Workshop 6:
Augmenting Spatial Communication through 3D Sketch Mapping in Extended Reality

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01.09 - 05.09.2025

ETH zürich

geoinformation engineering ikg eth zurich

Home Publications Projects Teaching Mentoring Presentations CV

Tianyi Xiao

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Zürich, Switzerland

ETH Zürich

Website

Email

Google Scholar

GitHub

LinkedIn

Home

About Me

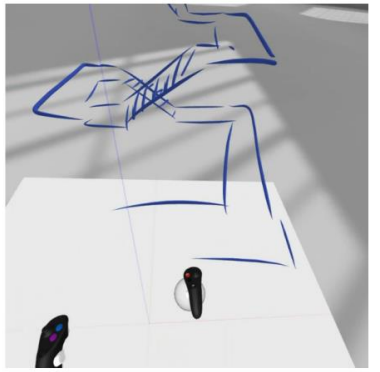
I am a Ph.D. candidate at ETH Zürich's geoGazeLab, with an interdisciplinary background in computer science and urban/architectural design. My research is situated at the intersection of **Human-Computer Interaction (HCI)**, **eXtended Reality (XR)**, **3D Sketch Mapping**, and **Spatial Iintelligence & Cognition**. I work for the 3D Sketch Maps project, funded by the Swiss National Science Foundation (SNSF) within the Sinergia grant program, which investigates 3D sketch maps from theoretical, empirical, cognitive, and tool-related perspectives, with a particular focus on Extended Reality (XR) techniques. I am advised by Martin Raubal and Christian Holz.

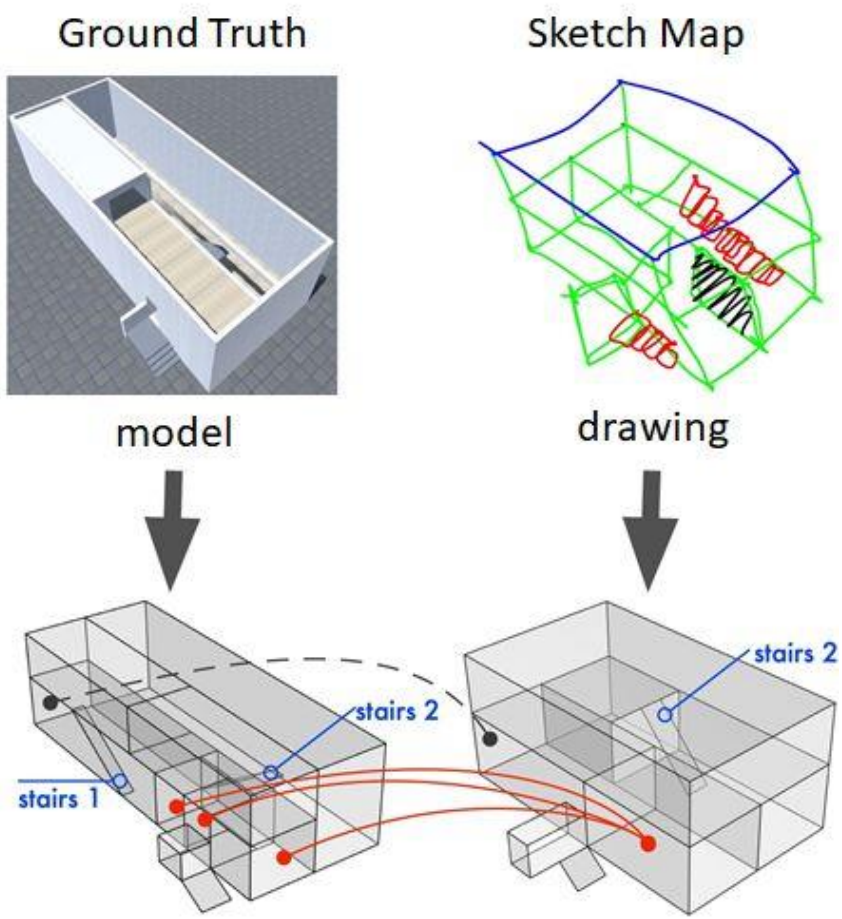
https://tianyixiao.top/

Topic

This workshop explores new forms of **spatial communication** through **3D sketch mapping** in XR. Participants will engage with real-time collaborative sketching and visualization, leveraging spatial annotation tools to communicate design ideas and spatial relationships across shared virtual environments. Skills developed include multi-user interaction design, spatial storytelling, and 3D annotation workflows.

Tutor: Tianyi Xiao, Institute of Cartography and Geoinformation, ETH Zurich





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geoGAZE

Swiss National Science Foundation

Aesthetic expression

Ideation

Sketch Mapping

Communication

Visualization

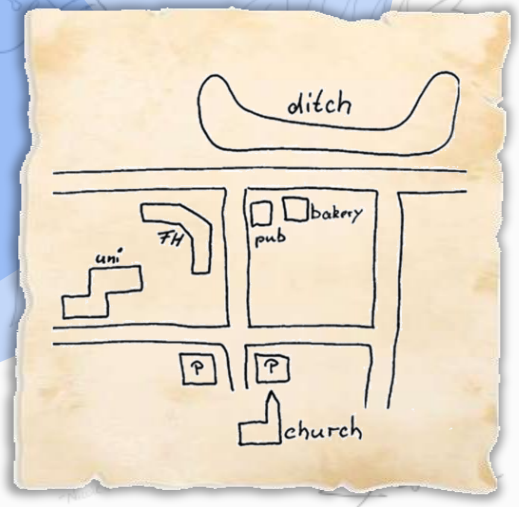
Fig: Tu, Joseph. "Visualizing Engagement: The Power of Fun, Interactive, Sketching and Humour in Conference Networking (FISH)." *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*. 2025.

