Collaviz®

An Asymmetric 2D Pointer / 3D Ray for 3D Interaction within Collaborative Virtual Environments

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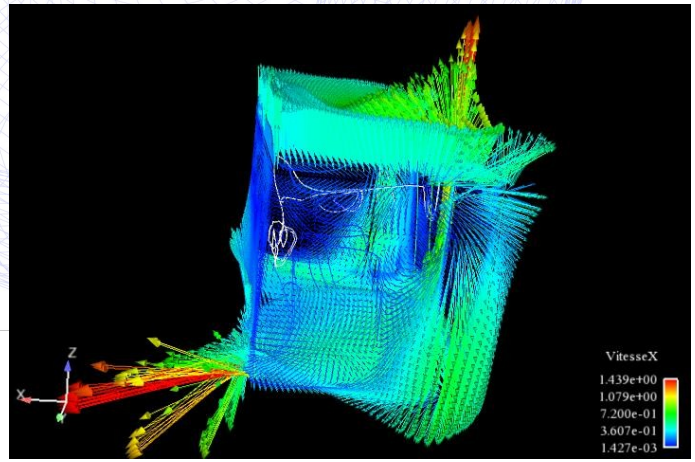
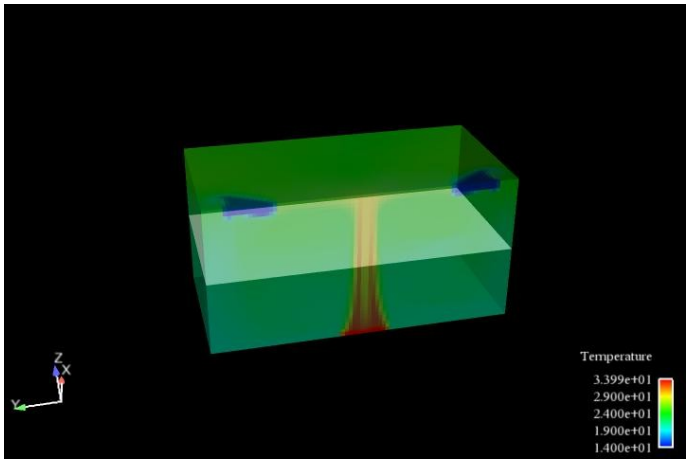
Introduction

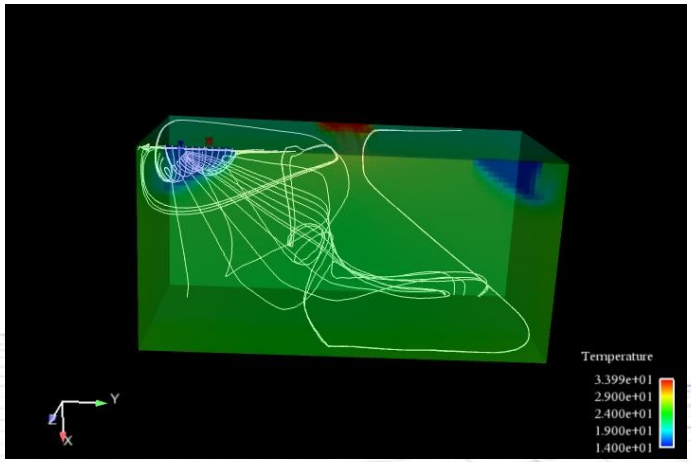
- There were 2 projects funded by the ANR (French National Research Agency) :
  - Part@ge : Virtual Reality project about technical collaborative 3D interaction
  - SCOS – V3D : 3D web oriented project about collaborative visualization of 3D scientific data
- ANR asked them to work together :
  - Two different communities had to meet and understand each other
  - They nearly succeeded ;-)
    - We showed yesterday a demo as a result of this work
    - We still work together through the CollaViz project

