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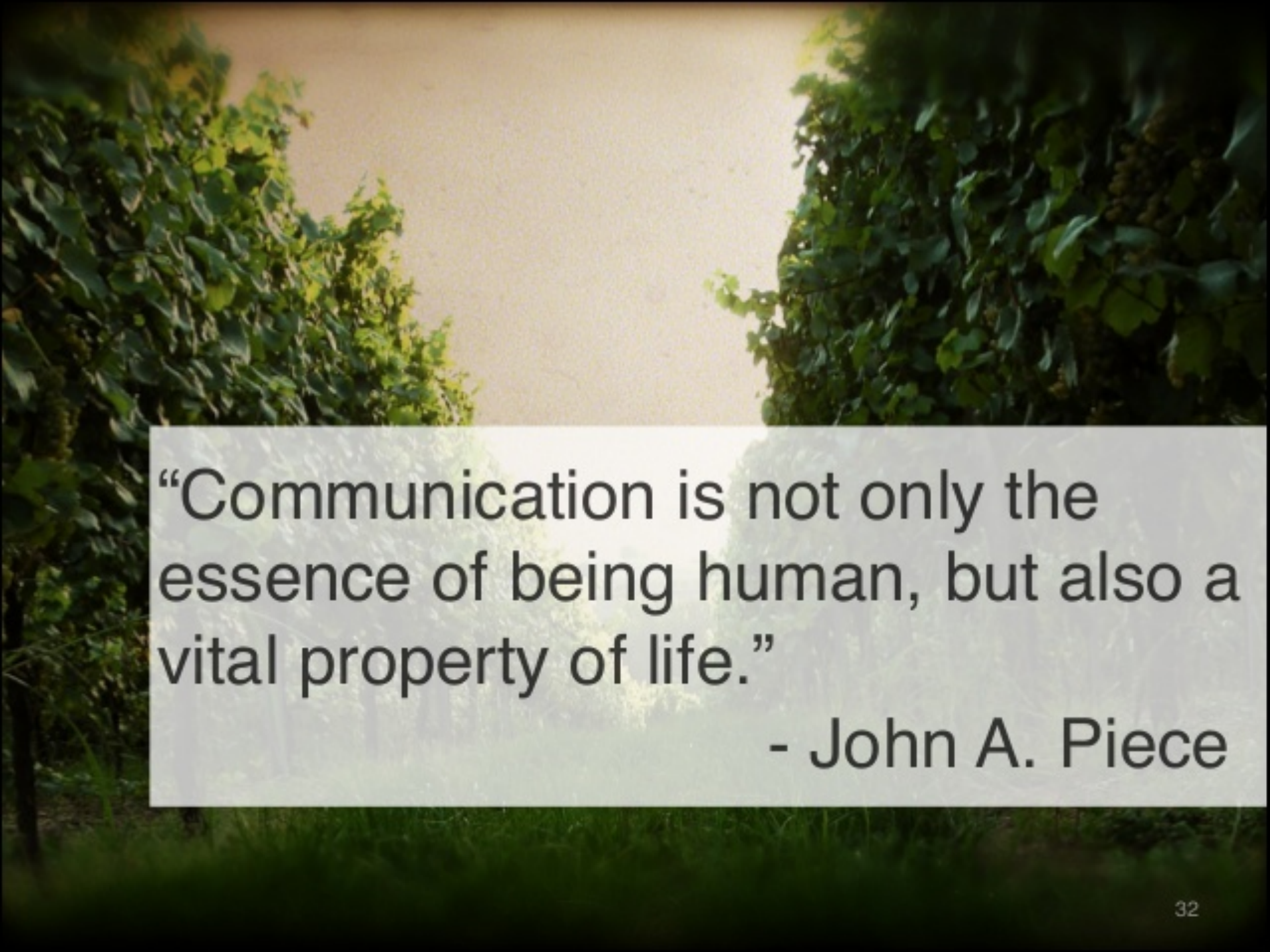
ARIVE Lecture Series
XR: Virtual and Augmented Reality

Empathic Computing

Mark Billinghurst
University of Auckland/South Australia

August 4th 2020


“Communication is not only the essence of being human, but also a vital property of life.”
- John A. Piece

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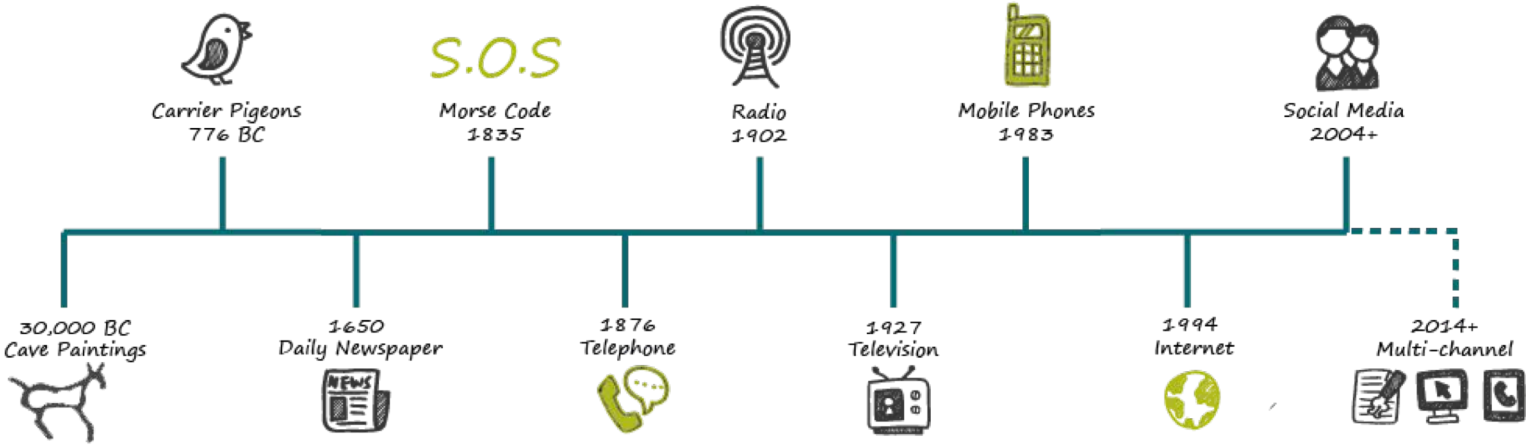
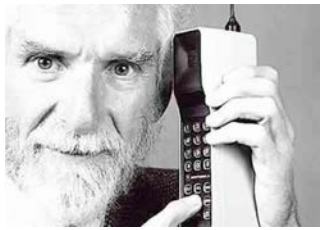
Evolution of Communication Tools





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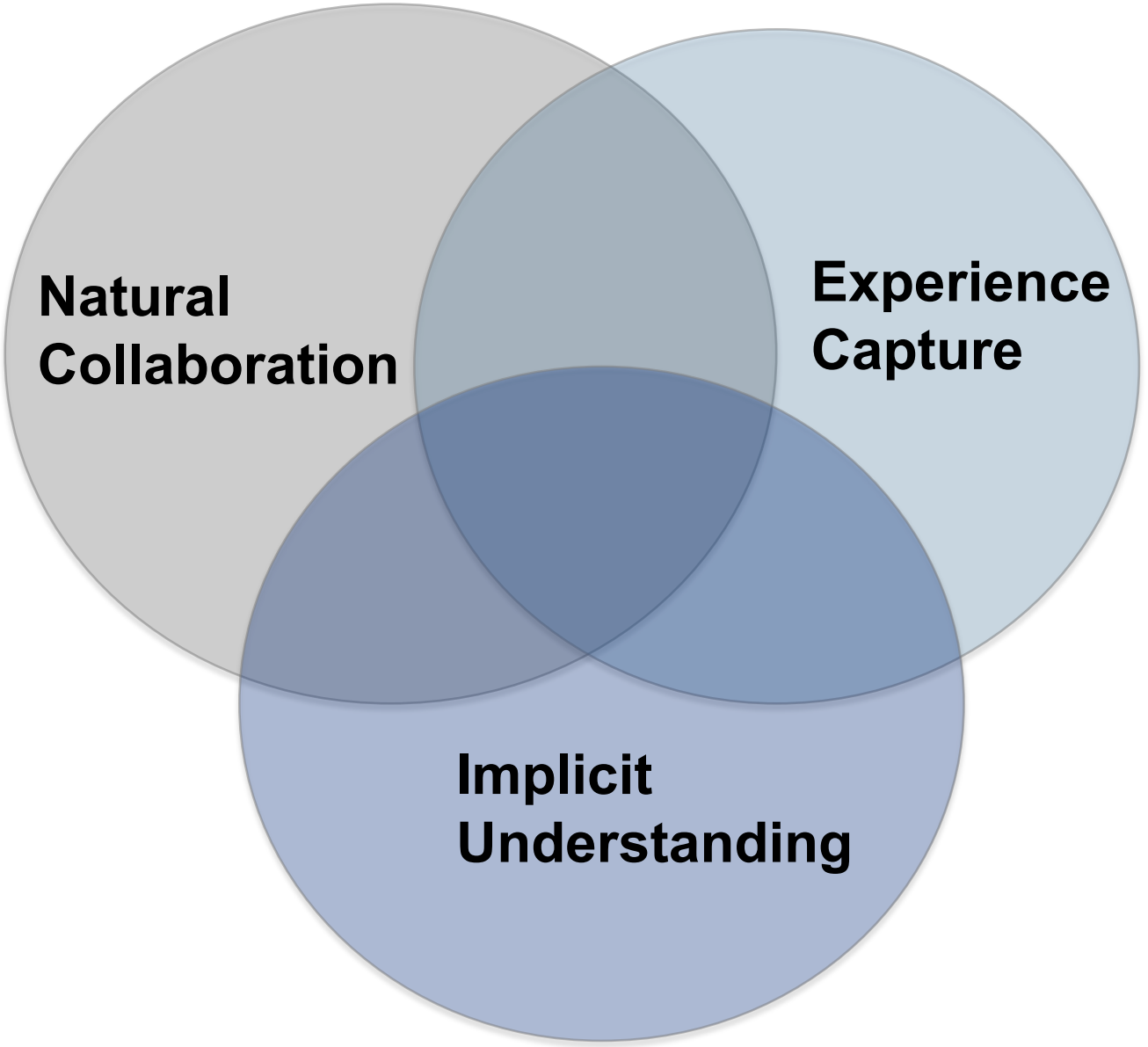
Modern Communication Trends

