Towards End-user Creation of Immersive Experiences

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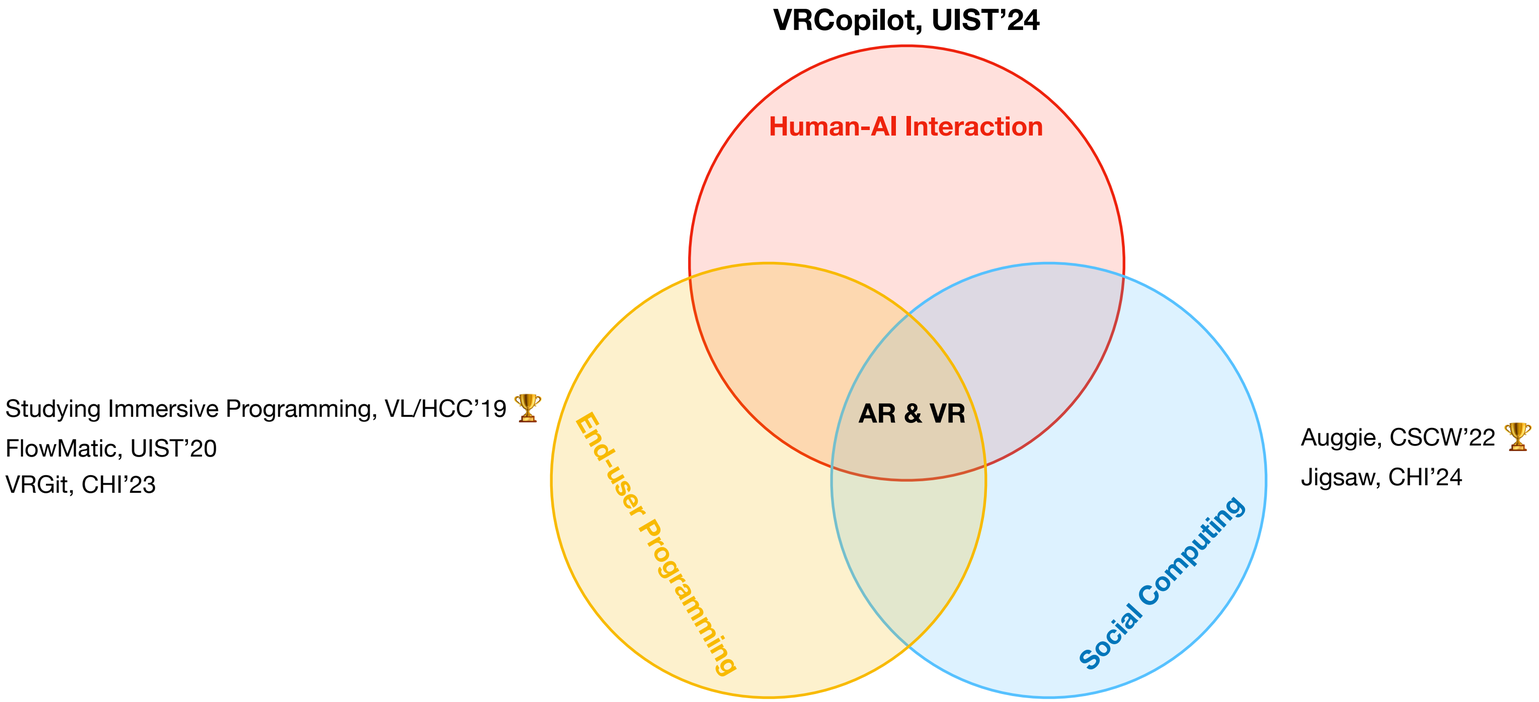
UNIVERSITY OF MICHIGAN

My research theme

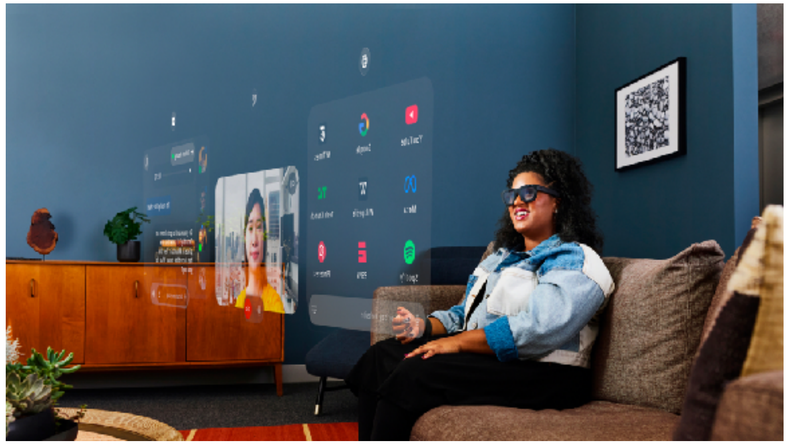
My research in Human-Computer Interaction (HCI) focuses on building interactive systems that enable end-users, including people with little to no technical skills, to create Augmented Reality (AR) & Virtual Reality (VR) experiences and studying the benefits and challenges of these systems.



