TOPOLOGICAL ACTIVE VOLUMES FOR 3D IMAGE SEGMENTATION

UNIVERSIDADE DA CORUÑA

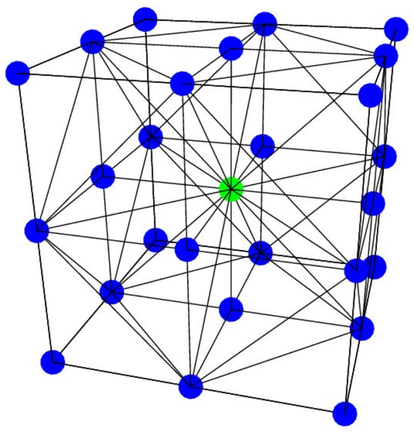
N. Barreira - University of A Coruña (Spain)
nbarreira@udc.es

Abstract

The Topological Active Volumes (TAV) model is a 3D active model focused on segmentation and reconstruction tasks [1]. The segmentation process is based on the adjustment of a 3D mesh formed by polyhedra. The deformation process is guided by energy functions based on low-level information. The model undergoes changes in its structure to improve the surface adjustment or to detect several objects in the scene.

Model

Mesh definition



External Nodes
Surface adjustment

Internal Nodes
Internal object features

Energy functions

Internal energy controls the shape, structure and contraction

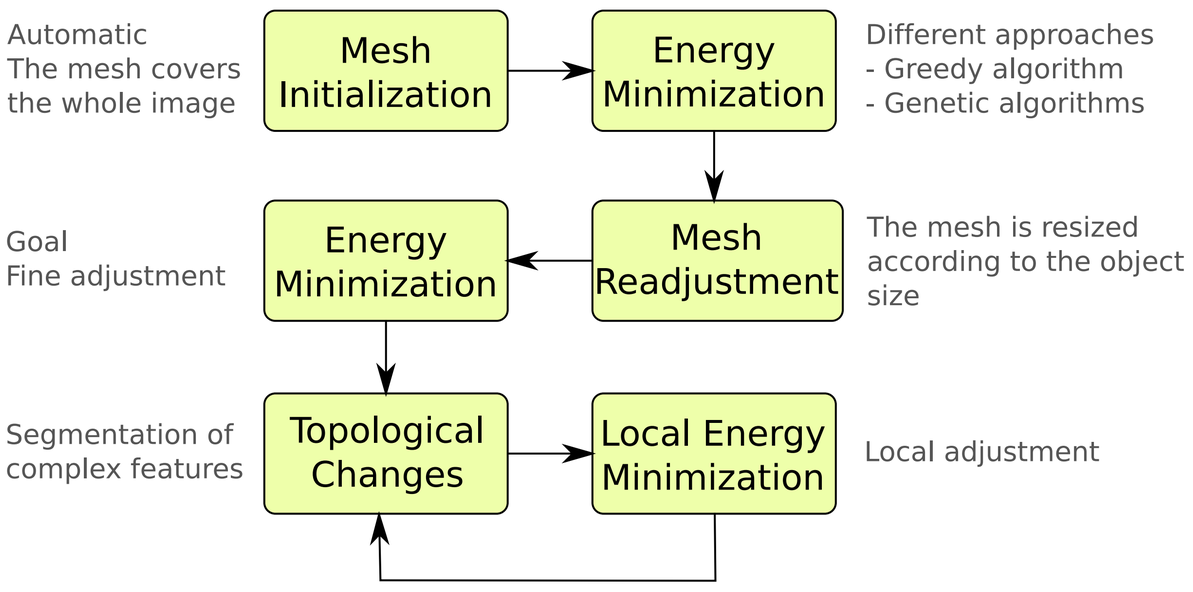
$$E_{int}(v) = \alpha(|v_r|^2 + |v_s|^2 + |v_t|^2) + \beta(|v_{rr}|^2 + |v_{ss}|^2 + |v_{tt}|^2) + 2\gamma(|v_{rs}|^2 + |v_{rt}|^2 + |v_{st}|^2)$$

External energy represents the features of the scene that guide the adjustment process

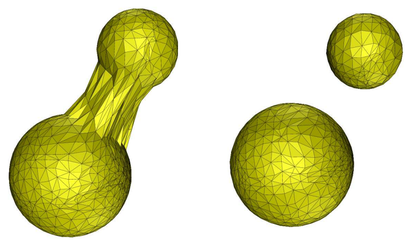
$$E_{ext}(v) = \omega f[I(v)] + \frac{\rho}{|\aleph(r,s,t)|} \sum_{p \in \aleph(r,s,t)} \frac{f[I(v(p))]}{\|v(r,s,t) - v(p)\|}$$

$$f[I(v)] = \begin{cases} h[\overline{I(v)_n}] & \text{for internal nodes} \\ h[I_{max} - \overline{I(v)_n} + \xi(G_{max} - G(v))] & \\ +GD(v) & \text{for external nodes} \end{cases}$$