1. **Improved Content Capture**
   Move from sharing faces to sharing places
2. **Increased Network Bandwidth**
   Sharing natural communication cues
3. **Implicit Understanding**
   Recognizing behaviour and emotion


Natural
Collaboration
Experience
Capture
Implicit
Understanding

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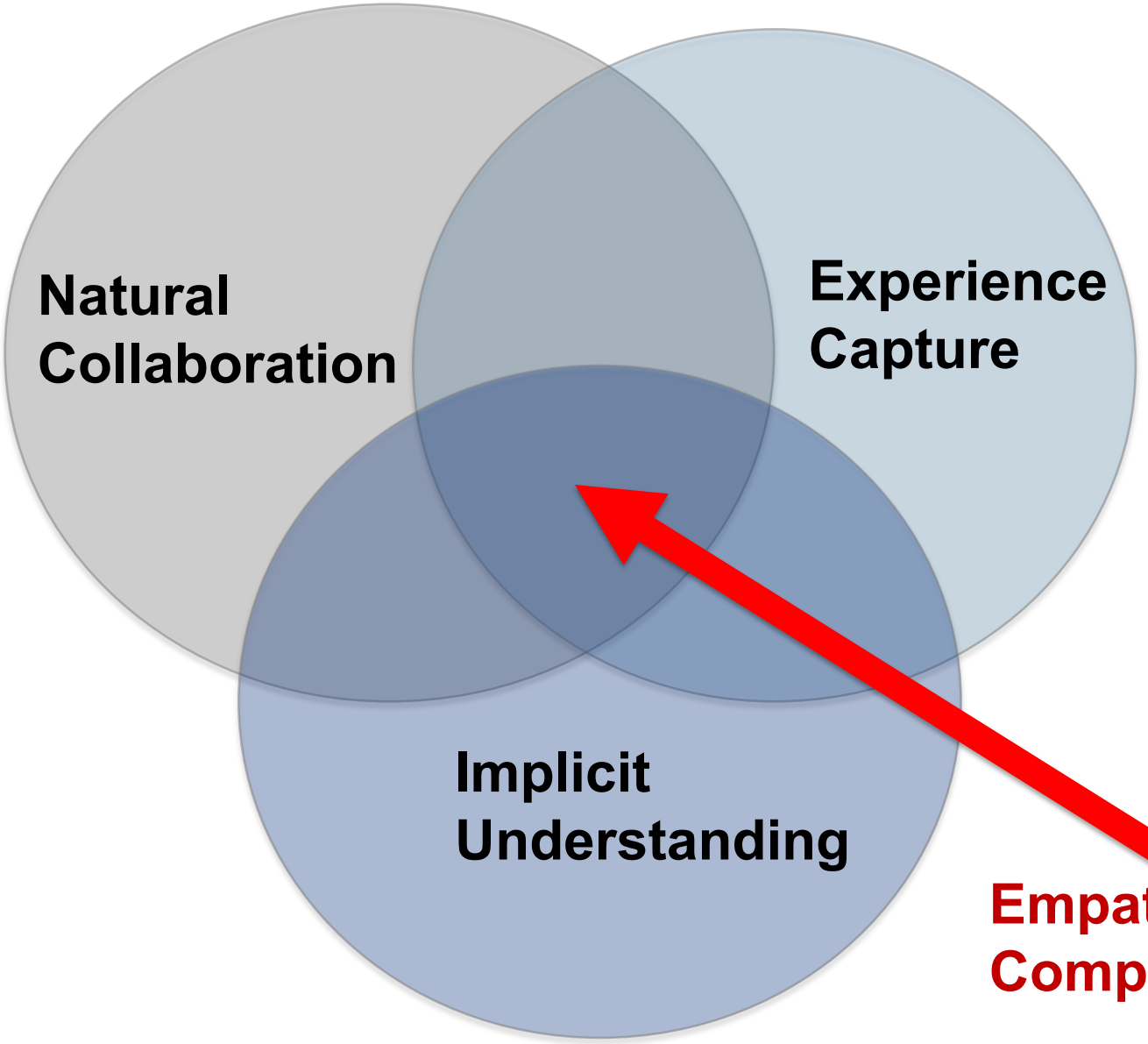
Natural
Collaboration
Experience
Capture
Implicit
Understanding
Empathic
Computing

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Empathy

"Seeing with the Eyes of another, Listening with the Ears of another, and Feeling with the Heart of another.."

Alfred Adler

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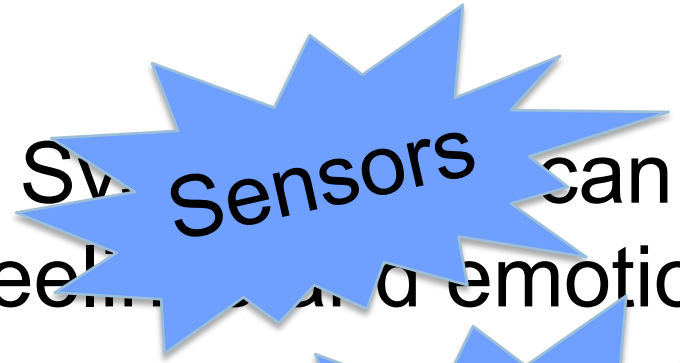
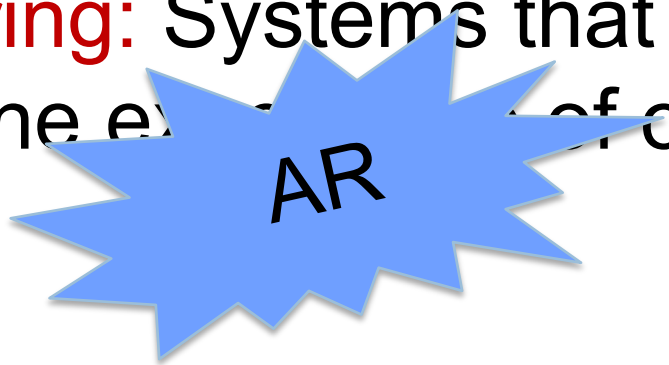
Empathic Computing

1. Understanding: Sy… …can understand your feel… …d emotions

2. Experiencing: System… …u better experience the wo… …rs

3. Sharing: Systems that help you better share the e… …of others





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1. Understanding: Affective Computing

Ros Picard – MIT Media Lab

Systems that recognize emotion

Appliances That Make You Happy

Jun Rekimoto – University of Tokyo/Sony CSL

Smile detection + smart appliances


Smiling
Makes Us
Happier
H.Tsujita, J.Rekimoto
The University of Tokyo
Sony CSL

2. Experiencing: Virtual Reality

"Virtual reality offers a whole different medium to tell stories that really connect people and create an empathic connection."

Nonny de la Peña

http://www.emblematicgroup.com/

Using VR for Empathy

USC Project Syria (2014)

Experience of Terrorism

- Project Homeless (2015)
- Experience of Homelessness

3. Sharing: Augmented Reality

Can we develop systems that allow us to share what we are seeing, hearing and feeling with others?


SHIMANO
SHIMANO

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Technology Requirements

1. Sharing Viewpoints
   - Looking through the eyes of another
2. Environment Capture
   - Seeing what others are seeing
3. Emotion Recognition
   - Sharing feelings

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Sharing Viewpoints

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AR View Remote Expert View

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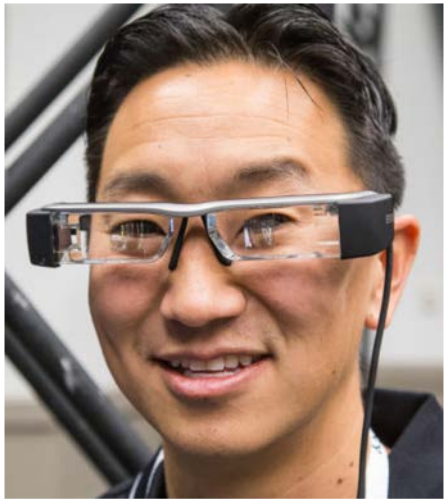
Empathy Glasses (CHI 2016)

