QCon 全球软件开发大会
INTERNATIONAL SOFTWARE DEVELOPMENT CONFERENCE

BEIJING 2018

Future Directions for Augmented Reality

Mark Billinghurst

主办方 Geekbang. 极客邦科技 InfoQ

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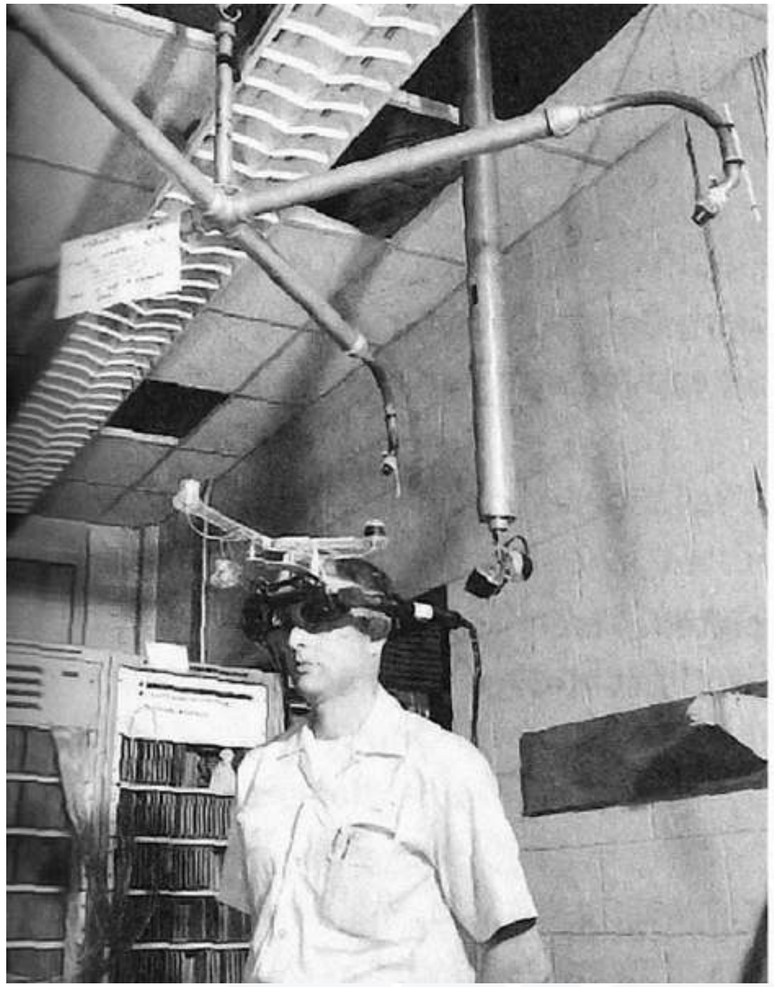
全球技术领导力峰会

通往**年薪百万**的CTO的路上，
如何打造自己的技术**领导**力？

扫描二维码了解详情

1968 – Sutherland/Sproull's HMD



https://www.youtube.com/watch?v=NtwZXGprxag

Star Wars - 1977

Augmented Reality

- Combines Real and Virtual Images
  - Both can be seen at the same time
- Interactive in real-time
  - The virtual content can be interacted with
- Registered in 3D
  - Virtual objects appear fixed in space

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

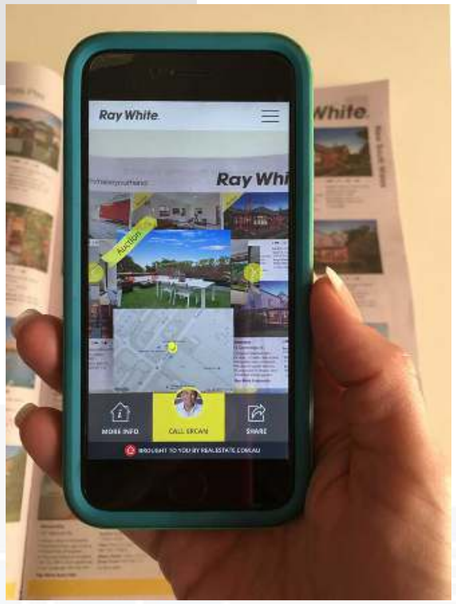
2008 - CNN

https://www.youtube.com/watch?v=v7fQ_EsMJMs

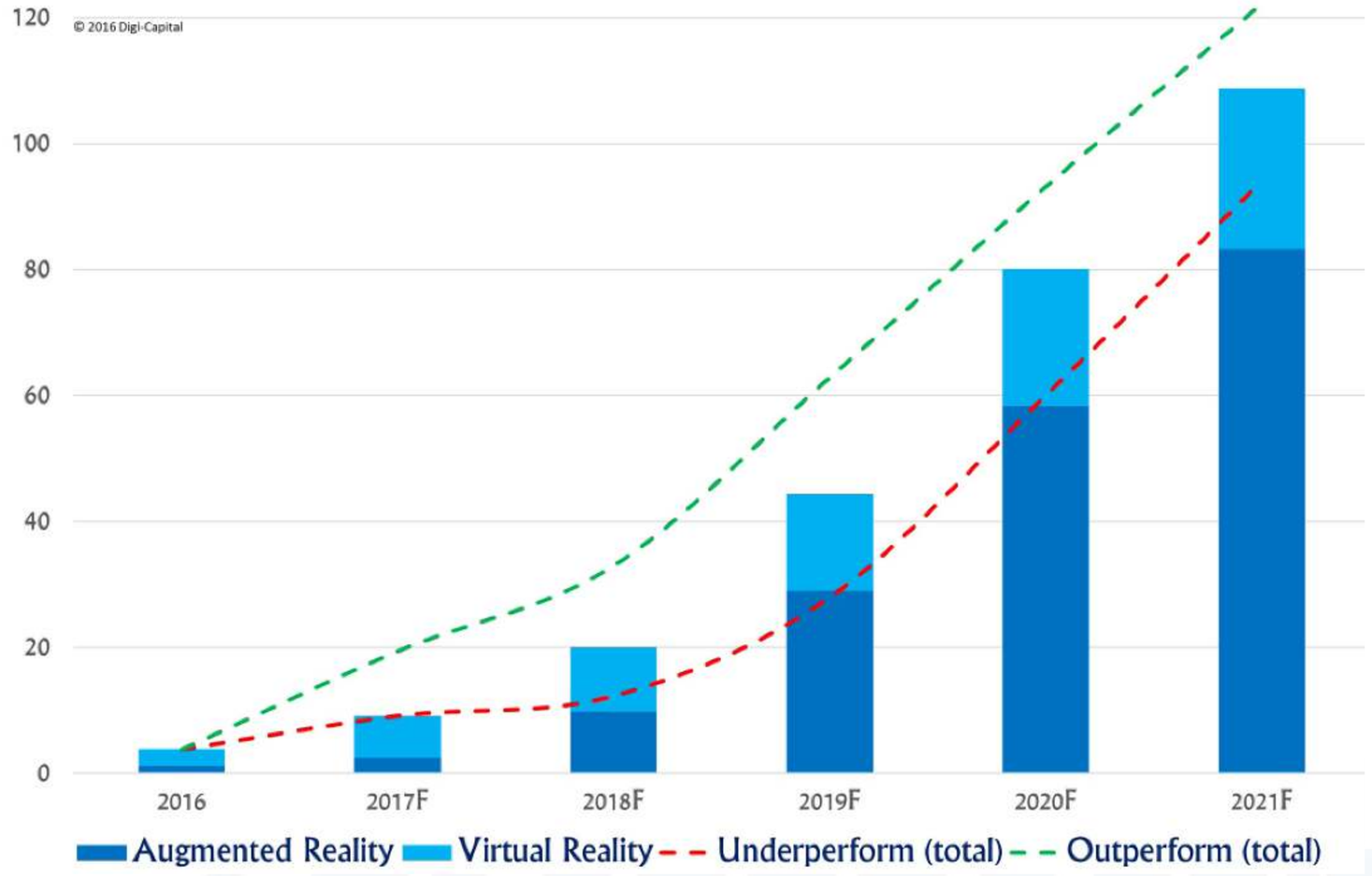
Augmented Reality Applications

Augmented Reality in 2018

- Large growing market
  - $1.2B USD in 2016, $3B in 2017
- Many available devices
  - HMD, phones, tablets, HUDs
- Robust developer tools
  - Vuforia, ARToolKit, Unity, Wikitude, etc
- Large number of applications
  - > 250K developers, > 100K mobile apps
- Strong research/business communities
  - ISMAR, AWE conferences, AugmentedReality.org, etc



