Making VR Inclusive for People with Low Vision

Meredith Ringel Morris
Microsoft Research
http://aka.ms/seeingvr
http://aka.ms/vraccess

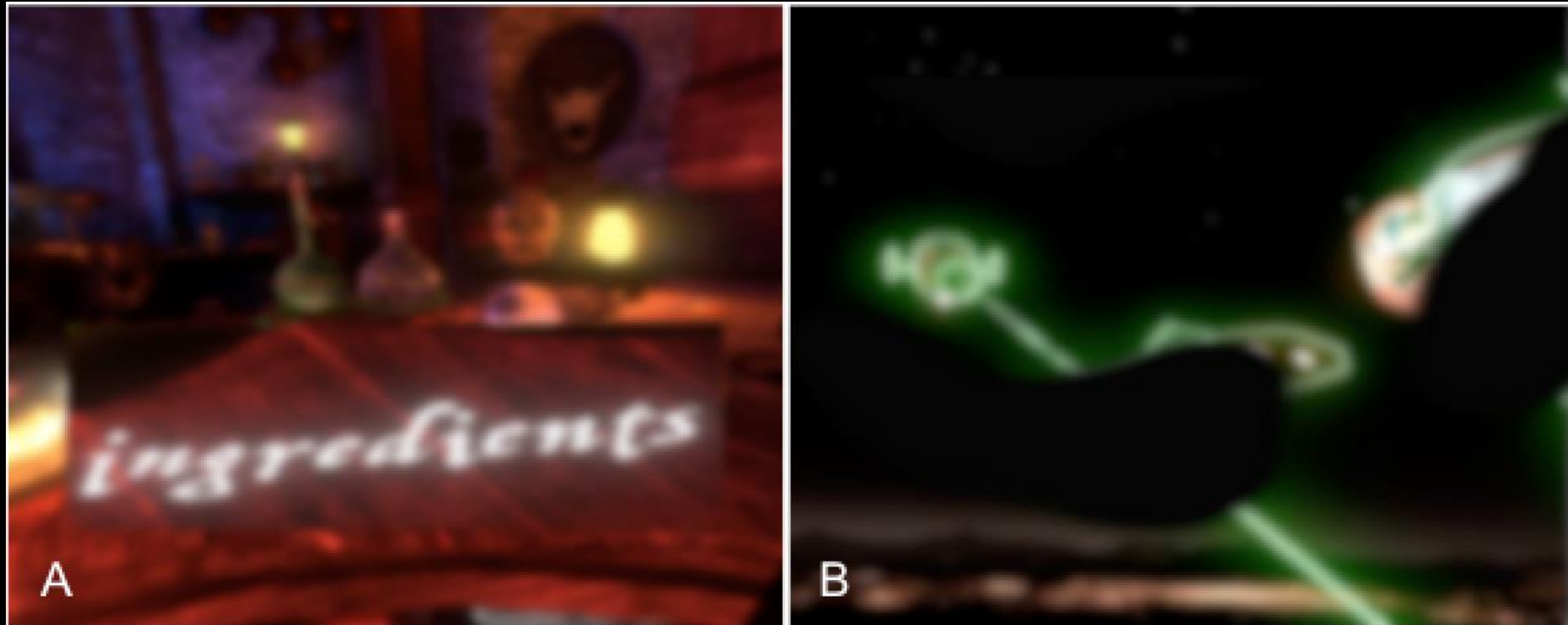Yuhang Zhao (Cornell)

