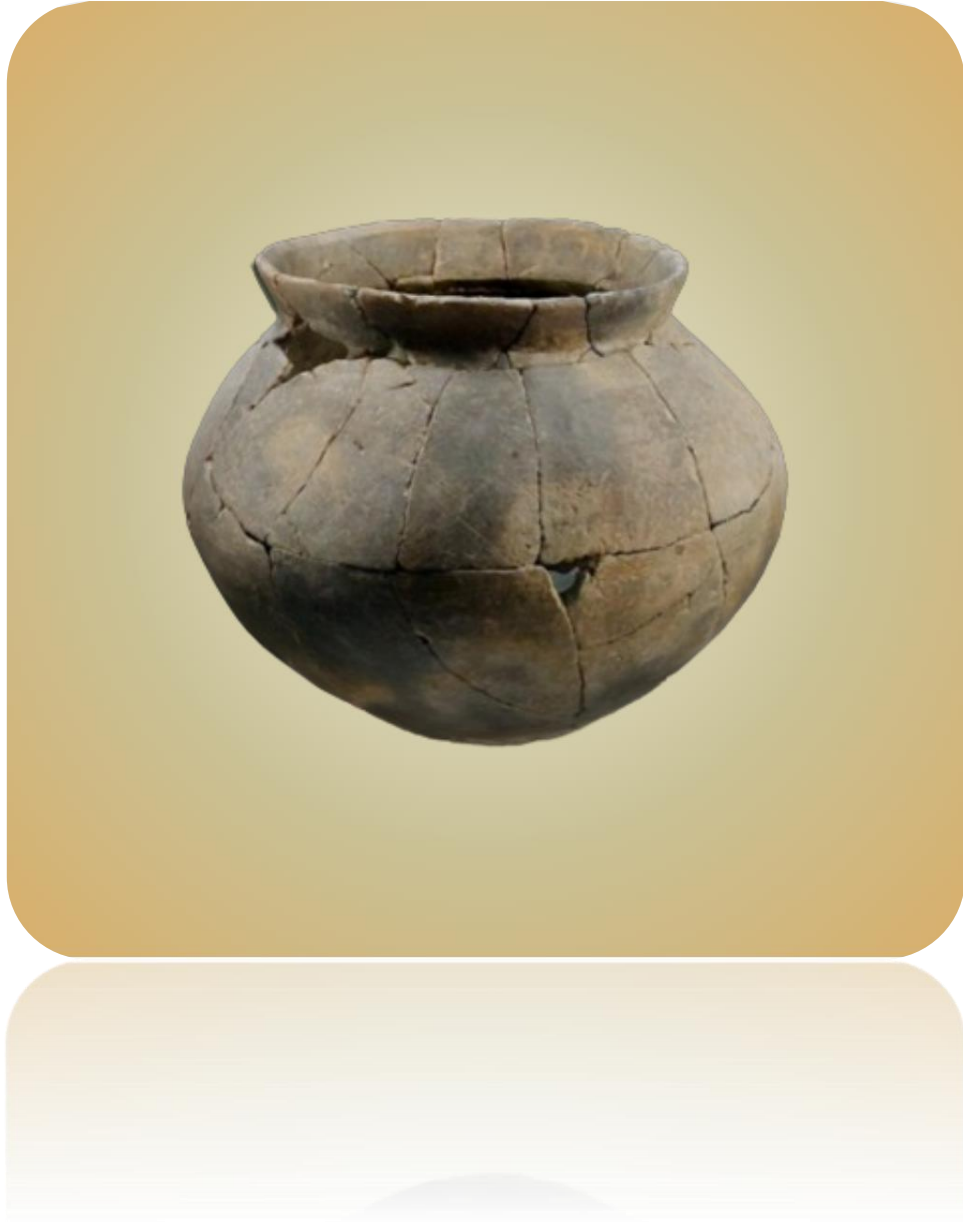


Installation and User Manual: VRUrn



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1. Installation

This installation guide is based on the Meta software versions available at the time of writing. Since Meta frequently updates the Meta Horizon app, Meta Quest Developer Hub (MQDH), the Meta Quest operating system, and its online documentation, some menu names, option locations, user interface elements, and URLs may differ from those shown in this manual. If this occurs, use the instructions as a general guide to complete the installation.

1.1 Prerequisites

Before installing the VRUrn application, ensure that the following requirements are met:

- A Meta Quest headset (Quest 3 / Quest 3S)
- A mobile device (Android or iOS)
- An Internet connection
- An active Meta account

1.2 Create or Verify a Meta Account

A Meta account is required to configure the headset, access Meta services, and enable the installation of the VRUrn application.

1. Go to the Meta Developers website: <https://developers.meta.com/horizon/>.
2. Create a Meta account or sign in to your existing account.

1.3 First-Time Setup of the Headset

Before installing the application, the Meta Quest headset must be configured and paired with the Meta Horizon app. Complete the initial setup by following the steps below.