AR Revenue Projections



- > $80Bilion by 2021, > 3x VR Revenue (Digi-Capital)

Future directions

Key Enabling Technologies

- Combines Real and Virtual Images

  Display Technology

- Interactive in real-time

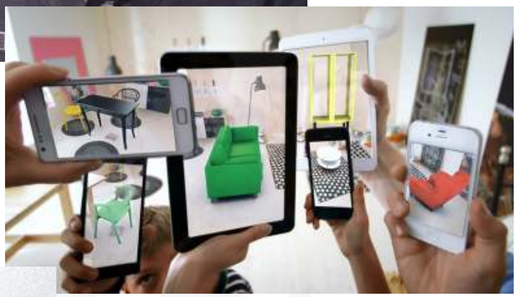
  Int

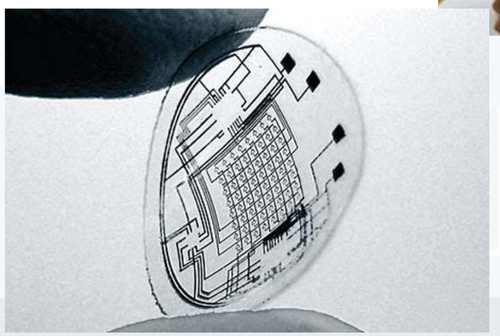
- Registered in 3D

  T

Display Technology

- Past
  - Bulky Head mounted displays
- Current
  - Handheld, lightweight head mounted
- Future
  - Projected AR
  - Wide FOV see through
  - Retinal displays
  - Contact lens





Wide FOV See-Through (3+ years)

- Waveguide techniques
  - Thin, wider FOV
  - Socially acceptable

Lumus DK40

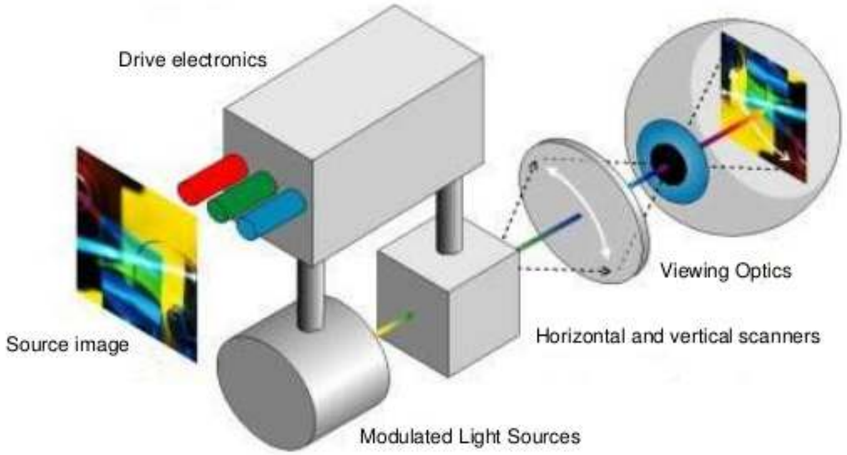
- Pinlight Displays
  - LCD panel + point light sources
  - 110 degree FOV

Maimone, A., Lanman, D., Rathinavel, K., Keller, K., Luebke, D., & Fuchs, H. (2014). Pinlight displays: wide field of view augmented reality eyeglasses using defocused point light sources. In *ACM SIGGRAPH 2014 Emerging Technologies* (p. 20). ACM.

https://www.youtube.com/watch?v=P407DFm0PFQ

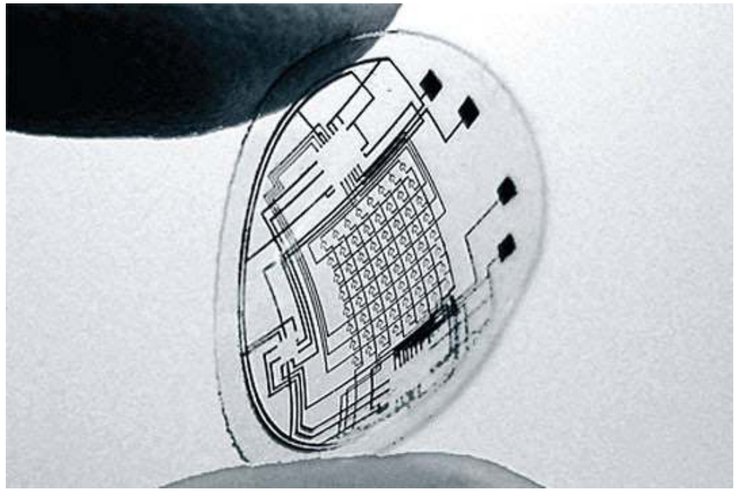
Retinal Displays (5+ years)

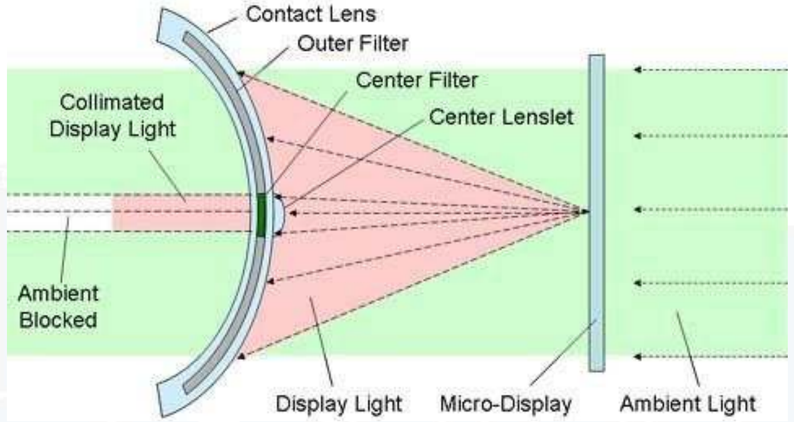
- Photons scanned into eye
  - Infinite depth of field
  - Bright outdoor performance
  - Overcome visual defects
  - True 3D stereo with depth modulation
- Microvision (1993-)
  - Head mounted monochrome
- MagicLeap (2013-)



Contact Lens (10 – 15 + years)