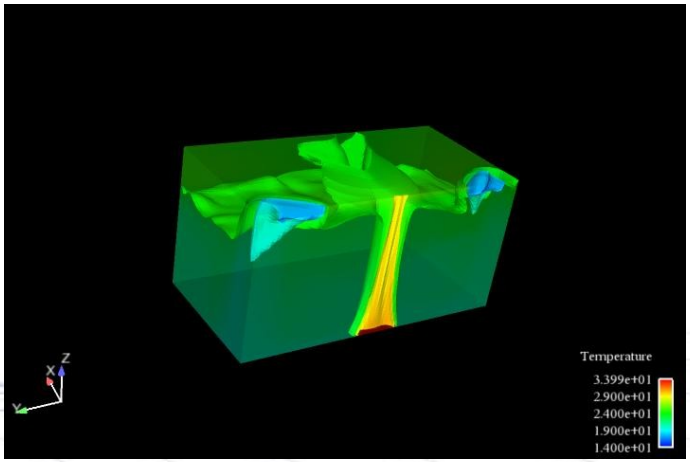
Context

- 3D VR for Collaborative Scientific Visualization









Users' background

- Our end-users are used to :
  - Scientific Visualization
  - Complex 2D interaction
    - With a “classical” 2D mouse

- But our end-users are not used to :
  - Virtual Reality
  - 3D interaction
    - Especially with “exotic” input devices
  - Computer Supported Collaborative Work

Users' requirements

- Early “2D” requirements :
  - Several “2D” cursors
    - One for each user
  - Each other user's 2D cursor must be visible
- 3D requirements :
  - Several viewpoints
    - One for each user...
  - Each other user's 3D viewpoint must be visible
    - Each viewpoint can have a 3D “avatar”
  - 3D interactions that could remain the same :
    - With different kinds of physical displays
    - With different kinds of physical input devices

The problems to solve

- Seeing other users' 2D pointers :
  - Easy and useful if users share a common viewpoint
  - Useless otherwise
- Providing 3D interactions with a 2D like input Device :
  - Need to make some interpretation of the 2D inputs for 3D translations and 3D rotations
- Adapting to different kinds of physical environments for display and input devices
  - Need to provide a 2D logical input device

Related work

- Making users aware of other users' 3D actions
  - To understand collaboration [Gutwin and Greenberg 1998][Fraser et al. 1999][Fraser et al. 2000]
  - Avatars for users
  - Visualization of the other users' :
    - viewing frustums
    - interaction tools
    - gestures

Related work

- 3D interaction tools and techniques
  - Virtual 3D cursor [Zhai et al. 1994]
  - Aperture based selection [Forsberg et al. 1996]
  - One-eyed cursor [Ware and Lowther 1997]
  - 3D Virtual Ray [Bowman and Hodges 1997]
  - Ray-casting technique [Poupyrev et al. 1998]
  - And many others [Bowman et al. 2004]

- Many of these egocentric metaphors are well suited for collaboration thanks to their graphical visualization

The ideas

- Provide to users a logical input device :
  - As easy to use as a 2D mouse
  - Able to provide 6 DOF interactions
  - Able to deal with several physical input devices

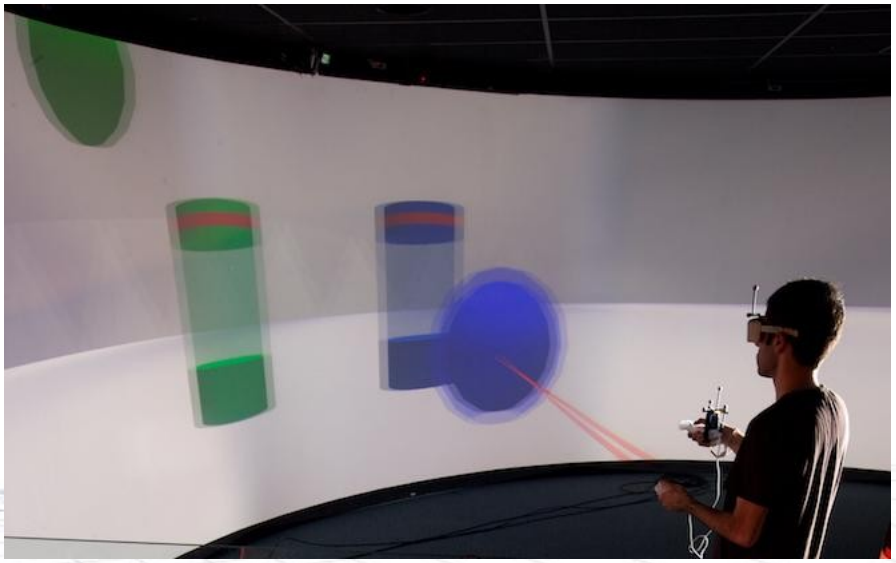
- Make the other users aware of the 3D interactions :
  - By providing a 3D representation of this logical input device

