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Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration

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VRST 2023

Motivation

limited field of view of head-mounted displays, the annotations or actions of remote users not always visible.

a **single viewpoint difficult** to understand and explore the dynamic physical space and perceive others' actions

*Faisal Zaman, Craig Anslow, Taehyun Rhee "**Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration**". VRST 23*

Problem

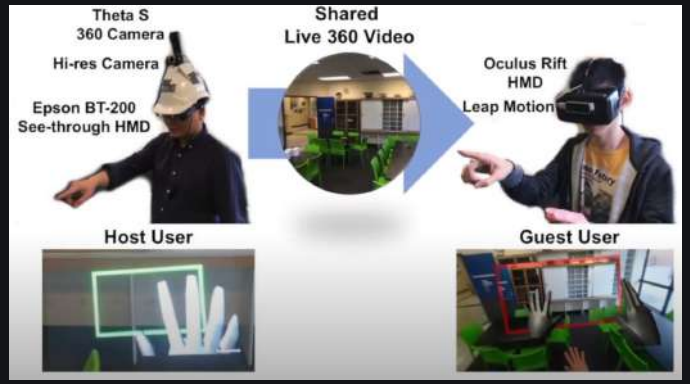
Mixed-perspective shown to improve the collaborative experience in remote settings

managing multiple viewpoints challenging for users to decide which views to focus on

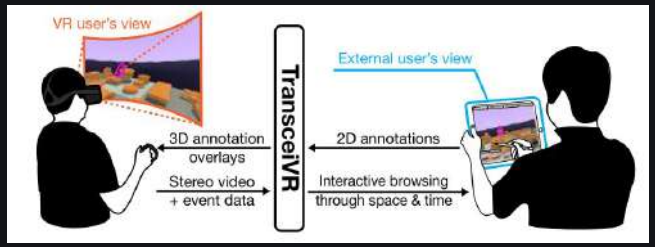
Related Work

[Billinghurst et al 2001]

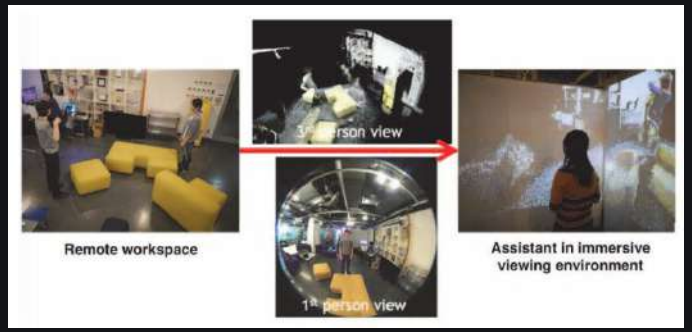
Related Work



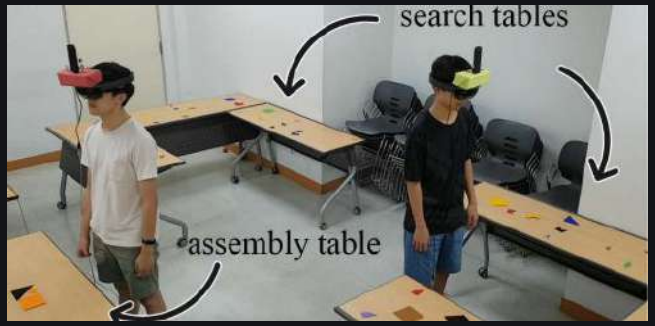
[Teo et al 2017]



[Thoravi et al 2020]



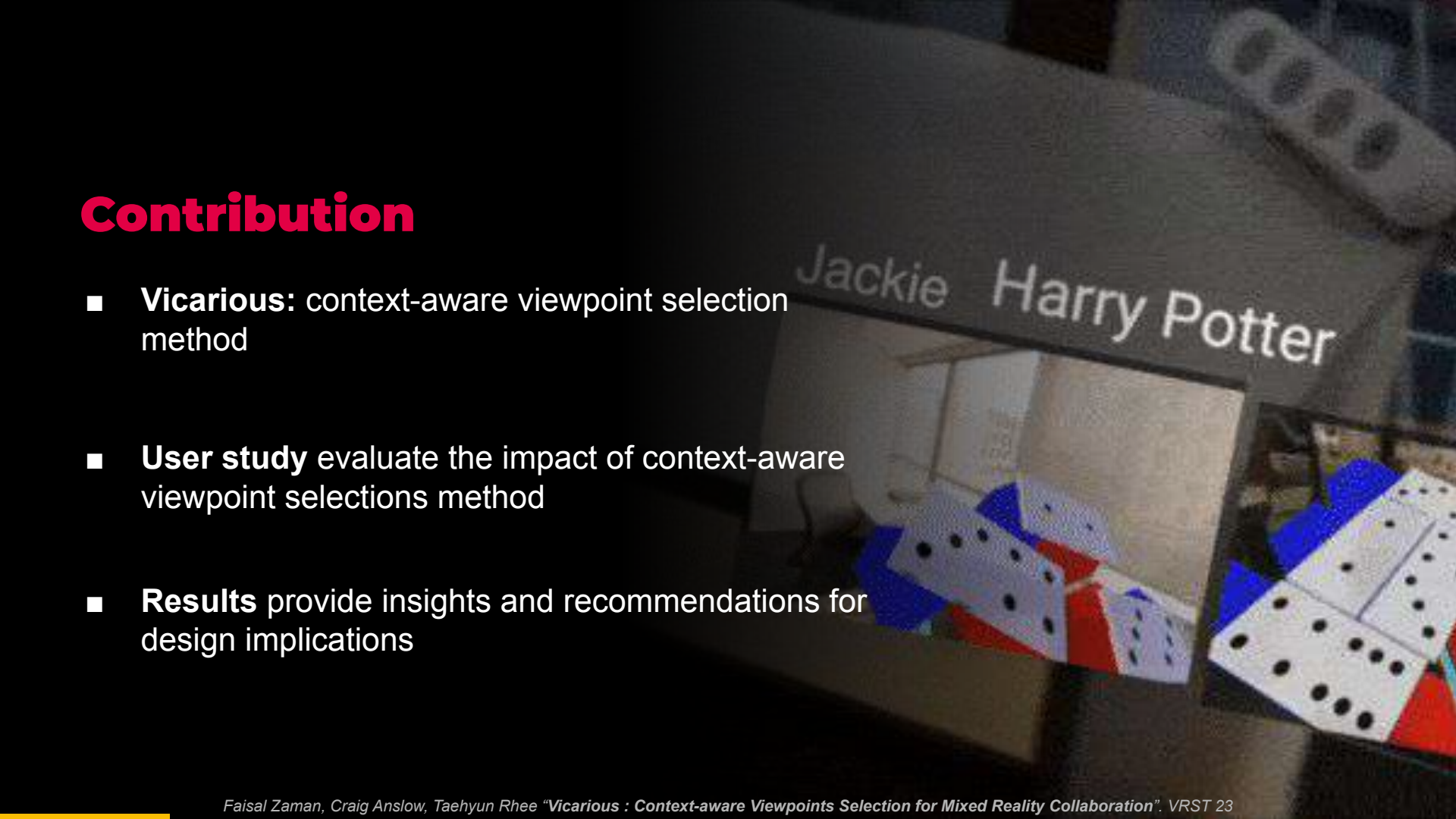
[Komiyama et al 2017]



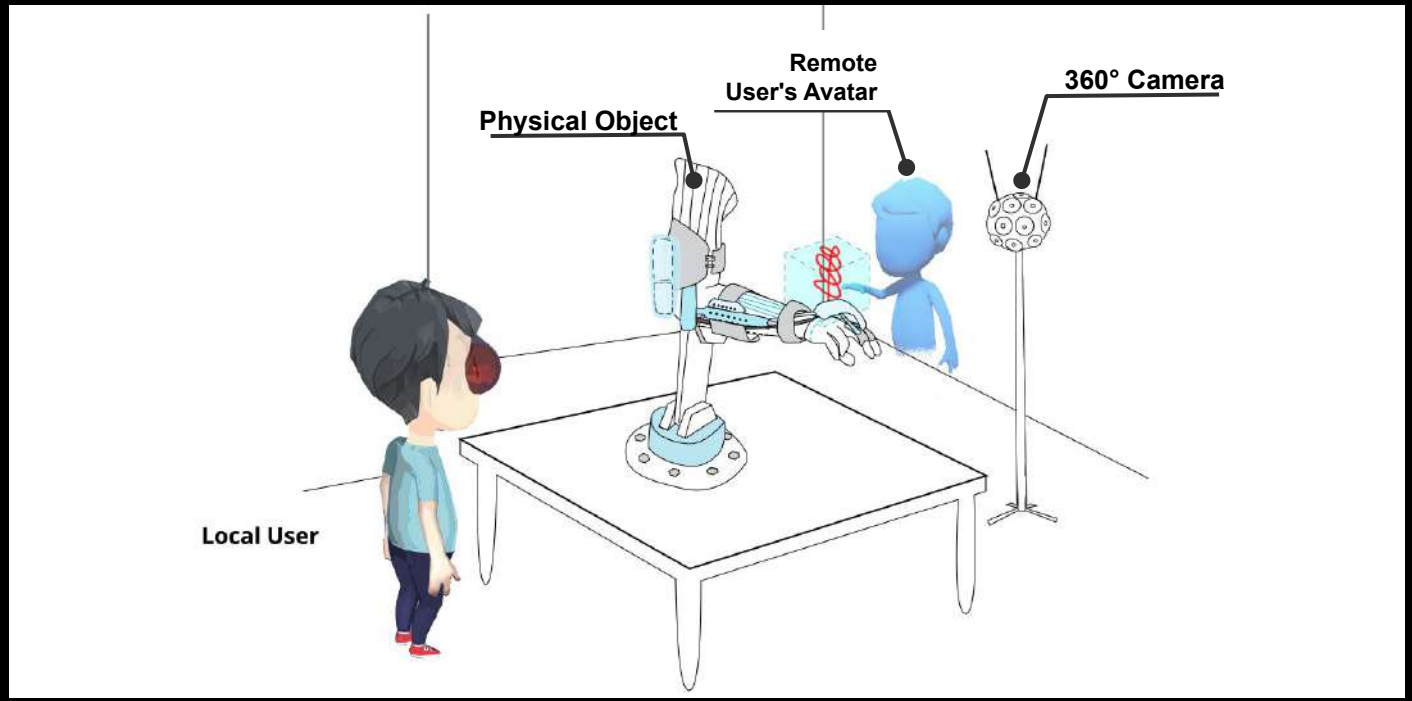
[Lee et al 2020]

Contribution

- **Vicarious:** context-aware viewpoint selection method
- **User study** evaluate the impact of context-aware viewpoint selections method
- **Results** provide insights and recommendations for design implications



