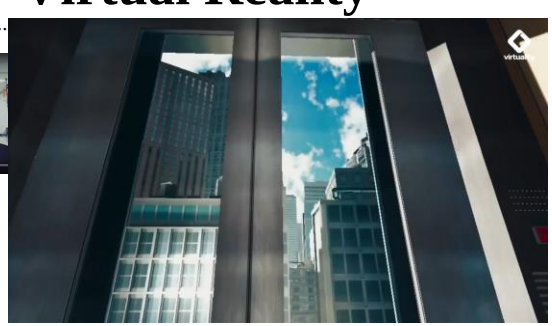
Virtual Reality

Saving a cat in VR...



https://www.youtube.com/watch?v=zhljsCx6Yiw

Virtual Reality

Virtual reality (VR) is a simulation in which computer graphics is used to create a **realistic-looking world**. Moreover, the synthetic world **responds to the user's input** (gesture, verbal commands, etc.)

↓

Real-time Interactivity

↙

"**Real-time**" means that the computer is able to detect a **user's input** and **modify the virtual world instantaneously**. People like to see things change on the screen in response to their commands and become captivated by the simulation.

Virtual Reality

Interactivity and its captivating power contributes to the feeling of **immersion**, of **being part of the action on the screen**, that the user experiences.

But virtual reality pushes this even further by potentially using **all human sensorial channels**.

In some VR systems, users not only see and manipulate graphic objects on the screen, they also **touch** and **feel** them.

Virtual Reality

Definition

Virtual reality is a high-end user-computer interface that involves **real-time simulation** and **interactions** through **multiple sensorial channels**. These sensorial modalities are visual, auditory, tactile, smell and taste.

Output:
Sensory feedbak

Olfactive display (smell) has been experimented with sparingly, and computer-controlled display of gustation (taste) are at the stage of early research.

Virtual Reality

Virtual reality is a medium that allows us to have a simulated experience **approaching that of physical reality**.

Virtual reality also allows us to **reduce the danger of physical reality** and to create scenarios not possible in the real world.

Virtual Reality -**The three I's of virtual reality**

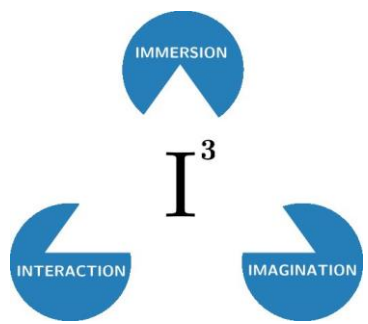
VR is both **interactive** and **immersive**.

VR is not just a medium or a high-end user interface, it also has applications that involve **solutions to real problems** in **engineering**, **medicine**, **the military**, etc. The extent to which an application is able to solve a particular problem, that is, the extent to which a simulation performs well, depends very much on the human **imagination**.

Interaction + Immersion + Imagination

Virtual Reality -**The three I's of virtual reality**

VR triangle



Grigore Burdea and Noshir A. Langrana. Virtual force feedback: Lessons, challenges, future applications. Journal of Robotics and Mechatronics, 5(2), 1993.

Virtual Reality

The **Sense of Presence** (SoP) is the subjective **sensation** of "**being in the Virtual Environment**". It is a complex mental mechanism that is strongly linked to our emotional reasoning abilities, **depending on the user's abstraction capacities**.

The concept of presence is not restricted to VR: reading a book, watching TV, and talking on the phone can all engender some level of presence. This is why there is currently no single agreed upon way to appreciate its quality.

Virtual Reality

When experiencing a space with other human participants, it is often important to be able to **sense their presence in the world** where they are located, which way they are looking/pointing, and what they are saying.

The Hindi word *avatar* (which means the worldly incarnation of a deity) is used to denote the concept of **representing users in a virtual world**.

Avatar:

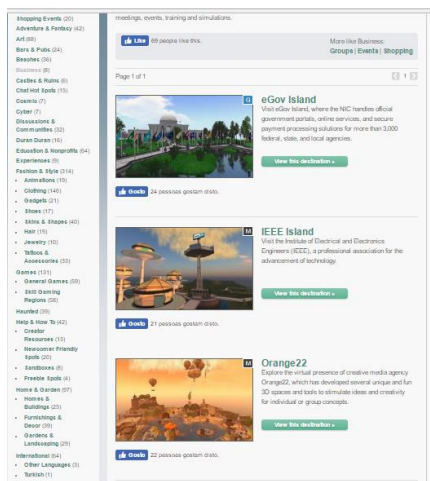
1. a virtual object used to represent a participant or physical object in a virtual world; the (typically visual) representation may take any form.
2. The object embodied by a participant.

