Geometric Surface Processing via Normal Maps[a]

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Abstract

The generalization of signal and image processing to surfaces entails filtering the normals of the surface, rather than filtering the positions of points on a mesh. Using a variational framework, smooth surfaces minimize the norm of the derivative of the surface normals—i.e. total curvature. Penalty functions on the surface normals are computed using geometry-based shape metrics and minimized using gradient descent. This produces a set of partial differential equations (PDE). In this paper, we introduce a novel framework for implementing geometric processing tools for surfaces using a two step algorithm: (i) operating on the normal map of a surface, and (ii) manipulating the surface to fit the processed normals. The computational approach uses level set surface models; therefore, the processing does not depend on any underlying parameterization. Iterating this two-step process, we can implement geometric fourth-order flows efficiently by solving a set of coupled second-order PDEs. This paper will demonstrate that the framework provides for a wide range of surface processing operations, including edge-preserving smoothing and high-boost filtering. Furthermore, the generality of the implementation makes it appropriate for very complex surface models, e.g. those constructed directly from measured data.