1. Install the Meta Horizon app on your smartphone.
 - Available on Google Play and the App Store.
 - The app is required for the initial setup.
2. Sign in to the app using your Meta account.
3. Turn on the Meta Quest headset.
 - Press and hold the power button on the side of the headset.
4. Follow the on-screen setup instructions.
 - Select your language.
 - Connect to a Wi-Fi network.
 - Set up your play space.

5. Pair the headset with your smartphone.
 - The Meta Horizon app should automatically detect the headset.
 - Alternatively, enter the pairing code displayed in the headset.
6. Complete the basic setup.
 - Update the headset software (if required).
 - Configure the controllers and safety settings.

1.4 Create a Meta Developer Organization

Installing applications outside the Meta Store requires Developer Mode. To enable this feature, you must first create a Meta Developer Organization associated with your Meta account.

1. Go to: <https://developers.meta.com/horizon/manage/organizations/>
2. Sign in with your Meta account.
3. Create a Meta Developer Organization. This is a required step to enable Developer Mode.
4. Accept the Terms and Conditions.

1.5 Enable Developer Mode on the Headset

Once the Meta Developer Organization has been created, Developer Mode must be enabled on the headset before applications can be installed using Meta Quest Developer Hub (MQDH).

1. Open the Meta Horizon app on your mobile device (Android or iOS).
2. Sign in using the same Meta account that you use on your headset.
3. Pair the headset with the app (if it is not already paired).
4. In the Mobile app, go to:
 - Menu → Devices
 - Select your Meta Quest headset.
 - Open Headset Settings. The headset must be powered on and connected for these options to appear.
 - Enable Developer Mode.
5. Restart the headset to ensure the changes are applied correctly.
6. Ensure that the headset has sufficient storage space and that its software is up to date.

1.6 Installing the VRUrn Application on a Meta Quest Headset

After completing the previous configuration steps, the VRUrn application can be installed on the Meta Quest headset using Meta Quest Developer Hub (MQDH). Follow the procedure described below.

1. Download and install Meta Quest Developer Hub (MQDH) from the official Meta website, <https://developers.meta.com/horizon/documentation/unity/ts-mqdh-getting-started> (Figure 1)
2. Open the Meta Quest Developer Hub (Figure 2).
3. Connect the headset to your computer using a USB-C cable.
4. When connecting the headset to your computer, a prompt requesting authorization for USB debugging will appear in the headset. An example of this prompt is shown in Figure 3 (displayed in Spanish). Select 'Allow' to continue.
5. If this prompt does not appear or it is not accepted, the headset is not recognized and the VRUrn application cannot be installed.
6. Open the Device Manager section in Meta Quest Developer Hub. If the headset has been successfully detected, its status will be displayed as Active (Figure 4), indicating that it is ready for installation. If the headset is not detected, select Devices > Meta Quest 3 and choose your headset from the list.
7. Drag the VRUrn-1.9.apk file into the right-hand panel of Meta Quest Developer Hub (the connected device area) (Figure 5). The installation process starts automatically (Figure 6). Once the installation is complete, the application will appear in the list of installed applications in MQDH (Figure 7).

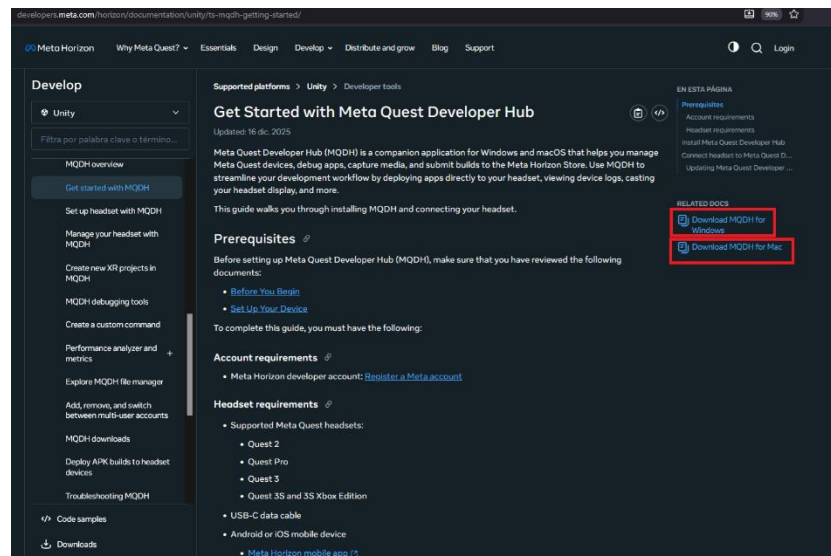


Figure 1. Meta Quest Developer Hub (MQDH) download page.

