Surface Modelling Based on Subdivision Surfaces and Geometric Partial Differential Equations

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For obtaining better curvature distributions of subdivision surfaces, various improvements for Loop's subdivision scheme on triangular surface meshes have been made. A careful analysis shows that the fast evaluation technique of the subdivision surface proposed by Stam is no longer usable to these improved schemes. This paper describes a fast and efficient evaluating algorithm for improved Loop's subdivision surfaces. The algorithm is applicable to a vast class of subdivision schemes for triangular surface meshes. Using the proposed algorithm, one can evaluate the subdivision surface at any domain point for any set of input subdivision masks and a control mesh.

Use two fourth order geometric partial differential equations to efficiently solve several surface processing problems, including surface blending, N-sided hole filling and complex free-form surface fitting. The nonlinear equations used include surface diffusion flow and willmore flow. These nonlinear equations are discretized using the mixed finite element method based on the desirable combination of the Loop's basis and the linear basis. Furthermore, propose a simple and natural stratagem for the treatment of the boundary conditions.

Construct discrete three- and four-sided surface with specified G^0 or G^1 boundary conditions, using several (second order and fourth order) geometric intrinsic curvature driven flows. The flow equations are solved numerically based on discretizations of the involved differential-geometry operators, which are derived from parametric approximations. The constructed surface patches satisfy certain geometric partial differential equations, and therefore have the desirable shape. These patches are assembled together for constructing complicated geometric models for shape design. Multi-resolution representations of the models are achieved using repeatedly subdivision and evolution.

Keywords: Evaluation of the Improved Loop's Subdivision Surfaces, Geometric Partial Differential Equations, Surface Processing, Mixed Finite Element Method, Geometric Modelling, Discrete Surface Patches.