

Geometric Modeling on Different Levels of Abstraction

Leif Kobbelt

Computer Graphics and Multimedia
RWTH Aachen University Germany
kobbelt@cs.rwth-aachen.de
www.graphics.rwth-aachen.de

Abstract. For a number of years, performance and surface smoothness have been the major driving forces in the development of new geometry processing algorithms. Structure and shape analysis have mostly been considered as an independent pre-processing stage in order to partition a given geometric model into meaningful segments. This segmentation was then used to restrict the scope of certain mesh operations such as parametrization for texturing or reverse engineering, deformation, and re-meshing. The recent trend towards a higher and higher complexity of 3D models and the diversification of geometric modeling and processing into a much wider range of application domains (CAD/CAM in Architecture and Engineering, Simulation, Visualization, Games, Animation, Medicine, ...) has revealed the need to introduce higher levels of abstraction into geometric models in order to manage this versatility. At the same time, new (interactive) modeling paradigms are being investigated which facilitate the exploration of shape design spaces through intuitive and sometimes sketch-based user interfaces. Hence, on the one hand an integrated view on model representation and shape control is desirable for the sake of simplicity and efficiency but on the other hand, the diversity of requirements in different application scenarios implies that shape control has to be made independent from the underlying geometry representation. This is achieved by introducing different levels of abstraction for geometric models. In my presentation, I propose a taxonomy which distinguishes (1) the representation layer, (2) the feature layer, (3) the control layer and (4) the constraint layer. I will present, a number of recent projects performed by the Computer Graphics Group at RWTH Aachen University in which we have generated and exploited these levels of abstraction in order to solve specific geometric modeling tasks. This includes examples for model augmentation, i.e. the transformation of raw triangle meshes into meshes whose structure better captures the global features of the underlying geometric shape by proper orientation and alignment of polygonal faces (quad mesh/layout generation). Moreover, I will present shape modeling techniques that abstract from the particular representation and allow for effective and intuitive interactive shape modifications. Through the introduction of (potentially non-linear) constraints, we can further abstract from the underlying implementation of geometric objects and control handles by restricting shape modifications to "plausible" or "admissible" designs.