

ABSTRACT

Mesh quality for unstructured finite element meshes is defined. In this research, the mesh quality metric used is *a posteriori* error indicators.

The problem of interactive analysis of mesh quality for three-dimensional unstructured tetrahedral meshes is described. One goal of this work is to provide mesh quality information within a geometrical representation of the mesh. Problems encountered when attempting to visualize the geometric and error information for a visually complex mesh are identified. The difficulty of searching a complex unstructured mesh at the tetrahedron level is asserted. The need for information management to control the complexity of the information presented to the user is also asserted.

A design for an interactive software/hardware system for mesh quality analysis within a geometrical representation of the mesh is presented. The design provides information about the quality of individual tetrahedra in such a way that the user can compare tetrahedral quality across the mesh. Haptic and visual displays for the interaction are described. The haptic display provides information about the scalar error indicator values as surface texturing applied within the volume of the tetrahedron. The visual display provides two separate views of the mesh, one which serves as a coarse-grain road map to the locations of the “bad” tetrahedra, and the other which provides fine-grain geometric and nongeometric information specific to the mesh quality metric. Other details for the interaction design are given and shown to be appropriate.

A prototype of the design was implemented for a desktop-based user workstation. Results from using the system with the sample mesh are shown and described. No formal user study of the system was undertaken. However, qualitative evaluations are presented

from the interface's performance when used over the course of several sessions by one mesh quality expert. Graphical output from the user interface is presented as evidence that the interface provides the user with necessary information in a form which allows the user to isolate "bad" tetrahedra and analyse the individual contributions of element shape, orientation, geometric neighborhood, and solution behavior. A quantitative study of the system refresh rates demonstrates that, for the 16,000-element mesh used, the interface runs at interactive rates. Qualitative evidence as to the importance and role of individual interface components is also presented.