

VIRTUAL REALITY

Arquitecture



Course 2024/2025

Organization

- Architecture of a Virtual Reality system
- The model
- Challenges and Advanced applications

Reality and Virtual Reality

How we perceive reality?



Stereoscopic vision



Spatial sound



Gloves and Haptics



Olfactory
Experiences



Thermal emitters



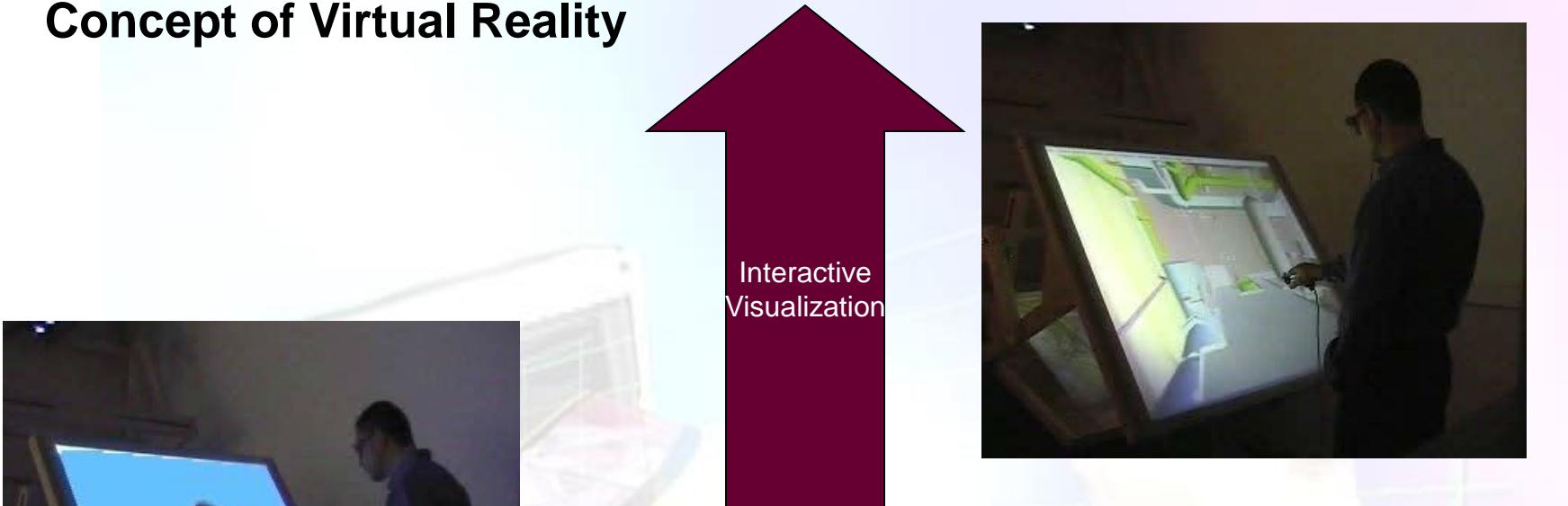
Reality and Virtual Reality

How we perceive reality?

- Digital 3D Model
- Interactivity – immediate response
- Natural interaction (implicit)
- Sensorial immersion (3D vision)

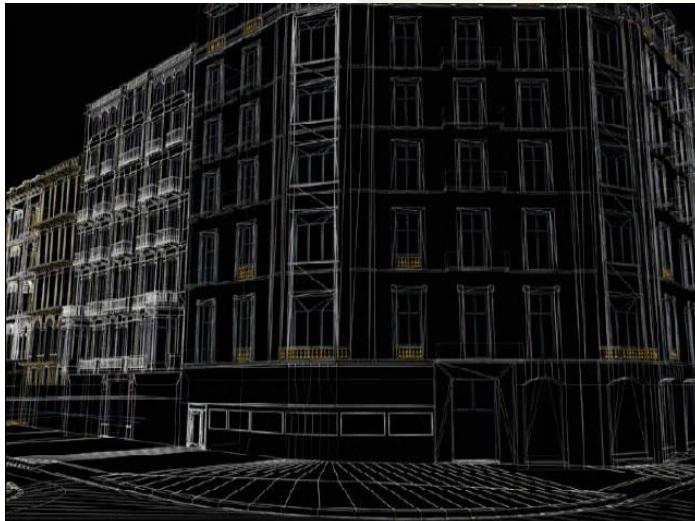


Concept of Virtual Reality



Interactive Visualization

- Interactive Visualization →
- Implicit interaction
- Immersion

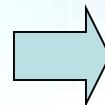


Reproduces a virtual world which only exists as a digital model inside the computer

- **Interactive simulation vs animation**
 - passivity, previously decided
 - improvisation, real time response
- **3D geometric** and appearance representation
- Realistic visualization algorithms
- Memory management algorithms
- Multiresolution models
- “Zoom” capacity
- Visibility pre-process

Interactive Visualization

- Factors involved in the interactive visualization
- Factors involved in the implicit interaction
- Factors involved in the immersion



- Level of simulation
 - Empiric
 - Cinematic
 - Dynamic
 - Deformations
 - Collisions
 - Vehicles (training, flight, etc.)
 - Physical systems (preprocess)
- Interactivity
 - Inspection, navigation
 - Frames /second
 - Latencies and delays
 - Objects with behaviour, driving vehicles, etc.

Immersion

- Interactive Visualization
- Implicit interaction
- Immersion



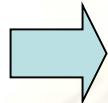
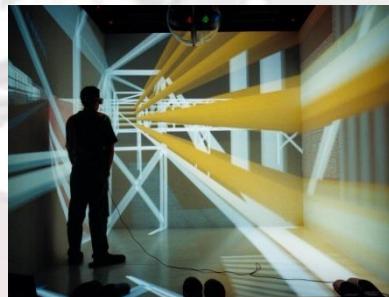
Disconnecting senses from the real world, and connecting them to the virtual environment

- **Visual immersion:** objects exist independently of the visualization device
 - Stereoscopic vision. Presence feeling into the space
- Acoustics immersion
- **Touch immersion**
- Movement immersion: acceleration
- Smelling, tasting...



Immersion

- Factors involved the interactive visualization
- Factors involved in the implicit interaction
- Factors involved in the immersion



- Senses
 - Visual
 - Hearing
 - Touch
 - Balance, Cinestesy (perception of the body)
- Systems
 - Immersive
 - semi-immersive
 - non immersive
- Factors
 - Quality of the stimulus
 - Actualization velocity
 - Latencies
 - Coherence among stimuli
 - Temporal coherence

Implicit interaction

- Interactive Visualization
- Implicit interaction
- Immersion

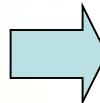


The system decides what the user wants from his **natural movements**

- Gestures, head movements vs interaction with the mouse
- Interaction, selection: movements of grab with hand or finger, etc.
- Transparency of the devices and the computer
- Perception of the direct interaction with objects
- **Window to the model vs immersion to the virtual environment**

Implicit interaction

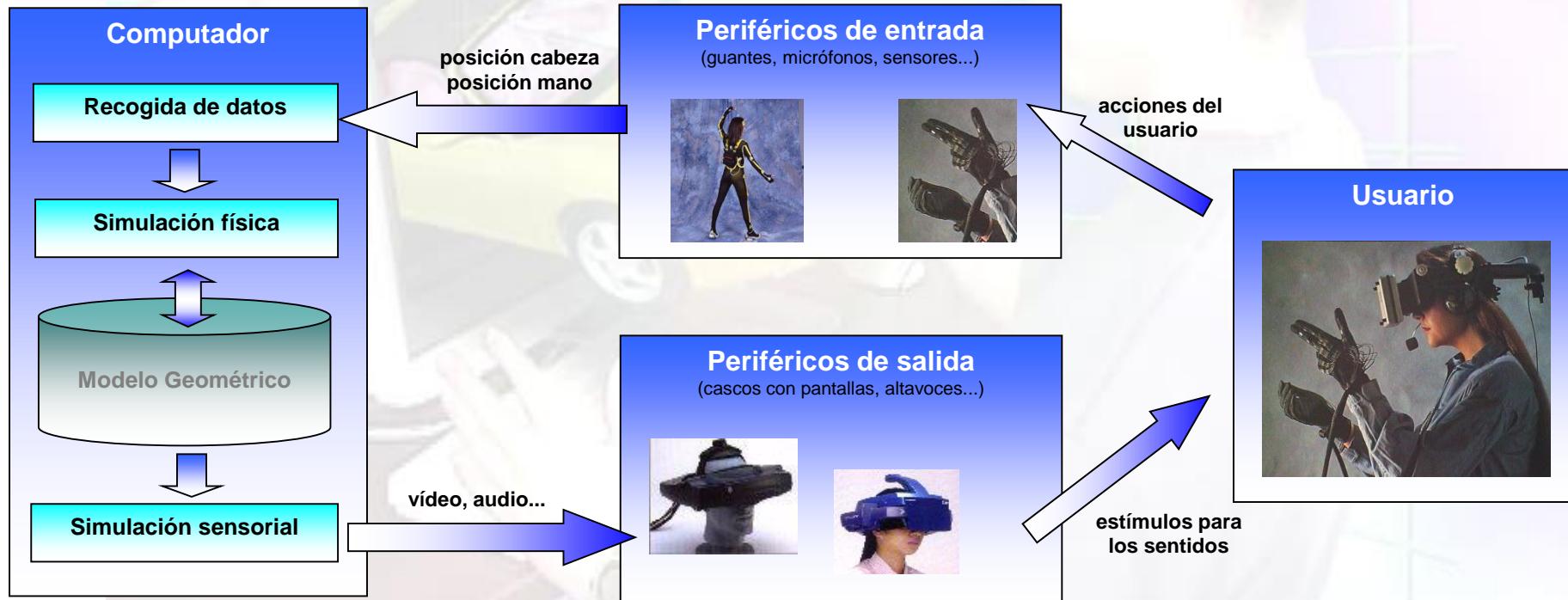
- Factors involved the interactive visualization
- Factors involved in the implicit interaction
- Factors involved in the immersion



- Getting the position
 - Head
 - Hand
 - Finger
 - Eyes
- Virtual menus
- Voice recognition
- Gesture recognition
 - Zero learning

