User Guide

MESH SMOOTHING TOOL

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General Information

System Overview

3D shapes and surfaces obtained from real world data usually present undesired noise. This kind of problems are treated using smoothing techniques whose key aspects are denoising and fairing. Denoising is related to high-frequency noise removal, and fairing is related to obtain the smoothest version of the input regarding an energy function. This smoothing step is very important in a typical geometry processing pipeline.

Surfaces are commonly represented as triangular meshes due to its simplicity and easy processing. The smoothing task over meshes is called mesh smoothing, and is related to the modification of the geometric properties of the mesh (e.g. vertex positions). There are some important considerations in mesh smoothing algorithms such as detail-preserving, low normal variation, volume preservation, etc. Depending on the application these features determine robustness.

For example, in the case of medical data, several techniques are used to obtain a volume which represents the anatomy of the patient (e.g. X-ray radiography, medical ultrasound, Magnetic Resonance Imaging (MRI), etc.). Using a subset of this volume, a surface model can be reconstructed to represent the target region. Each step of the reconstruction process can introduce noise to the final surface.

To remove this kind of noise, we developed *Mesh Smoothing Tool*. Our tool allows the user to smooth meshes following a global or a focalized scheme. The software consists of a single interface for execution of mesh smoothing algorithms and visualization of the noisy and denoised meshes. The user can manipulate these algorithms without knowledge of the parameters and corresponding behavior. We developed a friendly interface with an intuitive interaction.

The visualization shows rendered images in real time including interaction for navigation in the 3D space while smoothing is performed.

Mesh Smoothing Tool only processes triangular meshes in any of the supported mesh formats of OpenMesh library. We do not support the processing of huge meshes (more than 10 million vertices), in this case the mesh should be previously partitioned and each partition should be processed individually. The computer minimum requirements are: 2GB Ram and a modern graphics processing unit (later than 2010).

Getting started

User should have installed QT5and OpenMesh. Installers are available in:

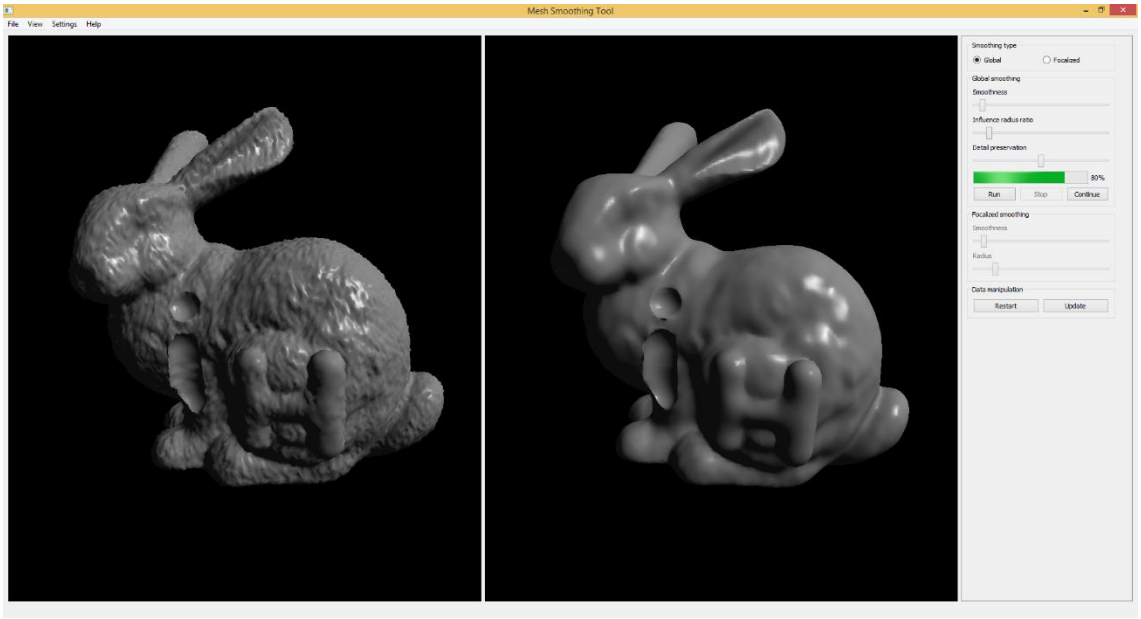
- https://www.qt.io/
- http://www.openmesh.org/

After that, user should only copy the content of bin folder.

