A Practical Method to Model Complex 3D Geometries with Non-Uniform Material Properties Using Image-based Design and COMSOL

Jihan Cepeda^{1,2}, S. Birla², J. Subbiah^{1,2}, and H. Thippareddi¹

¹ Department of Food Science and Technology, University of Nebraska-Lincoln ² Department of Biological Systems Engineering, University of Nebraska-Lincoln

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COMSOL CONFERENCE BOSTON2013



OUTLINE

- 1. Introduction
- 2. A Practical Method to Model Complex Multipart Geometries
- 3. Case Study
 - Modeling Air-Cooling of a Chicken Carcass



OUTLINE 1. Introduction

2. A Practical Method to Model Complex Multipart Geometries

3. Case Study

Modeling Air-Cooling of a Chicken Carcass



Modeling Complex Multipart Geometries can be a Challenge

Image-based 3D reconstruction





Modeling Complex Multipart Geometries can be a Challenge

- Image-based 3D reconstruction
- Form Union/Assembly





Modeling Complex Multipart Geometries can be a Challenge

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- 1. 3D Reconstruction
- 2. Meshing
- 3. Material Labeling
- 4. Material Definition in COMSOL



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Read Mesh of Object Read Meshes of Subparts

For Each Subpart
 For Each Node in Subpart
 *Find Nearest Neighbor
 Node in Object Mesh
 *Label the Node in
 Object Mesh with

Corresponding Material

Next Node in Subpart Next Subpart

- 1. 3D Reconstruction
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Output:

Labele	ed Node	es.txt					×
x [m]	y [m]	z [m]	Material	k [W / m K]	Cp [J / kg K]	ρ [kg / m³]	^
1.30E-01	1.14E-01	2.78E-02	Meat	0.265	2,021	1,040	
1.33E-01	1.15E-01	2.98E-02	Meat	0.265	2,021	1,040	
1.77E-01	5.69E-02	5.48E-02	Round Bone	0.265	2,021	1,040	
1.05E-01	7.71E-02	7.06E-02	Air	0.026	1,005	1.2	
7.16E-02	6.97E-02	-1.98E-02	Rib Bone	0.265	2,021	1,040	
7.26E-02	6.55E-02	-1.73E-02	Rib Bone	0.265	2,021	1,040	~

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a. Import Mesh of Object



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a. Import Mesh of Object

b. Define interpolation functions

 Parameters 				
Data source:	File			
F.1	C:\Carcass The	C:\Carcass Thermal Conductivity.txt		
Filename:	Browse	Browse Import		
Data format:	Spreadsheet		•	
Number of argume - Functions	ents: 3			
Function name		Position in file		
k1		1		
ት 🕀 🐱				
 Interpolation an 	d Extrapolation			
Interpolation:	Nearest neighbor			
Extrapolation:	Nearest function			

Excerpt from the Proceedings of the 2013 COMSOL Conference in Boston

Function:

W/(m*K)

- 1. 3D Reconstruction
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- a. Import Mesh of Object
- b. Define interpolation functions
- c. Define material properties as functions of X, Y, Z coordinates

Geometric Entity Selec	tion				
Geometric entity level:	Domain				
Selection:	All domains				
1				0	
* Material Contents					
 Material Contents Property 		Name	Value	Unit	
 Material Contents Property Thermal conduct 	tivity	Name k	Value k1(x,y,z)	Unit W/(m*K	
 Material Contents Property Thermal conduct Density 	tivity	Name k rho	Value k1(x,y,z) rho1(x,y,z)	Unit W/(m*k kg/m^3	

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Case Study Modeling Air-Cooling of a Chicken Carcass

Case Study *Modeling Air-Cooling of a Chicken Carcass*

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Case Study *Modeling Air-Cooling of a Chicken Carcass*



- Heat Transfer in Solids
- ✓ Transport of Diluted Species
- LiveLink for MATLAB



CONCLUSION

 Image-based mesh generation, a custom algorithm, and interpolation features of COMSOL Multiphysics can be used to define heterogeneous material properties of complex geometries without the difficulties associated with assembling multiple parts.







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