COLLABORATIVE RESEARCH CENTER 837

INTERACTION MODELING IN MECHANIZED TUNNELING

RUB

IMAGE-BASED NUMERICAL PREDICTION FOR EFFECTIVE THERMAL CONDUCTIVITY OF HETERO-GENEOUS MATERIALS: A QUADTREE BASED SCALED BOUNDARY FINITE ELEMENT METHOD

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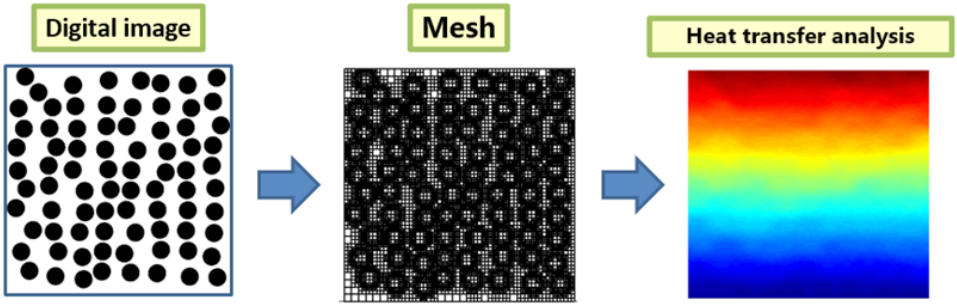

The evaluation of Effective Thermal Conductivity (ETC) for heterogeneous materials is of interest in many heat transfer applications. For example, the ETC is proved to be one of the most important parameters in packed beds, metal foams and sponges, functionally graded materials, granular materials and fibrous porous materials, etc.

In this talk, a new framework that centres about a quadtree based scaled boundary finite element method (SBFEM) is developed for the heat transfer analysis and the estimation of ETC. Two significant advantages of the proposed methods includes:

1. The proposed method can be used to model the geometrical features directly based on images. Each generated quadtree or octree cell can be modelled as a scaled boundary polygonal element or a scaled boundary polyhedral element, respectively, which eliminates the hanging node issue encountered in the FEM and XFEM. Furthermore, as the element solutions for cells of the same pattern but different sizes are proportional, so the efficiency of this approach is high, because the limited cell patterns generated can be precomputed and quickly extracted when required.
2. An inverse analysis is presented to numerically evaluate the ETC. The inclusions are considered to be randomly distributed. The temperatures values at some sample points in the heterogeneous material is calculated as the measured points, and then the ETC is identified in an equivalent material model by solving an inverse problems, in which the sensitivity is calculated and the Gauss-Newton method is used.

Numerical examples are provided to demonstrate the effectiveness of the proposed method, considering the distribution of circular or elliptical inclusions are random, and the influence of the size and shape of inclusions are investigated.

Guests are welcome!