- Contact Lens only
  - Unobtrusive
  - Significant technical challenges
    - Power, data, resolution
  - Babak Parviz (2008)
- Contact Lens + Micro-display
  - **Wide FOV**
  - **socially acceptable**
  - **Innovega** (innovega-inc.com)





http://spectrum.ieee.org/biomedical/bionics/augmented-reality-in-a-contact-lens/

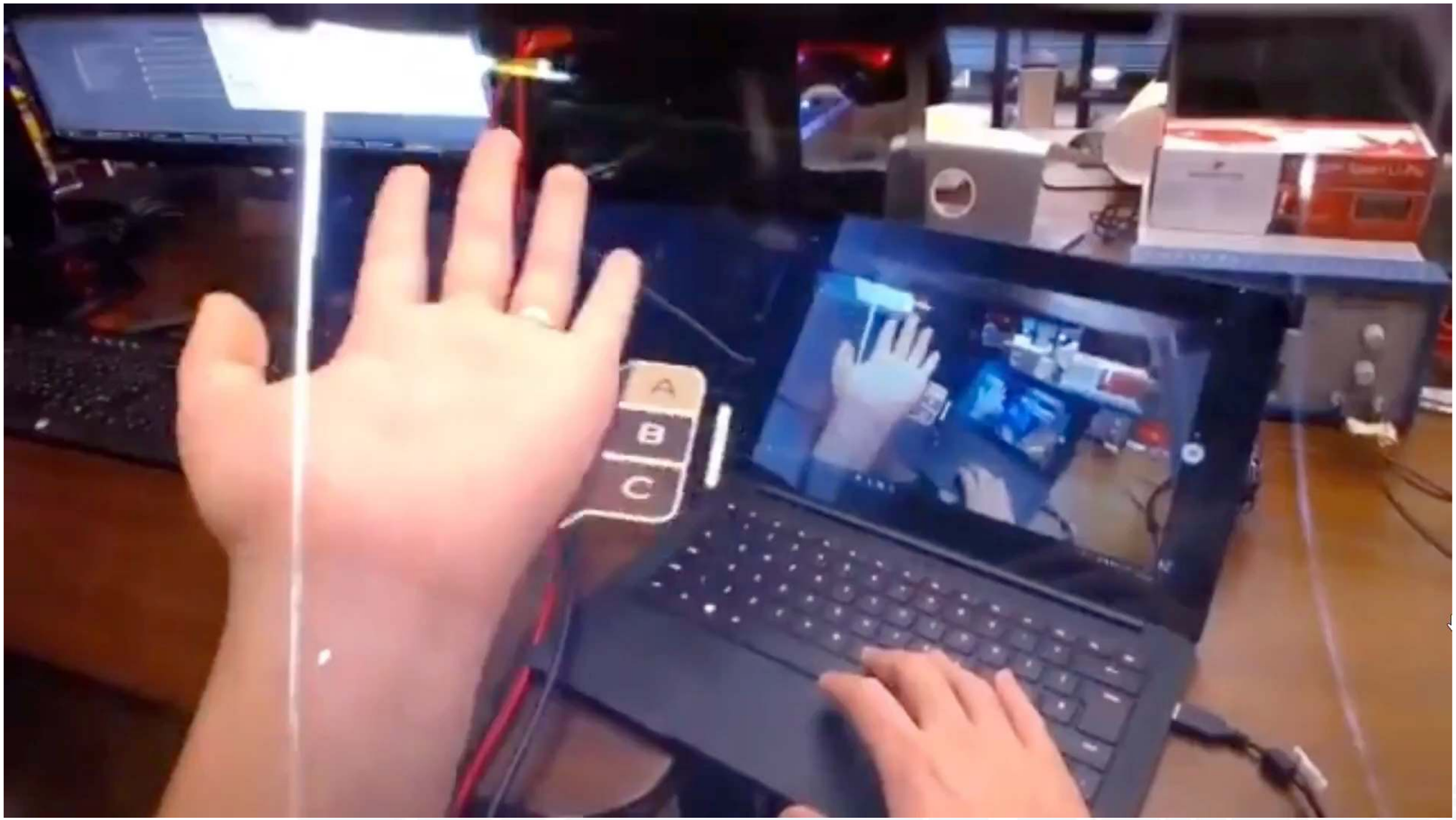
Interaction

- Past
  - Limited interaction
  - Viewpoint manipulation
- Present
  - Screen based, simple gesture
  - tangible interaction
- Future
  - Natural gesture, Multimodal
  - Intelligent Interfaces
  - Physiological/Sensor based

Natural Gesture (2-5 years)

- Freehand gesture input
  - Depth sensors for gesture capture
  - Rich two handed gestures
- E.g. Microsoft Research Hand Tracker
  - 3D hand tracking, 30 fps, single sensor
- Commercial Systems
  - Meta, MS Hololens, Occulus, Leap Motion, Intel, etc

Sharp, T., Keskin, C., Robertson, D., Taylor, J., Shotton, J., Leichter, D. K. C. R. I., ... & Izadi, S. (2015, April). Accurate, Robust, and Flexible Real-time Hand Tracking. In *Proc. CHI* (Vol. 8).



https://www.youtube.com/watch?v=LblxKvbfEoo

Multimodal Input (5-10+ years)

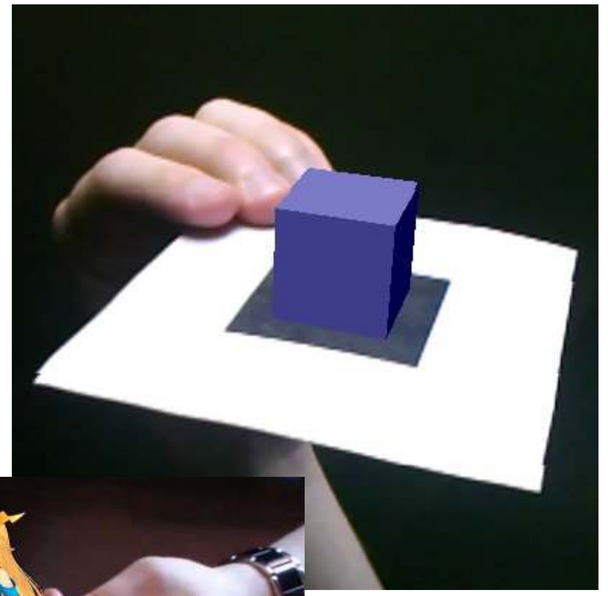
- Combine gesture and speech input
  - Gesture good for qualitative input
  - Speech good for quantitative input
  - Support combined commands
    - “Put that there” + pointing
- E.g. HIT Lab NZ multimodal input
  - 3D hand tracking, speech, multimodal fusion
  - Complete tasks faster with MMI, less errors

Billinghurst, M., Piumsomboon, T., & Bai, H. (2014). Hands in Space: Gesture Interaction with Augmented-Reality Interfaces. *IEEE computer graphics and applications*, (1), 77-80.

