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MESHLESS METHOD FOR 3D MODELS WITH FREE FORM SURFACES

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Abstract In the use of numerical simulation for engineering and scientific problems, the finite element method(FEM) is the most widely adopted method. Nevertheless, the main drawback is it requires finite element meshes to be the analysis models that considerable manpower and effort usually is needed for building the meshes. The emerging meshless method, generally including only nodes in analysis models, mainly aims to avoid building meshes. However, the meshless models with only nodes lack complete geometry information needed for simulations, especially for those with three-dimensional irregular-shaped geometry. That becomes a significant shortage and limits the applications to those with simple geometry.

The STL (Stereo-Lithography) geometry format, i.e. for faceted geometry, has been widely used for the applications in rapid prototyping, computer-aided manufacturing, computer graphics, and the emerging 3D printing fields. It has become a useful and flexible way to represent three-dimensional irregular geometry with free form surfaces. Thus, most CAD tools can output the geometry in STL format. Moreover, in reverse engineering, the geometry data usually obtained by 3D scanning, e.g. with 3D scanners or CT scanners, are also in STL or similar formats.

The main objective of this work is to address the deficiency of the meshless method in geometry treatment by directly adopting the STL geometry format and implement the simulations directly with the geometry of the analyzed objects. To achieve this, several geometry processing schemes are proposed. With those schemes, the geometry data can thus be directly used to do the analysis. The proposed method includes those schemes along with several automatic processes. With the method, not only the need of building the meshes can be eliminated, but also the processes of analyses can be considerably shortened and accelerated.

To demonstrate the advantages and efficiency of the new method, several biomechanical analyses with irregular-shaped geometry have been conducted, e.g. the analysis of the L3 bone of the lumbar vertebrae, as shown in Fig. 1 and Fig. 2. The geometry which is irregular and includes free form surfaces is obtained with 3d scanner. Then, a structural analysis can be carried out without any manual model processing. The procedure can be applied to any other analysis models with complicated geometry, especially for those medical parts of which the geometry is typically complicated and irregular that it usually introduces difficulties for other numerical methods.

Fig. 1 STL geometry obtained with 3d scanner

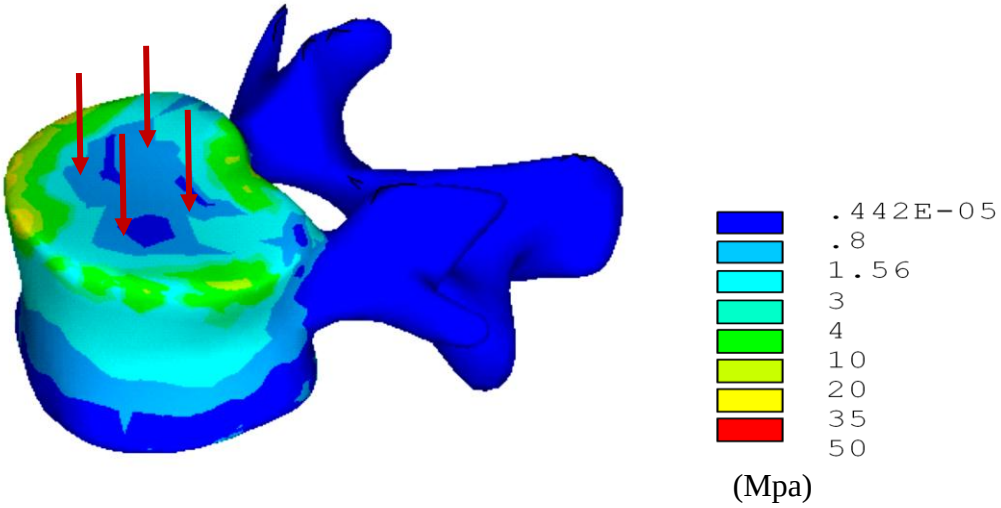

Fig. 2 von Mises stresses distribution

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