Artec Space Spider

Scanning Protocol for 3D Bone Models

Authors:

Dr. Rubén Martos

Dr. Fernando Navarro

Departamento de Medicina Legal, Toxicología y Antropología Física

UNIVERSIDAD DE GRANADA

This protocol provides a complete guide to using the Artec Space Spider for 3D bone scanning, from setup to export.

CONTENT

PRELIMINARY RECOMMENDATIONS

- **Workstation Setup**: Ensure a rotating platform and materials to secure the pieces (e.g., masking tape, Blu-Tack, etc.).
- **Laboratory Safety**: Wear appropriate lab attire (lab coats, gloves).
- **Power Supply**: Ensure enough power outlets (at least two for the computer and scanner).
- **Lighting**: Work in an area with stable lighting or use supplementary light sources (e.g., lamps, spotlights).
- **Fragmented Bones**: For fragmented pieces, bring erasable markers for easy annotation directly on the bone.

1. GETTING STARTED

A. WORKSPACE

This scanner is handheld, so ensure there is enough space to move freely while operating it.

B. CONNECTING AND SOFTWARE SETUP

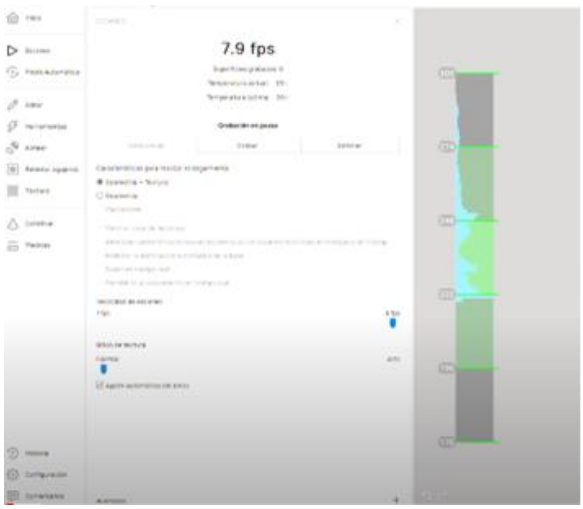
Once the scanner is connected to the computer, launch **Artec Studio** software. Note that there may be compatibility issues between different versions of the software, so always save projects in a format that is compatible with the version you are using.

C. FILE ORGANIZATION

Before starting to scan, especially in projects involving multiple objects, take a moment to plan how you will organize the folders and files. Poor organization can make post-processing very difficult.

D. INITIATING SCAN

You can start a new scan either directly in the software by navigating to **Scan > Start Scan** or by using the buttons on the scanner itself. For the first scan, it is recommended to use the software to adjust the scanner's capture settings before proceeding.