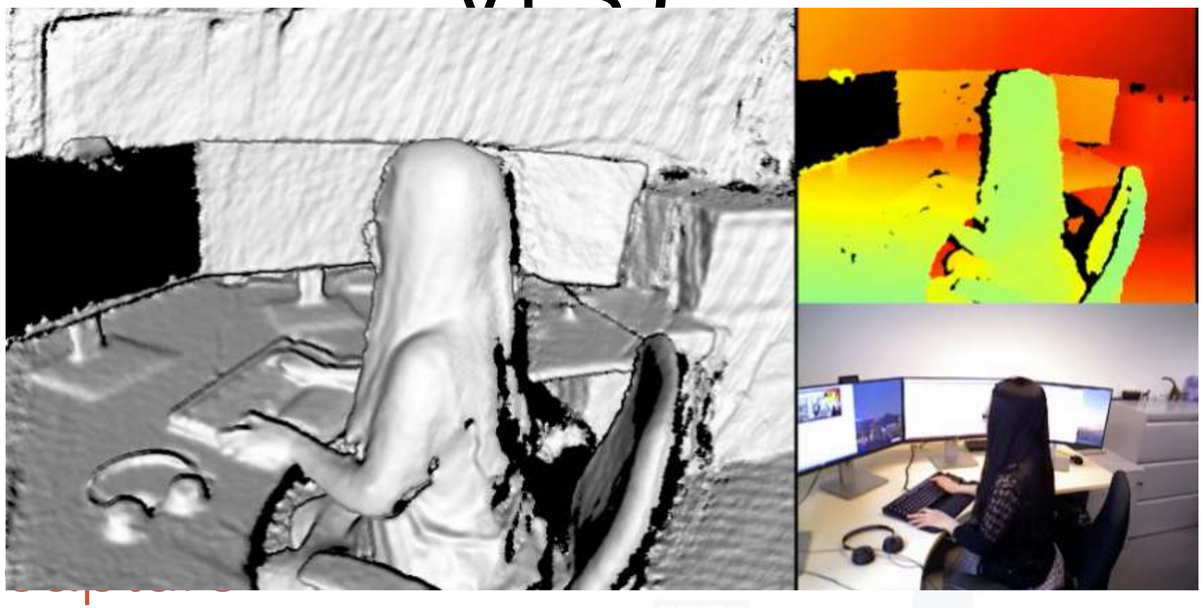
HIT Lab NZ Multimodal Input

Tracking

- Past
  - Location based, marker based,
  - magnetic/mechanical
- Present
  - Image based, hybrid tracking
- Future
  - Ubiquitous
  - Model based
  - Environmental



Environmental Tracking (1-3+ yrs)

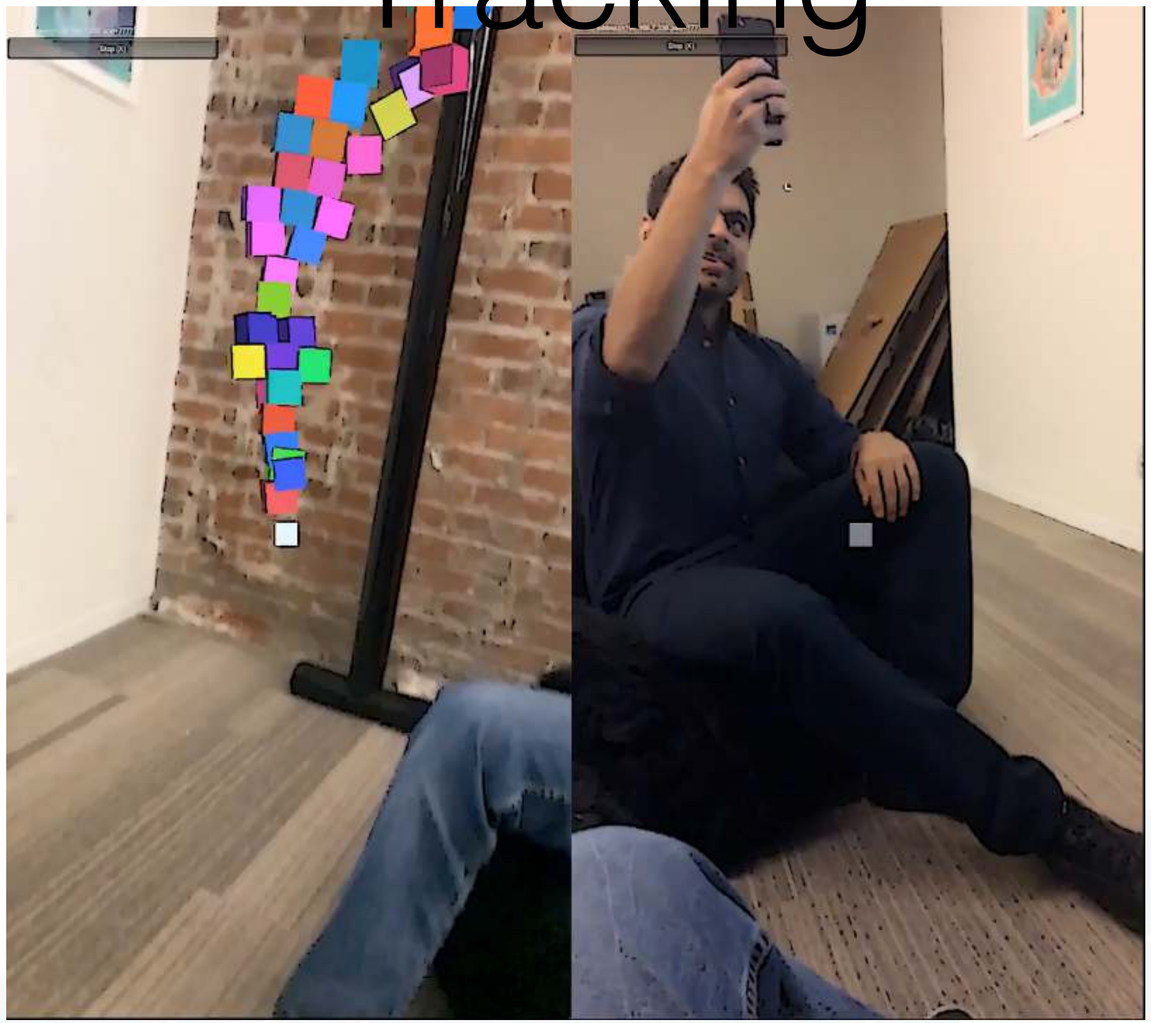


- Environment capture
  - Use depth sensors to capture scene & track from model
- InifinitAM (www.robots.ox.ac.uk/~victor/infinitam/)
  - Real time scene capture on mobiles, dense or sparse capture

InfinitAM Demo

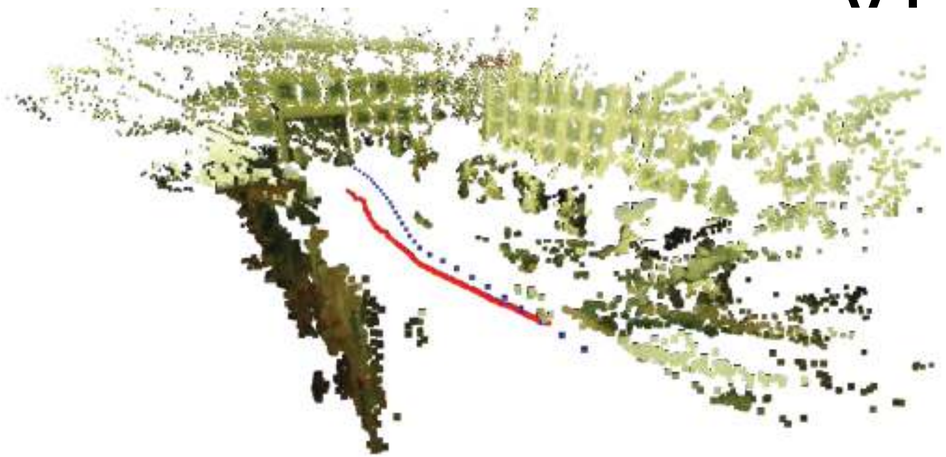
https://www.youtube.com/watch?v=47zTHHxJjQU

Ubiquity6 - AR Cloud Tracking



https://www.youtube.com/watch?v=LxQY_7COzQg

Wide Area Outdoor Tracking (5 + yrs)



- Combine panorama's into point cloud model (offline)
- Initialize camera tracking from point cloud
- Update pose by aligning camera image to point cloud
- Accurate to 25 cm, 0.5 degree over very wide area

Ventura, J., & Hollerer, T. (2012). Wide-area scene mapping for mobile visual tracking. In *Mixed and Augmented Reality (ISMAR), 2012 IEEE International Symposium on* (pp. 3-12). IEEE.

