3DReshaper Practical Exercise

Ex7 - Meshing a facade point cloud

Introduction

In the software, several meshing commands are available. The combination of these commands provides many different meshing strategies.

Here, we will show an example coming from a facade which is difficult to process for several reasons:

- The cloud is noisy.
- The cloud contains many missing parts (holes).
- The shape is very detailed but some details have the same size as the cloud noise.

Note that in the Samples directory there is another example based on a point cloud of the Samothrace victory (famous statue in the Louvre museum in Paris), which is a very noisy point cloud representing a smooth surface. Then, another strategy is used in the case of this statue.

Exercise overview

In this exercise, we will see how to mesh point cloud:

- Make a first mesh to see what happens and decide the strategy to use.
- Make a very rough mesh without hole.
- Refine taking directly the points of the cloud.
- Refine interpolating new points.
- Locally smooth noisy parts.
- Rebuild sharp edges.

The file used in this tutorial is **Facade.rsh**.

Observe the aspect of the point cloud. The points distribution is not uniform and there are many missing parts, but these areas should not be interpreted as real holes.

1 Make a first mesh to see what happens

Generally when opening a new cloud, it is difficult to know what the meshing parameter ideal values are. When you enter inside the command Mesh \ 3D Mesh, the software computes parameters for you to get a result in less than 30 seconds regardless of your point cloud size. These “default” parameters usually give you good results but need sometimes to be adjusted according to your model and your expectations.

- Select all the clouds that you see on the screen with a rectangle. 3DReshaper will automatically merge the clouds to mesh them together.
- Launch the command Mesh \ 3D Mesh.
- Options **Regular Sampling** and **Hole detection** are selected with their default values.
- Click **Preview**. The first mesh should arrive in less than 30 seconds. Validate with **OK.**
- When the mesh is on the screen click the right button to select the representation **Flat**, to better visualize the result without artifacts from the smoothing routines of your graphics board.
- Note that you can invert the normal of the mesh typing the **i** key.

You are now ready to analyze your first result. After a quick look, we remark that:

- Many holes are present in zones where there is no point.
- The complex shapes of the top of the pillars are difficult to mesh and leave holes.
- The level of details is insufficient.
- The surface is quite faceted and not smoothed as it should be.

The conclusion of this first test is:

- We need a bigger triangle size to avoid holes.
- We need smaller triangles locally, where a higher level of detail is required.

The problem is that these two requirements are not reconcilable. As a consequence, we will not be able to deal with these two problems in the same step. We should, therefore, first create a rough mesh without holes and then refine the mesh locally using the original point cloud. We can memorize that **it is always preferable to start with a mesh having the desired topology and to refine it** than to fill the holes of a fine mesh.

Figure 1: Making the first mesh with the default parameters to see what happens.

2 Make a very rough mesh without hole

The conclusion of the previous test is that the mesh should be created using larger triangles to avoid holes in the first place. Thus, we repeat the meshing using our original point cloud and only adapt the parameters of the process:

- Make an undo (**CTRL-Z**).
- Select again all the clouds that you see on the screen with a rectangle.
- Launch the command Mesh \ 3D Mesh.
- Option **Regular Sampling** is selected.
- Enter 0.2 in the field **Average distance between points**. The software automatically recalculates the cut-off triangle size and the resulting value should be high enough to fill all the holes.
- Click **Preview** to start the meshing.
- Validate the result with **OK**.
- Swap the mesh normal typing the **i** key.

The level of detail is, as expected, worse than our previous result but most importantly the surface has the right topology (no hole).