Combining well known tools

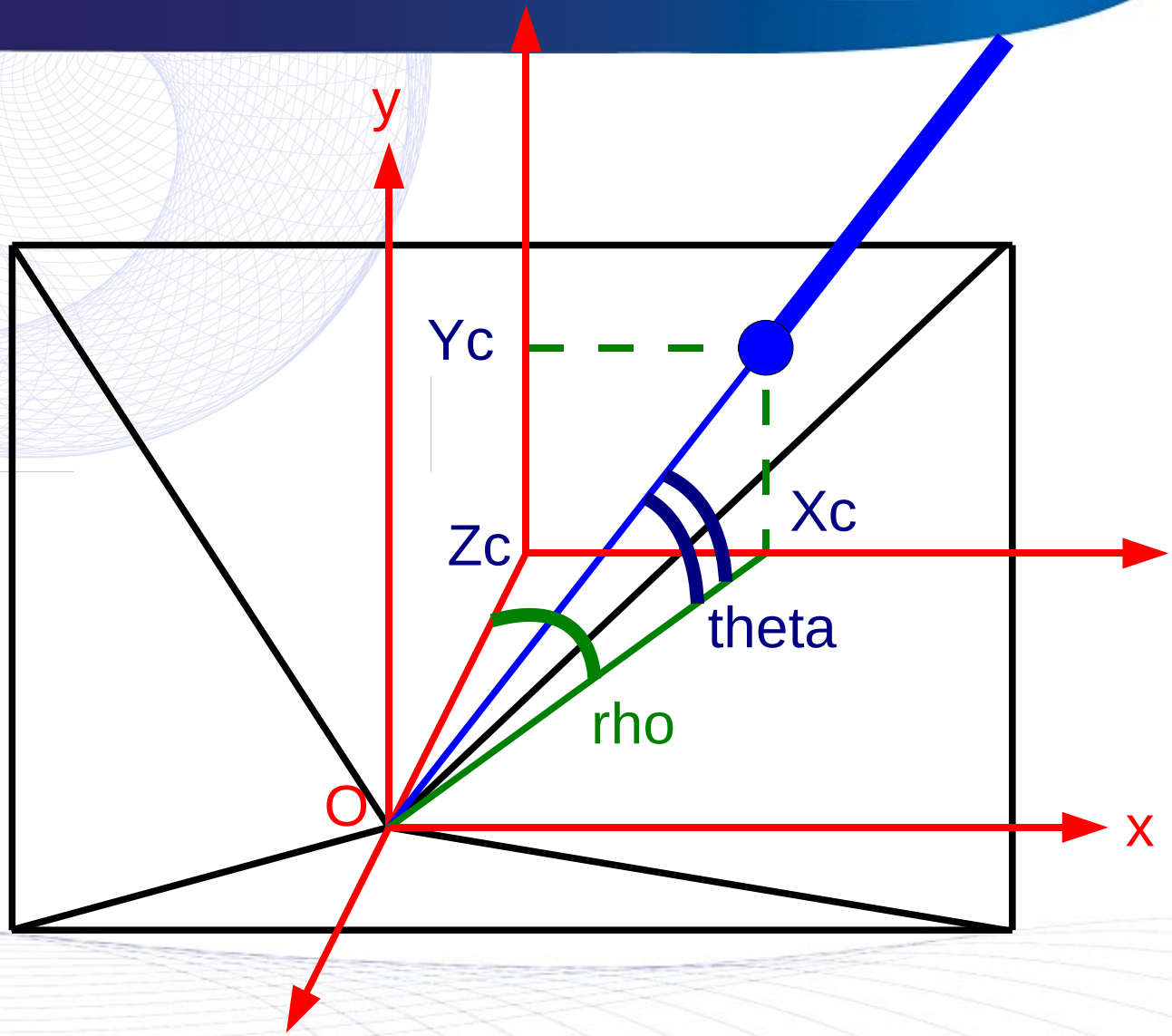
- The 2D pointer (such as a mouse pointer) :
  - Easy to use
- The 3D virtual ray :
  - Easy to use
  - Good awareness for collaboration
  - The projection of a 3D ray can be a spot on the screen...
- Driven by a 2 DOF input device :
  - A 2D mouse
  - Any kind of cheap joystick