(ex: Second-life, see next slides)

Second Life secondlife.com

Ex: Social Anxiety Disorder in Second Life

http://secondlife.com/destinations/business



VR and AR applications

- **Entertainment (films and videogames €€€€€€)**
- Education
- Medical applications
  - Virtual anatomy
  - Surgery
  - Rehabilitation
- Training
- Virtual Heritage
- Robotics
- Visualization

A little bit of history...

Virtual Reality- **First VR systems**

Sensorama: the first virtual reality video arcade
Morton Heiling, 1962.

http://www.insightsinretail.com/wp-content/uploads/2009/05/morton-heilig-the-sensorama-vr-machine.jpg
http://www.youtube.com/watch?v=vSINEBZNCks

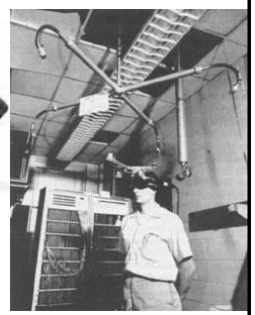
This VR workstation had 3-D video feedback, motion, color, stereo sound, aromas, wind effects (using small fans placed near the user's head) and a seat that vibrated.

But a major component was missing:

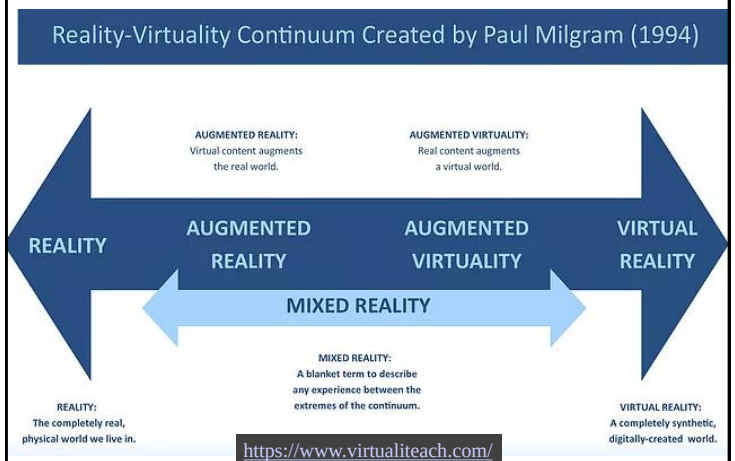
System response based on user's actions.

Virtual Reality- **First AR system**

The work of Morton Heiling on head-mounted displays was continued by **Ivan Sutherland**, 1966. This author realized that he could use **computer-generated scenes instead of analog images** taken by cameras.

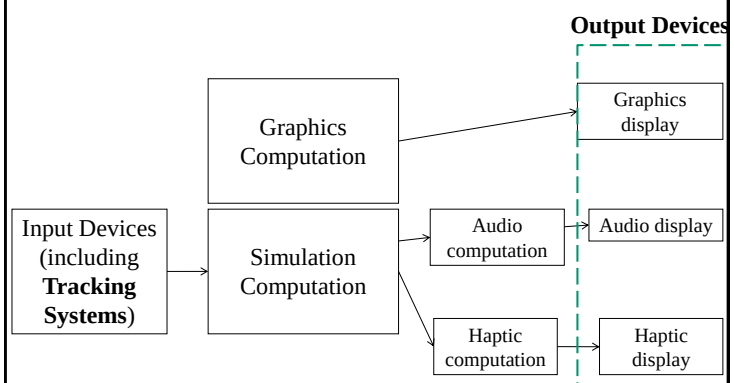


http://www.youtube.com/watch?v=7B8aq_rsZao



https://www.virtualiteach.com/

Typical VR System



VR –Output Devices

Output devices: designed to provide feedback from the simulation in response to this input. The **sensorial channels fed back by these interfaces** are:

- **sight** (through **graphic displays**),
- **sound** (through **3D sound displays**)
- **touch** (through **haptic* displays**)

- **taste** and **smell** (…)

(* The Greek word *haptai* means touch)

