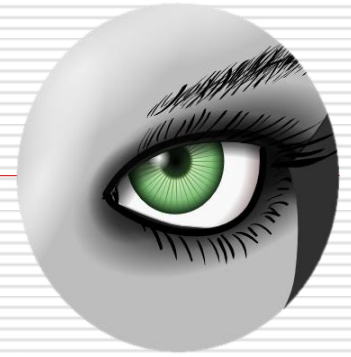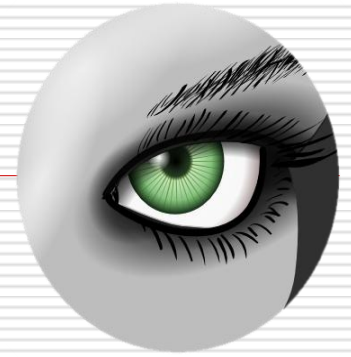# Grafica 3D per i beni culturali: MeshLab features
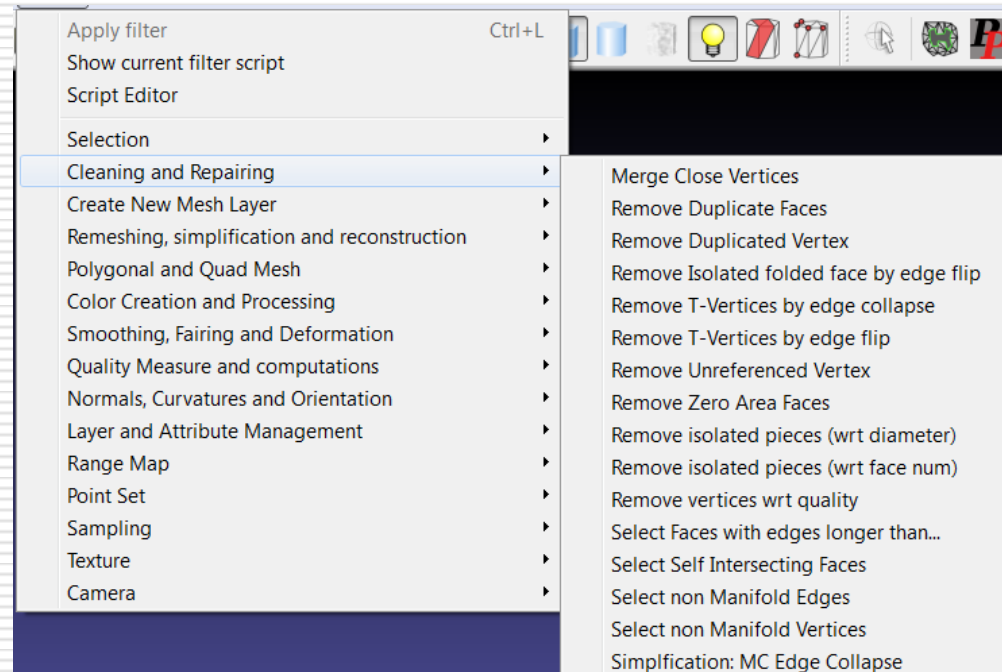
## Lezione 9: 12 Aprile 2012

# 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

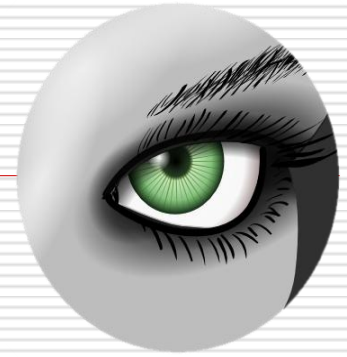☐ Most of the cleaning filters is in the Cleaning and repairing sub-menu

