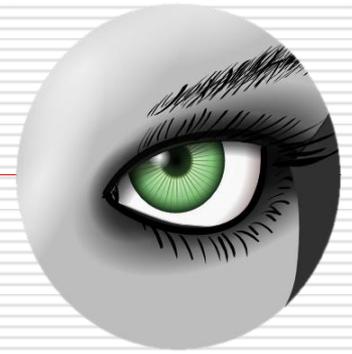


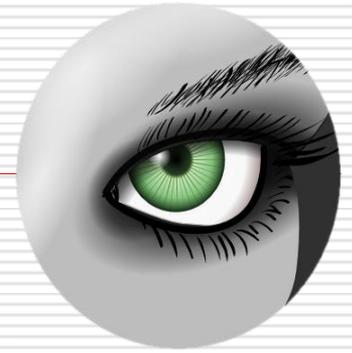
Grafica 3D per i beni culturali: MeshLab features

Lezione 10: 9 Aprile 2015



Cleaning

Cleaning

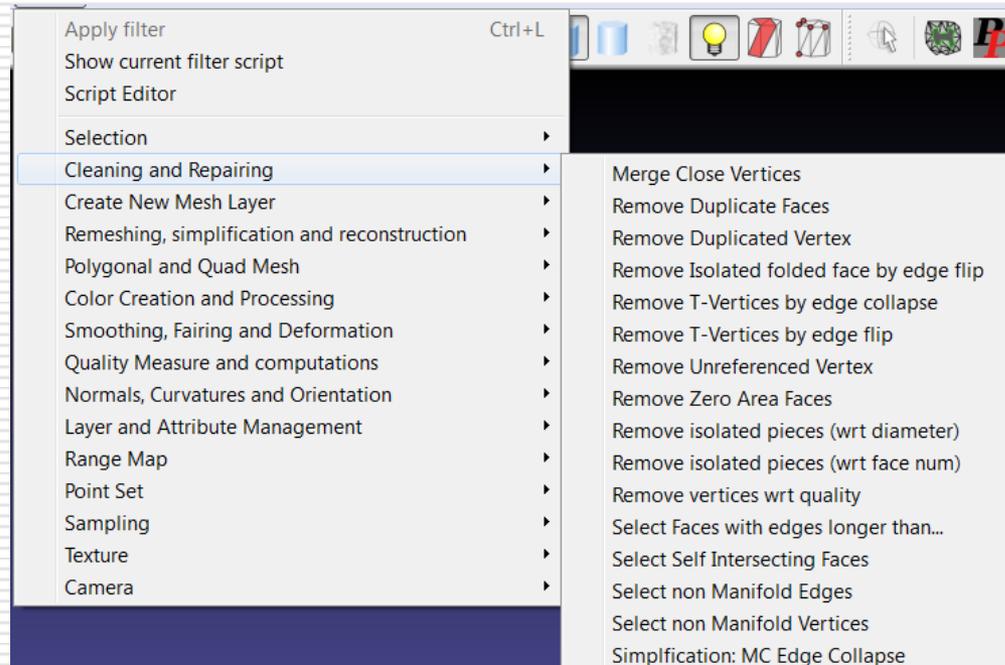


- ❑ Cleaning a mesh is an operation which is often necessary before, during and after the processing of a mesh
 - ❑ There's a number of possible cleaning operations
-