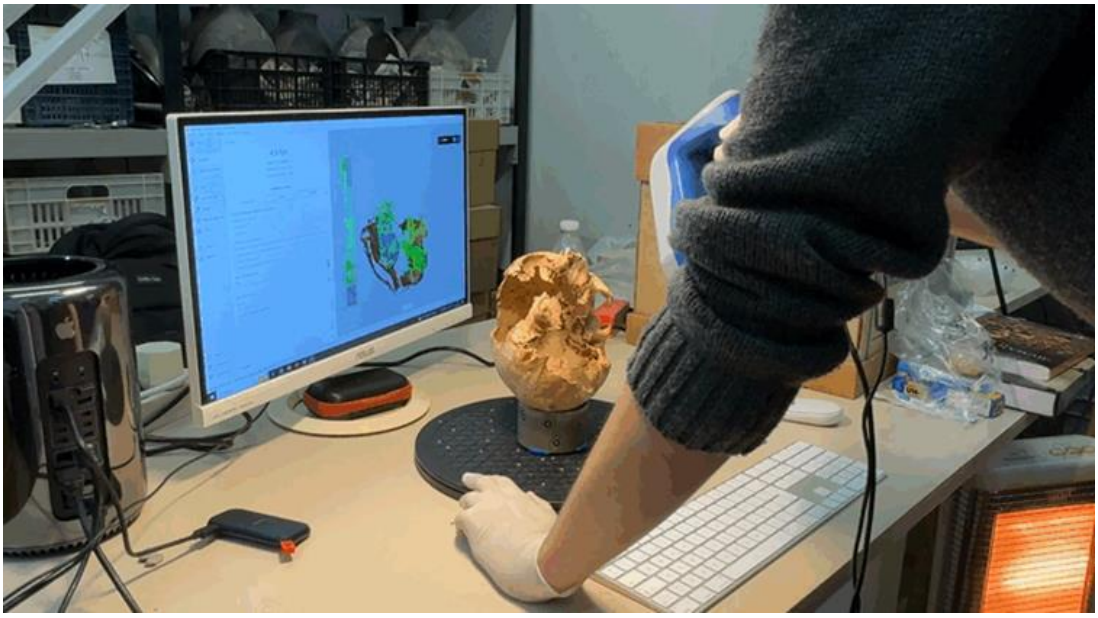


2. SCANNING OBJECTS

A. SCANNING SKULLS

Skulls are among the most complex objects to scan. For a skull with no fractures, and with favorable lighting conditions, two scans can produce an optimal model.

1. **First Scan**: Place the skull on the rotating platform resting on the maxilla (if no teeth are present) and occipital condyles. Begin scanning while rotating the platform and moving the scanner up and down to capture as much detail as possible.
    - **Caution**: Abrupt movements between the scanner and the platform can cause the scanner to lose track of the object, especially if both are moved independently.
2. **Second Scan**: Flip the skull to capture its base. Secure it with a cylindrical object (e.g., masking tape roll or a cushion) and follow the same scanning process, paying special attention to cavities and foramina. For dentition, take extra care to capture the teeth in detail.
3. **Fractured Skulls**: If the skull is fractured, the number of scans will increase to capture as much of the internal cranial vault as possible. You will need to place the fragments in various positions for scanning.



B. SCANNING MANDIBLES

To scan mandibles, follow a process similar to skulls. Start by placing the mandible on the rotating platform, resting it on the gonions and chin. Secure it with Blu-Tack to avoid shifting during the scan.

- **Caution**: The scanner may struggle when moving from a lateral view of the mandible to the posterior side. To avoid losing track of the object, scan the back of the teeth first, before proceeding to the condyles.

C. SCANNING LONG BONES

Although the long bones vary in shape, the scanning process is generally the same. If a bone is fragmented, additional scans will be needed.

1. **Positioning**: Place the bone on the rotating platform, ideally fixed with Blu-Tack if it is not stable. Start by scanning the distal epiphysis completely before moving up the shaft.

2. **Scan**: Gently move the scanner from the distal to the proximal end, making sure to capture both lateral and anterior aspects of the bone. Then repeat the process on the opposite side.

- **Caution**: Due to the shape of long bones, the scanner can easily lose track of the object. Rotate the platform slowly and avoid scanning the same area twice to prevent this.

D. SCANNING RIBS

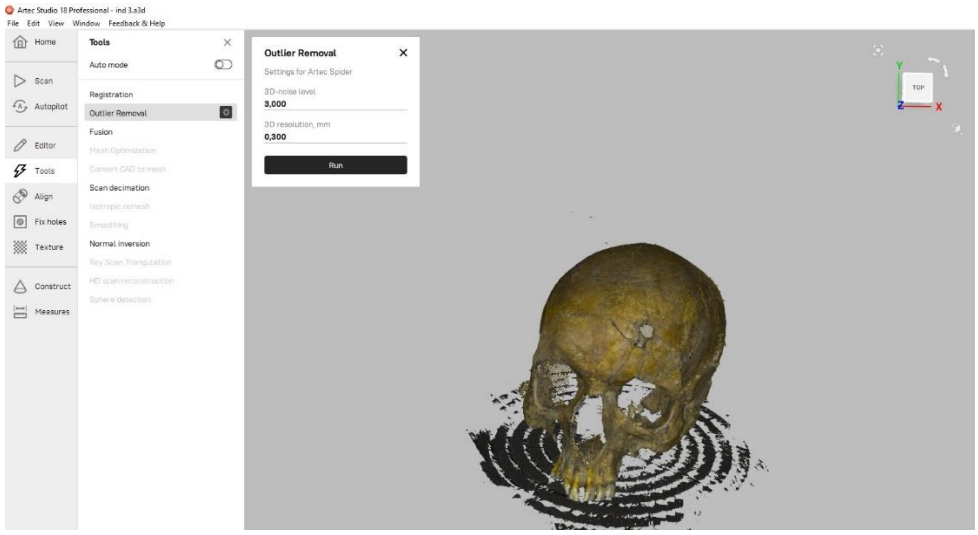
To scan ribs, place them on the costal angle (secured with Blu-Tack) and start by scanning the inner surface. Rotate the platform slowly, as the scanner may lose track in this instance. Once the inner side is scanned, reposition the rib to capture the outer surface, allowing it to rest naturally on the platform without securing it.