Sketch Mapping

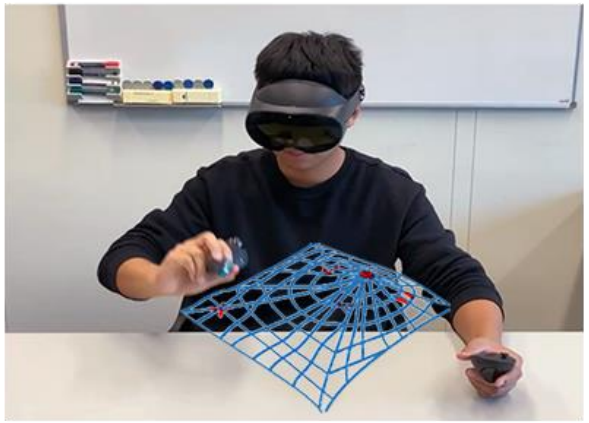
Communication

Visualization

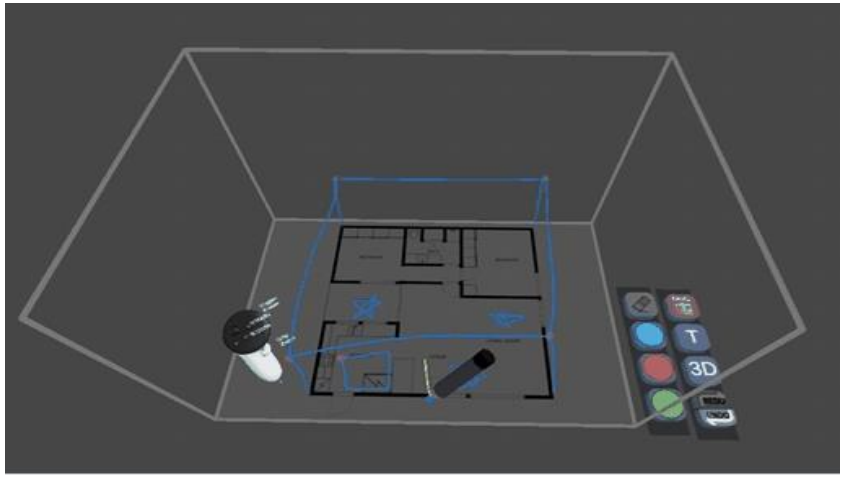
- It is an intuitive and effective way to externalize spatial knowledge.
- It is used to study human spatial decision-making and information processing.