Background

The rise of AR & VR

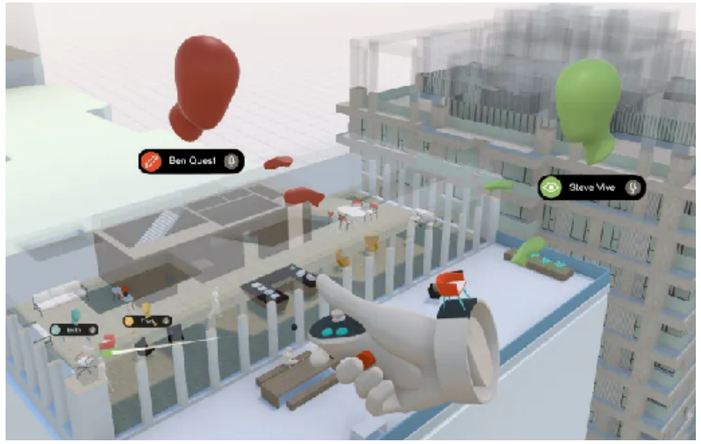
Apple Vision Pro



Meta Orion

Entertainment

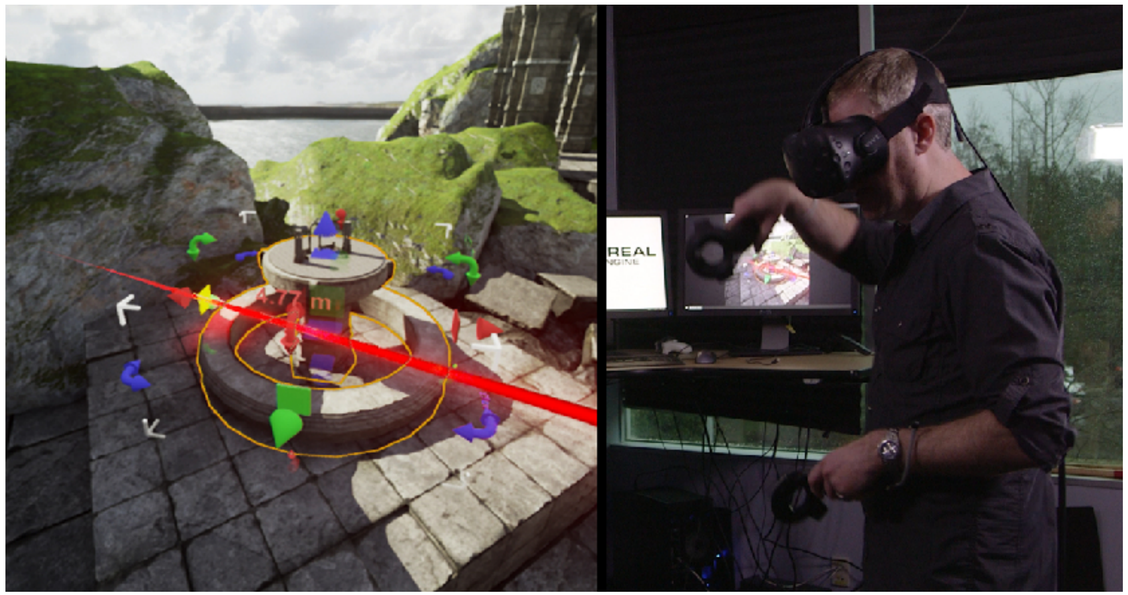
Future of Work



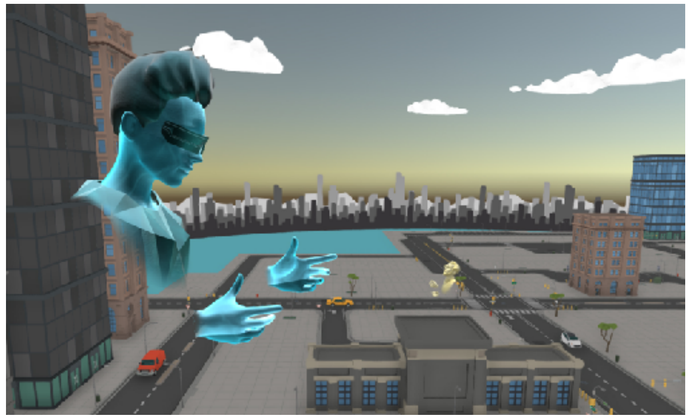
Architecture

3D Design

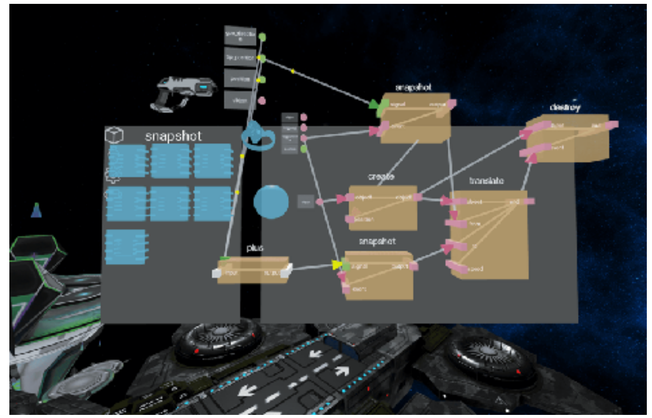
Increasing need for efficient 3D scene creation



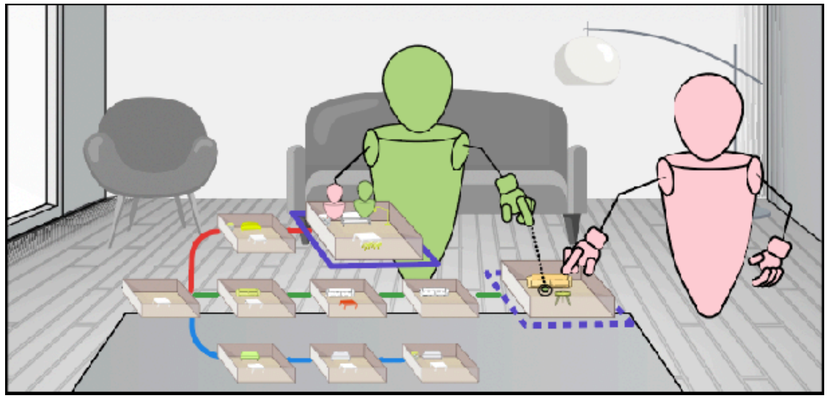
Immersive Authoring Tools
cr: Unreal Engine



Spacetime (UIST ’18)



FlowMatic (UIST ’20)

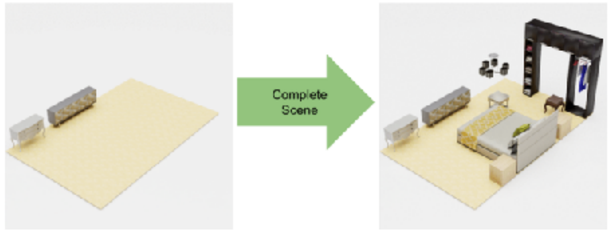


VRGit (CHI ’23)

However, most current 3D scenes are created through *manual* placement of 3D models.