+



+

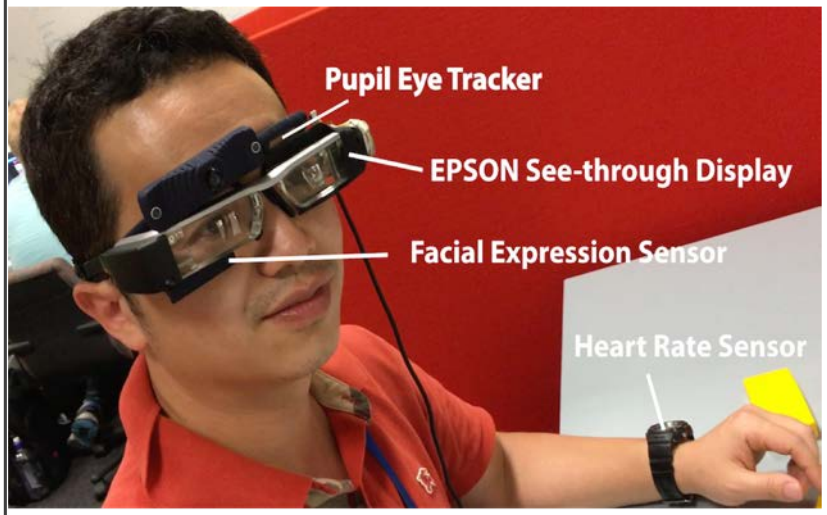
Pupil Labs Epson BT-200 AffectiveWear

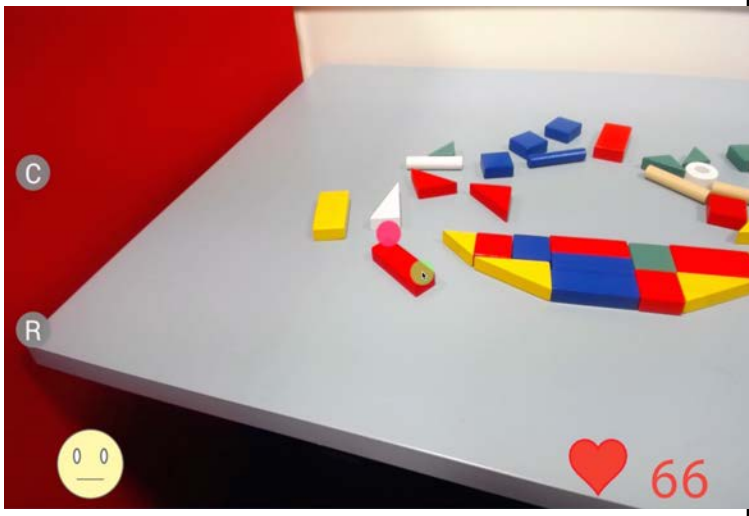
Combine together eye-tracking, display, face expression

Implicit cues – eye gaze, face expression

Masai, K., Sugimoto, M., Kunze, K., & Billinghurst, M. (2016, May). Empathy Glasses. In *Proceedings of the 34th Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM.

Remote Collaboration





Eye gaze pointer and remote pointing

Face expression display

Implicit cues for remote collaboration

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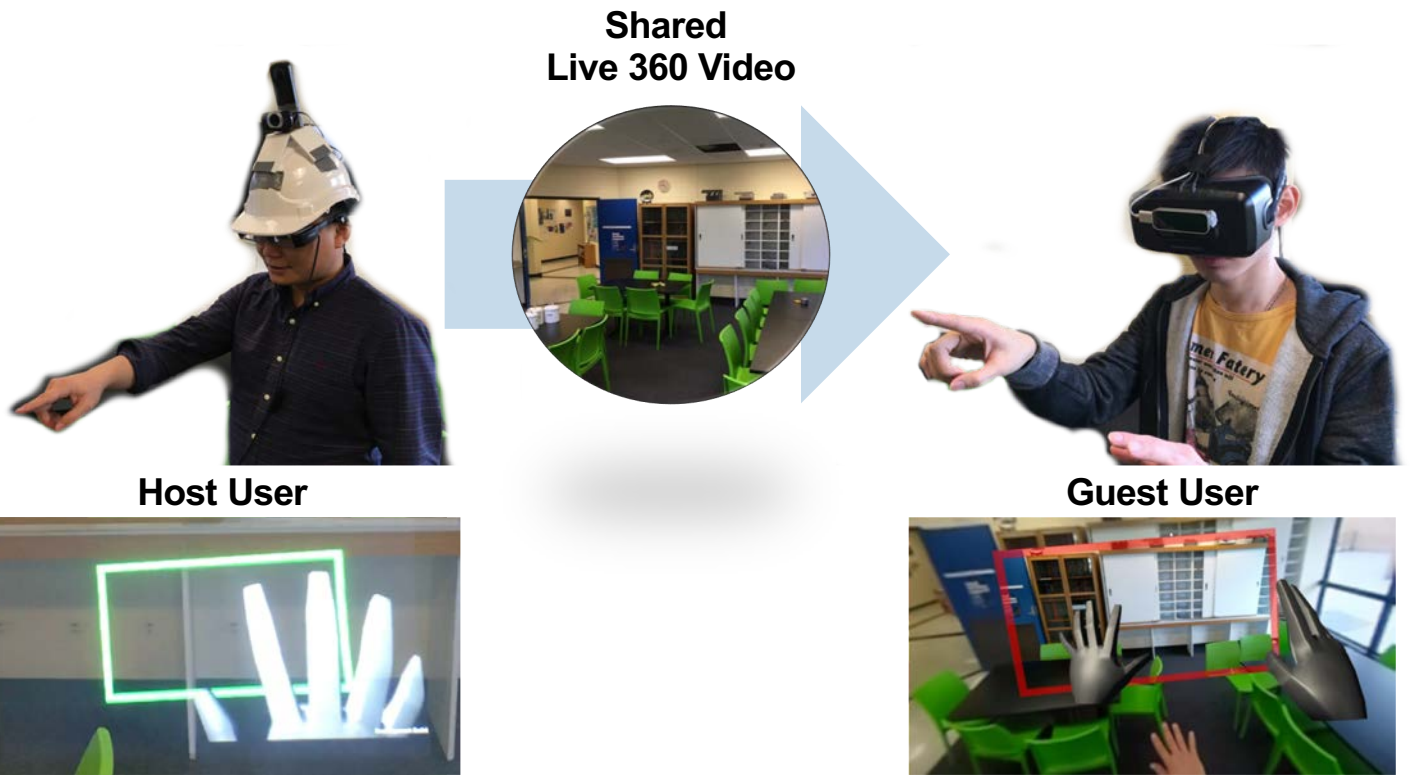
Shared Sphere – 360 Video Sharing



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Shared Sphere

– 360 Panorama-based Mixed Reality Collaboration

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Nova Systems
Experience Knowledge Independence