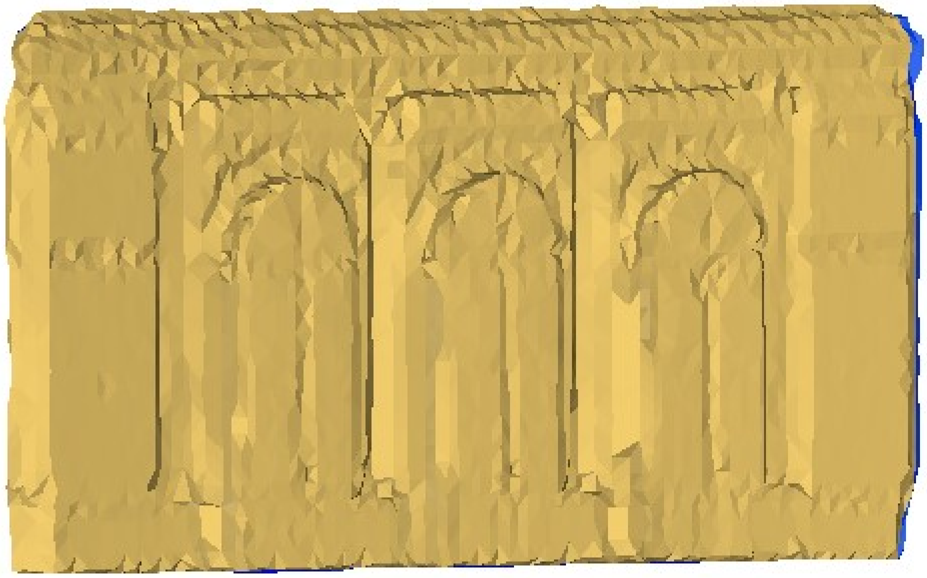


Figure 2: Meshing the facade points of 0.2m. The result has no hole and is a good starting point to start a refinement.

3 Refine taking directly the points of the cloud

As we have seen, our rough mesh has the desired topology but its level of detail is very poor. We are, therefore, going to refine it locally using the points of the original point cloud:

- Select the mesh and the corresponding clouds.
- Launch the command Mesh \ Refine Mesh \ From a point cloud.
- In the meshing generation method, **Take points of the cloud**.
- As the point cloud contains a high number of noisy points, we will use the option **Deviation error with best points only** and choose an error of 0.005.
- Put 0.2 as **Outlier distance** because it was the value in the previous step.
- Click **Preview**.