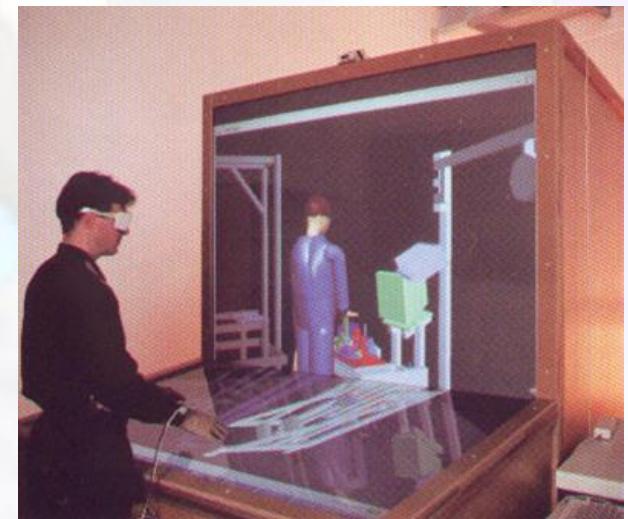
Architecture of a VR System

- Actualization frequency
- Latency time



Virtual Reality Systems

- Immersive systems
- Semi-immersive systems

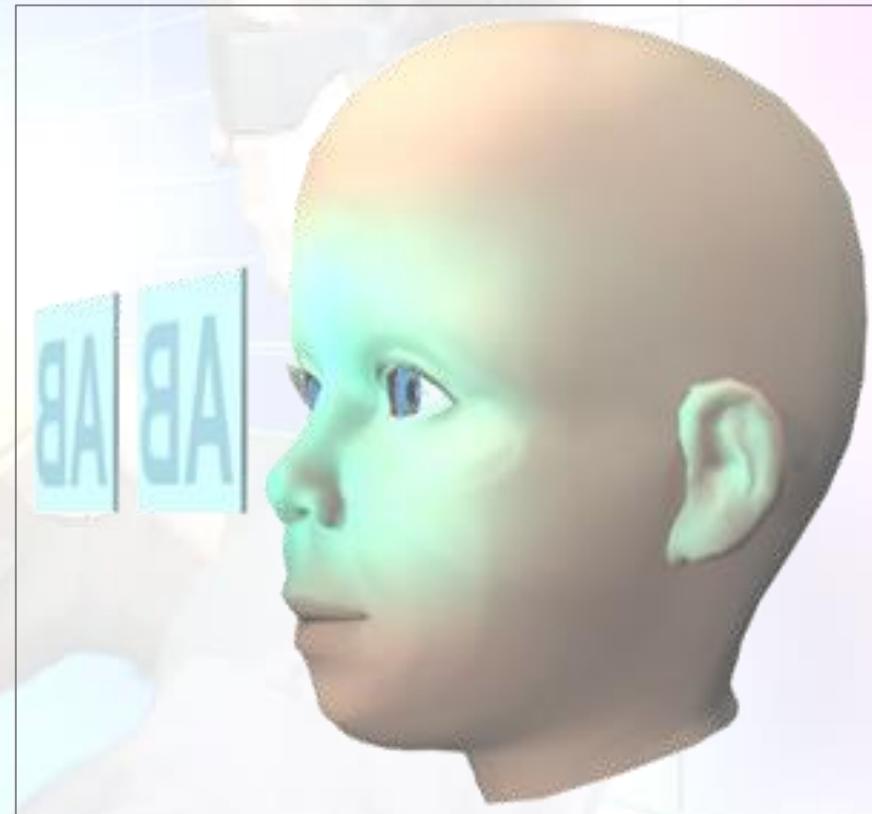


Virtual Reality Systems

- Head Mounted VR

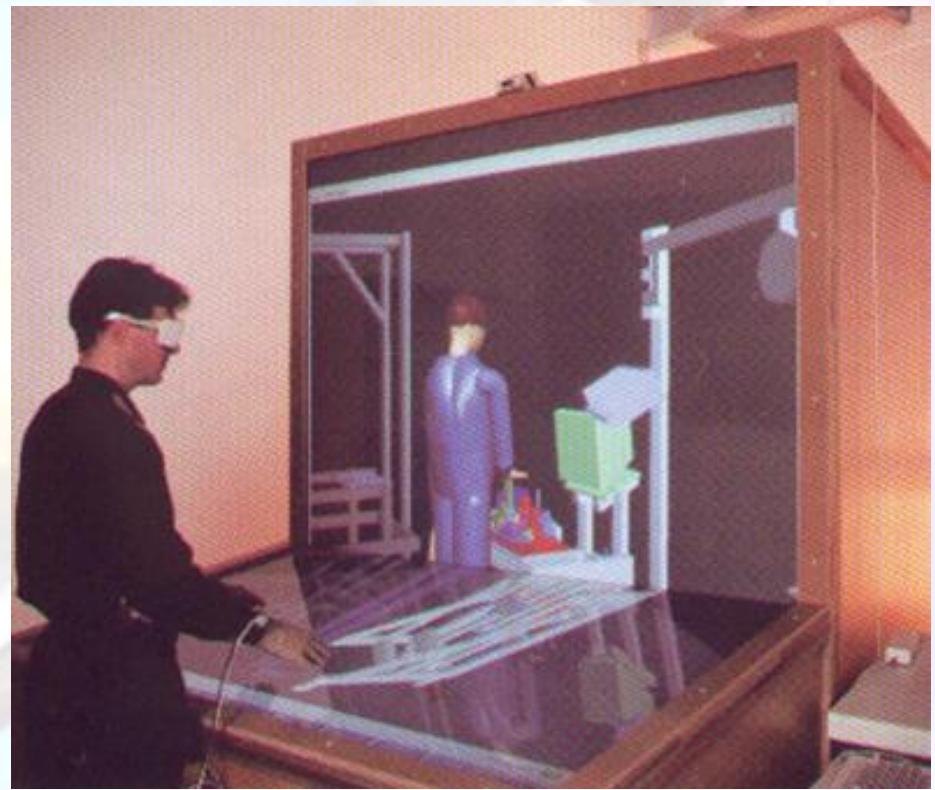


VR: Immersive systems



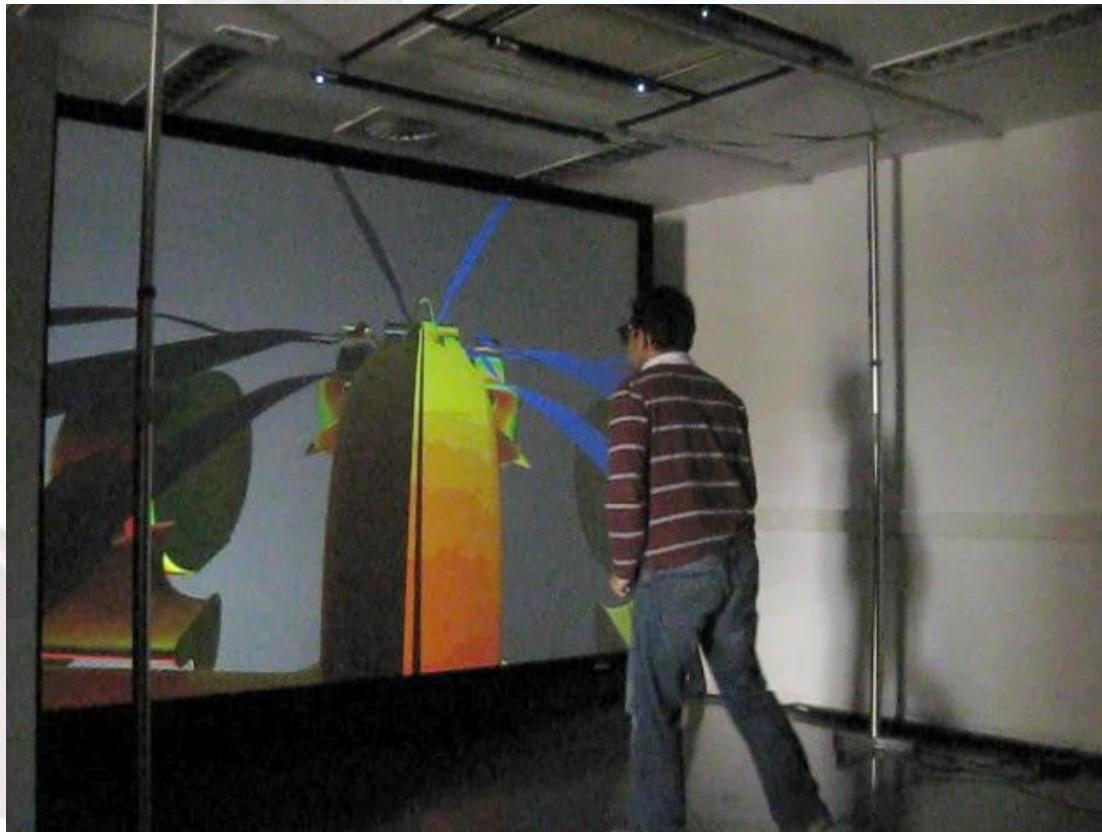
Virtual Reality Systems

- VR Table



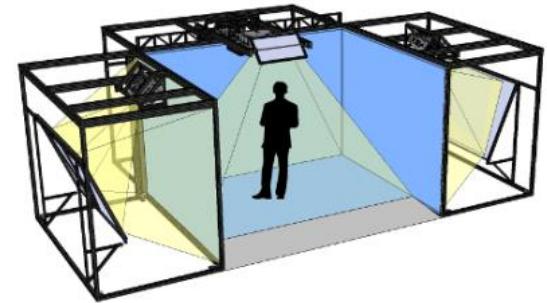
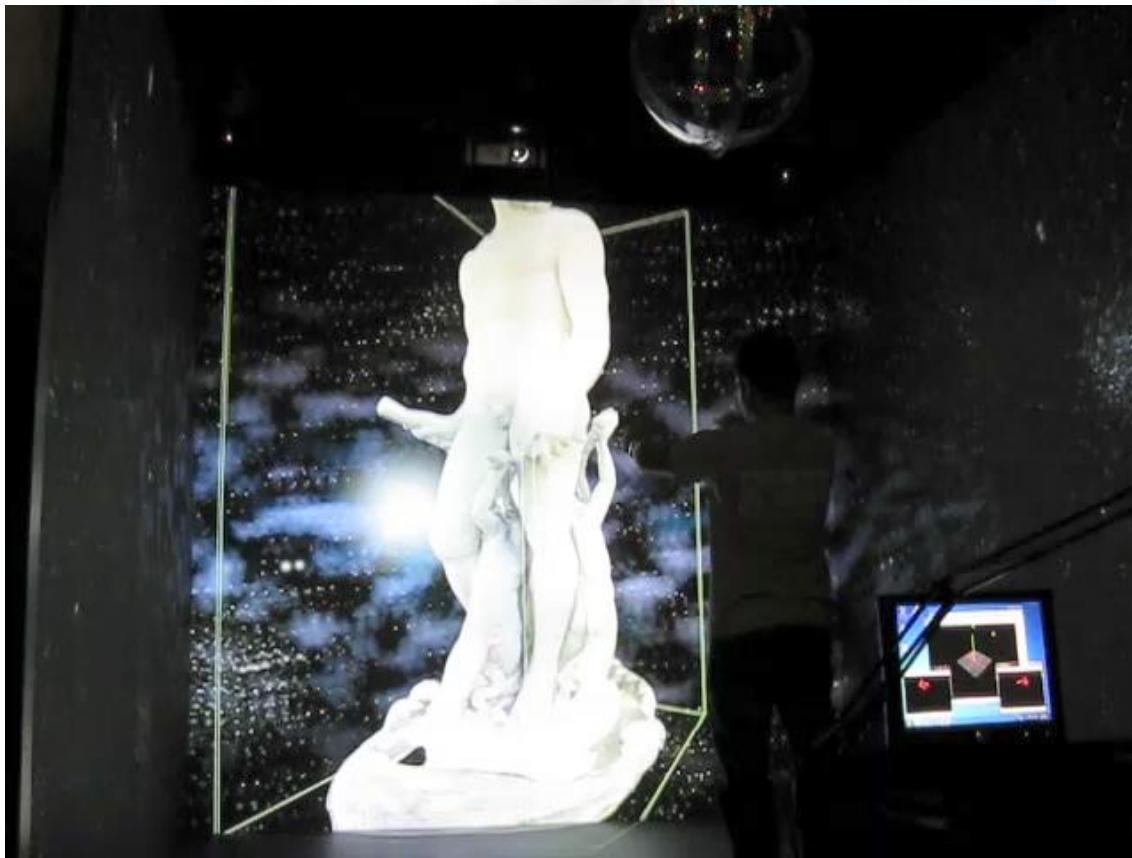
Virtual Reality Systems

