

Demonstrating Track-Anything-3D: How to Integrate Meta Quest 3 Touch Controller Tracking into Arbitrary 3D-Fabricated Objects

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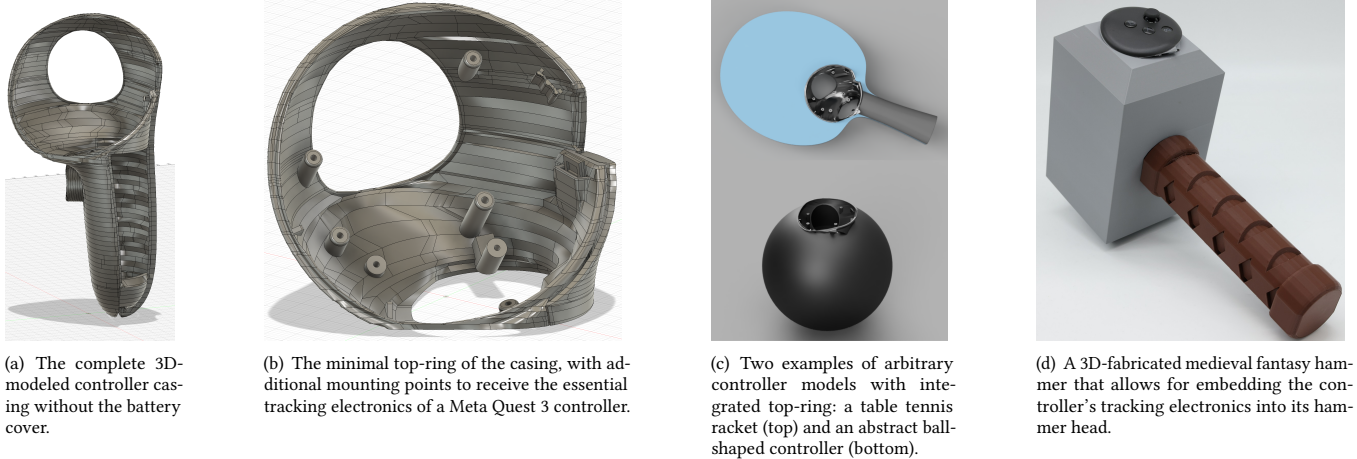


Figure 1: We present an open-source 3D model of the Meta Quest 3 Touch controller casing (a). The upper section provides dedicated brackets and mounting holes to house the original tracking electronics securely (b). Merging this mesh with arbitrary 3D models enables physical proxies to integrate tracking hardware natively, as shown in two conceptual designs (c). A fully assembled example (d) features a 3D-printed medieval hammer that directly houses the controller's electronics, allowing native spatial tracking with the Meta Quest 3.

Abstract

While custom haptic proxies significantly enhance immersion in Virtual Reality (VR), the native tracking of arbitrary physical objects remains a persistent challenge. Researchers typically rely on expensive, external, or bulky tracking add-ons because commercial Head-Mounted Displays (HMDs) cannot natively recognize custom shapes. We address this limitation by introducing an open-source artifact that replicates the casing and internal mounting layout

of the Meta Quest 3 Touch controller. Our modular model allows designers to seamlessly merge native tracking architecture with any 3D-printable object, embedding the original internal tracking electronics directly into custom proxies without requiring external hardware. This demonstration showcases the applicability of the open-source model by letting visitors experience the workflow for designing custom controllers at an interactive station, view live 3D printing, and explore the physical benefits of natively tracked, haptically diverse proxies within a VR application.

CCS Concepts

• **Human-centered computing** → *Human computer interaction (HCI); Virtual reality.*

Keywords

Virtual Reality, Controllers, Manufacturing, 3D-Model

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1 Introduction

Most interactions in Virtual Reality (VR) rely on either natural hand tracking or bundled handheld controllers (e.g., Meta Quest or HTC Vive). While natural hand-tracking completely lacks haptic feedback, standard controllers suffer from static, passive haptics; their shape, texture, and weight remain identical regardless of the virtual object being held. For instance, lifting a heavy hammer in VR feels no different than holding any other object, failing to convey the expected physical properties. To bridge this gap, researchers have developed custom proxy objects to simulate physical properties like shape, weight, and texture.

