M-Smart—An Improved Multi-style Engineering Design CAD System for Clothing Thermal Functions

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Abstract

A virtual CAD system for thermal functional design is reported in this paper. An improved multi-style garment design and segmental condition specification was achieved in this system. Moreover, this system predicted the thermal status of human and clothing system while the predicted results correspond well with the experimental results. Both 3D static and dynamic visualization were presented to the users to get a feedback for the design case.

Keywords: Thermal Functional Engineering Database; Multi-style Garment Design; Cad System; Segmental Specify

1 Introduction

With the application of CAD technologies in thermal functional design area, designers can perform virtual garment design on a computer instead of doing experimental tests in laboratories. This does not only reduce the development period but also saves significant costs involved in conducting testing experiments. Published papers and models can be found extensively, describing the heat and moisture transfer process between human and multi-layer fabrics which provides the theoretical foundations and possibilities for CAD functional design.

In previous researches, a CAD system named P-smart for multi-layer clothing thermal engineering design had been developed to predict the thermal status of both human and clothing during a serious of activities [1]. With P-smart system, designers can design the clothing in a virtual environment with the assigned activities and predict the thermal status of both human body and clothing. Compared to the traditional clothing testing methods, P-smart allowed designers to perform the clothing design on a computer which reduces the design period. Moreover, P-smart

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system proposed a basic framework for thermal functional design for human and clothing system especially for multi-layer garments design.

However, the thermal regulation of human is a two-node model which means that the whole body is still viewed as two layers, core and skin. This two-node human model [2-4] has many limitations, for example the entire clothing covering different segments is the same including the material and the fabric layers. So, multi-style garment design such as short sleeve and short pants cannot be realized with P-smart system. Afterwards, a software named T-smart [5] was published and reported that each segment can be simulated individually. The calculation model in T-smart for human regulation is a 25-node model [6] in which the whole human body is divided into six parts and the clothing on each part can be defined by designers. Moreover, it allows the designers to take the effect of multi-style design into consideration. However, the limitation of T-smart also comes in terms of multi-style design. The T-smart cannot realize the true status of multi-style because all the segments share similar temperature, wind velocity, cover ratio and effect of convection. As shown in Fig. 1 in a real situation, different segments may suffer from a distinguished velocity and this can cause an entirely different thermal sensation on the segment.

In this paper, an improved CAD system which allows designers to perform real multi-style design with the consideration of boundary condition for each segment individually is reported. The new software can specify the scenarios for each segment individually. Moreover, the 3D static and dynamic visualization are designed in this system to present the simulation results.
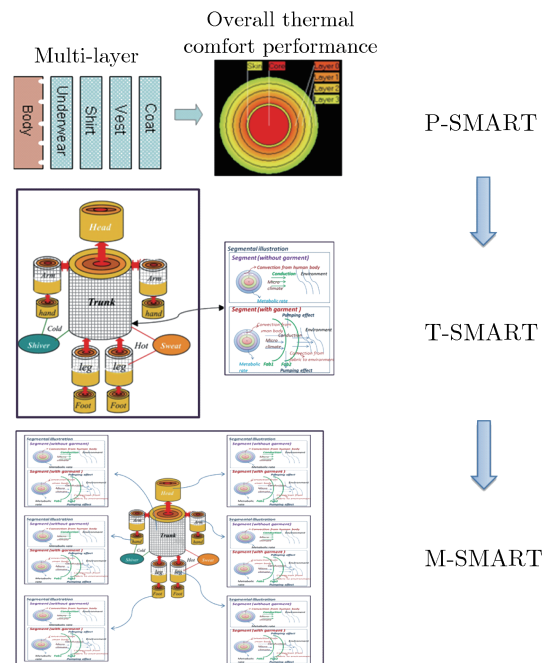

Fig. 1: Analysis of P-smart and T-smart

2 Integrated Mathematical Model for Human and Clothing System

The computational models for M-smart includes two parts which are 25-node thermal regulation