Andy Wilson

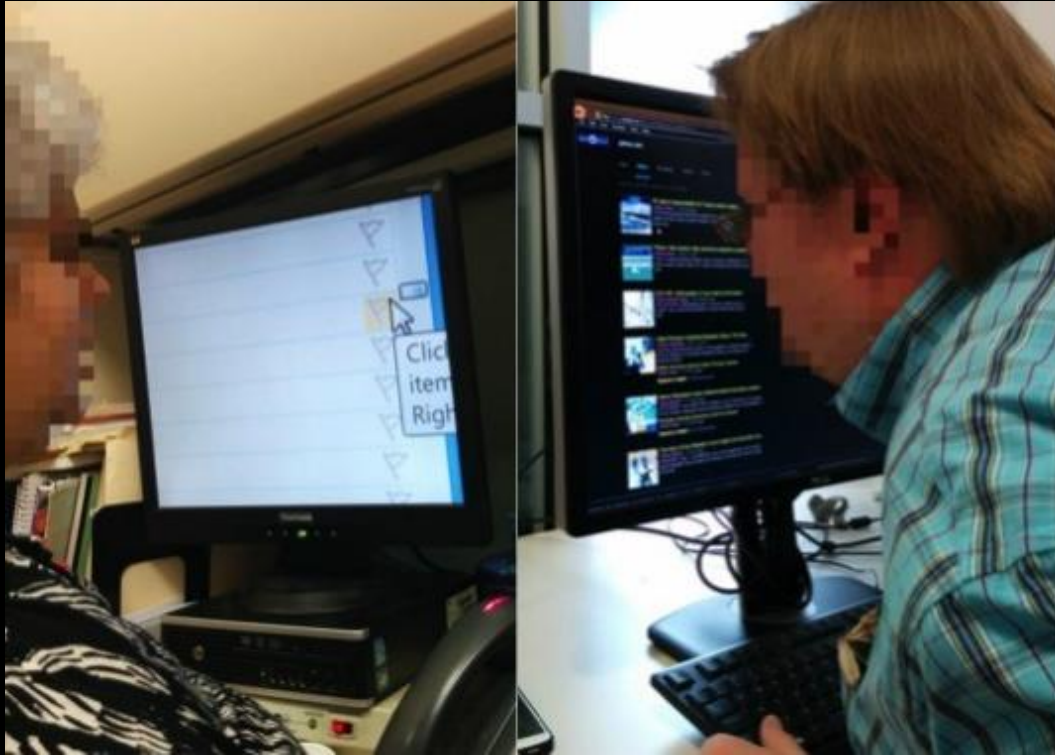Eyal Ofek

Christian Holz

Ed Cutrell

Meredith Ringel Morris

Low Vision

VR apps under simulated low vision augmented by SeeingVR: (A) *Waltz of the Wizard* [Aldin Dynamics, 2016] under diffuse depression of vision, with Bifocal Lens; (B) *Space Pirate Trainer* [I-Illusions, 2017] under blurred vision with blind spots, with Edge Enhancement and Depth Measurement.

Related Work


Azenkot et al., 2016

(a)

(b)

Zhao et al., *CueSee*, 2016

User-Centered Design Process

- Interviews and observations with six low-vision participants
- Key challenges:
  - Seeing things at a distance: "If I'm really playing, I have to be balancing, 'can I read from here or do I want to teleport and read it'" –L2
  - Interacting with virtual elements: selecting distant objects, judging depth, tracking moving targets
  - Dealing with lighting effects: contrast, brightness
  - Variety of visual conditions/abilities

