

# AUGMENTED REALITY – SHARED SPHERE

---

Mark Billinghamurst

Gun Lee

University of South Australia



**Empathic Computing Lab**

Systems That Create Understanding



**University of  
South Australia**











22 February 2011 at 12:51 pm - Magnitude 6.3 Earthquake

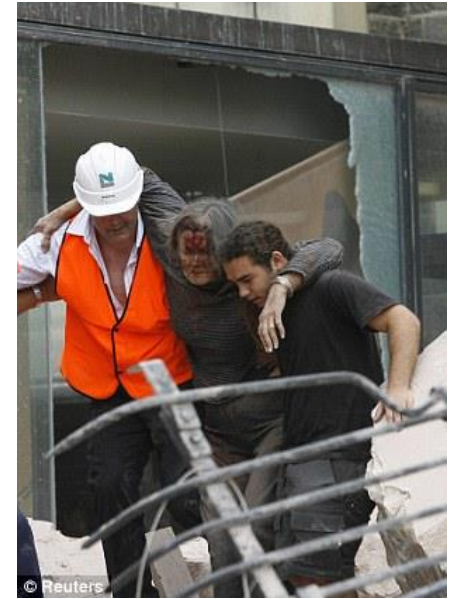
# PGC Building – Before and After







# Matty Lovell

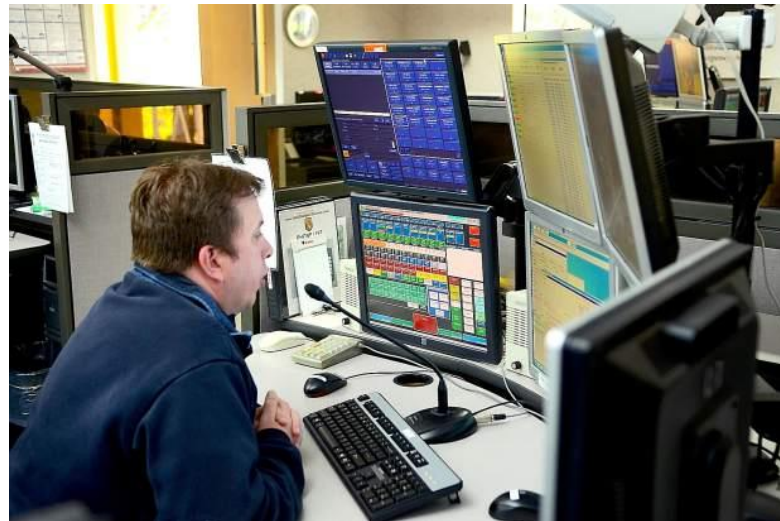


- First responder, finding people in collapsed building



# Remote Assistance

- How can expert outside the building help the first responder?
- **Wearable system**
  - Live camera view
  - Remote annotation
  - Information display
  - Sensor feedback





# Google Glass



- Camera + Processing + Display + Connectivity
- Ego-Vision Collaboration (But with Fixed View)

# Augmented Reality



- Combines Real and Virtual Images
- Interactive in real-time
- Virtual content registered in 3D

Azuma, R. T. (1997). A survey of augmented reality. *Presence*, 6(4), 355-385.

