Interpolating Implicit Surfaces From Scattered Surface Data Using Compactly Supported Radial Basis Functions

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Abstract

We describe algebraic methods for creating implicit surfaces using linear combinations of radial basis interpolants to form complex models from scattered surface points. Shapes with arbitrary topology are easily represented without the usual interpolation or aliasing errors arising from discrete sampling. These methods were first applied to implicit surfaces by Savchenko, et al. and later developed independently by Turk and O'Brien as a means of performing shape interpolation. Earlier approaches were limited as a modeling mechanism because of the order of the computational complexity involved. We explore and extend these implicit interpolating methods to make them suitable for systems of large numbers of scattered surface points by using compactly supported radial basis interpolants. The use of compactly supported elements generates a sparse solution space, reducing the computational complexity and making the technique practical for large models. The local nature of compactly supported radial basis functions permits the use of computational techniques and data structures such as k-d trees for spatial subdivision, promoting fast solvers and methods to divide and conquer many of the subproblems associated with these methods. Moreover, the representation of complex models permits the exploration of diverse surface geometry. This reduction in computational complexity enables the application of these methods to the study of shape properties of large complex shapes.