Generative AI Models

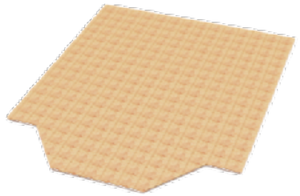
3D Tasks



ATISS (NeurIPS ’21)

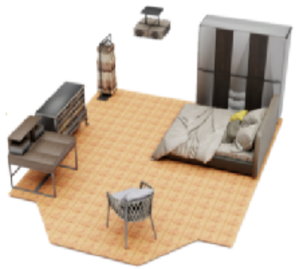
DiffuScene (CVPR ’24)

LayoutGPT (NeurIPS ’24)



Floor plan

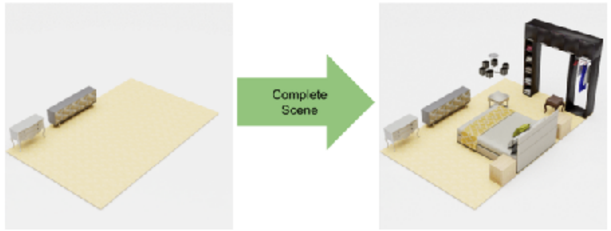
GenAI



Layout

Research Objectives

3D Tasks



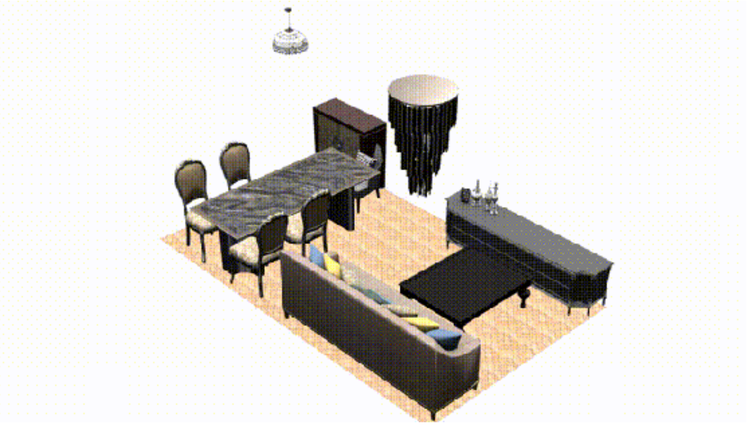
ATISS (NeurIPS ’21)

DiffuScene (CVPR ’24)

LayoutGPT (NeurIPS ’24)

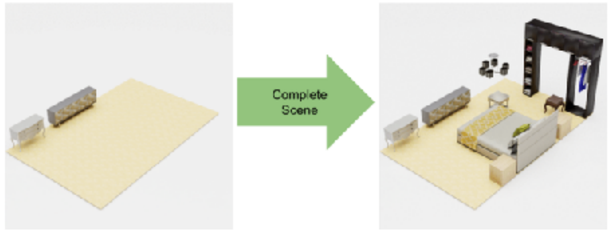
VRCopilot

Aligning with human preferences



Research Objectives

3D Tasks



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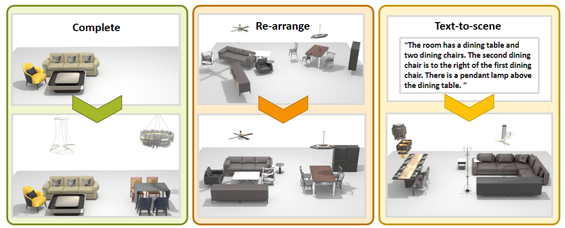


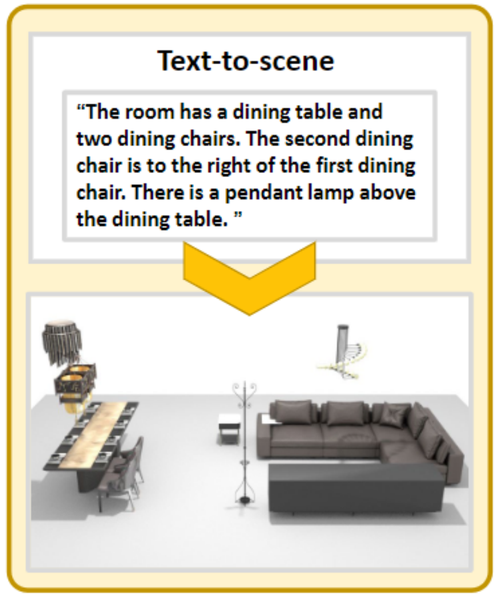
DiffuScene (CVPR ’24)

LayoutGPT (NeurIPS ’24)

VRCopilot

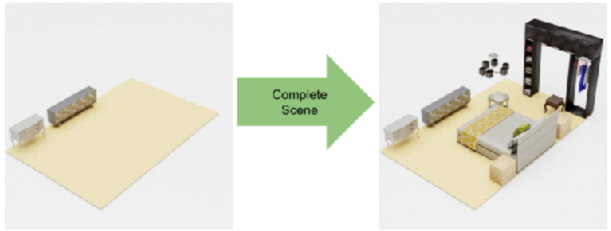
Aligning with human preferences

Designing intuitive interactions

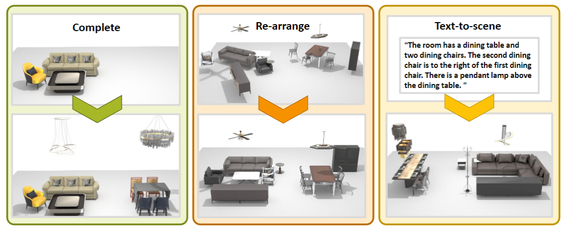


Research Objectives

3D Tasks



ATISS (NeurIPS ’21)



DiffuScene (CVPR ’24)

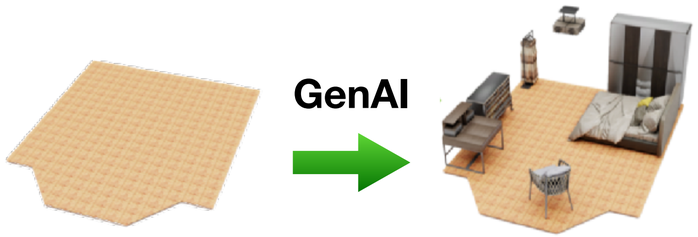
LayoutGPT (NeurIPS ’24)