- Powerwall

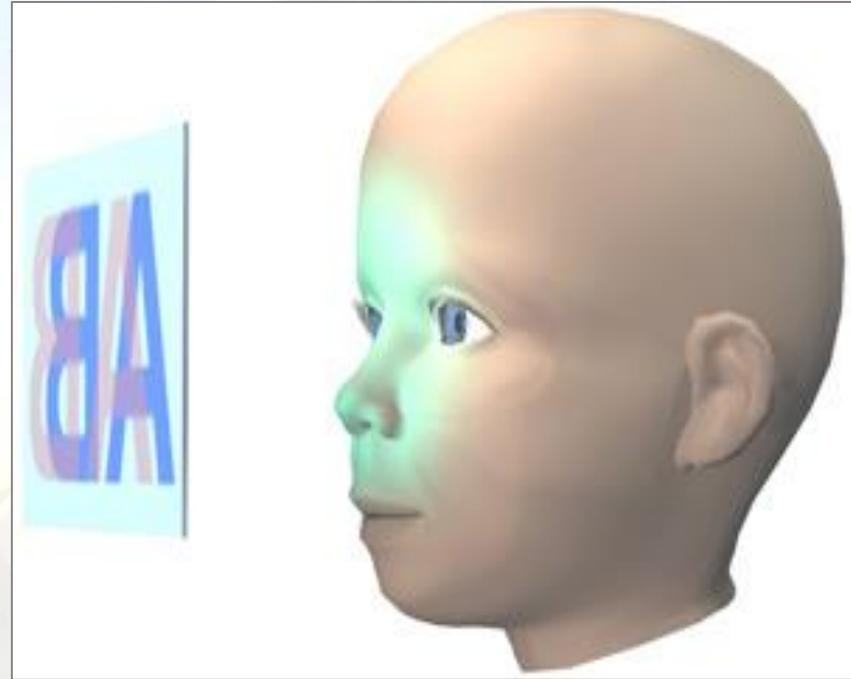


Virtual Reality Systems

- CAVE



VR: Semi-immersive systems



The Model

• • •

Aquisition & modeling.

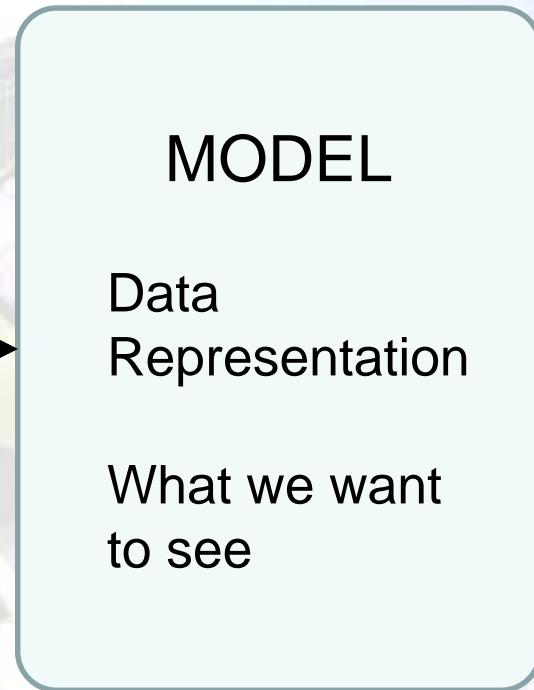
Model



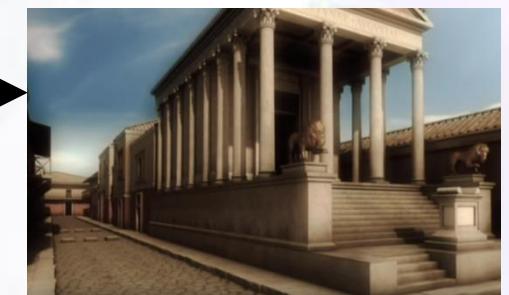
Existent object
Aquisition



Non existent object
or damaged
Modeling



Obtained from reality



Subjective interpretation

Aquisition vs modeling



Existent object

Aquisition

- Data: object points, obtained by sensors.
- Tools: digitalization
- Semi-automatic: “photography”



Obtained from the reality



Non existent object
or damaged

Modeling

- Data: maps, sketches, text... interpreted by an expert.
- Tools: modeling 3D
- Proces manual: “repainting”



Subjective interpretation

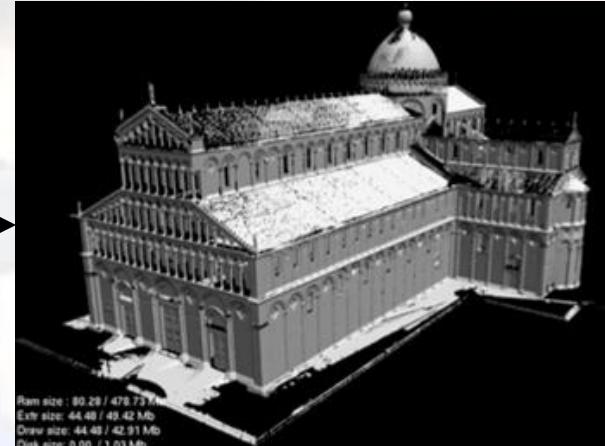
Aquisition vs modeling



Existent object

Aquisition

- Require acces to the object (field work)
- 3D Model sometimes incomplet
- Measurable resultant model



Obtained from the reality



Non existent object
or damaged

Modeling

- Applicable to non existent objects
- Compare different historical hypotheses
- 3D Model often complete
- Result non measurable



Subjective interpretation

Aquisition (digitization, scanning)

