Title:

Functional 3D Human Model Design: A Pilot Study based on Surface Anthropometry and Infrared Thermography

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Introduction:

The information of human body is crucial in many areas such as product design, medical science, engineering and manufacturing. 3D human models are increasingly adopted to enhance the efficiency and sustainability in these human centered disciples [1]. In recent years, a growing trend on functional and smart products have aroused the popularity among the consumers. The traditional geometry human model based on linear and non-linear anthropometry (e.g. 3D body scanning), which conveys size, shape, surface and volume properties of human being [2], may not fully satisfy the requirements for further research and rapid development on functional design [3, 4]. There is a necessity toward launching functional human model design.

Main idea:

3D body scanners, as instruments to capture the whole body and create a set of dimensionally accurate data, are widely used in human surface modeling. With the technological innovations, sufficient data related to internal human body can be cheaply obtained using computed tomography (CT), X-ray, positron emission tomography (PET), ultrasound imaging, Magnetic resonance imaging (MRI) and Infrared thermography (IRT). As one kind of inoffensive methods, IRT can provide thermal imaging and map the surface temperature distribution of human body. In this pilot study, surface anthropometry and Infrared thermography techniques was combined to develop a customized functional human model, called thermal model (T-model).

In this experiment, the environment was under thermoneutral condition (temperature: 24±0.5°C, relative humidity: 60±5%). The male subject wearing only briefs was scanned by a 3D body scanner system in a naturally standing gesture. After scanning, in the same lab, an infrared camera was used to obtain thermal imaging from the front, back, right side and left side views of the torso of the subject, see Fig.1. The whole process was controlled and conducted in the same environment and completed within 15 minutes which potentially avoiding obvious surface temperature changes of the subject.

For data processing, 3D body scanner provides one set of cloud point raw data of whole body. Due to the general limitations on noises arising from various sources, the 3D raw data was cleaned and smoothed by 3D software such as Rapidform (http://www.rapidform.com) and Meshlab (http://meshlab.sourceforge.net). A 3D torso model, called geometric model (G-model) was selected and cut for thermal mapping from 2D thermal imaging to 3D human body (Fig. 2).

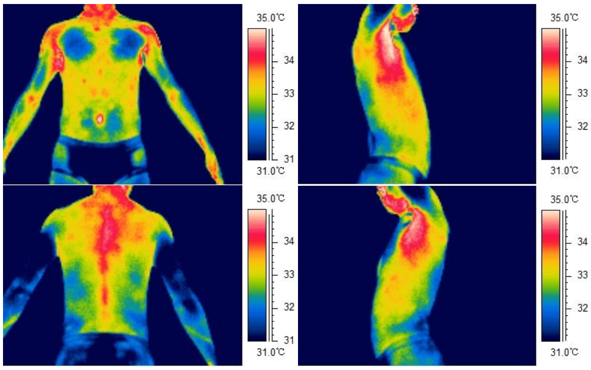

Fig. 1: From left to right, Thermal imaging of torso (a) front side, (b) right side, (c) back side, and (d) left side.

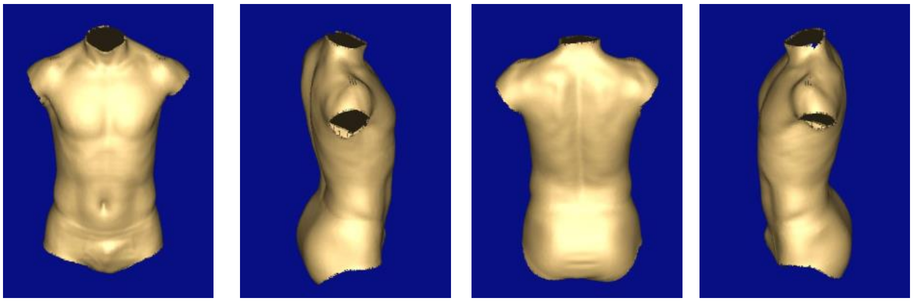

Fig. 2: From left to right, G-model (a) front, (b) right side, (c) back, and (d) left side.

After the previous original data collecting and processing, the surface temperature conveyed by thermal imaging was mapped to 3D torso by using 3D software or programming on Matlab software, see Fig. 3. The T-model have been created by means of Rapidform software, from which accurate size, surface and volume data can be read together with real body's skin temperature distribution. This T model can visualize the thermal features in a 3D way and quantify the surface temperature distribution by point to point corresponding match.

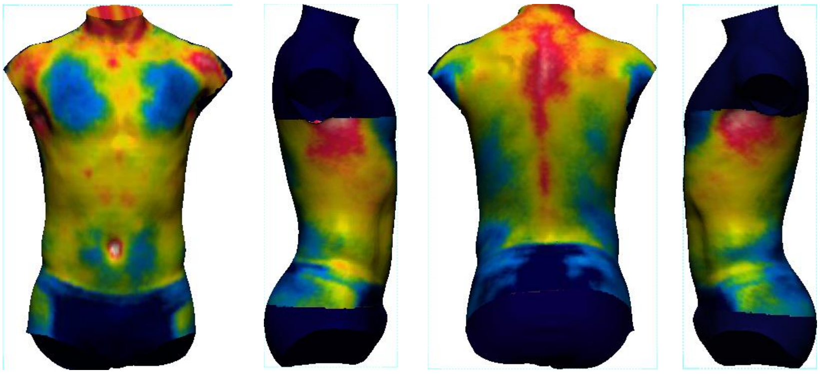

Fig. 3: From left to right, T-model (a) front, (b) right side, (c) back, and (d) left side.

Conclusion:

Geometry human model presents the basic dimensional information of human body. This pilot study initiates an innovative approach on functional human model design. The T-model innovatively endows the simple cloud point with thermal mapping on the 3D surface. This new model can be used for functional product development and application in medical field. Especially for functional clothing developers, they will be able to do 3D functional design, pattern making and virtual fitting in a relatively accurate and efficient way.

As every human body has its own thermal distribution characteristics, a customized design on T-model is recommended. The setting of T-model database in the near future will be helpful for medical diagnosis and related functional product design. Due to the limitations in this pilot study on techniques, more details should be considered to improve this model in further research work.

References:

[1] Ameersing Luximon, H.C.: Shape Modeling: From Linear Anthropometry to Surface Model, in ACHI 2013, The Sixth International Conference on Advances in Computer-Human Interactions 2013: Nice, France, 420 to 425.

[2] Jones, P.R.M.; Rioux, M.: Three-dimensional surface anthropometry: Applications to the human body, Optics and Lasers in Engineering, 28(2), 1997, 89-117. http://dx.doi.org/10.1016/S0143-8166(97)00006-7

[3] Jayaraman, S., et al.: Intelligent Textiles for Personal Protection and Safety, 2006, IOS Press.

[4] Chowdhary, U.: Functional Clothing, Body Comfort, and Special Needs. 2002, Central Michigan University.

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