ABSTRACT

Automatic Mesh Generation of CAD Model using VOXEL

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The finite element method is a widely used numerical method for solving problems of engineering and mathematical physics. In general, the time and efforts required for finite element mesh generation reach 60~70 percentage of the entire finite element analysis. To reduce the manual operation, many automatic mesh generation methods have been suggested, but these schemes depend heavily on the geometry of objects, and can generate distorted meshes. If finite elements can be generated directly from a CAD model, the total time spent for the analysis will be reduced and the product development cycle of design and analysis will be shortened.

In this study, automatic mesh generation method of a CAD model using VOXEL is proposed. VOXEL, simply a cube, stands for volume pixel and is used to represent 3D objects in image processing field. If the analysis model is composed of VOXEL, the process for assembling global stiffness matrix becomes much faster than the traditional solid elements since every element has same stiffness matrix. Also the size of finite elements can be easily controlled by specifying the slicing resolution of a CAD model regardless of the geometry of 3D objects.

The proposed automatic mesh generation method consists of four steps as follows.

- CAD model generation: It is assumed that 3D objects are modeled in standard file formats of a CAD model, for example, STL, IGES, etc. so that any commercial CAD software can import.

- Slicing a CAD model into 2D sections: Slicing function of CATIA software is utilized to produce information of point sets of each section of a CAD model.
- Digitization: Four-node square elements corresponding to pixels are generated based on point sets of each section. The geometry algorithm is applied for the IN/OUT check and allocation of the digitization value either 0 or 1.
- Voxelizaion: Eight-node cubic elements corresponding to voxels are generated from digitization information of two neighboring sections. AND Boolean operator is applied to classify the existence of voxel elements.

The proposed method for the automatic mesh generation of a CAD model is implemented with C language and the resulted finite elements are evaluated in FEMAP, pre-post processor. Several examples are included to substantiate the effectiveness of voxel elements and the linear static finite element analysis is performed to compare the result with the finite element model made by the automatic mesh generation function in FEMAP. It turns out that the maximum displacement approaches to the theoretical value as the resolution of discretization decreases while the value of the maximum von Mises stress is sometimes much higher value than that of traditional finite elemetns depending on the geometry.