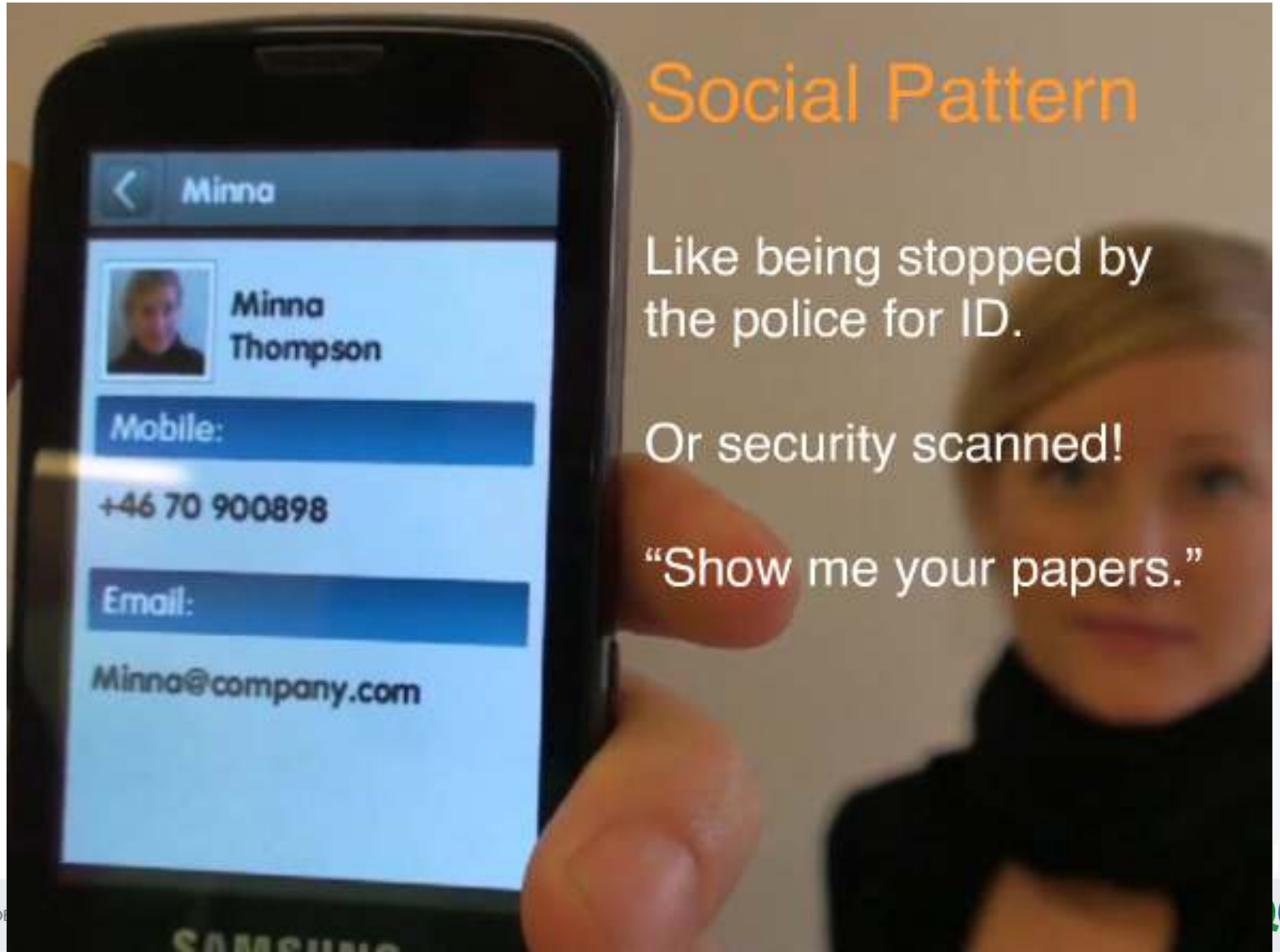
Wide Area Outdoor Tracking

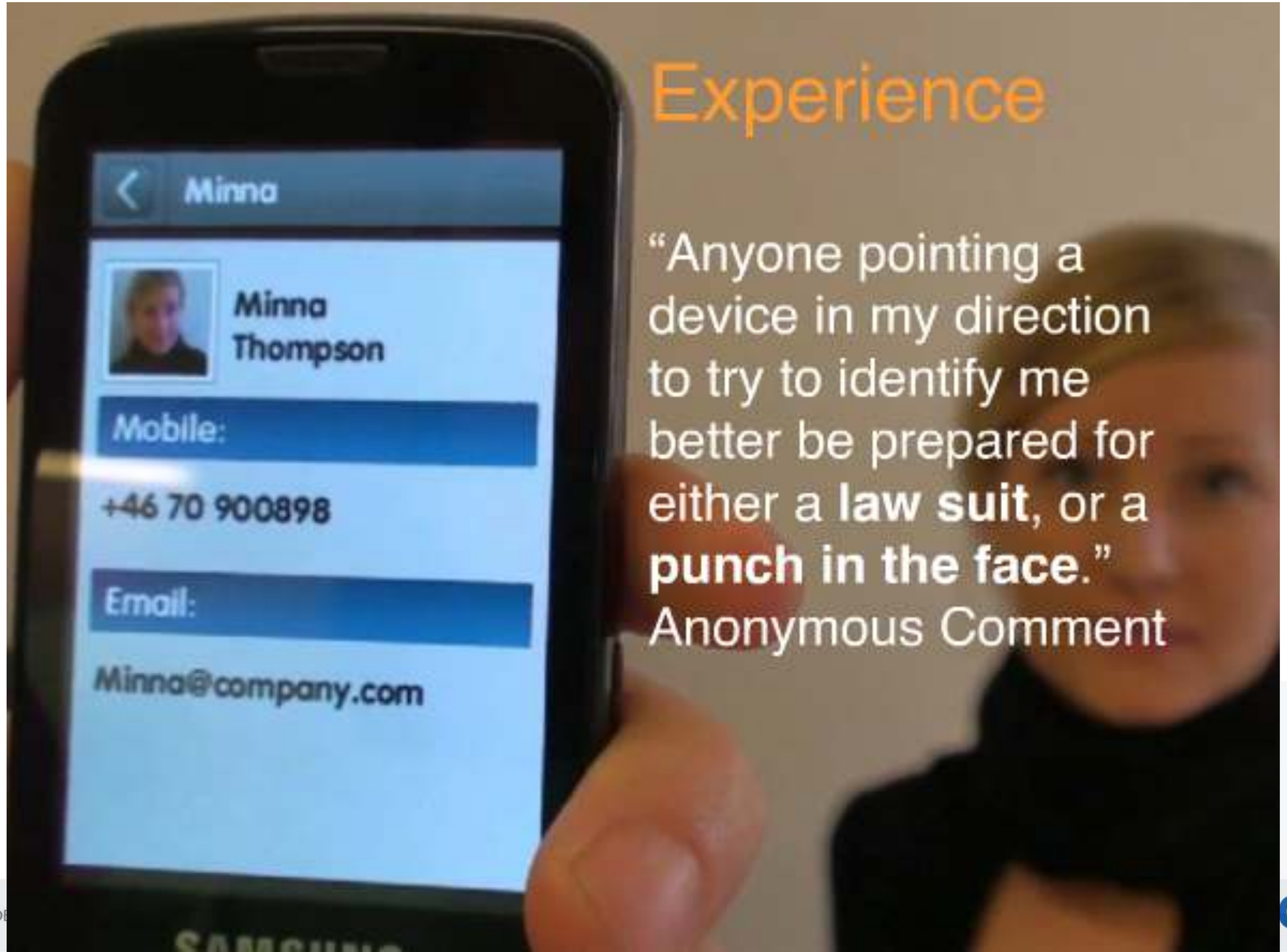
Social Acceptance

- People don’t want to look silly
  - Only 12% of 4,600 adults would be willing to wear AR glasses
  - 20% of mobile AR browser users experience social issues
- Acceptance more due to Social than Technical issues

Example: TAT Augmented ID

TAT AugmentedID


Minna
Minna
Thompson
Mobile:
+46 70 900898
Email:
Minna@company.com
Social Pattern
Like being stopped by the police for ID.
Or security scanned!
“Show me your papers.”


