VESPA: VTK Enhanced with Surface Processing Algorithms

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ParaView

- Leading open-source software developed and maintained by Kitware for scientific visualization
- Applies to any scientific domain: chemistry, computational physics, medical imaging, etc.
- Provides a great variety of post processing filters for data analysis and visualization
- Can be extended through plugins
- Based on the Visualization ToolKit library: VTK

CGAL

- The Computational Geometry Algorithms Library
- Robust open-source library maintained mainly by GeometryFactory, for reliable geometric processing
- Supports a wide range of input meshes thanks to the Boost Graph Library [1] and generic programming
- Offers efficient algorithms for:
  - mesh generation, reconstruction and deformation
  - boolean operations
  - mesh classification
- Distributed under dual-licensing: GPLv3 / Commercial

Benefits for users:
- As a ParaView plugin, VESPA can:
  - Interact with a complete data processing system
  - Use an advanced picking and selection mechanism
  - Display and update results in a controllable 2D / 3D renderer
  - Access all ParaView filters, readers, writers, exporters, ...

Benefits for developers:
- As a VTK module, VESPA can:
  - Take the output of VTK readers and filters (as long as the type is compatible)
  - Display its output in a VTK rendering pipeline
  - Be integrated into applications
  - Easy to extend with new CGAL algorithms

Use Case: Unmolding

Concept:
We need to create a shape that englobes our model and can slide along an axis.

Motivations:
Medical prosthesis, dental impression, mold casting (die, metal)

1. Fill tunnels and cavities. The removed parts are visible through the surface in color.
2. Linear extrusion along the casting axis, and remeshing with alpha wrapping. In this example, we consider an unmolding along the red axis.
3. Use a boolean operation to "invert" the mesh. This results in a casting die of the initial shape. The sharp edges of the original mesh are highlighted.
4. Pipeline Details
   - The initial shape here is a made up example of a mechanical piece, represented as a 2-manifold triangulation. On each step, the sharp edges of this piece are shown in orange.
   - Using the vtkCGALPatchFilling filter, we can select areas on the surface that will be remeshed. By selecting tunnels (as shown in color), the filling step then shrinks each boundary while respecting a continuity mode driving the new shape.
   - In order to permit the mold to slide along the vertical axis, we extrude each triangle linearly along the z-axis and remesh using the vtkCGALAlphaWrapping filter. This also adds a small offset for unmolding and smoothes obtuse edges.
   - Thanks to vtkCGALBooleanOperation, we can create a negative of the mesh, corresponding to the final casting die. In practice, we may want to try several unmolding axis angles, to reduce the volume of material for example. This can easily be done with the available VESPA filters.

CGAL in ParaView: VESPA