3. POST-PROCESSING

The post-processing steps are the same for all objects. Here is an example of post-processing a skull scan:

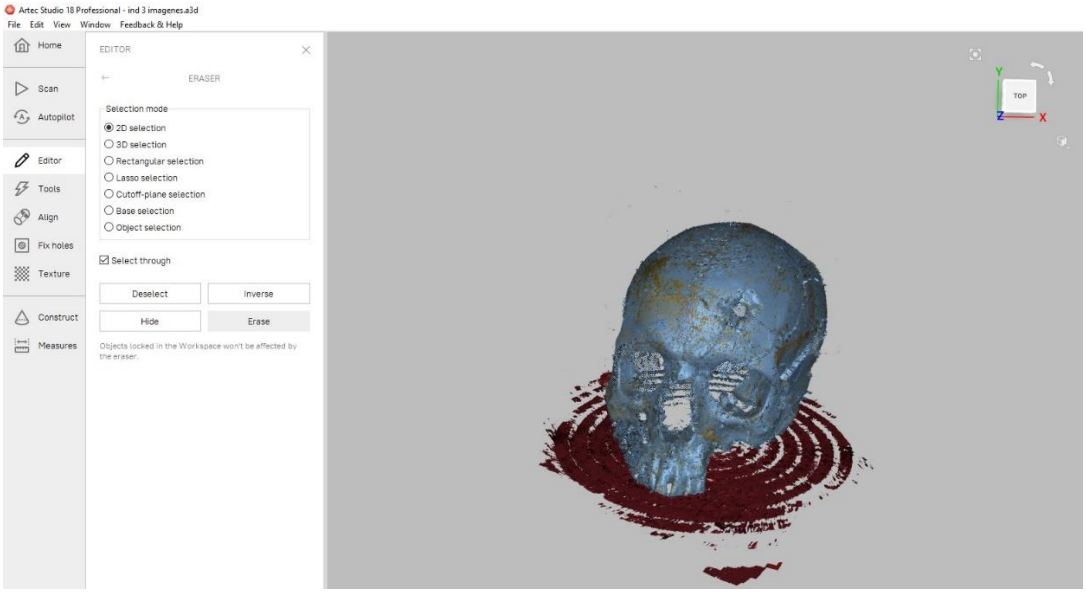
1. INITIAL CLEANING

After scanning, the point clouds will not be aligned, and there will be various artifacts. Start by cleaning each point cloud independently using the "Remove Outliers" tool in **Tools**. This reduces noise and makes the dataset easier to work with.



