

Mesh-Assisted Interaction Techniques for Object Placement in Mixed Reality

Internship period:

starting in March/April 2027, 5 or 6 months duration.

Supervisors:

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Location:

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Mixed Reality (MR) applications, such as industrial maintenance, indoor navigation, and collaborative design, often require virtual objects to be positioned within the physical environment. In these applications, users frequently manipulate virtual content using their bare hands. However, placing objects at a desired location can be difficult when that location is physically inaccessible or unsafe to reach.

Raycasting provides an alternative by allowing users to select distant locations using a virtual ray. However, raycasting can be tiring and imprecise [1], and controlling the depth at which the ray terminates can be particularly challenging. Alternatively, the system can automatically position virtual objects within the environment, but this approach limits users' control over the final placement and typically requires semantic information about the environment [2].

Recent MR headsets, such as the HoloLens, Meta Quest, and Apple Vision Pro, provide access to reconstructed representations of the physical environment, including meshes that can support object placement relative to physical surfaces and objects [3, 4]. Such representations can be used to determine where a virtual ray intersects the environment or to identify suitable locations for placing virtual content. However, reconstructed meshes can be noisy or incomplete, particularly around reflective or geometrically challenging surfaces [6]. These imperfections can introduce discontinuities and errors in estimated positions and surface orientations, resulting in misplaced or incorrectly aligned virtual objects.

Moreover, surface-based placement alone does not address all placement needs. For example, users may want to position a virtual annotation near a machine without attaching it directly to the machine's surface or obstructing important parts of it.

The goal of this internship is to design, implement, and evaluate interaction techniques that use reconstructed environmental geometry to assist manual object placement in MR. The techniques should help users position virtual objects relative to physical surfaces and objects, including at locations that are difficult to reach directly, while preserving users' control over the final placement. One key challenge is to make these techniques robust to imperfections in the reconstructed environment. Potential approaches include estimating missing surface geometry from neighbouring regions, smoothing noisy geometric estimates [5], adapting placement constraints to the reliability of the reconstruction, and providing feedback when the available geometric information is uncertain.

Work Outline

1. **Related work:** Review MR object placement techniques, and environment reconstruction.
2. **Interaction design:** Design one or more interaction techniques that use reconstructed geometry to assist manual placement.
3. **Prototype development:** Implement the selected technique or techniques on a MR headset, including appropriate mechanisms for handling reconstruction errors.
4. **Evaluation:** Design and conduct a user study comparing the proposed technique or techniques with relevant baselines, such as direct hand placement and raycasting.

Bibliography

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4. SoonUk Kwon, Barrett Ens, and Pourang Irani. 2026. Draped Surfaces: A Contour-Adaptive Interface Overlaid on the Physical Environment for Mixed Reality Workspaces. In Proceedings of the 2026 CHI Conference on Human Factors in Computing Systems (CHI '26). Association for Computing Machinery, New York, NY, USA, Article 455, 1–18. <https://doi.org/10.1145/3772318.3791455>
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6. Robert Xiao, Julia Schwarz, Nick Throm, Andrew D. Wilson, and Hrvoje Benko. 2018. MRTouch: Adding Touch Input to Head-Mounted Mixed Reality. *IEEE Transactions on Visualization and Computer Graphics* 24, 4 (April 2018), 1653–1660. <https://doi.org/10.1109/TVCG.2018.2794222>