Professors d'IDI - UPC

Interacció i Disseny d'Interfícies

Continguts

- **Realitat Virtual**
- Augmented Reality

Realitat Virtual

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- Definició A. Rowell:
  - "La Realitat Virtual és una simulació interactiva per computador des del punt de vista del participant, en la qual se substitueix o s'augmenta la informació sensorial que rep".

Realitat Virtual

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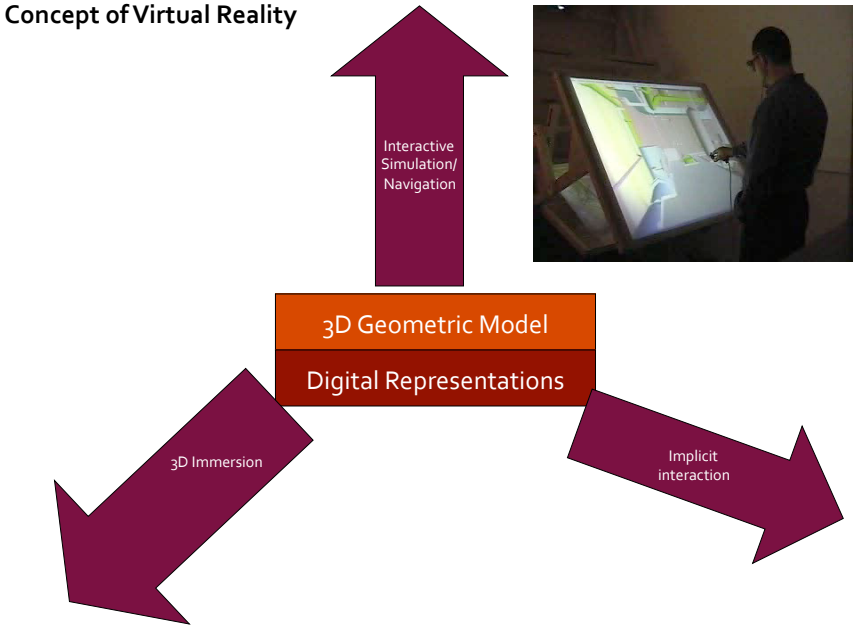
- Elements bàsics que han d'estar presents en qualsevol sistema de realitat virtual:
  - **Simulació interactiva**
  - **Interacció implícita**
  - **Immersió sensorial**

Concept of Virtual Reality



The Virtual Reality

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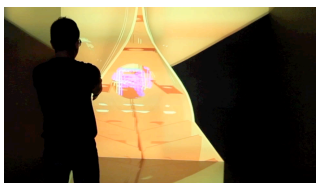
- Interactive Simulation
- Implicit interaction
- Immersion



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

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

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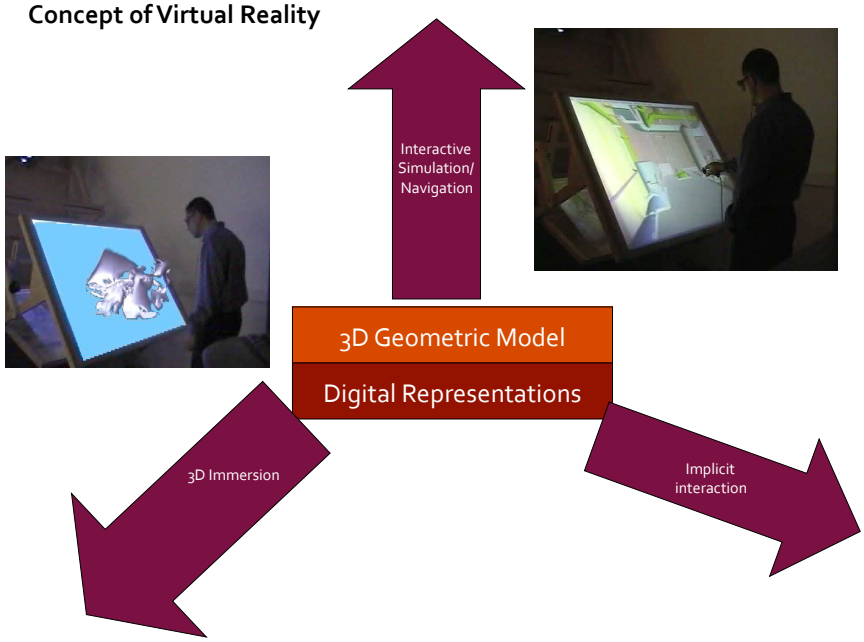
Concept of Virtual Reality