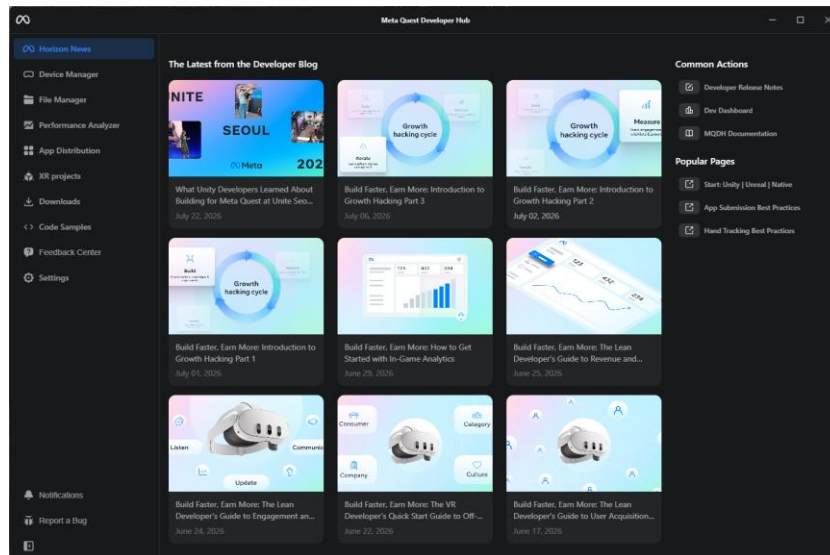


Figure 2. Meta Quest Developer Hub (MQDH) home screen after installation and sign-in.

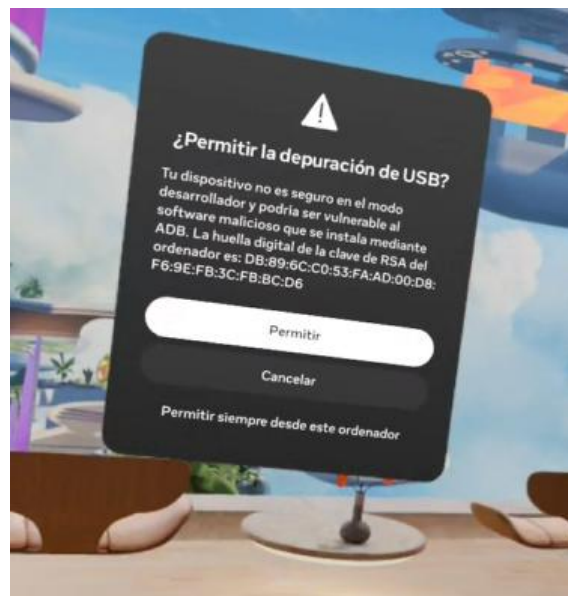


Figure 3. USB debugging authorization prompt displayed on the Meta Quest headset (Spanish interface).

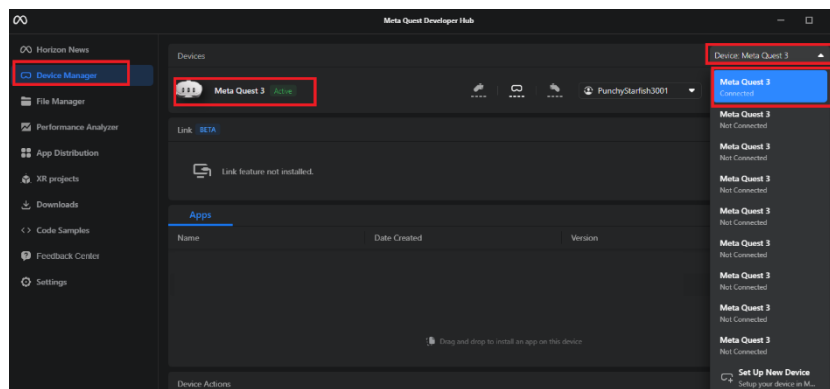


Figure 4. Device Manager displaying the selected Meta Quest headset with Active status, indicating that the headset is ready for installation.

