3D GEOMETRIC MODELING & PROCESSING

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Obiettivi

- Foundations for treating 3D surfaces and shapes in mathematics and computer science
  - Discrete Representations for Surfaces
  - Data Structures for Simplicial Complexes and spatial Indexing
  - Differential Geometry and Topology for Comp. Graphics
  - Mesh Processing Algorithms
    - Remeshing, Refinement & Simplification
    - Parametrization and Texturing
    - Fairing and Smoothing
    - Surface reconstruction and Sampling
    - Shape Analysis and Representations for Machine Learning

Dove servono queste cose?

Dovunque serva una rappresentazione 3D

- Computer Graphics (ovvio)
- Data Visualization
- Machine Learning and AI
  - Come rappresento l'informazione su un manifold?

Requisiti

- Conoscenza minima delle basi della grafica
  - Rendering?
  - RayTracing vs Rasterization?
  - Texture Mapping?
  - Lighting Models?

Requisiti

- Geometria, algebra lineare e un minimo di analisi
- Conoscenza del C++
  - Buona. Se non la avete iniziate subito.
- Conoscenza python
  - Media. Basta che sia migliore della mia :)
- Git as usual

Esame

- Costituito da una parte teorica ed una progettuale.
- La parte teorica riguarda gli argomenti teorici non coperti dal progetto e' sostenuta con un orale al momento della consegna della parte progettuale.
- La parte progettuale vale 20/30, mentre la parte teorica vale 10/30.

Voto finale = progetto +orale

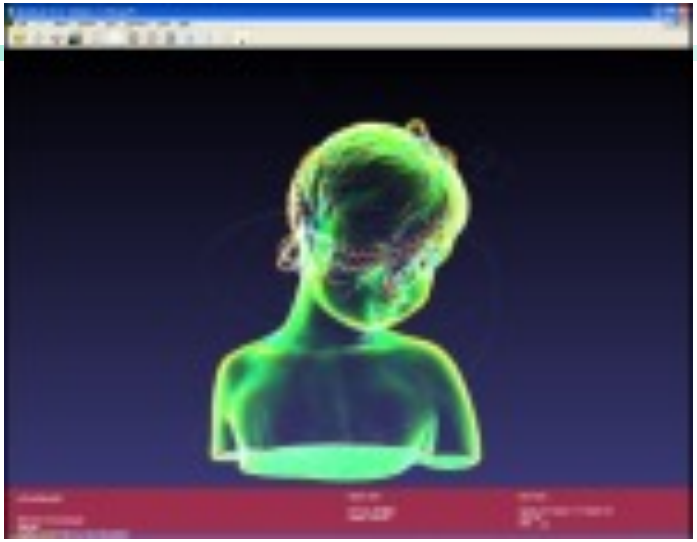
MeshLab

- Generic mesh processing tool
- Open source GPL available for win and linux
  - The system relies on a vcglib large GPL library for mesh processing
- Aimed to the (almost) automatic processing of large unstructured 3d models
  - acquired 3D models are different from human built models
    - No structure, no particular need of a scene graph
    - Large datasets : millions of primitives

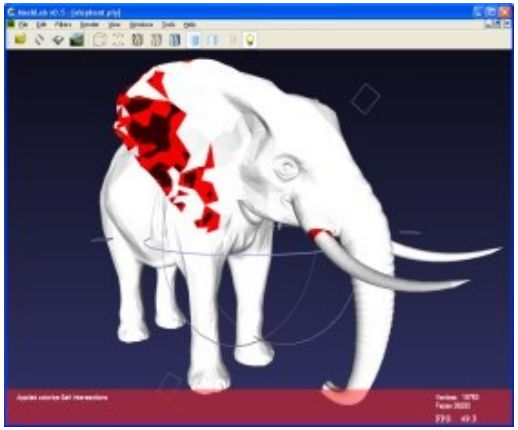
MeshLab

- Audience
  - 3D scanning (mesh cleaning, etc)
  - Entertainement industry (mesh reduction, checking, conversion)
  - Simulation (checking, visualization)
  - 3D printing
  - Research Labs (it is a swiss knife)