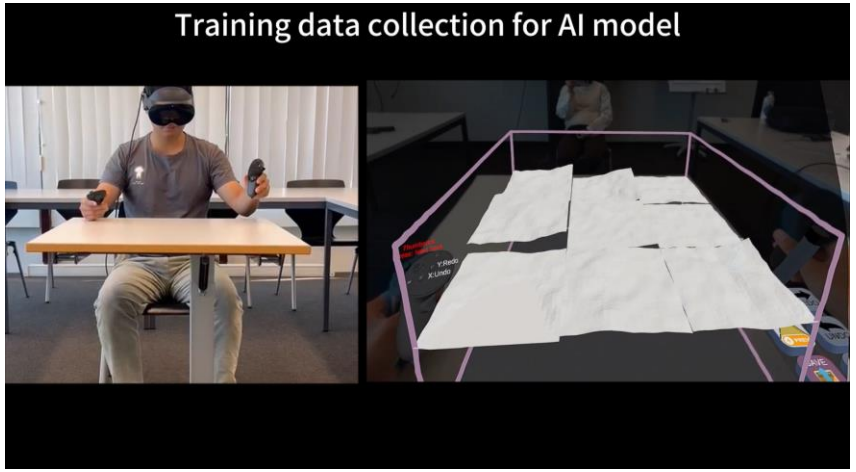


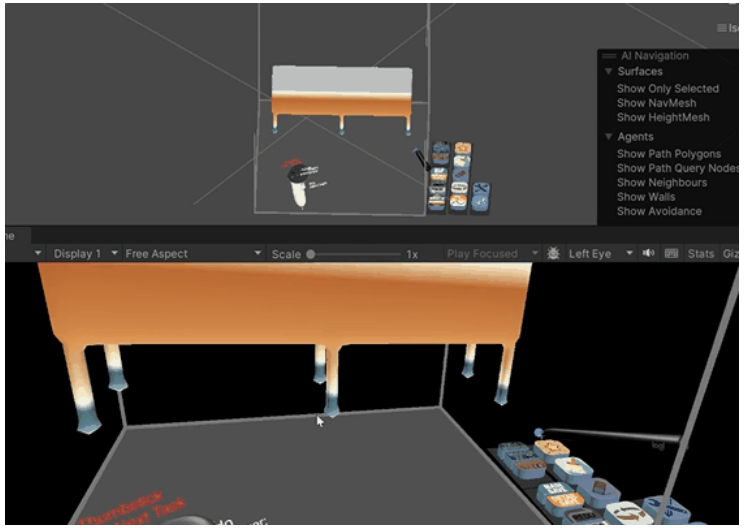
3D Sketch Mapping

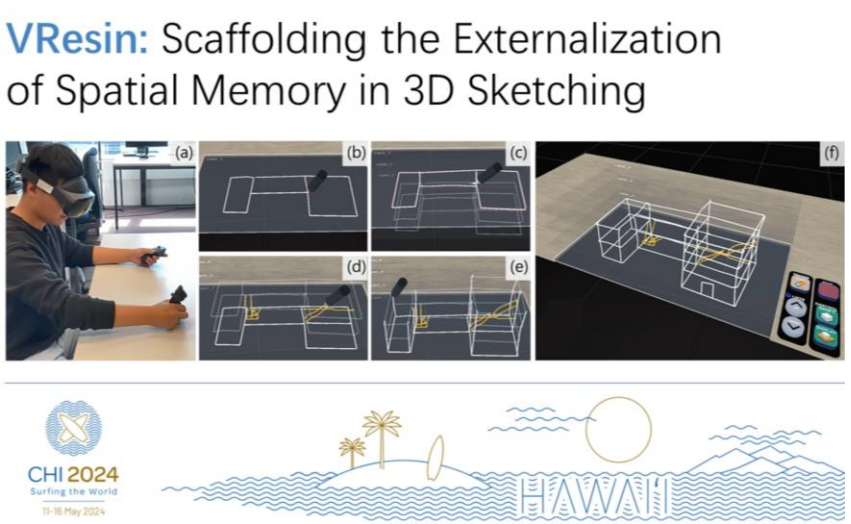
2D sketch maps	3D sketch maps
	
Paper-based	VR/AR HMDs

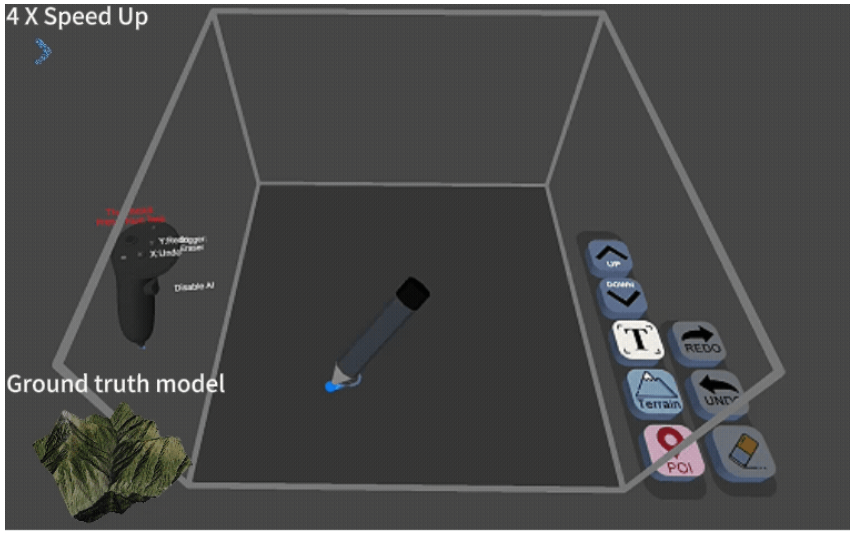
3D Sketch (Mapping) System



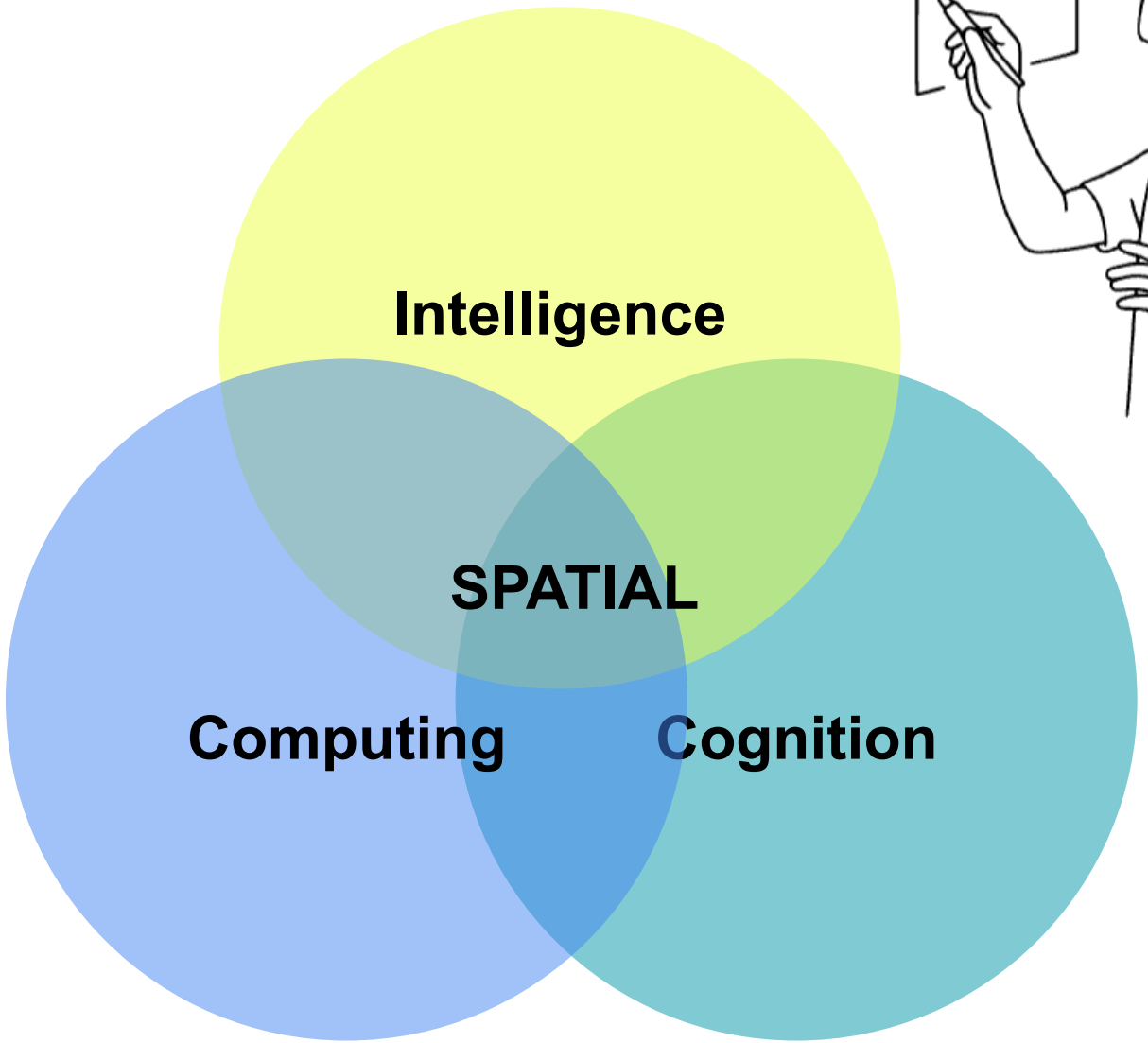


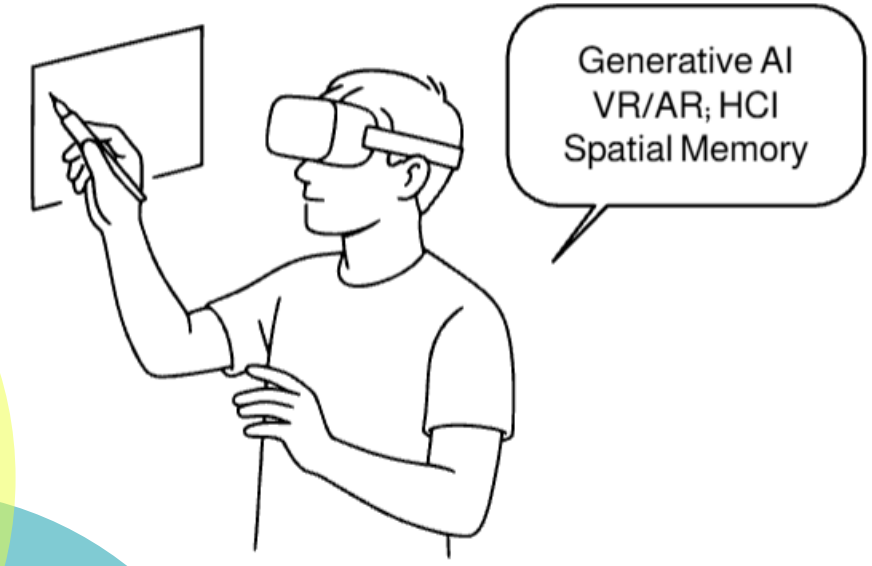


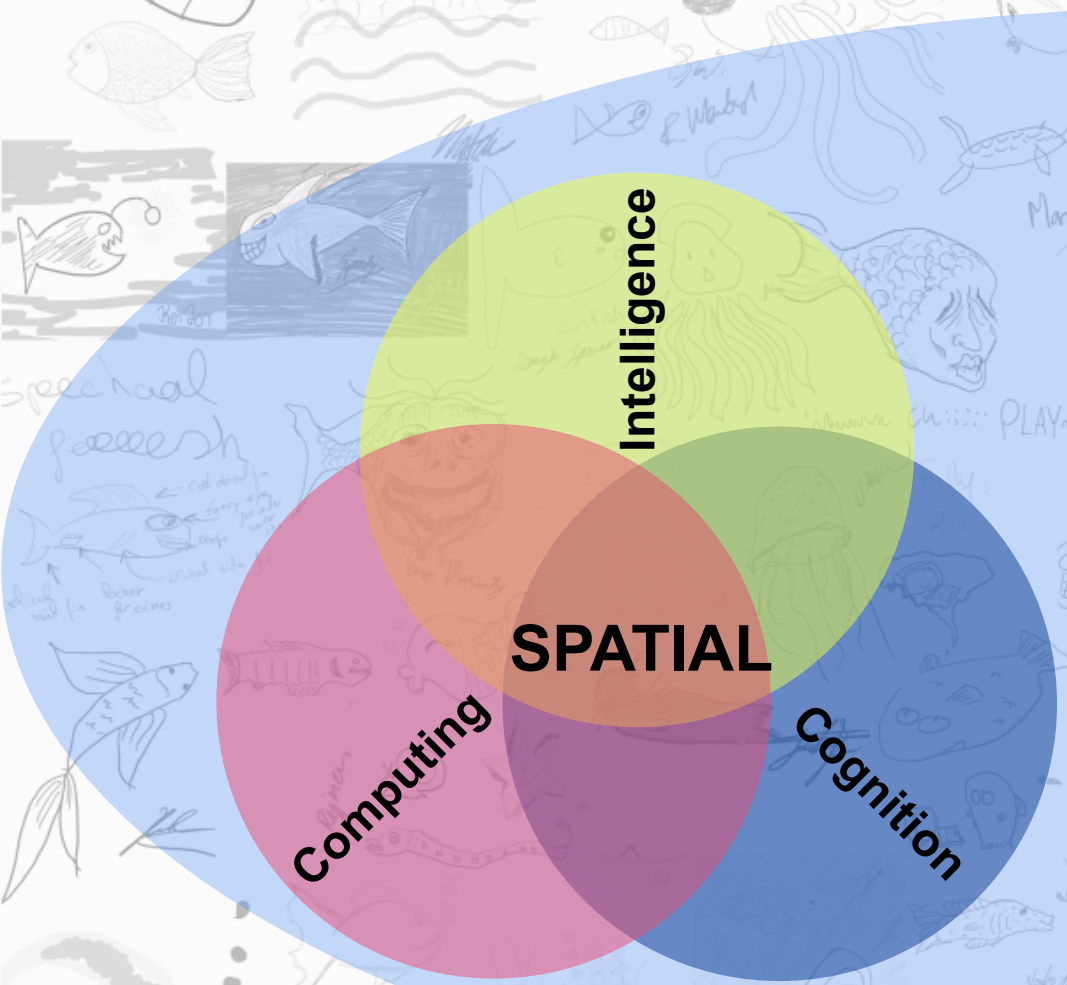


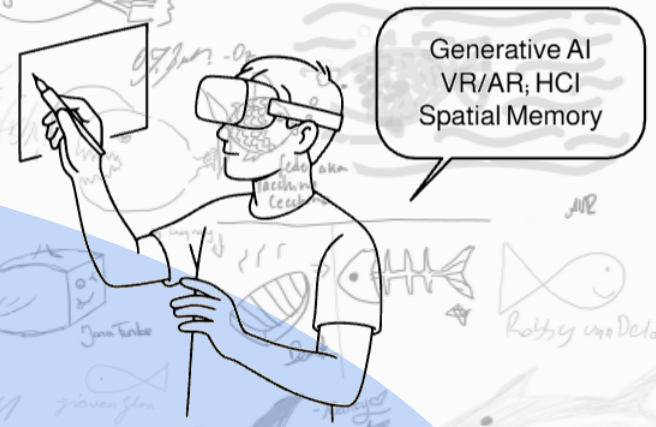


1. Kim, K. G., Krukar, J., Mavros, P., Zhao, J., Kiefer, P., Schwering, A., ... & Raubal, M. (2022). 3D sketch maps: Concept, potential benefits, and challenges. In *15th International Conference on Spatial Information Theory (COSIT 2022)* (Vol. 240, p. 14). Schloss Dagstuhl-Leibniz-Zentrum für Informatik.
2. Kim, K. G., Kwok, T. C., Zhong, S., Kiefer, P., & Raubal, M. (2024). Can You Sketch in 3D? Exploring Perceived Feasibility and Use Cases of 3D Sketch Mapping. In *16th International Conference on Spatial Information Theory (COSIT 2024)* (pp. 3-1). Schloss Dagstuhl–Leibniz-Zentrum für Informatik.
3. Xiao, T., Kim, K. G., Krukar, J., Subramaniyan, R., Kiefer, P., Schwering, A., & Raubal, M. (2024). VResin: Externalizing spatial memory into 3D sketch maps. *International Journal of Human-Computer Studies*, *190*, 103322.
4. Xiao T, Chen Y, Zhong S, Kiefer P, Krukar J, Kim KG, Hurni L, Schwering A, Raubal M. Sketch2Terrain: AI-Driven Real-Time Terrain Sketch Mapping in Augmented Reality. In Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems 2025 Apr 26 (pp. 1-24).