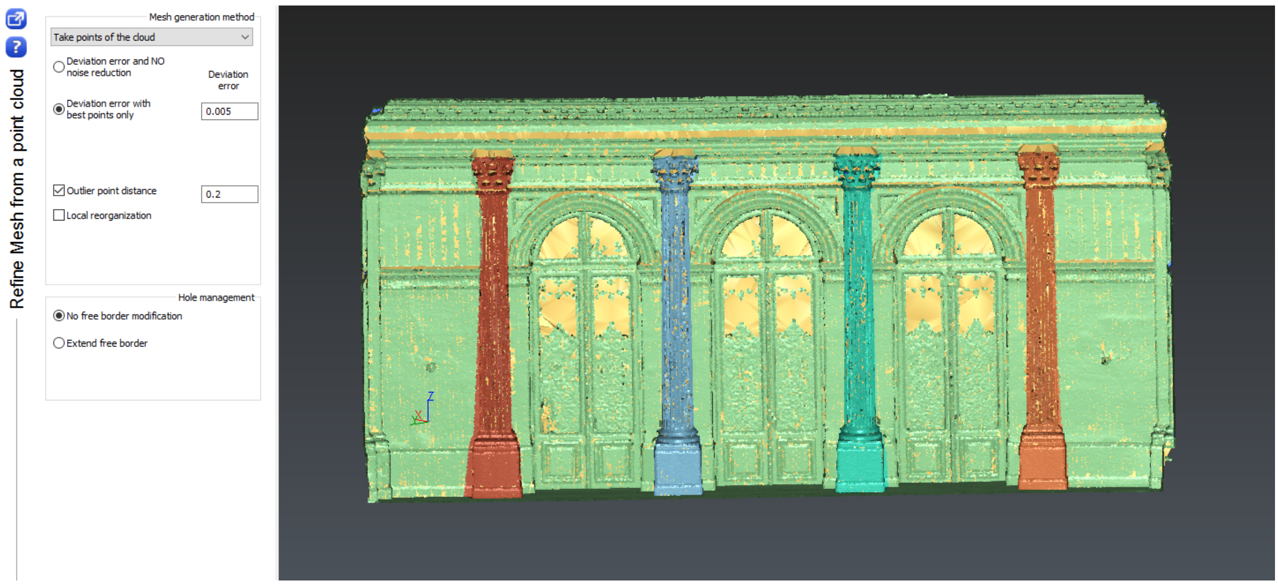


Figure 3: Refining the mesh using directly the points of the cloud to include all the details needed for the future step.

The result is **very faceted, spiky and noisy**, however if you use a "standard" smoothing as shown in the following picture (Mesh \ Smooth \ Regular Smoothing), you will see that most of the unattractive noise can be removed.

Unfortunately, this smoothing tends to deform the model and to transform the sharp edges in radii. We will discard this result, since there is a better way to get a nice smooth mesh which is truthful to the data. **Cancel** this operation.

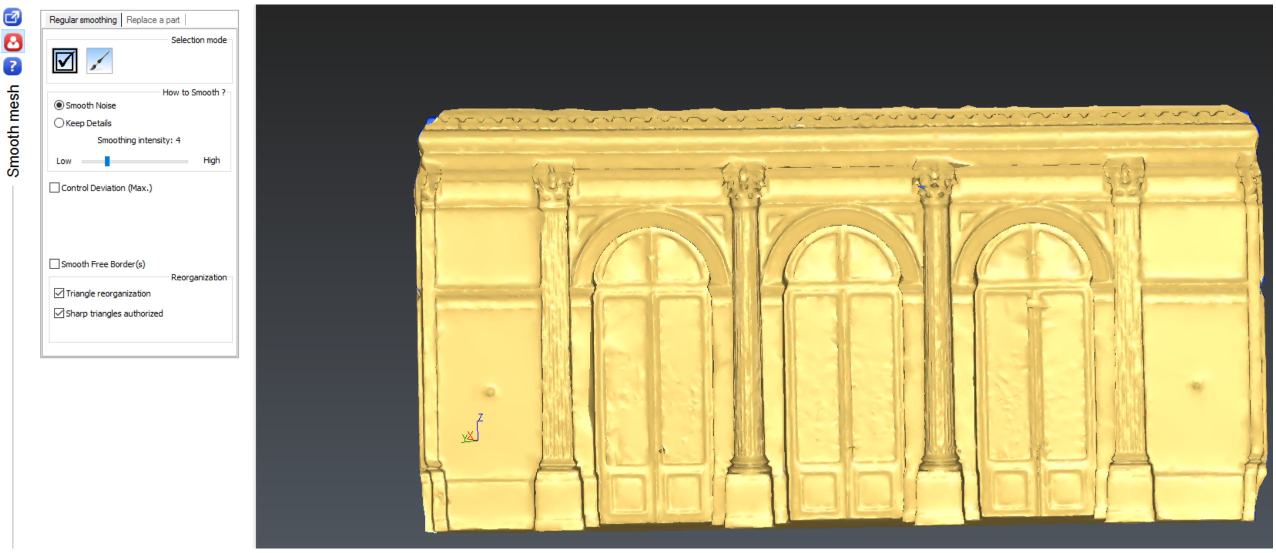


Figure 4: Using the standard smoothing removes most of the noise but the deformation of shape is too high.

4 Refine interpolating new points

Since all the details are already present in the mesh, even if it looks noisy, we are now going to optimize this mesh by finding the “best” smoothed surface in the middle of the noise thickness.

- Select the mesh and all the clouds.
- Launch the command Mesh \ Refine Mesh \ From a point cloud.
- For the mesh generation method, chose **Interpolate new points** and **Refine with deviation error**.
- Enter 0.001 as **Deviation error** and 0.005 as **Minimum triangle size**.
- Enter 0.1 as **Outlier point distance**.
- Don't generate more than 1 million of triangles.
- Click **Preview**. The result should be considerably nicer than the result before.
- Validate the result with **OK, Exit**.

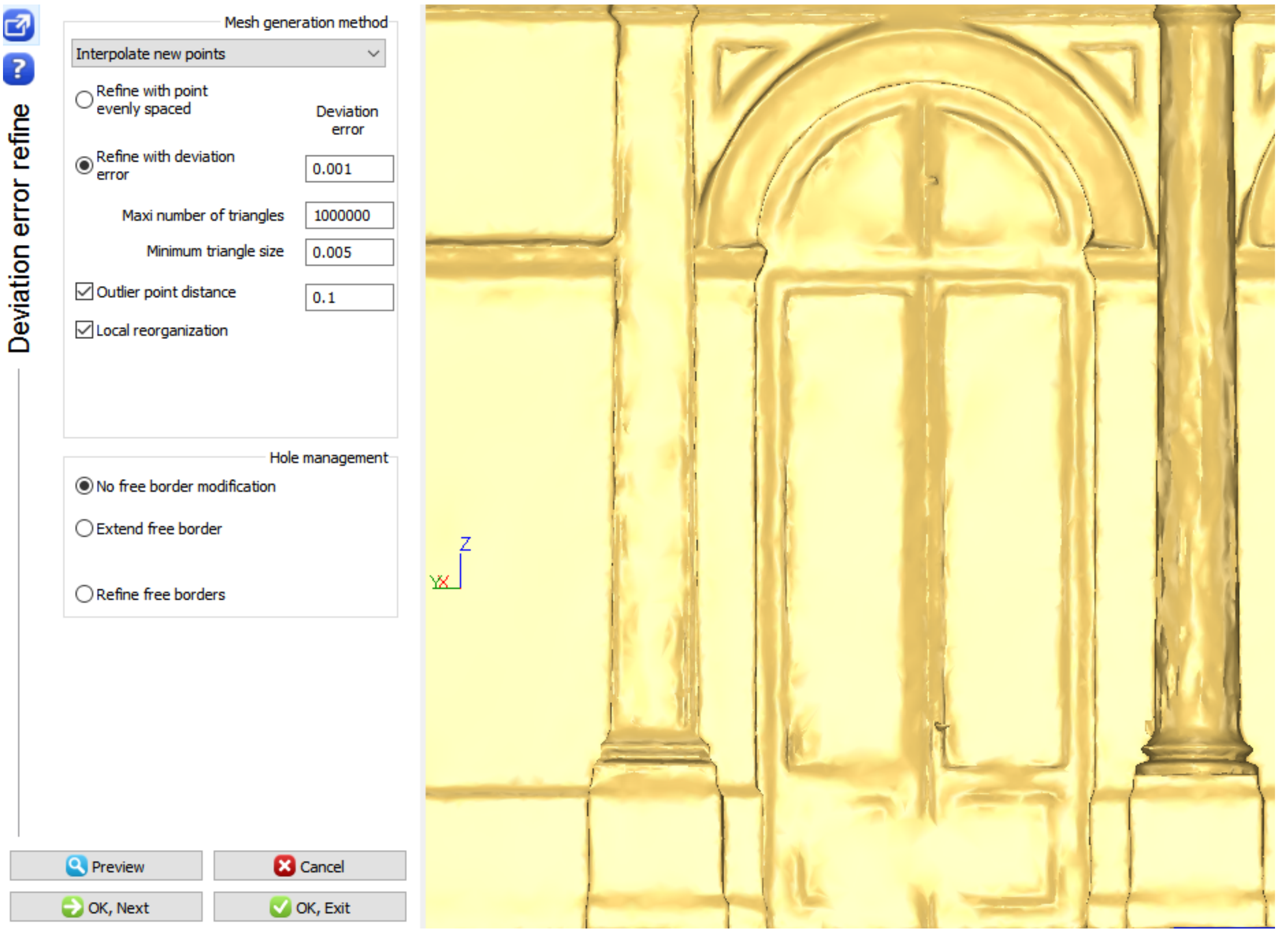
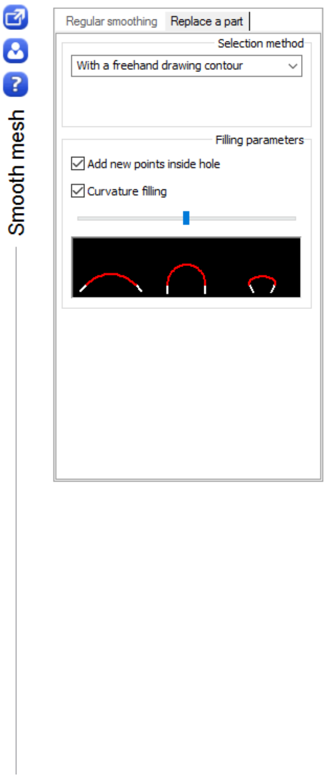


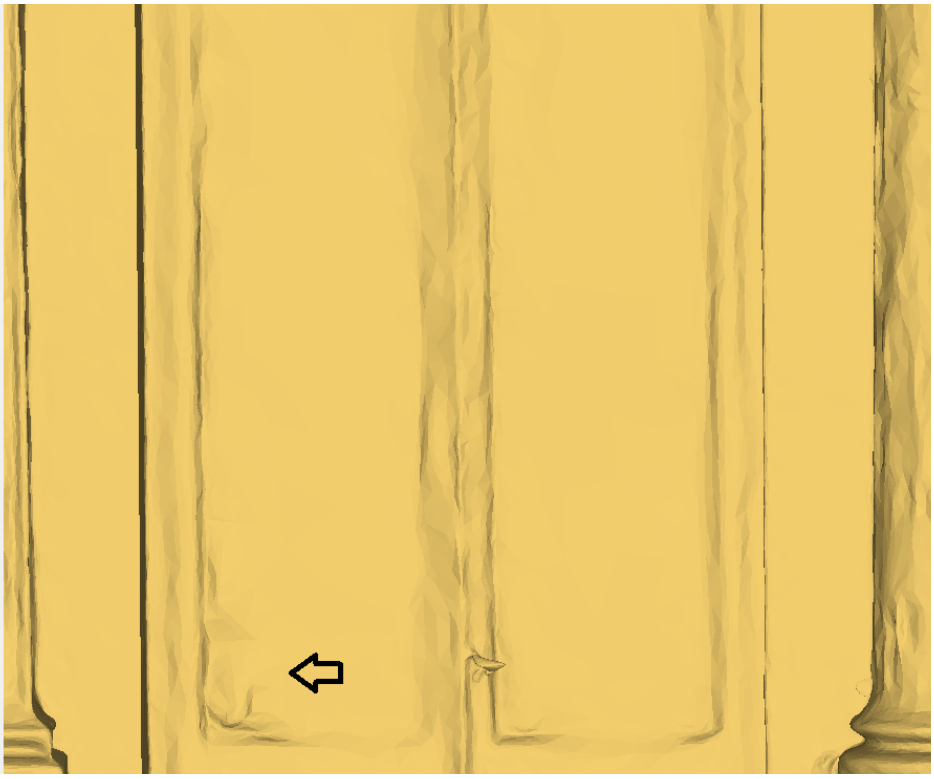
Figure 5: Interpolate new points produces a nicer result.

5 Locally smooth noisy parts

In regions where your cloud contains aberrant points, you will obtain unaesthetic shapes that you can easily correct manually.

- Select the mesh.
- Launch the command Mesh \ Smooth \ Replace a part.
- Draw a freehand contour to encircle the zone to correct.
- If you are satisfied with this correction, click **OK, Next** otherwise click **Reset**.
- Do this operation for all the zones which need to be replaced. Depending on the zone, you must sometimes enable or disable the curvature filling.
- Note that for the small areas you can also use the **Regular smoothing** tab and take the **pencil tool**. The shape will be locally modified when you press the left button of the mouse and move over the zone to smooth.





6 Recalculate the sharp edge on the pillar corners

Some pillar corners may be rounded and it is possible to make these corners perfectly sharp.

- Launch the command Measure \ Plane \ Extract Plane.
- Click on the plane of the most rounded pillar.
- Adjust the extraction tolerance around 0.002.
- Click **OK, Next**.
- Click to extract the second plane of the pillar side.
- Click **OK, Exit**.
- Launch the command Construct \ Intersection and click on the 2 planes to get the intersection line.
- Select the line and launch Construct \ Polyline \ From Geometry(ies) to create the corresponding polyline.
- Select the polyline and launch the command Polyline \ Extend / Shorten Polyline(s) to limit the line to the portion of pillar to be modified.
- Choose the option **With control points**. If the balls are not visible you can zoom out a little, or rotate the mesh to go on the backside. Do it for both sides.
- Select both the polyline and the mesh and launch the command Mesh \ Sharp Edges.
- Click on the button **Click a point on the limit of the zone to modify** and select a point on the edge. Click **Preview**.
- The mesh has been modified to follow the selected polyline.

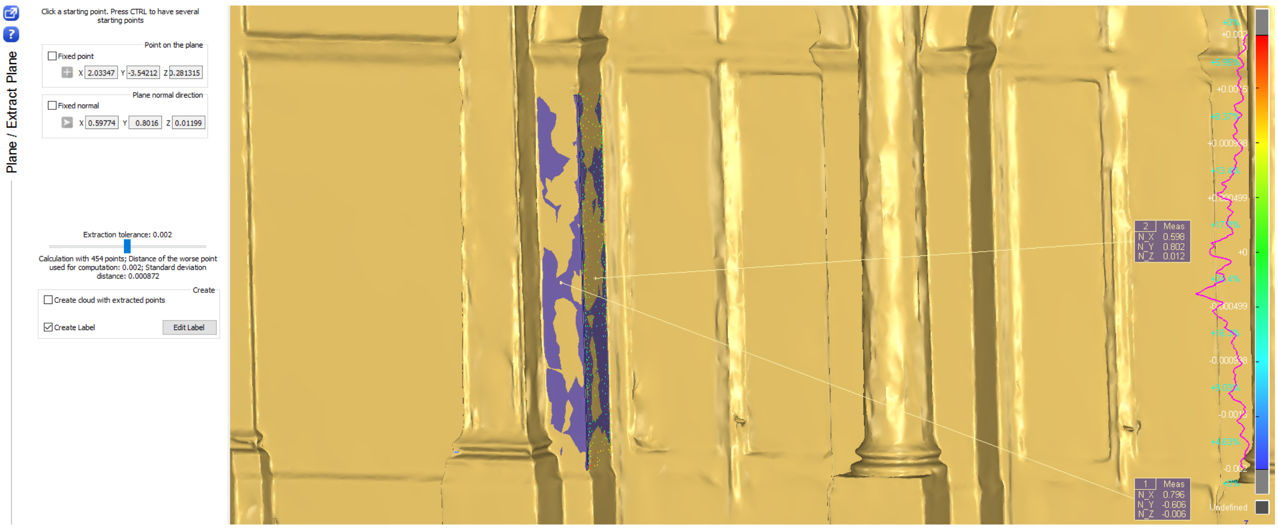


Figure 7: Extract the planes of the pillars in order to improve the sharp edges.