Methodology



Topological Changes

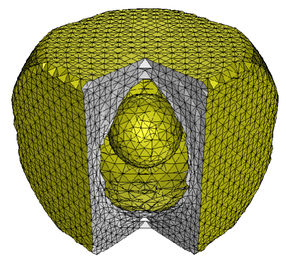


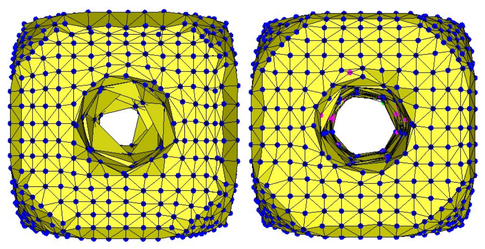
Removal of nodes
External nodes away from surfaces are removed

- Segmentation of several objects
- Hole location

Transformation of nodes
Internal nodes in background areas are converted into external nodes

- Internal holes

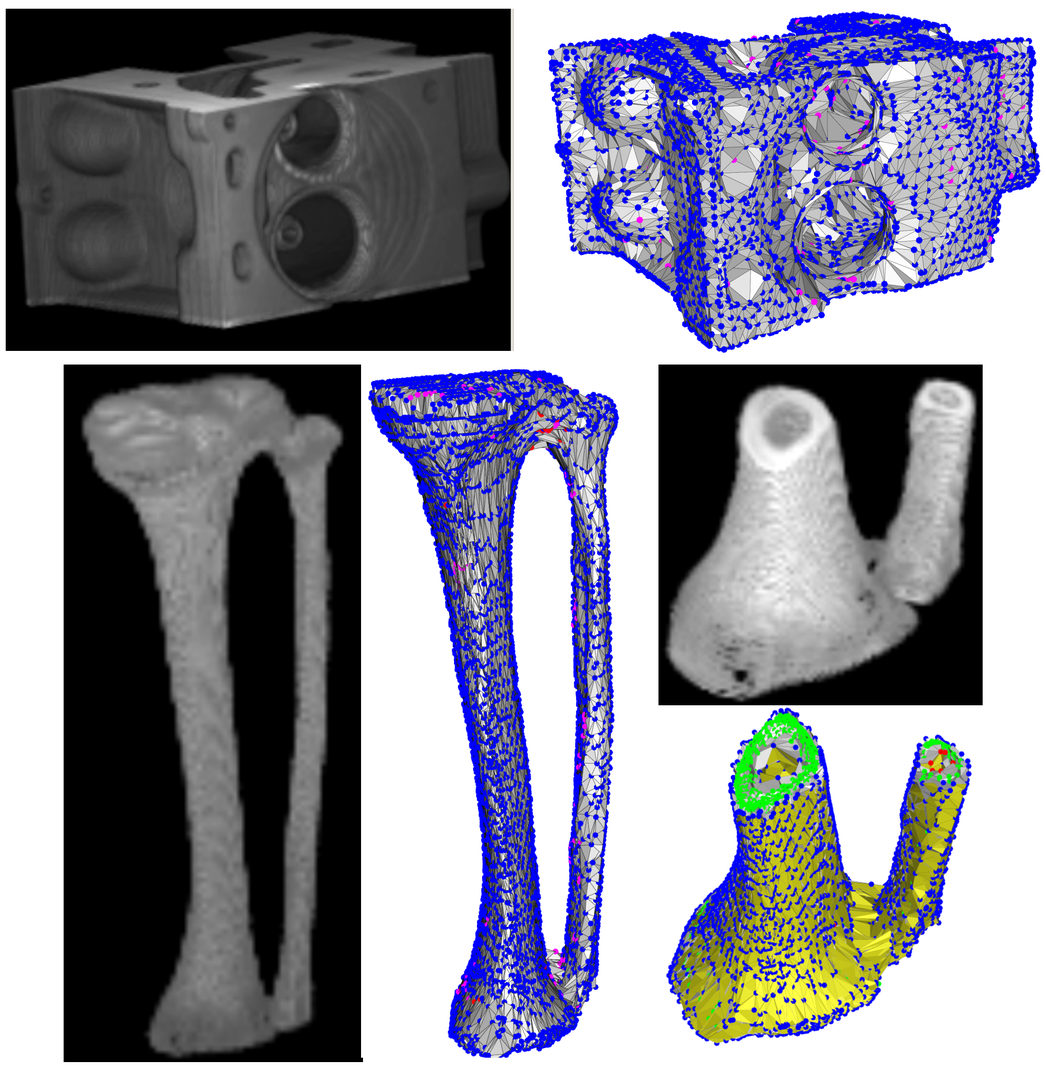




Insertion of nodes
New external nodes are added near high-curvature surfaces obtained by the structure tensor

- Fine surface adjustment

Results



Conclusions

The TAV model allows the adjustment of complex features such as holes or pronounced curvatures as well as the detection of several objects in a scene by means of three kinds of topological changes in its structure.
The model has been tested with both synthetic and CT images where accurate results were obtained.

References

[1] N. Barreira, M. G. Penedo, L. D. Cohen, M. Ortega, *Topological Active Volumes: a Topology-Adaptive Deformable Model for Volume Segmentation*, Pattern Recognition, 43 (1), 255-266, 2010.

[2] O. Ibáñez, N. Barreira, J. Santos, M. G. Penedo, *Genetic Approaches for Topological Active Nets Optimization*, Pattern Recognition, 42, 907-917, 2009.