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Feature Preserving Mesh Simplification

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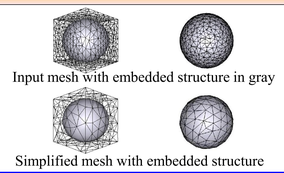
Mesh Simplification: Motivation & Goals



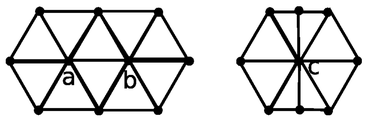
- Simplify high resolution meshes for faster computations
- Preserve important features while simplifying
- Topology preservation of embedded structure
- Tumour preservation for diffuse optical tomography (DOT)

Adaptive simplification preserving region of interest containing breast tumour

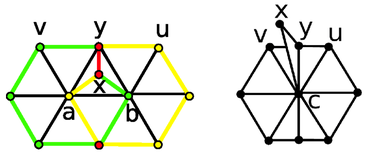
Key Ideas

- Quadric error metric preserves scalar field and quality of mesh
- Theoretical guarantee of topology preservation for embedded structures
- Adaptive simplification based on sensitivity of DOT
- Faster image reconstruction for tumour identification

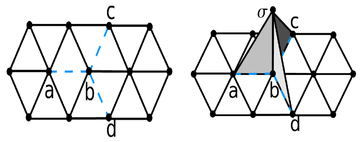
Topology Preserving Simplification of Embedded Structures



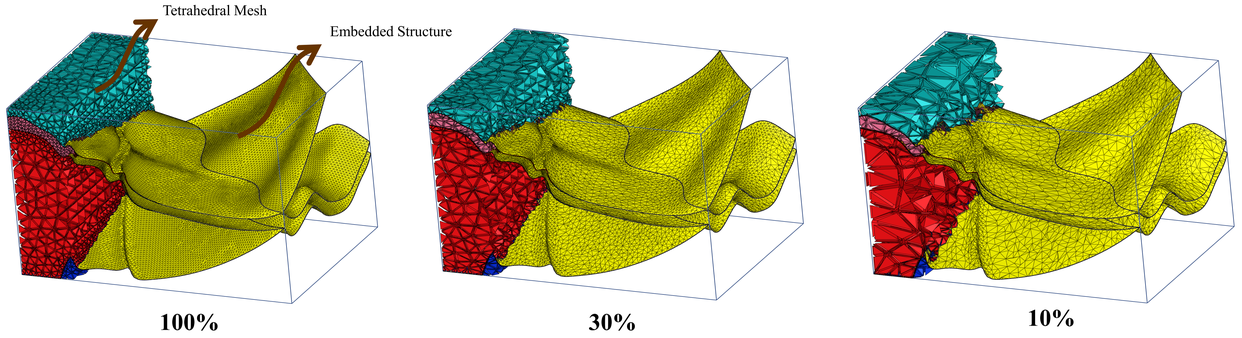
- Simplification done using repeated edge contraction
- Edges are selected based on quadric error metric
- Results in good quality mesh that preserves shape and scalar field



- Contracting *ab* violates topology since *yc* is incident on 3 triangles
- Link conditions check if *Link(a)* ∩ *Link(b)* is equal to *Link(ab)*
- Link condition is violated due to red vertices and edge

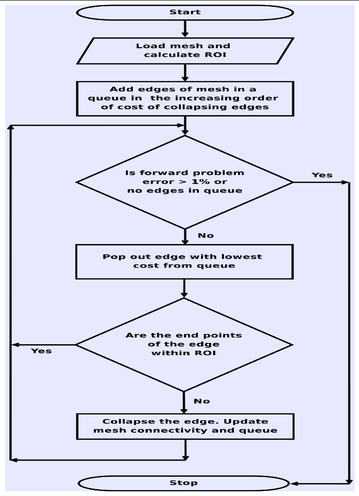


- Embedded structures are handled by extending the mesh
- Cones are added from a dummy vertex, σ to embedded structures
- Link conditions are evaluated on the extended mesh

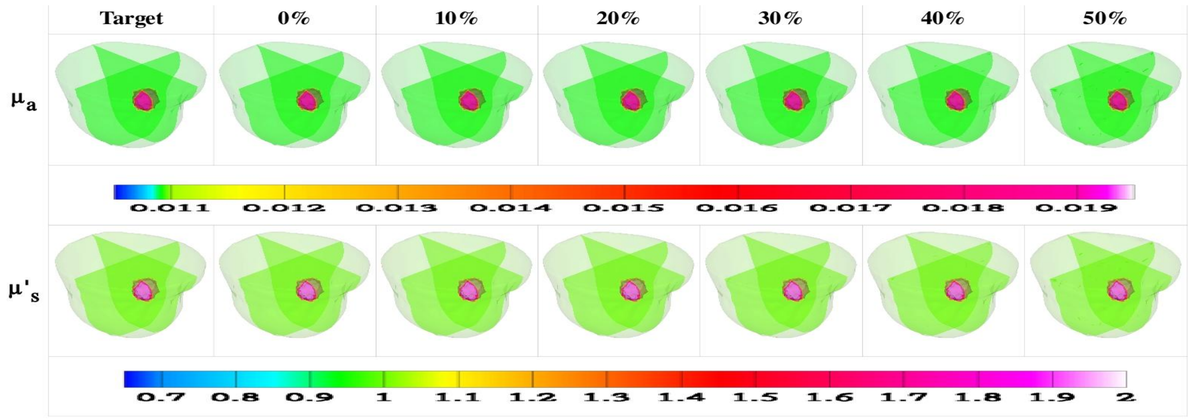


- Cut-away view of a tetrahedral mesh modelling different soil types before and after simplification
- The topology of regions with different soil types is important for earthquake prediction, oil exploration, and mining
- Yellow region show the boundary between different soil types and is treated as an embedded structure
- Topology of the mesh and the embedded structure is preserved during simplification
- Simplified mesh contains good quality tetrahedra and preserve boundary between different soil types

Adaptive Simplification for Faster DOT Reconstruction



- Volume rendered images of a breast containing tumour
- Mesh representing breast is computed from an MRI scan
- Finite element analysis using DOT measurement computes optical properties of tissues and identifies tumour
- Mesh is adaptively simplified by preserving spatial region that has low sensitivity to DOT
- Optical properties computed on simplified and target mesh are very similar
- Simplification of mesh to 50% results in around 3 times speed up in computation time while incurring only 3% error



Publications:

Dilip Mathew Thomas, Vijay Natarajan, and Georges-Pierre Bonneau, **Link conditions for simplifying meshes with embedded structures,** *IEEE Transactions on Visualization and Computer Graphics*, 2011, to appear. http://doi.ieeecomputersociety.org/10.1109/TVCG.2010.90

Dilip Mathew Thomas, Phaneendra Yalavarthy and Vijay Natarajan, **Adaptive Mesh Simplification for Faster Diffuse Optical Tomography Image Reconstruction,** *Manuscript under preparation.*

For more details, visit: http://vgl.serc.iisc.ernet.in/projects/project.php?pid=002

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