# 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
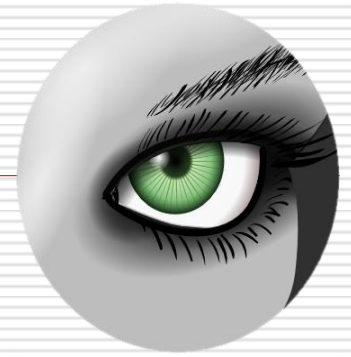
# Cleaning: general hints
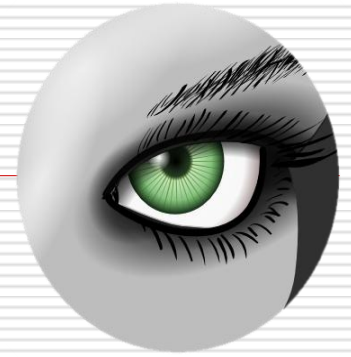
☐ Some general hints
- ■ If a filter or external tool crashes, clean the meshes!
- ■ Save frequently (no undo!)
- ■ A "nice" mesh is closed, with triangles of the same size, a very clean topology...
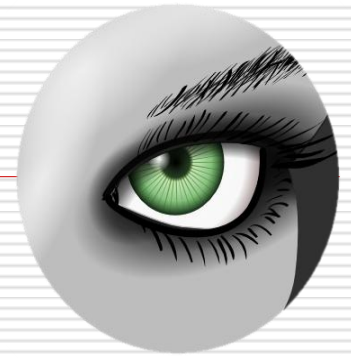
# ReMeshing

# 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

# Subdivision
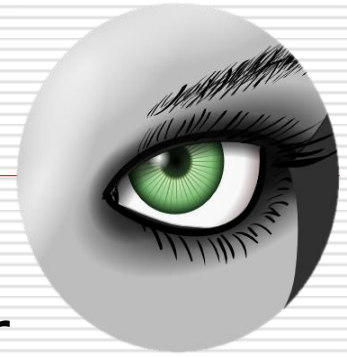
- The subdivision increases the number of triangles in a mesh
- Several ways to do that
- Reliable one:

  Remeshing, simplification and reconstruction->Subdivision Surfaces: MidPoint

  Parameters: Edge Threshold

# Subdivision
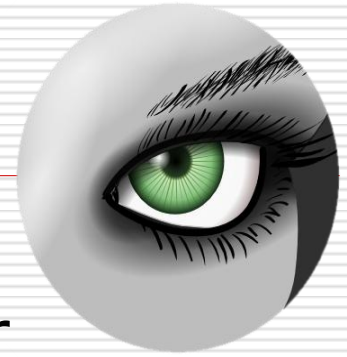
- ☐ The subdivision increases the number of triangles in a mesh
- ☐ Several ways to do that
- ☐ More complex one:

  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

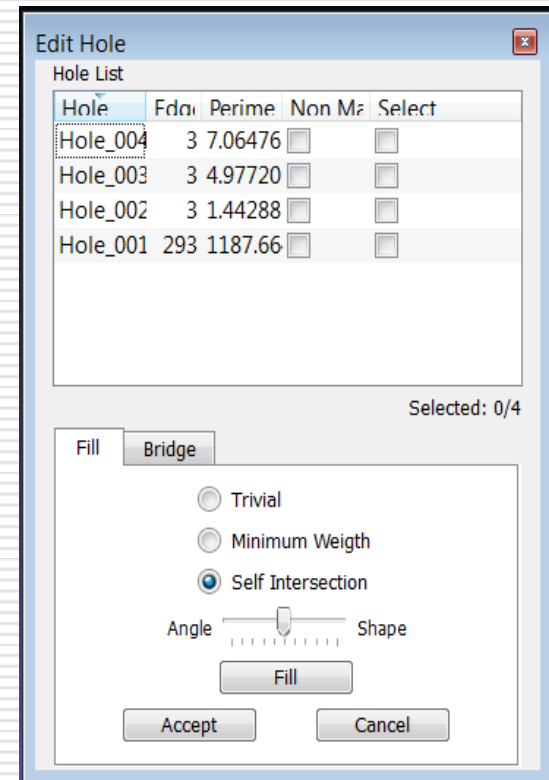   Parameters: max size to be closed
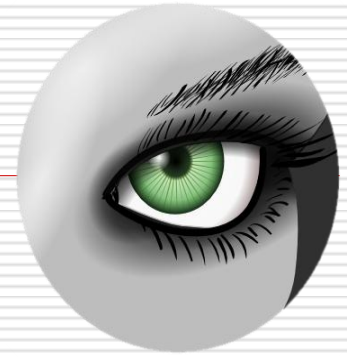
# Close Holes

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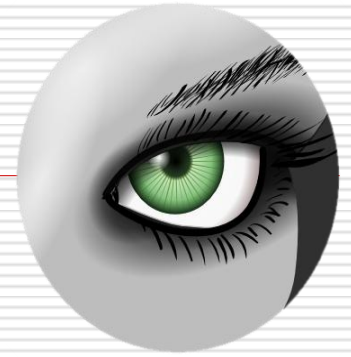
Parameterization is an important, yet critical, problem in mesh processing.