The Virtual Reality

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- Simulation
- 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…

Retinal disparity

Difference in the L/R images of an object due to the eyes' horizontal separation

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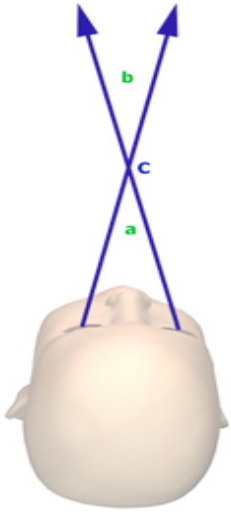
Retinal disparity: zero



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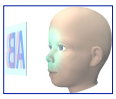
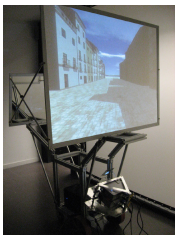
The Virtual Reality

- Immersive systems



Semi-immersive systems



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The Virtual Reality

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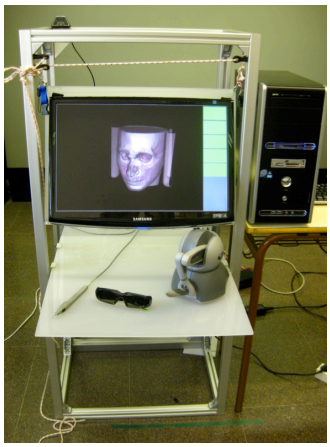
Realitat Virtual



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Realitat Virtual

Ventricular Puncture Trainer

Paper ID: 1034

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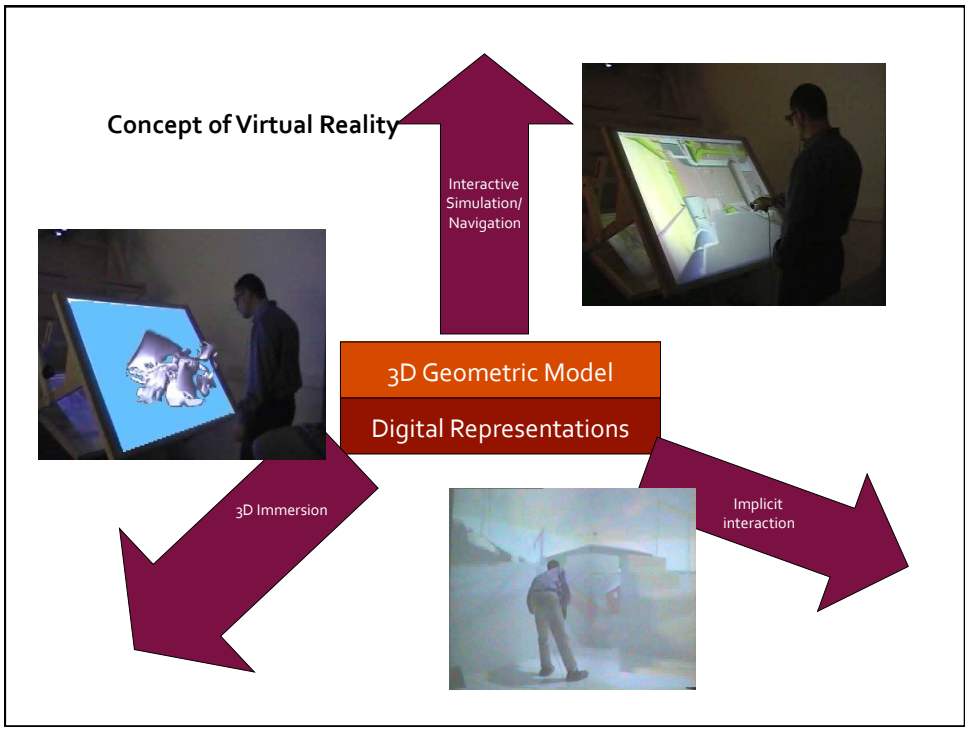
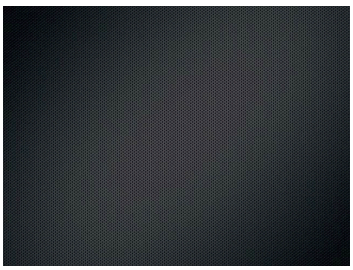