Minna
Minna
Thompson
Mobile:
+46 70 900898
Email:
Minna@company.com
Experience
“Anyone pointing a device in my direction to try to identify me better be prepared for either a **law suit**, or a **punch in the face**.”
Anonymous Comment

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New Research

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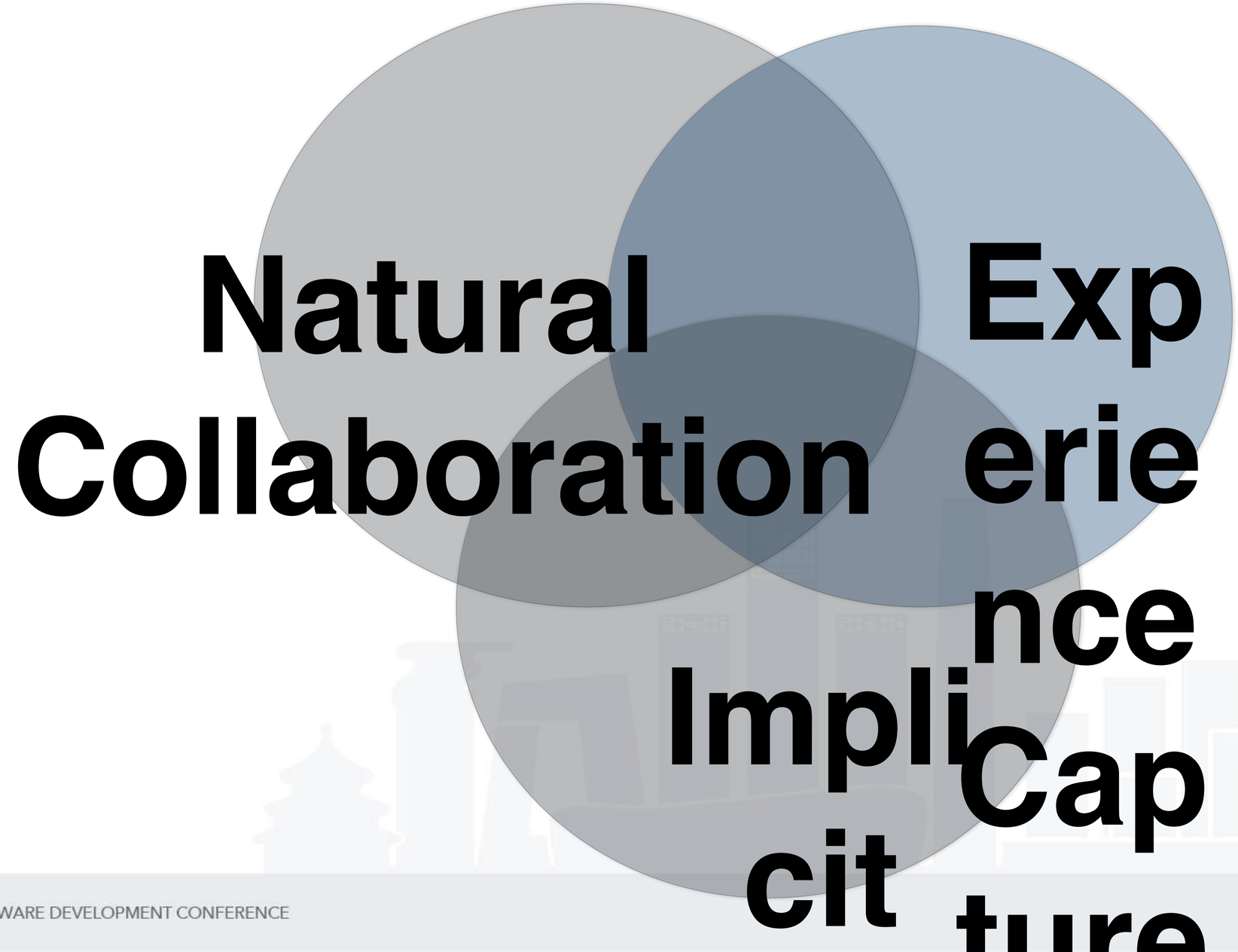
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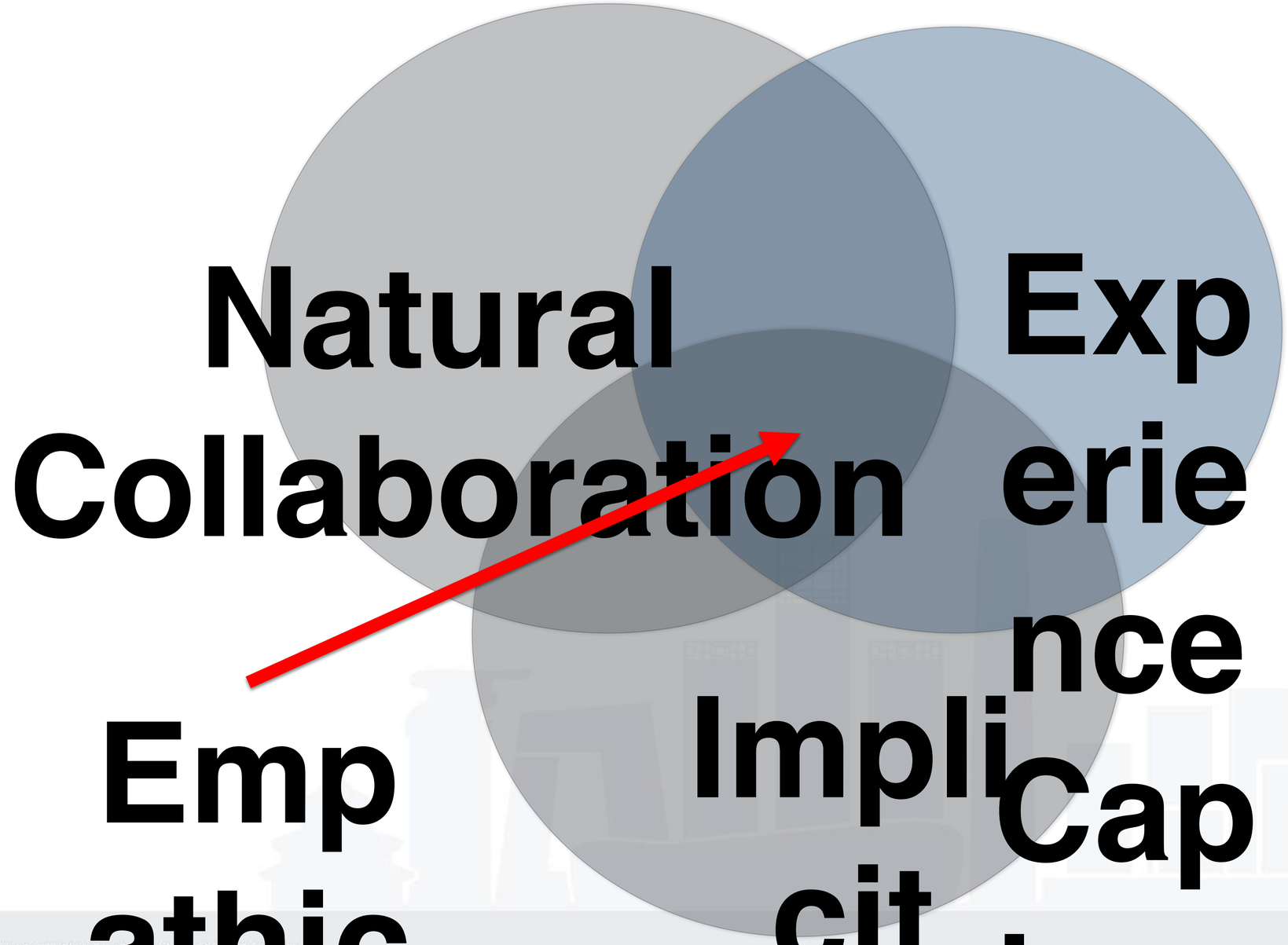
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Empathic Computing