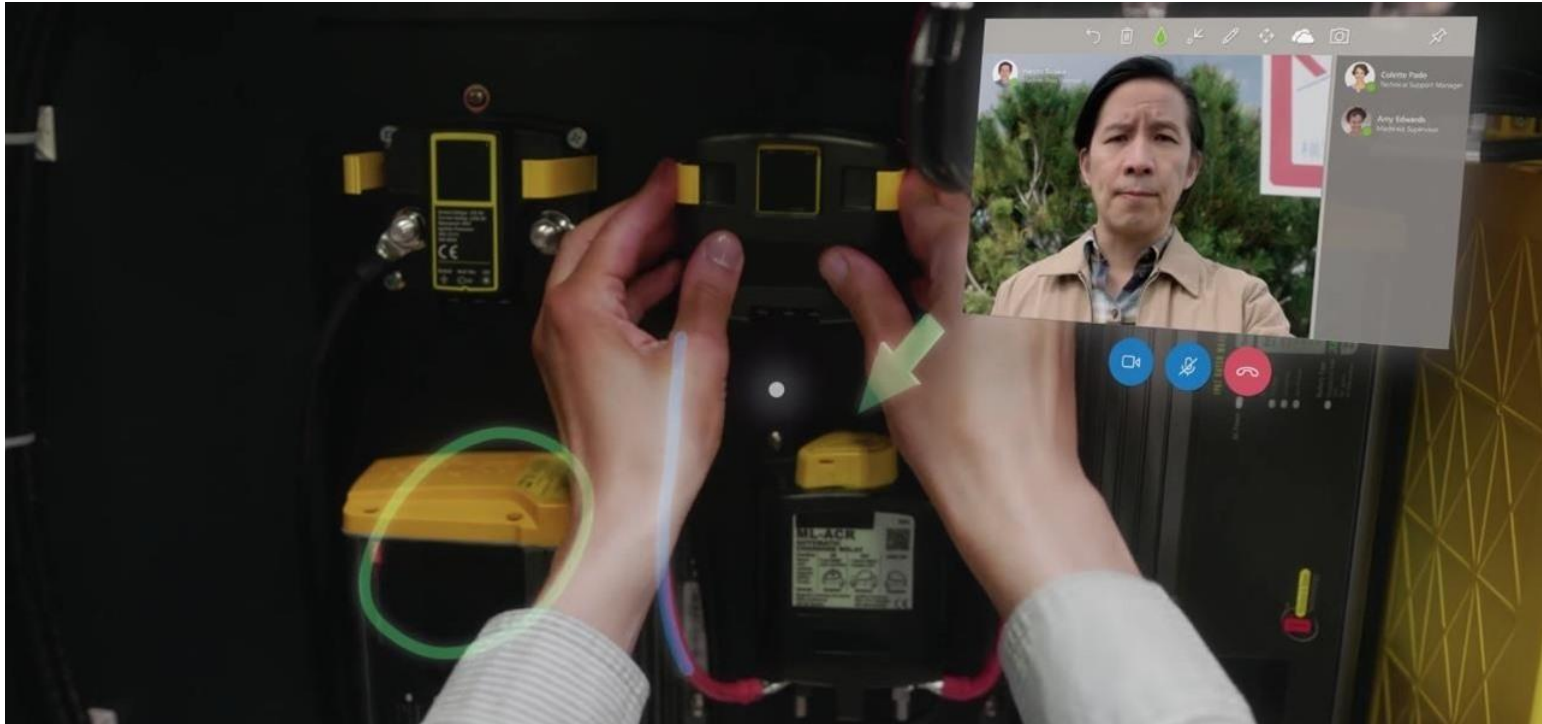


# AR for Remote Collaboration

- **Many previous examples**
  - View sharing
  - Remote annotation
  - Virtual video conferencing



# HoloLens Remote Assist



- Share workers view with remote expert on desktop
- Support AR annotations, gesture input





<https://www.youtube.com/watch?v=UpmolMrf5HQ>

# Current Collaboration on Wearables



- **First person remote conferencing/hangouts**
- **Limitations**
  - View fixed to sender, Lack of spatial understanding
  - Few communication cues, Limited situational awareness



# Social Panoramas (ISMAR 2014)



- Capture and share social spaces in real time
- Supports independent views into Panorama

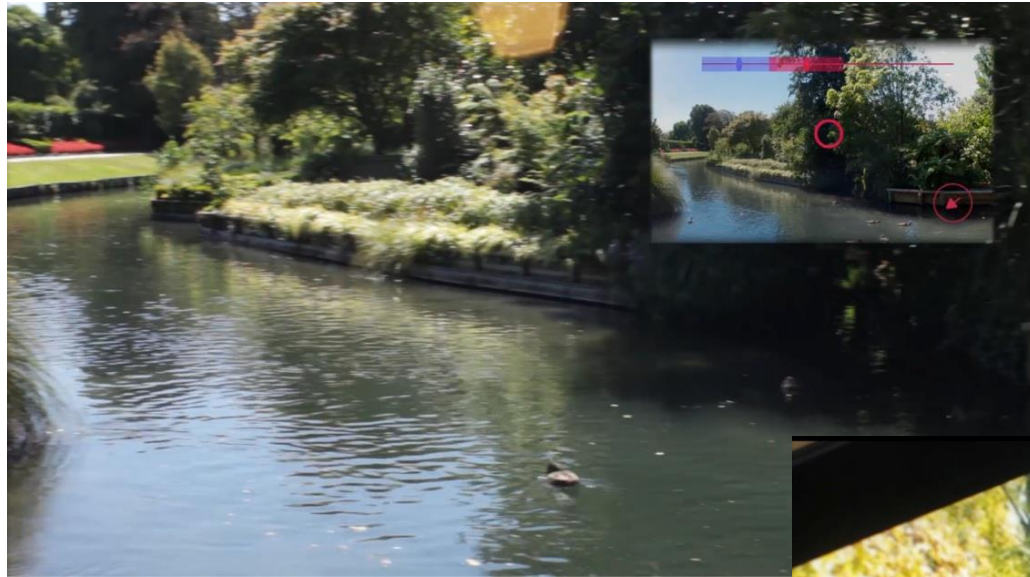
# Implementation



- **Google Glass**
  - Capture live image panorama (compass + camera)
- **Remote device (tablet)**
  - Immersive viewing, live annotation