The Virtual Reality

- Simulation
- 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**

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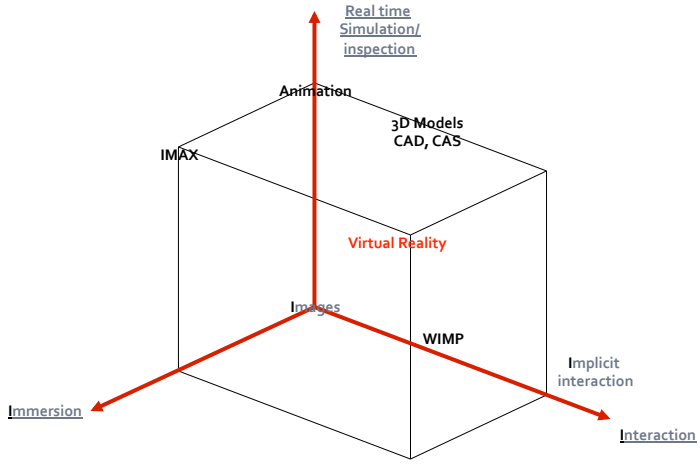
The Virtual Reality



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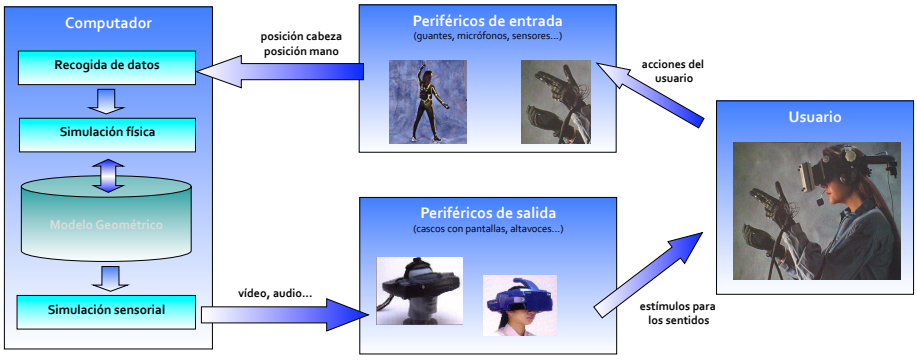
Architecture of the Virtual Reality systems

- Actualization frequency
- Latency time



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Realitat Virtual

- **Perifèrics d'entrada (sensors)**
  - Capturen les accions del participant i envien aquesta informació al computador.
    - posicionadors
    - guants
    - micròfons

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Realitat Virtual

- **Computador**
  - Realitza la simulació interactiva, basant-se en el model geomètric 3D i en el programari de recollida de dades, simulació física i simulació sensorial.
  - És el procés més crític en realitat virtual
- **Model geomètric 3D**
  - Permet fer els càlculs d'imatges, generació de so espacial, càlcul de col·lisions, etc.

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Realitat Virtual

- **Perifèrics de sortida (efectors)**
  - S'encarreguen de *traduir els senyals d'àudio, vídeo, etc. generats pel computador en estímuls pels òrgans dels sentits* (so, imatges, etc.).
    - **Visuals** (cascos estereoscòpics, pantalles...)
    - **Àudio** (sistemes de so, altaveus)
    - **Força i tacte** (dispositius tàctils)
    - **Equilibri** (plataformes mòbils).