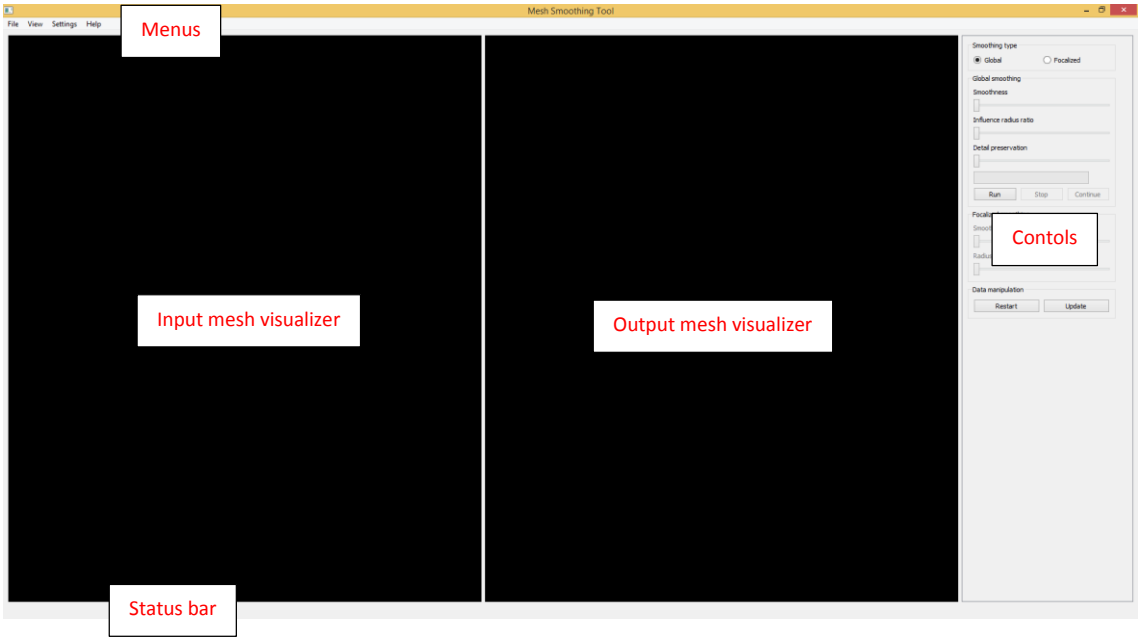
Using the software

Main Interface

In this picture we can see a typical state of the interface:



Each section is described as follows:



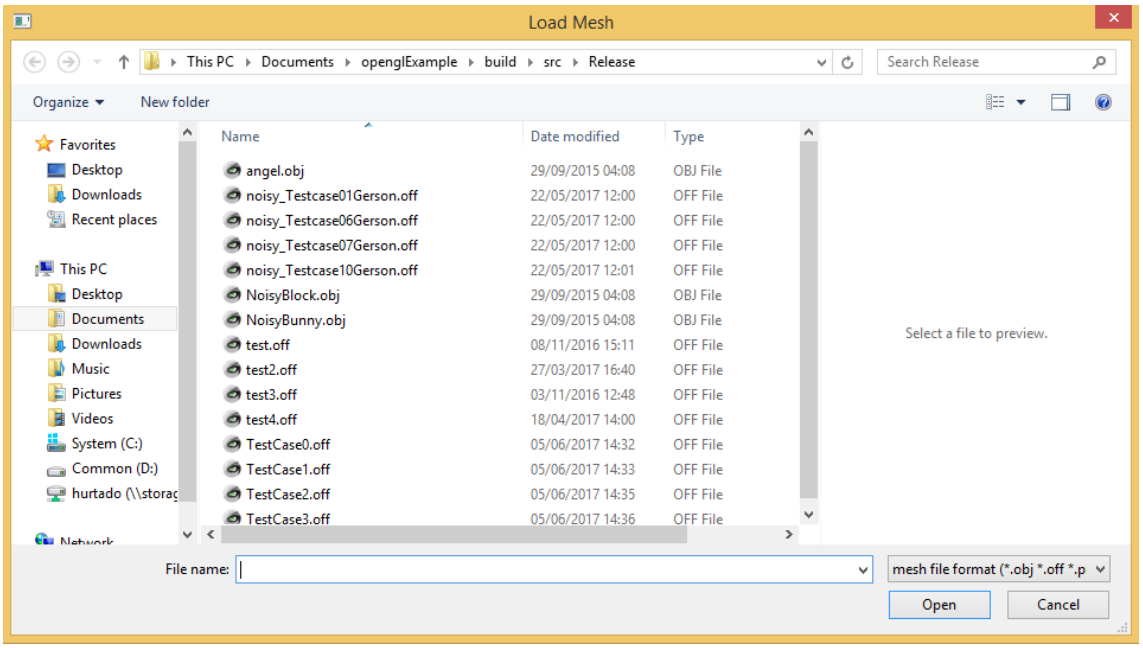
Menu structure

The menus are structured as follows:

- File
    - Load
    - Save
    - Exit
- View
    - Shaded
    - Wireframe
    - Points
- Settings
    - Set shaders
    - Set global smoothing algorithm
    - Set focalized smoothing algorithm
- Help
    - About
    - User Guide

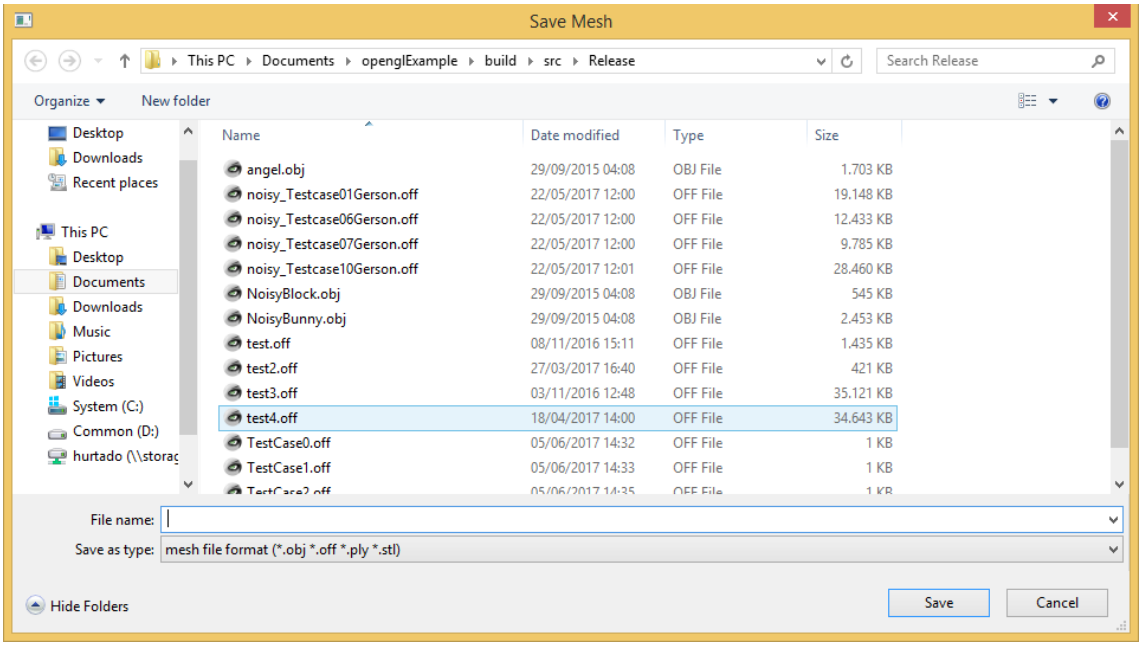
Load mesh

To load a mesh just click on File -> Load and a file dialog interface will appear to allow the user to select the target mesh. Mesh formats allowed for this task are obj, off, ply and stl. We show the Load Mesh dialog here:



Save mesh

To save a resulting mesh just click on File -> Save and a file dialog interface will appear to allow the user to select where and what name he want. Mesh formats allowed for this task are obj, off, ply and stl. We show the Save Mesh dialog here:

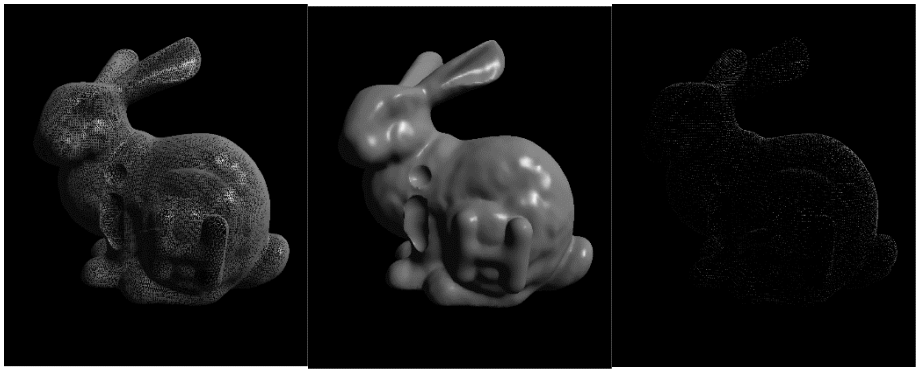


Exit

To close the program just click on File -> Exit or on the X button.