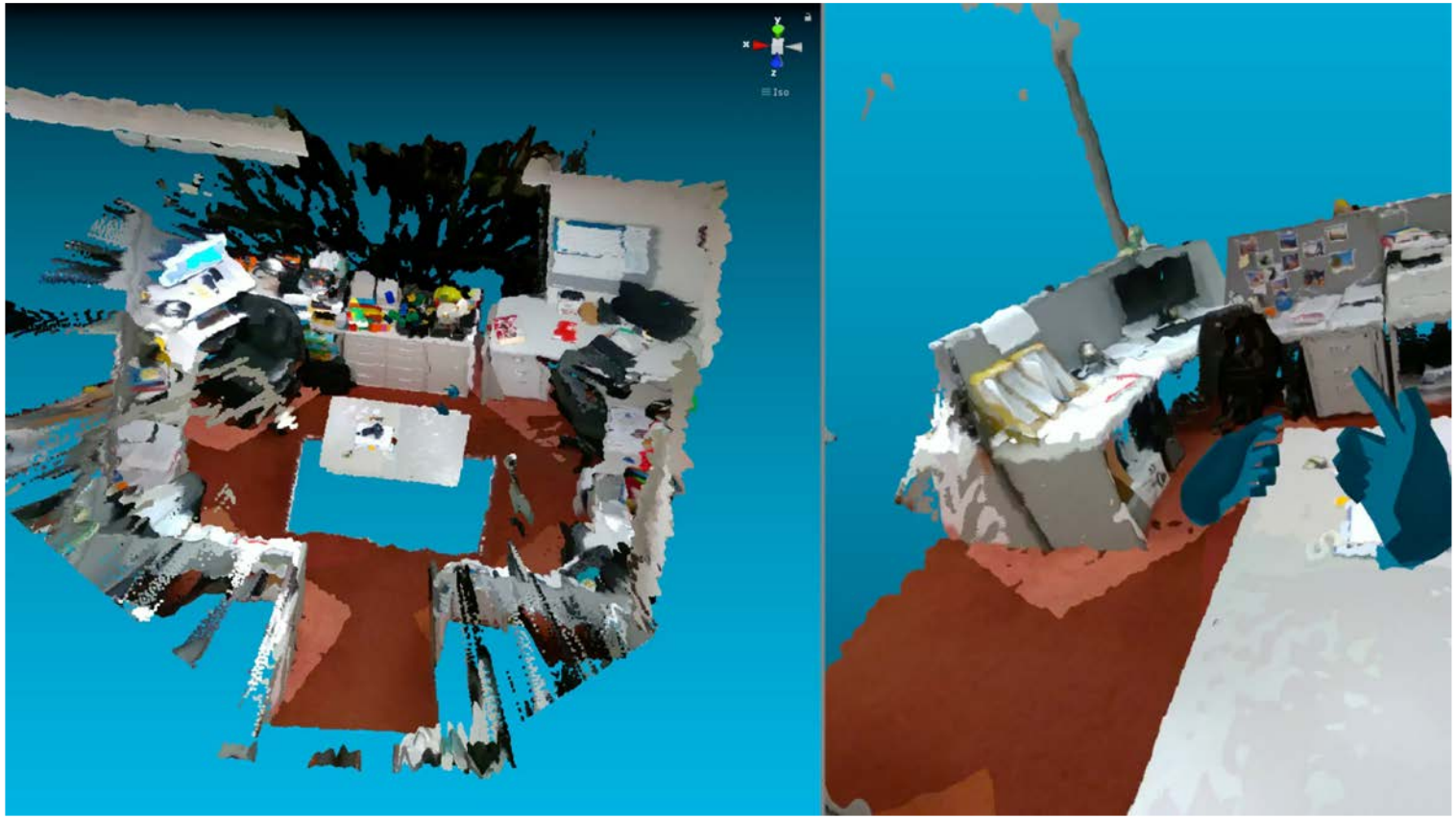
ptc

SA Power Networks

3D Live Scene Capture

Use cluster of RGBD sensors

Fuse together 3D point cloud



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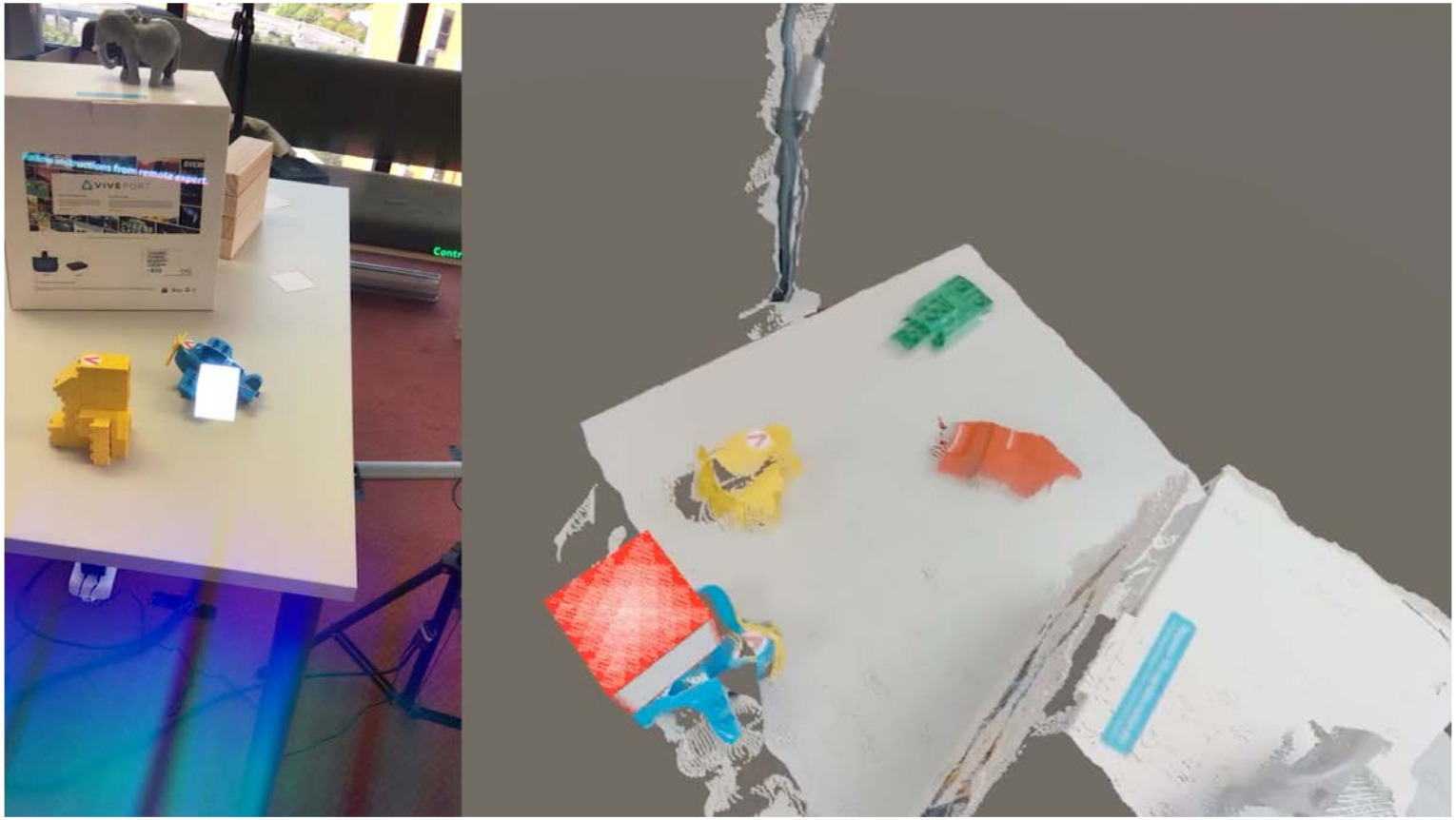
AR View Remote Expert View



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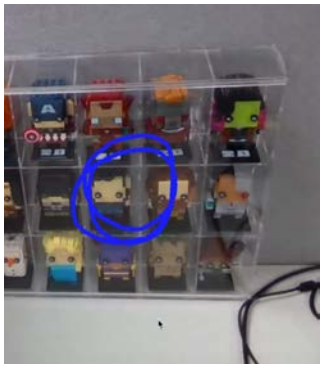
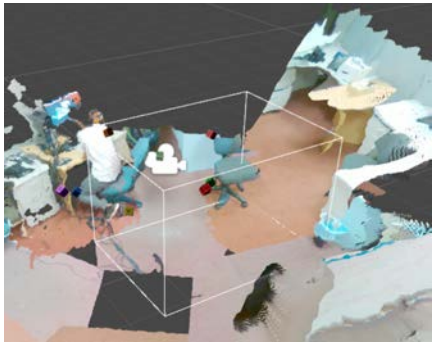
View Sharing Evolution



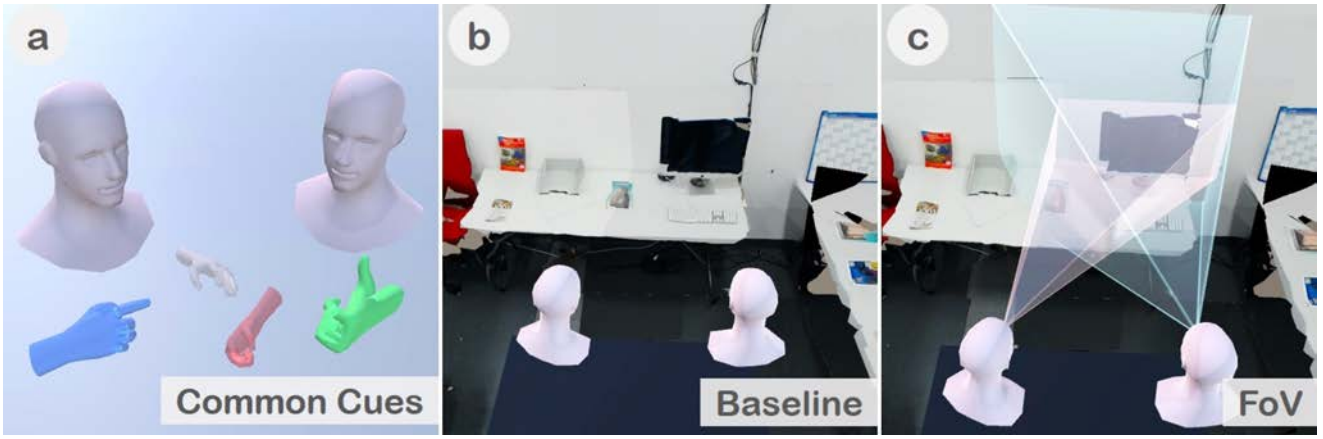
2D

360



3D

Virtual Communication Cues



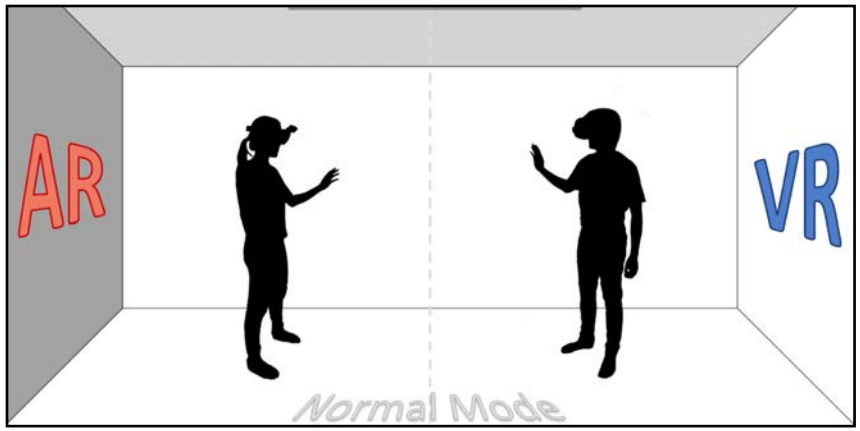
AR/VR displays

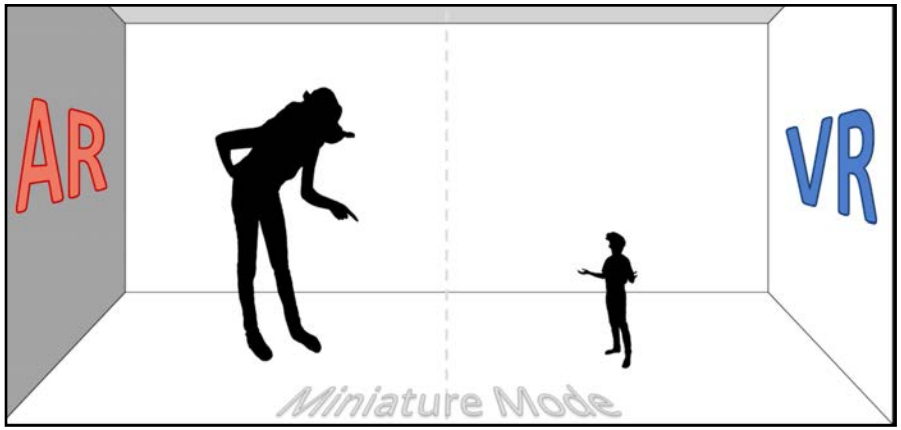
Gesture input (Leap Motion)

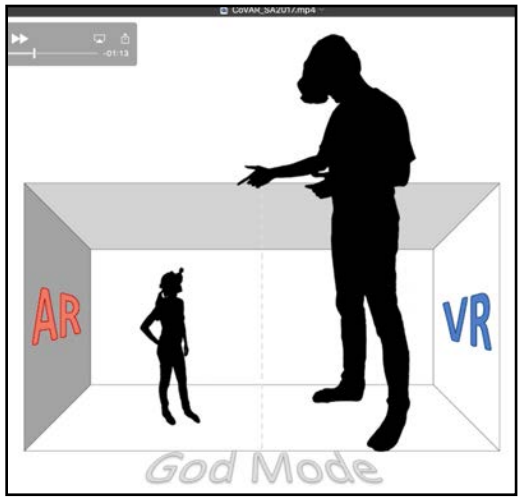
Room scale tracking

We reconstructed the environment on the AR side and shared it with the VR side for spatial reference.