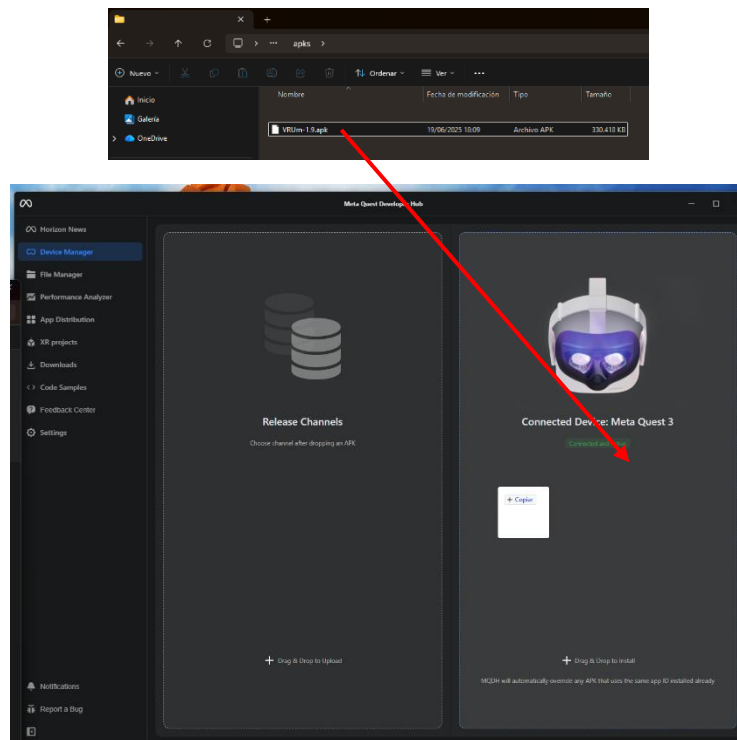


Figure 5. Drag the VRUrn APK file into the connected device area of Meta Quest Developer Hub to begin the installation.

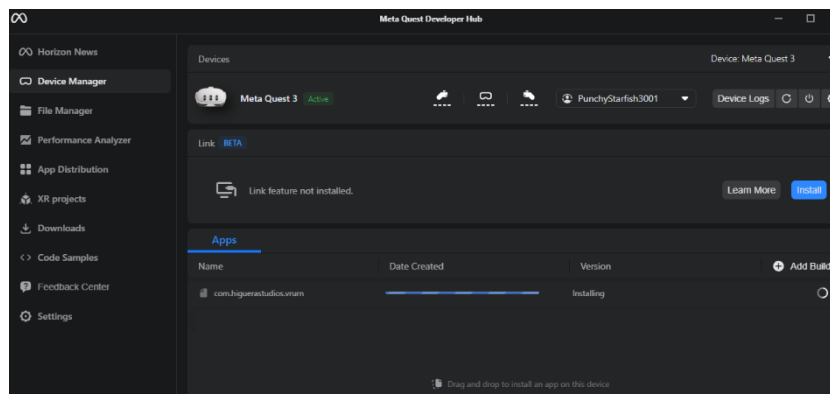


Figure 6. Installation is in progress.

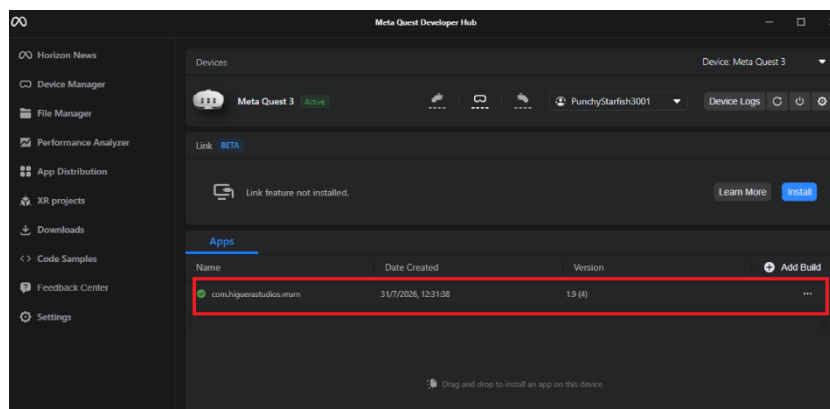


Figure 7. VRUrn successfully installed on the Meta Quest headset.

2 Launching the VRUrn Application

Once the application has been successfully installed on the Meta Quest headset, follow the steps below to launch the VRUrn application.

1. Open the Applications Library (Figure 8).
2. Open the left-side menu (Figure 9).
3. Select Unknown Sources (Figure 10).
4. Locate the VRUrn application and select it to launch the application (Figure 11).

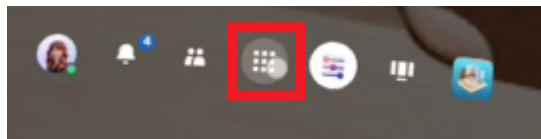


Figure 8. Open the Applications Library by selecting the Applications icon.

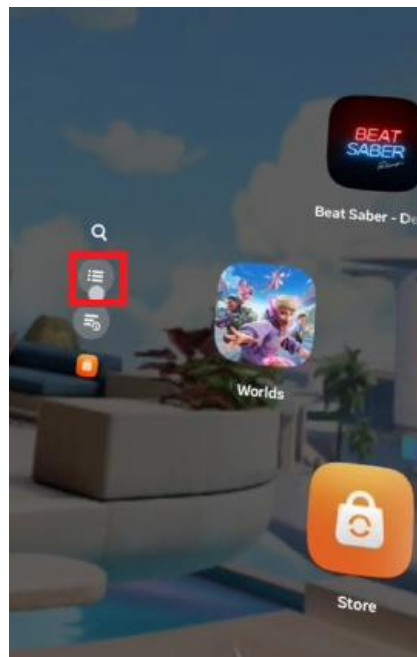


Figure 9. Open the left-side menu.