VRCopilot

Aligning with human preferences

Designing intuitive interactions

Enhancing user agency and creativity



Floor plan

Layout

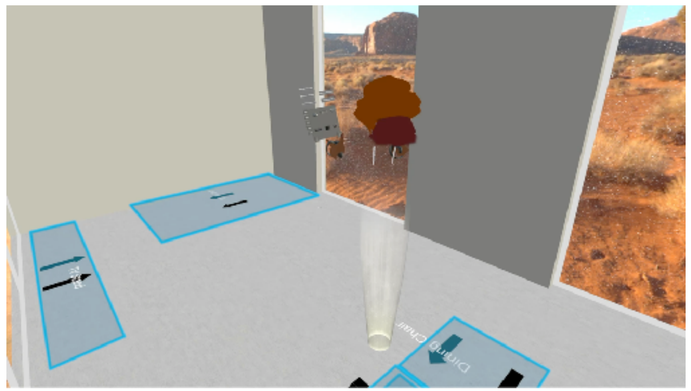
VRCopilot

Immersive Authoring for 3D Room Layouts

Automatic Creation

Human-AI Co-Creation in VR

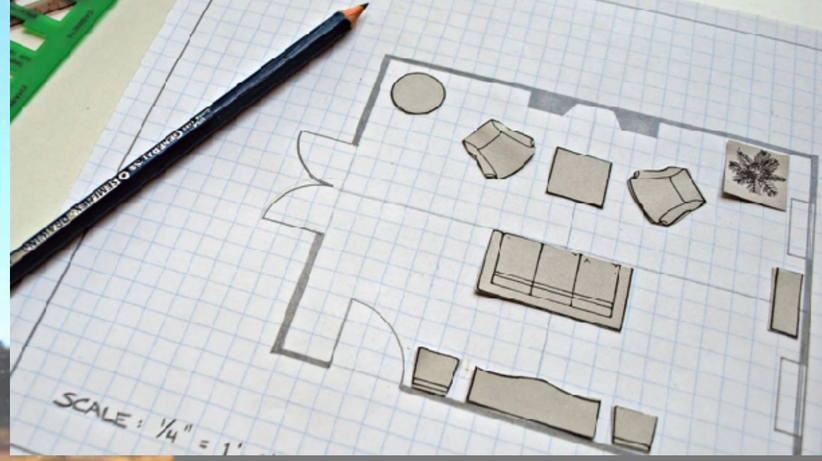
Scaffolded Creation



Automatic Creation

Machine Automation

Scaffolded Creation



Intermediate Representation: Wireframes

Delete all in the room

Wireframe->Furniture

Funiture->Wireframe

Generate Wireframes

Generate Layouts

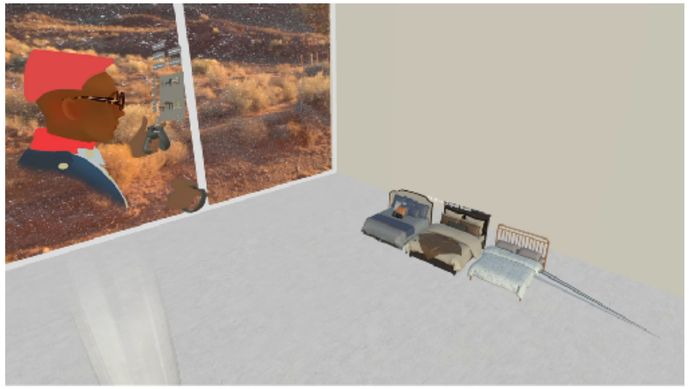
Sofas

Tables

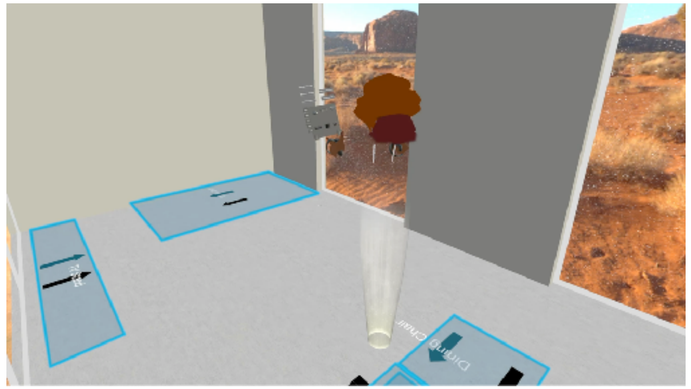
Chairs

Human-AI Co-Creation in VR

Manual Creation



Scaffolded Creation



Automatic Creation

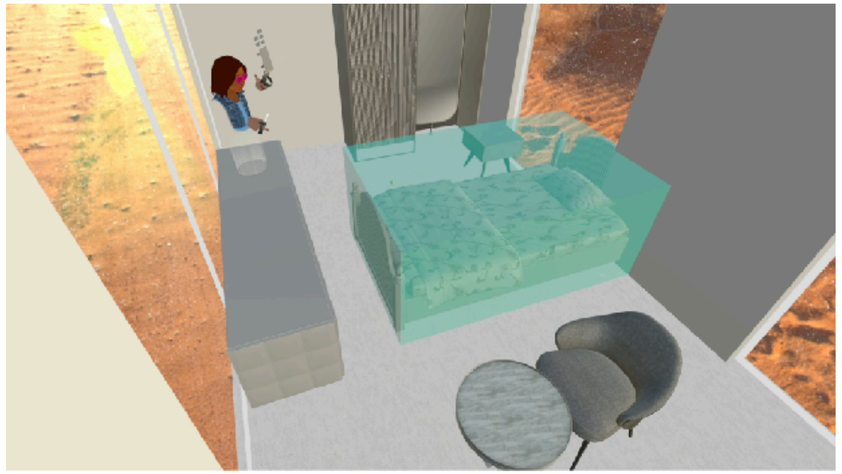
Machine Automation

Manual Creation

Multimodal Specification

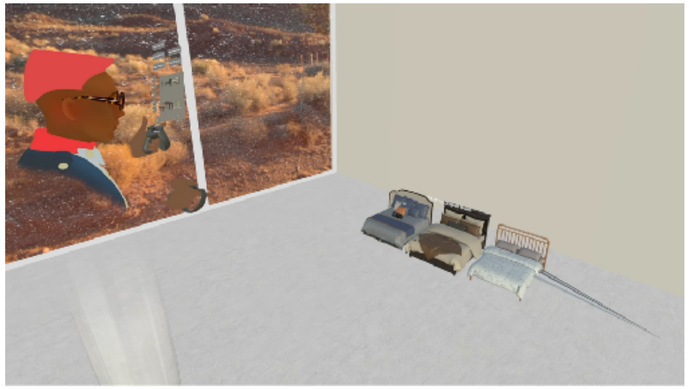
“Delete”