We'll talk about this when dealing with color
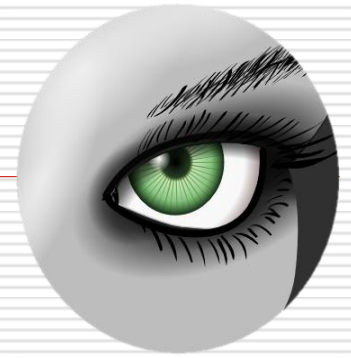
# Measuring

# 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 
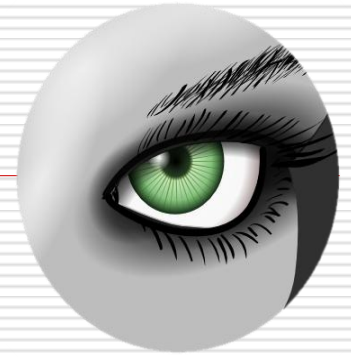
  Veeeeeery basic annotation tool..

# Multiple Mesh: Hausdorff distance

- ☐ Another type of measure is the one obtained between to meshes
- ☐ It is important that the meshes are perfectly aligned
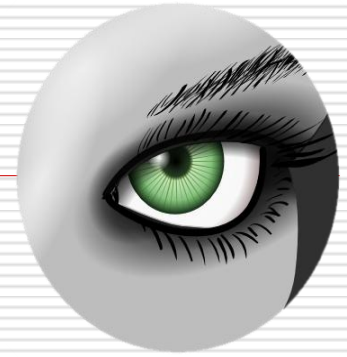- ☐ Filter

  Sampling-> Hausdorff distance

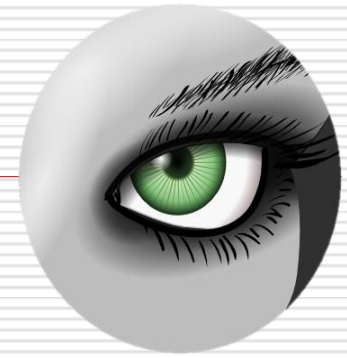  Parameters: N. of samples

# 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.
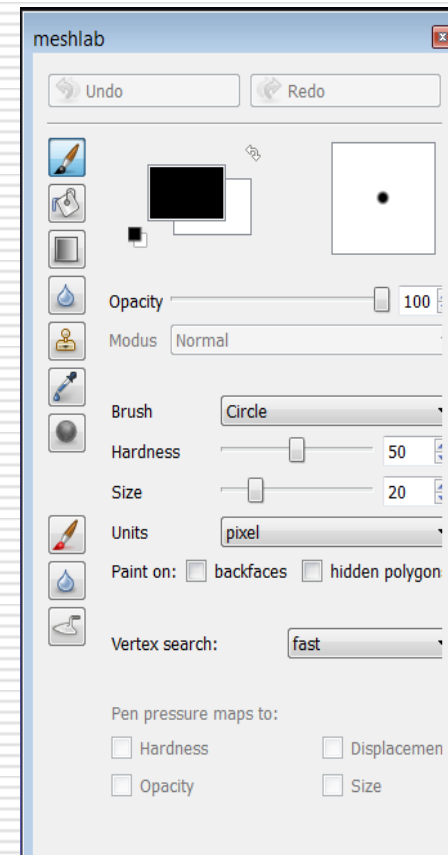
# Painting

A simple "Photoshop style" painting tool is availabl

The features are the typical ones:

- Pen

- Bucket

- Gradient

- Stamp

- ...

It also has the Undo!!!