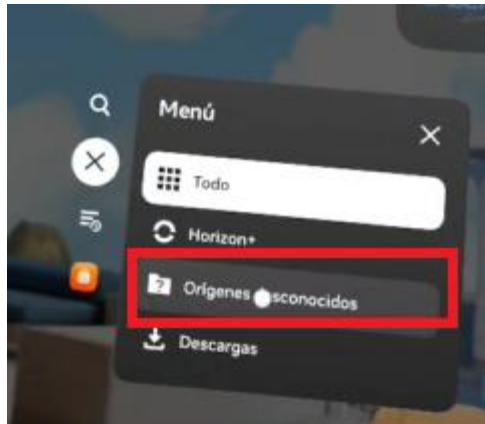


Figure 10. Select Unknown Sources from the menu.

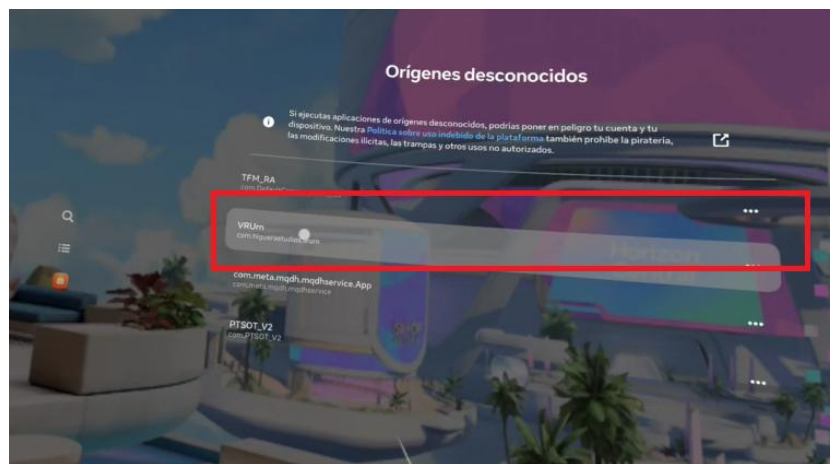


Figure 11. Locate the VRUrn application and select it to launch the application.

3 Using the VRUrn Application

3.1 Initial Screen

When the application starts, the user is placed in a virtual laboratory environment. The first step is to select the preferred language (English or Spanish) by pressing the corresponding button (Figure 12).



Figure 12. Initial laboratory environment with the language selection buttons..

3.2 Introduction and Tutorial

After selecting the preferred language, a series of introductory panels is displayed in the selected language (English or Spanish), accompanied by voice narration (Figure 13). These panels introduce the purpose of the application, explain the virtual excavation activity, and provide basic safety recommendations for moving within the virtual environment.

The introduction is followed by an interactive tutorial that teaches the user how to use the Meta Quest controllers and interact with the virtual environment. The tutorial explains the basic interaction techniques, including selecting interface elements, manipulating objects, and completing the actions required throughout the application (Figures 14-16).

The tutorial is designed so that users with no previous experience in virtual reality can become familiar with the controls before starting the excavation process.



Figure 13. Introductory panel displayed at the beginning of the VRUrn application.



Figure 14. Tutorial introducing the interaction with on-screen messages and user interface elements.

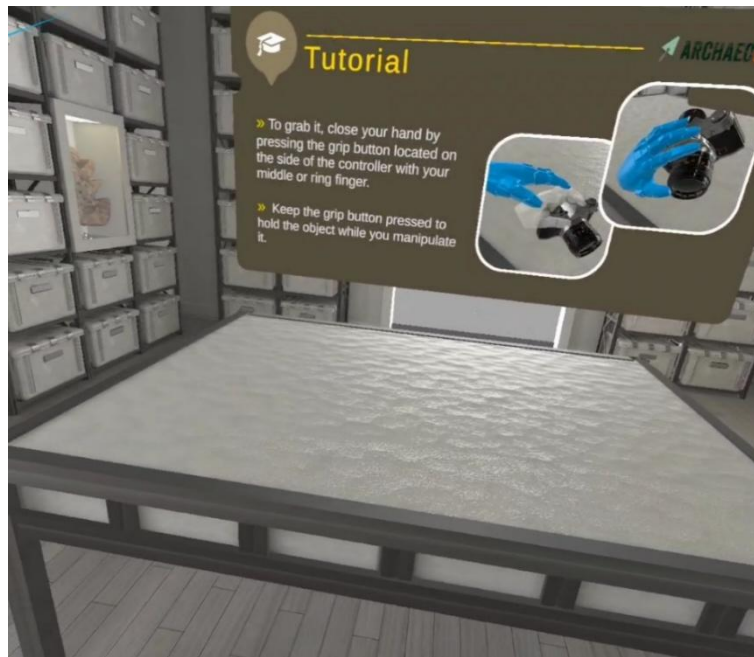


Figure 15. Tutorial explaining how to grab and hold virtual objects using the Meta Quest controllers.