Prominent examples include handheld proxies that alter their mass distribution using internal sliders or liquid transfer, such as “Shifty” [13], “PumpVR” [6], and “MobileGravity” [5], as well as devices that manipulate aerodynamic drag like “Drag: on” [12]. Beyond weight and drag, researchers have explored specialized form factors and haptic modalities, including active force feedback via propeller propulsion [4], pin-based shape displays [11], handheld sketching tools [1], and multifunction controllers providing grasping feedback [2, 10]. To streamline the creation of these custom devices, toolkits like “HapTwist” [14] have been introduced to help designers quickly build interactive, hand-graspable proxies.

Despite these innovations, a common challenge persists: commercial Head-Mounted Displays (HMDs) cannot natively track custom proxy objects because they lack the necessary internal tracking electronics. Consequently, researchers must rely on expensive, external, or additional tracking hardware. For instance, systems like Shifty [13], VRSketch [1], and Tactile Drones [7] rely on complex external OptiTrack architectures, while others require high-end VICON setups [4]. Alternatively, researchers frequently resort to bulky add-ons such as the HTC Vive Tracker to enable positional tracking, as seen in CLAW [2], Haptic Revolver [10], and PoCoPo [11]. While some low-cost approaches work around this by constructing rigid structural mounts to hold a stock VR controller alongside the proxy [8], today’s HMDs still cannot natively track arbitrary custom shapes.

We address this limitation by providing an open-source artifact, which is core to this demonstration [9]. Using 3D scanners and precise manual modeling, we replicated the casing of the Meta Quest 3 Touch controller, one of the most widely used standalone HMD controllers. Figure 1(a) shows the complete model created in Autodesk Fusion 360, and Figure 1(b) highlights the top ring designed to house the tracking electronics. By using our open-source replica, researchers can merge the controller’s internal layout with the mesh of any custom 3D-printable object (cf. Figure 1(d)). This allows the original Meta Quest 3 tracking electronics to be directly embedded into arbitrary physical proxies, eliminating the need for external tracking systems or additional hardware.

We showcase the versatility of our artifact through an interactive experience at MuC 2026. Visitors can participate in a guided process to generate custom VR controllers, watch live 3D printing of the custom designs, and receive the generated 3D models. Additionally, a hands-on VR demo will showcase the tactile benefits of these haptically diverse, natively-tracked custom controllers.

2 Design and Integration of the 3D Model

We developed the artifact in a two-step process: an initial 3D scanning phase followed by manual CAD modeling. To capture the complex geometry and physical dimensions of the Meta Quest 3 controller, we first scanned it using a CreaLity Raptor 3D scanner [3]. This step digitized the hardware, generating a high-resolution mesh to serve as a precise dimensional guide.

We then imported this reference mesh into Autodesk Fusion 360 to manually reconstruct a clean, optimized digital model from scratch. Particular attention was given to accurately recreating the internal mounting points to ensure the tracking electronics fit securely, while also precisely modeling the battery cover and the handle interface to maintain modularity. This manual reverse-engineering process was labor-intensive and ultimately produced a parametric Fusion 360 file with over 180 design checkpoints. The finalized CAD model successfully replicates the essential structure of the original hardware, making it ready to be merged with arbitrary 3D-printable objects.

2.1 Applying Our Artifact to Arbitrary Objects

Our open-source artifact is published in multiple common 3D-mesh formats (.stl, .3mf), native Autodesk Fusion 360 files (.f3d, .f3z), and cross-platform STEP files (.step)¹. The model consists of three modular parts: a full casing replica (Figure 1(a)), a standalone battery cover, and a compact top ring containing only the tracking electronics (Figure 1(b)).

For most custom proxies, using the compact top ring is ideal. However, certain design trade-offs must be noted: the grip button and vibration motor are excluded, standard input buttons may become inaccessible depending on placement, and a new external housing for the power source must be integrated into the custom proxy object.

Integrating the artifact into a custom object and assembling the final controller follows a straightforward three-step workflow visualized in Figure 2:

- (1) **Merge:** In CAD software (e.g., Fusion 360), a custom 3D mesh is imported alongside our tracking ring artifact. A Boolean cut-and-merge operation is performed to seamlessly embed the artifact’s mounting geometry into the proxy object.
- (2) **Fabricate:** The combined mesh is exported and fabricated using a standard 3D printer.
- (3) **Install:** The tracking electronics (the main board containing seven infrared LEDs and an IMU) are uninstalled from the original Meta Quest 3 controller by removing the top cover and unscrewing the main board. This hardware is then fit into the 3D-printed proxy ring in reverse order, and reconnected to a relocated power source, such as the original AAA battery or a compact button cell.