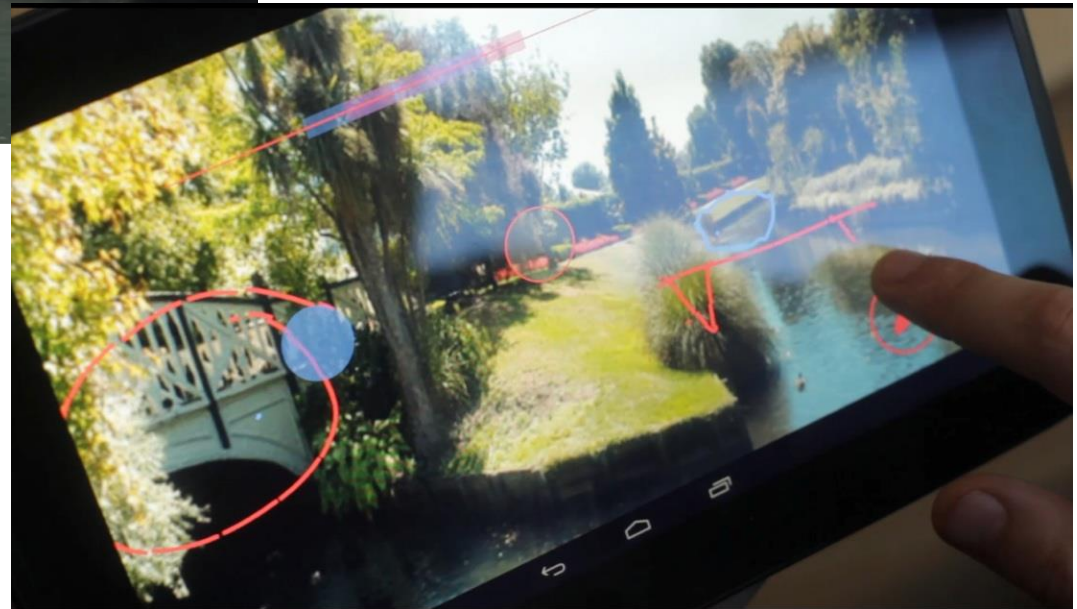


# User Interfaces



Glass View

Tablet View

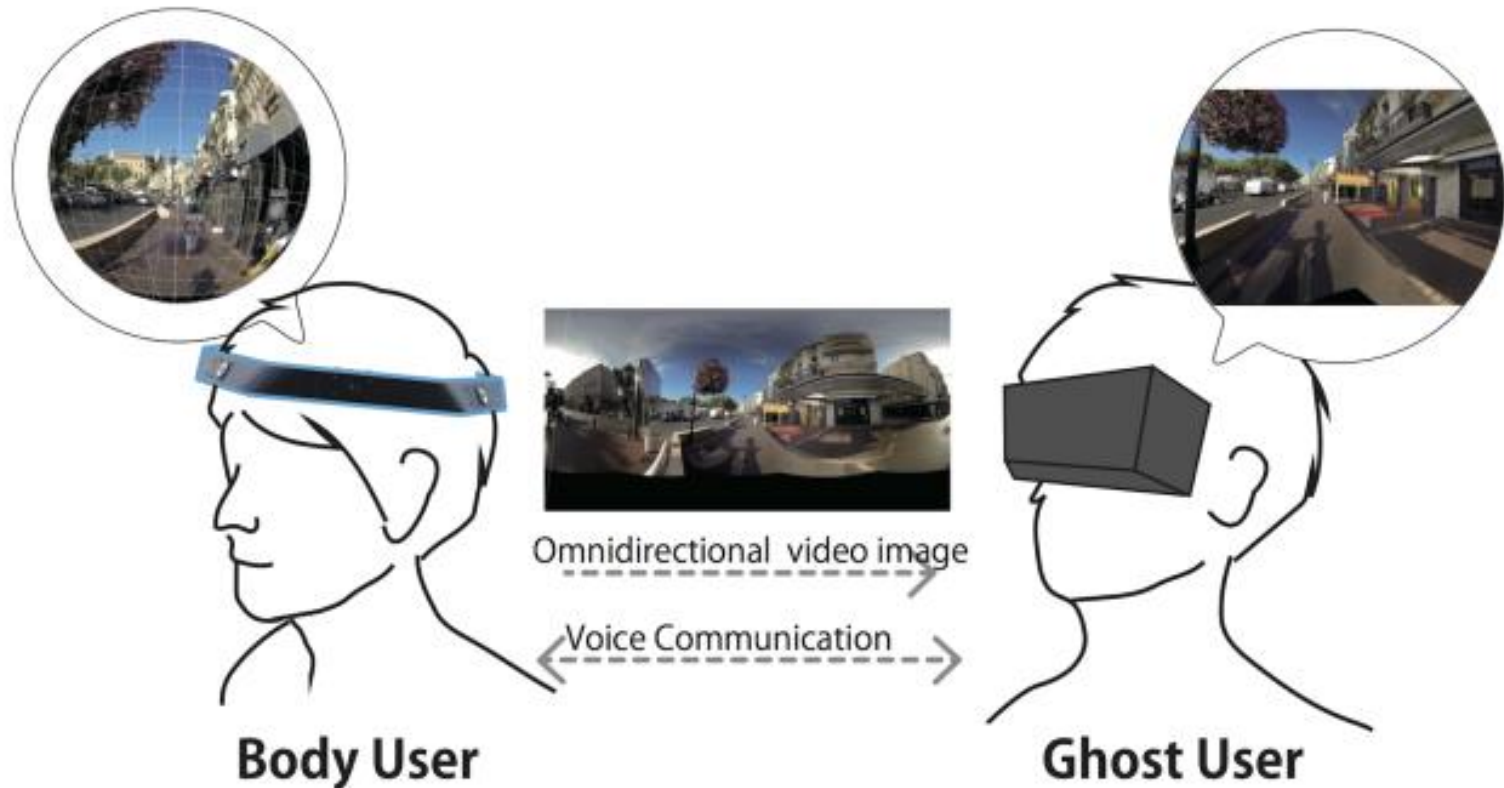


# Social Panorama Demo



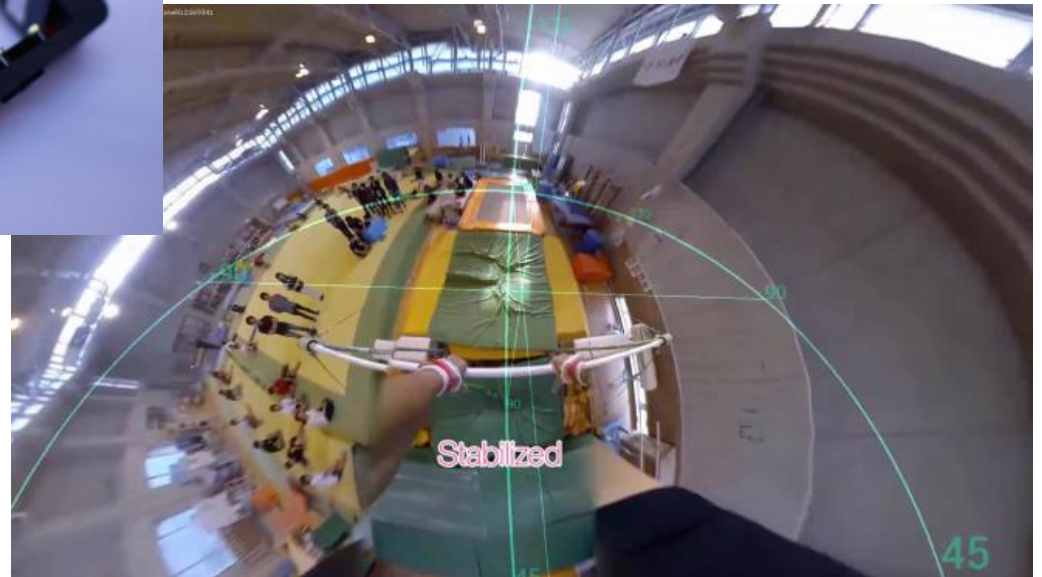


# JackIn – Live Immersive Video (2015)



- Jun Rekimoto – University of Tokyo/Sony CSL

# JackIn Hardware



- Wide angle cameras – 360 degree video capture
- Live video stitching



# JackIn Demo

**Sports Virtual Reality  
with JackIn Head**



# Joseph Tame – Tokyo Marathon

**JOSEPH  
RUNS  
MARATHON**



**YOU 'RUN'  
SITTING  
ON SOFA**



**LIVE STABILISED  
360° VIDEO  
FROM JACK-IN HEAD  
CAMERA VIA INTERNET  
TO IPHONE / ANDROID / PC**



- Live streaming from Tokyo marathon
- <http://josephta.me/en/tokyo-marathon/>



# Inexpensive 360 Cameras



Kodac 360



Fly 360



Gear 360



Theta S



Nikon



LG 360



Pointgrey Ladybug



Panono 360



Bublcam

# Shared Sphere



Host User



Shared  
Live 360 Video



Guest User



# Shared Sphere System Features

- **AR / VR view collaboration**
  - VR user feels that they are in AR users location
- **View independence**
  - Allow one user to look around independently from another
- **View awareness cues**
  - Show where the other user is looking
- **Hand gesture communication cues**
  - Sharing hand gesture cues