Systems that allow us to share what we are seeing, hearing and feeling with others..

Empathy Glasses


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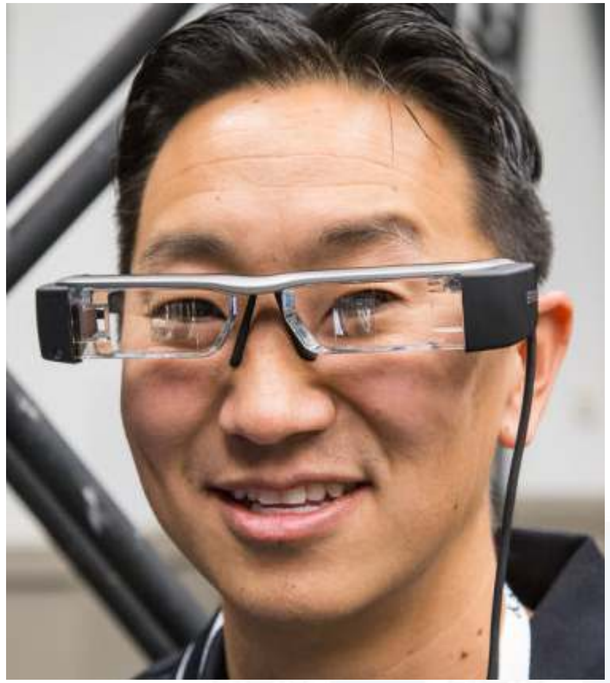
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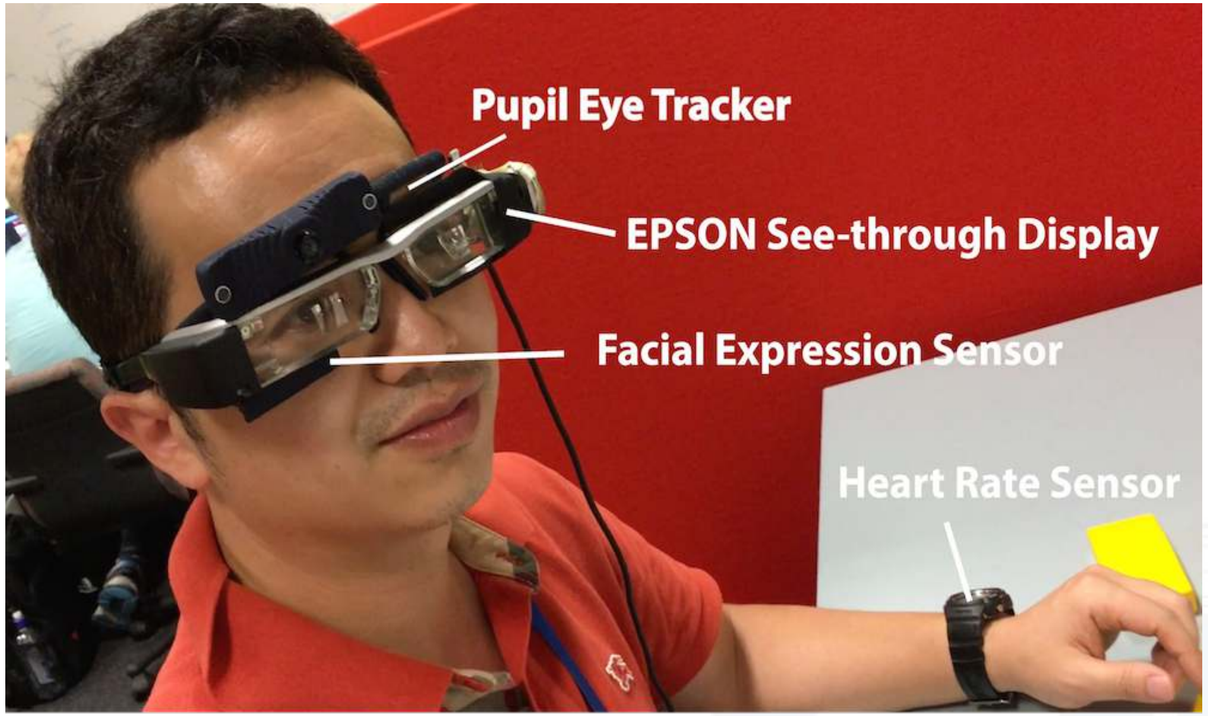
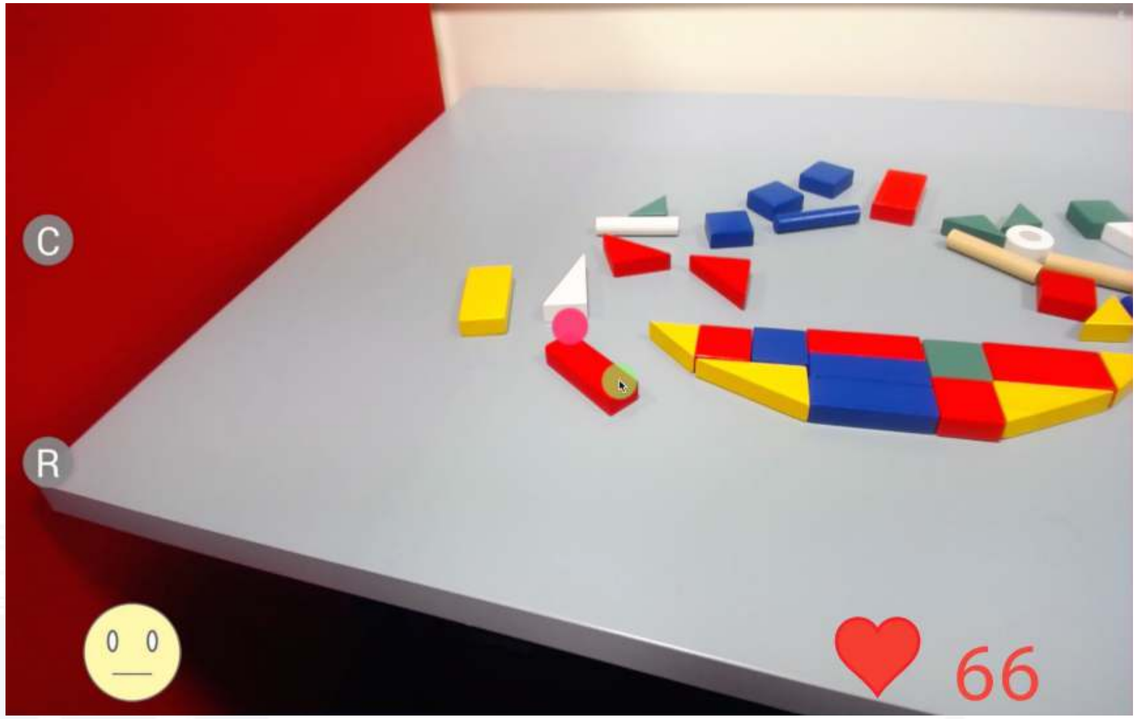
Pupil Labs Epson BT-200 AffectiveWear

