CAD SHAPE RECOGNITION AND MESH GENERATION TECHNIQUE USING ANSA SCRIPT

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FEM, FEA, Automatic, Mesh Generation, Shape Recognition, CAD cleanup

ABSTRACT –
It is important to use high-quality mesh for simulations since the result may vary depending on the input FEM mesh model. To assure the quality of simulation results, it is common to create FEM mesh models according to specific meshing rules.
In this paper, we described how we automatically generate FEM mesh for CAD models according to meshing rules using ANSA script. The CAD shape recognition algorithm that we used is for both surface-only CAD models and solid models. From the input CAD models, we analyze characteristics of each face and face continuity. The characteristics of face includes size, radius, and shape. For solid CAD models, we also analyze thickness to assure solid mesh quality. FEM mesh generation algorithm works based on this shape recognition database. To satisfy advanced meshing rules, we use shape data such as cross-sectional shape and face combination. We also use the CAD shape recognition data for quality error mesh modification process to maintain the CAD shape representation as much as possible.
Using the technique we described in this paper, we achieved to clean up CAD models and generate high-quality mesh according to meshing rules while maintaining CAD shape representation as much as possible. We applied this technique to an engine CAD model and confirmed that the entire process takes only about 1.5 hours to get the meshing result without quality error.

TECHNICAL PAPER -

1. INTRODUCTION

Using high-quality mesh for simulations is important since the result may vary depending on the input FEM mesh model. To assure the quality of simulation results, it is common to create FEM mesh models according to specific meshing rules. Feature recognition and mesh generating algorithms have been studied. [(1)-(5)] ANSA has various features and functions to recognize CAD surface shapes and generate mesh along with feature recognition parameters and mesh quality parameters. Using ANSA can result in getting FEM mesh models from input CAD models automatically according to the parameters you set in advance. However, it still takes time and effort on manual modification work when you have meshing rules beyond ANSA functions.
This paper describes how we automated manual modification work by CAD shape analysis and mesh generation using ANSA script.

2. SYSTEM CONFIGURATION AND PROCESS FLOW

The system has its own Graphical User Interface (GUI) to get input CAD model path and parameter setting files. With ANSA script and external C++ programs we developed, the system inputs a CAD model, constructs database, recognizes CAD shape, generates mesh, and outputs a FEM mesh model. The system configuration diagram is shown in Figure 1, and the main process flow is shown in Figure 2.

