

How to achieve the goal of 5aCAE based on BIE

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Within a successful Computer Aided Engineering (CAE) driven product development, an ideal CAE tool should possess the following five features:

- 1) Automatic meshing and analysis for any complicated structures with complex geometries;
- 2) Accuracy much better than existing FEM tools is achievable;
- 3) Arbitrary geometries and material compositions of structures can be easily handled;
- 4) Accelerated by the fast methods, such as the Fast Multipole Method, the Hierarchical Matrix;
- 5) Adaptive solution procedures to guarantee the reliability of the computational results.

We name this kind of CAE as 5aCAE. In this talk, I will first explain why the BIE has advantages over FEM to achieve the goal of 5aCAE, also considering the currently popular meshless methods and isogeometric analysis, and then briefly introduce some new algorithms we have proposed for software implementation. These algorithms are as follows:

1) A Boundary Face Method (BFM) [1], which combines the BIE with Computer Graphics and is a truly isogeometric analysis method, can perform CAE analysis on a CAD model directly.

2) A Dual Interpolation Method [2], which combines the traditional element interpolation and meshless approximation, unifies the conforming and nonconforming elements that are separately used in traditional BEM implementations.

3) A simplified binary tree meshing method, which realizes entirely automatic meshing for arbitrarily complex structures, even with geometrically ‘dirty’ part of their CAD models.

4) A Spherical Element Subdivision Method [3], by which the singular integrals and nearly singular integrals can be evaluated accurately and efficiently for cases of arbitrary type fundamental solution, arbitrary shape of element and arbitrary location of the source point.

5) An adaptive Fast Multipole Method [4] and a Geometric Mapping Cross Approximation (GMCA) Method.

6) A domain sequence optimization method for multi-domain problems, which can deal with arbitrary inter-domain connections with optimized band of the assembling system matrix.

Finally, I will introduce the software developed using above algorithms and Integrating the BFM into the commercial CAD software UG-NX, making the CAE entirely within the CAD environment. I will also show a number of examples of real complicated industrial products and engineering structures.

References

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