Modeling, Mesh Generation and Numerical Simulations

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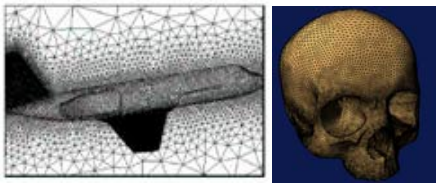
My major research areas are in the application of geometry modeling, numerical simulations techniques to problems in science and engineering. The focus is on the following three core areas: modeling and mesh generation, computational electromagnetics and computational biomedical engineering.

(1) Geometry Modeling and Mesh Generation



Modeling and mesh generation from complicated geometries are essential parts of real-life numerical simulations. My work involves robust and high quality tetrahedral mesh generation based on guaranteed conforming/constrained boundary recovery and the construction of Centroidal Voronoi Tessellation (CVT) [1-2]. Recent work also includes efficient generation of high quality surface grids based on remeshing techniques [4]. Current work focuses on robust three dimensional adaptive meshing for transient problems from computational physics and CFD.

(2) Computational Biomedical Engineering

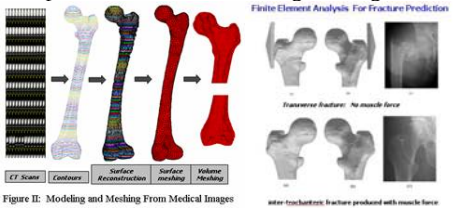
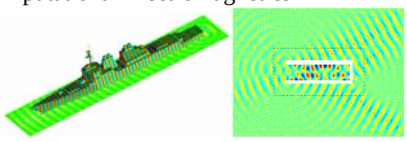


Figure II: Modeling and Meshing From Medical Images

Femur fractures are a very common occurrence in the elderly people. And it would be a significant benefit if the subjects or patients who are at high risk of fracturing their femur could be predicted with an adequate accuracy. We've developed an efficient method for geometry modeling and mesh generation from patient-specific CT scans based on two dimensional Delaunay triangulation [5]. We are now seeking to apply the advanced finite element techniques to develop a reliable and real-time finite element simulation model for clinically oriented femur fracture prediction.

(3) Computational Electromagnetics



Numerical simulation of wave propagation and scattering in electromagnetics is an intensive research area in computational electromagnetics. By generalizing the Yee's scheme (co-volume) to the high quality unstructured triangular Delaunay/Voronoi dual meshes, an efficient low-order algorithm is developed for simulation of wave scattering from complicated geometries [6]. Current work includes the implementation of three dimensional co-volume scheme and the construction of high quality dual tetrahedral meshes.

Recent Publications

1. Tetrahedral mesh generation and optimization based on centroidal Voronoi tesselaltion. Int Journal for Numerical Methods in Engineering Volume 56, Issue 9, 003, Pages: 1355-1373 (with Qiang Du) .
2. Constrained Boundary Recovery for 3D Delaunay Triangulations. Int. J. Num. Method. In. Eng. 2004. 61: 1471-1500. (with Qiang Du).
3. A three-dimensional adaptive method based on the iterative grid redistribution, Journal of Computational Physics, 2004. 199, 423-436. (with Xiaoping Wang)
4. EQSM: An Efficient High Quality Surface Grid Generation Method based on Remeshing, Computer Methods in Applied Mechanics and Engineering, 2006, in press (with O.Hassan, K.Morgan, N.P.Weatherill).
5. Efficient Surface Reconstruction from Contours Based on Two Dimensional Delaunay Triangulation, Int. Journal for Numerical Methods in Engineering. Volume 65, Issue 5, 2006, Pages: 734-751 (with O.Hassan, K.Morgan, N. Weatherill).
6. A Stitching method of unstructured mesh generation for co-volume solution techniques (invited paper for a special edition), Computer Methods in Applied Mechanics and Engineering, Volume 195, Issues 13-16, Pages 1826-1845, (with I.Sazonov, O.Hassan, N.P.Weatherill and K.Morgan).

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