Intelligence
SPATIAL
Computing
Cognition

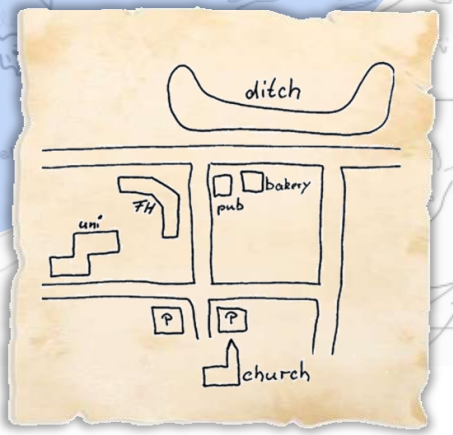

Generative AI
VR/AR; HCI
Spatial Memory

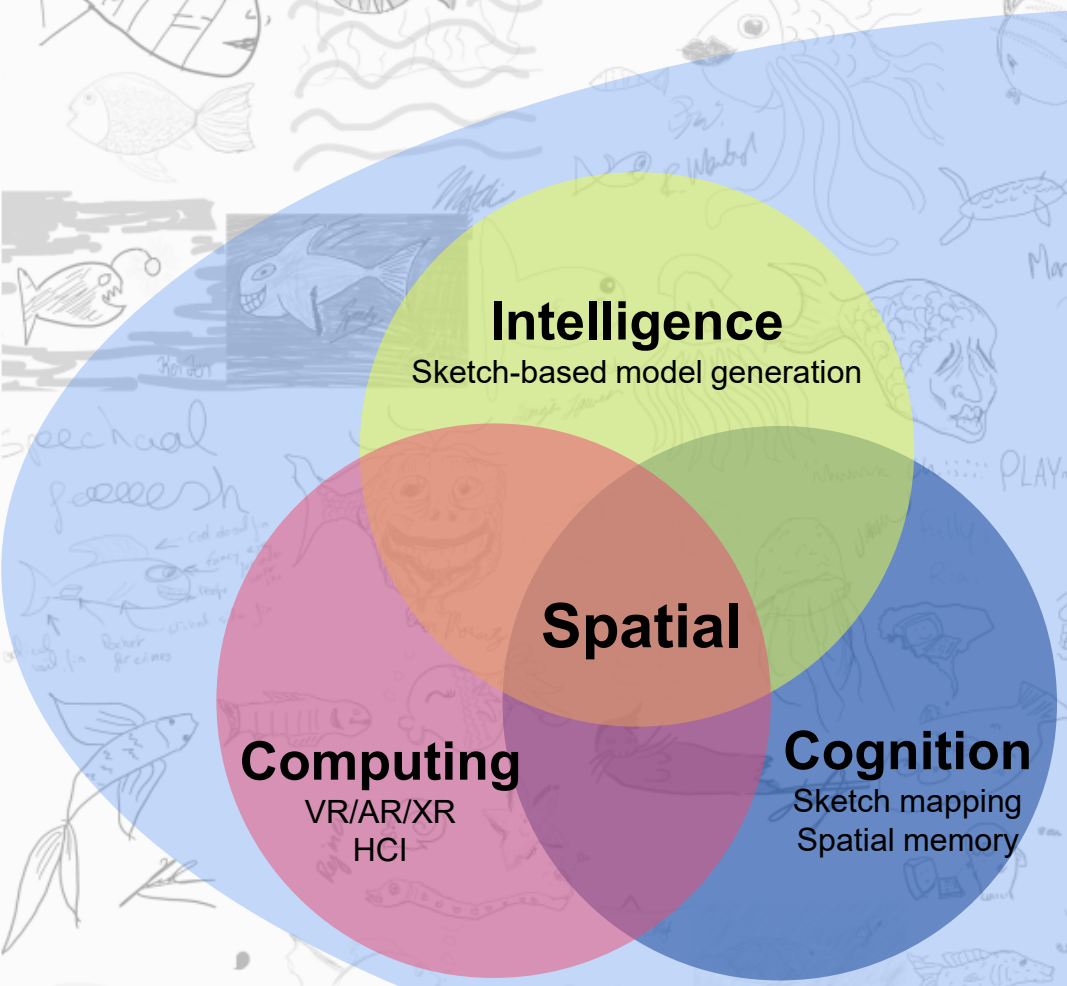


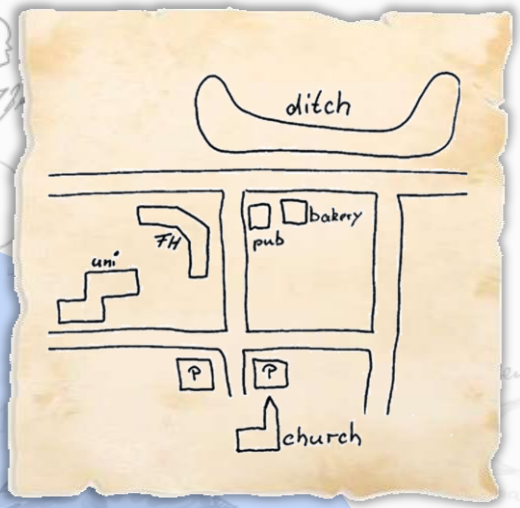


Sketch Mapping

- It is an intuitive and effective way to externalize spatial knowledge.
- It is used to study human spatial decision-making and information processing.