# View Independence



# View Independence

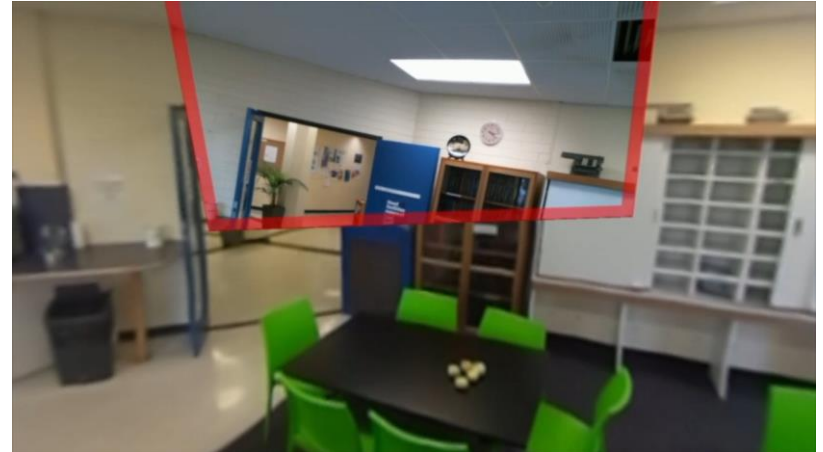


# View Independence



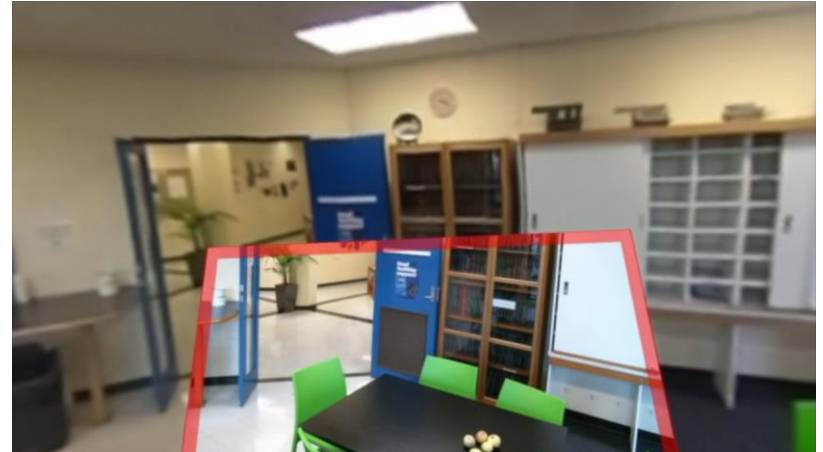


# View Independence



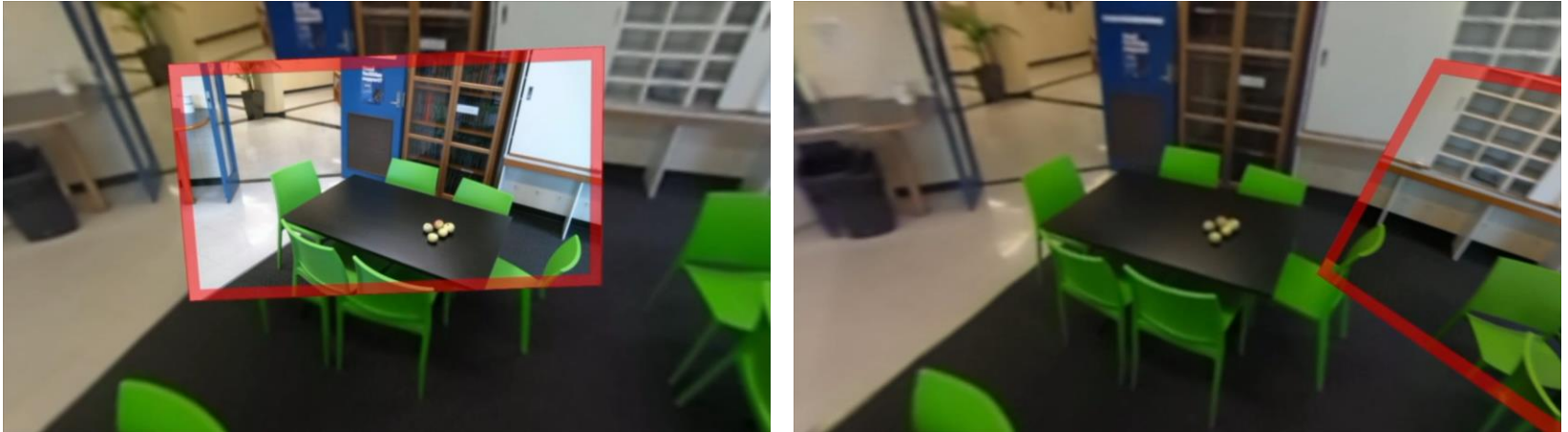
Guest user's view

# View Independence



Guest user's view

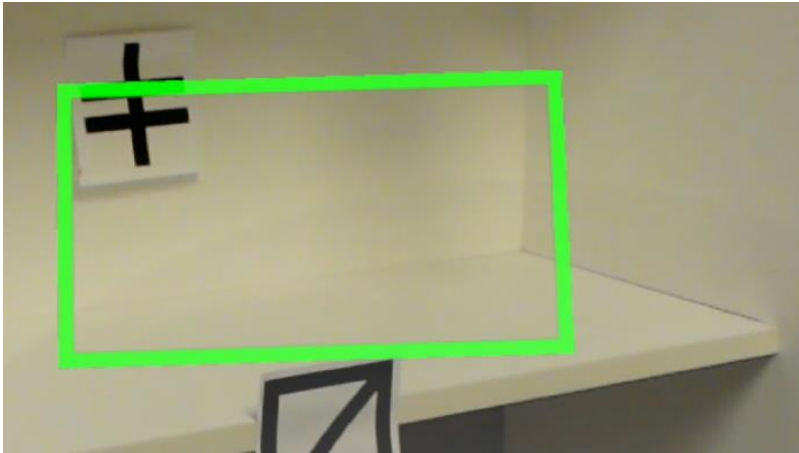