# Coloring and Quality mappin

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.
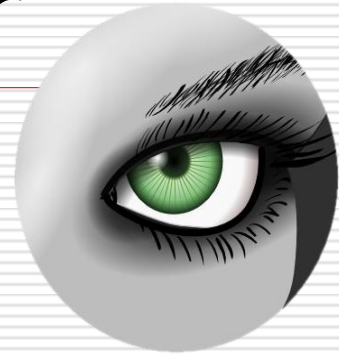- Some filters (especially the remeshing ones) tend to cancel the color.
- Filter:

  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
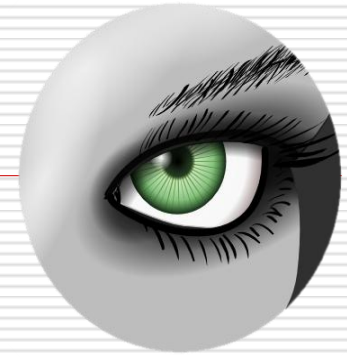
- ☐ If a mesh already has color on it (per-vertex or per-face only) it is possible to modify it using a number of "photoshop style" filters.

- ☐ They are all in the "Color creation and Processing" menu. Some of them are

- Fill

- Invert

- Gamma correction

- Colourisation

- Brightness and contrast

- …
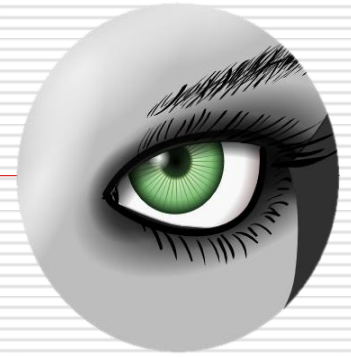
# **Advanced Visualization**

# 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…
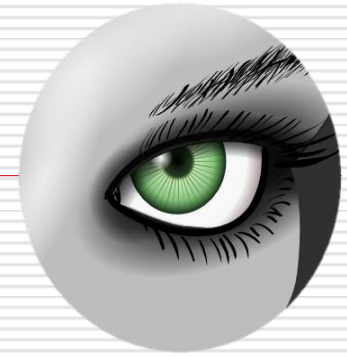
# Decorations

☐ A very simple way to add information to a rendering is the use of Decorations

☐ Menu:

Render

☐ Useful ones:

- Axis

- Quoted Box

- Principal Curvatures
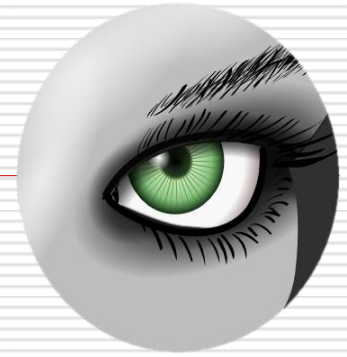
- Face/Vertex Normals

- ...
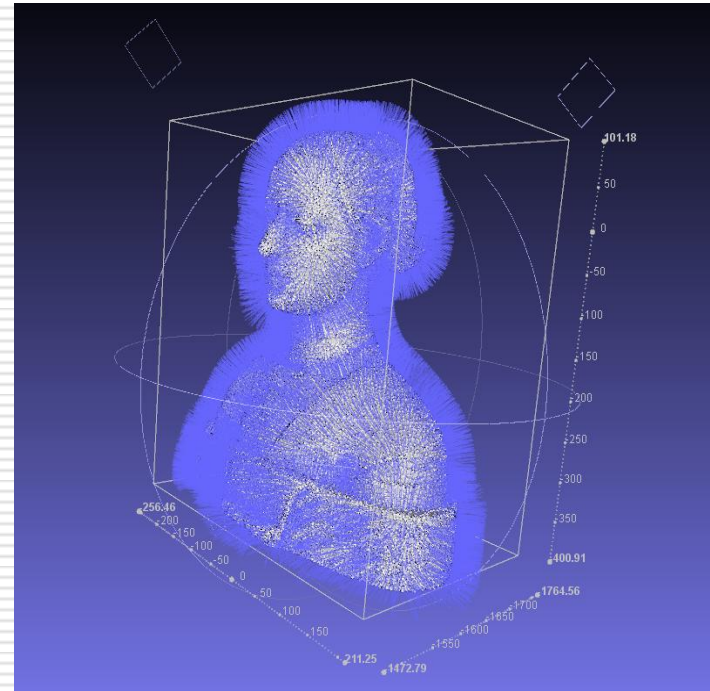
# The Shaders



- ☐ The shaders use the GPU to make fast computations on geometry.