- Combine together eye-tracking, display, face expression
- Implicit cues – eye gaze, face expression

Empathy Glasses in Use





- Eye gaze pointer and remote pointing
- Face expression display

https://www.youtube.com/watch?v=CdgWVDbMwp4

Shared Sphere – 360 Video Sharing

Theta S
360 Camera

Hi-res Camera

Epson BT-200
See-through HMD

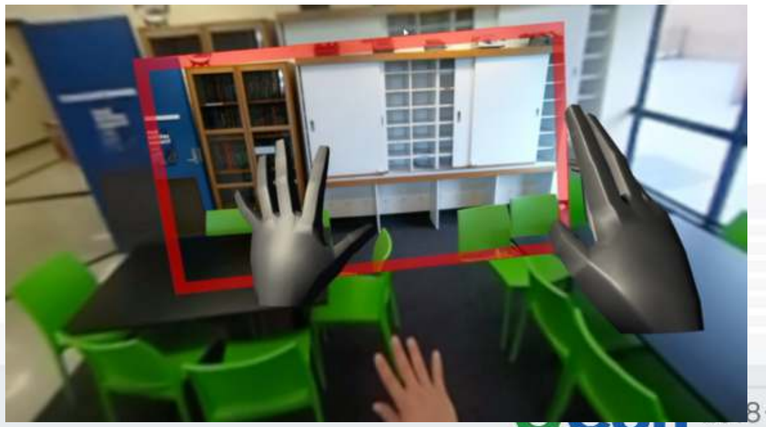
Host User

Shared
Live 360 Video

Oculus Rift
HMD

Leap Motion

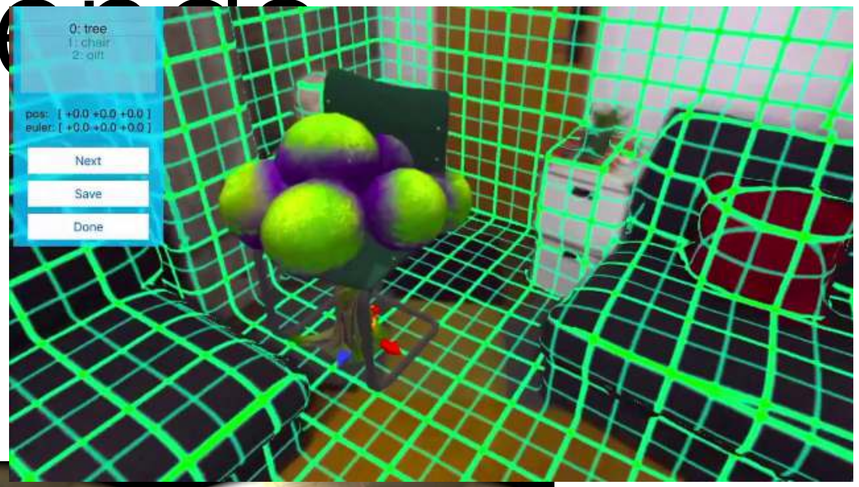
Guest User

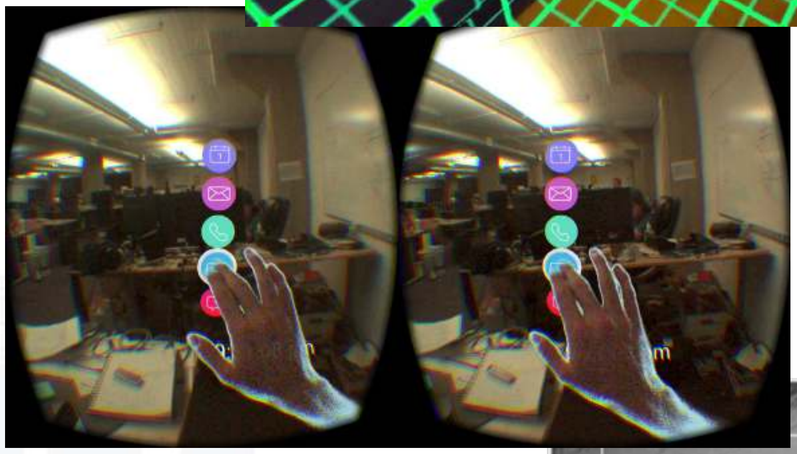


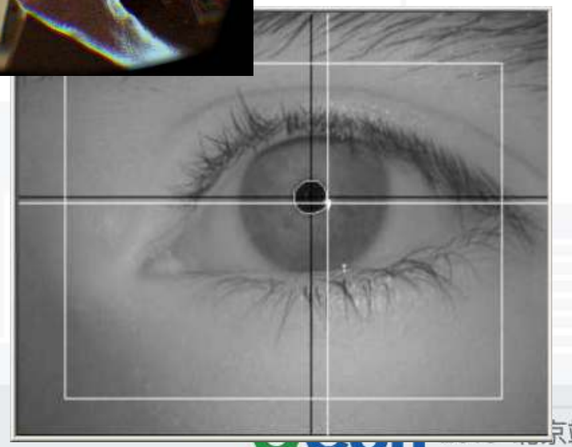

Shared Live 360 Video
Guest user's view through Oculus Rift

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

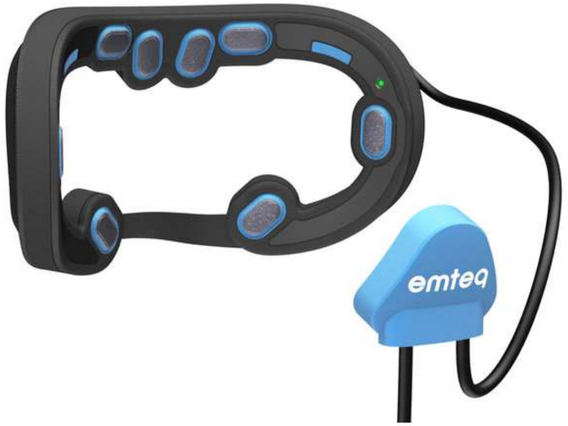






Emotion Sensing HMDs are Coming

- Looxid
  - EEG/Emotion sensing
  - Eye tracking
- Emteq
  - EMG sensing
- Neurable
  - EEG/BCI for VR
- PhysioHMD (MIT Media Lab)
  - GSR, PPG, Emotion Sensing



Looxid VR HMD

https://www.youtube.com/watch?v=0jCGLUbJ800

Technology Trends

- 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

Conclusions

- AR Reality Market Growing
  - New display, interaction, tracking technologies
- Trend toward Empathic Computing
  - Sharing what you see, hear and feel
- Many directions for future research
  - Capture/sharing emotion, interface design, etc..

www.empathiccomputing.or

mark.billinghurst@unisa.edu.au

@marknb00

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