Multimaterial Geometric Design Theories and their Applications

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Introduction

Topology Design

- Decide the connection relationships
Introduction

Shape Design

- Decide the shape related parameters.
Introduction

Size Design

- Decide the size related parameters.
Introduction

Multimaterial Components

• Enhance the performance of single-material components by adding a new design option, material type variation.

Multimaterial Design

• Decide the topology, shape and size of every involved material in a multimaterial component.
Introduction

Multimaterial Design
Introduction

Challenges for Multimaterial Design

- Effective geometric modeling of the multiple materials involved in a multimaterial component.
- Efficient design method of multimaterial components.
Motivation and Objective

- Introducing an effective geometric modeling method of multimaterial components by using multilayer wide curves.
- Establishing an efficient geometric design method for multimaterial components based on the desired functions.
Multilayer Wide Curves

Parametric Curves (Bezier, B-Spline or NURBS)
Multilayer Wide Curves

Planar Wide Curve
Multilayer Wide Curves

Planar Multilayer Wide Curve
Multilayer Wide Curves

Planar Multilayer Wide Curve
Multilayer Wide Curves

Planar Multilayer Wide Curve
Multilayer Wide Curves

Spatial Wide Curve
Multilayer Wide Curves

Spatial Multilayer Wide Curve
Multilayer Wide Curves

Spatial Multilayer Wide Curve
Multilayer Wide Curves

Spatial Multilayer Wide Curve
The General Constraints

The Constraints for Planar Wide Curves
The General Constraints

The Constraints for Planar Wide Curves
The General Constraints

The Constraints for Spatial Wide Curves
The General Constraints

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The Constraints for Spatial Wide Curves
The General Constraints

The Constraints for Spatial Wide Curves
Multimaterial Geometric Modeling

- Represent each multimaterial branch by a multilayer wide curve
- Model a multimaterial component by a set of multilayer wide curves
- Control the geometry of a multimaterial component by the control parameters of the corresponding multilayer wide curves
Multimaterial Geometric Design

- Use finite element analysis to know the performance of a multimaterial component
- Optimize the control parameters to design a multimaterial component
Multimaterial Design Examples

Cantilevered Beam Structure

![Cantilevered Beam Diagram](image-url)
Multimaterial Design Examples

Cantilevered Beam Structure
Multimaterial Design Examples

Cantilevered Beam Structure
Multimaterial Design Examples

Cantilevered Beam Structure

\[ D_1 \rightarrow D_2 \rightarrow D_3 \rightarrow D_4 \]
\[ D_5 \rightarrow D_6 \rightarrow D_7 \]
Multimaterial Design Examples

Cantilevered Beam Structure
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Multimaterial Design Examples

Compliant Gripping Mechanism
Multimaterial Design Examples

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Multimaterial Design Examples

Compliant Gripping Mechanism
Conclusions

- Multilayer wide curves are introduced.
- The general constraints of wide curves are established.
- Multilayer wide curves are used to model multimaterial components.
- The geometric design of a multimaterial component is formulated as the optimization of the control parameters of the corresponding multilayer wide curves.
- The proposed modeling and designing methods have been successfully applied to some examples.
- These methods are expected to be applied in other areas.
References
