Exercise 7: Meshing of a facade point cloud Reshaper V7...

In 3DReshaper several meshing commands are available. The combination of these commands provides many meshing strategies.

Here we will show an example coming from a façade 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 standard Reshaper tutorial 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.

In this exercise, we will see how to mesh point cloud(s).

- Making a first mesh to see what happens and decide the strategy to be used.
- Making a very rough mesh without holes.
- Refine taking directly the points of the cloud.
- Refine interpolating new points.
- Locally smooth noisy parts.
- Rebuild sharp edges.
- Extract some planes from the surface.

➢ Open the file: 3DReshaper-Practise/Meshing2/Facade.rsh

Observe the aspect of the point cloud. Distribution of points is not uniform and there are many places where points are missing, however these areas should not be interpreted as holes.

➢ Making 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**", Reshaper 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.

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

- Select all the clouds that you see on the screen with a rectangle. Reshaper will automatically merge the clouds to mesh them together.
- Launch the command "**Mesh -> 3D Mesh**" and insure that the option "create one mesh with all selected points" is activated.
- Click OK. The first mesh should arrive in less than 30 seconds.
- When the mesh is on the screen click the right button to select the representation -> flat. This is because the flat rendering is a mode that suppresses any artifact or smoothing coming from the graphic board.
- Note that you can swap the mesh normal typing the "**i**" key.

You are now ready to analyze your first result. Here are the remarks that we can make after a quick look:

- Many holes are present in zones where there are no points.
- Complex shape of the base and the top of the pillars makes holes difficult to fill.
- 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:

- From the holes point of view, it would require to mesh with a bigger triangle size.
- From the level of details point of view, it would require to mesh with a smaller triangle size.

The problem is that these two actions are contradictory. It means that we will not be able to treat the two problems at the same step. The constraint regarding the holes is more important than the other one because **it is always better to start with a mesh having the good topology**.

➢ Making a rough mesh to wrap the shape without holes

The conclusion of the previous test is that the mesh should be done with a larger triangle size to pass over the holes:

- Make undo.
- Select again all the clouds that you see on the screen with a rectangle.
- Launch the command "**Mesh -> 3D Mesh**" and insure that the option "create one mesh with all selected points" is activated.
- Enter 0.2 in the field "average distance between points". Reshaper automatically recalculates the triangle size and the resulting value should be high enough to fill all the holes.
- Click OK.

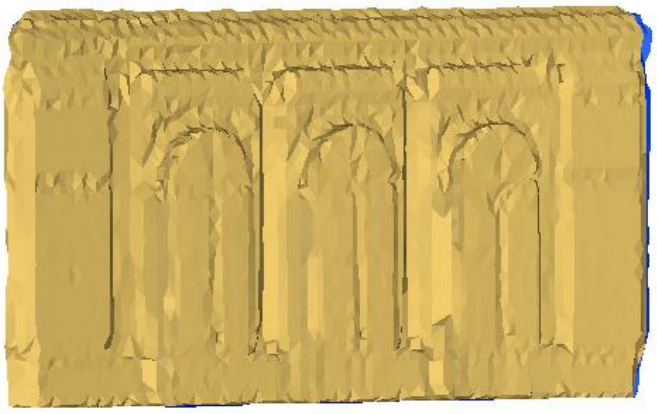

Figure 2: Meshing the facade points of 0.2m. The result has no holes and is a good starting point to start a refinement.

The level of detail is even worse than before but the main thing is that the surface has the right topology (no holes).

➢ Refining using the points of the cloud

As, in our rough mesh, all the details are not visible, we need to take directly the points of the cloud to refine the mesh.

- Select the mesh and the corresponding cloud(s).
- Launch the command "**Mesh - deviation error refine**"
- In the meshing generation method, "take the points of the cloud"
- Put 0.2 as "outlier distance" because it was the value in the previous step.
- As the point cloud contains a high number of noisy points, we will take the best points only and a deviation error of 0.005.
- Click OK.

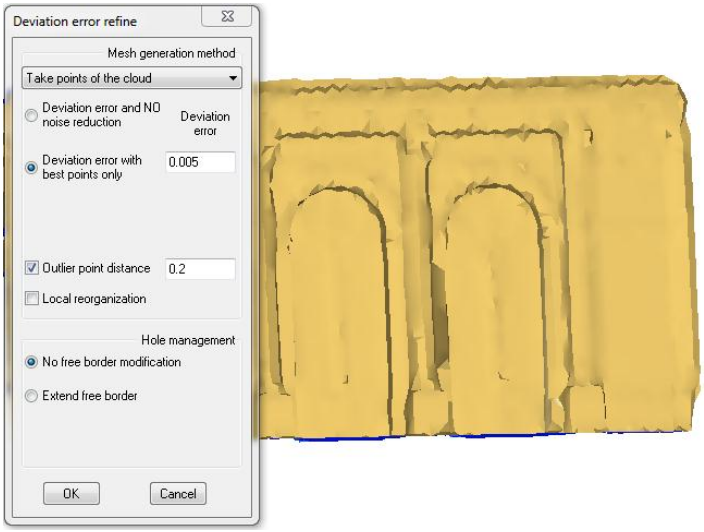

Figure 3: Refining the mesh using directly the points of the cloud to include all the details needed for the future step.

The result is **very faceted, spiky and noisy**, however if you make a "standard" smoothing like on the right picture, you will see that most of this noise can be removed.

The problem of this smoothing is that it tends to deform the model and to transform the sharp edges in radii. This is the reason why we will not keep this result.

Cancel this operation.

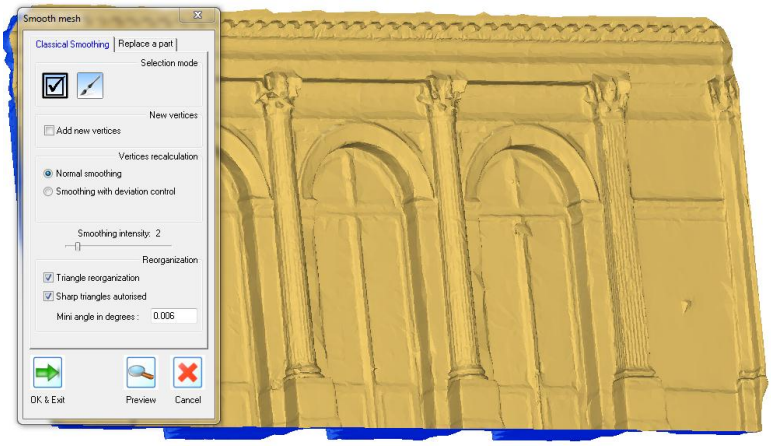

Figure 4: Using the standard smoothing removes most of the noise but the deformation of shape is too high

➢ Refining with new point interpolation

As all the details are present in the shape, even if it is noisy, it is now possible to optimize this mesh to find the “best” smoothed surface in the middle of the noise thickness.

- Select the mesh.
- Launch the command “**Mesh** ->**deviation error refine**”
- In the meshing generation method, take “interpolate new points”
- Enter 0.001 as deviation error and 0.005 as smallest triangle size.
- Enter 0.1 as outlier distance.
- Do no generate more than one million of triangles.
- Click OK. The calculation here should be much more intensive.
- The result should really be nicer.

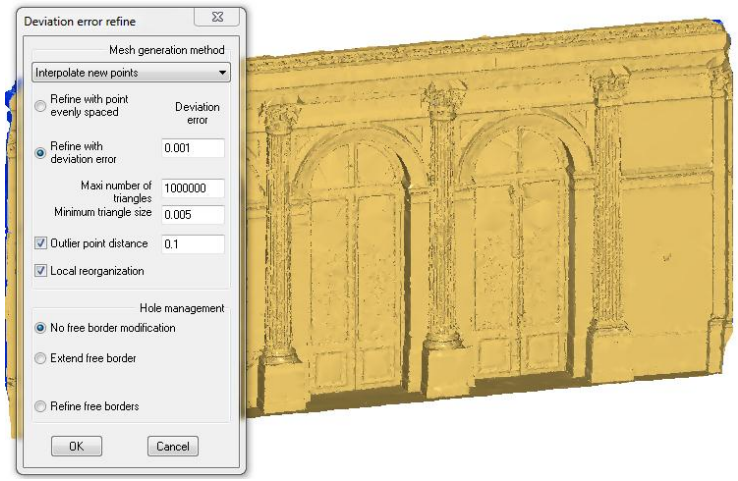

Figure 5: Explode the mesh into disconnected parts.

➢ Replacing some parts to remove some aberrant zones

In the region where your cloud contains aberrant points, you will obtain some wrong shapes that you can easily correct manually.

- Select the mesh.
- Launch the command “**Mesh -> Smooth**”.
- Select the tab “**Replace a part**”.
- Enable or disable curvature filling depending whether the zone is flat or not.
- Draw a freehand contour to encircle the zone to correct
- If you are satisfied with this correction, click “Valid” otherwise click “Undo”.
- Do this operation for all the zones that have to be replaced.
- Note that for the small areas you can also use the “**Classical 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.

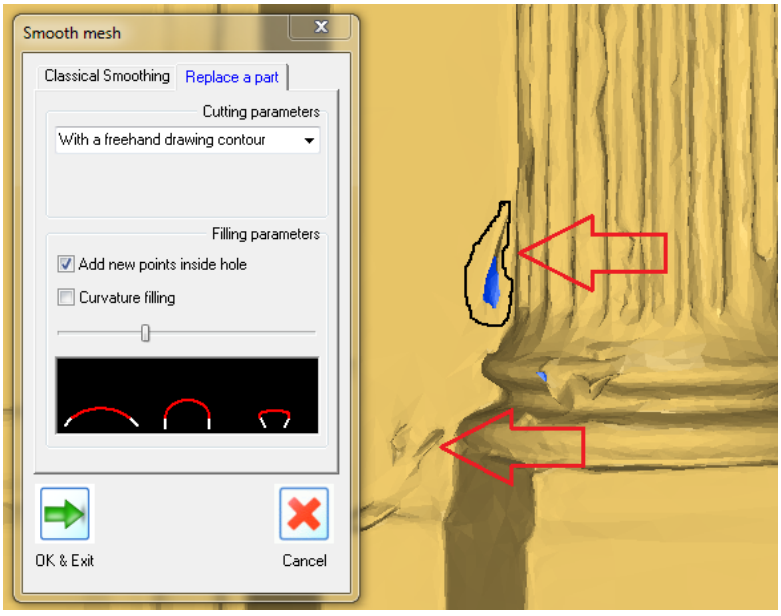

Figure 6: Aberrant zones can be easily replaced or locally smoothed

➢ Recalculate sharp edge on the pillar corner

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

- Launch the command "**Measure -> Extract shape**" and "**Quick plan**".
- Select the "plane tab" and click on the plane of the most rounded pillar.
- Adjust the extraction tolerance around 0.002.
- Click "OK continue".
- Click to extract the second plane of the pillar side.
- Click "OK"
- Launch the command "**Create -> Planar intersection**" and click on the 2 planes to get the intersection line.
- Show only the line and the mesh.
- Launch the command "**Polyline -> Extend / shorten contour**" to limit the line to the portion of pillar to be modified.
- Choose the option "With control points" and if the balls are not visible you can zoom out a little.
- Select both the line segment and the mesh and launch the command "Mesh -> sharp edge"
- Click the point on the border of the zone to modify.
- Click preview.