The 3D Virtual Ray

- The 3D virtual Ray :
  - Is easy to use
  - Provides good awareness for collaboration
  - Needs head-tracking for co-location with the hand
    - Generally using precise and expensive tracking devices



2D Pointer / 3D Ray



2D Pointer / 3D Ray

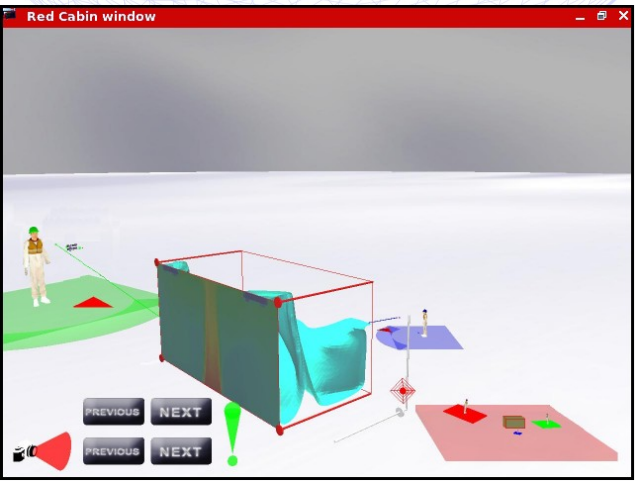
- When driven by a strict 2D device...
- 3D coordinates of the closest extremity :
  - X and Y :
    - Provided by the 2D device
  - Fixed Z
  - Heading (around Y) :
    - Rho = atan (-Xc / Zc)
  - Pitch (around X) :
    - Theta = atan (Yc / sqrt (Xc * Xc + Zc * Zc))
  - No Roll (around Z)

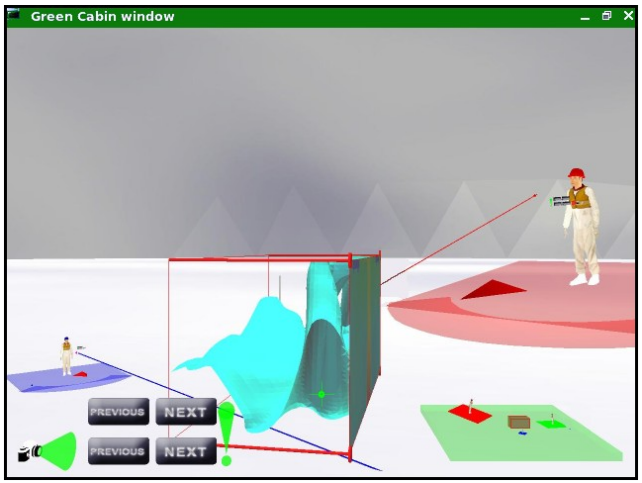
2D Pointer / 3D Ray

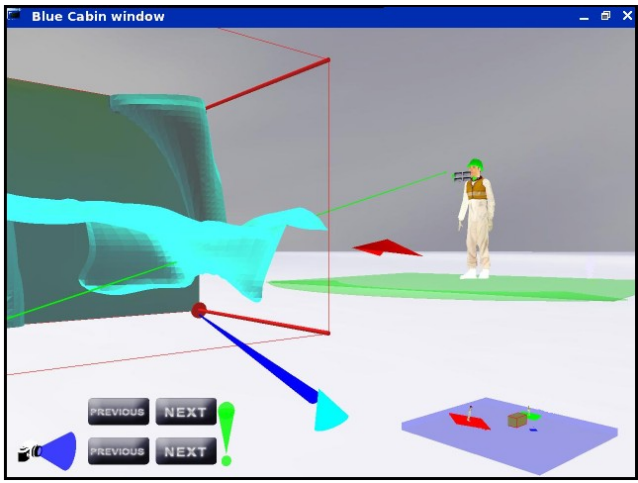
- A 3D coordinate is computed for grabbed objects :
  - According to the movements of the 3D Ray
- 3D offsets can be proposed :
  - According to other input events :
    - Keys pressed on the keyboard
    - Mouse wheel events
    - Special buttons of a joystick
    - ...
  - X, Y, Z
  - H, P, R

2D Pointer / 3D Ray

- Demonstration...