Figure 16. Completion of the interactive tutorial before starting the virtual excavation experience.

3.3 Excavation Methodology

Before the practical activity begins, a series of introductory panels presents the archaeological methodology followed during the excavation and documentation of cremation funerary urns

(Figure 17). The information is displayed in the selected language and accompanied by voice narration.

These panels explain the main stages of the intervention, from the identification and excavation of the urn in the archaeological site to its consolidation, extraction, transport to the laboratory, and subsequent micro-excavation. They also introduce the methodology implemented in the VRUrn application and explain that the excavation process should be documented by taking photographs at each stage.



Figure 17. Introductory panel describing the archaeological methodology for the excavation and documentation of cremation funerary urns.

3.4 Beginning the Micro-Excavation

After the introductory panels, the practical activity begins. The funerary urn is placed on the worktable in the same condition in which it would arrive at the laboratory after its extraction from the archaeological site (Figure 18).

The application guides the user through each stage of the micro-excavation process using on-screen panels and voice narration. At this stage, the user is introduced to the first archaeological element (a stone placed on top of the urn) and is instructed to document its initial state by taking a photograph before any intervention. Throughout the experience, photographic documentation is required at each stage of the excavation to record the progress of the intervention.

The application then presents the first guided activity. Each activity is introduced by an information panel describing the archaeological context and the task to be performed. The object involved in the activity is highlighted to help the user identify it easily. In this first activity, the user documents the initial state of the funerary urn by taking a photograph before removing the stone covering the burial (Figures 19 and 20).



Figure 18. Initial state of the funerary urn at the beginning of the micro-excavation process, before removing the covering stone and documenting the intervention.



Figure 19. First guided activity introducing the documentation of the initial state of the funerary urn before any intervention.



Figure 20. Using the virtual camera to photograph the initial state of the funerary urn before removing the covering stone.

3.5 Removing the Covering Stone

Once the initial state has been documented, the user proceeds to remove the stone covering the funerary urn. The virtual blue hands mirror the user's movements through the Meta Quest controllers. The user grasps the stone with both hands, lifts it carefully, and places it on the tray beside the urn. This reproduces the first stage of the laboratory micro-excavation process, allowing access to the upper layer of the burial (Figure 21).



Figure 21. Removing the covering stone from the funerary urn and placing it on the adjacent tray.

3.6 Removing the Protective Gauze

Before removing the protective gauze, the user must first photograph its condition for archaeological documentation. The virtual blue hands mirror the user's movements through the Meta Quest controllers. The user picks up one of the solvent-soaked cotton swabs from the table and applies it to the highlighted area of the urn with gentle circular movements. As the swab is moved over the highlighted area, the solvent progressively dissolves the consolidating resin, allowing the protective gauze to be removed without damaging the surface of the funerary urn (Figure 22).

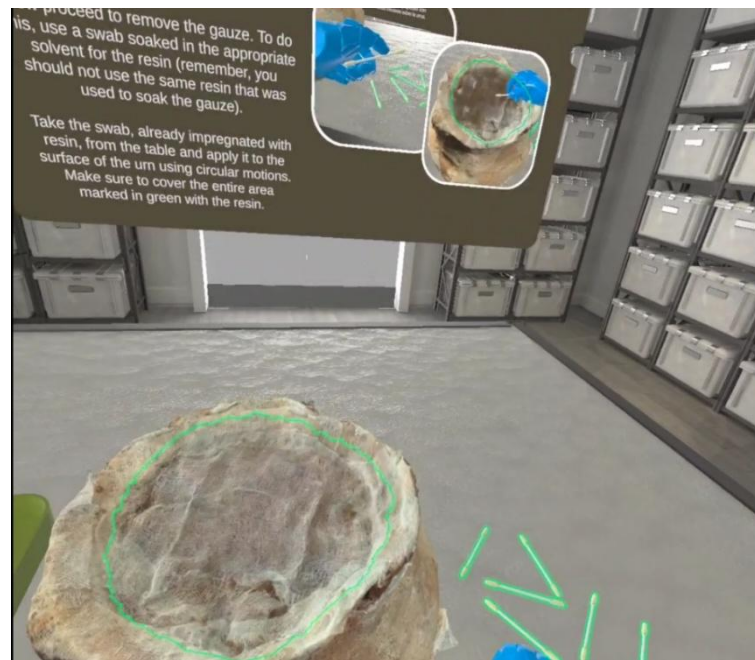


Figure 22. Using a solvent-soaked cotton swab with circular movements over the highlighted area to dissolve the consolidating resin and remove the protective gauze.

3.7 Excavating the First Soil Layer

After removing the protective gauze, the excavation of the first soil layer begins. The virtual blue hands mirror the user's movements through the Meta Quest controllers. Using one virtual hand, the user picks up the punch tool from the table and carefully removes the upper layer of soil from inside the urn. As the user removes the sediment, it is automatically transferred to the adjacent tray. This activity simulates the first stage of the archaeological micro-excavation process, in which the user progressively removes the sediment while observing changes in its colour, composition, and texture, as well as the appearance of archaeological remains (Figure 23).