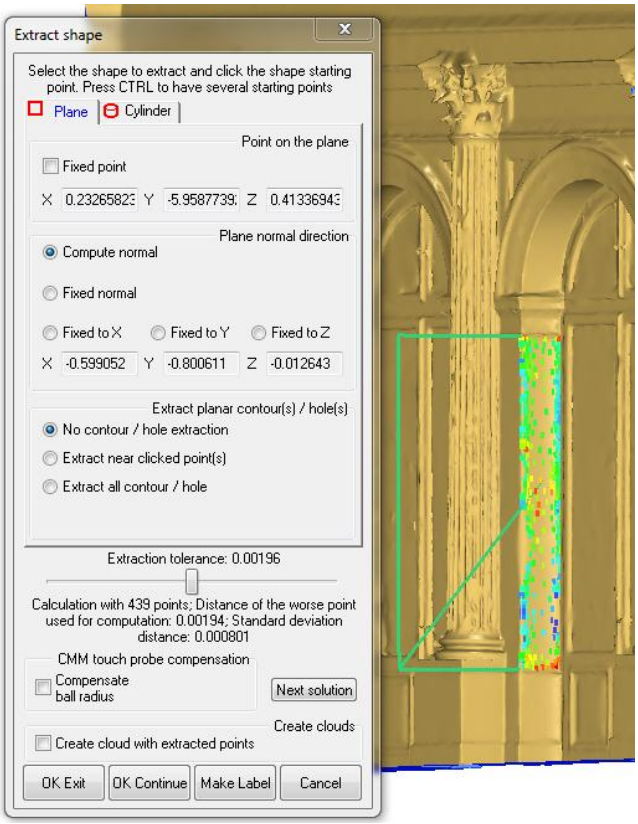

Figure 7: The "Deviation error command" improves the accuracy of the mesh.

➢ Reconstruct the sharp edge over the vault.

- Select the mesh.
- Launch the command "**Polyline -> Extract feature line**".
- Click on the starting and ending point of the vault as shown on the right picture.
- Once your feature line is correctly detected, click "Border and fictive".
- Select both the border and fictive detection.
- Select a constant width detection around 0.1.
- Click "compute line".
- Click the "smoothing" button.
- If the detection occurred in several parts, enable the "chaining" option.
- Enable the smoothing of both the fictive and the border lines.
- Click the button "Recreate sharp edge" and compute the sharp edge.

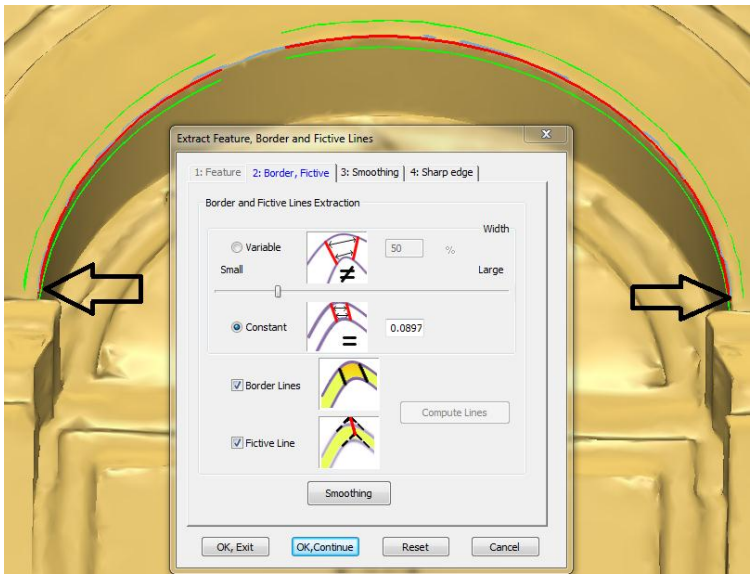

Figure 8: Use of the feature line extraction to reconstruct the sharp edge when the planar intersection is not relevant.

Show only the resulting surface and look at the sharp edge of the vault.

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