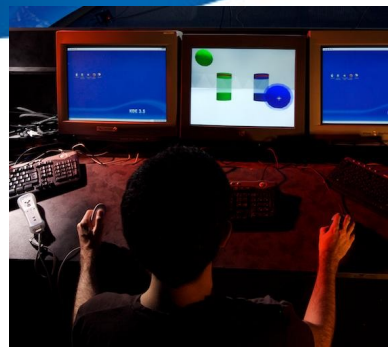


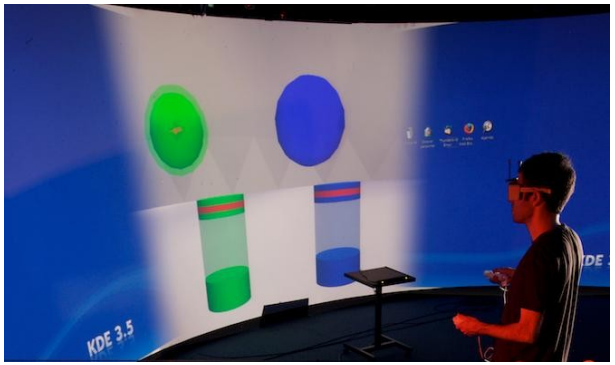
Comparing the 2D Ray / 3D Pointer to other techniques

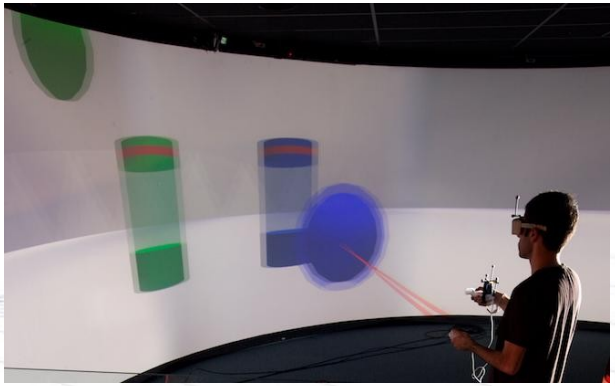
- H1 :
  - The best solution for 3D interaction is immersion with head-tracking
- H2 :
  - Our 2D Pointer / 3D Ray can be as efficient than immersion with head-tracking
- H3 :
  - Immersion without head-tracking is not a good solution for 3D interaction
- H4 :
  - A semi-immersed 2D Pointer / 3D Ray can be as efficient as a 3D virtual ray without head-tracking

Experimentations

- 4 situations :
  - In front of a workstation with a mouse
  - Semi-immersed with a Nintendo Wiimote
  - Immersed with stereo and AR Tracking
  - Fully immersed with stereo and AR Tracking for the hand and the head (for co-location)