7 Reconstruct the sharp edge over the vault

- Select the mesh.
- Launch the command Polyline \ Feature Line.
- Click on the starting and ending point of the vault as shown on the following picture.
- Once your feature line is correctly detected, click **Border, Fictive Extraction**.
- Select both the **Border lines** and **Fictive line** option.
- Select a **Constant** width detection around 0.1.
- Click **Compute Lines**.
- Click **Smooth Lines** to go to the next step.
- If the detection occurred in several parts, enable the **chaining** option.
- Enable the smoothing of both the **fictive** and the **border** lines (for each radio button, click on the checkbox **smoothed**).
- Click the button **Recreate sharp edge** and compute the sharp edge.
- Click on **Compute sharp edge from border and fictive lines**: the mesh is modified between the border lines.
- Show only the resulting surface and look at the sharp edge of the vault.

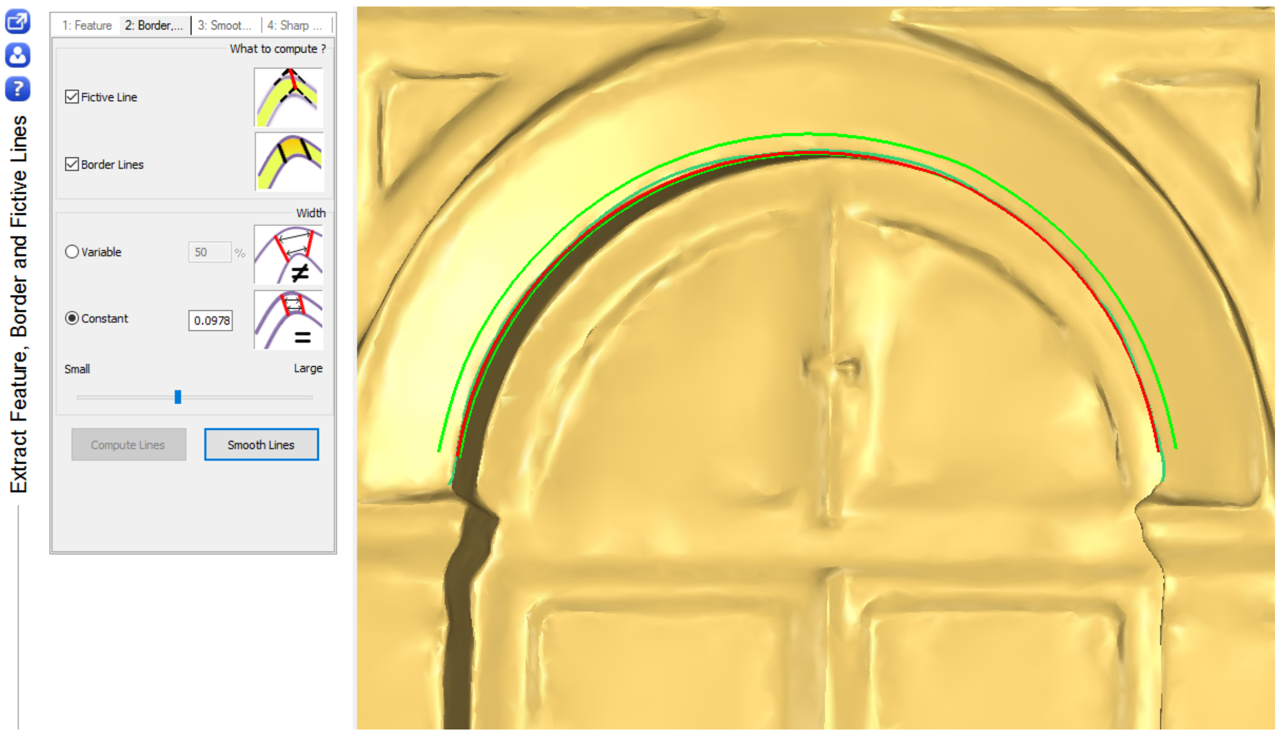


Figure 8: Use of the feature line extraction to reconstruct the sharp edge when the planar intersection is not relevant.

Figure 9: With the optional command Feature line, it is possible to reconstruct the perfect sharp edge of the vault.