Multi-Scale Collaboration







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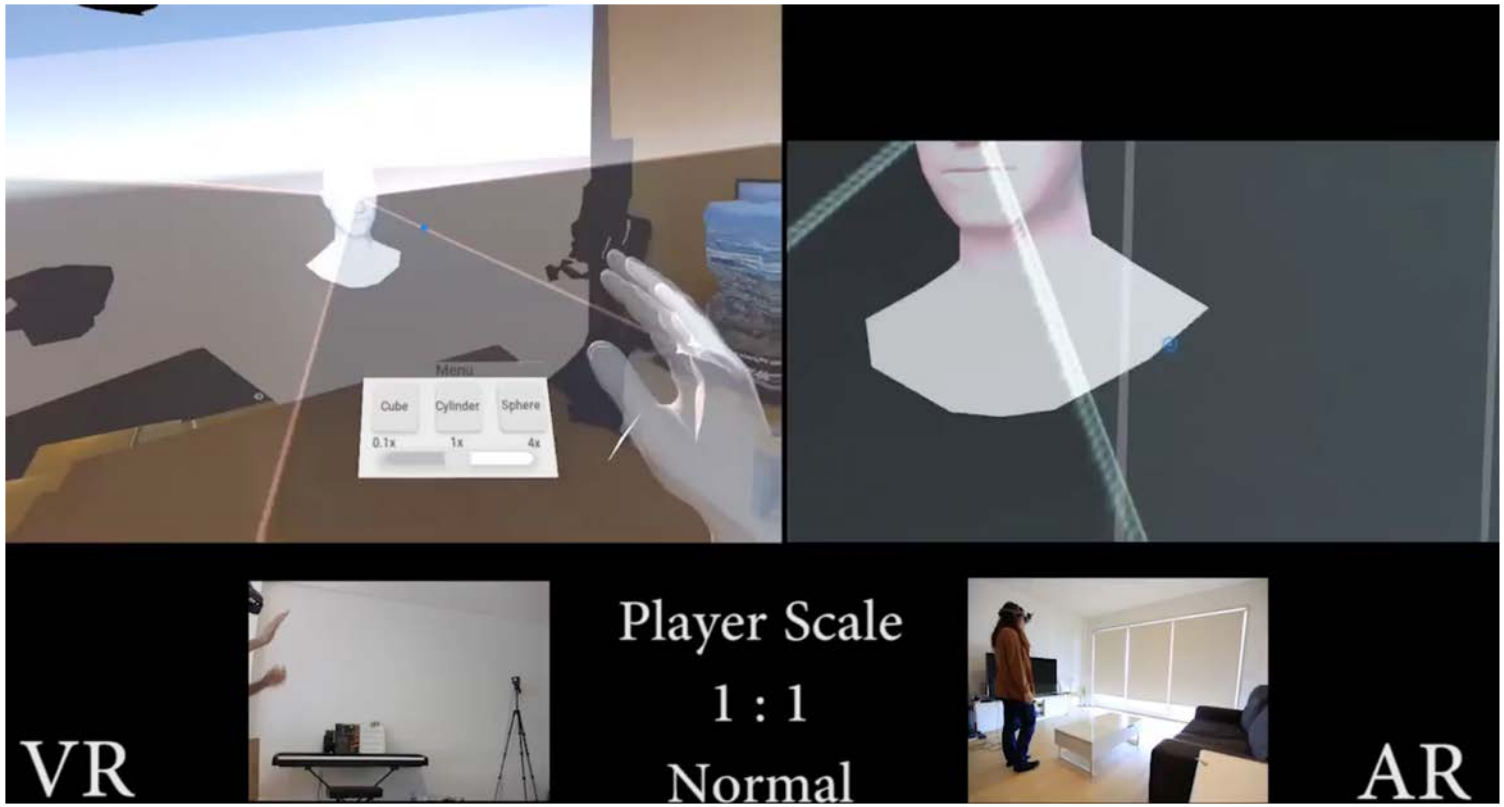
Menu
Cube
Cylinder
Sphere
0.1x
1x
4x
VR
Player Scale
1 : 1
Normal
AR

Mini-Me – Separating Communication Cues

Creating a miniature you to help with collaboration

Share communication cues even when out of sight

Piumsomboon, T., Lee, G. A., Hart, J. D., Ens, B., Lindeman, R. W., Thomas, B. H., & Billinghurst, M. (2018, April). Mini-me: an adaptive avatar for mixed reality remote collaboration. In *Proceedings of the 2018 CHI conference* (p. 46). ACM.

Mini-Me: An Adaptive Avatar for Mixed Reality Remote Collaboration

Thammathip Piumsomboon[1], Gun A. Lee[1], Jonathon D. Hart[1], Barrett Ens[1],
Robert W. Lindeman[2], Bruce H. Thomas[1] and Mark Billinghurst[1]

[1]University of South Australia, Adelaide, Australia
[2]University of Canterbury, Christchurch, New Zealand

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Empathic Computing Lab
www.empathiccomputing.org

CHI 2018

HITLabNZ
www.hitlabnz.org

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On the Shoulder of the Giant:

A Multi-Scale Mixed Reality Collaboration with 360 Video Sharing and Tangible Interaction

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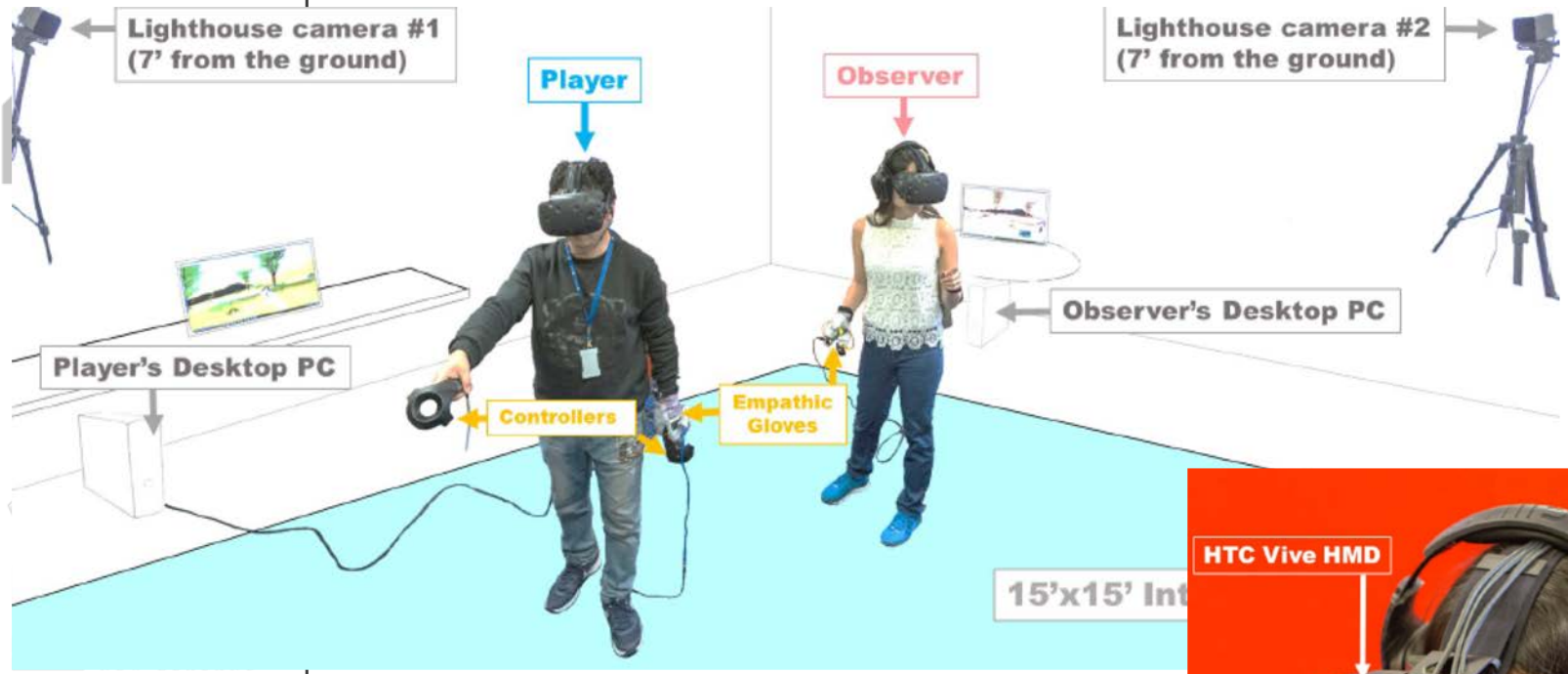
Sharing VR Experiences