3D Aquisition



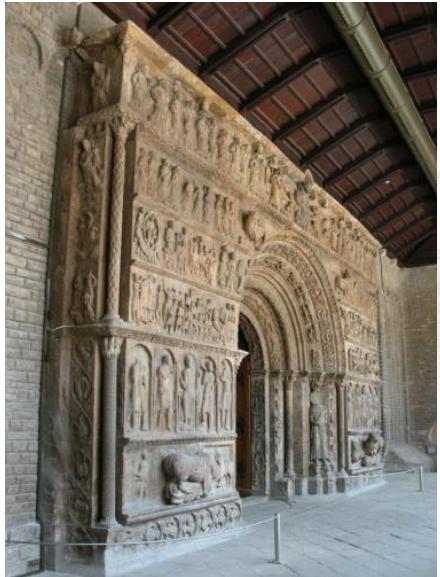
Real object

3D Model

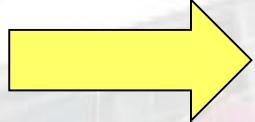
Aquisition - Ripoll



Aquisition



Adquisició



12 x 7 metres
62 escanejats
200 fotos

Dades sense
tractar

Registre



172 M triangles

Malla
Alta resolució
Sense reparar

Repació
Model



Visualització

Representació
Diferents
Details

Simplificació

Malla
Alta resolució
Reparada

Photography reconstruction

1. Taking photos



Photography reconstruction

1. Taking photos
2. Find & assign features
3. Camera positions + 3D points
4. Points and grid reconstruction

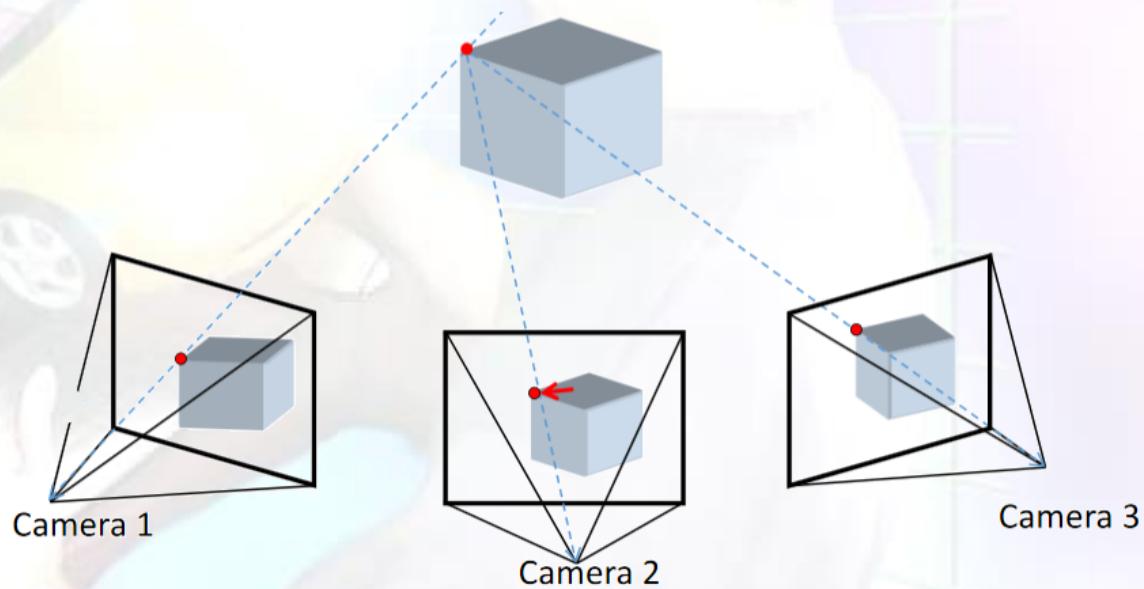


Photography reconstruction

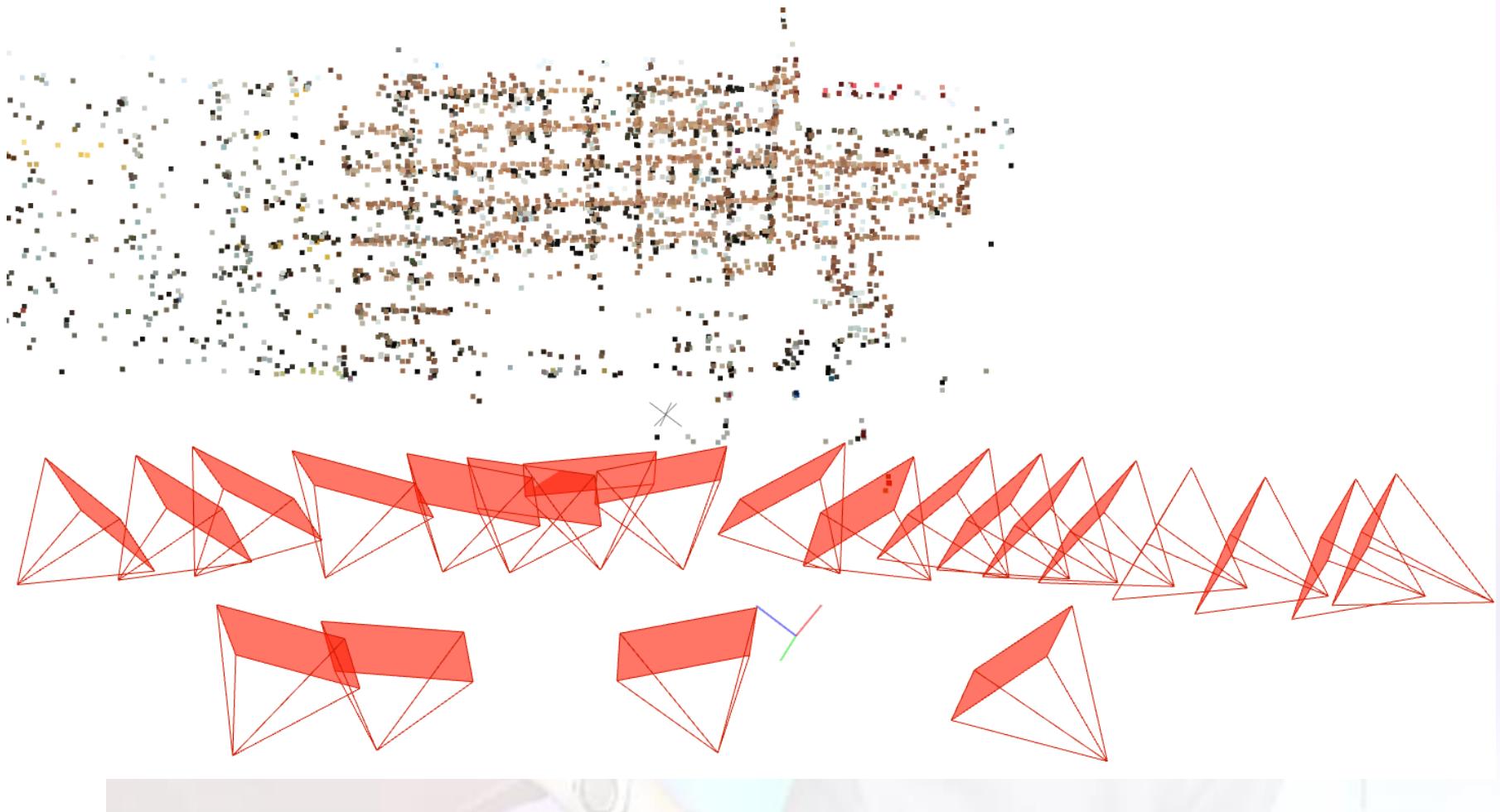


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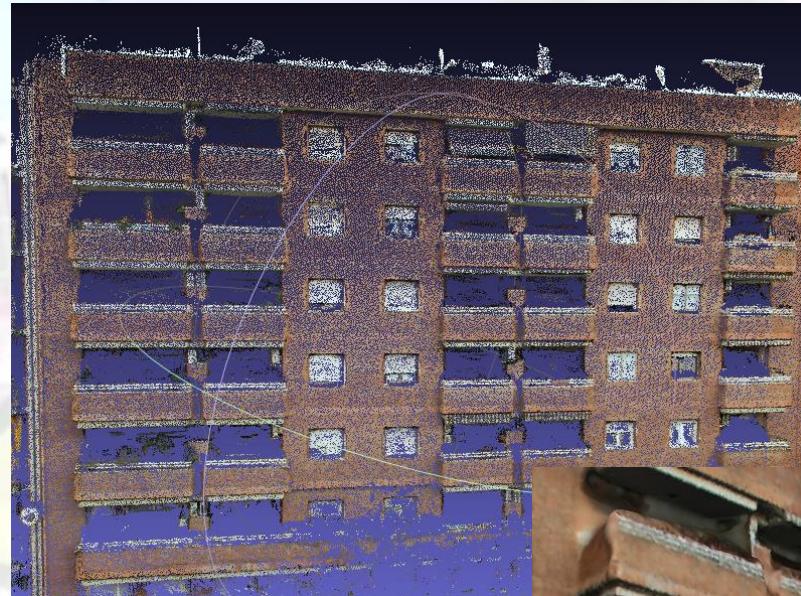


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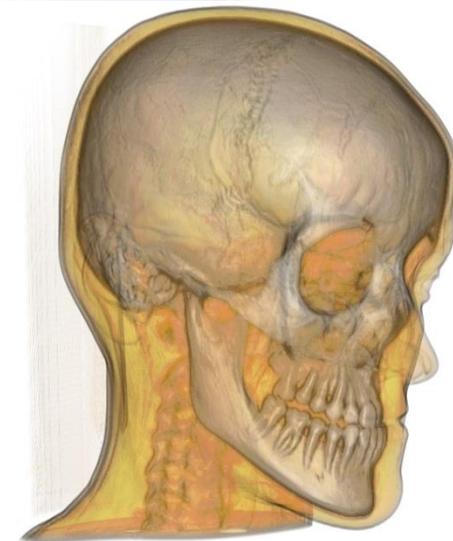
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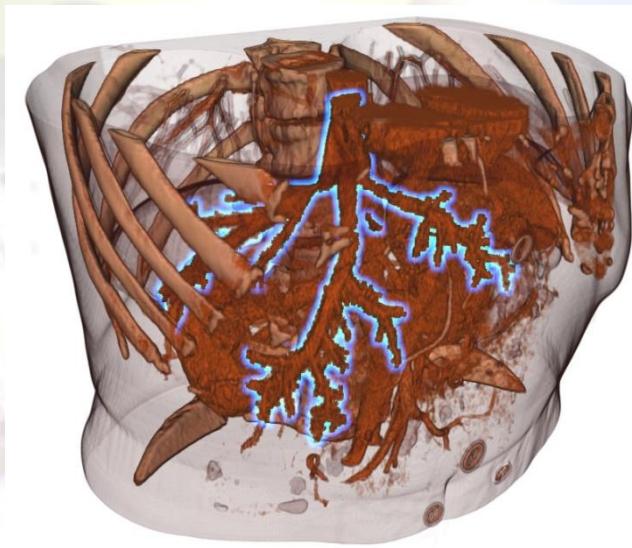
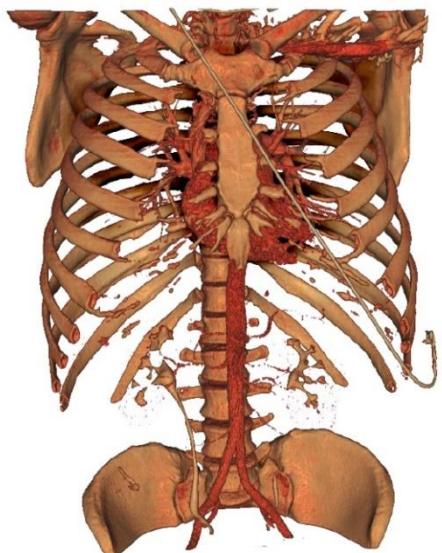
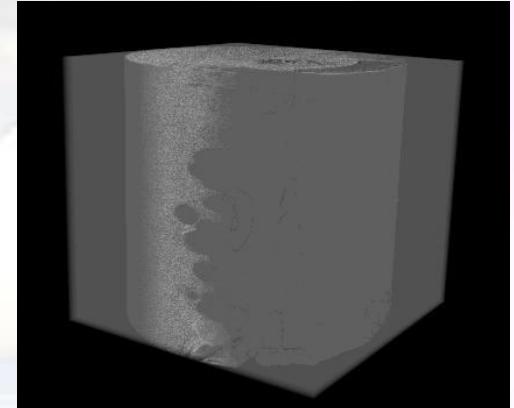
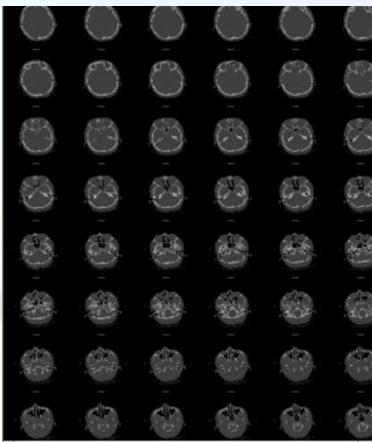
Aquisition (medical data)



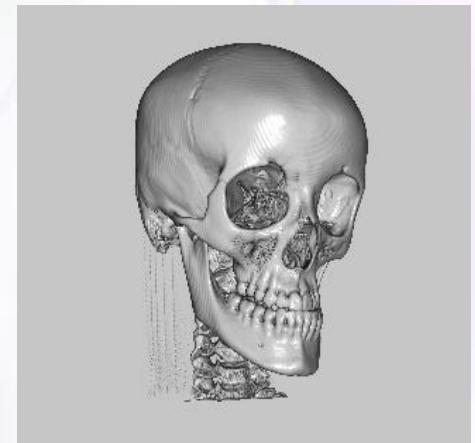
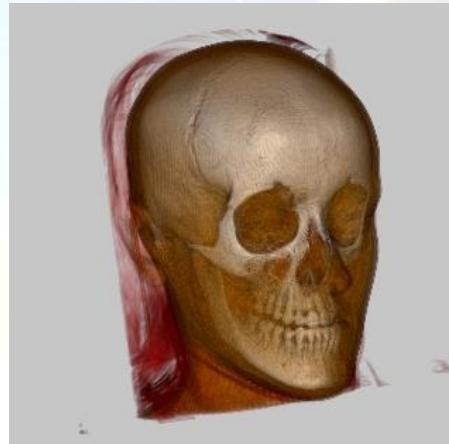
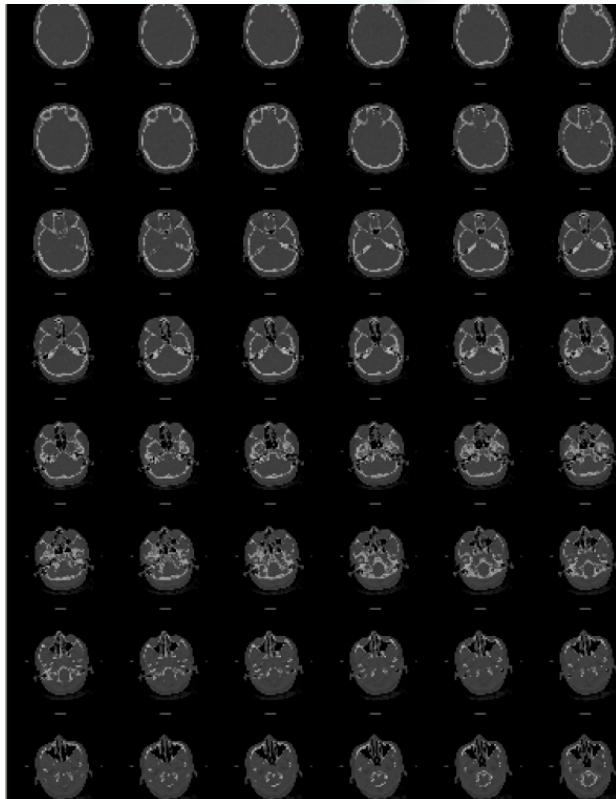
CT, MRI, ...