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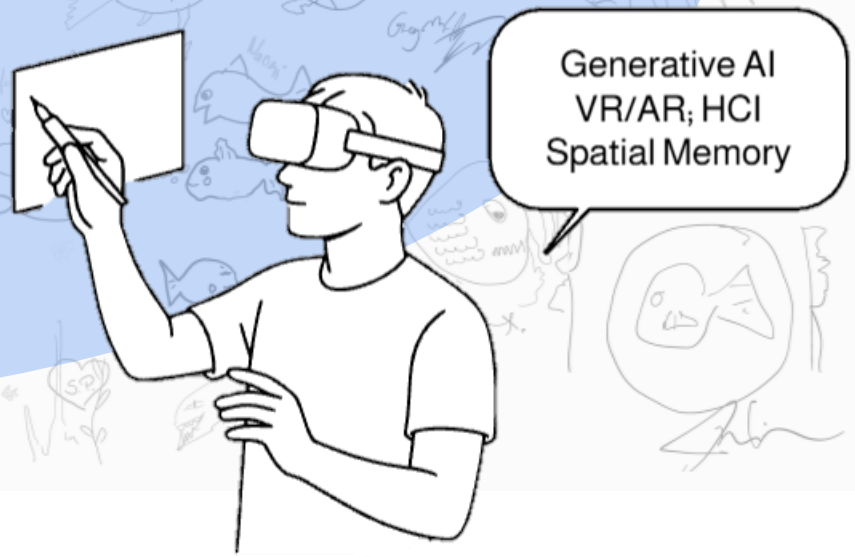
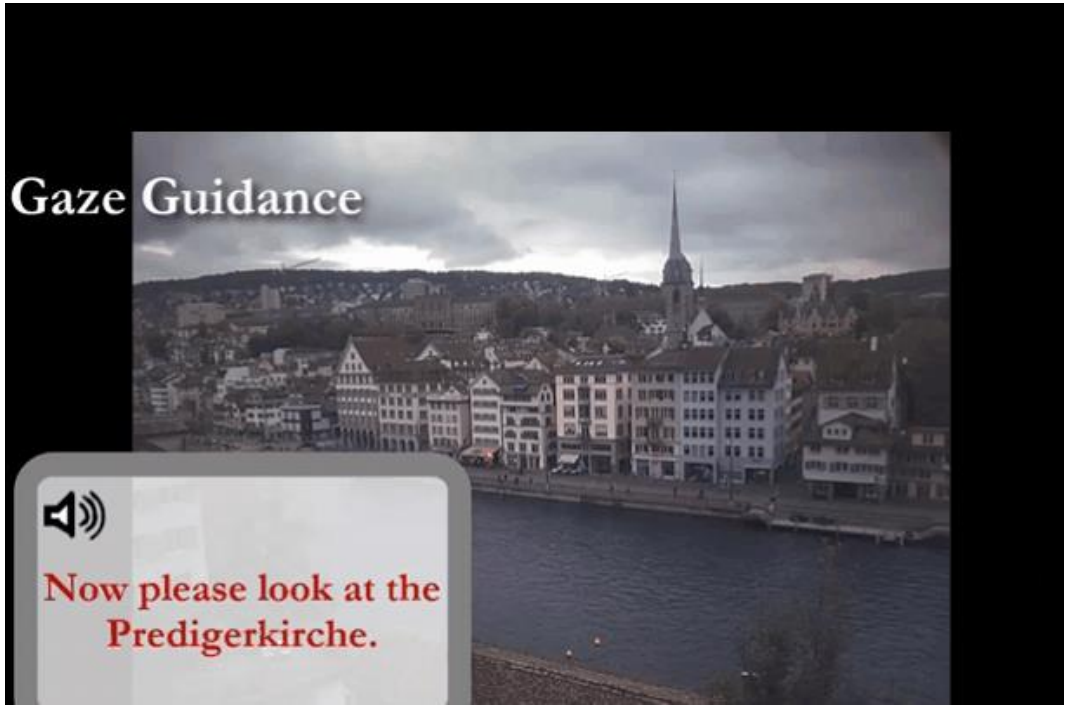
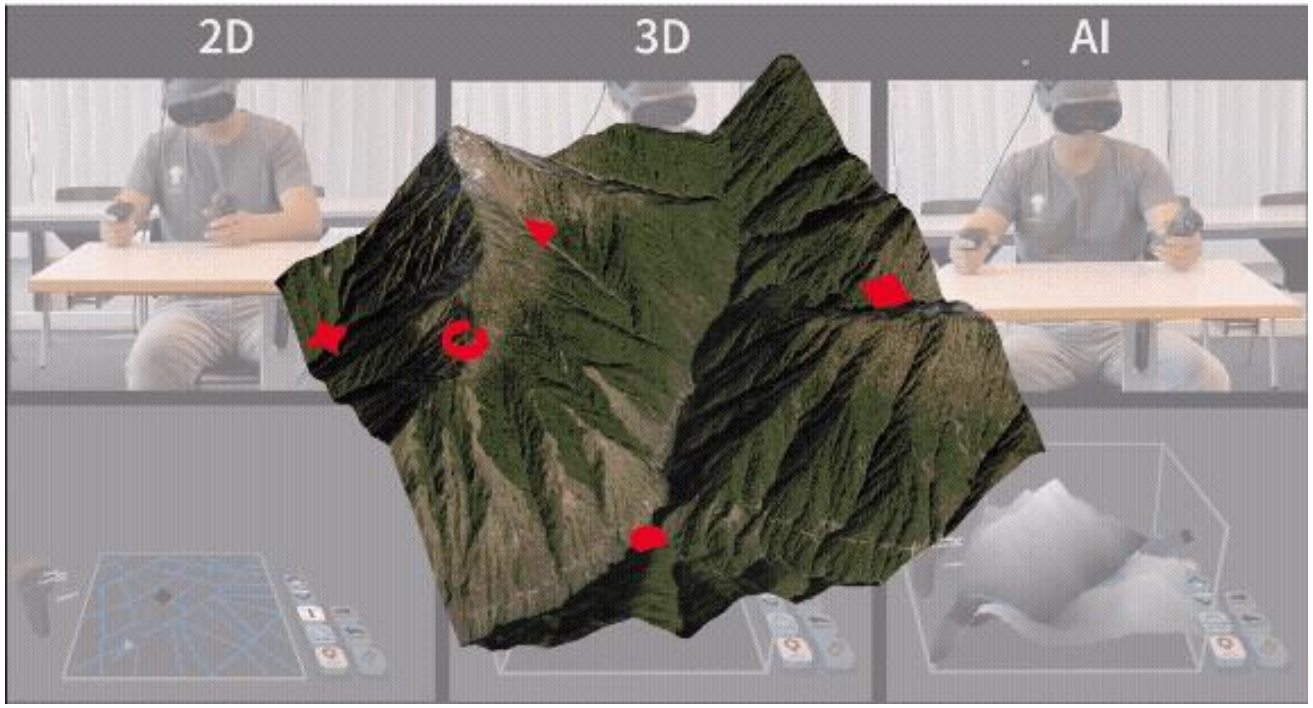


Study objectives

- Learn the theoretical knowledge of spatial cognition, sketch mapping, and immersive sketching



Kwok, T. C., Kiefer, P., Schinazi, V. R., Adams, B., & Raubal, M. (2019, May). Gaze-guided narratives: Adapting audio guide content to gaze in virtual and real environments. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1-12).