HTC Vive HMD

Empathic glove

Empatica E4

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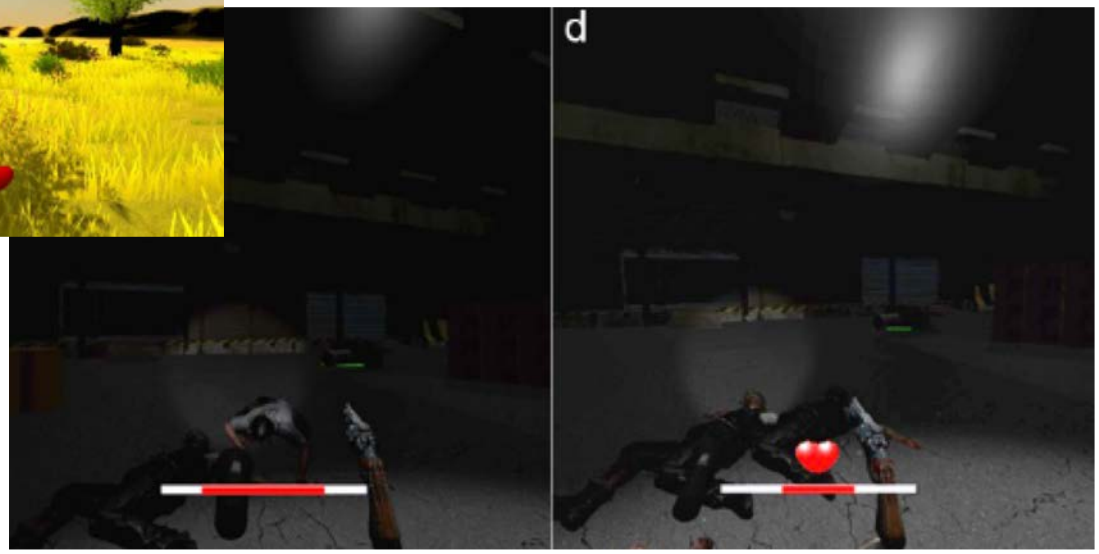
VR Environments



Butterfly World: calm scene, collect butterflies

Zombie Attack: scary scene, fighting zombies

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AR and VR for Empathic Computing

VR systems are ideal for trying experiences:

- Strong story telling medium
- Provide total immersion/3D experience
- Easy to change body scale and representation

AR systems are idea for live sharing:

- Allow overlay on real world view/share viewpoints
- Support remote annotation/communication
- Enhance real world task

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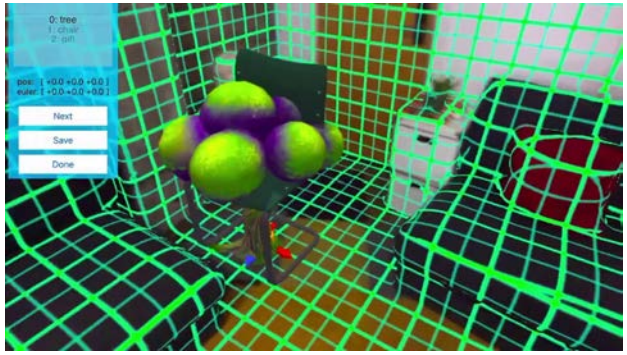
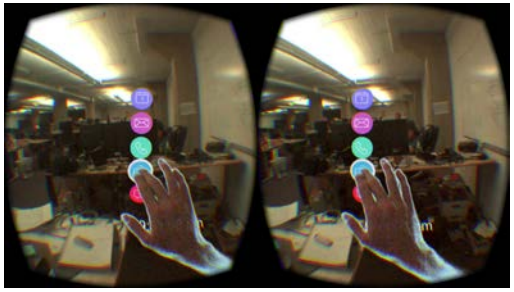
Technology Trends



Advanced displays

- Wide FOV, high resolution

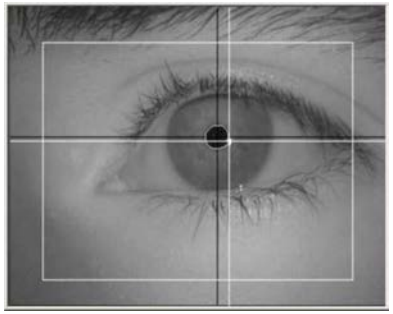


Real time space capture

- 3D scanning, stitching, segmentation

Natural gesture interaction

- Hand tracking, pose recognition



Robust eye-tracking

- Gaze points, focus depth

Emotion sensing/sharing

- Physiological sensing, emotion mapping

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- Advanced displays
- Real time space capture
- Natural gesture interaction
- Robust eye-tracking
- Emotion sensing/sharing

} Empathic Tele-Existence

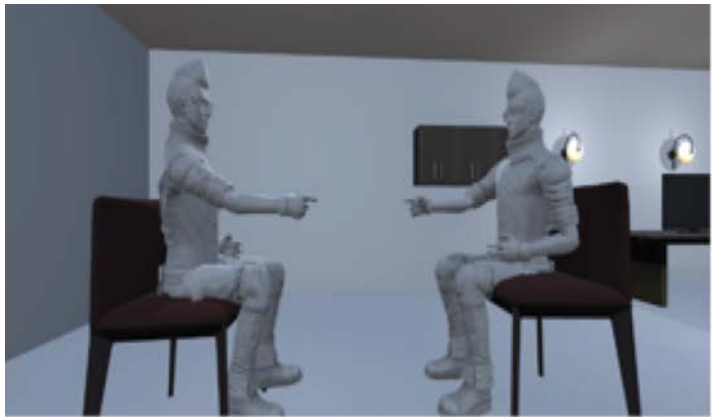
Empathic Tele-Existence

Move from Observer to Participant

Explicit to Implicit communication

Experiential collaboration – doing together

Brain Synchronization



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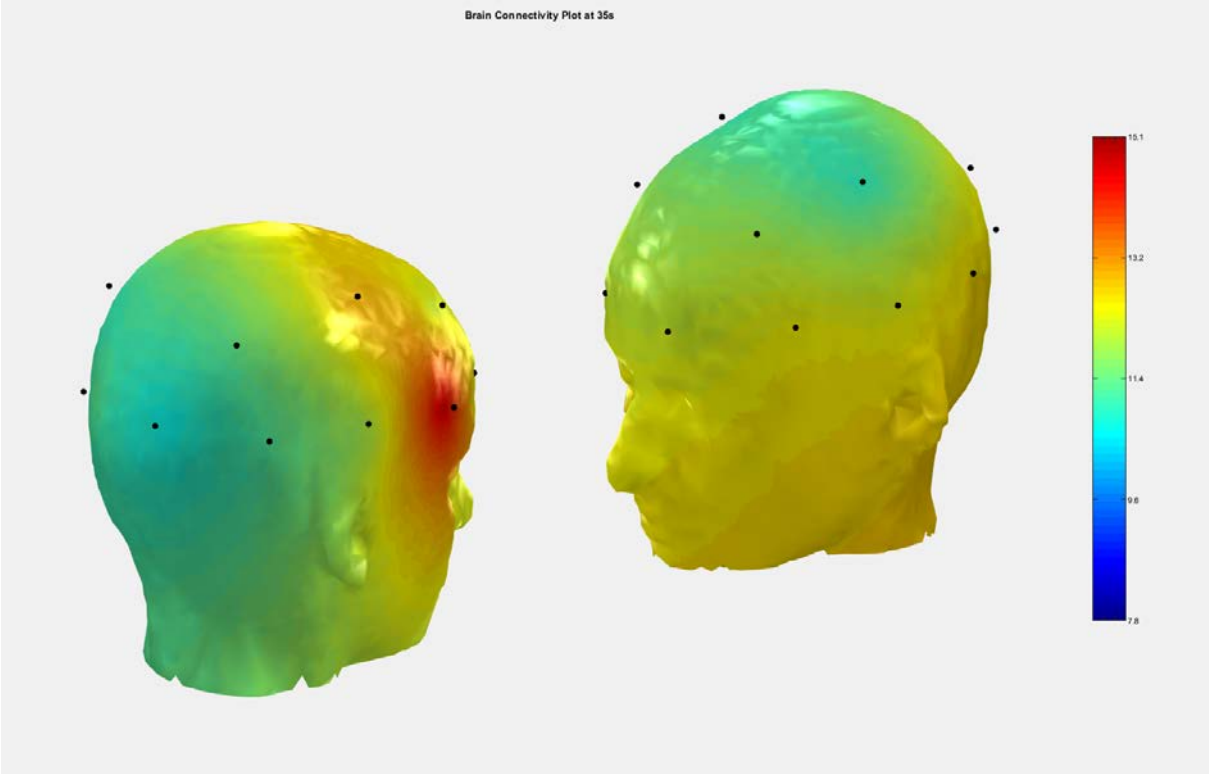
Pre-training (Finger Pointing) Session Start