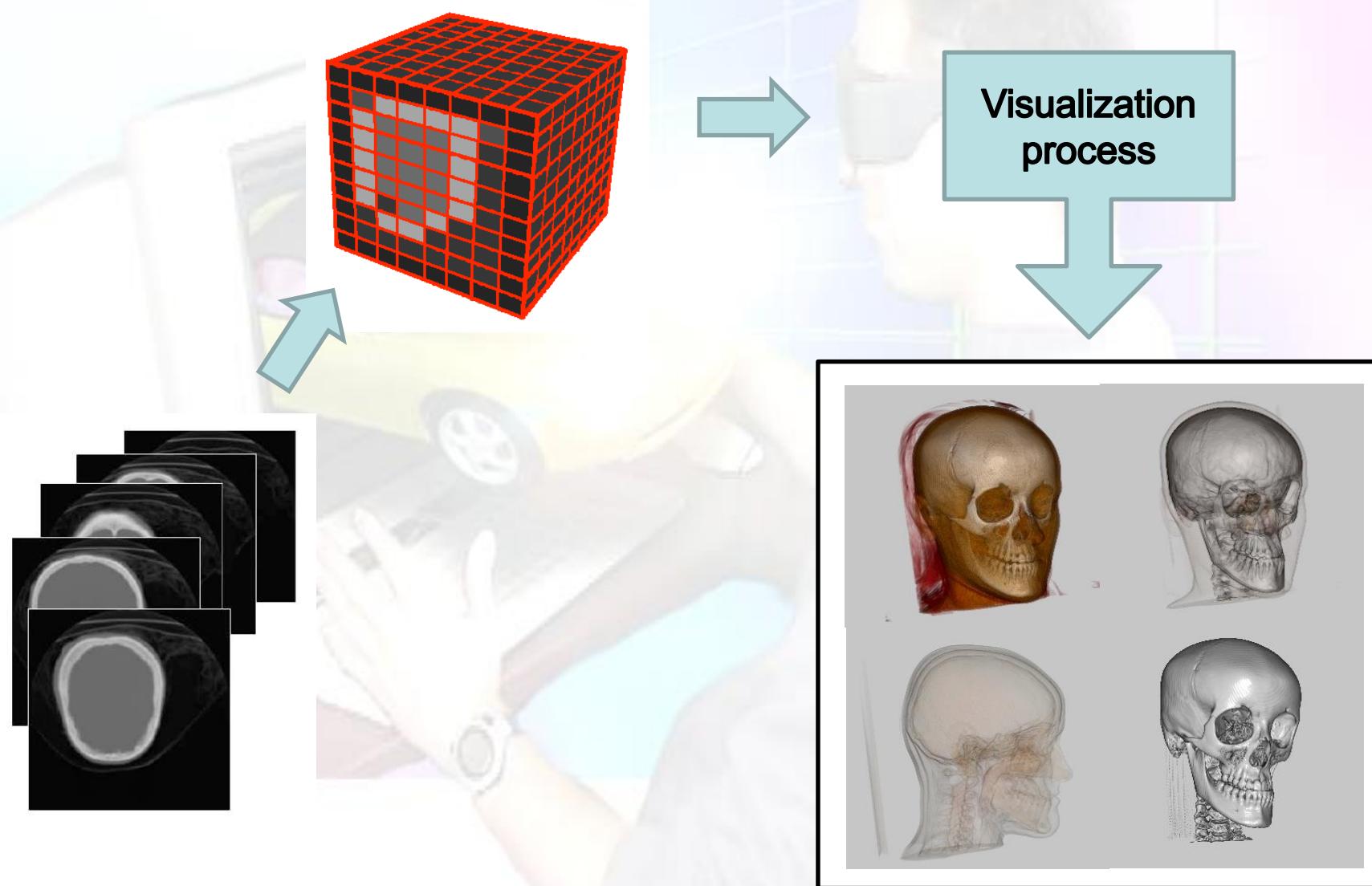
Aquisition in medicine: Volume Rendering



Volume Rendering



Volume Rendering



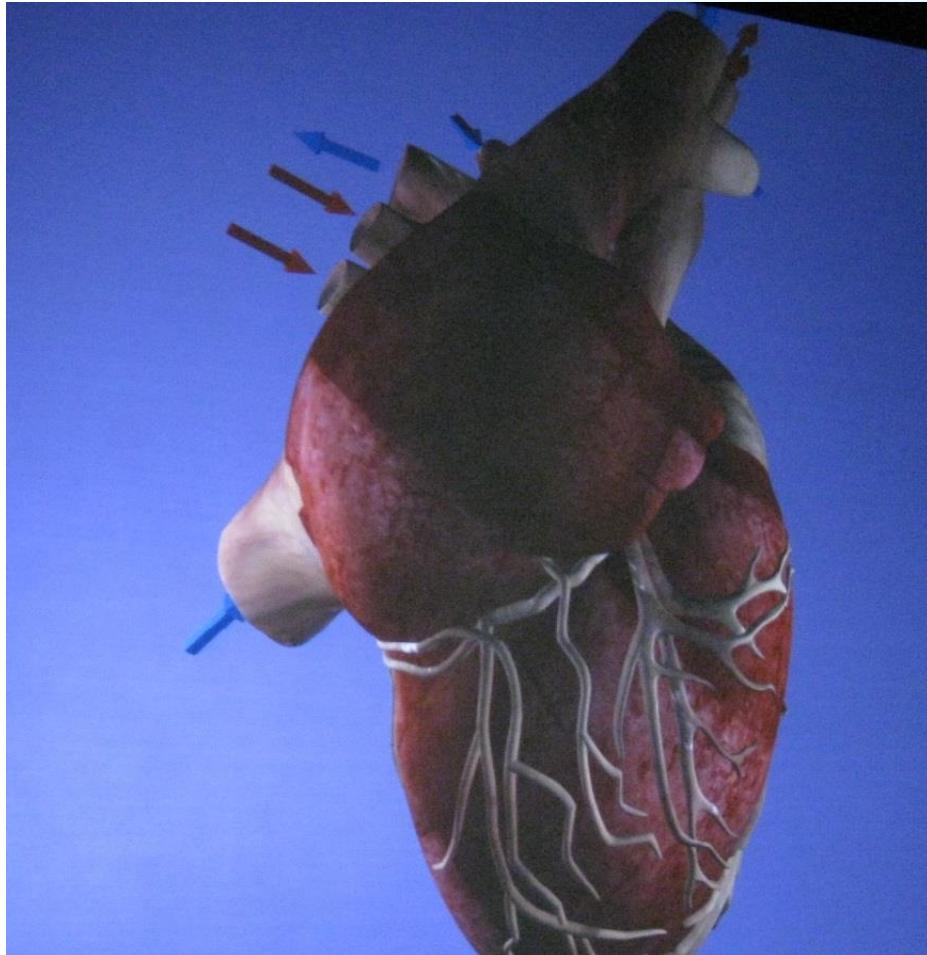
Modeling



Geometrical model:

- Wireframe representation
- Procedural
- CSG
- Octrees
- ...

Modeling



Geometrical model:

- Wireframe representation
- Triangles



Challenges Advanced applications

...

Real-time, visualization and perception.



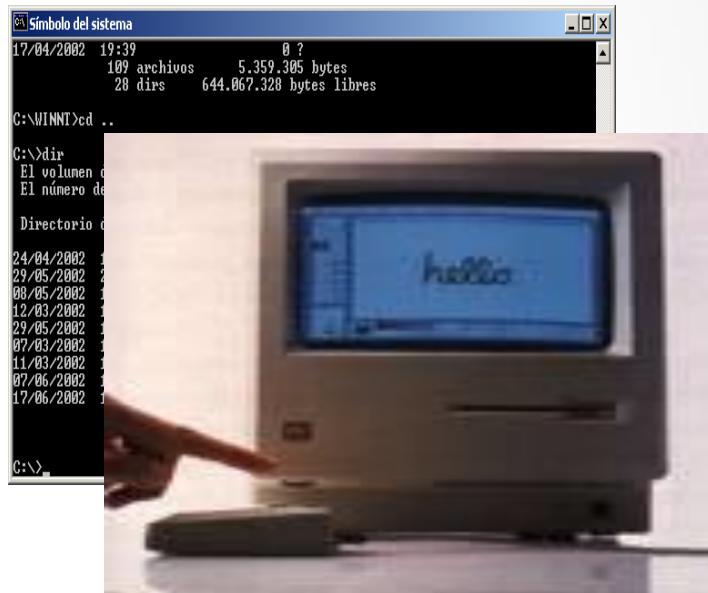
¿What's given by Virtual Reality?

- Interactive simulation + implicit interaction + immersion.



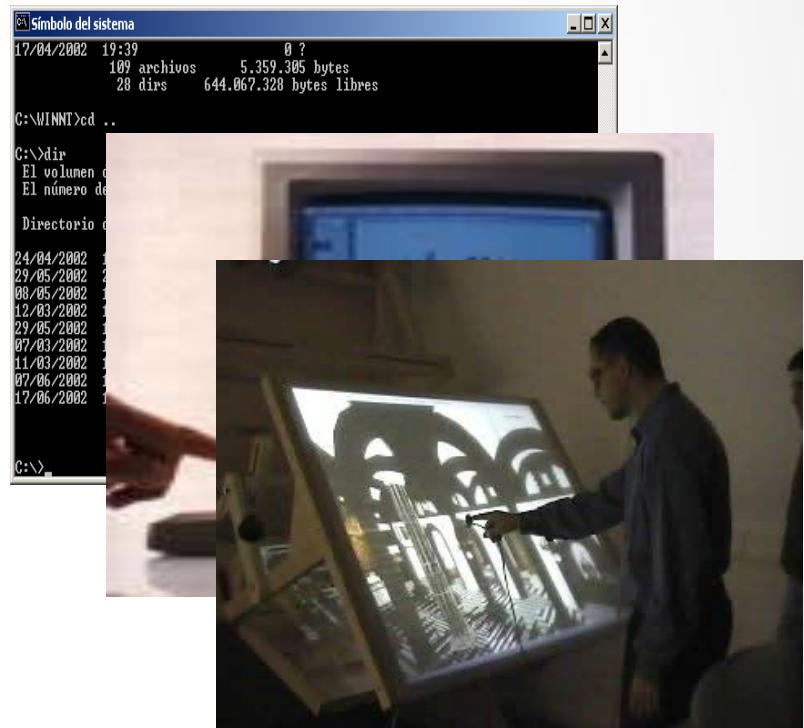
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¿What's given by Virtual Reality?

- Interactive simulation + implicit interaction + immersion.
- Revolution in the field of the interaction human-computer.
- Applications in industry, medicine, architecture, education, art...



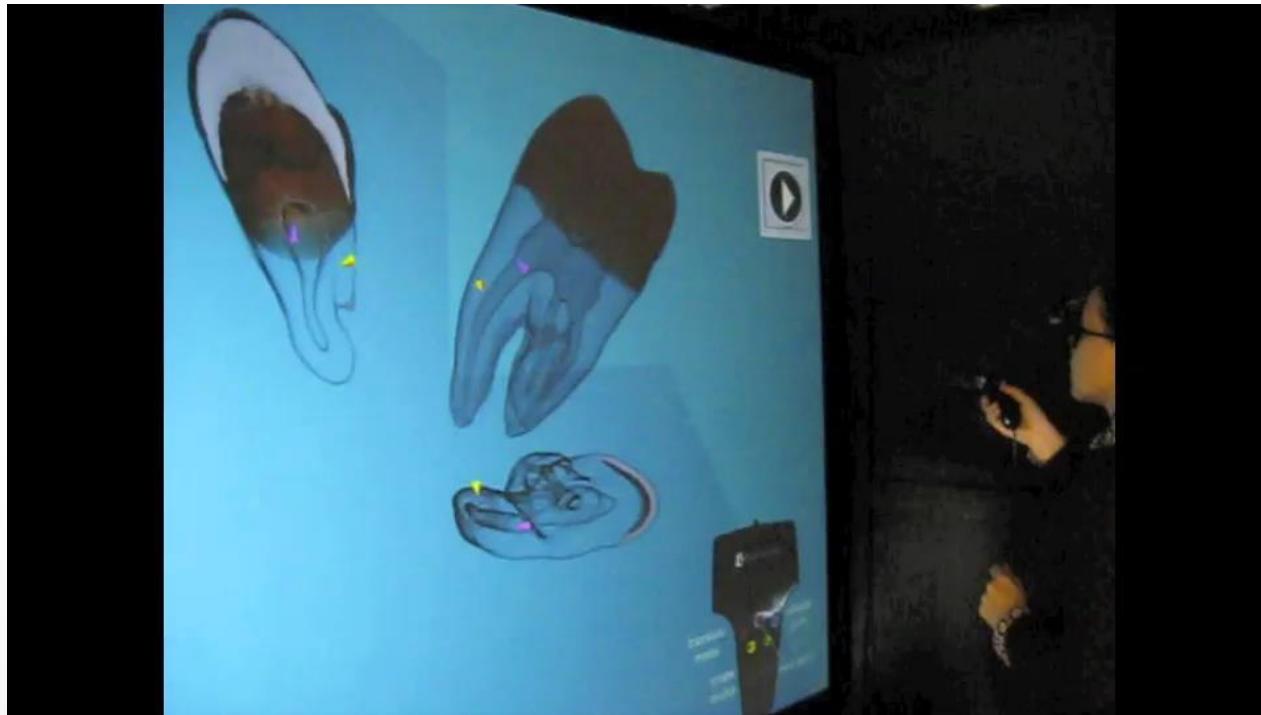
¿What's given by Virtual Reality?

- Interactive simulation + implicit interaction + immersion.
- Revolution in the field of the interaction human-computer.
- Applications in industry, medicine, architecture, education, art...
- Growing discipline



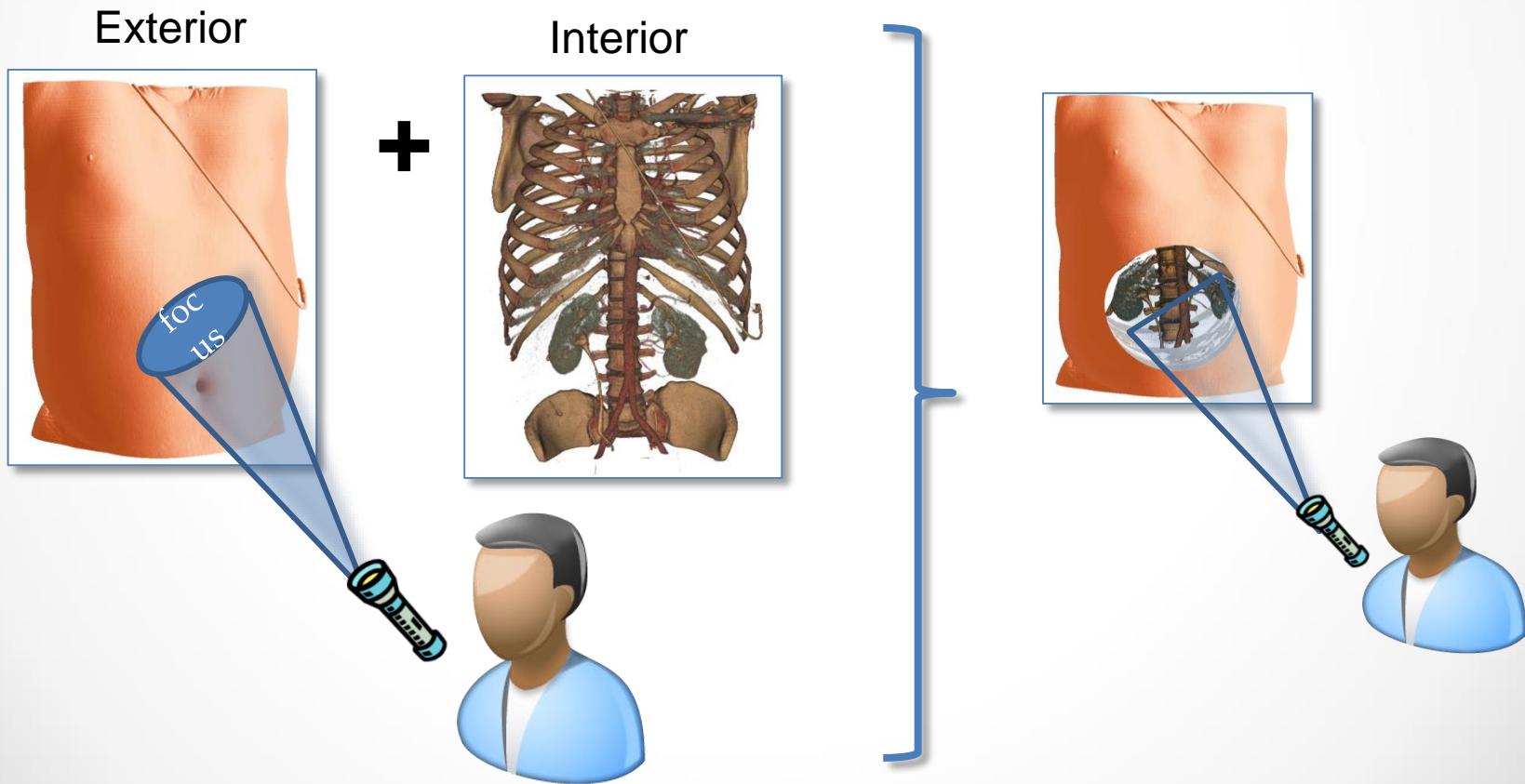
Applications in medicine

- Visualization and measure techniques



Applications in medicine

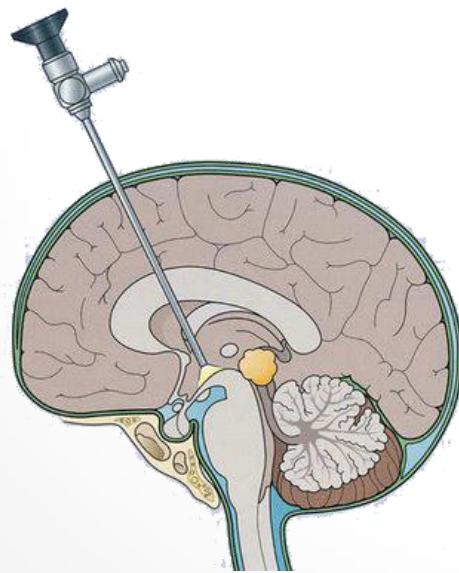
- Visualization and measure techniques



Applications in medicine

- Visualization and measure techniques
- Training and teaching

Ventriculostomy: Neurosurgical procedure for draining a cerebral ventricle.



✗ Visual feedback

✓ Kinesthetic feedback

Ventriculostomy prototype

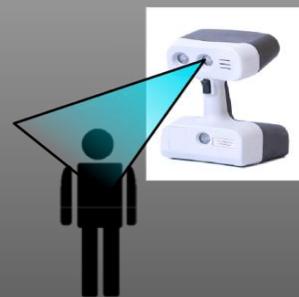


Step 1
Choosing the incision point.

Step II
Performing the surgery.

Step III
Inspecting the trajectory.

DATA ACQUISITION



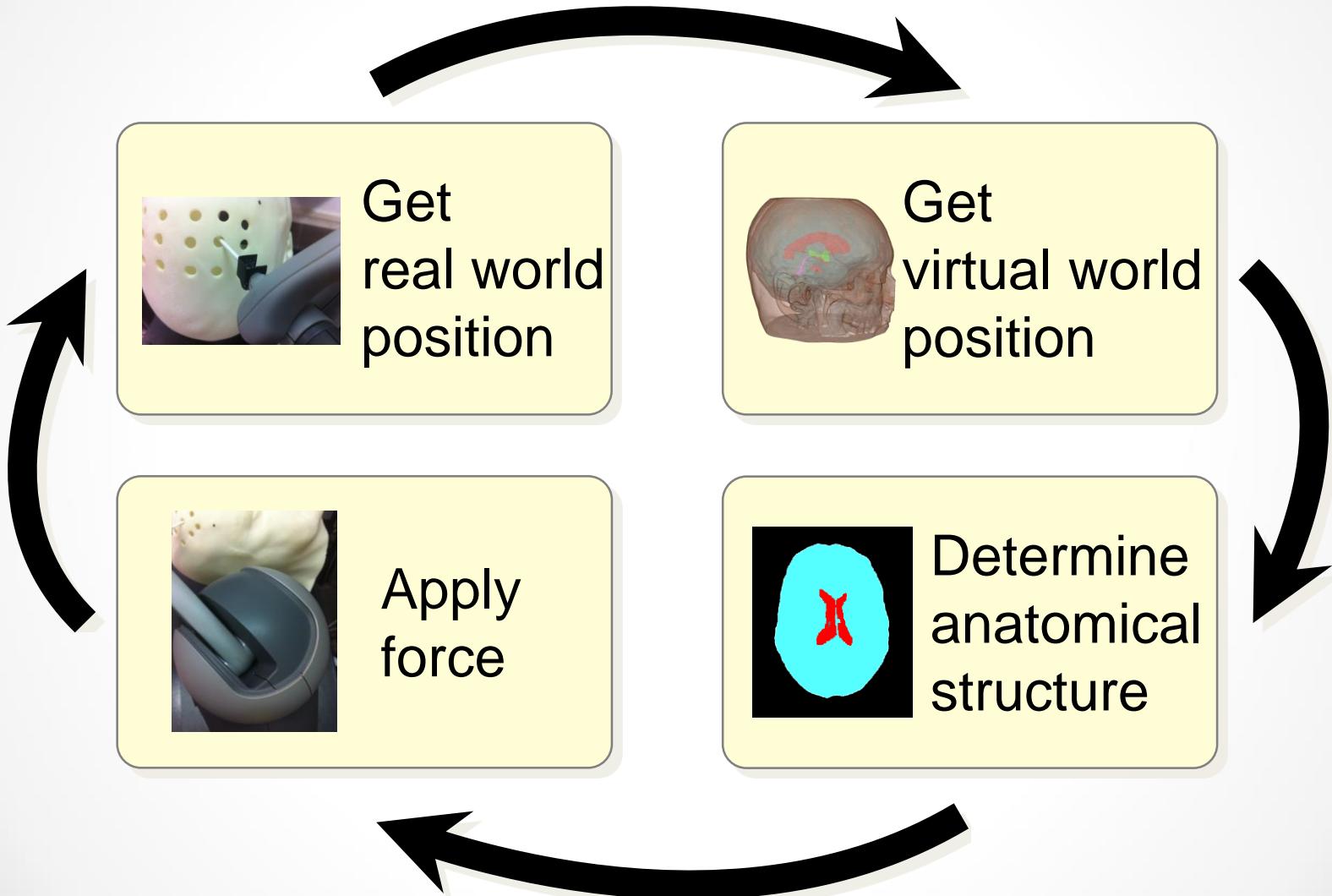
Physical Model



DATA MODEL

Virtual Model





Applications in medicine

- Visualization and measure techniques
- Training and teaching
- Phobias treatment and Patient helping

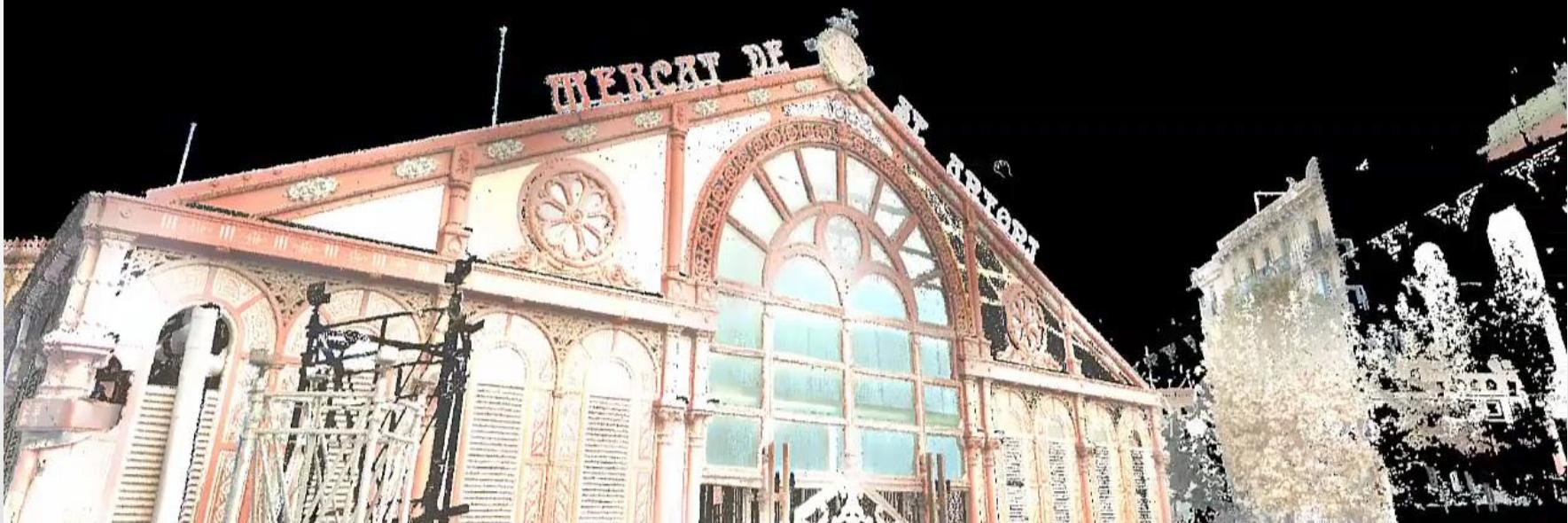


Visualization and Interaction



Visualization and Interaction

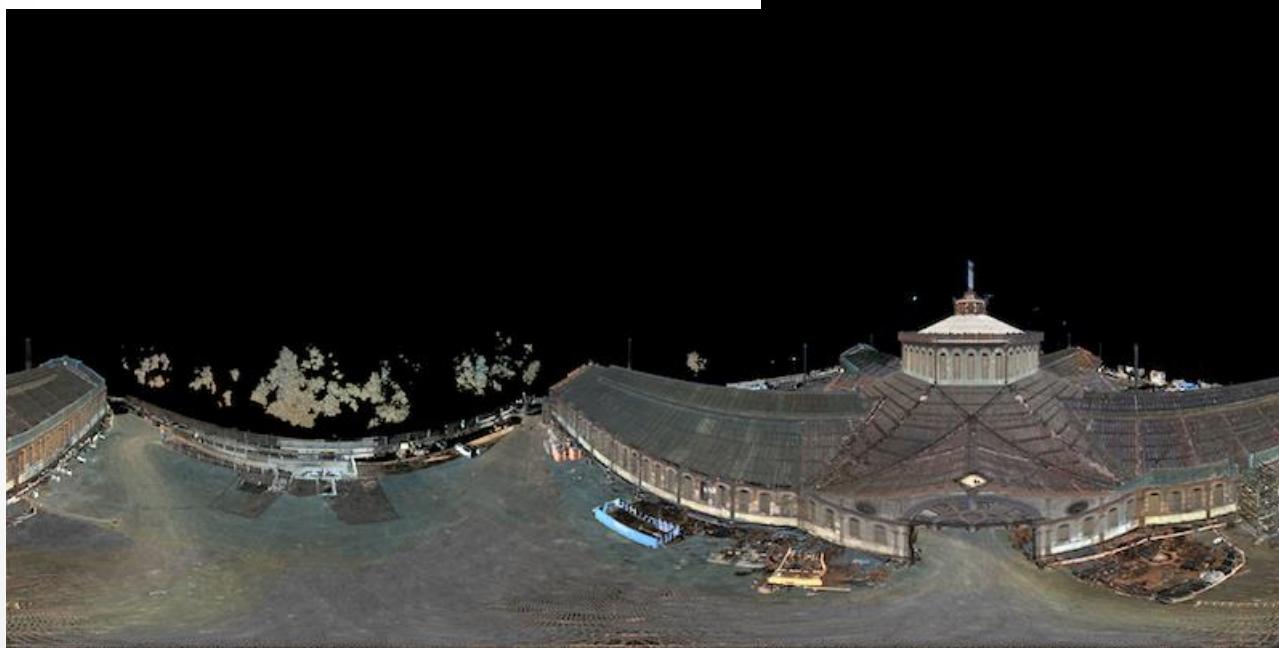
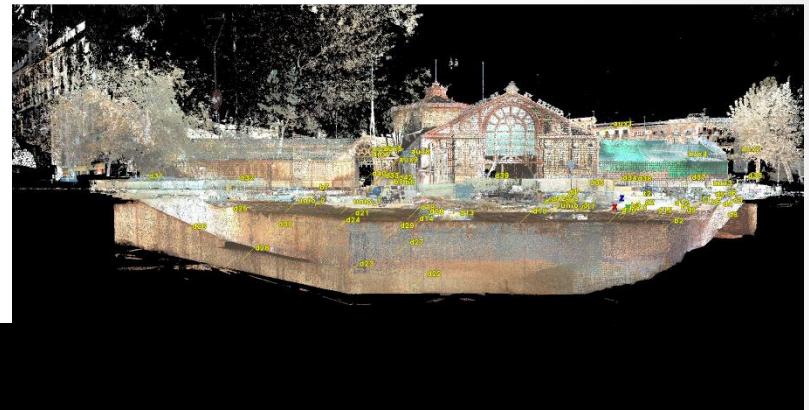
3600 Millions of points



Panoramas

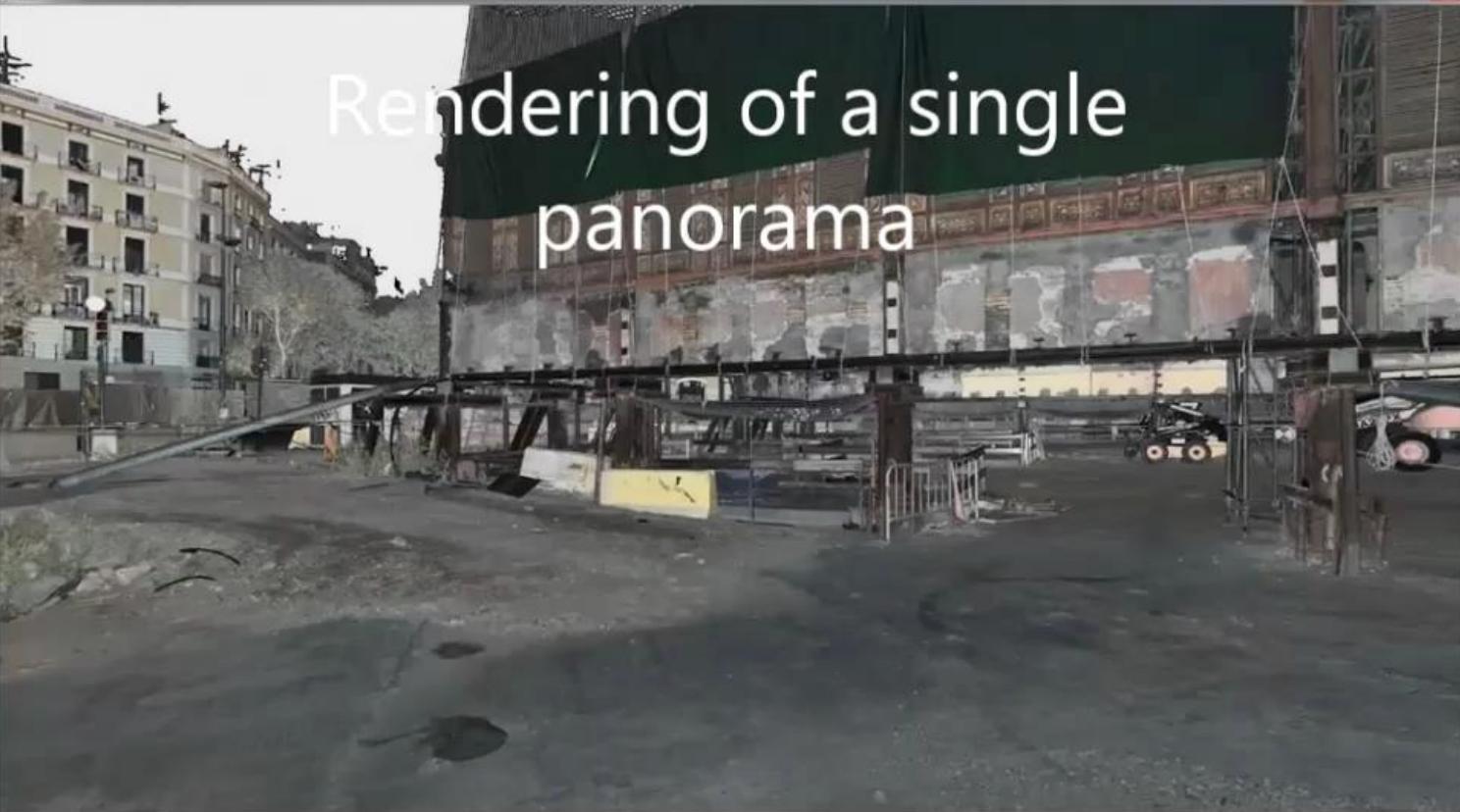


Mercat de Sant Antoni
Generation of panorams of 360°



Panoramas

3600 Millions of points → 30 photos 360



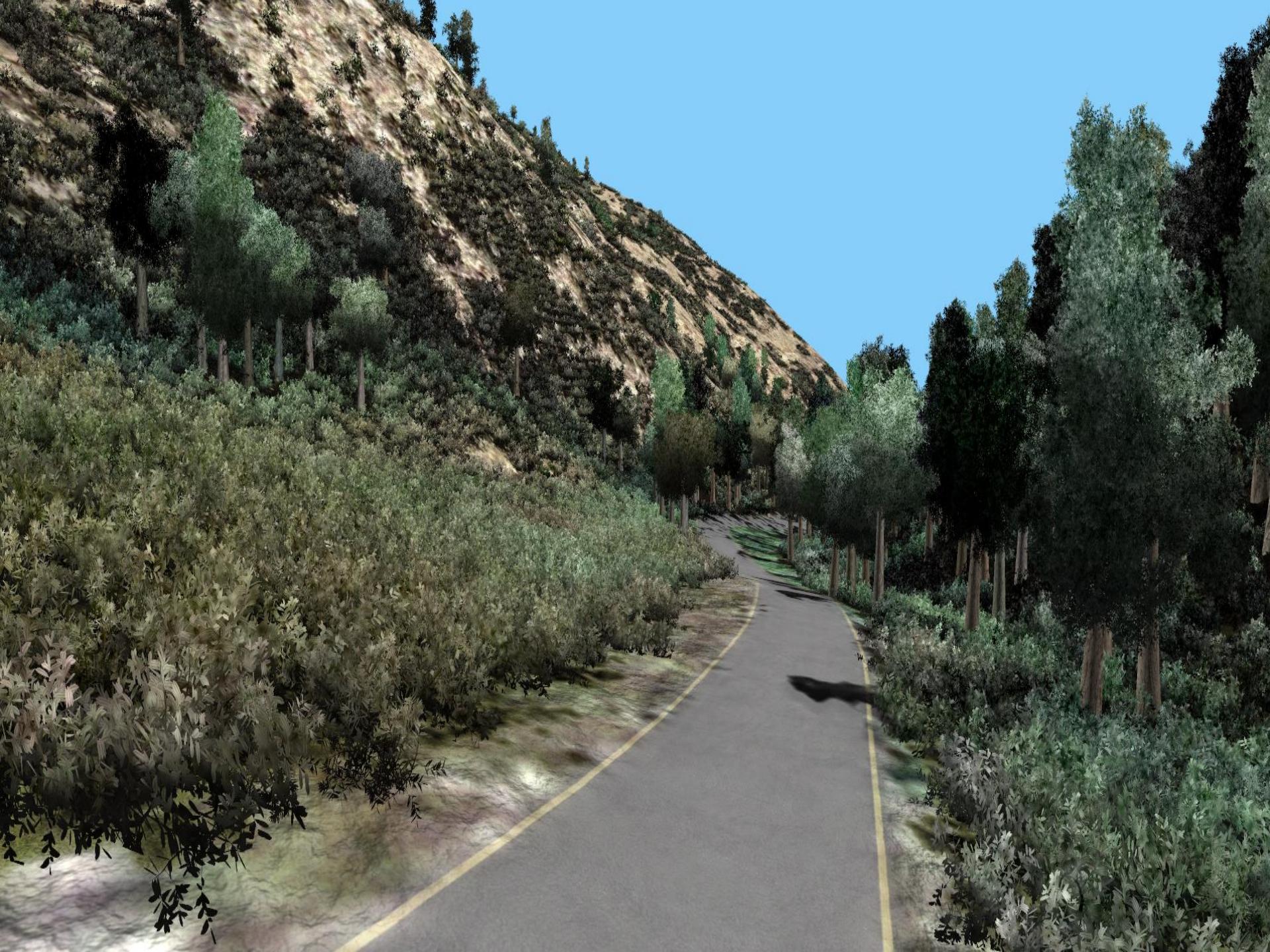
Rendering of a single
panorama

Information & Perception

Visualization of the environment



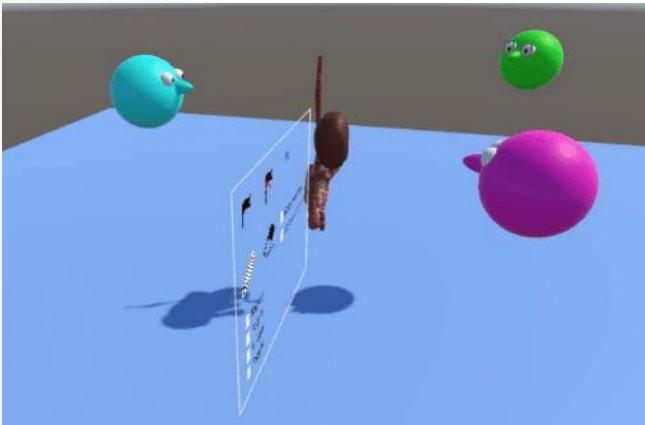


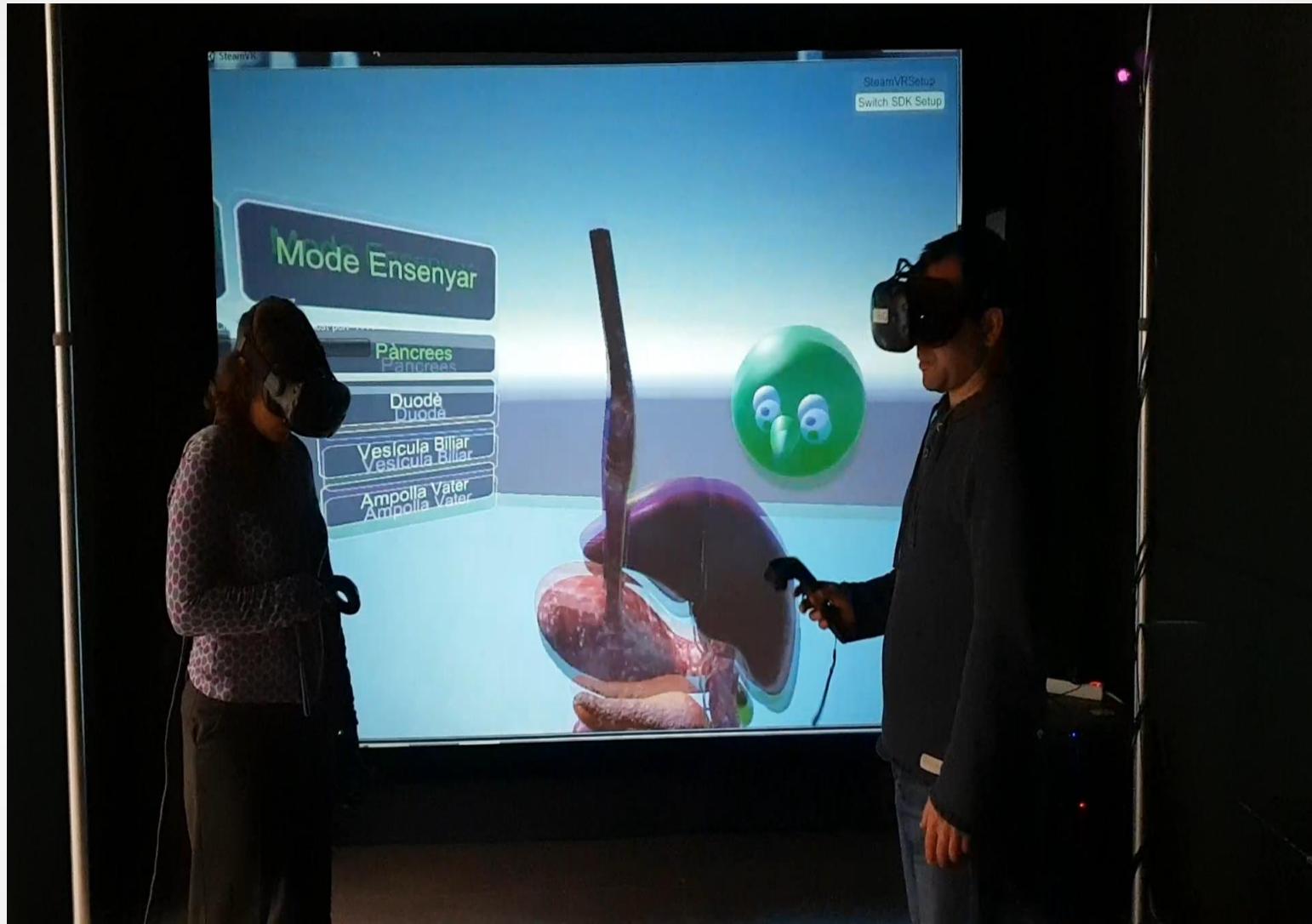


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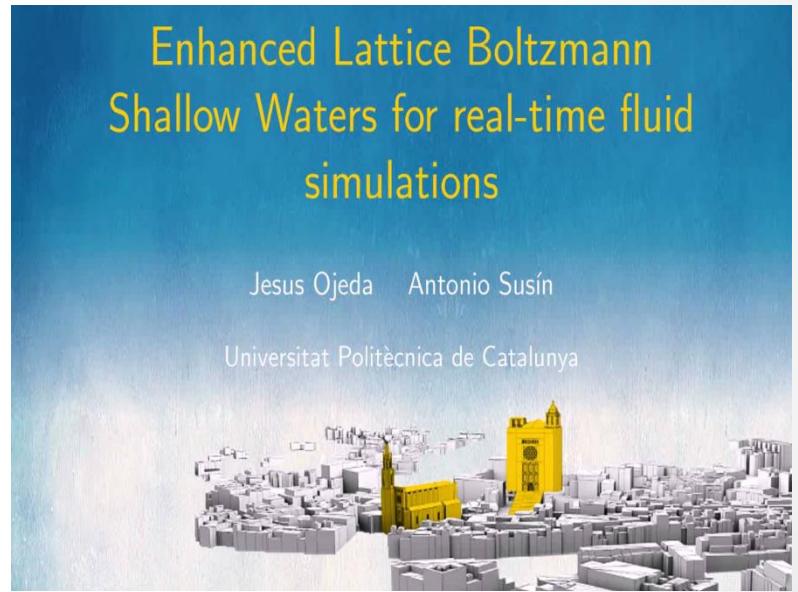


Collaborative environments





Animation



Animation



VIRTUAL REALITY

Arquitecture



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