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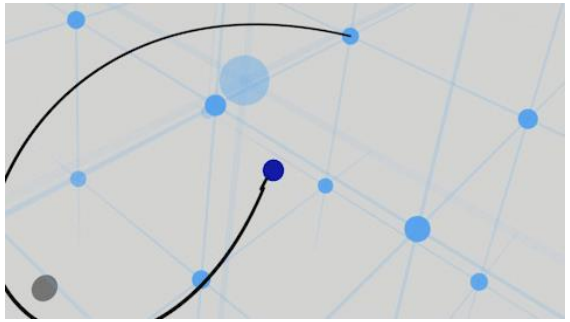
Study objectives

- Learn the theoretical knowledge of spatial cognition, sketch mapping, and immersive sketching
- Experience different sketching/modeling/sketch mapping techniques

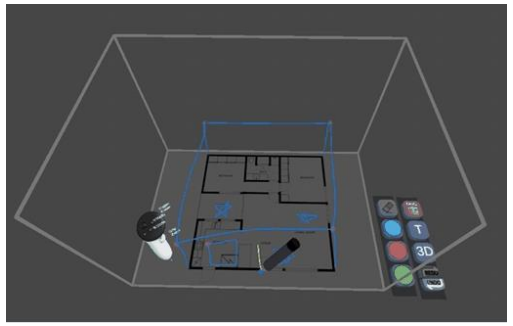
OpenBrush

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



CASSIE

https://www.youtube.com/watch?v=A3ORhg8OeBE



3D Sketch Mapping Minimum Viable Product (3DSM-MVP)

Gravity Sketch

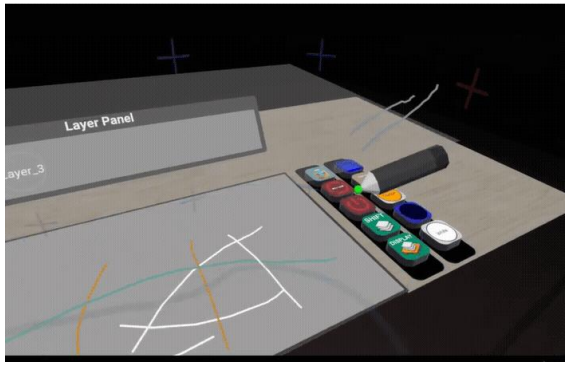
@GravitySketchYouTube · 25K subscribers · 795 videos

Gravity Sketch is an immersive, intuitive 3D ideation and collaboration workspace.

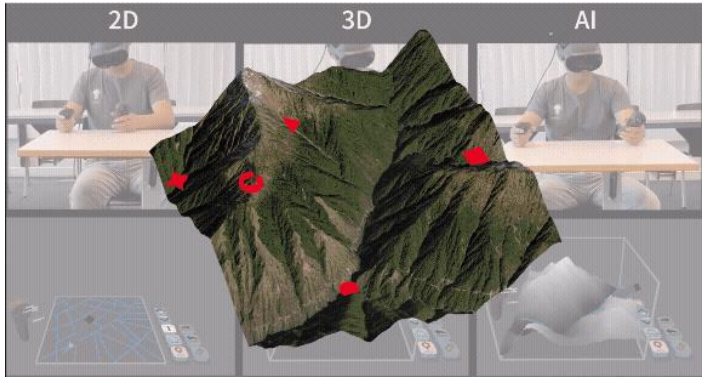
discord.com/invite/nMs73Zw and 4 more links

Subscribe

https://www.youtube.com/watch?v=tVbA3KdFGkI&list=PLdcetkoP2x8RV_EGwBhQaAom9dqq4Bii0&index=2



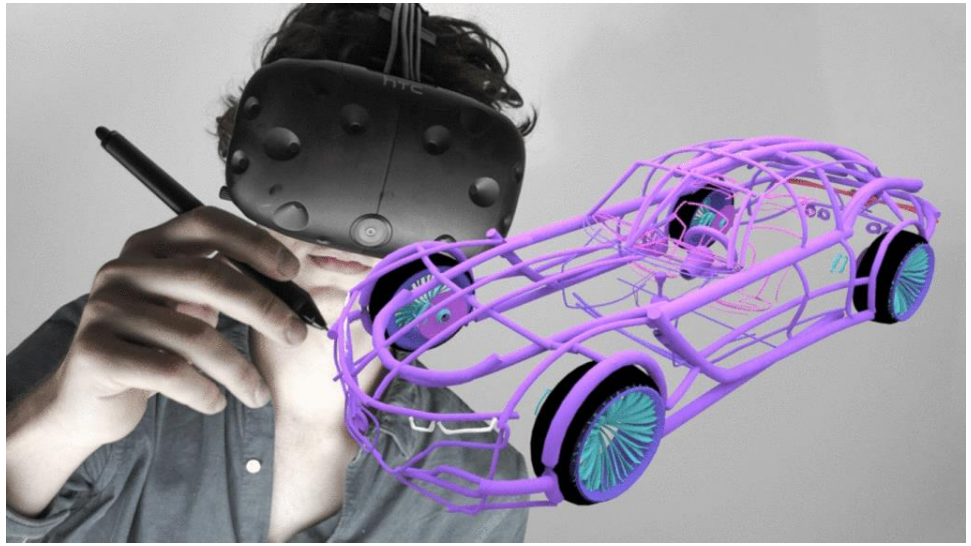
VResin



Sketch2Terrain

Study objectives

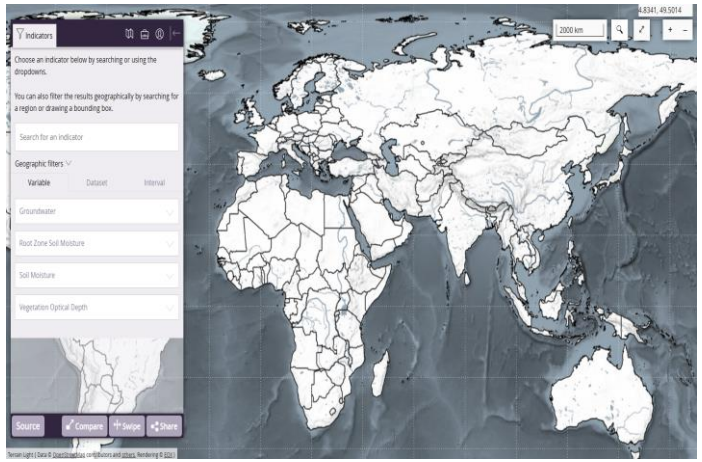
- Learn the theoretical knowledge of spatial cognition, sketch mapping, and immersive sketching
- Experience different sketching/modeling/sketch mapping techniques
- Learn the basic knowledge of VR development and C# programming for Unity