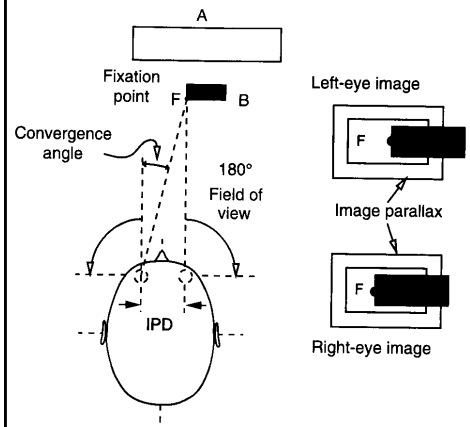
VR –Output Devices- **graphics display**

A **graphics display** is a computer interface that presents synthetic world images **to one** or **several users** interacting with the virtual world.

personal graphics display

large volume displays

VR –Output Devices- **graphics displays**



The point F will appear **shifted horizontally between the right and left eyes** because of its different position in relation to the two eyes. This shift is called **image parallax.**

Viewing 3D

VR –Output Devices- **graphics display**

Wide field of view (FOV) is an important characteristic for **immersive environments**.

A typical human has a total horizontal field of view between 160 and 208 degrees and a binocular field of view (important for **depth perception**) between 120 and 180 degrees.

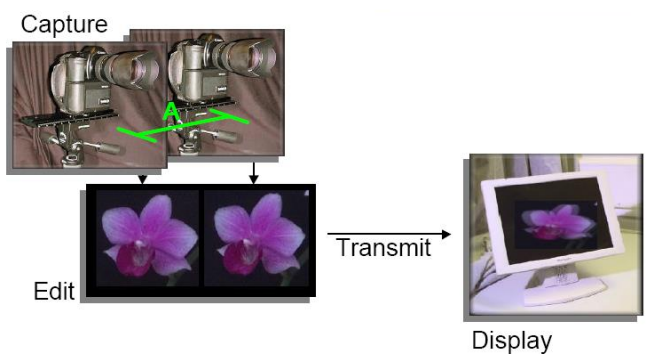
Since the FOV is so wide, **it is impossible to completely fill the users vision with a single flat screen**.

VR –Output Devices- **graphics displays**

Spatial multiplexing (3D) consists of positioning separate images in front of each eye:

- using two small separate screens ← Ex: HMD
- using a filter to separate the views ← Ex: anaglyphic glasses

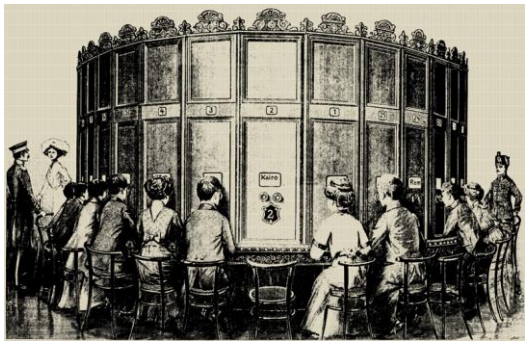
VR –Output Devices- **graphics displays**



Exposição "A Terceira Imagem|A Fotografia estereoscópica em Portugal e o desejo do 3D" na Torre do Tombo- OUT 2015

A primitive stereoscopic device (beginning of the 20th century)

In Exposição "Cinema em Portugal, os primeiros anos", Museu da Ciência da UL



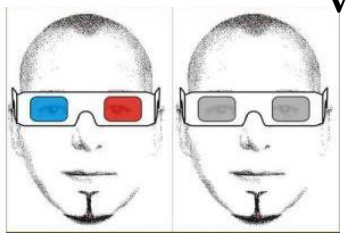
KaiserPanorama- is a form of stereoscopic entertainment medium used chiefly in the 19th and early 20th centuries, a precursor to film, invented by August Fuhrmann (1844 – 1925).

https://en.wikipedia.org/wiki/Kaiserpanorama

http://www.view-master.com/en-us

VR –Output Devices- **graphics displays**

VR glasses



Anaglyphic glasses **Polarized glasses**

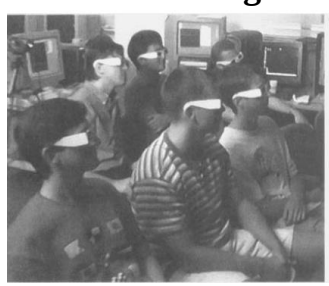
Passive glasses

VR –Output Devices- **graphics displays**

VR glasses

Anaglyphic stereo- displays the view for each eye in a different colour.