- ☐ Using si mple shaders it's possible to obtain very nice visual results

- ☐ Menu:

   Render-> Shaders

- ☐ Useful ones:

   - Xray

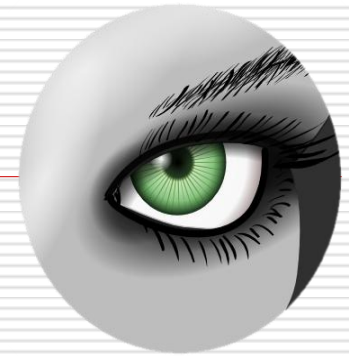   - Toon

   - Hatch

   - Glass

   - ...
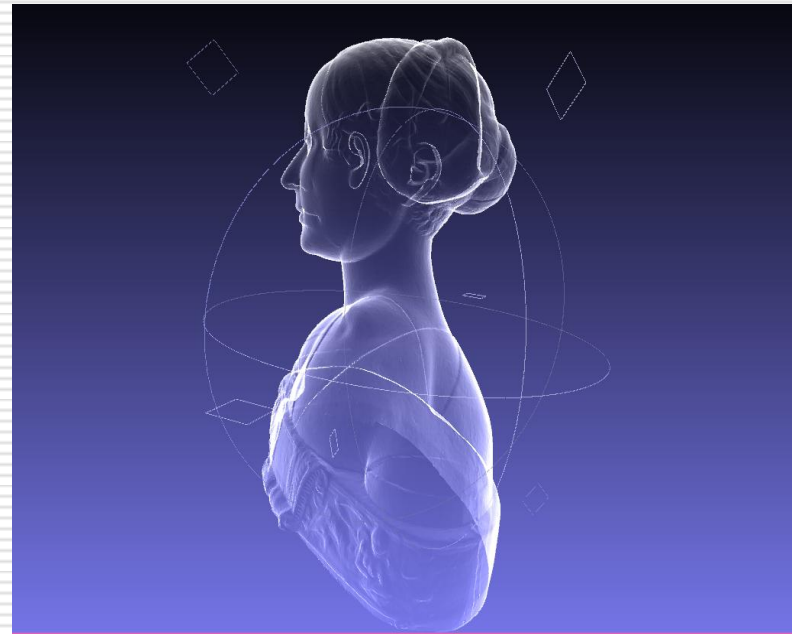
# Ambient occlusion

- ☐ 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!

# 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.
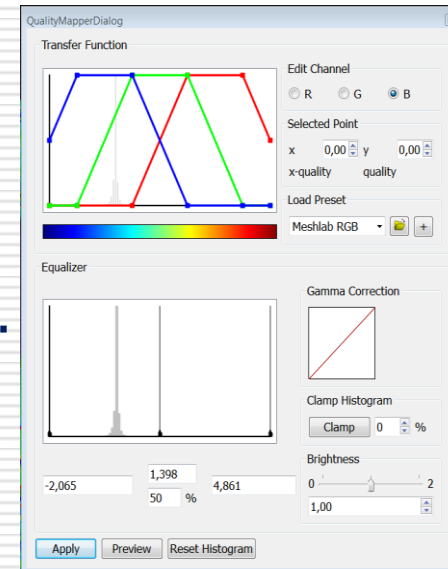
# Quality mapper

- [ ] Mapping the quality is a very useful way to enhance the important features of a mesh
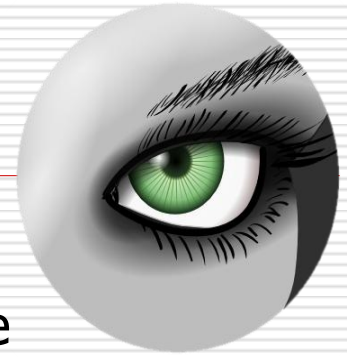- [ ] The Quality Mapper tool is very flexible and extremely valuable

- [ ] 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:

- Examples of 3D Scanning

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