Human Torso Model for Heat Transfer Analysis

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Introduction: A 3D human model is essential for heat transfer analysis using finite element analysis (FEA). This describes the approach to creating a human torso in Solidworks for heat transfer simulation in COMSOL.

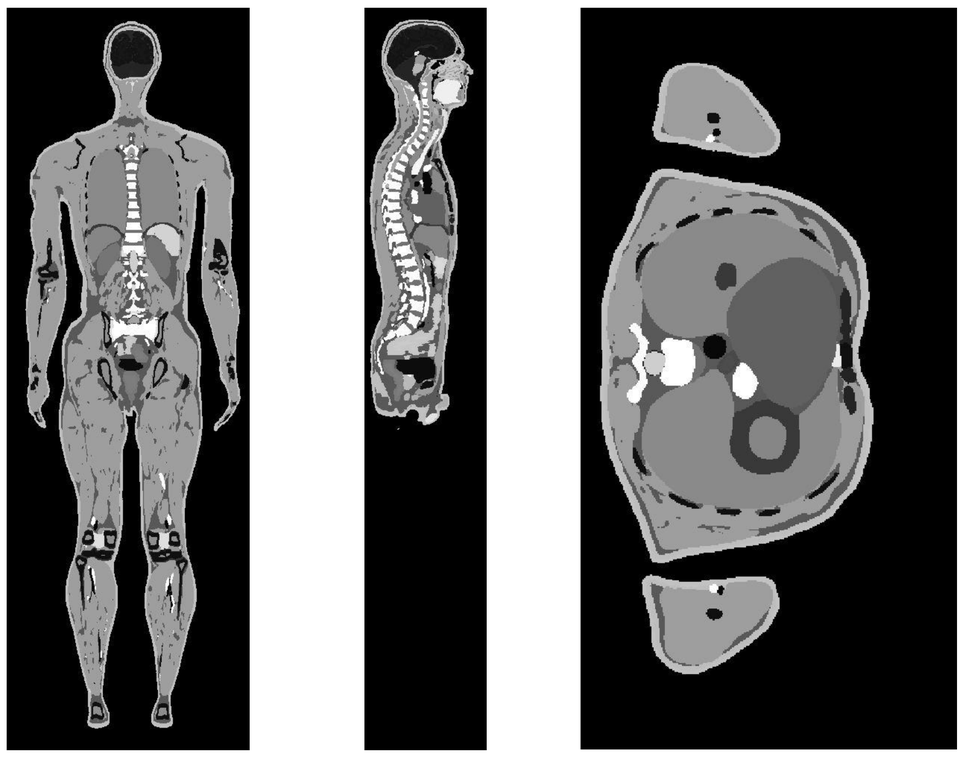

Figure 1. ITIS Data

Methods: The torso was derived from the 'Virtual Family' whole-body voxel labelmaps from the ITIS Foundation (Zurich, Switzerland)[1] and built in Solidworks. ITIS data is 1mm voxel data segmented into 77 tissue types. Since the major tissue types that affect metabolic heat transfer are skin, fat, muscle, bone, and core, all tissues were binned into these categories and individual components were created. Geometric parameters were determined by taking measurements of anatomical structures within the 3d voxel data along the coronal, sagittal, and axial planes. Table 1 compares ITIS and Solidworks tissue volumes.

	Whole Torso	Fat	Muscle	Skin	Core
ITIS	2183.3	454.2	861.1	102.0	765.5
Solidworks	2187.9	422.5	875.7	127.7	761.9

Table 1. ITIS and Solidworks torso tissue volumes (in^3)

Results: Solidworks Livelink was used to perform a steady state heat transfer analysis in COMSOL. The torso surface was divided into four regions: front and back, top and bottom. Each region can have its own boundary conditions, representing impacts of local clothing properties on heat exchange between body surface and the environment.

Figure 2. Torso Boundaries

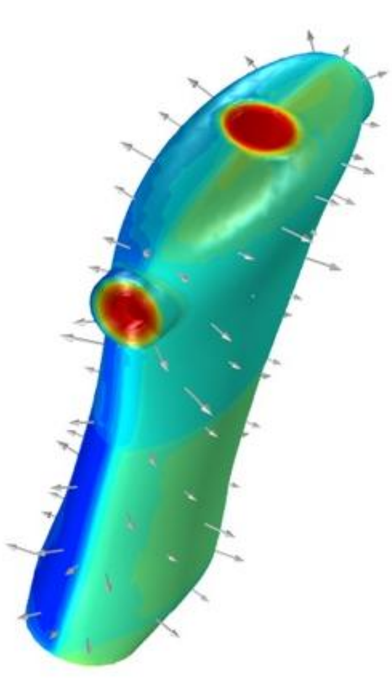

Figure 3. Torso Heat Transfer

Conclusions: This approach is feasible for creating a human model in CAD format. The FEA heat transfer module has the capability to simulate inhomogeneity of a clothing ensemble.

References:
1. Foundation for Research on Information Technologies in Society (IT'IS): Human & Animal Models, http://www.itis.ethz.ch/services/human-and-animal-models/human-models

Excerpt from the Proceedings of the 2012 COMSOL Conference in Boston