Computational Geometry for Interrogative Visualization

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Abstract

In several scientific applications a physical quantity is measured (or computed, in the case of a simulation) at a large number of points in space (*volumetric data*). From these spatial measurements, one would like to *reconstruct* a suitable model of the physical quantity in a three-dimensional region containing the points, based on some assumptions of its geometric and physical properties. In other cases the data values might be associated with points on the surface of an object (*manifold data*), rather than throughout space. For example, in an experiment the air pressure or velocity at several points on the surface of an airplane wing might be measured.

In this talk, I shall describe parallel computational geometry techniques that we are developing to approximately model *large* sets of volumetric scalar, vector and tensor data with piecewise algebraic splines (A-splines) of low degree, defined on spatial structured and unstructured grids. The parallel environment consists of an ATM cluster of workstations as well as the Intel Paragon and IBM-SP2 machines. I shall also show how to reduce the manifold data reconstruction problem to volumetric data modeling, by defining suitable trivariate functions associated with the set of manifold data points. This then allows one to reconstruct A-splines approximation of both the manifold geometry as well as the associated physics defined on the manifold surface (*functions-on-surface*).

A primary goal of this adaptive modeling is a compact data structure of the field data to support interrogative visualization. Interrogative visualization refers to the process of interactive display and accurate quantitative querying of data for metric, combinatorial and topological information. To support

quantitative querying, we additionally build search structures over the fields via a preprocessing step. Isocontours and topology of the field data are quickly realized by fast range search techniques.

This is joint work with members of the labs of Aeronautics, Earth & Atmospheric Sciences, Paralysis Research Center, and Computer Sciences of Purdue University.