Grafica 3D per i beni culturali: MeshLab features

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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](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](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!
Smoothing

Smoothing operation helps in removing geometry noise.

It can be done in two ways:

- Using a filter: i.e. Filters->Smoothing, Fairing and Deformation-> Laplacian smooth (it can be applied only on selection)

- Using a painting approach, with the paint edit mode, and using the smoothing functionality
Aligning the model
Manipulator tool

- A good alignment of the model w.r.t. the reference system may be crucial for a lot of uses.
- A lot of filters (under the “Trasform” group) enable to manipulate the model
- The Manipulator tool offers a flexible alternative. Tutorial: https://www.youtube.com/watch?v=FGaNv23Xvtw
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..
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.
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...
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
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](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.
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:

- RTI Imaging

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