“Regenerate”

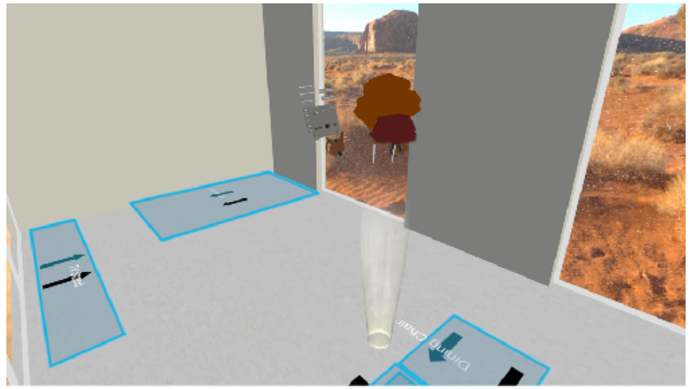


3 Ways of Human-AI Co-Creation in VR

Manual Creation



Scaffolded Creation



Automatic Creation

Machine Automation

User Studies

User Study 1 - with v.s. without AI

Procedure

- 14 participants created layouts with and without genAI

Without AI

With AI

User Study 1 - with v.s. without AI

Procedure

- Participants created layouts with and without genAI
- A workshop of a design expert on the creation results from the participants
  - The expert did open-coding of patterns they found in the creation results

Creation results without AI by P10

Creation results with AI by P13

User Study 1 - with v.s. without AI

Key Findings

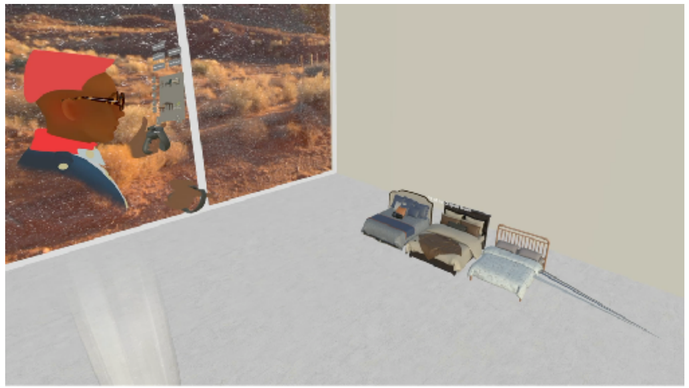
- Creation with AI tends to have diverse *functionality* and color palette.
- Creation without AI tends to have better consideration of *s p a c i n g* (e.g., circulation and daylighting).

