Video-mediated reflection technology in rehabilitation and pain management

Some first steps

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Outline

1. Virtual and Augmented Reality supported therapy/rehab
2. Mirror-Box therapy
3. Augmented Mirror Box – work in progress
VR/AR Therapy and Rehabilitation
Multiplexed Telerehabilitation (after stroke) in Virtual Reality project at Rutgers
VR/AR therapy::Examples

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UNIVERSITY OF OTAGO

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VR/AR therapy::Examples

(A) VR exercise setup, (B) birdball exercise game, (C) conveyor exercise game, and (D) soccer exercise game

VR/AR therapy::Examples

Hines Veterans Affairs Hospital – Wiimote rehab training
VR/AR therapy::Examples

Using Virtual Reality for after stroke pain management (hot/cold stimuli: Snow World and Dante’s Canyon)

Shahrbanian, Maureen & Simmonds (2008)

San Diego, CA, USA]
VR/AR therapy::Examples

Figure 1. The Rehabilitation Gaming System. A subject faces a display with the arms resting on a table. The arm movements are tracked by a camera positioned on top of the display. The tracking system detects in real-time the position of the color patches located on the wrists and elbows. Data gloves are used to detect finger movements. This way, on the display two virtual arms reproduce the movements of the subject’s arms.

Cameirão, Bermúdez i Badia, Oller & Verschure (2008)
[Abstracts from CyberTherapy 2008, June 23-25, 2008 San Diego, CA, USA]
Moseley, Olthof, Venema, Don, Wijers, Gallace, & Spence (2008). Psychologically induced cooling of a specific body part caused by the illusory ownership of an artificial counterpart. PNAS September 2, 2008 vol. 105 no. 35 13169–13173
Mirror-Box Therapy
Fig. 6 The mirror box. A mirror is placed vertically in the centre of a wooden or cardboard box whose top and front surfaces have been removed. The patient places his normal hand on one side and looks into the mirror. This creates the illusion that the amputated hand has returned.

Ramachanderan & Hirstein (1998)
Mirror Box therapy::Examples

Mirror Box therapy::Examples

Mirror Box therapy::Examples

Augmented Mirror Box
work in progress
Augmented Mirror Box::Replication of “traditional” box
Augmented Mirror Box::Objectives

- Providing more therapeutic control in mirror-box applications using Augmented Reality technology
- Possible use of similar technology in different therapy/rehab areas, e.g. preventive (occupational) healthcare
- Research on experienced sense of presence / motor control of real and imagined scenes: embodied interaction, affordances, possible actions, …
- Provision of a system (mature prototype) actually usable in practitioners' office

- Based on previous work, also by partners, in particular Liz’ mirror-box work and embodied interaction research, Brian’s and Holger’s VR exposure therapy activities, Holger’s presence research and technical VR/AR work
Augmented Mirror Box::Demonstrator AMB

- Computer display replaces mirror
- Virtual/augmented content (including own (mirrored) hand)
- Camera
- Simulation with fed-through camera
Augmented Mirror Box::Principle MkI Version

observation side (impaired limb)  interaction side (healthy limb)

screen (augmented mirror)  cameras  holes for hands (can be placed on both sides for LH / RH mode switch)
Augmented Mirror Box::Working Prototype MkII.1.0
Augmented Mirror Box::Working Prototype MkII.1.1
Augmented Mirror Box::
Working Prototype. Perceived Screen(s)
Augmented Mirror Box:: Working Prototype. Actual 3D environment
Augmented Mirror Box:: Working Prototype. Virtual and real space to be used

Mixed Reality Space
Augmented Mirror Box::First Observations / Findings

- Mirror effect seems to work
- Placement of camera(s)
- First case study on CRPS: patient did not believe in / accept ownership of mirrored limb but pain levels dropped nevertheless!
- Current setup suitable for hands, but probably too small for feet (but still working)
- Display placement deserves more consideration
### Augmented Mirror Box: Potential Application Areas

Disorders/conditions with paralysis or disturbances of sensation that may be responsive to augmented virtual mirror approaches

- **Hemiplegia/hemiparesis** (full or partial paralysis) due to traumatic brain injury, stroke, TIA’s or spinal injury/neoplasm

- **Alternating Hemiplegias**

- **Missing or damaged limb/appendage** sensory abnormalities (eg “Phantom limb” pain).

- **Bell’s palsy** (Facial palsy; Idiopathic peripheral facial palsy).

- Paralysis of limb resulting from **poisoning/botulism**

- Paralysis due to **anoxic brain injury** (eg caused by suffocation, strangulation, carbon monoxide, drowning)

- Conditions involving weakness or altered sensory awareness (eg of pain, temperature, pressure etc) affecting a limb or appendages - such as **Complex regional pain syndrome** (CRPS) and Brown-Sèquard syndrome.
Augmented Mirror Box::Potential Application Areas

Current focus on primary application fields (unilateral impairments)
- Stroke and brain injury rehabilitation
- Complex Regional Pain Syndrome
- Phantom Limb Pain Management

Also:
- AMB technique as a diagnostic tool
- AMB to help understanding the underlying (perceptual / neuropsychological) processes
Augmented Mirror Box: Future Work

- More studies on perceptual phenomena
- Case / treatment studies on CRPS, Stroke rehab and phantom limbs
- Two camera setup with switch interface
- Augmentation of space in boxes
- Stereo camera approach (depth of hands in boxes): depth-correct augmented reality application
- Different 3D models for scientific and therapeutic purposes
- Funding opportunities
- Collaboration opportunities
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