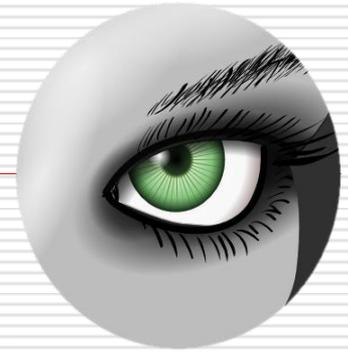
Cleaning



- ❑ Most of the cleaning filters is in the Cleaning and repairing sub-menu

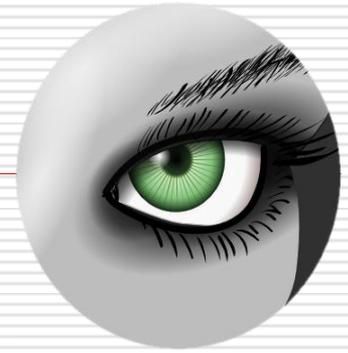


Cleaning: basic filters



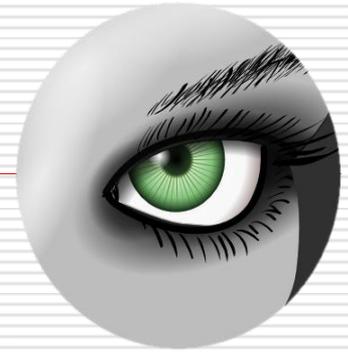
- The basic filters are simple to use (no parameter) and usually not “dangerous”
 - Remove duplicated faces
 - Remove duplicated vertex
 - Remove Zero Area faces
 - Select Non Manifold Edges -> Remove
 - Select Non Manifold Vertices -> Remove
 - Remove Unreferenced Vertex
-

Cleaning: other filters



- Other useful filters need simple parameters setting
 - Remove isolated pieces
Parameter: n. of faces
 - Select faces with edges longer than...
Parameter: edge threshold
 - Select border faces
Parameter: iteration
 - Close holes: something between remeshing and cleaning, we'll see later
-

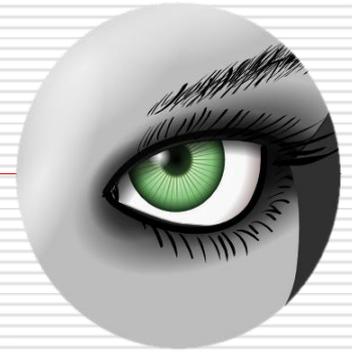
Cleaning: general hints



- Some general hints
 - If a filter or external tool crashes, clean the meshes!
 - Save frequently (no undo!)
 - A “nice” mesh is closed, with triangles of the same size, a very clean topology...

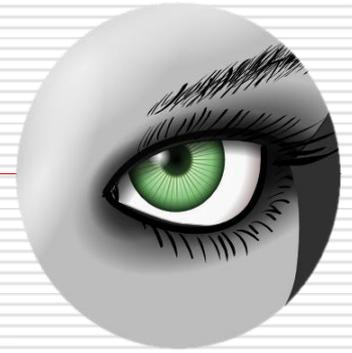
- Videotutorial playlist:

http://www.youtube.com/playlist?list=PLBBF41579E4B65566&feature=view_all



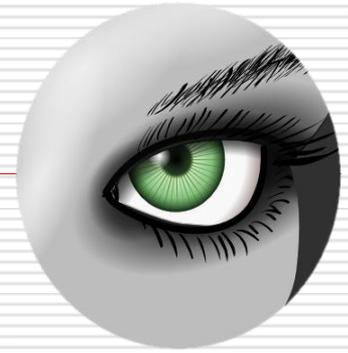
ReMeshing

Remeshing



- Remeshing operations modify an existing geometry, by completing, removing, adding, changing the triangles.
 - There's a number of possible remeshing operations, and several ways to do each...
-

Simplification



- The simplification reduces the number of triangles in a mesh
- Several ways to do that
- Best one:

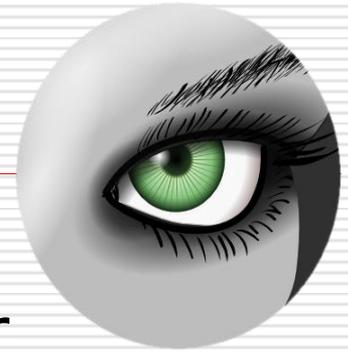
Remeshing, simplification and reconstruction-
>Quadric Edge Collapse Simplification