Creation results without AI by P10

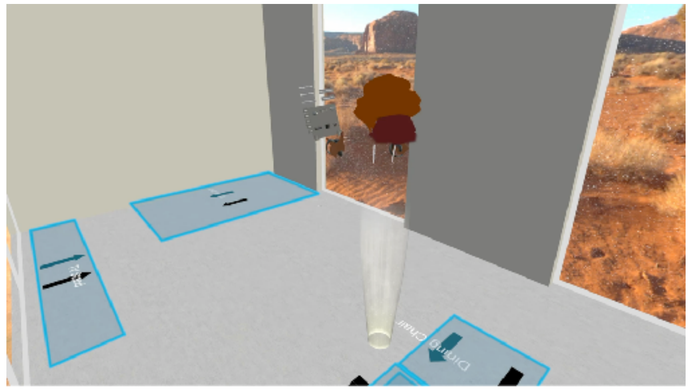
Creation results with AI by P13

User Study 2 - Ways of Human-AI Co-creation

Manual Creation



Scaffolded Creation

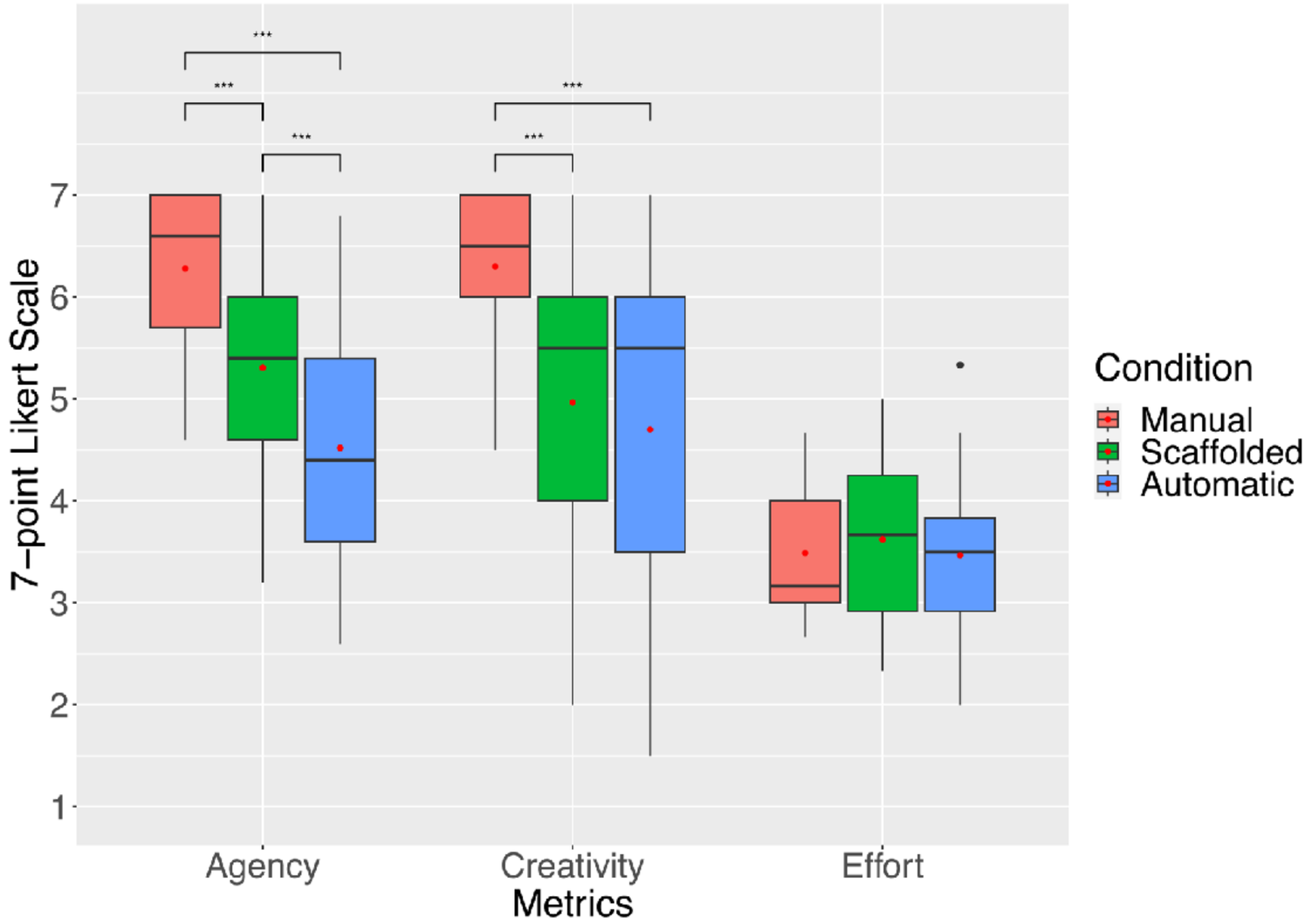


Automatic Creation

Procedure

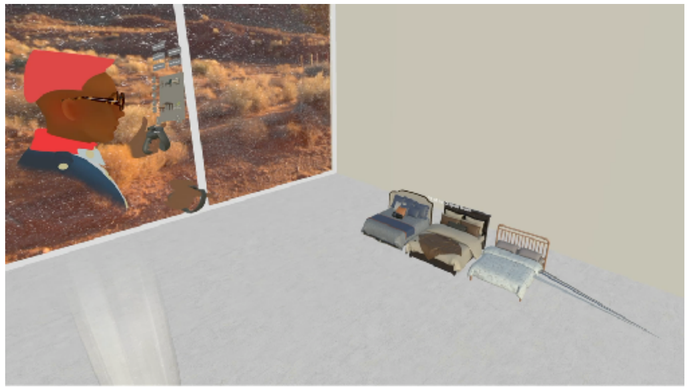
- Participants created layouts using all modes: manual, scaffolded, and automatic creation.
  - Constraints for the task such as 1) finishing at least *three* versions, 2) having least *four* objects in each version, 3) providing enough space for users to *navigate* in the room, etc.
  - Surveys that measure subjective user-perceived *agency (sense of being in control)*, *creativity (sense of being creative)*, and *effort (sense of physical and mental effort)*.
  - Retrospective interviews.

User Study 2 - Ways of Human-AI Co-creation

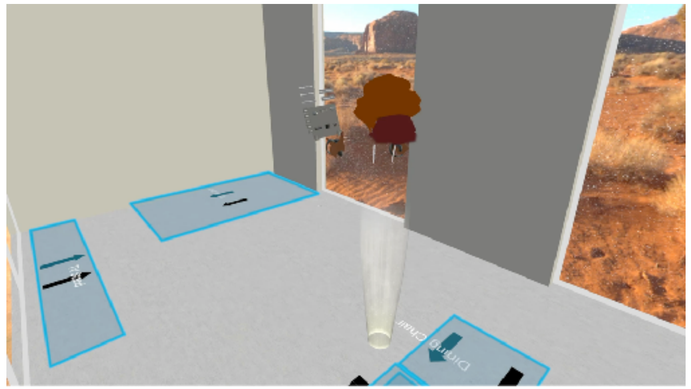


User Study 2 - Ways of Human-AI Co-creation

Manual Creation



Scaffolded Creation



Automatic Creation

Agency Manual > Scaffolded > Automatic

"I can pick, only leather chairs, leather sofas, and then have a bed that matches that style... you just ***got more control over the style itself, rather than just the layout***"

-P21

"I could also ***decide what size and how it's positioned.*** Whereas the others, I think, particularly lost out on the sizing component."

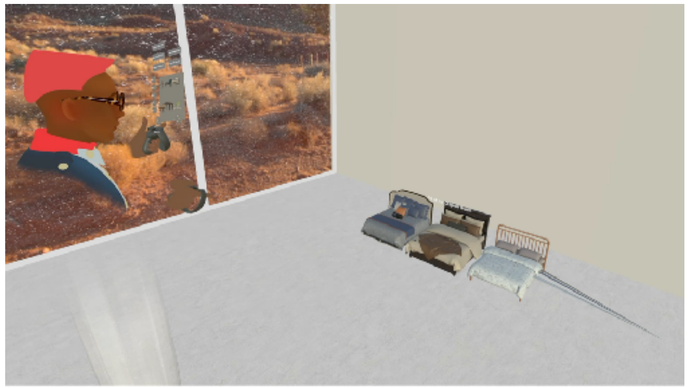
-P23

"Because it feels like that's already there. So **it looks like it already looks pretty good. So I wouldn't want to move it too much**, and definitely I have less control with it."

