Réalité Virtuelle et Interactions
Collaboration en Réalité Virtuelle

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Collaboration in Virtual Reality

• Several users work/play together in a VE
  – Co-expertise of 3D data
  – Complex manipulation (real or virtual)
  – Training
  – Social presence (telepresence)
Co-located collaboration
Remote Collaboration

Distributed virtual environment

Video
Collaboration in Virtual Reality

• Awareness
• Communication
• Collaborative Interaction
  – Navigation
  – Co-manipulation
Collaboration in Virtual Reality

• Awareness
• Communication
• Collaborative Interaction
  – Navigation
  – Co-manipulation
Awareness

• Perception of the other users
  – Where are they?
  – What are they doing?
    • What are they looking?
    • Are they looking at me?
  – What could they do ?
    • Can they see me?
    • Could they see what I am showing to them?
    • Could they do what I am asking them to do?
Awareness

• Improve the mutual understanding
  – Just next to me... But where are you?
  – Just in front of me ... But where are you looking at?
  – Etc.

• Multi-sensorial restitution
  – Visual awareness
  – Audio awareness
  – Haptic awareness
Visual Awareness

- Avatar: representation of users in the VE

Simplified

Realistic

[Fleury et al., 2012]

[DIVE, 1991]

[CALVIN, 1996]

[Fleury et al., 2008]

[Second Life, 2005]

[Beeler et al., 2010]

[Fleury et al., 2013]
Visual Awareness

- Animation of the avatars

Kinect Avatar

Body tracking

[Image of avatars and body tracking]
Visual Awareness

- Use of a WIM [CALVIN, 1996]

Mortal’s view

Deity’s view
Virtual Awareness

- Multi-scale collaborative virtual environment

[Zhang et Furnas, 2002]
Audio Awareness

• Spatialized voice restitution

• Remote users’ noises
  – Give a lot of information
    • Where they are
    • What they are doing
      – Add some sounds to describe the actions
  – Need to be spatialized sounds
Haptic Awareness

• Force feedback of the others
  – Direct
    • Touch the others through haptic devices
      – Virtual handshake
      – affective haptic
    • Can be asymmetrical
  – Indirect
    • Manipulate an object together
    • Feel the force apply by the other on the object
Awareness Model

• Spatial Model of Interaction [Benford et al., 1994]
  – Compute which users can interact which others

  – Medium
    • A typical communication medium
    • Ex: audio, visual, haptic, etc.

  – Aura
    • Sub-space bounding the presence in a particular medium
    • Interaction is possible between two users with colliding Aura

[Benford et al., 1994]
Awareness Model

• Spatial Model of Interaction [Benford et al., 1994]
  – Aura determines potential interactions
    (on a technical point of view)
  – Users are responsible for controlling interactions
  – Measure of awareness between two users
    • Asymmetrical
    • Dependent of the medium
      (i.e. different for each medium)
  – Introduction of the Focus and Nimbus
Awareness Model

- Spatial Model of Interaction [Benford et al., 1994]
  - Focus
    - Area where a user perceive the others
    - For each particular medium
  - Nimbus
    - Area where the others can perceive a particular user
    - For each particular medium
    - Different from the focus
⇒ How can users understand what the others are doing?
⇒ How can they understand what the others can do?
Interaction Workspaces

• 3D space in the real world
  – Associated to a particular material device
  – Perceive or interact with the virtual world
  – Ex: visual, audio, haptic, physical displacement, etc.

• Why integrating these interaction workspaces?
  – Each user can have different interaction workspaces
  – Take into account workspaces for users’ interaction
    • Adapt the interaction techniques
    • Capabilities perception
Examples of Interaction Workspaces

• User’s physical displacement workspace
  – Magic Carpet in 3DM [Butterworth et al. 92]
  – Magic Barrier Tape [Cirio et al. 09]
Examples of Interaction Workspaces

• Haptic interaction workspace
  – Bubble technique [Dominjon et al. 05]
Immersive Interactive Virtual Cabin

• Organizes and integrates interaction workspaces
  – Users can carry them on the VE
• Based on a structured hierarchy
Activities Perception

What is the user seeing?

What is the user doing?