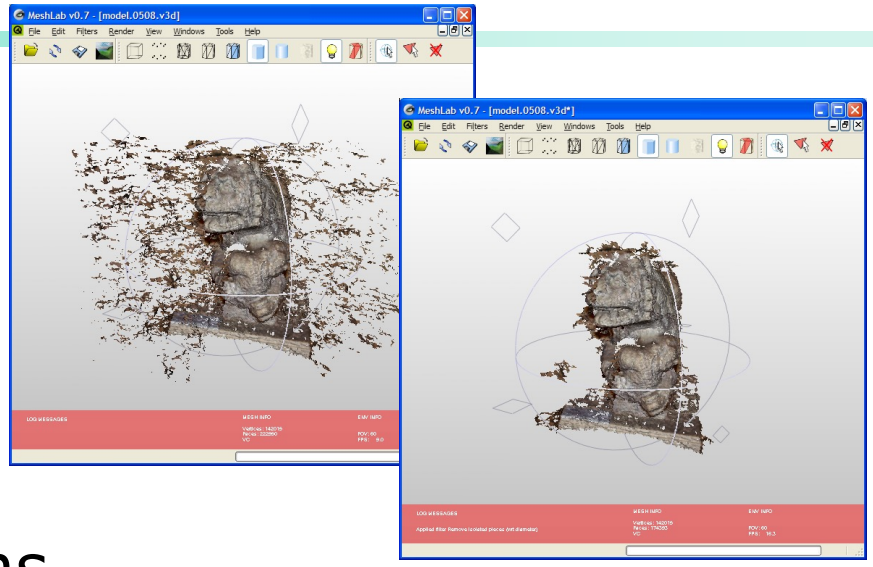
Checking



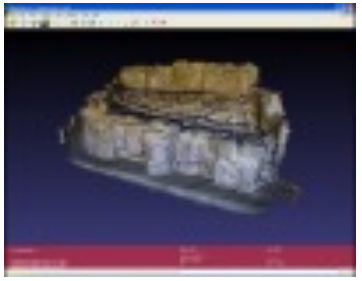
- Visual inspection
  - See through filters (shaders)
- Quality evaluation
  - Curvatures, distances
- Automatic marking of mesh inconsistencies
  - topological: non manifoldness)
  - Geometric: self intersection
  - Small connected components removal