Parameters: Target number of faces, preserve boundary or normal

Videotutorial:

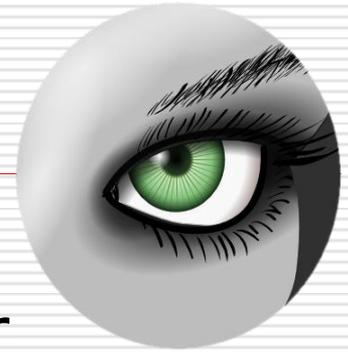
<http://www.youtube.com/watch?v=PWM6EGVVNQU>

Subdivision



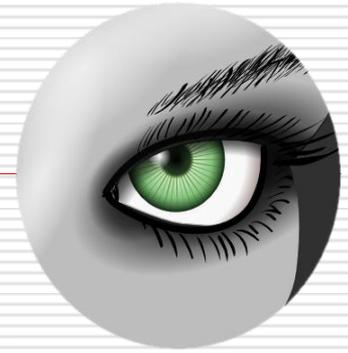
- ❑ The subdivision increases the number of triangles in a mesh
 - ❑ Several ways to do that
 - ❑ Reliable one:
Remeshing, simplification and reconstruction->Subdivision Surfaces:
MidPoint
Parameters: Edge Threshold
-

Subdivision



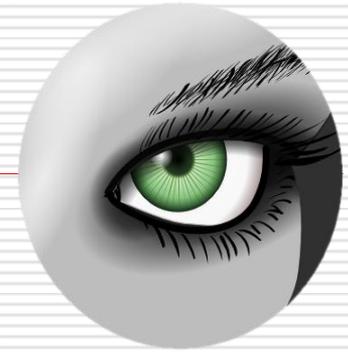
- ❑ The subdivision increases the number of triangles in a mesh
 - ❑ Several ways to do that
 - ❑ More complex one:
Remeshing, simplification and reconstruction->Refine User-Defined
Parameters: refinement decided by the user (using also color and quality!)
-

Close Holes



- ❑ Most of the meshes have holes, but some of the filters need “watertight” models.
 - ❑ Hole filling is not always a trivial operation
 - ❑ Two possible approaches to fill holes in Meshlab
 - 1) Small Holes
 - Remeshing, simplification and reconstruction->Close Holes
 - Parameters: max size to be closed
-

Close Holes

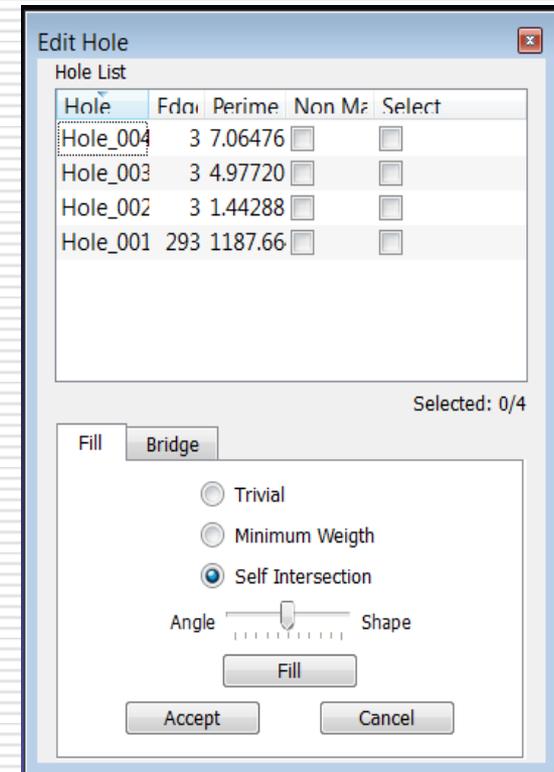


2) Bigger holes Holes

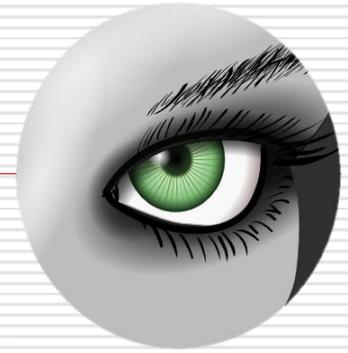
Hole filling tool 

- Select the holes to fill
- Fill and accept
- (Use of bridges to help the filling)

3) Use Poisson or other reconstructions!



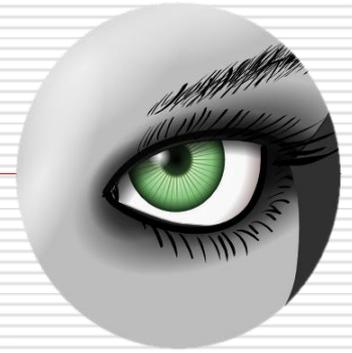
Optimization



In some cases (i.e. after the hole filling) it is necessary to optimize the triangulation of part of the mesh. This is usually reached via a combination of filters.

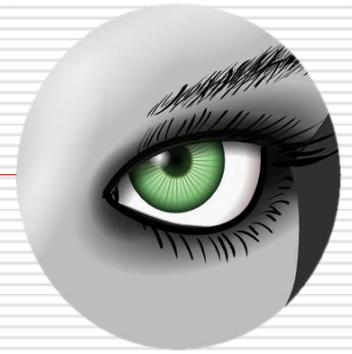
- Remeshing, simplification and reconstruction-> Subdivision Surfaces: MidPoint
 - Remeshing, simplification and reconstruction-> Planar Flipping Optimization
 - Smoothing, Fairing and Deformation-> Laplacian Smoothing (Surface Preserving)
 - Remeshing, simplification and reconstruction-> Quadric Edge Collapse Decimation
-

Parameterization



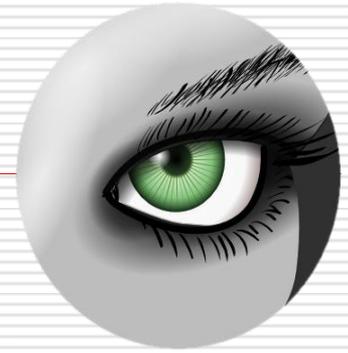
Parameterization is an important, yet critical, problem in mesh processing.

We'll talk about this when dealing with color



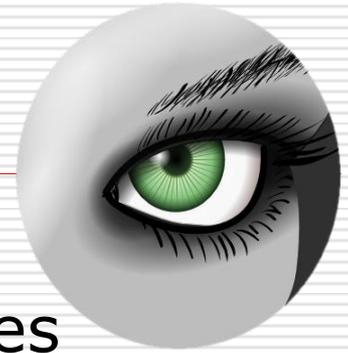
Measuring

Measuring



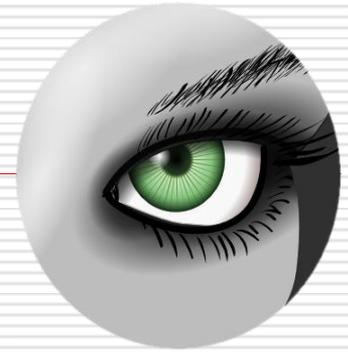
- ❑ The measurement of a mesh (of the difference between meshes) can be extremely valuable for a practical application of MeshLab
 - ❑ There are different measures that can be extracted from one or more meshes
 - ❑ To see most of the data, use the Layer Dialog!
-

Single Mesh: simple direct measures

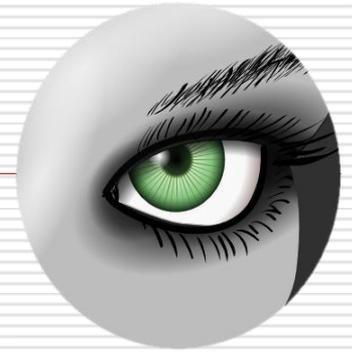


- ❑ It is possible to obtain simple measures with a couple of tools
 - ❑ Point picking 
The coordinates of the picked triangle can be seen.
 - ❑ Measuring 
The Euclidean Distance between two points is given
 - ❑ PickPoints 
Veeeeery basic annotation tool..
-

Multiple Mesh: Hausdorff distance

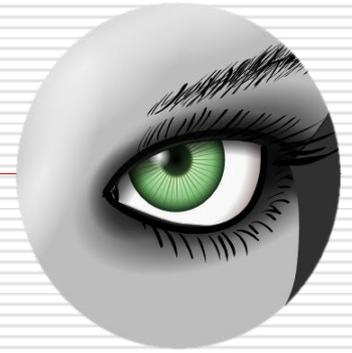


- ❑ Another type of measure is the one obtained between two meshes
 - ❑ It is important that the meshes are perfectly aligned
 - ❑ Filter
 - Sampling -> Hausdorff distance
 - Parameters: N. of samples
-



Coloring

Coloring



- ❑ The color attribute of a mesh can be extremely important both for the realism of visualization, the enhancement of features and lots of other things...
 - ❑ In MeshLab there are already a few features related to color, and others will come in the future.
-

Painting

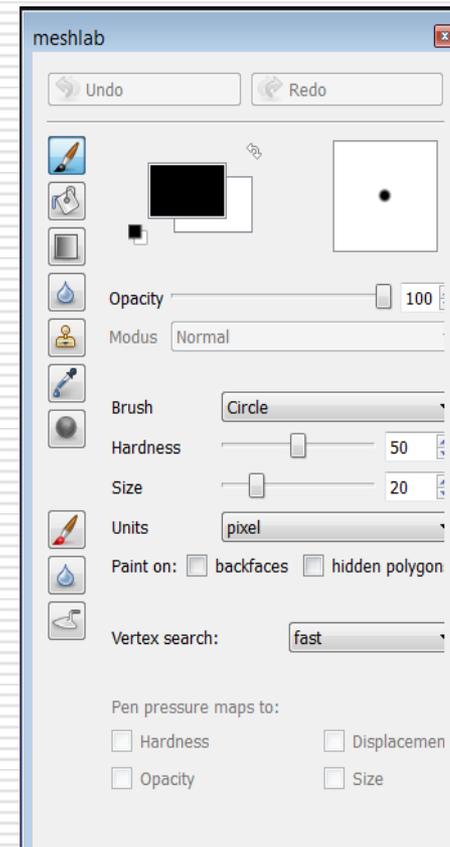


A simple “Photoshop style”
painting tool is available 

The features are the typical
ones:

- Pen
- Bucket
- Gradient
- Stamp
- ...

It also has the Undo!!!



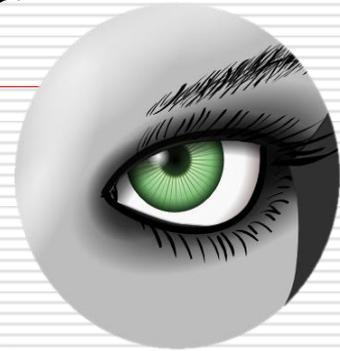
Coloring and Quality mapping



An alternative way to map measures on a 3D model is to use the color and/or the quality.

We'll see how to use it in the next presentation...

Coloring and Attribute transfer



- A very interesting feature is the possibility to transfer the color from a mesh to another mesh.
- Some filters (especially the remeshing ones) tend to cancel the color.