# View Independence



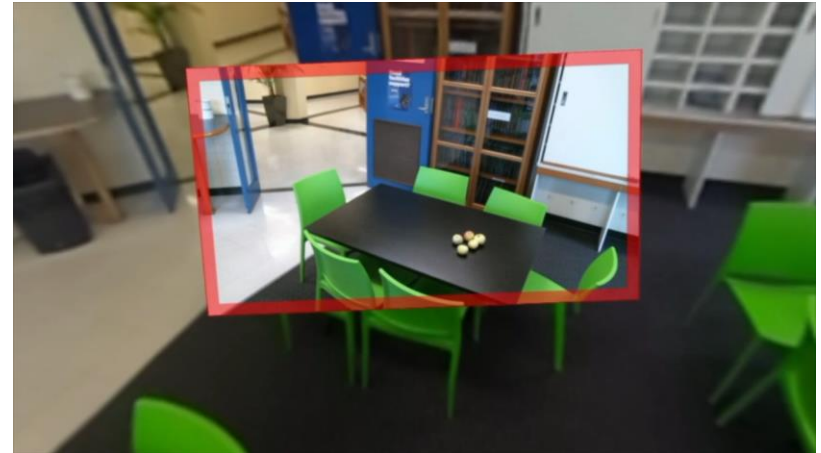
Guest user's view



# View Awareness Cues



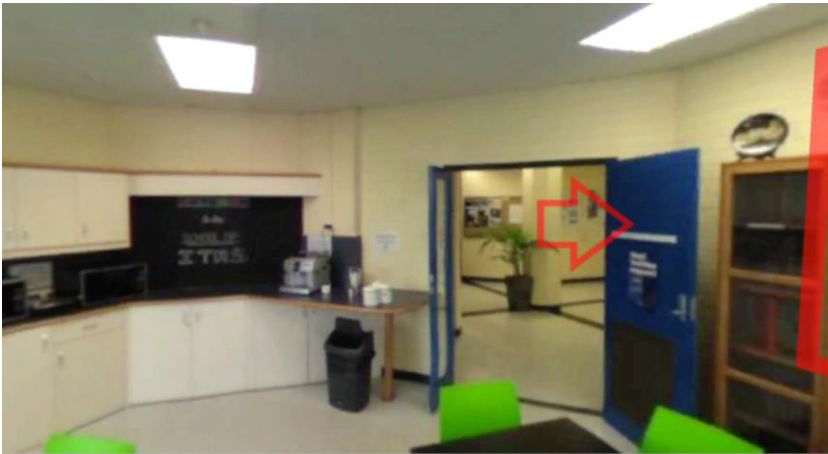
Host user's view



Guest user's view

- View Frame Rectangle
- Optional high-resolution camera inset on guest user

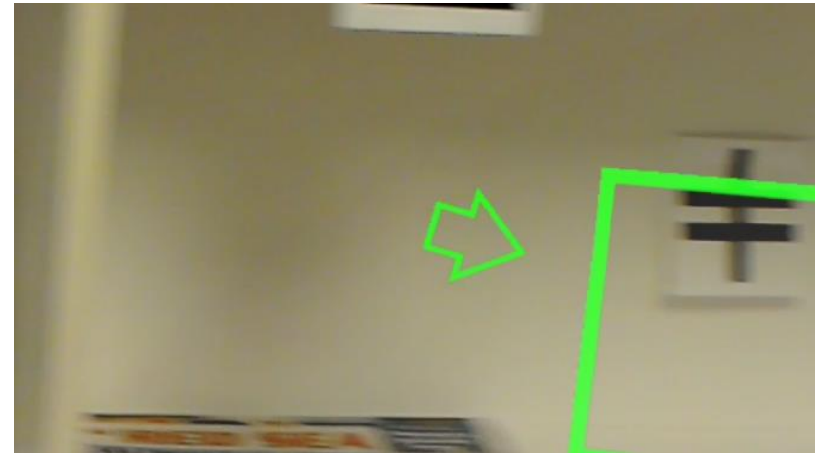
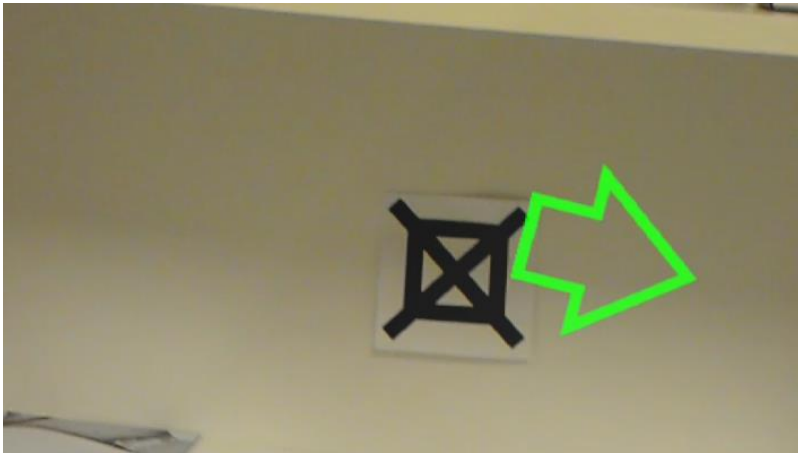
# View Awareness Cues



