

Constructing complex B-spline solid with representation of material and performance

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Abstract

There have been emerged many products complex in geometry, topology and material. The 3D printing technology makes it possible for manufacturing of these products. But the conventional design method, with the properties of separation of geometric design and performance analysis, too much manual intervention and no share of the model in different design stages has urgent need to improvement.

Heterogeneous materials widely exist in the nature. Isogeometric analysis method constructing on the base of volume parametric model has been proposed and has been applied in some analysis fields. Volume parameterization method is proposed to generate proper analysis model for the isogeometric analysis. Because of many advantages of volume parametric model, constructing a heterogeneous volume parametric model becomes an interesting and worthy tasting thing.

Using CT scan data as original data, from which point cloud data can be extracted, to achieve a construction of geometry and material space for heterogeneous products. Use volume parameterization methods to acquire geometric space of model. Use parameterization of gray-scale values to acquire materials space of model. By solving a quadratic optimization problem to embed material space into geometric space and achieve the coupling of geometry and material through. Finally, volumetric parametric heterogeneous model is constructed. After coupling of these two spaces, a volume parametric heterogeneous model is completed for design and analysis. Isogeometric analysis is implemented without model conversion. Two presented examples show the effectiveness and efficiency, along with the future development potentials.

Take the femur model from human body as example, the result shows that the method of volume parametric modeling for heterogeneous products based on reverse-material-oriented is more convenient and precise to represent the actual distribution information for heterogeneous products and can provide the models for performance analysis and rendering based on volume parameterization model.