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Freeform Shape Representations for Efficient Geometry Processing

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Abstract

The most important concepts for the handling and storage of freeform shapes in geometry processing applications are parametric representations and volumetric representations. Both have their specific advantages and drawbacks. While the algebraic complexity of volumetric representations is independent from the shape complexity, the domain of a parametric representation usually has to have the same structure as the surface itself (which sometimes makes it necessary to update the domain when the surface is modified).
On the other hand, the topology of a parametrically defined surface can be controlled explicitly while in a volumetric representation, the surface topology can change accidentally during deformation. A volumetric representation reduces distance queries or inside/outside tests to mere function evaluations but the geodesic neighborhood relation between surface points is difficult to resolve. As a consequence, it seems promising to combine parametric and volumetric representations to effectively exploit both advantages.
In this talk, a number of projects are presented and discussed in which such a combination leads to efficient and numerically stable algorithms for the solution of various geometry processing tasks. Applications include global error control for mesh decimation and smoothing, topology control for level-set surfaces, and shape modeling with unstructured point clouds.