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Realitat Virtual

- **Programari de tractament de dades d'entrada**
  - Llegeixen i processen la informació que proporcionen els sensors. Això inclou els controladors dels dispositius físics, i també els mòduls pel primer tractament de les dades subministrades.
- **Software de simulació física**
  - S'encarreguen de les modificacions pertinents en la representació digital de l'escena, a partir de les accions de l'usuari i de l'evolució interna del sistema.

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Realitat Virtual

- **Software de simulació sensorial**
  - S'encarreguen de calcular la representació digital de les imatges, sons, etc. que el maquinari s'encarregarà de traduir a senyals i finalment a estímuls pels sentits.
  - El més important és el de **simulació visual**
  - La **simulació auditiva** requereix tenir en compte les propietats acústiques les objectes. És tan complicada com la visual.
  - **Simulació tàctil**:
    - Sensació de tacte (sovint limitada a la mà),
    - Sensació de contacte (també limitada a la mà)
    - Realimentació de força (impedeixen o ofereixen resistència a fer moviments amb la mà en les col·lisions).
    - Detecció en temps real de les col·lisions

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Realitat Virtual

- 3D **no** és Realitat Virtual:
  - RV implica 3D
  - 3D no implica RV
- Realitat Virtual no implica presència:
  - Presència: Sensació **d'estar allà**
    - El participant "oblida" que la simulació la veu utilitzant tecnologia

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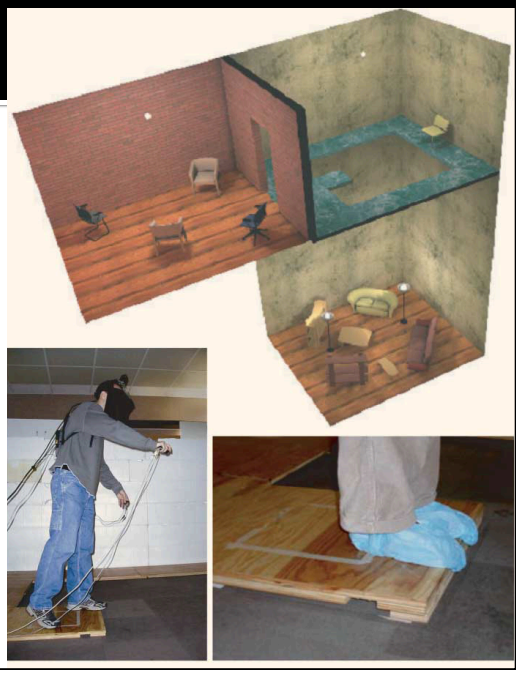
Realitat Virtual

- Presència



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Continguts

- Realitat Virtual
- **Augmented Reality**

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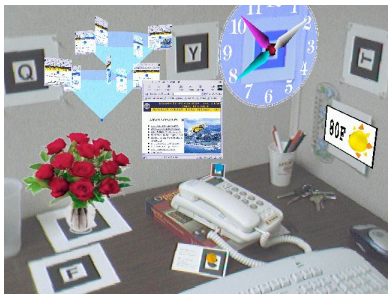
Introduction to AR

- Augmented Reality is a combination of a **real scene** viewed by a user and a synthetic **virtual scene** that augments the scene with additional information.
- AR environments differ from VEs in that we have access to both real and virtual objects at the same time.

Goal of AR

- Goal: enhance user **performance** and **perception** of the world.
- Challenge: keep users from **perceiving the difference** between the real world and the virtual augmentation of it.



Augmented Reality

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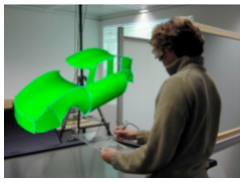
AR applications

- Archeology
- Entertainment

- Engineering design
- Consumer design



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Augmented vs Virtual Reality

Augmented Reality

- System augments the real world scene
- User maintains a sense of presence in real world
- Needs a mechanism to combine virtual and real worlds

Virtual Reality

- Totally immersive environment
- Visual senses are under control of system (sometimes aural and proprioceptive senses too)

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Augmented Reality

- The importance of object registration:
  - The computer generated virtual objects must be **accurately registered** with the real world in all dimensions.
  - Errors in this registration will prevent the user from seeing the real and virtual images as fused.
  - The **correct registration** must be maintained while the user moves about within the real environment.
  - Discrepancies or changes in the apparent registration will range from distracting (difficult to work with), to physically disturbing (unusable system).