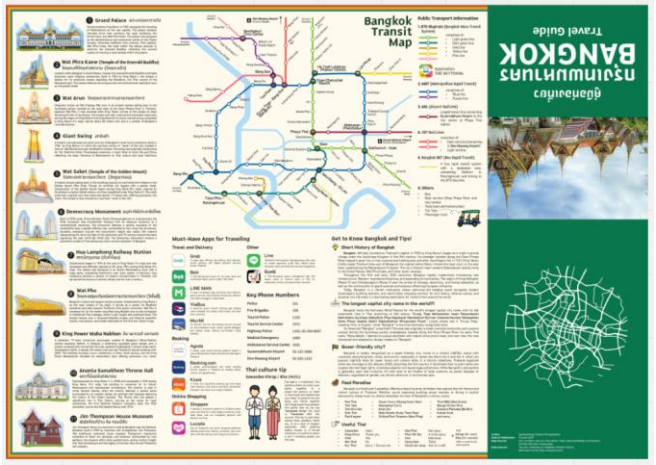
https://developers.meta.com/horizon/documentation/unity/unity-tutorial-hello-vr

Study objectives

- Learn the theoretical knowledge of spatial cognition, sketch mapping, and immersive sketching
- Experience different sketching/modeling/sketch mapping techniques
- Learn the basic knowledge of (multi-player) VR development and C# programming for Unity
- Learn empirical research methods for spatial cognition

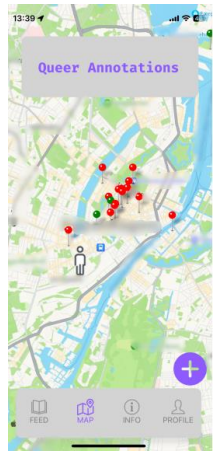


user interfaces for maps



[Map representation design](https://miro.com/app/board/uXjVJcOdSbI=/) (cartography)
https://miro.com/app/board/uXjVJcOdSbI=/

3D Physical Geo-Visualization [1]



novel location-based systems [2]

[1] Kirshenbaum, Nurit, et al. "Data in context: Engaging audiences with 3D physical geo-visualization." *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020.
[2] Neupart, Mack, Daniel Ashbrook, and Louise Barkhuus. "Queering the Space: Location-Based Stories for Transforming Space into Place." Extended Abstracts of the CHI Conference on Human Factors in Computing Systems. 2024.

Study objectives

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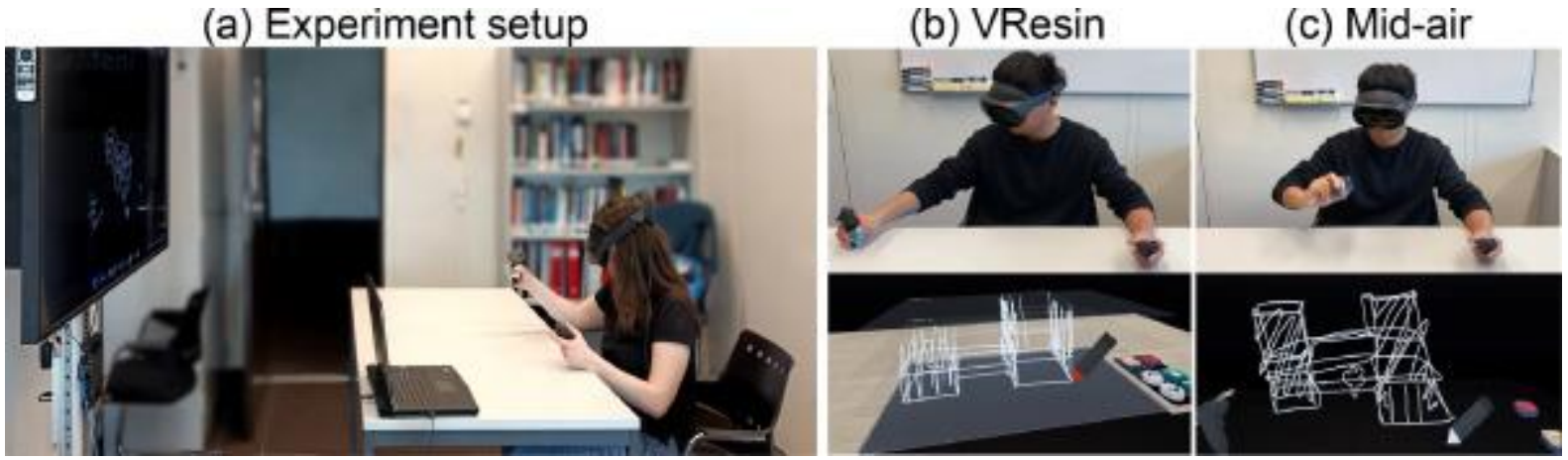
- Learn the basic knowledge of (multi-player) VR development and C# programming for Unity
- Learn empirical research methods for spatial cognition
- Design, perform, and analyze a pilot user study using 3D sketch mapping



Xiao, et al. "VResin: Externalizing spatial memory into 3D sketch maps." *International Journal of Human-Computer Studies* 190 (2024): 103322.

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- Experience different sketching/modeling/sketch mapping techniques
- Learn the basic knowledge of (multi-player) VR development and C# programming for Unity
- Learn empirical research methods for spatial cognition
- Design, perform, and analyze a pilot user study using collaborative sketch mapping
- Learn how to write an abstract for your pilot user study >> develop a paper!

COSIT

Conference on Spatial Information Theory

https://geosensor.net/

https://agile-gi.eu/

Target participants

Researcher

- User study design
- Data collection, analysis, and visualization
- Paper writing

Developer

- Develop novel 3D sketching tools in XR

Workshop schedule

Date	Topic
Day 1 - 01.09.2025	**L:** Spatial cognition & 2D/3D sketch mapping **E:** How to use VR HMD **E:** Experience different sketching tools
Day 2 - 02.09.2025	**E:** VR development
Day 3 - 03.09.2025	**E:** Guided sketch mapping experiment **L:** Empirical methods in spatial cognition & HCI **P:** Study design brainstorming/discussion
Day 4 - 04.09.2025	**P:** Idea pitch & kick-off **P:** Study refinement, pilot study, data analysis
Day 5 - 05.09.2025	**L:** How to write a geo-HCI paper **E:** Draft your abstract **P:** Wrap-up & final presentations

L: Lecture
E: Exercise
P: Project

OpenBrush

COSIT

Conference on Spatial Information Theory