STRUCTURED AND SEMI-STRUCTURED MESH STORAGE

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Computational simulation codes based on a structured mesh usually take advantage of the mesh structure to minimize storage and manipulation of mesh data. For example, in finite difference and structured finite element applications, element connectivity is inferred from a structured hexahedral mesh. However, although "unstructured" hexahedral meshes typically have a great deal of structured and semi-structured portions, this structure is seldom exploited. Furthermore, the mixing of structured and unstructured mesh in the same model, and the meshing of complex geometry, makes it difficult or impossible to always reduce mesh blocks to 4- or 6-sided structured regions in 2d or 3d, respectively.

We describe a mesh database storage scheme for unstructured hexahedral meshes which takes advantage of structured portions of the mesh. This approach uses transformations similar to those used in geometric modeling to facilitate the mapping of mesh regions to higher dimensions and to allow the sharing of structured interface meshes. Using this transformation scheme minimizes duplication of interface mesh data and simplifies the placement of a given interface mesh in the parameter space of a higher-dimensional entity it bounds.

The implementation of this storage approach in the Sandia Mesh DataBase (MDB)[1] is described. MDB has been integrated into the Sandia CUBIT mesh generation toolkit[2] and the VERDE mesh verification code[3]. We quantify the savings in both memory for storage of the mesh as well as cpu time saved in the manipulation of the mesh. We conclude by discussing extension of these techniques to h-adapted structured mesh and to the storage of semi-structured meshes like those generated using sweeping-type algorithms.

[1] MDB, the Sandia Mesh DataBase Component, http://endo.sandia.gov/cubit/mdb.htm.
[2] T. D. Blacker et al., 'CUBIT mesh generation environment, Vol. 1: User's manual', SAND94-1100, Sandia National Laboratories, Albuquerque, New Mexico, May 1994.
[3] The Verde (Verification of Discrete Elements) tool, http://endo.sandia.gov/cubit/verde_release_2.5b.txt.

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