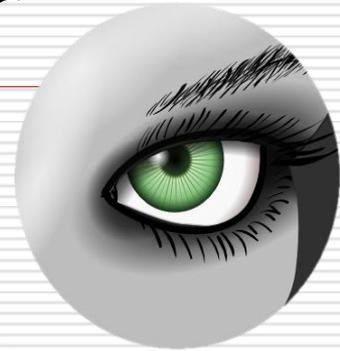
- Filter:

Sampling -> Vertex Attribute Transfer

Parameters:

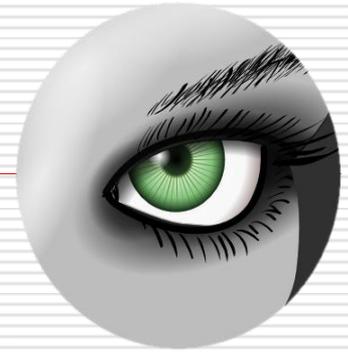
Source and target Mesh, what to transfer

Coloring and Attribute transfer

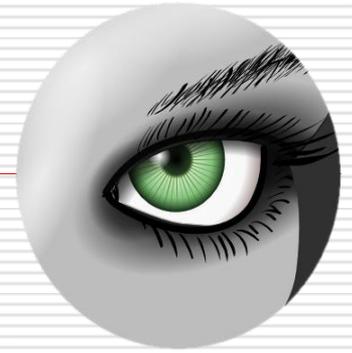


- There are three ways to see color in a mesh: color-per-vertex, color-per-face, texture
 - There are filters to transfer the color from one encoding to the other
 - Filters:
Color creation and processing -> Vertex to face, Face to vertex and Texture to Vertex Color transfer
-

Coloring processing

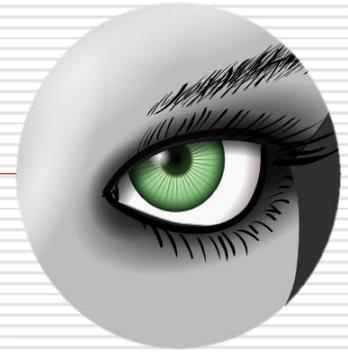


- If a mesh already has color on it (per-vertex or per-face only) it is possible to modify it using a number of “photoshop style” filters.
 - They are all in the “Color creation and Processing” menu. Some of them are
 - Fill
 - Invert
 - Gamma correction
 - Colourisation
 - Brightness and contrast
 - ...
-



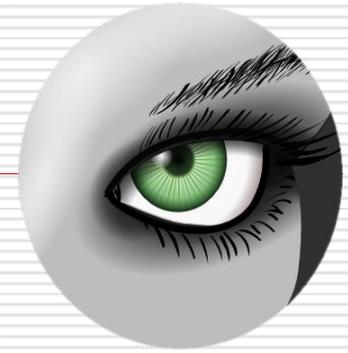
Advanced Visualization

Advanced visualization

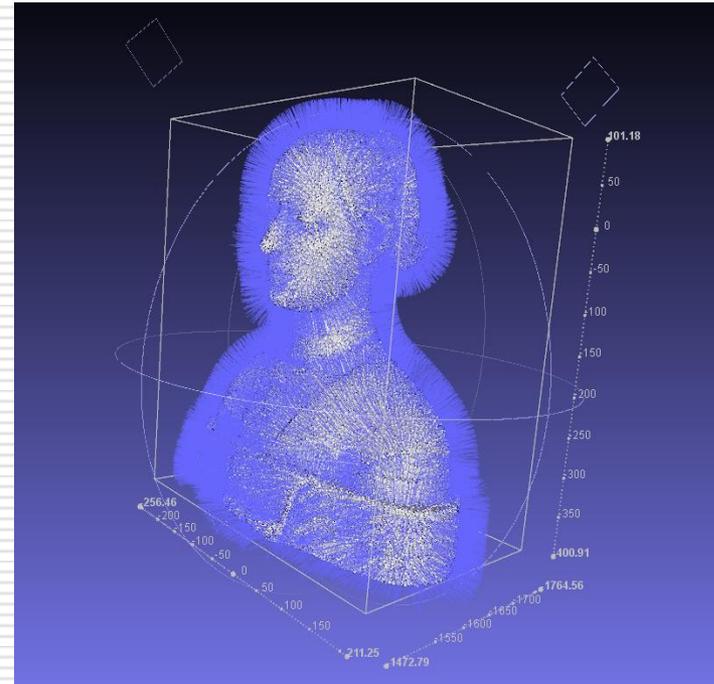


- ❑ One of the most important features of MeshLab is the possibility to easily visualize a mesh and create a snapshot.
 - ❑ There are a lot of functionalities to enrich visualization, enhance details, add information to the geometry...
-

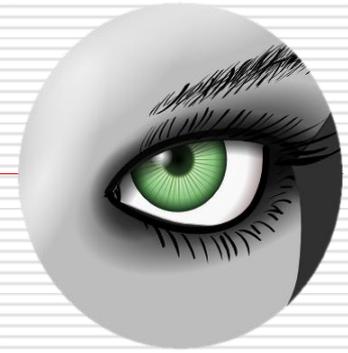
Decorations



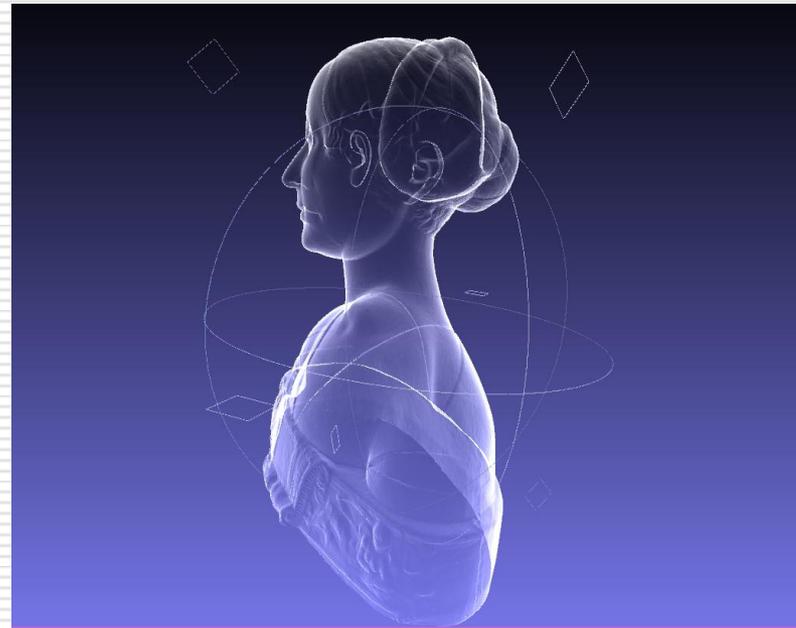
- ❑ A very simple way to add information to a rendering is the use of Decorations
- ❑ Menu:
Render
- ❑ Useful ones:
 - Axis
 - Quoted Box
 - Principal Curvatures
 - Face/Vertex Normals
 - ...



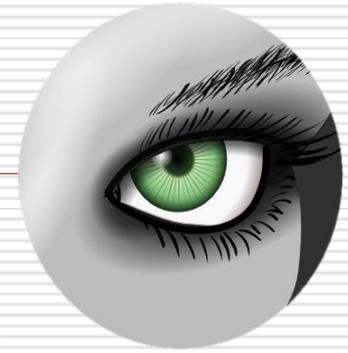
The Shaders



- ❑ The shaders use the GPU to make fast computations on geometry.
- ❑ Using simple shaders it's possible to obtain very nice visual results
- ❑ Menu:
Render-> Shaders
- ❑ Useful ones:
 - Xray
 - Toon
 - Hatch
 - Glass
 - ...

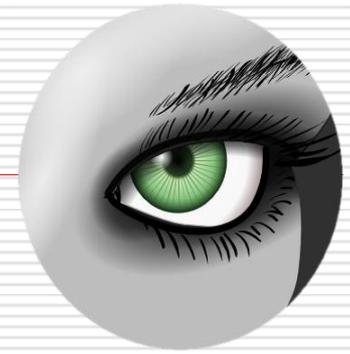


Ambient occlusion



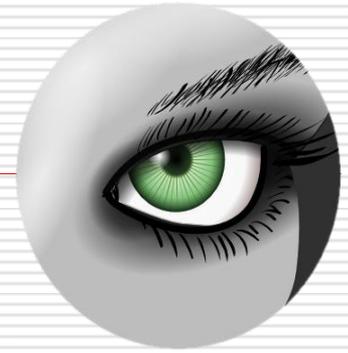
- ❑ If no color is available for a mesh, Ambient occlusion is a very nice way to present the geometry.
 - ❑ Filter:
Color creation and processing -> Vertex Ambient Occlusion
Parameters: Use VBO and/or GPU
 - ❑ It is possible to process the color to enhance the features!
 - ❑ Videotutorial:
<http://www.youtube.com/watch?v=wiNzvISGLAI>
-

User-defined coloring



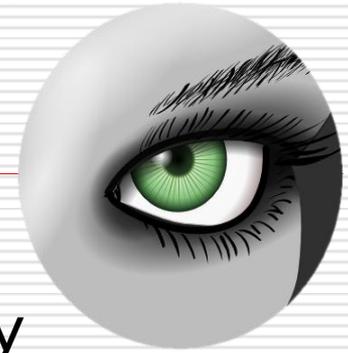
- ❑ Similar to User-defined refining
 - ❑ Filter:
Color creation and processing -> Per-Vertex Color Function
 - ❑ It is possible to process the color to enhance the features!
 - ❑ The same thing can be done on the Quality attribute
-

Discrete curvature



- ❑ An example of a nice coloring is the Discrete Curvature
 - ❑ Filter:
Color creation and processing -> Discrete Curvatures
 - ❑ This filter stores the curvature in the quality value, and shows it by coloring the mesh.
-

Quality mapper



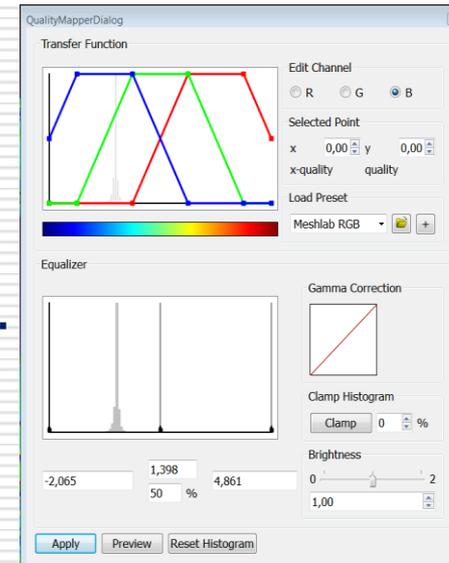
- Mapping the quality is a very useful way to enhance the important features of a mesh



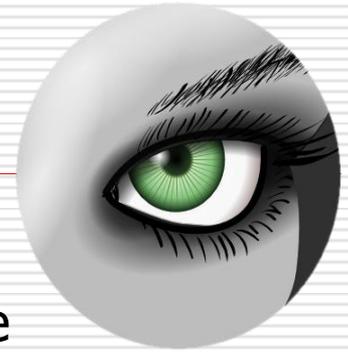
- The Quality Mapper tool is very flexible and extremely valuable

- Parameters:

A LOT! Need to “play” with it...



Advanced visualization



- The presentation of a mesh is key in most of the cases
- MeshLab gives much more possibilities than what it could seem at a first sight
- If you are able to deal with all these aspects:
 - Light
 - FOV
 - Coloring
 - Position
 - Shaders
 - Background
 - ...

Then you can make really nice stuff. You just need to practice a bit more...

Next in line...

Next lesson:

- Semi-automatic 3D from images

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