3 Interactive Demonstration

At MuC 2026, we present an interactive demonstration showcasing a variety of custom VR controllers created using our open-source artifact (e.g., like in Figure 1(c)), highlighting its versatility and practical utility. To give attendees a tangible understanding of the

¹Track-Anything-3D on GitHub: <https://github.com/Florad97/Track-Anything-3D>.

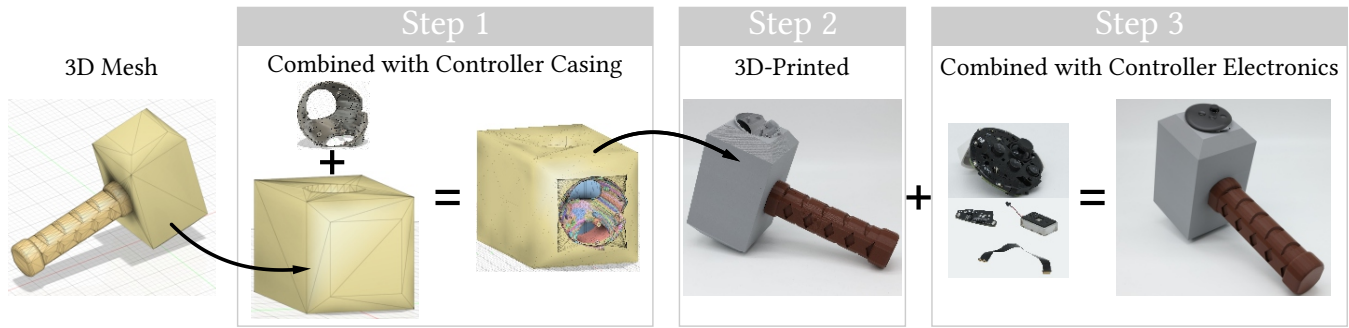


Figure 2: Generation process of a custom VR controller with our artifact on the example of Thor’s Hammer by skimbal on Thingiverse. <https://www.thingiverse.com/thing:17637>. Licensed under CC BY-NC-SA, last accessed July 23, 2026.

fabrication workflow, we will feature live, on-site creation and 3D printing of various controller models throughout the conference. The demonstration is divided into two main interactive experiences:

First, visitors can engage in a guided, step-by-step design workflow at our interactive design station, which features a desktop PC setup with a dedicated display, mouse, and keyboard. During this session, attendees can browse popular online repositories to select any 3D object they wish to transform into a functional VR controller. This process works with any arbitrary model, provided the platform hosts accessible mesh or CAD files for download. Once the visitor selects a model, we guide them through the process of merging their chosen 3D shape with our controller casing artifact. To demonstrate this workflow, we use Autodesk Fusion 360 as our exemplary CAD software. Attendees scale and rotate their selected model to an appropriate size and position, place our 3D artifact within the shape, and perform the necessary cutting and joining operations to combine the models. We actively support attendees at all stages of this design process, offering direct assistance with CAD functions (e.g., when navigating more complex geometries).

Once the model is complete, we email the ready-to-print file directly to the visitor, enabling them to fabricate their custom proxy after the conference concludes. This experience provides attendees with both a practical artifact they can integrate directly into their personal research and a foundational understanding of how to apply our method to their own future projects. To accompany the visualization of the fabrication process, we will print some custom controller models on two small consumer-grade 3D printers live at the demo booth.

Second, attendees can experience the physical benefits of custom proxies generated with our method firsthand through an exemplary VR game application. The application will be controlled with the fantasy hammer controller depicted in Figure 1(d). As a result, visitors can experience the tactile feel, weight distribution, and handling of a custom controller in a virtual environment. To engage a wider audience and spark discussion among spectators, the user’s real-time VR view will be streamed to a publicly visible screen at the demo booth.

4 Conclusion and Future Work

Our proposed open-source artifact enables researchers and designers to directly embed the tracking electronics of a Meta Quest 3 Touch controller into arbitrary 3D-printed physical proxies. By eliminating the need for expensive external tracking systems or bulky add-on sensors, this approach provides an accessible, low-cost solution. Ultimately, it empowers creators to freely experiment with novel controller shapes, dimensions, and physical properties without sacrificing native tracking fidelity.

In future work, we intend to systematically map out the capabilities and technical boundaries of this approach. Specifically, we plan to evaluate user perception across a spectrum of minor to radically altered controller designs, investigate streamlined standalone tracking for virtual objects, and explore how these custom controllers can enhance haptic realism. Finally, we aim to investigate newly unlocked interaction paradigms, such as complex bimanual controller configurations.

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