SeeingVR

- 14 low vision tools (9 can be applied post-hoc to Unity apps)
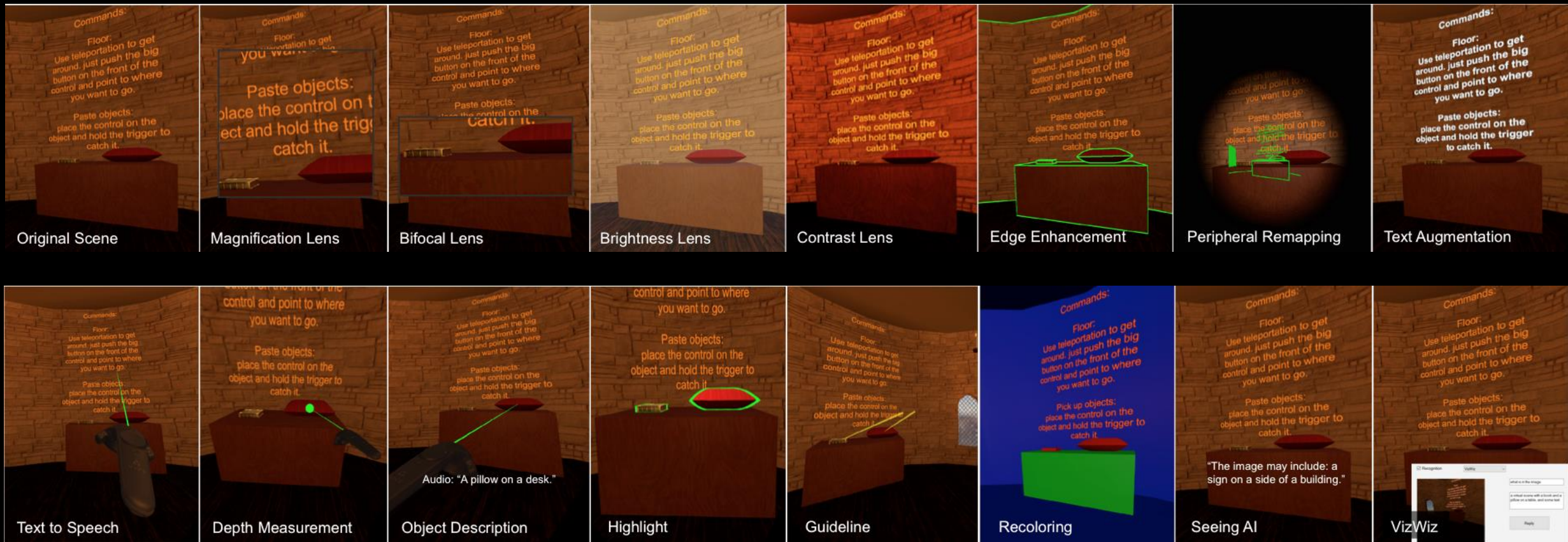
scene is from open-source Unity game *EscapeVR-HarryPotter*

SeeingVR: A Set of Tools to Make Virtual Reality More Accessible to People with Low Vision

Yuhang Zhao[1,2], Edward Cutrell[1], Christian Holz[1],
Meredith Ringel Morris[1], Eyal Ofek[1], Andy Wilson[1]

[1]Microsoft Research, Redmond
[2]Information Science, Cornell Tech, Cornell University

>> SeeingVR: A Set of Tools to Make

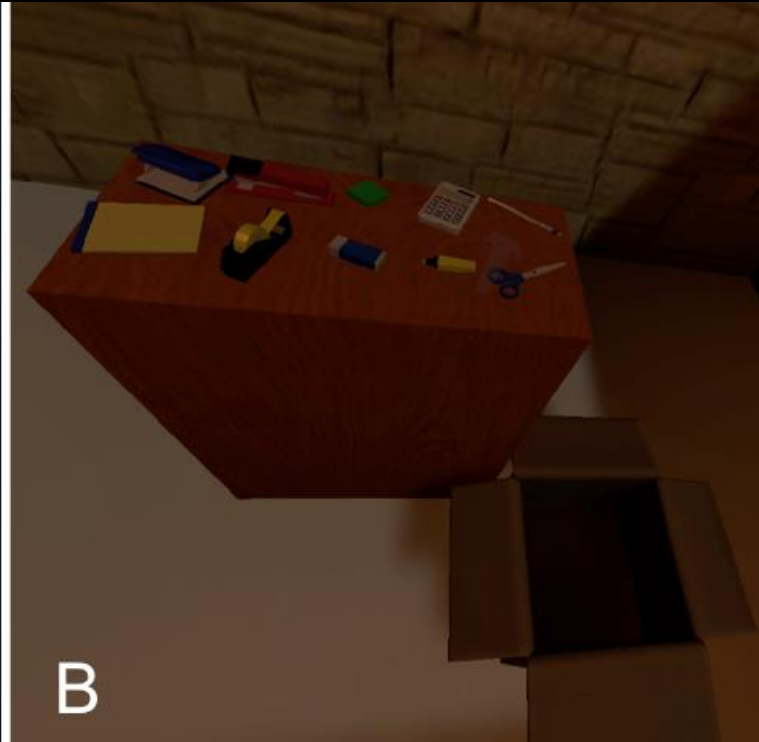# Evaluation: Users with Low Vision

- Does SeeingVR enhance the usability of VR for people with Low Vision? Which tools do people find most useful? What to improve?