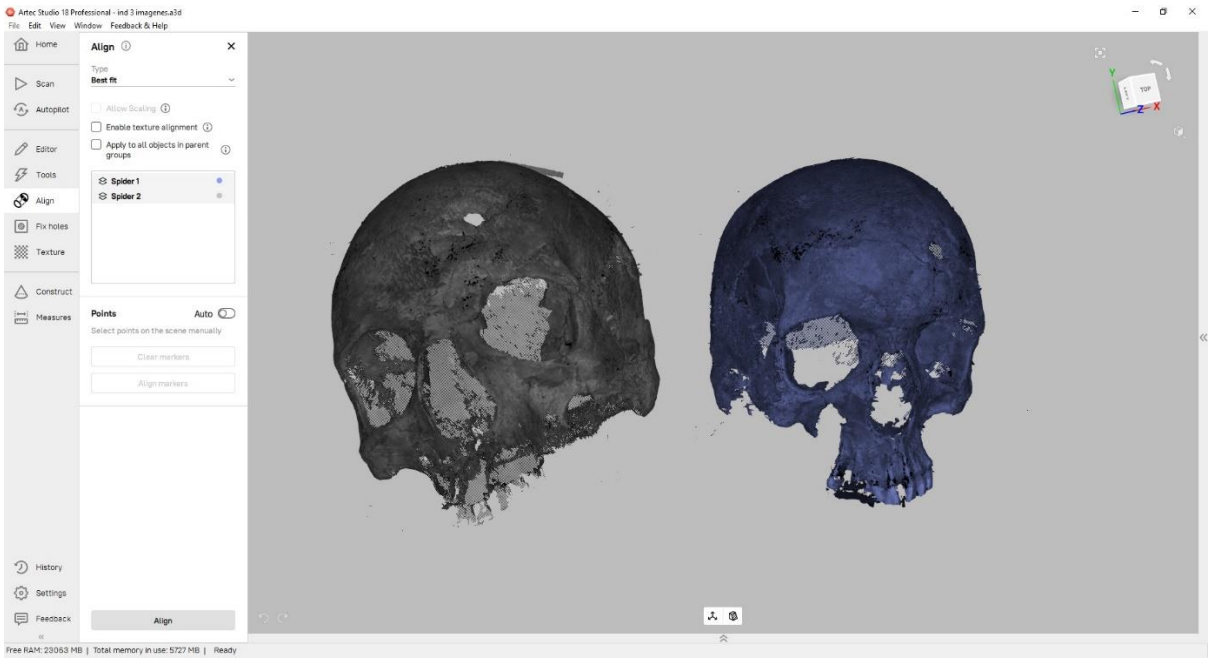
2. REMOVING THE ROTATING PLATFORM

Use the **Eraser** tool in the **Editor** menu. Select areas for deletion using the “Base Selection” and “Lasso Selection” tools to remove the rotating platform or other artifacts like Blu-Tack.



3. ALIGNING POINT CLOUDS

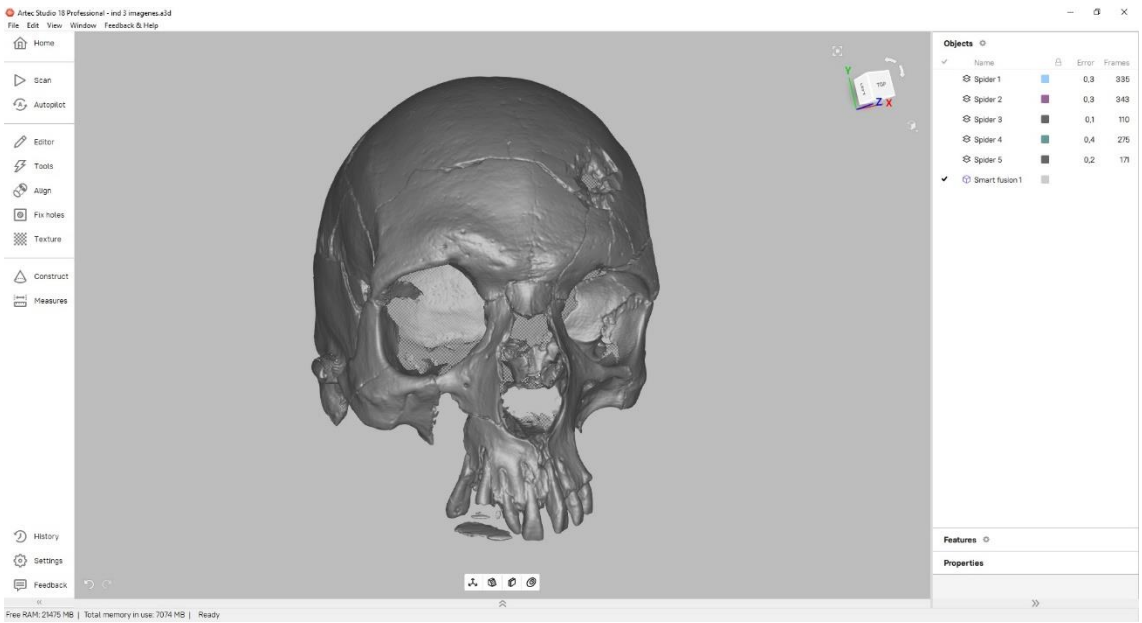
Once cleaned, align the point clouds to create a unified model. Use the **Alignment** tool, where you can either automatically or manually align point clouds.



- Automatic alignment typically works well with bones but may fail with small or simple fragments. In these cases, use a minimum of two corresponding points between the models for manual alignment. Enable “Texture Alignment” for better results.