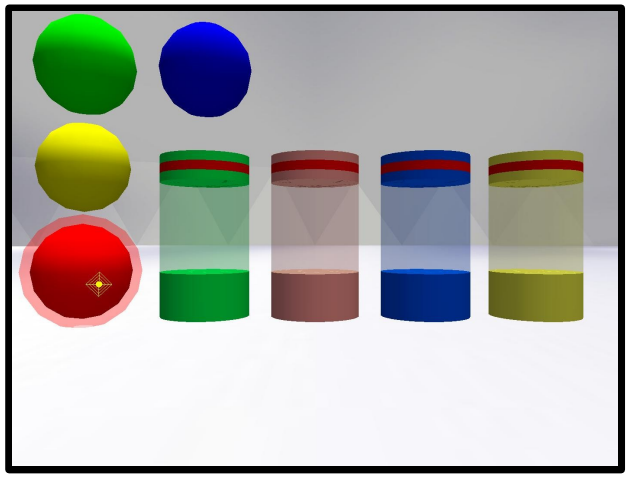




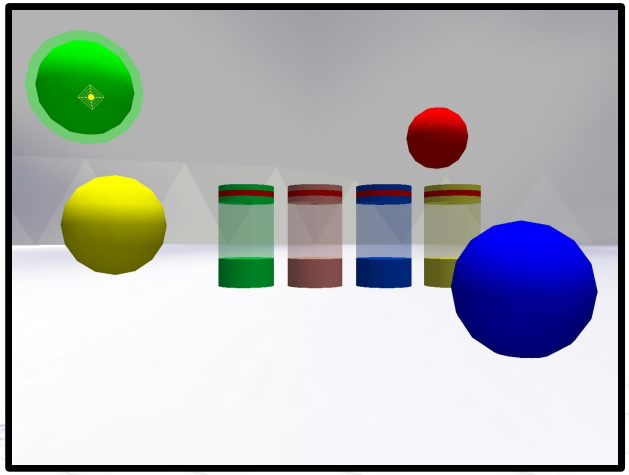


Experimentations

- Two tasks :
  - A 2D task :
    - All the objects are in the same plan, no need to adjust the depth

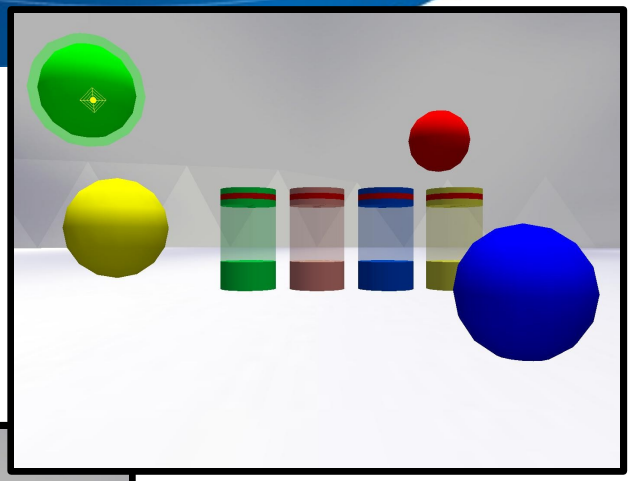


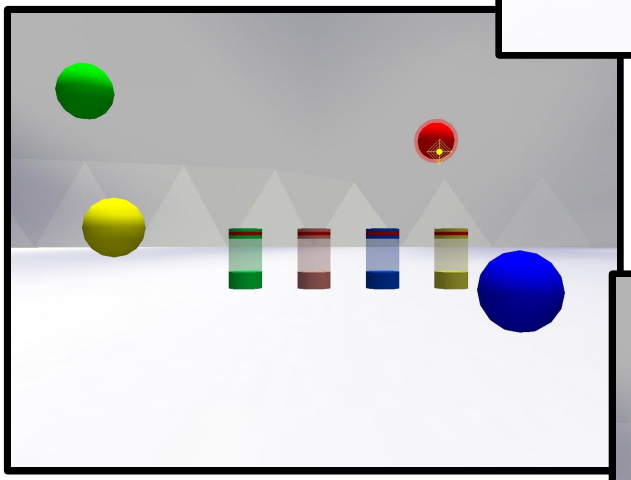
  - A 3D task :
    - The objects are not in the same plan, depth must be adjusted