- Participants: 11 people with low vision

- Method:
  - Interview + Tutorial/Think-Aloud
  - Virtual Tasks: Menu Navigation, Visual Search, and Target Shooting
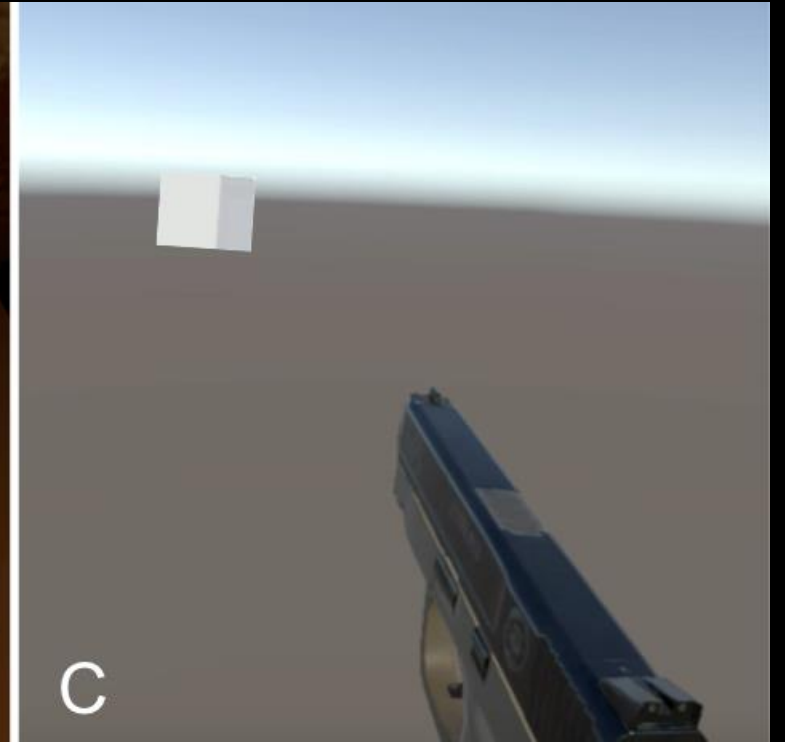 - App Exploration (*EscapeVR* and *Drop*)
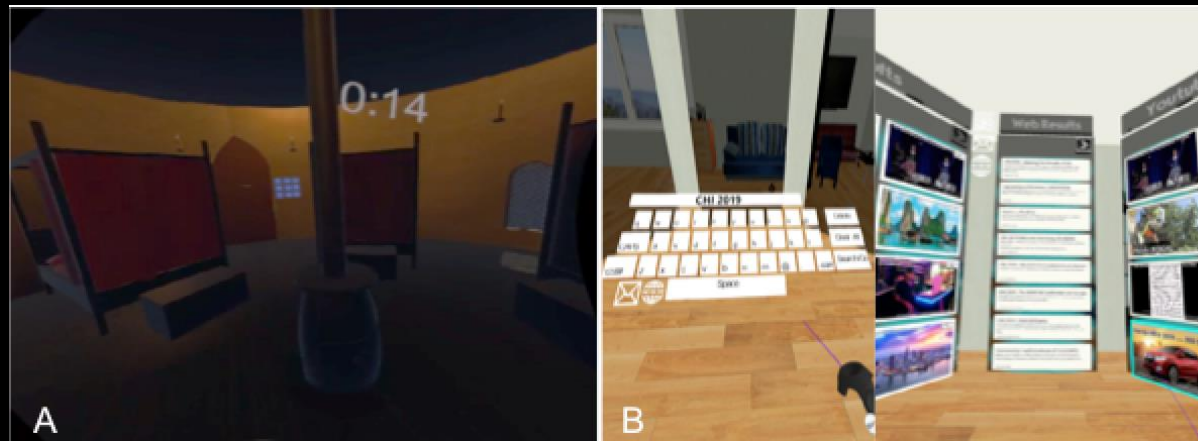
Virtual Tasks
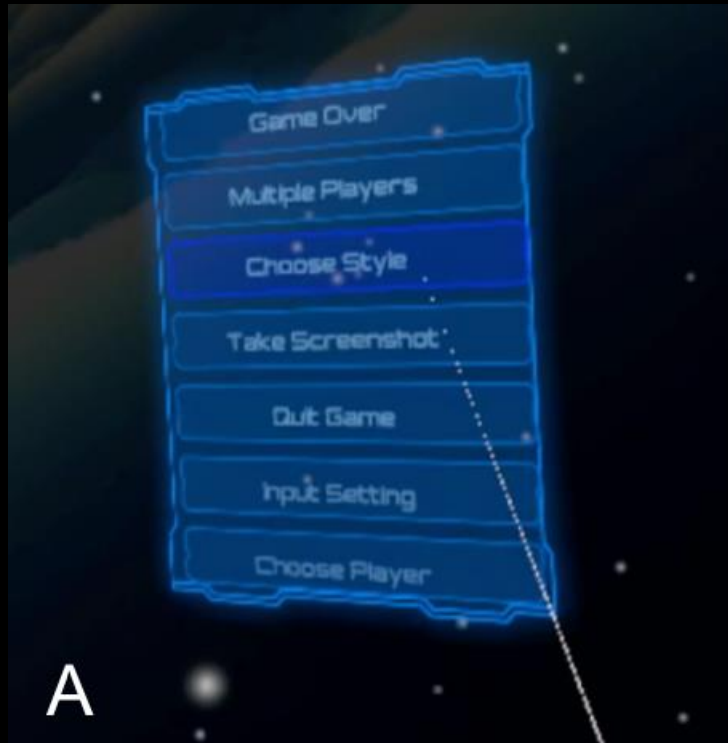
Menu Navigation   Visual Search   Target Shooting