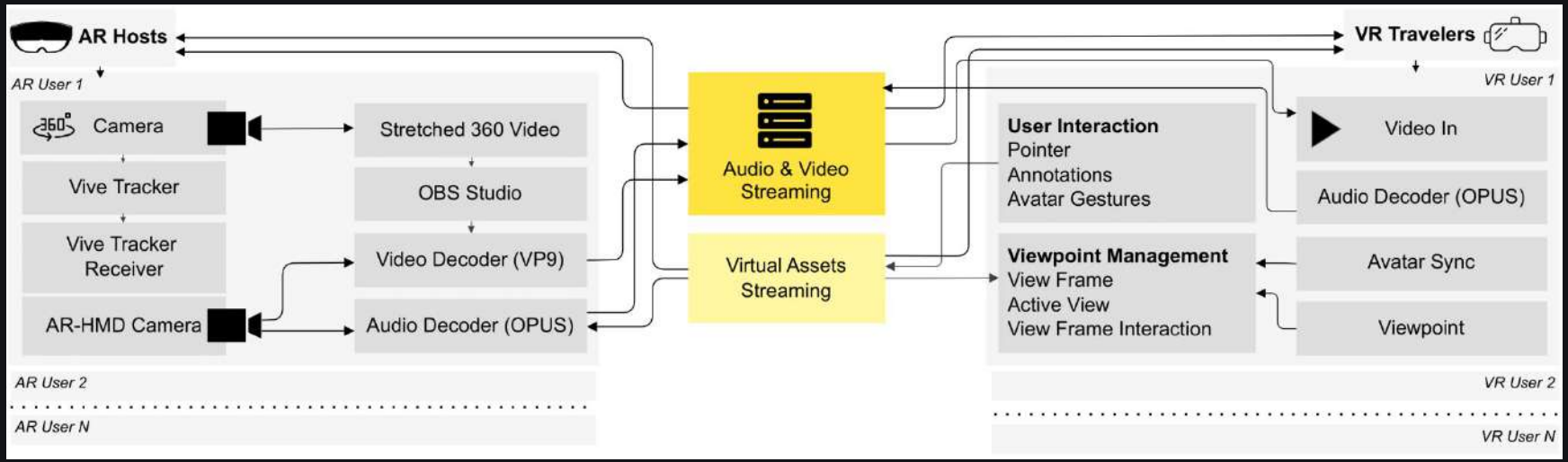
System Overview



MRMAC

- **Vicarious** builds on top of a large platform called **MRMAC**
- To be presented at ISMAR 23

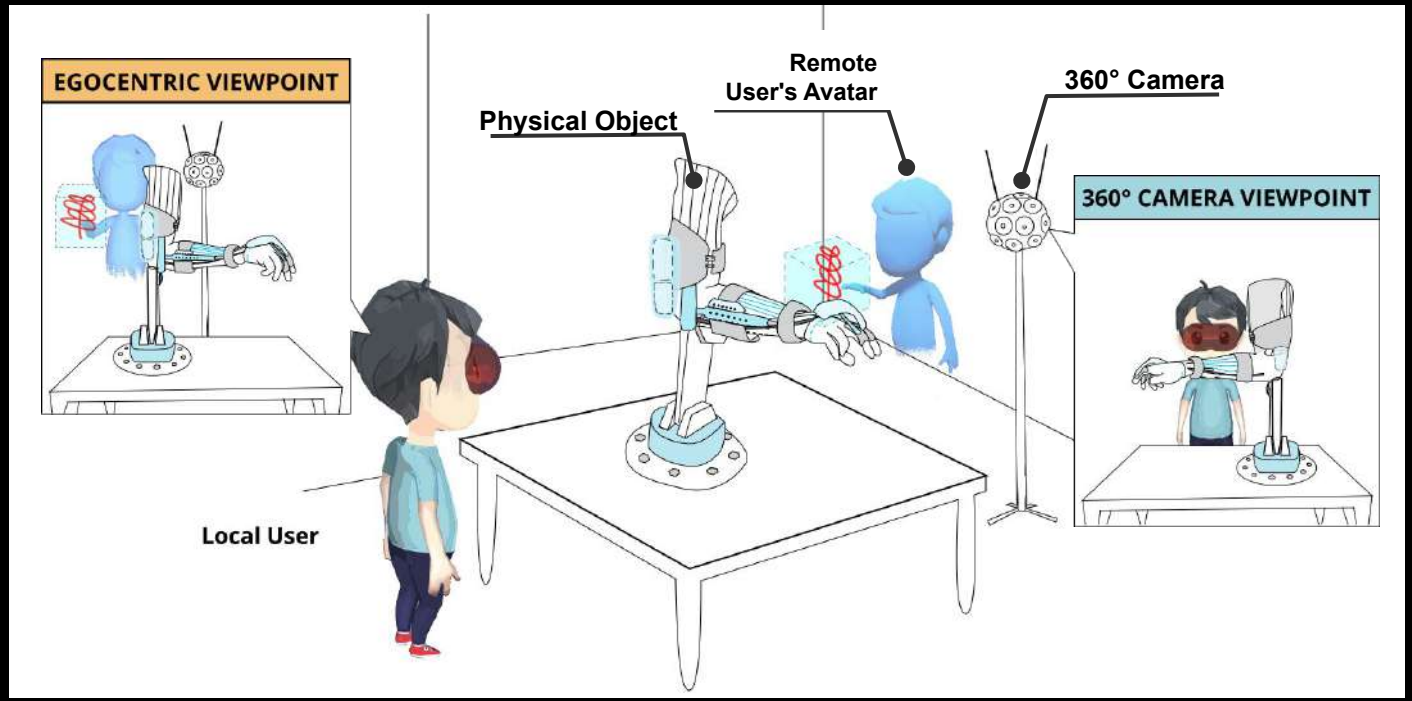
System Setup



System Architecture

*Faisal Zaman, Craig Anslow, Taehyun Rhee "**Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration**". VRST 23*

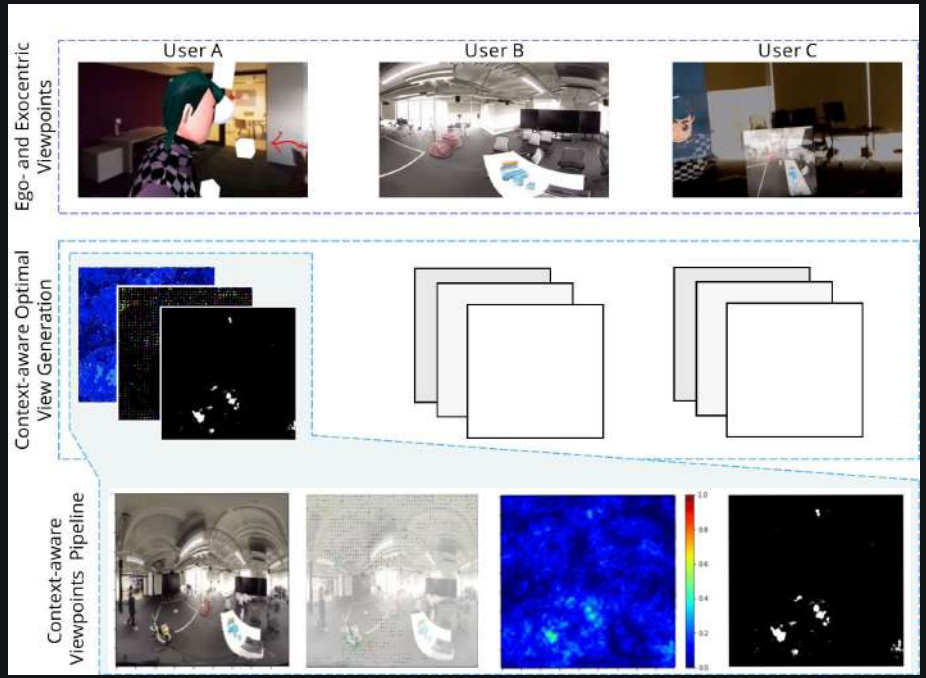
Vicarious



*Faisal Zaman, Craig Anslow, Taehyun Rhee "**Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration**". VRST 23*

Viewpoint Selection

- Visual saliency

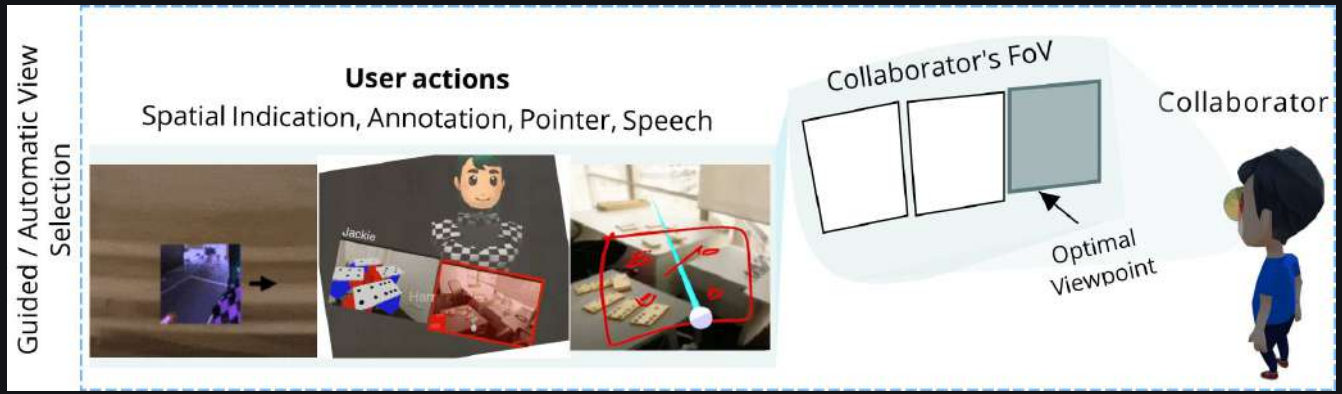


$$S(i) = w1 * K(i) + w2 * O(i) + w3 * G_\sigma(i)$$

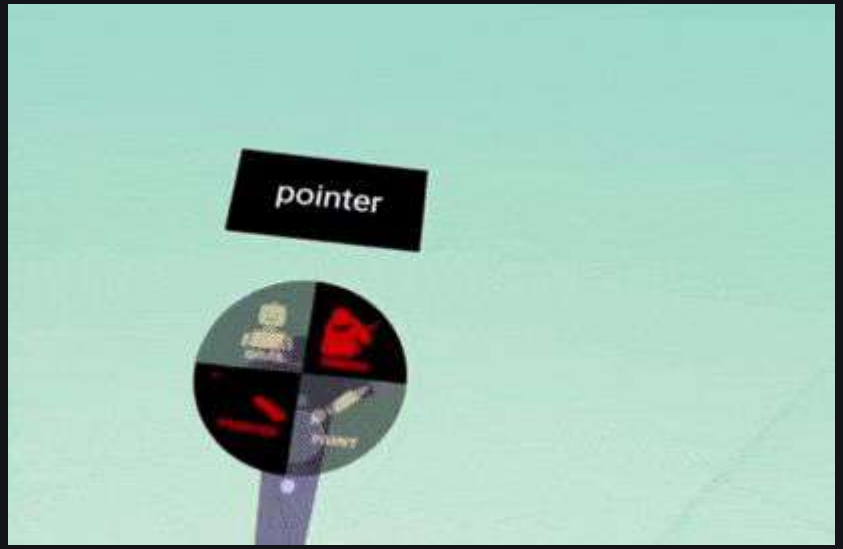
*Faisal Zaman, Craig Anslow, Taehyun Rhee "**Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration**". VRST 23*

Viewpoint Selection

- Predefined actions
  - Verbal cues (*Voice activity + Intensity)*
  - Visual cues (*Point, Annotate, Gestures)*



Predefined Actions



Predefined Actions

Verbal cues

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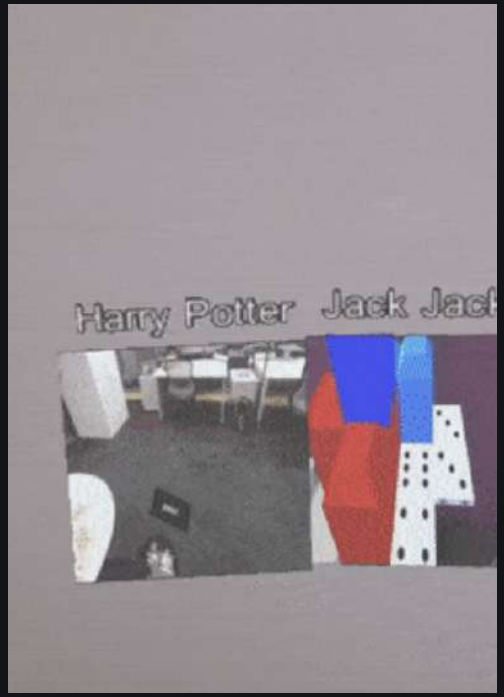
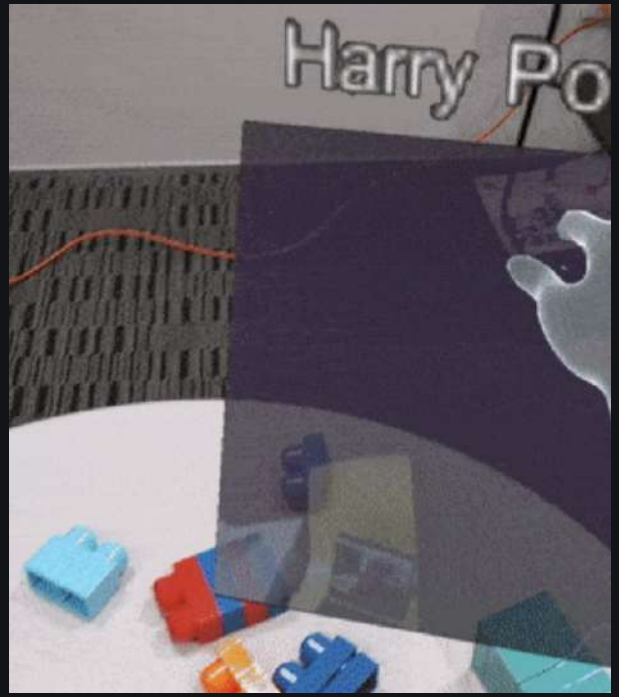
Visualization and Interaction

1. Smooth Follow



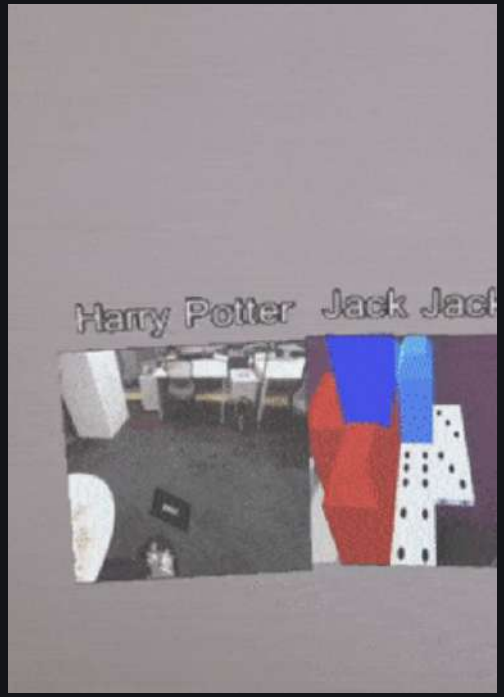
2. Pinned to Fixed Location



3. Spatial Indication

*Faisal Zaman, Craig Anslow, Taehyun Rhee "**Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration**". VRST 23*

1. Smooth Follow



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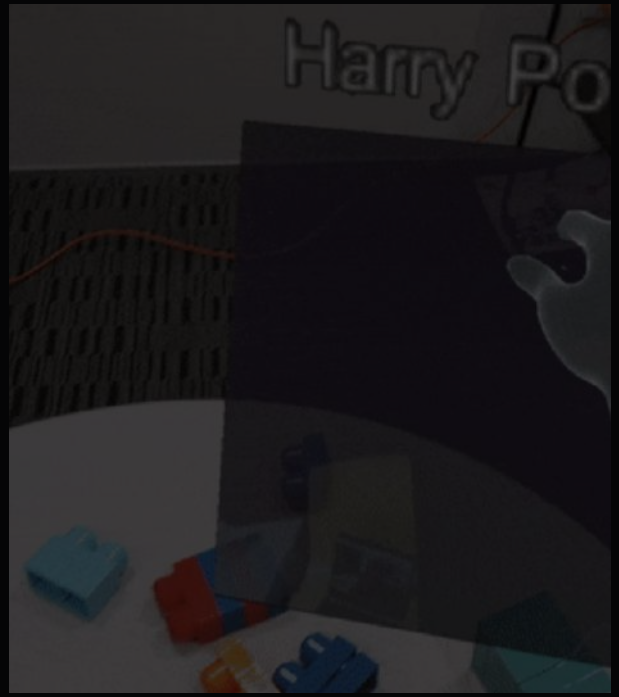
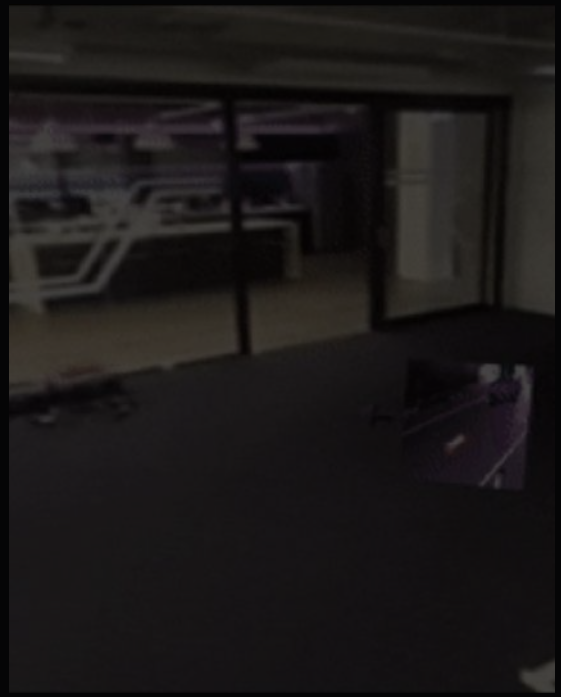


Spatial Indication



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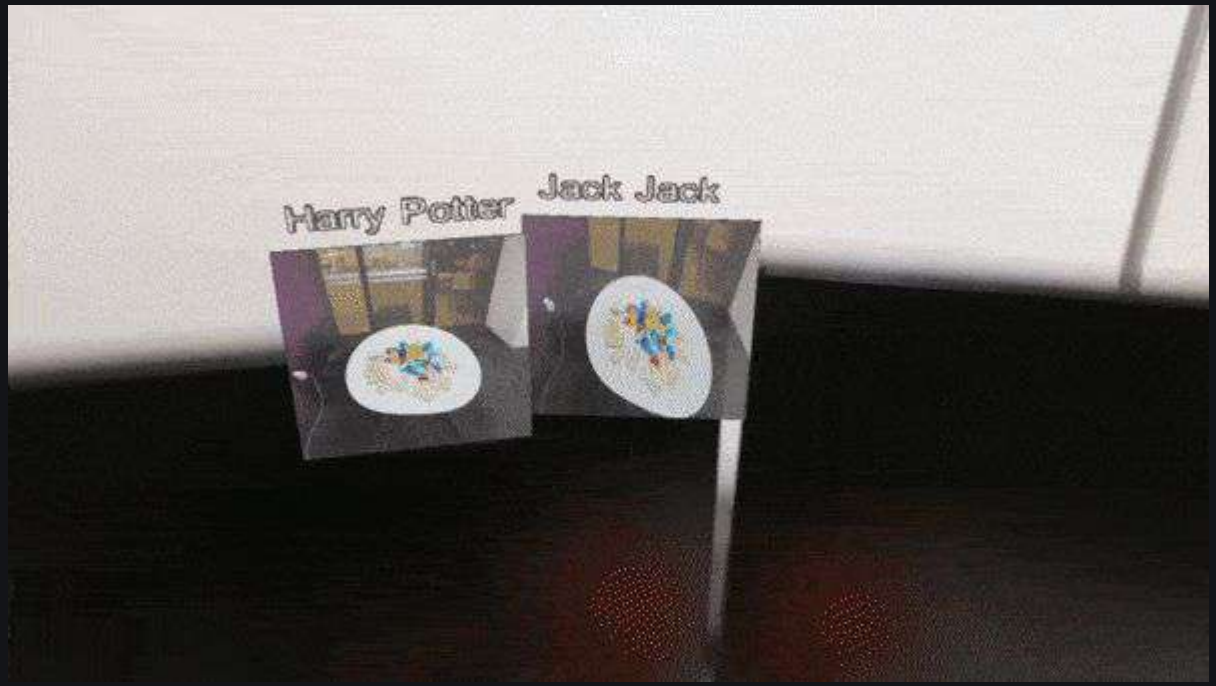

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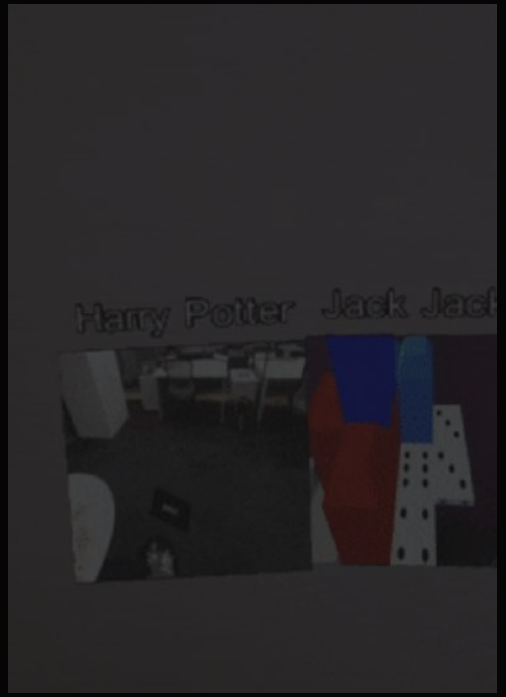
Smooth Follow



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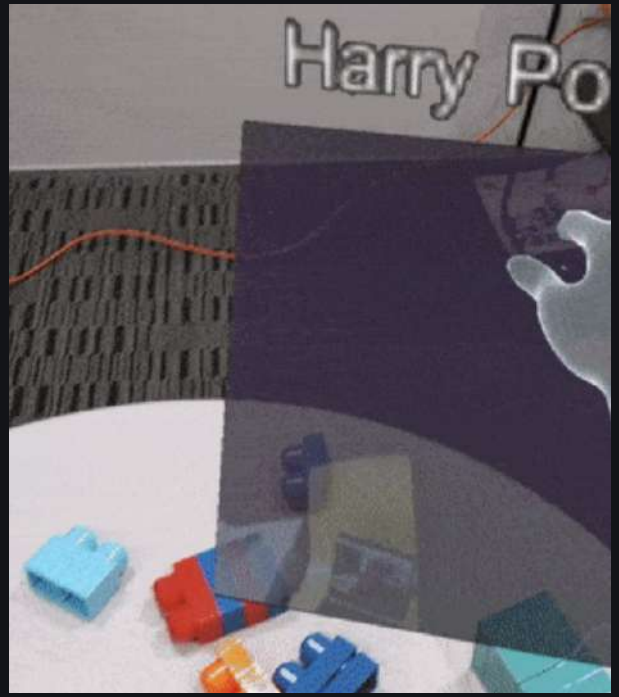
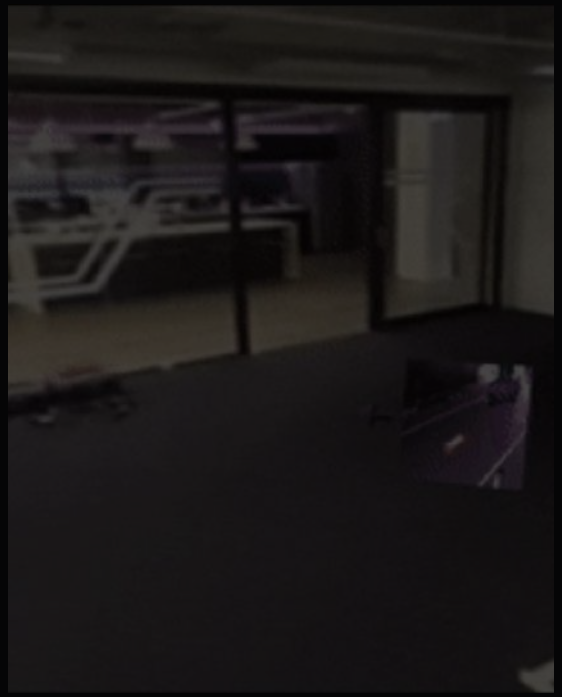


Spatial Indication



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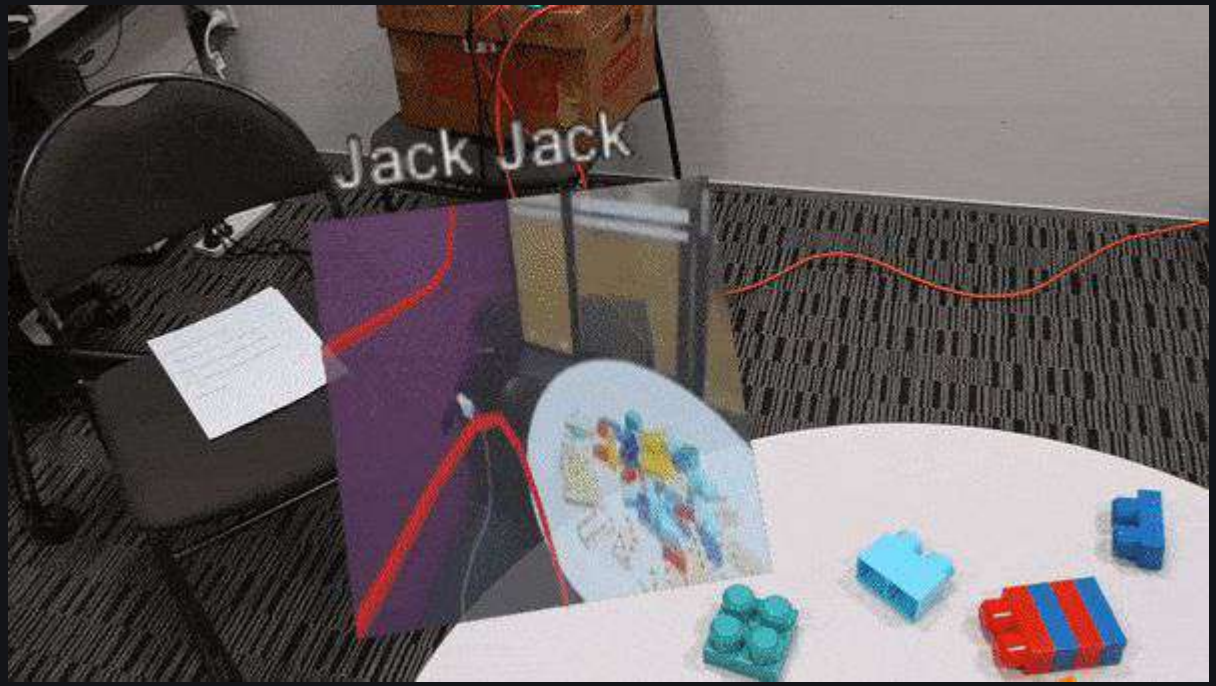

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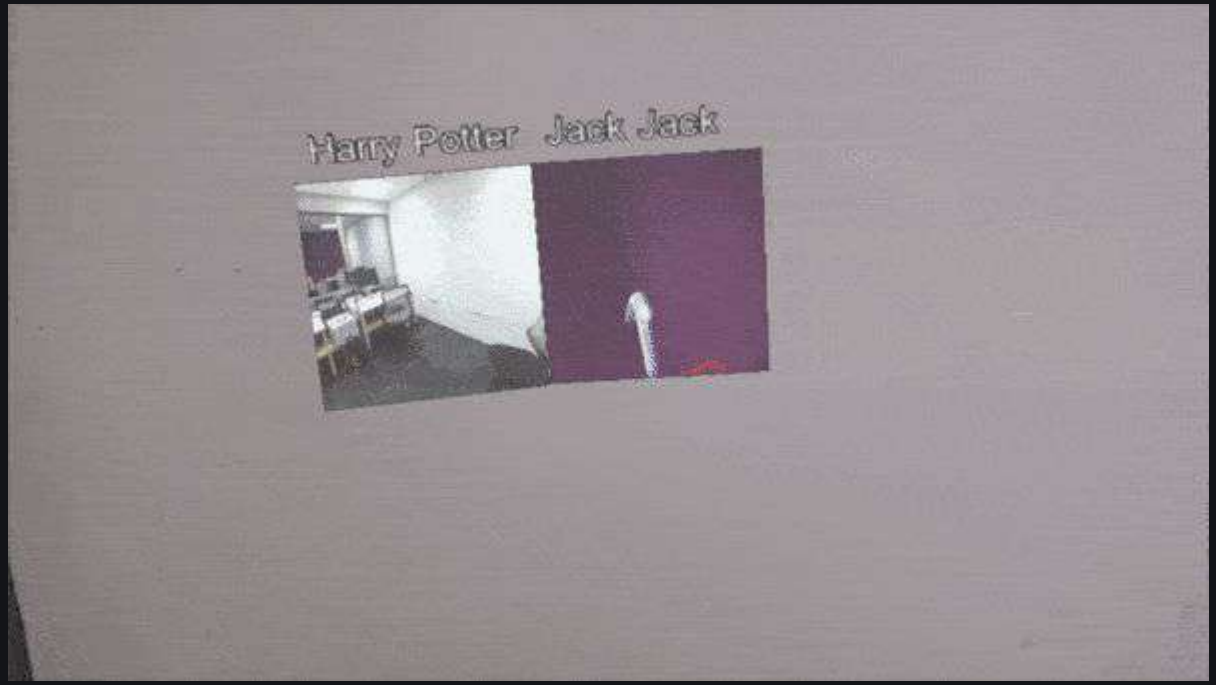
2. Pinned to Fixed Location (Zoom in/out)



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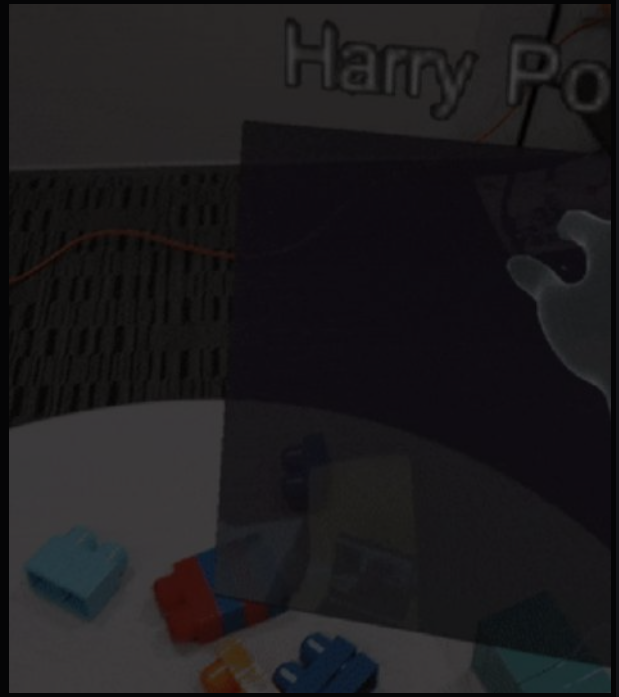
Smooth Follow

Pinned to Fixed Location



3. Spatial Indication

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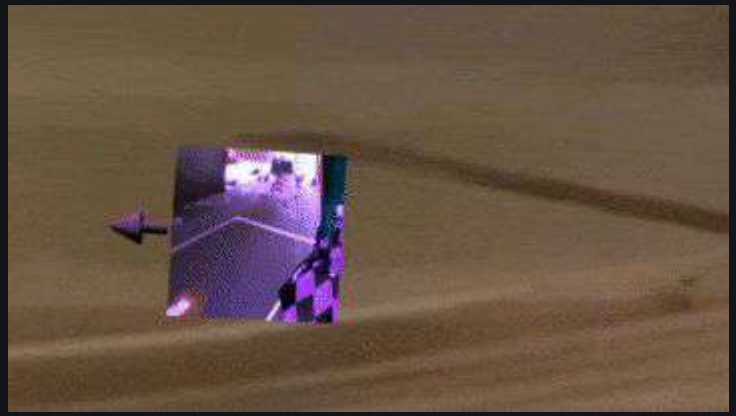
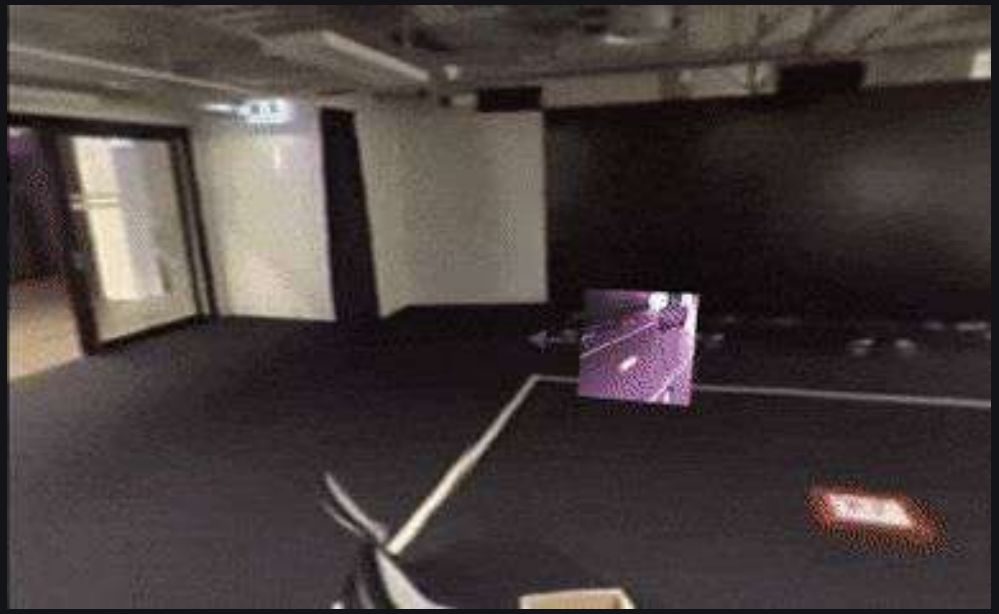
3. Spatial Indication





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USER STUDY

User Study

Research Questions

RQ1 Would context-aware viewpoint selection increase the sense of presence in remote collaboration?

RQ2 Would context-aware viewpoint selection improve the task performance compared to using no-view selection?

Experimental Setup

4×2 mixed factorial design

between-subjects factor:
local vs. remote

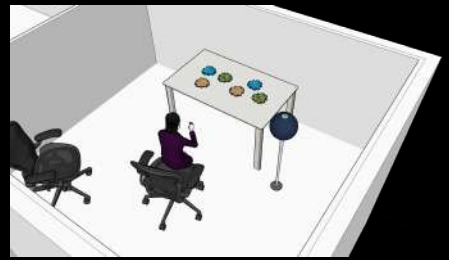
within-subjects factor:
NS vs. MS vs. GS vs. AS

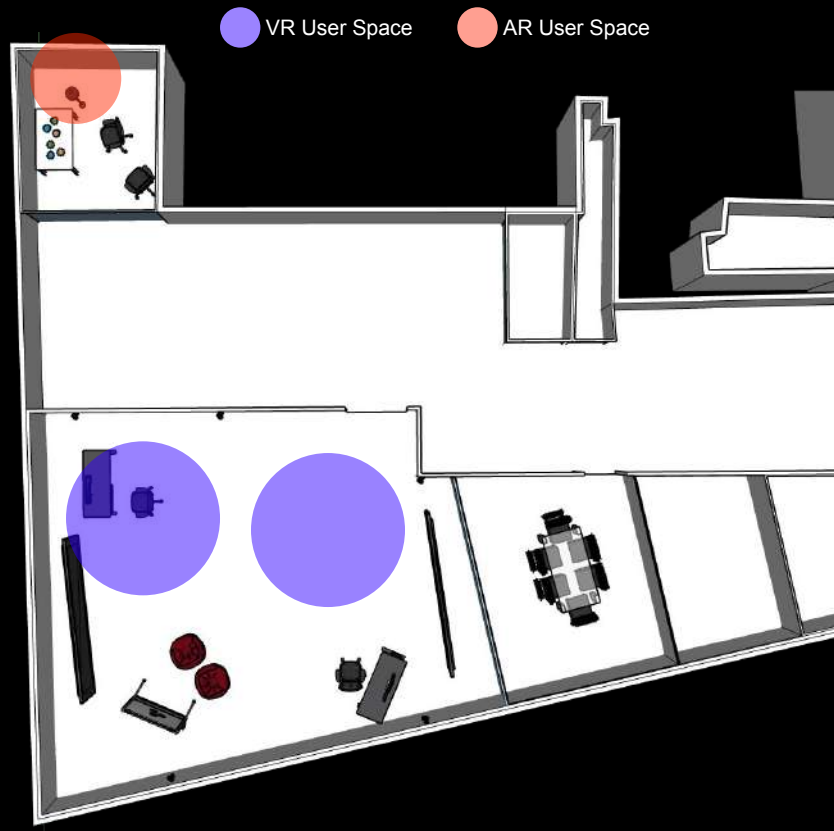
27 participants

18—55 years

μ = 28.13

σ = 7.32

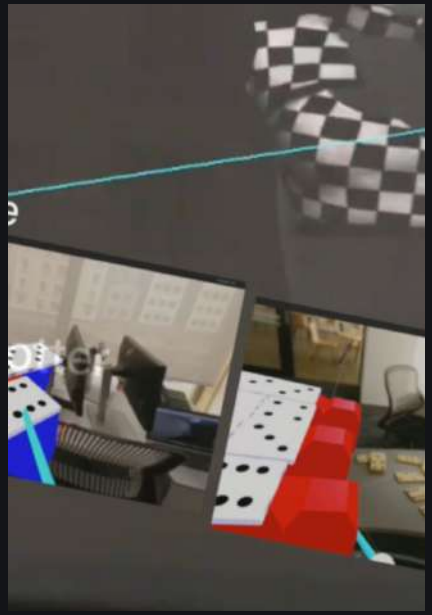




Conditions

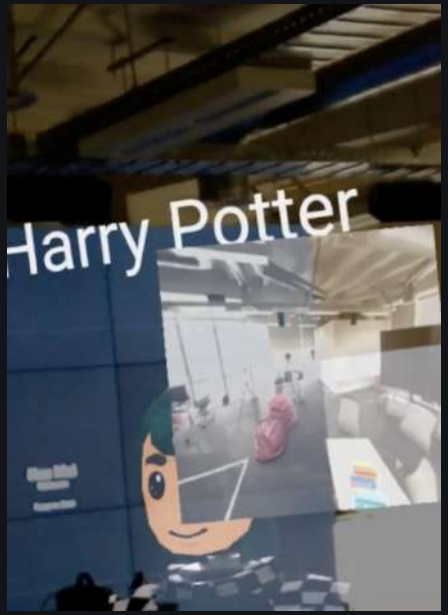
No Selection (NS)

Manual Selection (MS)



Guided Selection (GS)

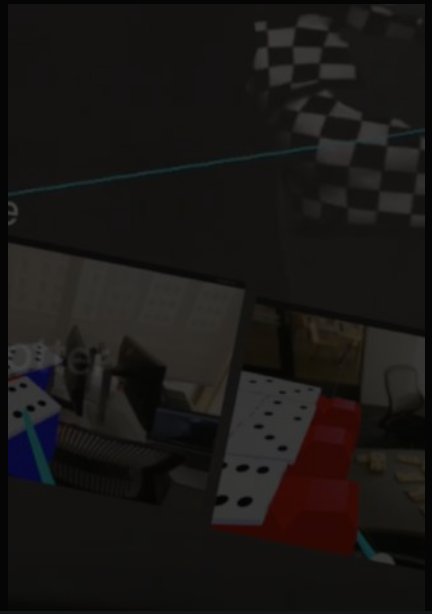
Automatic Selection (AS)



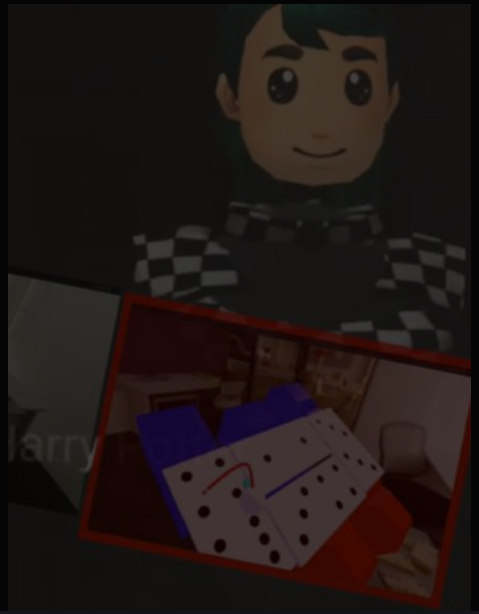
Conditions

No Selection (NS)

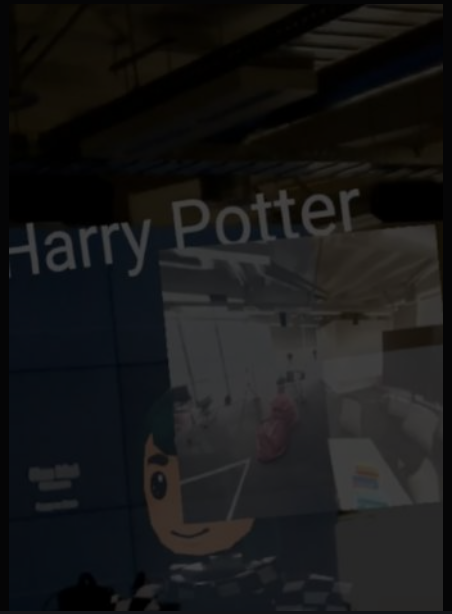
Manual Selection (MS)



Guided Selection (GS)



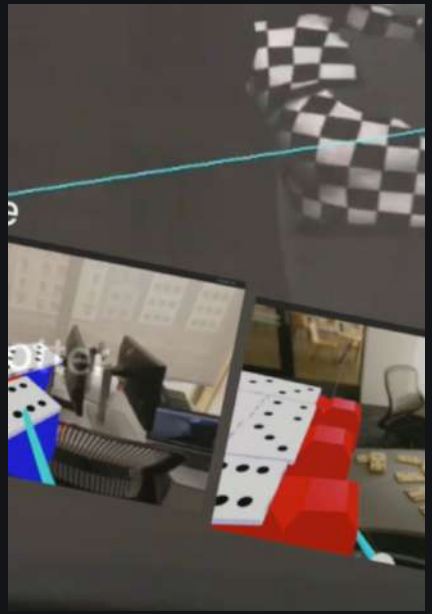
Automatic Selection (AS)



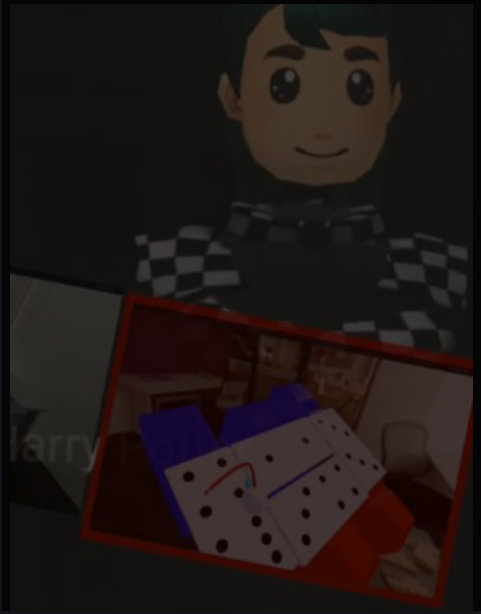
Conditions

No Selection (NS)

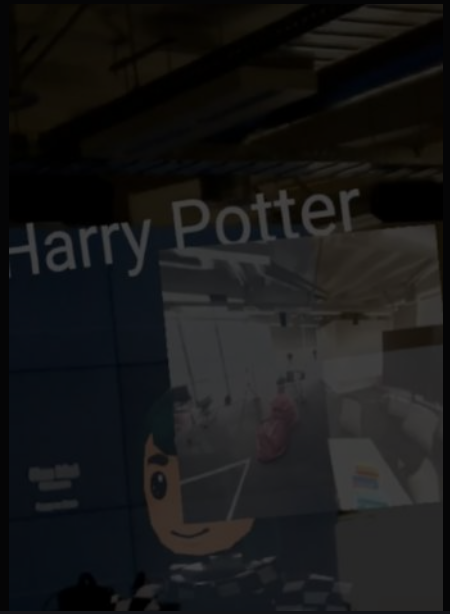
Manual Selection (MS)



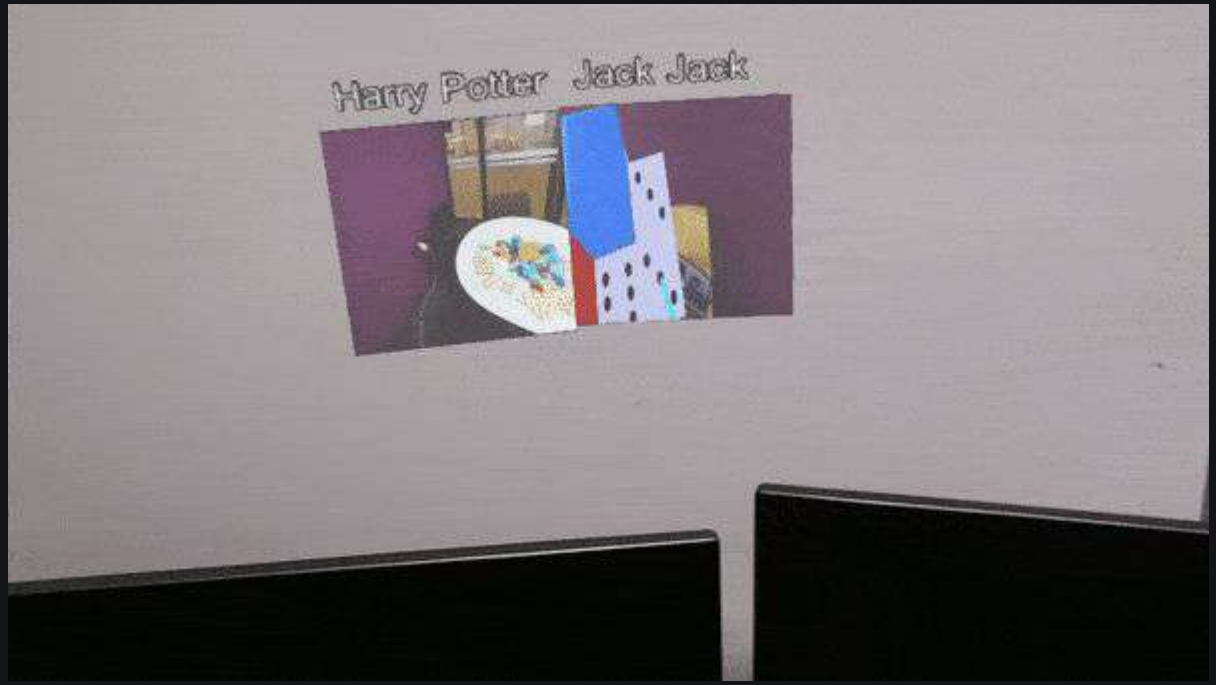
Guided Selection (GS)



Automatic Selection (AS)



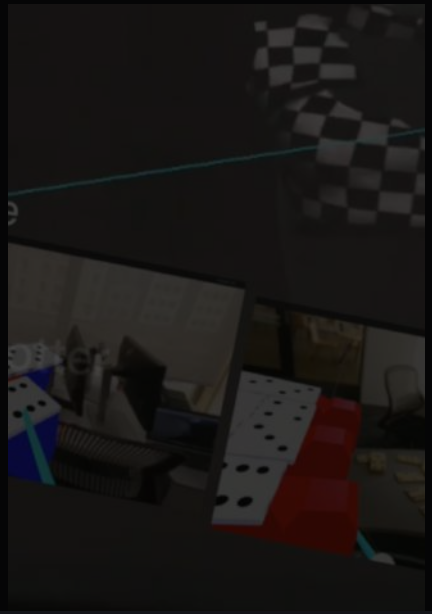
Conditions: Manual Selection (MS)



Conditions

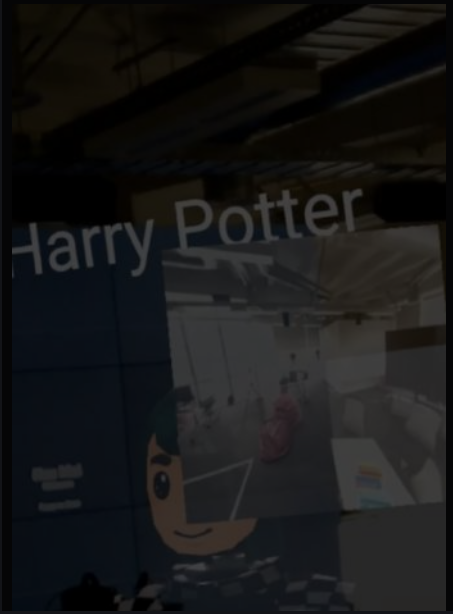
No Selection (NS)

Manual Selection (MS)



Guided Selection (GS)

Automatic Selection (AS)

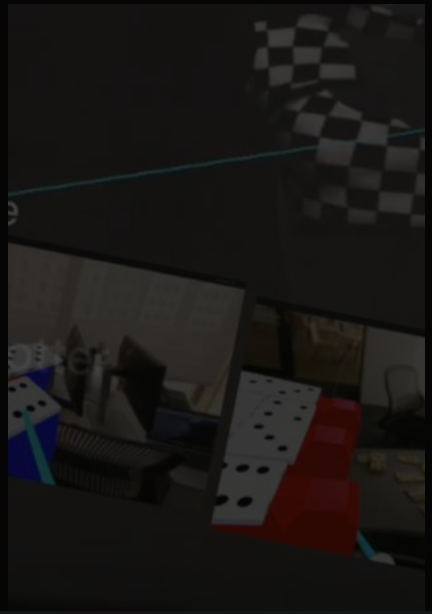


Conditions: Guided Selection (GS)

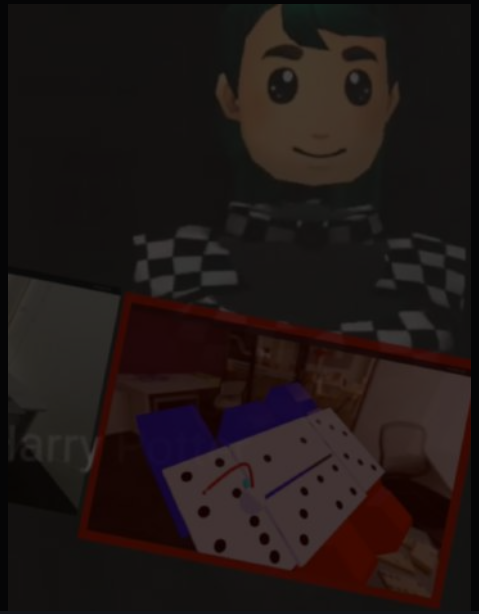
Conditions

No Selection (NS)

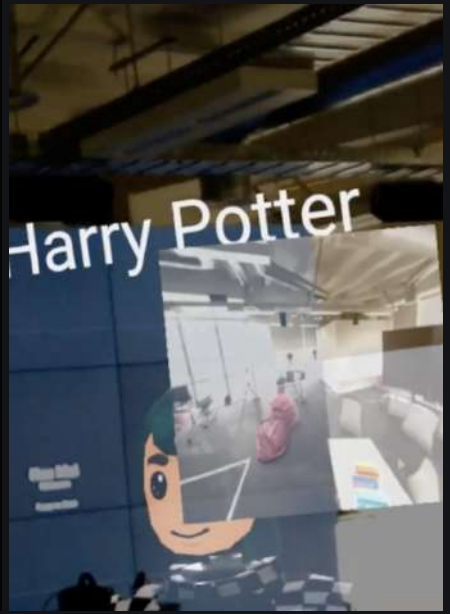
Manual Selection (MS)



Guided Selection (GS)



Automatic Selection (AS)



Conditions: Automatic Selection (AS)

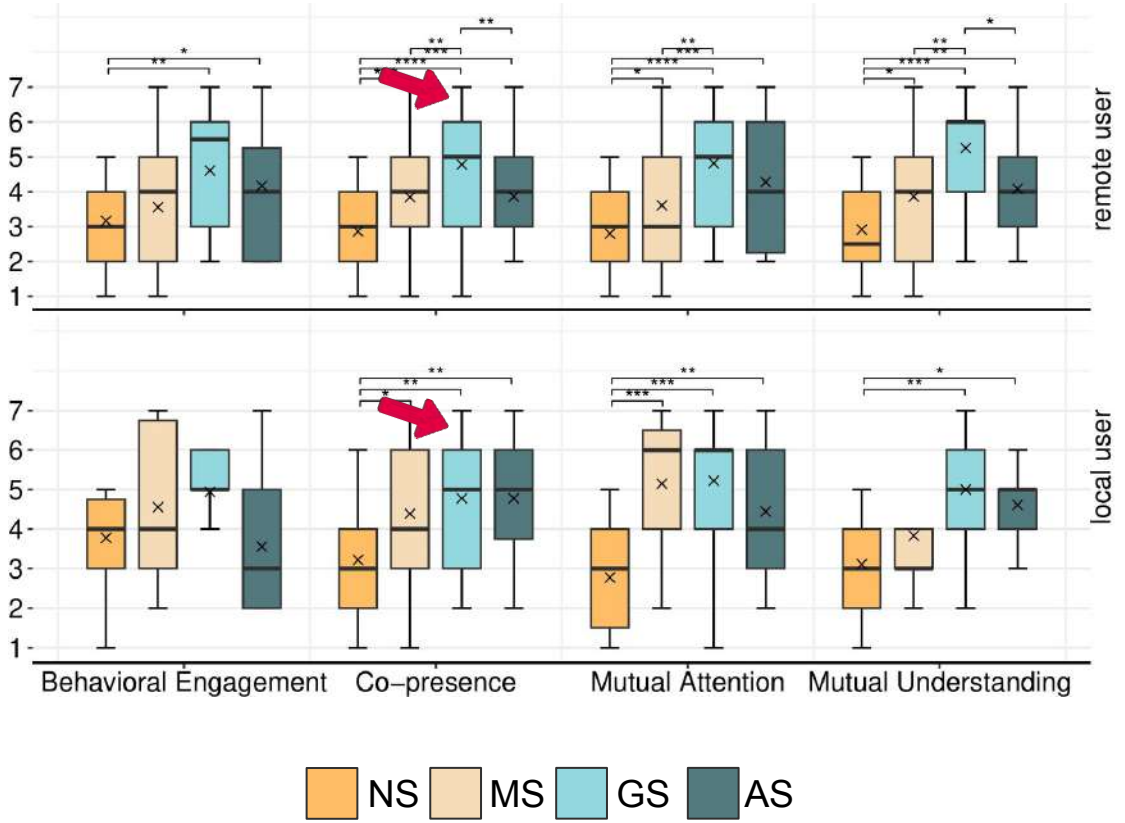
RESULTS

Results

Social Presence

- **H1: Guided viewpoint selection will result in a higher level of spatial presence and social presence compared to other conditions.**

  — Measured by: **NMM, Bail, Hauber**

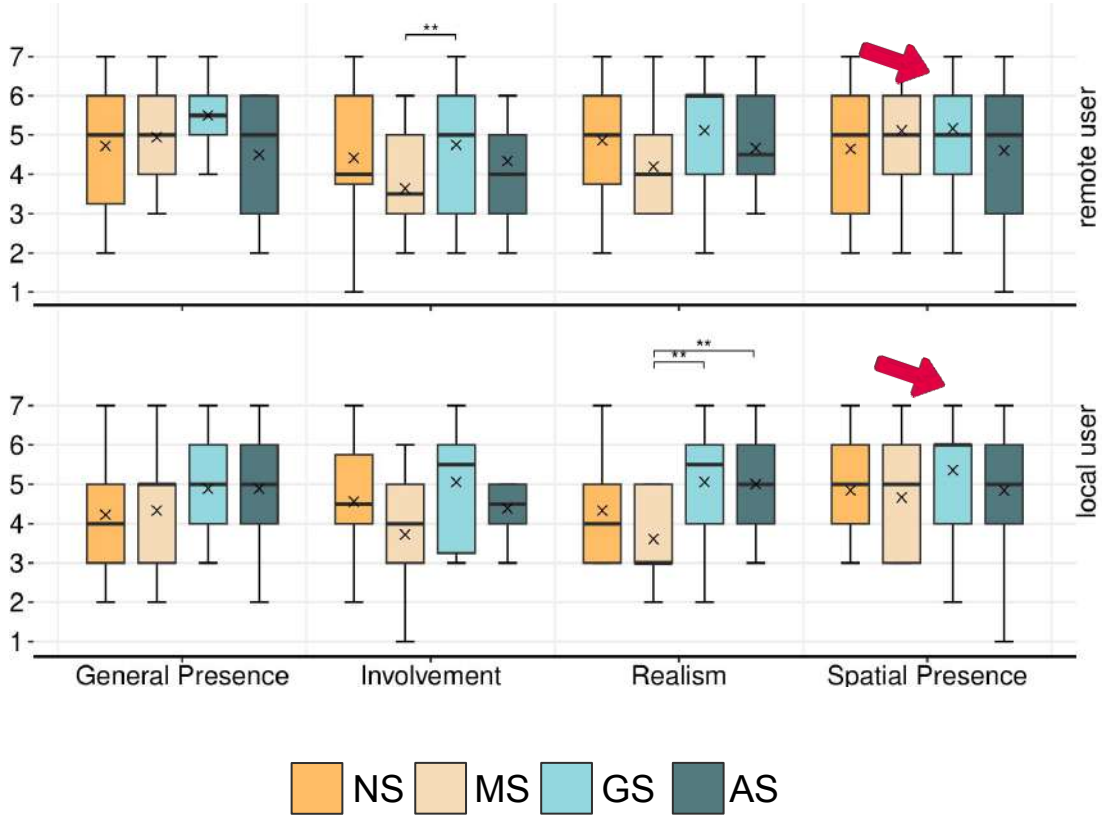


Spatial Presence

- **H2: Guided viewpoint selection will result in a higher level of spatial presence and social presence compared to other conditions.**

  — Measured by: **IPQ**

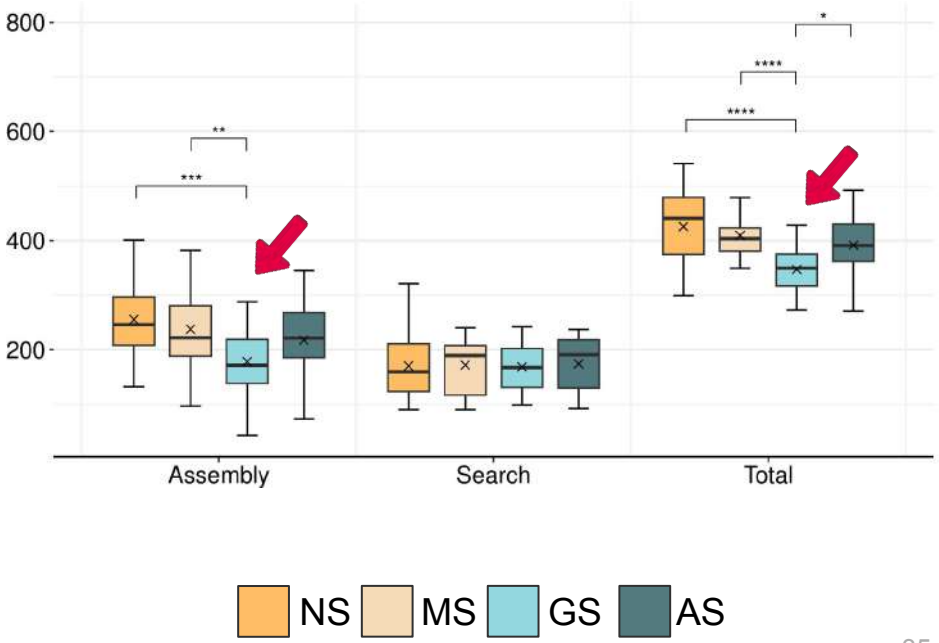
"It felt like we were in the same room. Also by looking at the viewport, I could easily see what they were drawing and looking at."
[P21]



Task Completion Time

- **H2: Both guided and automatic viewpoint selection will lead to reduced task completion time compared to the no-view and manual selection conditions.**

GS: M = 393.46, SD = 60.32



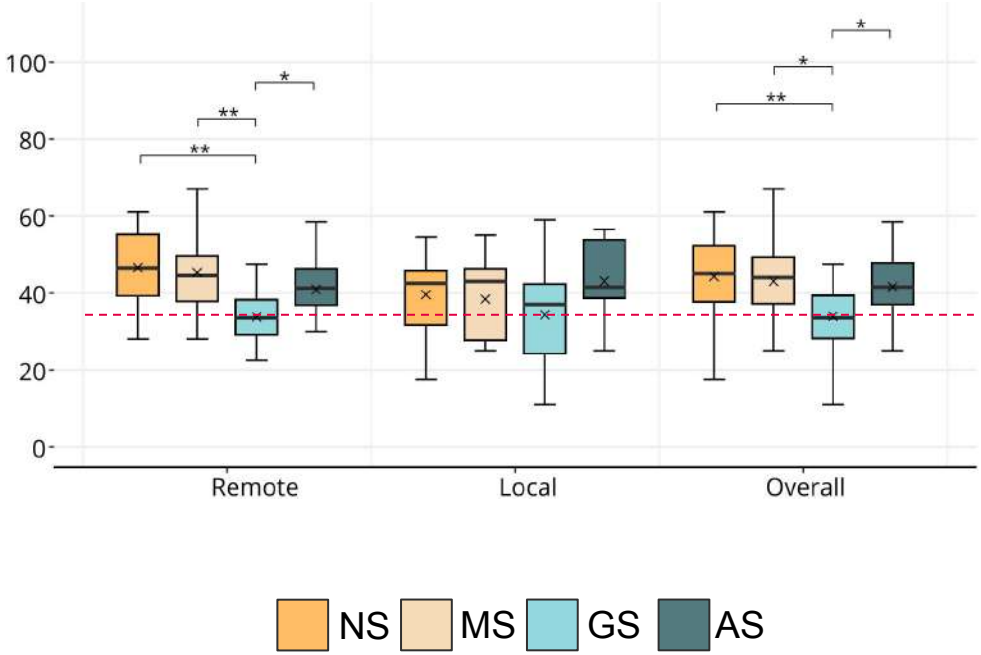
Workload

- **H2: Both guided and automatic viewpoint selection will lead to reduced task completion time compared to the no-view and manual selection conditions.**

  — Measured by: **RTLX**

GS

Local: M = 32.31, SD = 23.96
Remote: M = 34.76, SD = 25.41



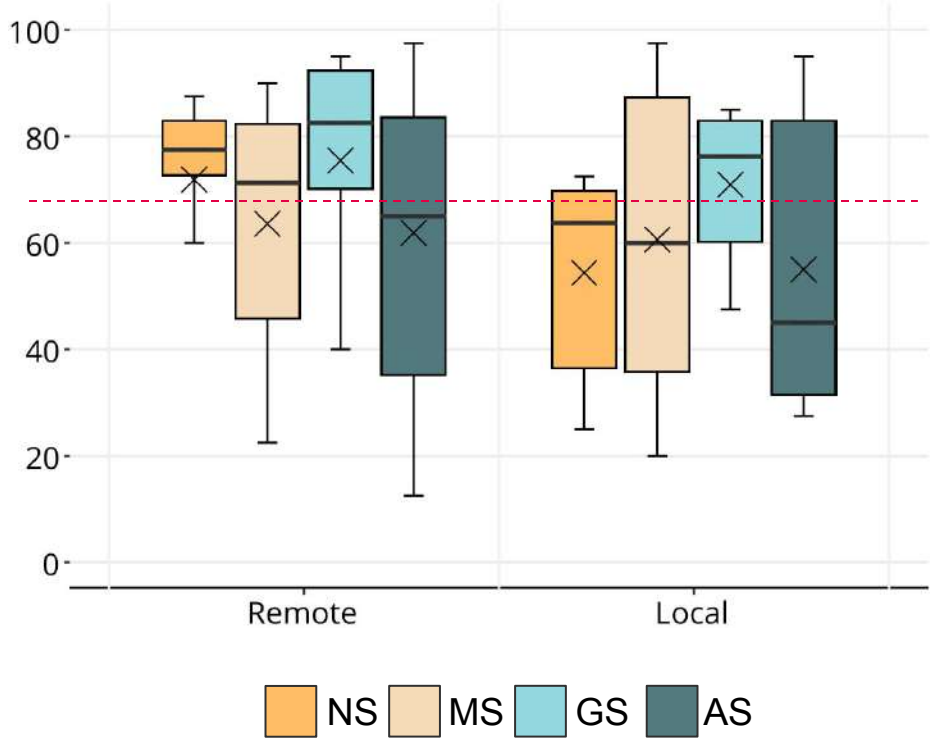
Usability

- **H3: Usability will be significantly higher in the guided and automatic viewpoint selection conditions**

— Measured by: **SUS**

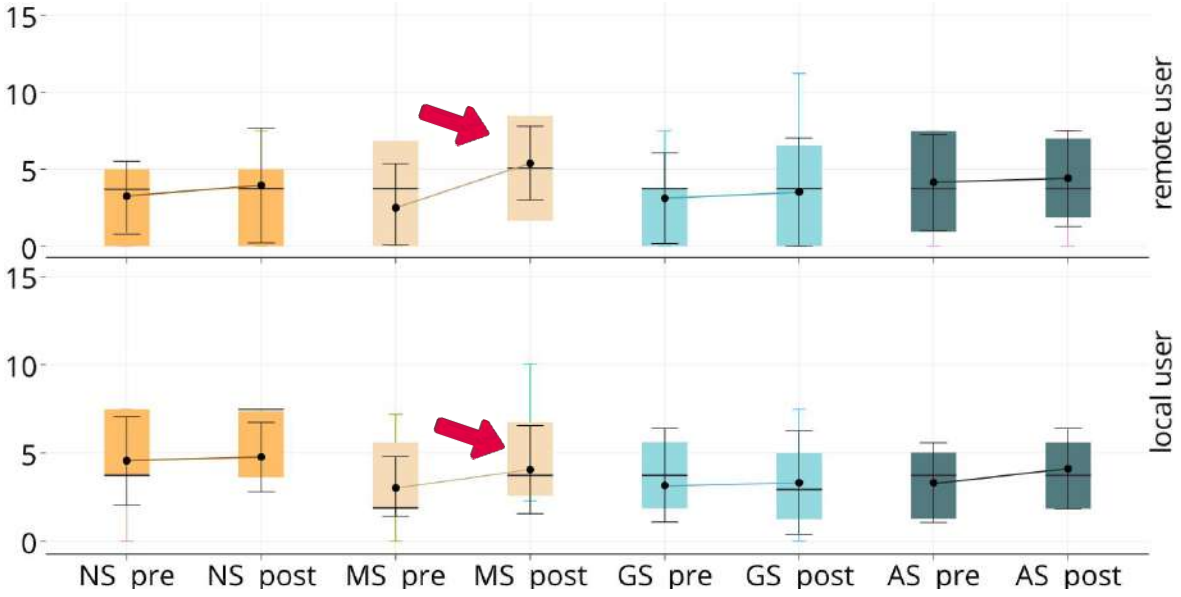
GS

Local: M = 68.61, SD = 15.87
Remote: M = 74.58, SD = 19.82



Simulated Sickness

- Compared pre and post measures of viewpoint selection conditions

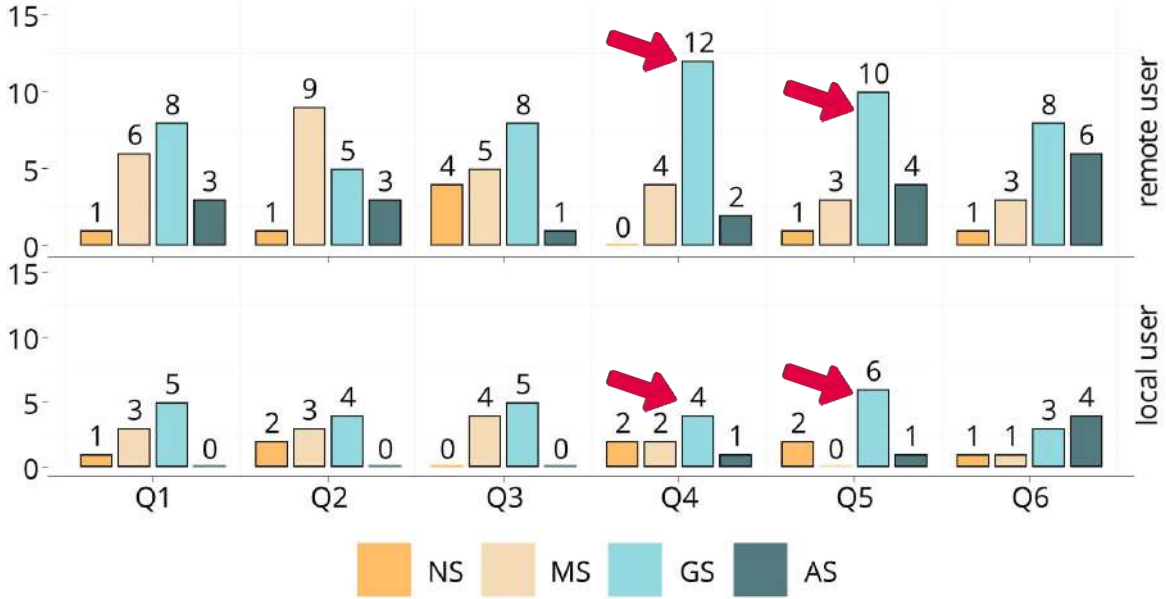


Preference

- **H4: Participants will prefer guided viewpoint selection more than other conditions.**

"The tool (GS) was spot-on, and the mini viewport window helped me understand exactly what my partner was seeing" [P4]

"I found that the GS conditions were the most effective for understanding and communicating with our partners" [P12]



Q4 Which condition did you find most effective for communicating with your partner?

Q5 Which condition did you find most helpful for completing the task?

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Limitation and Future Work

- **Explore more capture modalities**
  - Integrate depth information.
  - Teleoperate robots.
- **Conduct more user studies.**
- **Optimize system performance.**
- **Identify potential enhancements.**

Conclusion

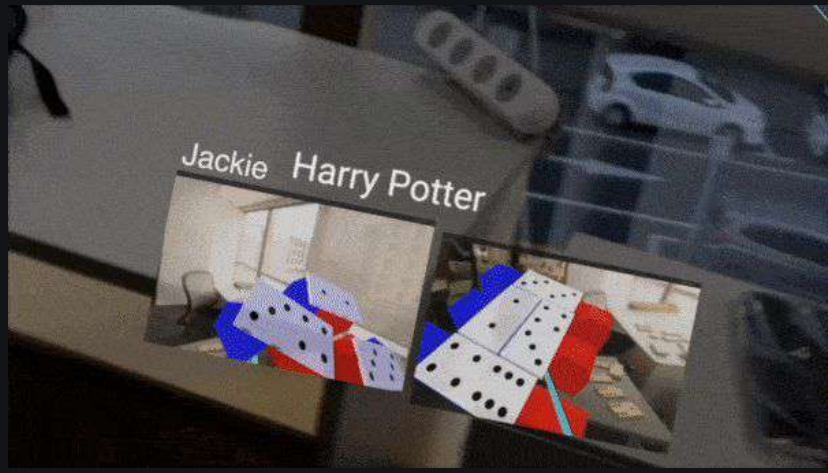
Summary

- **Context-aware viewpoint selection method**
  - simplifies and automates multiple viewpoints.
  - finds optimal viewpoints based on audio-visual cues.

- **User evaluation**
  - 27 participants under four distinct conditions
  - asymmetric multiuser AR-VR setup

✓ *Zaman et al. "**MRMAC: Mixed Reality Multi-user Asymmetric Collaboration**". ISMAR 23*

- **Findings and design implications**
  - improved task space understanding and performance reduced cognitive load
  - GS was the most preferred



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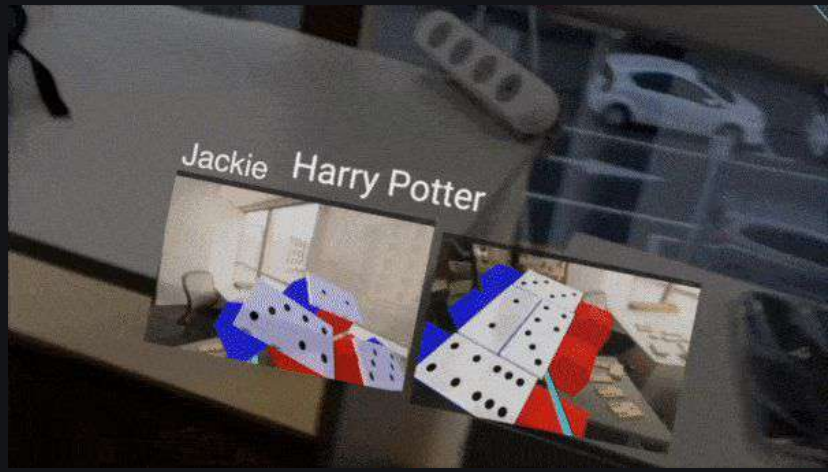
Vicarious : Context-aware Viewpoints Selection for Mixed Reality Collaboration

Why work remotely when you can work *Vicariously*?



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