Guest user's view

- Arrow indicating the view frame out of FOV

# View Awareness Cues



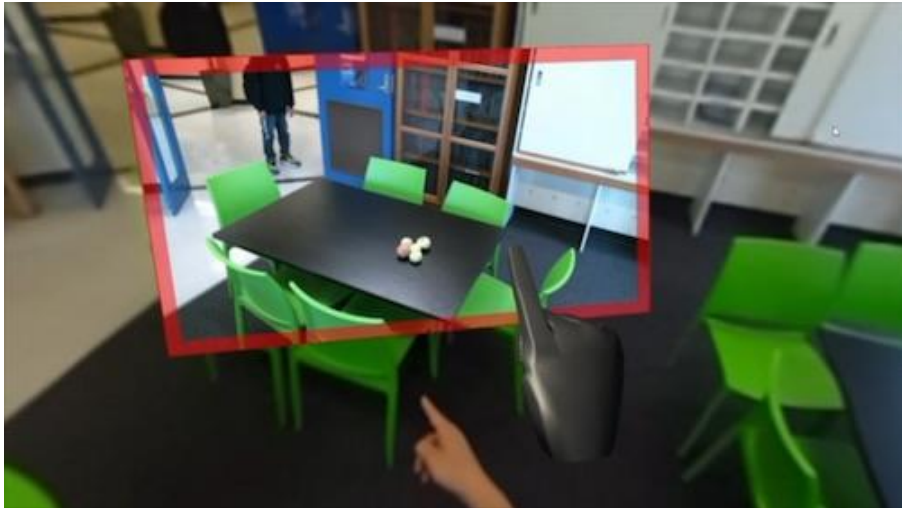
Host user's view

- Arrow size proportional to the angular distance



# Hand Gestures

- One of the representative non-verbal comm. cues

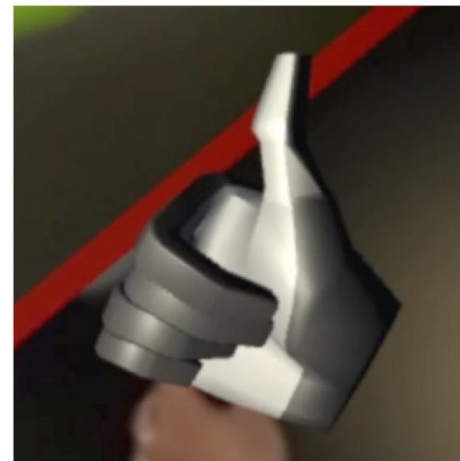
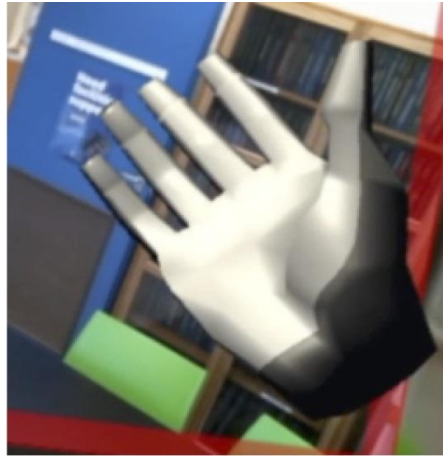
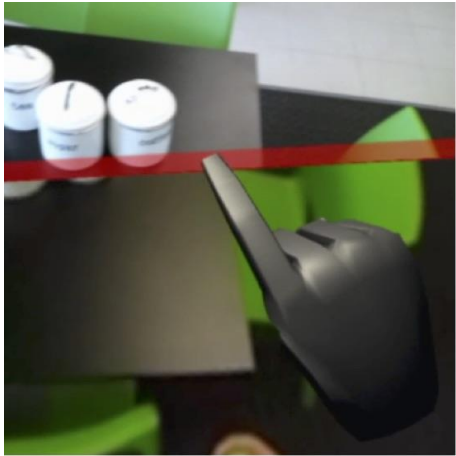