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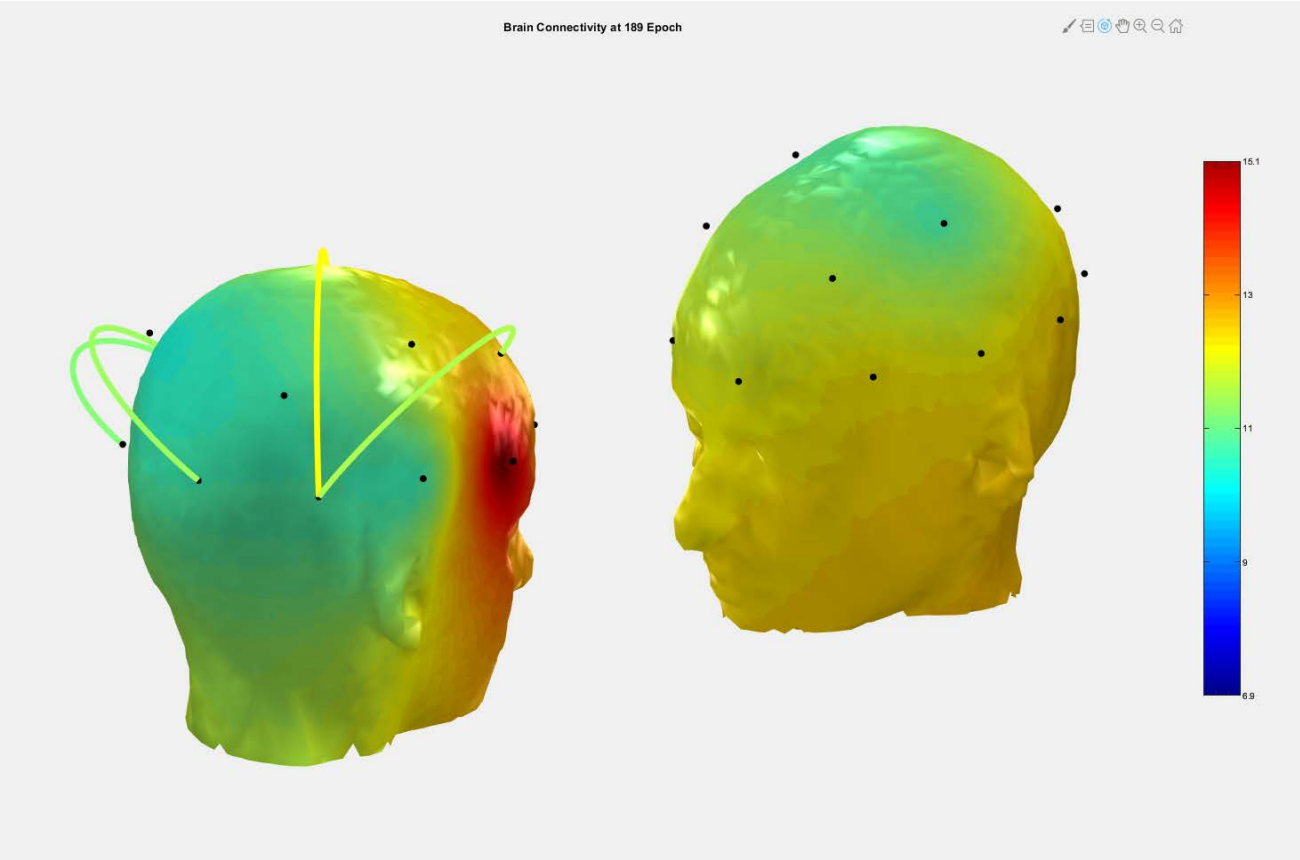
Pre-training (Finger Pointing) Session End



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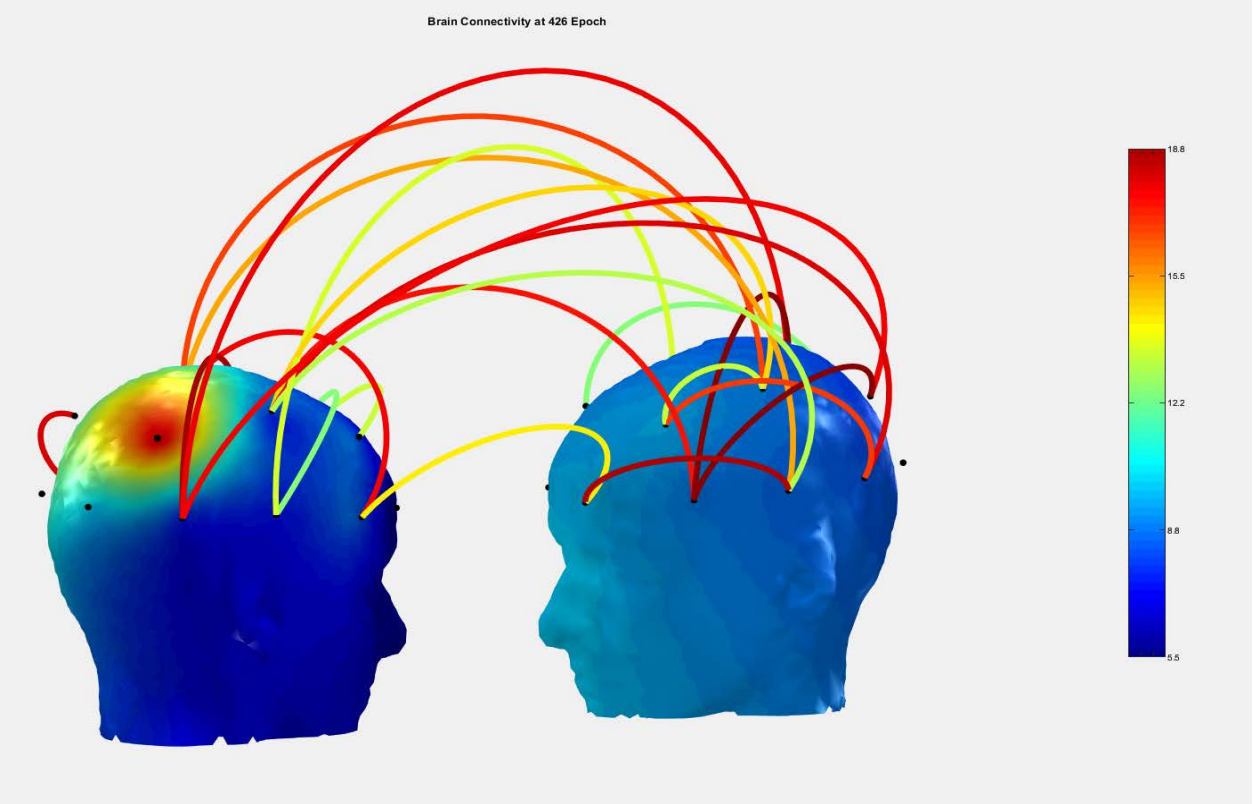
Post-Training (Finger Pointing) Session End



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Early Results

	Number of Connections			
Freq	**Before**	**After**	**P value**	**Chi-square**
Alpha	173	191	> .05	
Beta	**169**	**210**	**0.02**	**4.7**
Delta	133	160	> .05	
Gamma	187	157	> .05	
Theta	160	209	< .001	**6.9**

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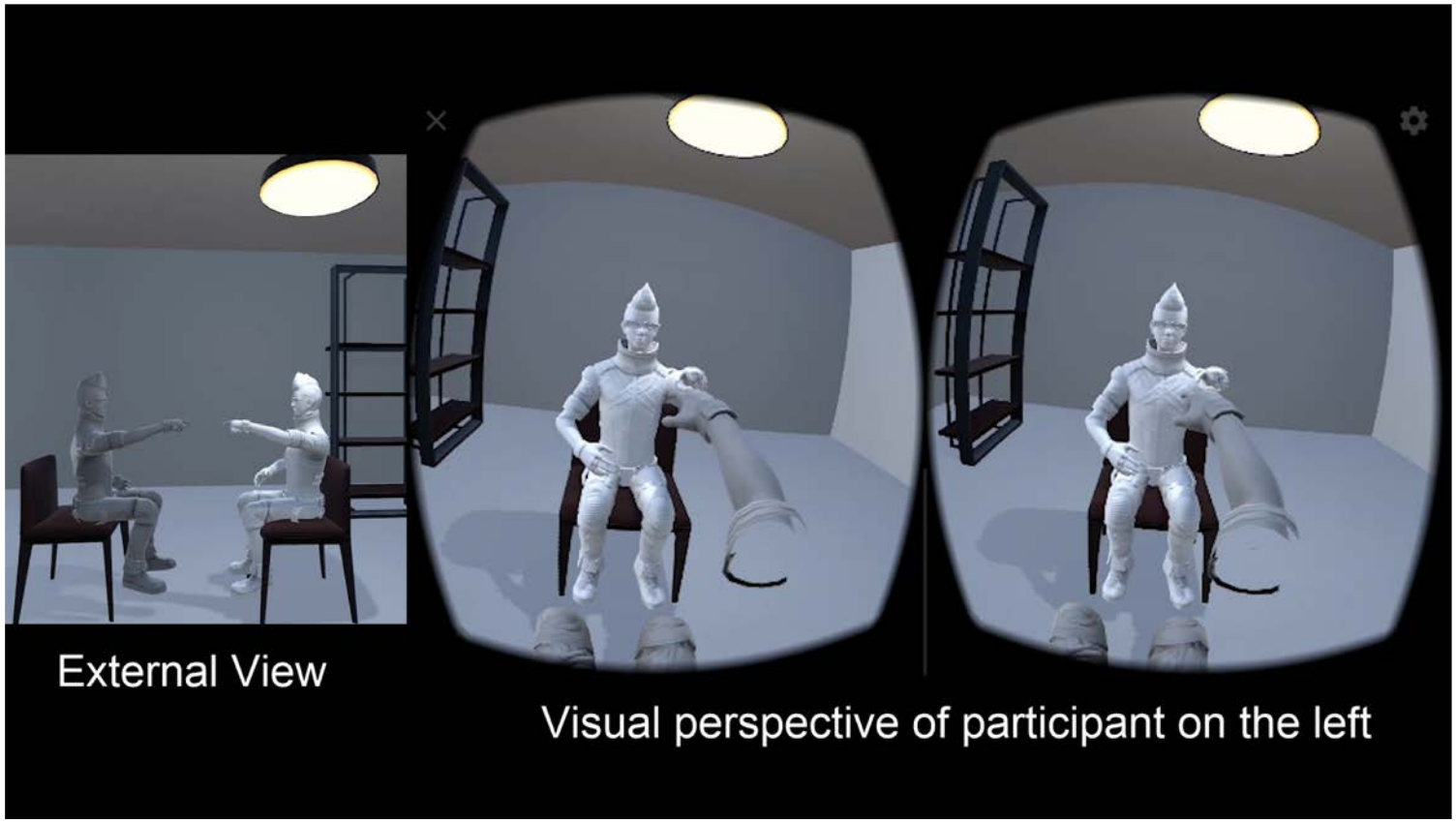
VR Copy of Real World