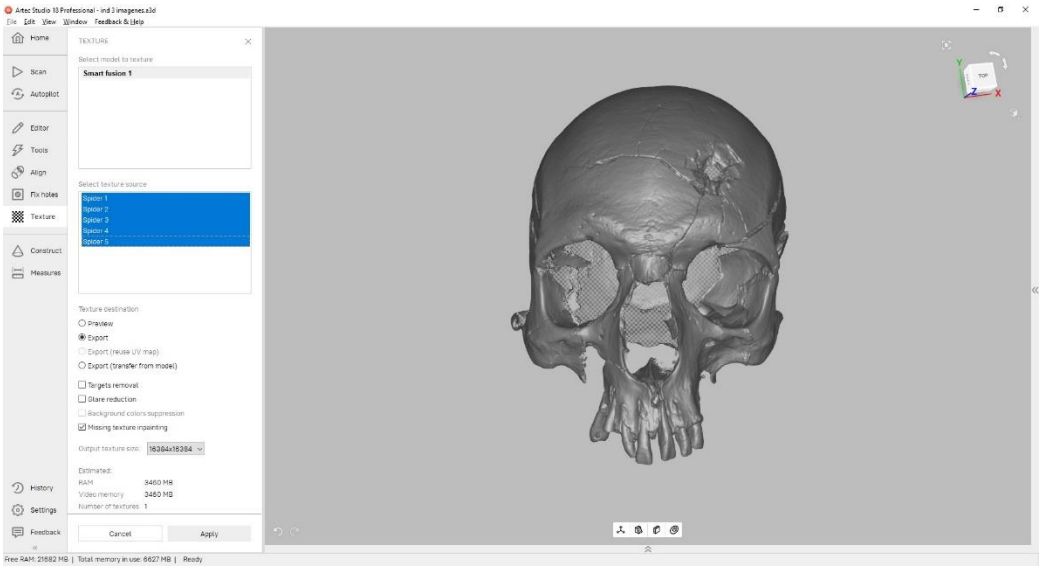
4. CREATING A MESH

After aligning the point clouds, apply the **Global Registration** tool to improve overlap. Then use the **Fusion** tool to generate a solid mesh.



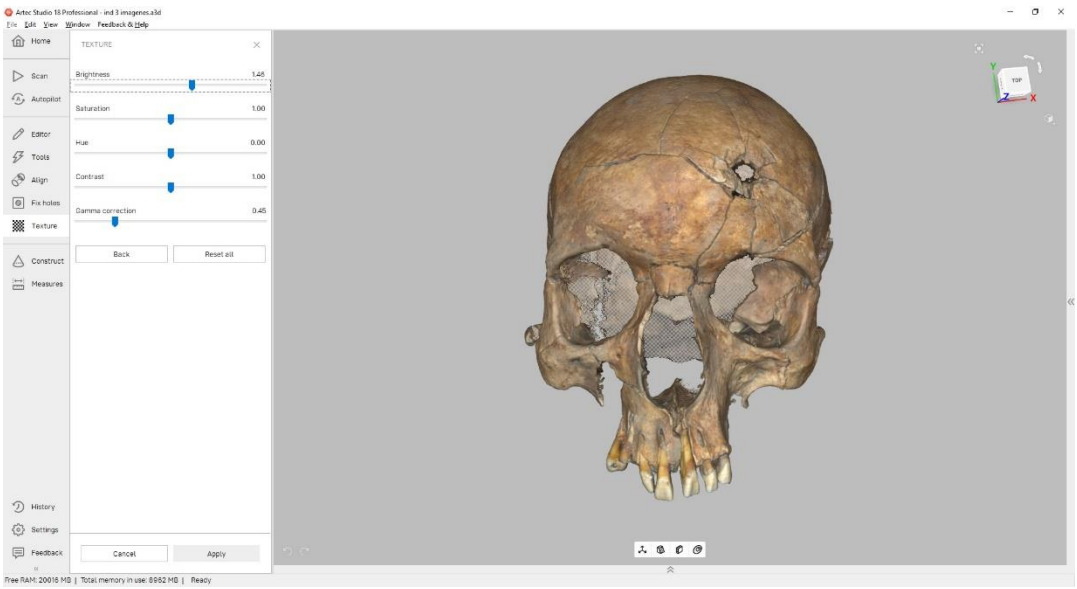
5. APPLYING TEXTURE

Textures are generated from the scanned frames. In the **Texture** tool, select all scans used in the mesh creation and enable options such as “Export Texture,” “Maximize Reflection Reduction,” and “Maximize Background Color Removal.” Set the texture size to 2048x2048 for optimal quality.



6. ADJUSTING TEXTURE

After generating the texture, you can fine-tune it using the adjustment panel. Adjust parameters until the model’s appearance matches the bone’s natural color and details.



4. EXPORTING AND SAVING MODELS

Once satisfied with the final model:

1. SAVE PROJECT

The project name you choose will automatically be applied to the export folder and files, so choose the final name carefully.

2. EXPORTING FORMATS

- For exhibit-ready models that retain the visual fidelity from the software, export in **PLYVC** format.
- For more detailed study, export in **OBJ** format, but note that this format may not retain scene values like PLYVC. The texture may appear darker, requiring adjustments in 3D editing software.
- **Fix File Names**: OBJ exports often have issues with file names. Run the **fix_mtl_names.py** script to correct any errors.