Guest user's view



Host user's view

# Hand Gestures



# Shared Sphere

Empathic Computing Lab  
2017

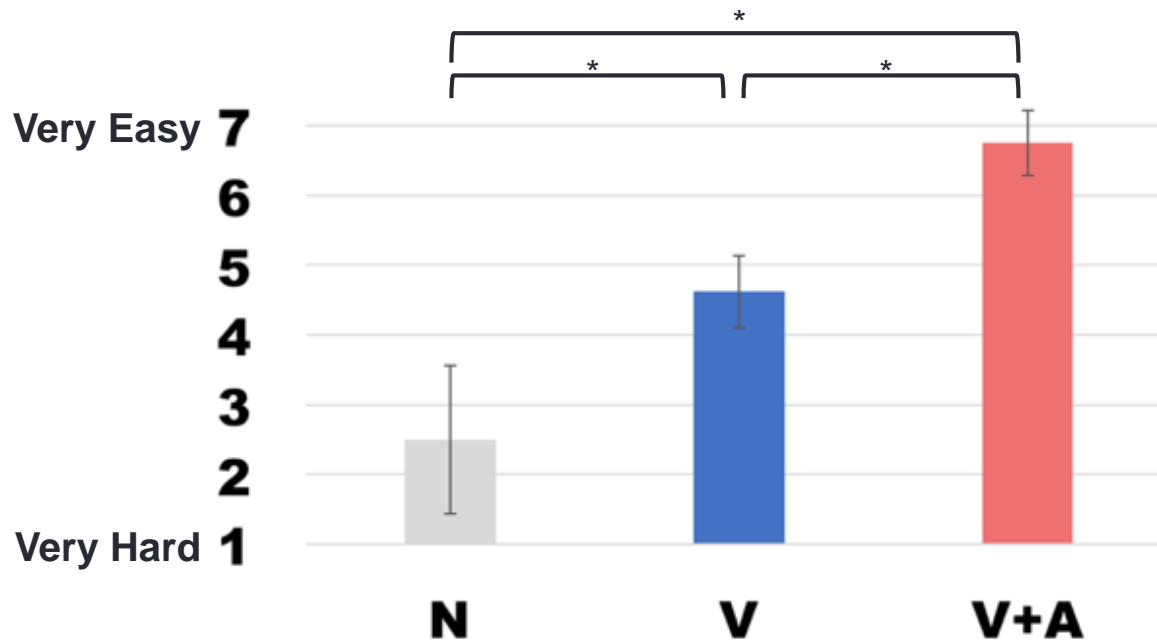


# Preliminary User Study

- **Focus Group Style**
  - **Tech Demonstration**
    - Each participant tried both 'host' and 'guest' user interfaces
    - Task: guessing what other user is looking at
    - 3 configurations: No cue, View Frame only, View Frame+Arrow
  - **Questionnaire**
    - How easy it was to find other person's view? (7-point Likert scale)
    - Strengths and weakness of the system?
  - **Group Discussion**

# Rating Results

- Friedman test ( $\alpha=.05$ )  $\chi^2(2)=16$ ,  $p=.0003$ 
  - Post-hoc tests: WSR with Bonferroni correction ( $\alpha=.0167$ )



# Qualitative Results

- **Strength**

- Immersive experience and independent view control (6 of 8)
- Easily understand what other user is looking at (4 of 8)
- Supporting sharing hand gesture (3 of 8)

- **Weakness**

- Motion sickness: turning and moving view (6 of 8)
  - Better image stabilisation, pause/dim while moving
- Narrow field of view



# Shared Sphere Version 2.0

- Collaboration with SA Power Networks, Nova Systems, PTC
- **Features added**
  - Remote pointing
  - Remote annotation
  - Audio streaming
  - Backpack VR setup
  - HoloLens AR display
  - HTC Vive VR display
  - Improved capture hardware
- **Testing with SAPN personnel**



# Shared Sphere

– 360 Panorama-based Mixed Reality Collaboration

FRONTIER 4.0



University of  
South Australia



Nova Systems  
Experience Knowledge Independence



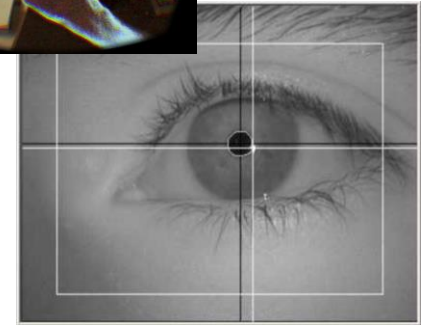
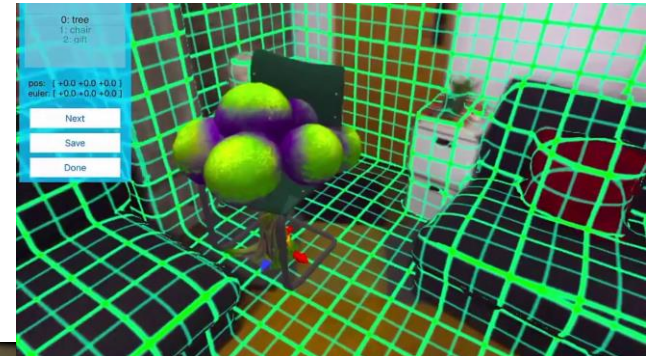
ptc



SA  
Power  
Networks

# 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



# Remote 3D Scene Sharing



Static local environment capturing and sharing for  
MR Remote Collaboration

Lei Gao<sup>1</sup>   Huidong Bai<sup>1</sup>   Robert W. Lindeman<sup>1</sup>   Mark Billingham<sup>2</sup>

<sup>1</sup>University of Canterbury  
<sup>2</sup>University of South Australia



# 3D Scene Capture



Scene Capture

# Technology Trends

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



Empathic  
Tele-Existence

# Conclusion & Future Work

- **Shared Sphere**

- View independence
- View awareness cues
- Hand gesture communication cues

- **Future work**

- Further formal user evaluation with real-world scenarios
- Richer non-verbal communication cues (eye gaze, face exp.)
- Scaling up to 1-to-many sharing
- Better scene capture – 3D capture



[www.empathiccomputing.org](http://www.empathiccomputing.org)



[mark.billinghurst@unisa.edu.au](mailto:mark.billinghurst@unisa.edu.au)



[@marknb00](https://twitter.com/marknb00)