Findings from Evaluation with PLV

- All participants completed all three tasks more quickly & accurately with Seeing VR
  - Menu Navigation: all 11 participants successful with SeeingVR, only 4 without, all 100% accurate with SeeingVR and faster ($p < .04$)
  - Visual Search: significantly faster with SeeingVR ($p < .001$), 100% accuracy with SeeingVR
  - Target Shooting: significantly faster with SeeingVR ($p < .001$)
- Tool preferences varied by visual condition and task
  - Text Augmentation, Depth Measurement, and Highlight were top-rated
  - Recoloring's aesthetic change considered too large

Evaluation: Generality

- Can SeeingVR's post-hoc tools successfully modify a range of VR apps?
- Method: applied SeeingVR to top 10 Unity apps as ranked by Steam Spy

Waltz of the Wizard
(Edge Enhancement)

VR apps	Ineffective tools in SeeingVR
The Lab	Brightness Lens; Contrast Lens; Edge Enhancement
Rec Room	None
Waltz of the Wizard	None
Beat Saber	None
SUPERHOT VR	None
Arizona Sunshine	None
Job Simulator	Text Augmentation; Text to Speech (TTS)
Space Pirate Trainer	None
Tilt Brush	Edge Enhancement
Audioshield	Edge Enhancement; Text Augmentation; TTS

Evaluation: Unity Developers

- How do developers feel about our 3 accessibility features? Is the toolkit easy to understand and use?

- Participants: 6 Unity developers

- Key Findings:
  - Lack of Accessibility Guidelines for VR – "Sometimes people just assume accessibility in VR is the same as accessibility on a 2D screen, which is not really right." –D1
  - Toolkit Features Easy and Understandable
  - Preferred Toolkit to Post Hoc Modification – "…you still want them [PWD] to enjoy the original game, which is handcrafted for the best experience." –D1
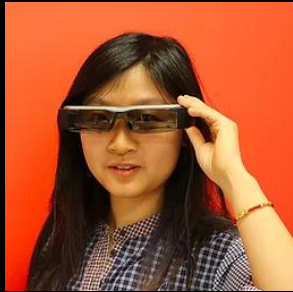
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