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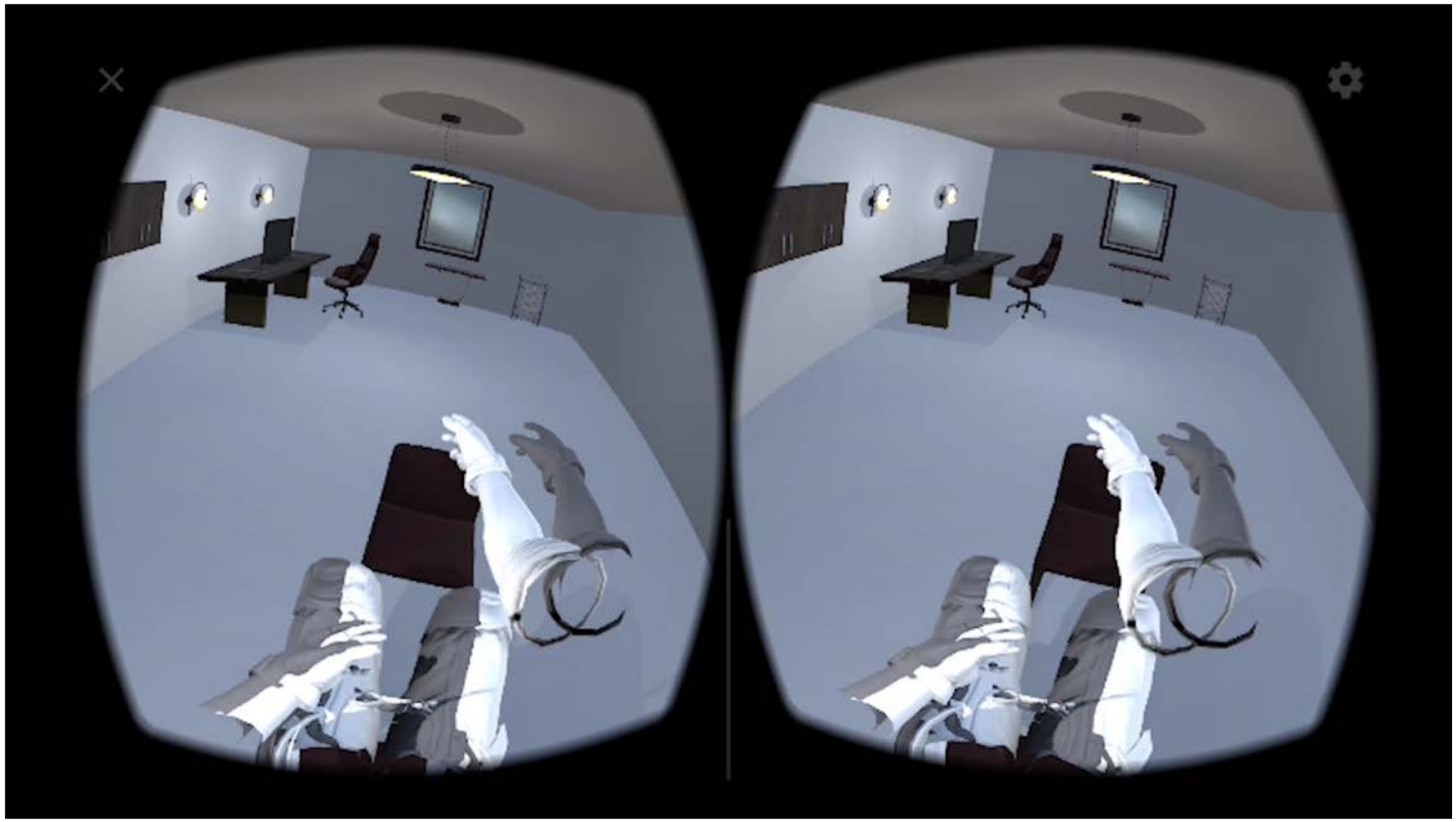
Viewpoint Sharing



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	Number of Connections			
Freq	Before	After	P value	Chi-square score
Alpha	**154**	**197**	**0.01**	**5.58**
Beta	179	165	> 0.05	
Delta	151	155	> 0.05	
Gamma	199	173	> 0.05	
Theta	175	152	> 0.05	

VR – Face to Face

	Number of Connections			
Freq	Before	After	P value	Chi-square score
Alpha	154	186	> 0.05	
Beta	**141**	**169**	**0.002**	**9.50**
Delta	137	160	> 0.05	
Gamma	202	145	0.001	9.92
Theta	202	145	0.001	9.92

VR – Shared Viewpoint

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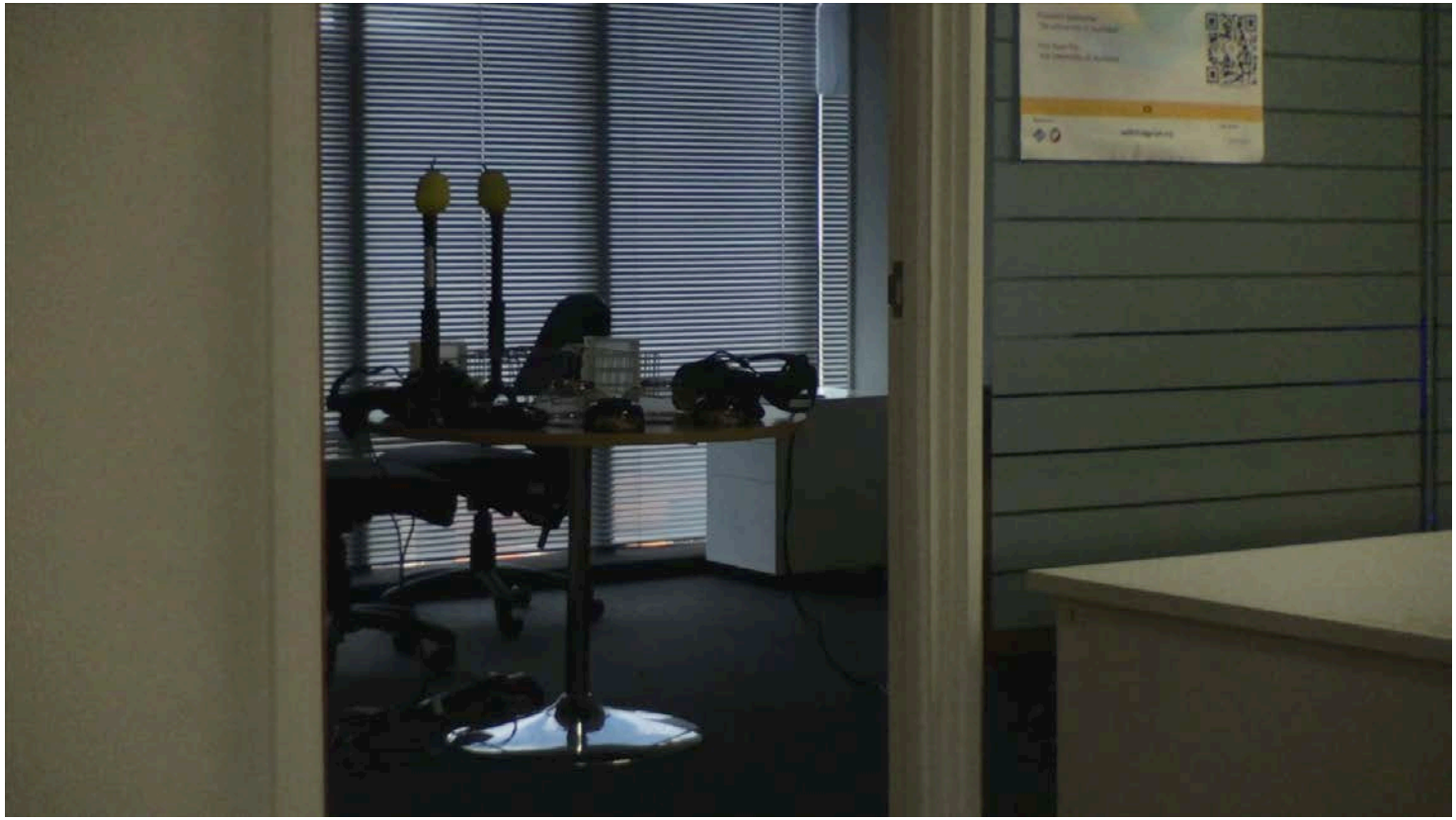

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Conclusions

Trend towards Empathic Computing

- Understanding, Experiencing, Sharing

AR/VR Enables Empathic Experiences

- Changes perspective
- Sharing space/experience
- Supports annotation/communication

Many directions for future research

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