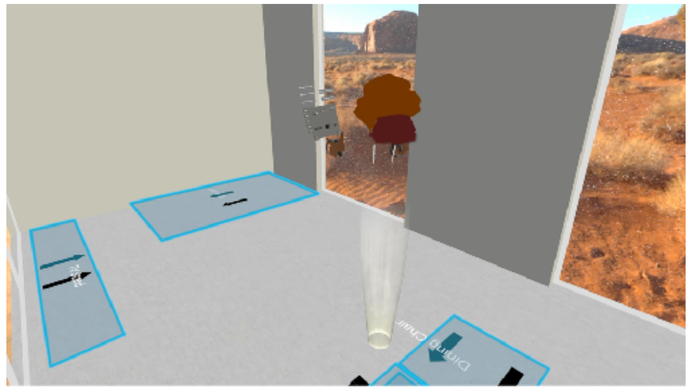
-P28

User Study 2 - Ways of Human-AI Co-creation

Manual Creation



Scaffolded Creation



Automatic Creation

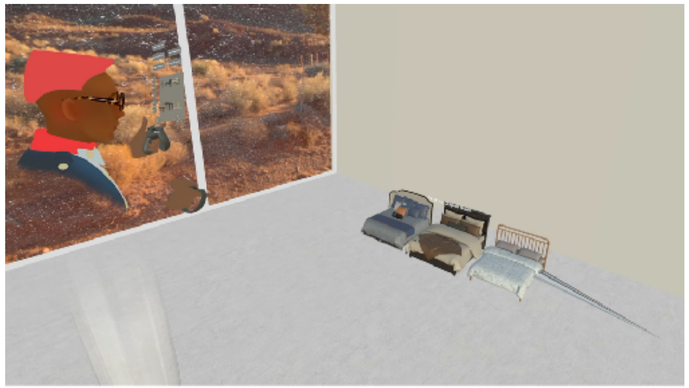
Agency	Manual	>	Scaffolded	>	Automatic
Creativity	Manual	>	Scaffolded	≈	Automatic

"When I saw the bed [from the three suggestions], and it's like bright green, yellow, I was like, 'maybe I can make this the theme of this room.' And I was trying to go with this style when I was choosing the other furniture... I think the [Manual Creation] condition facilitates creativity a bit more just because ***you can choose between the three options***." -P24

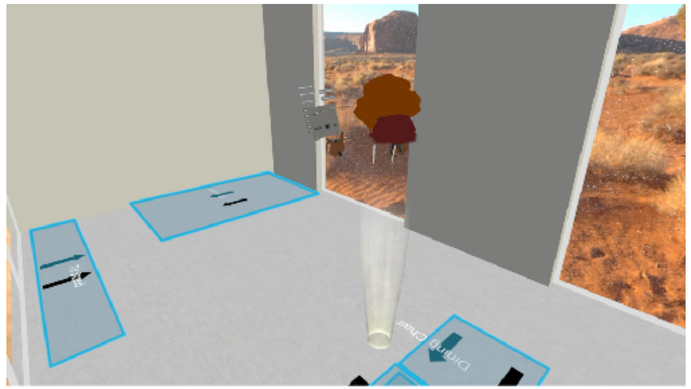
"I think having everything laid out for you already, it decreases your creativity. Because you'll ***have that bias towards the way that it just puts everything.*** So it's like the bed's here, I might just keep it there." -P21

User Study 2 - Ways of Human-AI Co-creation

Manual Creation



Scaffolded Creation

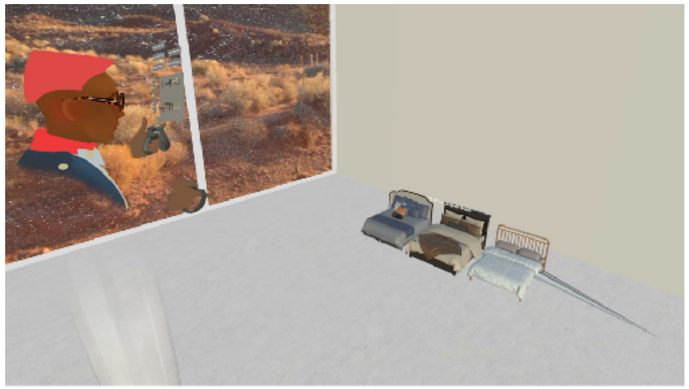


Automatic Creation

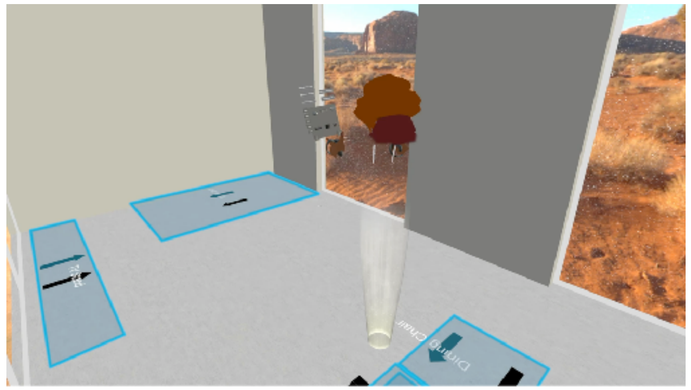
Agency	Manual	>	Scaffolded	>	Automatic
Creativity	Manual	>	Scaffolded	≈	Automatic
Effort	Manual	≈	Scaffolded	≈	Automatic
Misc.			Easy manipulation in VR Lack of understanding of GenAI capabilities Efficient for creating multiple rooms		Hard to manipulate distant or occluded objects in VR

VRCopilot: Authoring 3D Layouts with Generative AI Models in VR

Manual Creation



Scaffolded Creation



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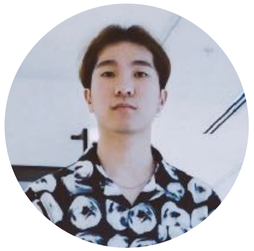

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PITTSBURGH | 2024

Discussion on Neurodiversity

Broaden the neurodiversity of AI data for 3D scenes

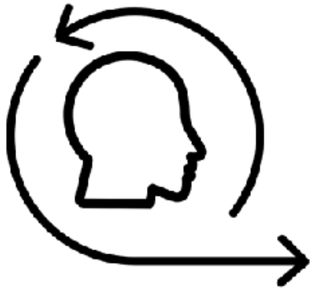
Sensory Room at Newark International Airport

VizWz (CVPR ’23)

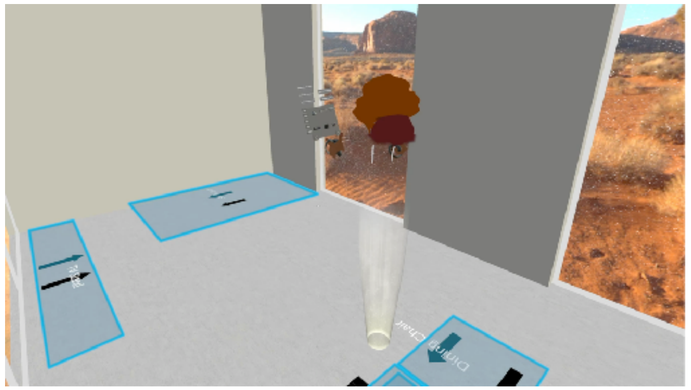
3D-FRONT (ICCV ’23)

Discussion on Neurodiversity

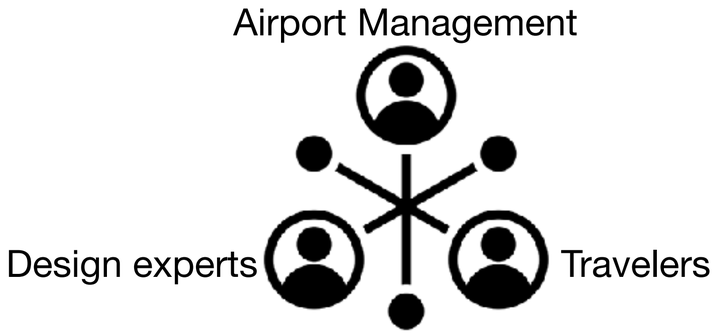
Broaden the neurodiversity of AI data for 3D scenes



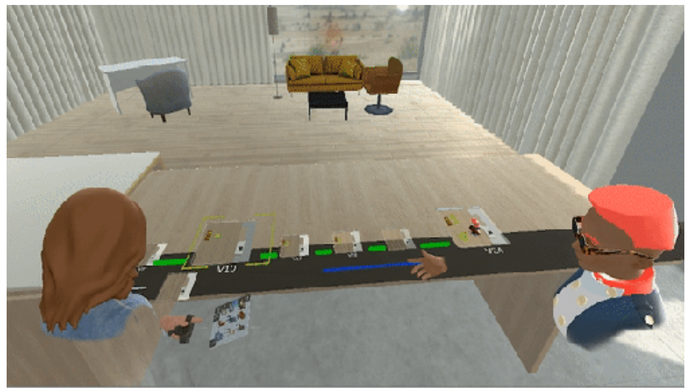
Human-centered AI systems for 3D scene design in VR



VRCopilot (UIST ’24)



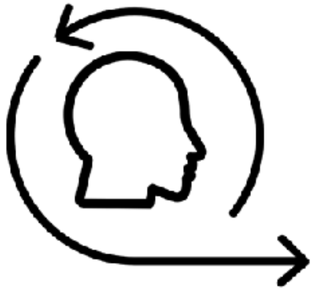
Understanding stakeholders’ needs



VRGit (CHI ’23)

Discussion on Neurodiversity

Broaden the neurodiversity of AI data for 3D scenes



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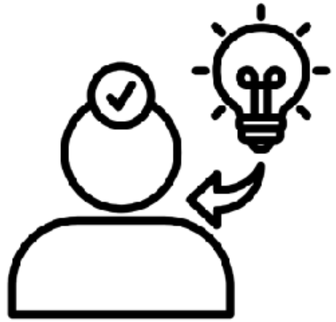
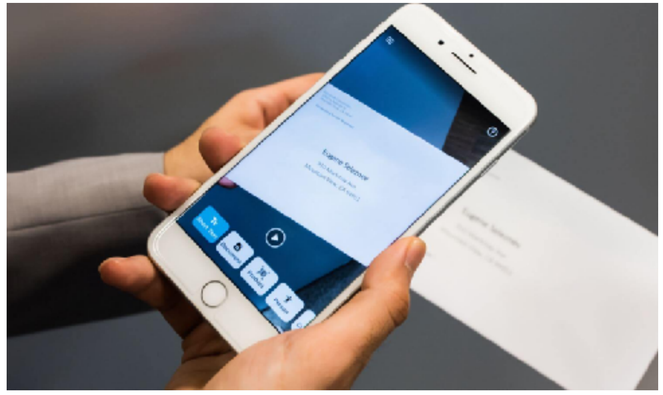
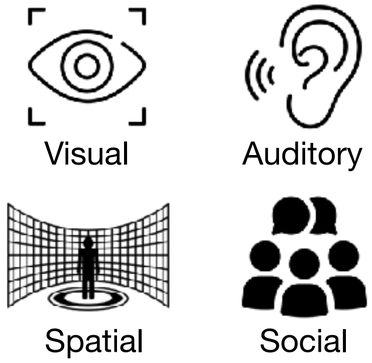


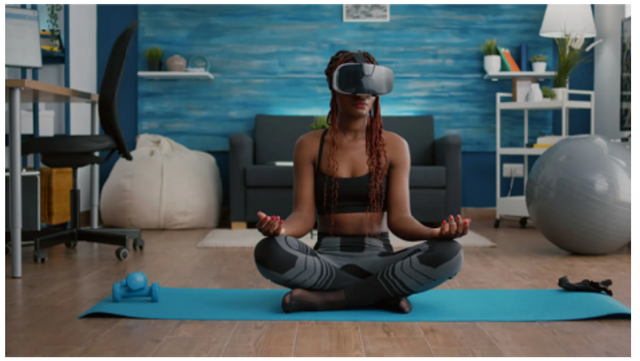
Sensing the world for people with non-visible disabilities



Seeing AI



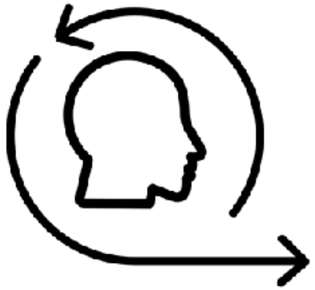
Building mental models of people with non-visible disabilities



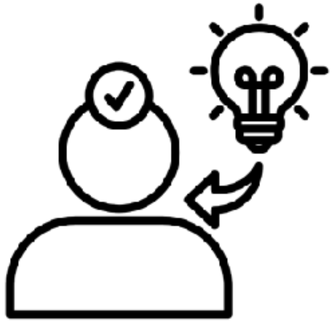
VR for mental health

Discussion on Neurodiversity

Broaden the neurodiversity of AI data for 3D scenes



Human-centered AI systems for 3D scene design in VR



Sensing the world for people with non-visible disabilities

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