Anaglyphic glasses neutralize the view for the incorrect eye.



VR –Output Devices- **graphics displays**

Sistema Infitec passivo

VR glasses

" Para obter a visualização estéreo, característica fundamental para a sensação de imersão no ambiente virtual, é utilizado o **sistema Infitec passivo** [INFITEC], isto é: **as cores do espectro visível são divididas em seis intervalos, dois para cada cor primária, e a cada olho é associado um intervalo de cada uma das cores.** São adicionados aos projectores e às lentes dos óculos dos utilizadores **filtros** de passa banda específicos para separar as imagens a serem percepcionadas por cada olho. Os dois projectores transmitem concorrentemente as imagens filtradas do olho direito e esquerdo"

CAVE Holowspace do Centro de Ciência Viva do Lousal

[Bastos08]

VR –Output Devices- **graphics displays**

VR glasses

Polarized glasses

To present a stereoscopic motion picture, **two images are projected superimposed onto the same screen through orthogonal polarizing filters**.

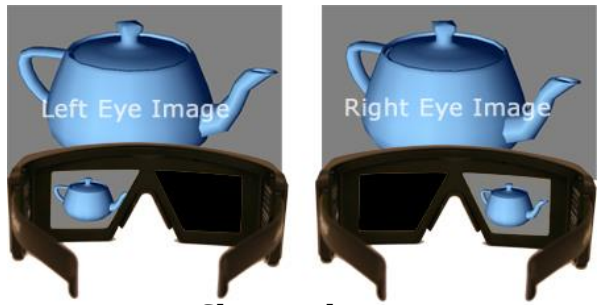
The viewer wears low-cost eyeglasses which also contain a pair of orthogonal **polarizing filters**.

As **each filter only passes light which is similarly polarized** and blocks the orthogonally polarized light, each eye only sees one of the images, and the effect is achieved.

Each eye sees only the information intended for it.

VR –Output Devices- **graphics displays**

VR glasses



Shutter glasses

↳ **Active Glasses**

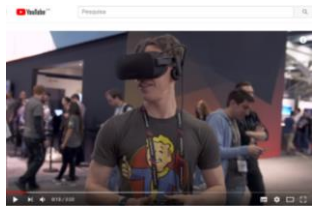
VR –Output Devices- **graphics displays**

If the virtual scene is destined to be viewed by a **single user** it is called a **personal graphics display.**

- Head-mounted displays (HMDs)
- Desk supported displays

Head-mounted displays (HMD)

What happens when the user moves his head?



Positional tracking

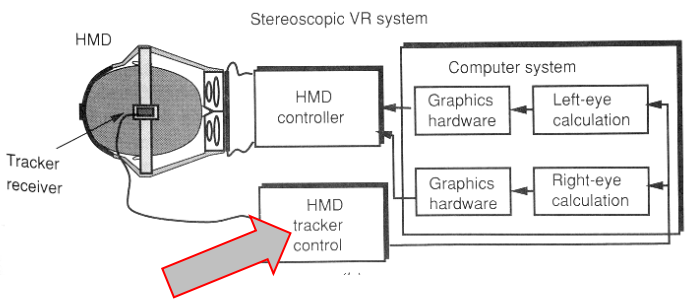
Positional tracking detects the precise position of the head-mounted displays, controllers, other objects or body parts within Euclidean space. Positional tracking registers the exact position due to recognition of the rotation (pitch, yaw and roll) and recording of the translational movements.

https://en.wikipedia.org/wiki/Positional_tracking

pitch, yaw and roll

VR –Output Devices- **graphics displays**

Head Mounted Display (HMD)



Cybersickness

In a **VR system** if the time delay between corresponding head and image motions is too large, **simulation sickness** may occur (it may be called **cybersickness**) .

To alleviate this problem, it is necessary to have **almost instantaneous response to the user's head motion**.

VR –Output Devices- **graphics displays**

http://www.oculusvr.com/

"standalone" VR headsets (don´t need a computer).

Oculus Rift

http://www.oculusvr.com/

Lenovo Mirage Solo

… low cost solutions (ex.)

Smartphone + support with an adjustable pair of lenses

Google CardBoard

Durovis- Dive