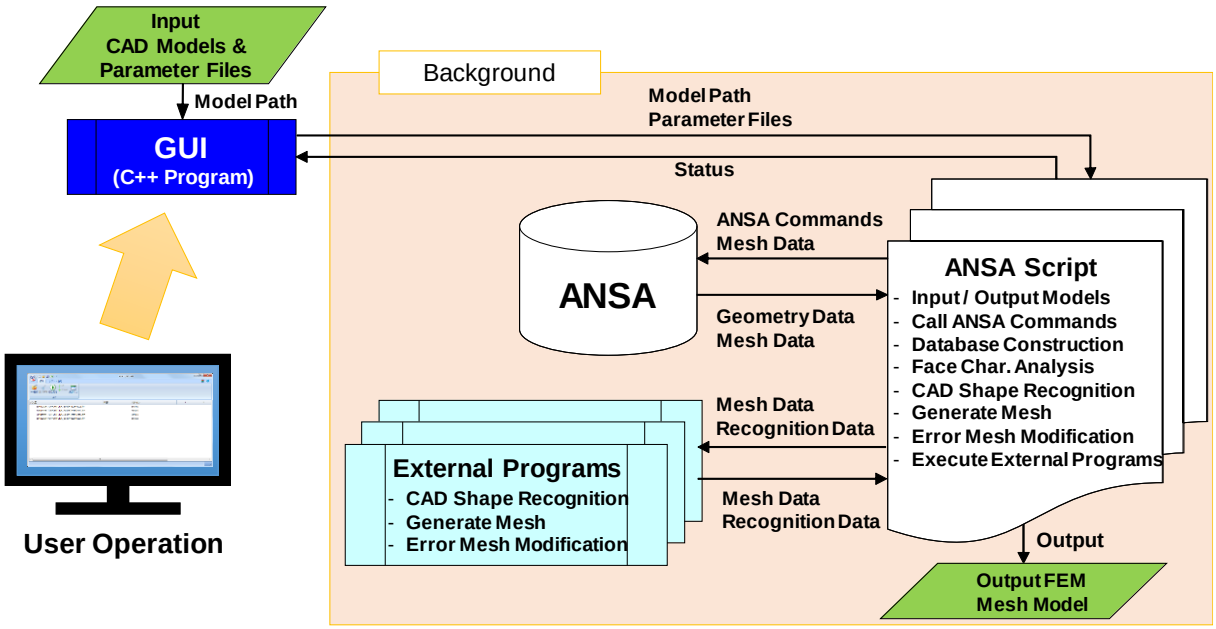

Figure 1 – System configuration diagram

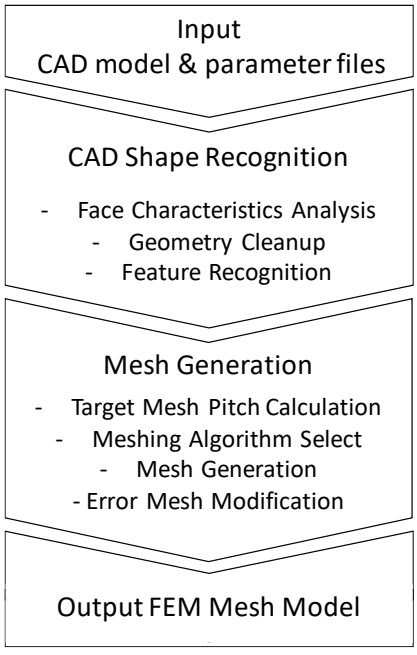

Figure 2 – Main process flow

3. INPUT CAD SHAPE RECOGNITION

To obtain face characteristics and feature recognition data and clean-up the input geometry, the input CAD shape recognition algorithm is developed. The entire procedure of the algorithm is divided into three steps.

Step 1. Analyse each face characteristics.
This step is executed to obtain data for geometry clean-up, feature recognition and mesh generation. For mesh generation, data such as curvature, width of the face is obtained. In addition, the distance to the other faces is obtained for solid models to assure solid mesh quality in the mesh generation procedure.

Step 2. Clean-up CAD Geometry
In this step, the input CAD model geometry is modified based on the data obtained in the step 1. The modification target CAD shapes include small holes, non-abutting lines, and self-intersections.

Step 3. Recognize features.
Finally, the features are recognized in this step. For surface shapes, features such as fillet flows, chamfers, and other specific features that need special treatment are recognized base on the data from the step 1 in addition to combinations of face types and cross-sectional shapes. For assembly models, parts such as bolts, nuts, washers, rivets, and welding parts are recognized.

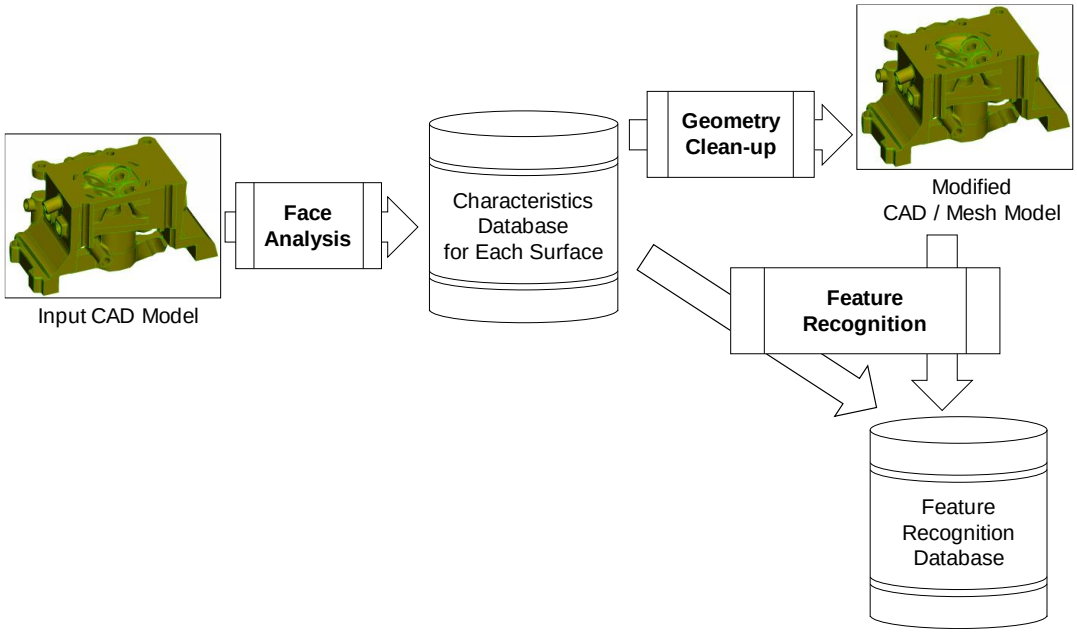

Figure 3 – Input CAD shape recognition flow

4. MESH GENERATION ALGORITHM

FEM mesh generation algorithm works with characteristics database for each surface. The feature recognition database is also used when required for controlling mesh according to meshing rules. To maintain the CAD shape representation as much as possible, the modified CAD model and initial mesh model that are created in the geometry clean-up step are considered.
To make the mesh generation procedure fast, we kept the algorithm simple. Firstly, the target mesh pitch and meshing algorithm are decided for each surface or feature group. Then, nodes are created on boundary lines between surfaces and recognized feature groups. The nodes are created based on the calculation from surface characteristics and meshing rules for features. The items that are considered when deciding the coordinates of nodes include the curvature and width of surfaces, surface continuity data, and the solid thickness. Finally, mesh is generated from node on the boundary lines according to the calculated mesh flows and specified meshing rules with the selected meshing algorithm. The diagram of the concept of the mesh generation algorithm is shown in Figure 4.

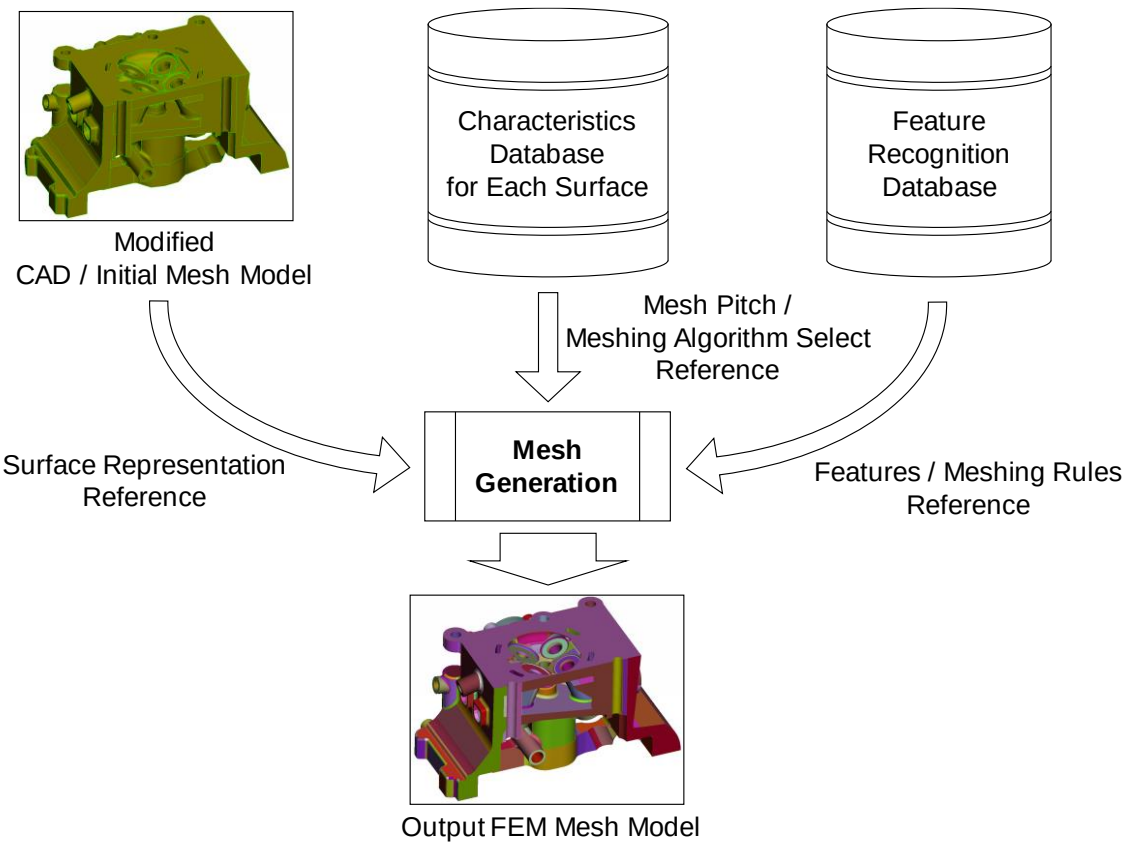

Figure 4 – Mesh generation algorithm using CAD model and databases

5. CONCLUSIONS

We developed algorithms to recognize input CAD shape and generate FEM mesh based on the CAD shape recognition database.
Using the technique we described in this paper, we achieved to clean up CAD models and generate high-quality mesh according to meshing rules while maintaining CAD shape representation as much as possible. We applied this technique to an engine CAD model and confirmed that the entire process takes only about 1.5 hours to get the meshing result without quality error.

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