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

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OUTLINE

1. Introduction

2. A Practical Method to Model Complex Multipart Geometries

3. Case Study
   – Modeling Air-Cooling of a Chicken Carcass
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Modeling Complex Multipart Geometries can be a Challenge

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

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1. 3D Reconstruction
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Output:

<table>
<thead>
<tr>
<th>x [m]</th>
<th>y [m]</th>
<th>z [m]</th>
<th>Material</th>
<th>k [W / m K]</th>
<th>Cp [J / kg K]</th>
<th>ρ [kg / m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.30E-01</td>
<td>1.14E-01</td>
<td>2.78E-02</td>
<td>Meat</td>
<td>0.265</td>
<td>2,021</td>
<td>1,040</td>
</tr>
<tr>
<td>1.33E-01</td>
<td>1.15E-01</td>
<td>2.98E-02</td>
<td>Meat</td>
<td>0.265</td>
<td>2,021</td>
<td>1,040</td>
</tr>
<tr>
<td>1.77E-01</td>
<td>5.69E-02</td>
<td>5.48E-02</td>
<td>Round Bone</td>
<td>0.265</td>
<td>2,021</td>
<td>1,040</td>
</tr>
<tr>
<td>1.05E-01</td>
<td>7.71E-02</td>
<td>7.06E-02</td>
<td>Air</td>
<td>0.026</td>
<td>1,005</td>
<td>1.2</td>
</tr>
<tr>
<td>7.16E-02</td>
<td>6.97E-02</td>
<td>-1.98E-02</td>
<td>Rib Bone</td>
<td>0.265</td>
<td>2,021</td>
<td>1,040</td>
</tr>
<tr>
<td>7.26E-02</td>
<td>6.55E-02</td>
<td>-1.73E-02</td>
<td>Rib Bone</td>
<td>0.265</td>
<td>2,021</td>
<td>1,040</td>
</tr>
</tbody>
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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

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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.