Figure 23. Removing the first soil layer from the funerary urn using the punch tool.

3.8 Excavating the Cremation Layer

Once the first soil layer has been removed, the user reaches the beginning of the cremation deposits. At this stage, the first bone fragments become visible, indicating that the archaeological remains associated with the burial are being exposed. Using the virtual blue hands controlled by the Meta Quest controllers, the user continues removing the sediment with the punch tool, taking special care not to damage the exposed remains (Figure 24).



Figure 24. Excavating the cremation layer with the punch tool as the first bone fragments become visible.

3.9 Cleaning the Exposed Remains

Once the larger pieces of sediment have been removed, the user continues the excavation using a brush. Using the virtual blue hands controlled by the Meta Quest controllers, the user picks up the brush from the table and gently sweeps away the remaining fine sediment. This allows the smaller fragments and the exposed archaeological remains to be separated and cleaned without damaging them (Figure 25).

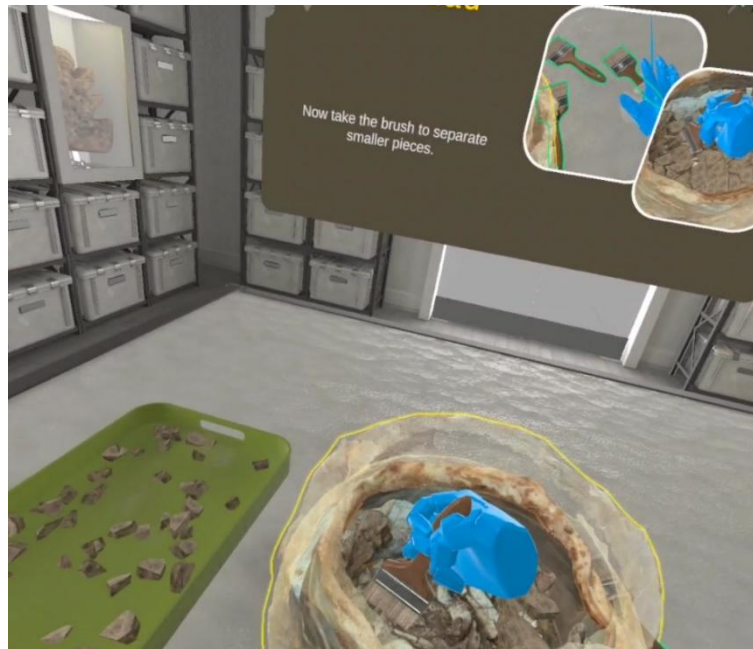


Figure 25. Cleaning the exposed remains with the brush to remove the remaining fine sediment.

3.10 Identifying and Recovering the Archaeological Remains

Once the excavation reaches the lower third of the urn, the cremated bones and associated grave goods become fully visible. At this stage, the user is informed about the archaeological characteristics of the cremation deposit and the importance of systematically documenting the excavation and its contents (Figure 26).

The final activity consists of identifying ten archaeological items within the urn (Figure 27). Using the virtual blue hands controlled by the Meta Quest controllers, the user picks up each highlighted bone fragment or grave good individually. When an item is held, the application provides an audio explanation describing its archaeological identification and significance. After listening to the information, the user places the item in the adjacent tray before continuing with the remaining highlighted objects until all ten items have been recovered (Figure 28).

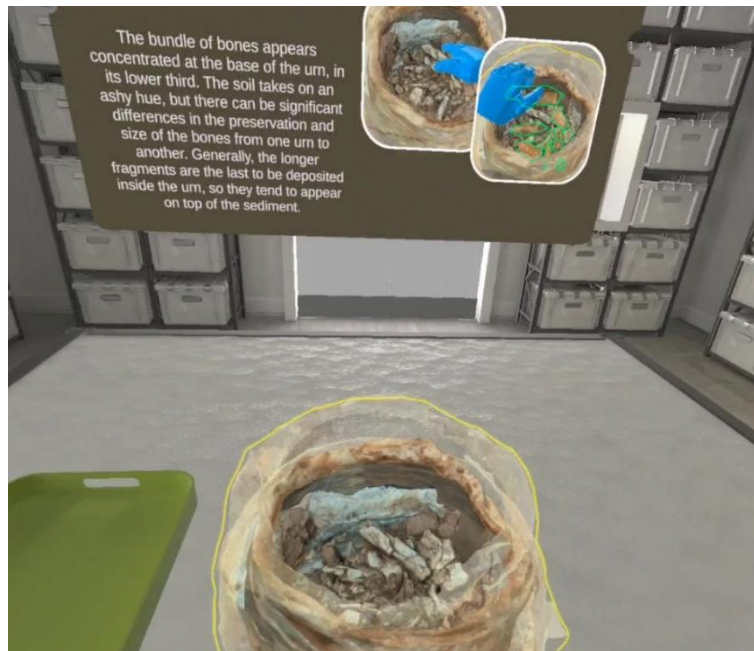


Figure 26. Informational panel explaining the characteristics of the cremation deposit within the funerary urn.