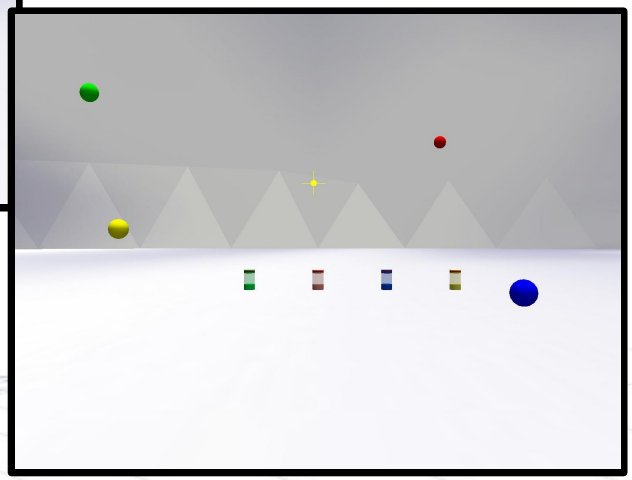


Experimentations

- Three different scales for objects :
  - Large
  - Medium
  - Small

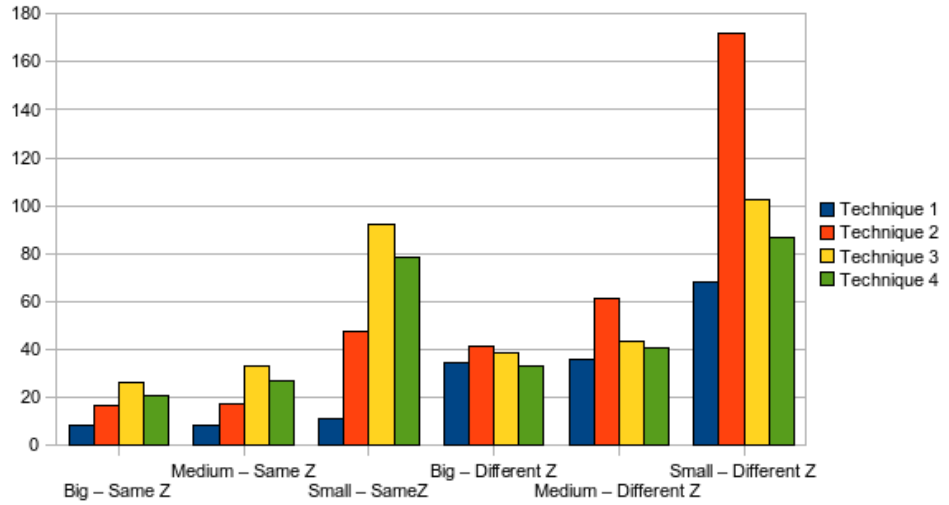




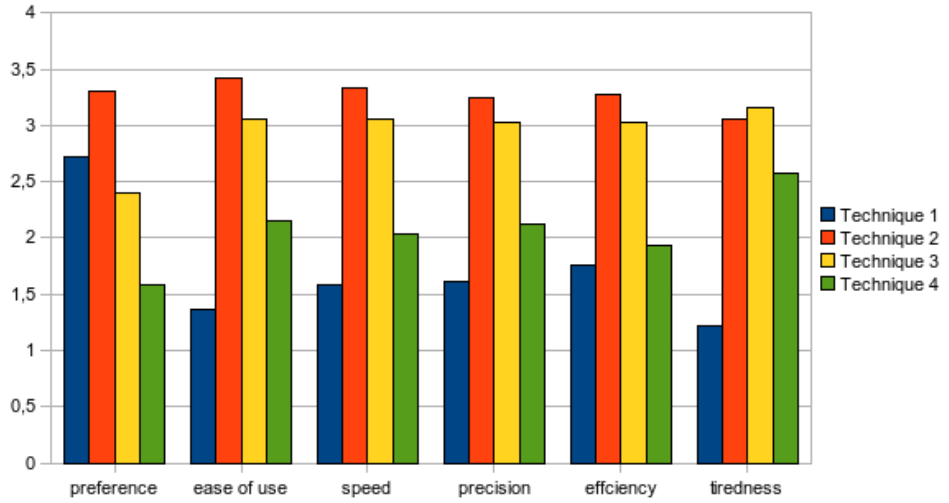


Some raw results

- About speed



- About the 36 users' preferences



Some interpretations

- H1 : Immersion is the best solution : OK
  - Immersion is efficient, users enjoy it
- H2 : our solution can be as efficient : OK
  - Using a mouse : the fastest and most accurate
- H3 : deficient immersion is not good : OK-
  - A little bit better than our solution in a semi-immersive context
  - Head-tracking is lacking...
- H4 : our solution can be as efficient as deficient 3D interaction : OK-
  - Problems with depth adjustment of small objects
    - Another solution has been implemented but not evaluated

Conclusion about the 2D Pointer / 3D Ray

- It can be as efficient as usual 3D metaphors used with high-tech input devices
- It can be used :
  - In front of a workstation
  - In front of an immersive display
    - Even if it is not the best solution in this case...
- It can be driven by :
  - A mouse and a keyboard
  - Any kind of low-cost input device
    - e.g. a Nintendo Wiimote

Perspectives

- For 3D interaction :
  - Improve and evaluate the technique for the depth
  - Improve the technique to enable easy 6DOF manipulation
    - By adding some orientation offsets
  - Implement the 2D Pointer / 3D Ray as an X3D node
    - To embed it within any VE description
- For 3D Collaborative Scientific Visualization :
  - Deploy over the internet, with WEB 3D standards
    - This is the objective of the CollaViz project

Thank you for your attention.

Are there any questions ?