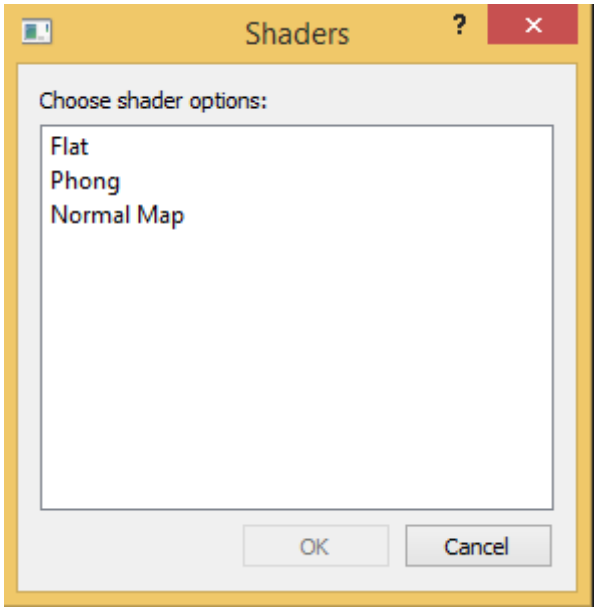
Visualization mode

It is possible to change visualization mode. The modes supported in this software are: Shaded (draw the surface), Wireframe (draw mesh edges) and Points (draw mesh vertices). An example of these modes is shown below:



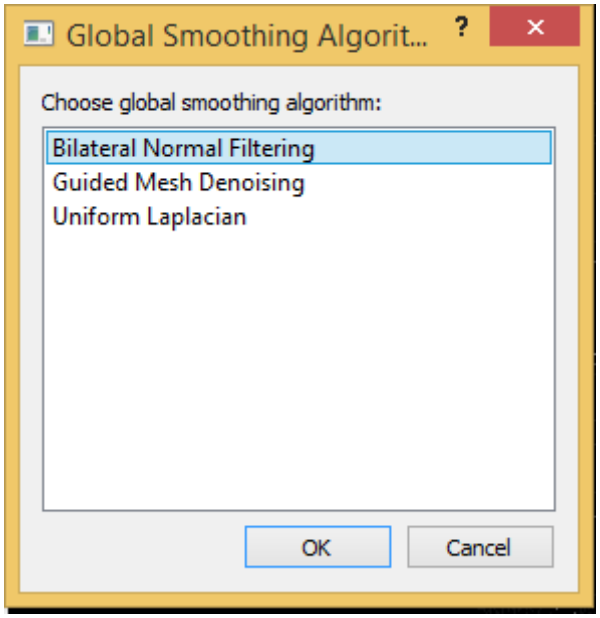
Set shaders

In this software we provide the user three shader programs which can be useful for smoothness analysis. These shaders are: phong based shader, flat rendering shader and normal field shader. The user can set which one to use just clicking on Settings -> Set shaders and then selecting one. The corresponding dialog is shown below:



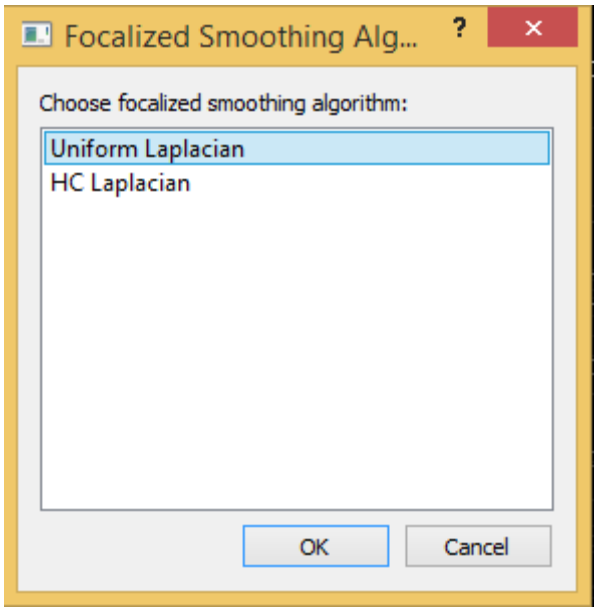
Set global smoothing algorithm

The user can select the global smoothing algorithm just clicking on Settings -> Set focalized smoothing algorithm and then selecting one. The available algorithms are Bilateral Normal Filtering, Guided Mesh Denoising and Uniform Laplacian. Each algorithm has a different behavior. The corresponding dialog is shown below:



Set focalized smoothing algorithm

The user can select the focalized smoothing algorithm just clicking on Settings -> Set focalized smoothing algorithm and then selecting one. The available algorithms are Uniform Laplacian and HC Laplacian. Each algorithm has a different behavior. The corresponding dialog is shown below:



Help

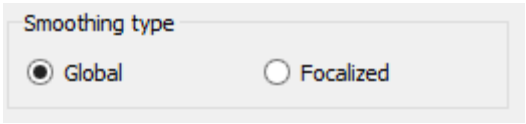
The user has access to a simple About dialog and a link to this guide.

Visualizer navigation

The visualizer allows the user to navigate in the 3D space of the mesh (both visualizers: input mesh visualizer and output mesh visualizer). To move the camera forward or backward just use the mouse scroll wheel. To move the camera left, right, up or/and down just press the right click and drag the mouse in the opposite of the corresponding direction. To rotate the object just press the left click and drag the mouse, the object will be rotated according to the mouse movement.

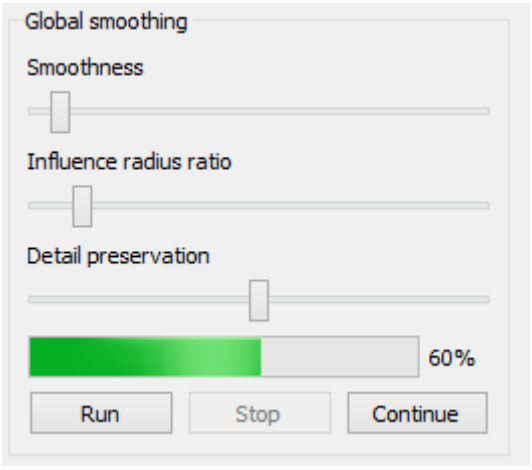
Smoothing type

The user can select which type of smoothing he wants: global or focalized. Just clicking in the corresponding radio button included in the control section:



Global smoothing control

The control of global smoothing looks like:



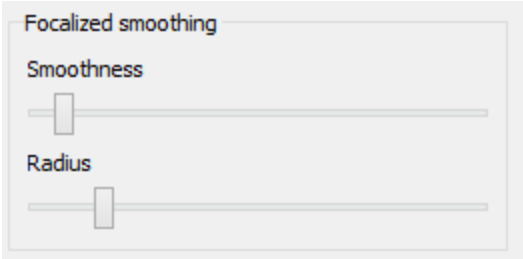
It has a slider to control the smoothness of the output mesh. Left: lower smoothness. Right: higher smoothness. Another slider controls the influence area for each vertex in the corresponding algorithm. Left: lower radius. Right: higher radius. Detail preservation depends on the desired mesh features. If it has sharp features (e.g. a cube) we recommend to increase (right) this value. For smoother meshes we recommend to decrease (left) this value.

This control also has a progress bar to see the progress of the execution of the algorithm. The button Run starts the algorithm execution from the initial state. It is possible to stop (pause) the algorithm pressing the Stop button. If the algorithm was stopped it is possible to continue running it pressing the Continue button, or restart the execution pressing Run button. It is important to say

that the execution will not interfere in the visualization. The user can visualize and navigate in the visualizers while the algorithm is running. Partial results will be updated and shown in the visualizer.

Focalized smoothing control and action

The control of focalized smoothing looks like:



It has two sliders, one to control the smoothness (same as global smoothing) and the other to control the target area (the area to be smoothed).

If you want to see which is the target area just press Shift and move the mouse cursor over the mesh. Target vertices will be colored (red). An example is shown here:

To smooth the corresponding area, just press left mouse button while pressing Shift. This interaction only happens in the output visualizer.

Reinitialize/Update data

To reinitialize the output regarding the input mesh, just press in the Restart button. To update the input mesh with a partial result, just press Update button. This section is shown below: