

Using a 6DoF Tracked Stylus in Augmented Reality Beyond the Desk

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This position paper describes the use of a 6DoF tracked stylus in augmented reality use cases. The use of the stylus tip allows for direct interaction with real-world objects, both at a traditional desktop setup but also in large open space work areas. Early stage explorations of this capability highlight interesting opportunities, but also significant challenges.

CCS Concepts: • **Human-centered computing** → **Interaction techniques**; **Pointing devices**; **User studies**.

Additional Key Words and Phrases: augmented reality, stylus

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1 Introduction

Logitech has released several 6DoF tracked XR stylus products in the past two years, including the “MX Ink” for Meta Quest and the “Muse” for Apple Vision Pro. This position paper will focus on experiences related to the use of the MX Ink device [8]. The initial design of this product targeted immersive creative, design, and education workflows [4, 14]. The MX Ink device introduced a familiar stylus tool to the XR ecosystem, and enables multimodal interaction possibilities together with standard Meta Quest controllers and tracked hands [6].

The major improvements in passthrough video quality on Quest 3, and other platforms, have been used by app developers to create what are essentially augmented reality (AR) experiences, i.e., the low-latency color passthrough video feed allows users to see, move, and interact with their real-world environment. Much of the published research on 6DoF tracked stylus devices has focused on their use in-air [1, 2] or in a fully immersive VR environment in which there is a manual alignment process to align a virtual surface with a real-world 2D planar surface [3, 7]. In contrast, this position paper describes scenarios in which the stylus tip interacts directly with real-world objects while using the passthrough video feed.

2 Using MX Ink in Mixed Reality - On 2D Planar Surface

A core feature of the MX Ink stylus is the pressure-sensitive analog tip, which facilitates high-fidelity interaction with real-world surfaces. The stylus tip can be used to naturally interact with 2D planar surfaces such as whiteboards and drawing pads, while also optionally using supporting tools such as stencils to guide and constrain the input path. In these scenarios, the pressure sensitive analog input from the stylus tip can translate

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the physical force applied by the user into app-specific digital parameters, such as line thickness, extrusion depth, or opacity.

Pen-based styling design of 3D geometry using 2D concept sketches is a widely used technique [5]. Figure 1 shows such an example using the Gravity Sketch app [14]. In this example, the designer traces key lines over traditional 2D paper sketches and then brings this content to a 3D modeling environment for further development and refinement.



Fig. 1. Using MX Ink on a 2D planar surface in Gravity Sketch, and then transferring that 2D content to 3D.

2.1 Challenges

This is typically a single user experience. The user is often working up close with existing sketches and perhaps supporting tools such as stencils and rulers. While working with users and app developers to experiment with stylus tip usage in this mode, several challenges were encountered. These include:

- **Image Resolution and Noise:** Performance degradation was noted in low-light conditions. When rooms aren't brightly lit, the passthrough cameras boost their sensitivity, resulting in noticeable "static" or image noise. This is problematic when viewing subtle details on a traditional 2D paper sketch.
- **Near-Field Distortion:** In this scenario, users often bring the reference sketch documents closer to their face for review. When viewed up close, the sketches can look distorted or "shimmer" at the edges. This distortion can also make precision motor tasks, such as tracing a fine line on a sketch, more difficult. You can directly experience this effect by using the PencilXR app [11] on Meta Quest today.

3 Using MX Ink in Mixed Reality - In 3D Space

Beyond 2D planar surfaces, the stylus tip can also be used to interact with real-world physical 3D topology away from a traditional desk office space. Working with developers, we have seen 3D topology explorations in a variety of AR scenarios including medical applications, safety training environments, and automotive workshops. This approach complements the more mainstream scanning techniques to create a 3D model from a physical artifact [10, 13]. It enables a portable and low cost system for fast and interactive design of sketched models using 3D curve networks [9, 15]. Figure 2 shows an example from an automotive workshop scenario [16]. In this case, the designer is tracing key lines of a real-world automobile with the stylus tip while in passthrough mode, and using that positional information to create a 3D model of the automobile.

One notable benefit of using a stylus in this large open space environment is that of tactile anchoring. Physical contact between the tip and a surface acts as a haptic anchor, significantly reducing the "gorilla arm" effect by

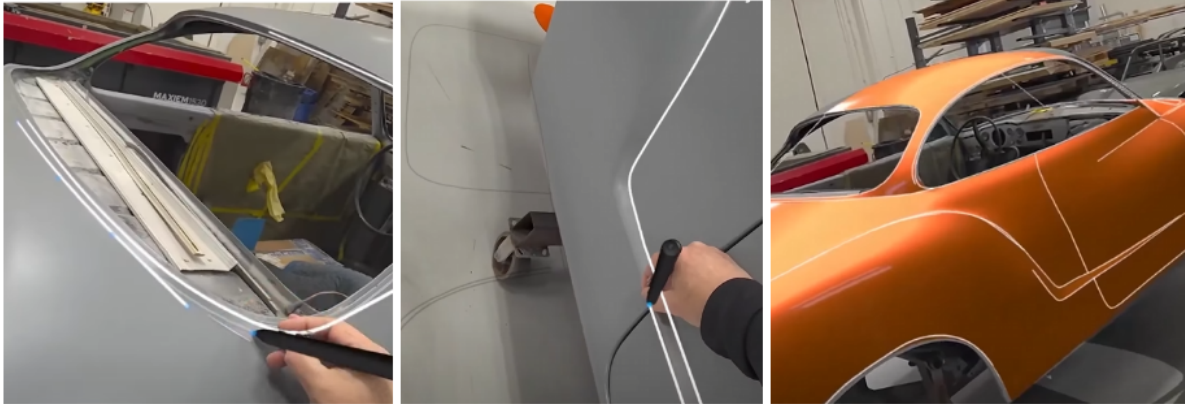


Fig. 2. Using MX Ink to trace key lines of a car in Gravity Sketch to create a 3D model.

allowing the user's hand to rest while performing precise topology tasks. The stylus is effectively "parked" in a fixed supported location when the user looks about and plans their next move around the automobile surface.

3.1 Challenges

While working with users and app developers to prototype this scenario a number of challenges were encountered. These include:

- **Passthrough Image Quality:** The quality of the passthrough image with respect to resolution, color depth and distortion was reported as an issue. The distortion was especially noticeable for objects with straight lines; these lines can appear unstable or exhibit 'swimming' artifacts as the user moves physically around the workspace.
- **Digital-Physical Offset:** A major hurdle is the potential for small misalignments between the digital stroke of the stylus tip and the physical surface. In mobile AR today, the headset's spatial map may have a few millimeters of drift or "jitter". When a user traces a real-world object, such as a car door, even a 2mm offset between the physical tip's location and the digital "ink" breaks the illusion of perfect real-virtual alignments and can render technical topology work, such as reverse engineering a part, inaccurate.
- **Multi-User Alignment:** These digital-physical offsets can be even more problematic in multi-user scenarios. The Photon Fusion multiplayer SDK [12] allows co-located users to interact with shared virtual content in the same physical space. However, there are an associated set of challenges as a result of different users potentially experiencing different digital-physical offsets. This may not be an issue for use cases in which high levels of both precision and accuracy are not required, e.g., adding a virtual post-it note to the environment. However, it could be a serious problem if users needed to accurately highlight or annotate very small elements of a physical object, e.g., sub-millimeter resolution.

4 Conclusion

The quality of the passthrough video experience for devices such as the Meta Quest 3 and the Apple Vision Pro allows users to experiment with AR-like experiences away from traditional desk spaces. The use of the 6DoF tracked stylus tip allows for direct interaction with real-world objects, both at a traditional desktop setup but also in large open space work areas. Our early stage exploration of this capability highlighted interesting opportunities, but also significant challenges.

Looking into the future, the challenges with passthrough video fidelity should be mitigated with optical seethrough AR solutions. However, the issues with precision tracking will remain a challenge. Future XR platforms must provide higher-precision local spatial mapping to support professional-grade stylus workflows. Beyond visual quality and tracking challenges, there are many opportunities to optimize interactions and input methods to better support users in these topology tasks.

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