[Fraser et al., 1999]

[Duval et al., 2008]
Capabilities Perception

• Example for the user himself: user’s displacement workspace
Capabilities Perception

- Example for another user: interaction workspace
Collaboration in Virtual Reality

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Voice communication

• Essential for collaborative application
  – Compensate a bad perception of the VE [Hindmarsh et al., 1998]
  – Share different point of view

• However:
  – Users need specific tools for communication

Voice communication induces also discontinuity in interaction [Bowers et al., 1996]
Tools for communication

• Virtual Ray
  – Laser pointer metaphor
  – Easy and intuitive manipulation

[Simon, 2005]  [Schild et al., 2009]
Tools for communication

• Annotations
  – Sketching, text, audio, videos
  – Especially relevant for scientific data analysis
  – Synchronous and asynchronous collaboration

[Schild et al., 2009]
Collaboration in Virtual Reality

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Collaborative Navigation

• Collaborative virtual environment
  – WYSINWIS (What Your See Is Not What I see)
    • Each user can have its own viewpoint
  – But, sometime users need:
    • To share the same viewpoint
    • To meet somewhere in the VE
    • To guide others in the VE
    • To follow each other
Collaborative Navigation

• 3 main modes of collaborative navigation
  – Share the same point of view
    • One user drives, the other follows
  – One move and the other follows with an offset
    • One user drives, the other can modify his offset
  – World in Miniature
    • Guide the others through the WIM
    • Move the others through the WIM

[CALVIN, 1996]
• Context: scientific data analysis
• Users can:
  – Save interesting viewpoints
  – Select on particular viewpoint
  – Travel cross of the saved viewpoints of a particular user

[Duval et al., 2008]
Group Navigation

[Dodds et Ruddle, 2008]

• Users are part of a predefined group
• Each user can travel independently
• Functionalities help to travel with the group
  – To follow the first member of the group
  – To come back at the middle of the group
    (mean of member positions)
Guidance techniques

[Nguyen et al., 2013]

• Context: collaborative navigation in a building
  – User 1 is in an immersive room
    • Find several targets in the building
  – User 2 is in front a desktop workstation
    • Guide the other user using a WIM
  – Not verbal communication
Guidance techniques

[Nguyen et al., 2013]

- Technique 1:
  - Draw arrows in the virtual environment
Guidance techniques

[Nguyen et al., 2013]

- Technique 2:
  - Orient an arrow attached to the user
    (like a compass)
Guidance techniques
[Nguyen et al., 2013]

• Technique 3:
  – Alight the path in the virtual environment
Outline

Collaboration in Virtual Reality

- Awareness
- Communication
- Collaborative Interaction
  - Navigation
  - Co-manipulation
Co-manipulation

• Several users manipulate a same virtual object
  – Achieve a hard manipulation task in VE
  – Mimic the same task than in the real world (training)

• 2 solutions
  – Users manipulate different DoF of an object
  – Users can manipulate the same DoF of an object

• DoF: Degree of Freedom
  – Usually 6 DoF (3 translations, 3 rotations) + the scale
  – Some other parameters (color, shape, etc.)
Manipulate different DoF

- Users use the same tools
  - Ex: two virtual rays [Pinho et al., 2008]
    - Help with obstacles
    - Help when the depth is hard to perceive
Manipulate different DoF

- Users use different tools
  - Ex: a virtual ray and a virtual hand
    - Virtual ray manages positions
    - Virtual hand manages rotations

- User studies show [Pinho et al., 2002]
  - Faster, easier and more precise than single user manipulations
Manipulate the same DoF

- Manipulate together positions and orientations
  - Compute the mean of each user’s actions
  - Use a physical engine [Noma et Miyasato, 1997]
    - Positions and orientations are the results of all the forces applied by the users
    - Add springs between users’ hands and the object to avoid instability
Manipulate the same DoF

• Holding together a virtual object
  – Need at least 3 control points
  – 3 hand manipulation technique [Aguerreche et al., 2009]
    • One user has 2 control points
    • The other has 1 control point
    • Co-located or remote collab. [Fleury et al., 2012]
    • Implemented with a prop (Reconfigurable tangible device) [Aguerreche et al., 2010]
Manipulate the same DoF

- Provide feedback to users about their actions
  - Force feedback with haptic devices
  - Springs or rubber bands
  - Curve virtual ray

[Riege et al., 2006] [Duval et Fenals, 2002]

[Aguerreche et al., 2009]
Conclusion

• Collaborative Virtual Environment (CVE)
  – Several solutions to represent users in a CVE
    • From realistic to simplified solutions
    • Activities/Capabilities perception

  – Usually voice communication
    • But not so much tools to improve the communication

  – Techniques for collaborative interaction
    • Navigation together or help the other to navigate
    • Move virtual objects together
Conclusion

• Collaborative Virtual Environment (CVE)
  – Feedback of what the others are doing is very important
    • Especially for co-manipulation

• Applications of CVE
  – Co-expertise, collaborative review or design
  – Training (learn a collaborative task or learn with a remote teacher)
  – Entertainment (video games, artistic performance, etc.)
  – Social presence (telepresence)