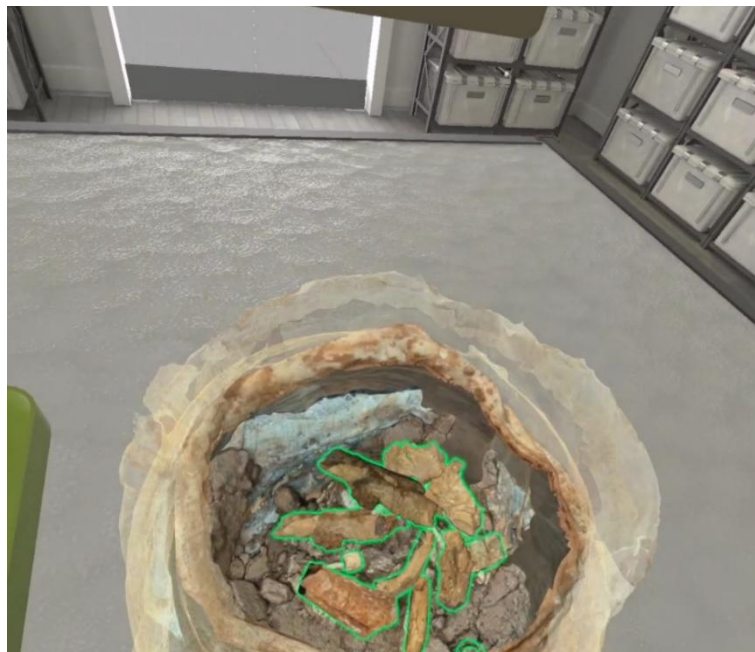


Figure 27. Cremated bones and grave goods highlighted for identification and recovery.



Figure 28. Recovering an archaeological item. When the object is picked up, the application plays an audio explanation before it is placed in the tray.

3.11 Completion of the Experience

Once all the archaeological items have been identified and recovered, the virtual excavation is completed. The application displays the restored funerary urn together with a closing message thanking the user for participating in the experience. The final screen also presents the project authors, acknowledgements, and the partner institutions of the ArchaeoPills project (Figures 29 and 30).



Figure 29. Restored funerary urn displayed at the end of the virtual excavation experience.



Figure 30. Final screen showing the project authors, acknowledgements, and participating institutions.

4 Tips for Proper Operation

1. Recommended Play Area

The virtual laboratory reproduces a real museum room measuring approximately 6 × 6 m. For the most immersive experience, it is recommended to use the application in a sufficiently large, obstacle-free physical space. This allows users to move around the virtual environment safely while reducing the risk of collisions with furniture or other objects.

If the application is used only to interact with the worktable, without moving around the virtual laboratory, a smaller physical play area is sufficient.

2. Controller Tracking Loss

For the Meta Quest controllers to function correctly, they must remain within the field of view of the headset's front-facing cameras. If the controllers move outside this area, for example, below waist level and close to the body, tracking may be temporarily lost. This may occur especially during the final stage, when collecting bone fragments or grave goods from the urn and placing them on the tray.

If this happens, release the object, slightly turn the head until the controllers are visible to the headset's front-facing cameras, and then continue.

3. Floor Level Is Lost

If the floor level is lost or becomes misaligned, for example, if the viewpoint appears below or above the worktable, the floor level should be recalibrated.

Go to Settings -> Environment -> Set Floor Level, then follow the on-screen instructions to adjust the floor level correctly.

4. Re-centering and Repositioning Inside the Virtual Museum

If, when launching the application, the initial position is not inside the virtual museum, first press and hold the Meta (∞) button on the right controller for approximately 2 seconds to recenter the view.

If the problem persists, close the application and redefine the play boundary using the current Meta Quest room setup options (for example, Settings -> Environment -> Create Boundary, depending on the installed software version). Stand near the centre of the physical play area when redefining the boundary, then restart the application.

5 Authorship and Copyright

Authors of the VRUrn application and this manual: Frank Higuera and M.-Carmen Juan.

Special thanks to the Archaeological Museum of Burriana, especially José Manuel Melchor, and Josep Benedito.

The VRUrn application and this user manual were developed within the ArchaeoPills project. The software, documentation, and associated materials are protected by copyright. This manual is distributed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) license.



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Related publication

The development and evaluation of VRUrn is presented in the following publication:

- Juan, M.-C., Benedito, J., Melchor, J. M., Higuera, F., Interdonato, E. An immersive virtual reality training application for laboratory micro-excavation of funerary urns. Virtual Reality (2026). <https://doi.org/10.1007/s10055-026-01435-x>

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