MeshLab tasks

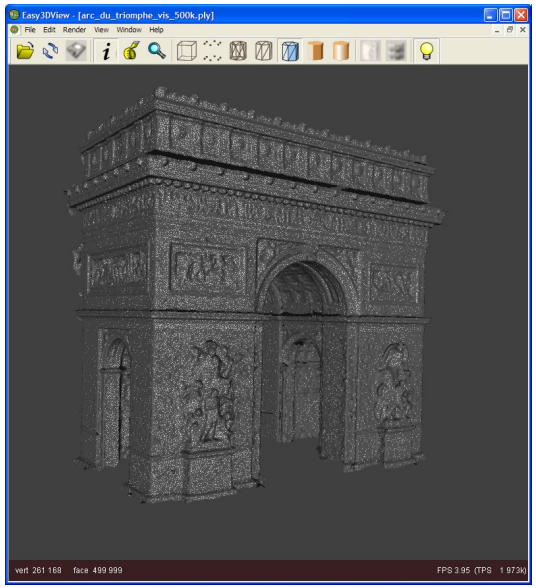


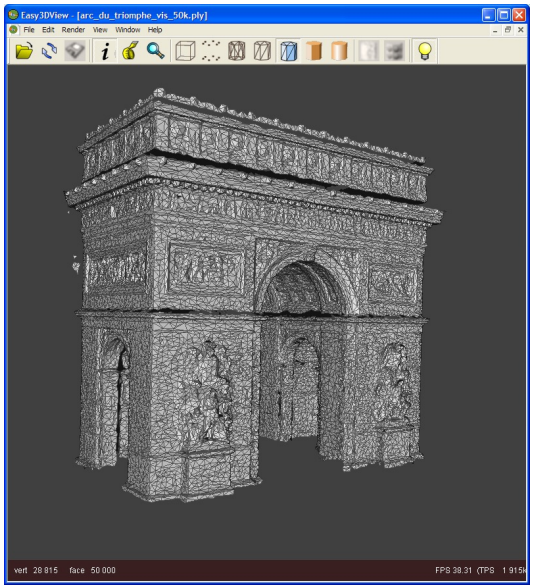
- Filtering
  - Removal of outliers according to various heuristics
- Smoothing out noise
  - Various fairing algorithms
- Editing
  - Selection of parts and removal of non interesting portions of the acquired data

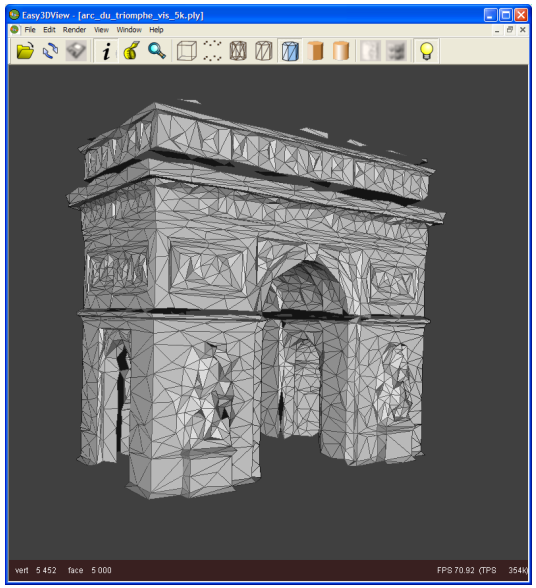


Remeshing

- Subdivision Surface (loop and butterfly)
- Reducing complexity through simplification
  - Both fast approximate and slower high quality algorithms
  - 500k 50k 5k







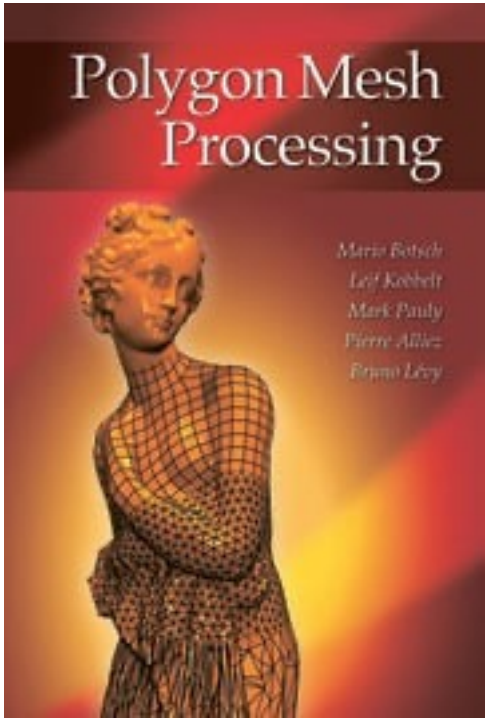
MeshLab Architecture

- Basic plugins are the filters
  - Algorithms that take some meshes in input, some user parameters and create/modify meshes.
  - Automatic dialog creation
    - Developer of filters simply declare the parameters and the gui for asking them is automatically created.
- More than two hundred filters
- pymeshlab
    - python version of meshlab that exploits the same filtering plugins for exposing scriptable functions

MeshLab numbers

- 2M download in the last 3y
- 30k monthly downloads
- Used in hundred of university all over the world
- Many companies using it
  - Game, simulation, aerospatial, 3d scanning, FX industries, military, medical,

Riferimenti Biblio



- Polygon Mesh Processing

  Mario Botsch, Leif Kobbelt, Mark Pauly, Pierre Alliez, Bruno Levy

  A K Peters/CRC Press