Virtual Modeling of Thermo-Physiological Comfort in Clothing

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Abstract

1 Introduction
The thermal functions of clothing are depending on the complex interactive physical behaviours involved in the clothing wearing system, which consists of (1) the human body, (2) the clothing and (3) the external environment. The related physical behaviours may include the thermal interactions among the human body, clothing and external environment, the biological thermoregulation of human body and the heat and moisture transfer processes in textile materials. On the other hand, the clothing is practically designed and made with textile materials and various technologies/functional treatments. For a clothed human, air gaps are produced between the clothing and the skin. The thermal and moisture properties in this microclimate are related to the external environment and the clothing system. Hence the virtual modelling of the comfort of a clothed thermal manikin should include the mechanism associated with heat and mass transfer and their distributions in the air layer. With the development of the Computational Fluid Dynamics (CFD), it should be possible to simulate and predict the thermal and moisture properties in the complete clothing wearing system including the microclimate flows. However few researchers have examined the flow and temperature distribution of clothed wearing systems including air gaps using CFD methods [1-3].

2 Use of COMSOL Multiphysics
This publication aims to investigate conjugate heat and mass transfer around a clothed virtual manikin. This research can be performed at different scales: (1) at material scale where a piece of textile is investigated in 1D or 2D space or (2) at system level where a clothed cylindrical body (2D) or a complete manikin (3D) is modeled. The work is based on previous methods and results from literature [4-9]. The textile material is considered as a porous material where convection and diffusion processes of air and water vapor are modeled together with water vapor absorption. COMSOL Multiphysics software with the CFD Module and Heat Transfer Module is used in this model.

3 Results
To illustrate the system level approach, in Figure 1 you can find the different steps to create a virtual model of a clothed manikin for COMSOL Multiphysics. A 3D scan made with the EVA hand scanner (ARTEC 3D) was post-processed using Rhinoceros and finally loaded inside COMSOL. First app results are shown for a naked manikin in Figure 2.

4 Conclusion

Modeling thermo-physiological comfort both at material level and at system level are essential for clothing manufacturers. The existence of a simulation app for the designer would be a very interesting easy-to-use tool for future clothing optimization.

Reference

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Figures used in the abstract

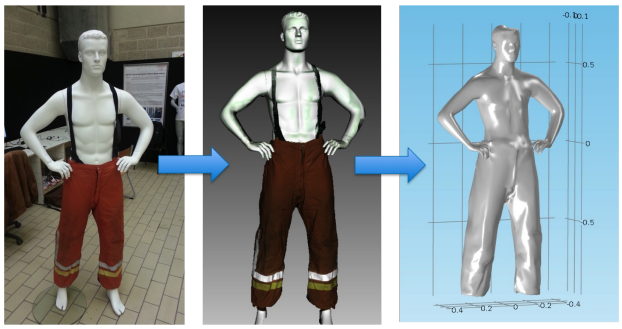

Figure 1: Creation of virtual clothed mannikin

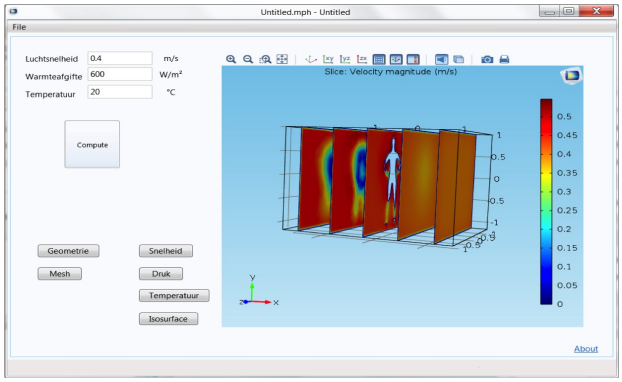

Figure 2: Preliminary results - simulation app