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Augmented Reality

- There are basically three ways to visually present an augmented reality.
  - **Video see-through:** the virtual environment is replaced by a video feed of reality and the AR is overlaid upon the digitised images
  - **Optical see-through:** Leaves the real-world perception alone but displays only the AR overlay by means of transparent mirrors and lenses.
  - **AR projection** onto real objects.

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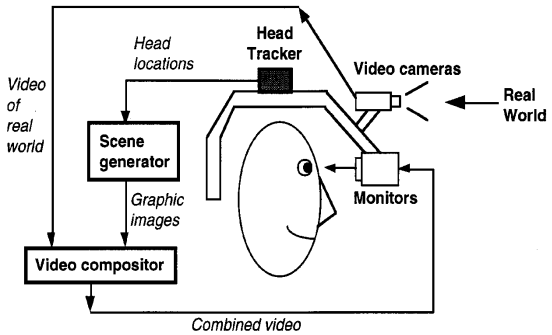
Video see-through HMDs

- Video see-through
  - Use closed-view HMDs.
  - Combine real-time video from head-mounted cameras with virtual imagery.



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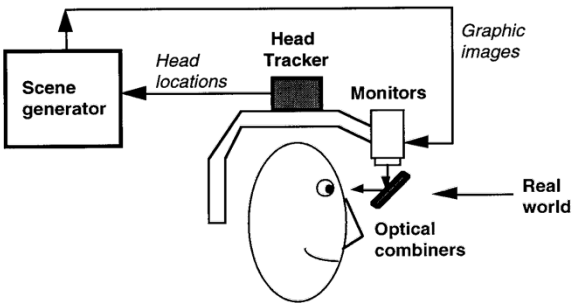
Optical see-through HMDs

- The user sees the real world **directly**
- Make use of optical combiners:
  - Half-silvered mirrors (partially transparent, partially reflective)
  - Transparent LCD



Optical see-through HMDs

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Augmented Reality

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Optical vs video see-through

Fixed focal length problem:
- **Video see-through**: real and virtual objects focused at the same distance.
- **Optical see-through:** real objects and virtual objects are sensed at different depths → the eyes are forced to either **continuously shift focus** between the different depth levels, or perceive one level as unsharp.

Calibration:
- **Video see-through**: graphics can be integrated on a pixel-precise basis.
- **Optical see-through:** require **difficult calibration** (user- and session-dependent) and precise head tracking to ensure a correct overlay.

Occlusion effects between real and virtual objects:
- **Video see-through:** well supported
- **Optical see-through**: **incapable of providing consistent occlusion effects**. To solve this problem, Kiyokawa et al. [79] use additional LCD panels to selectively block the incoming light from real objects.

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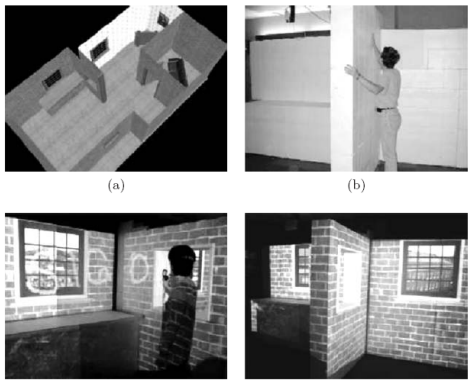
Projection-based spatial displays

- Images are projected directly into physical objects.
- Single static, single steerable or multiple projectors.



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Augmented Reality

- Projective displays. Advantages:
  - They do not require special eye-wear
    - Eye accommodation not required
  - They can cover large surfaces for a wide field-of-view

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Augmented Reality

- Projective displays. Disadvantages:
  - Projectors need to be calibrated each time the environment or the distance to the projection surface changes (crucial in mobile setups).
    - Fortunately, calibration may be automated
  - Limited to indoor use only due to low brightness and contrast of the projected images.
  - Occlusion or mediation of objects is also quite poor.