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A customized garment collaborative design process by using virtual reality and sensory evaluation on garment fit

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ABSTRACT

As the successful implantation of CAD (computer-aided-design) technology in garment industry, the 3D virtual garment technology has attracted a great attention of textile/garment companies. However, wearer's perception on virtual garment in terms of fitting and comfort has never been systematically studied. In this paper, we propose an original customized 3D garment collaborative design process by integrating interactions between the designer and the specific consumer. In this context, a normalized sensory evaluation on garment fitting effects will be organized in a virtual environment, in order to enhance communications of the concerned actors on perception of products. Also, by learning from the measured distances between the garment surfaces and the mannequin (input) and sensory descriptors (output), we model the relationship between the garment design parameters and the human perception on fit of the finished virtual products. Using this model, we can estimate the fit perception for a specific garment size on a specific body shape without any real try-on experience. In practice, the proposed collaborative design process will permit to develop an online recommendation system for garment size selection and fit estimation. Furthermore, it will permit to recursively modify the initial garment patterns according to the consumer's fit preferences so that they can obtain a real personalized garment. In this way, the consumer will be directly involved in the product design process by performing a series of sensory evaluations on virtual garment fit in order to obtain a desired finished product. This process has been validated by creating a collection of T-shirts meeting requirements of various customers.

1. Introduction

In modern society, under the economic pressure and faced to more and more demanding and various requirements of consumers in terms of fashion style, comfort and functionality, classical garment design and production need to be extensively innovated in order to deliver rapid and personalized products and services of high quality with low costs. The quick progress of information technologies such as virtual reality technology, e-business, mass customization and collaborative design, provide new opportunities for restructuring the entire textile/garment/distribution supply chain in a more optimized way.

The sizing system of a garment involves a series of grading rules and operations to enlarge or reduce a basic pattern to one or several sizes (Gilewska, 2008). In a classical garment design process, the designer first creates all the patterns for a dedicated size, called the basic size. Then they integrate the grading rules into each feature point of these patterns in order to proportionally increase or decrease the outlines of the original patterns and generate garments of the same style but with different sizes. Generally, the grading rules are developed from empirical knowledge of the garment designer by interpreting the body measurements of standard human models and ease allowance on different parts of the body. The grading rules can also vary with garment style and nature of materials used.

Based on generation of physical prototypes, the classical product design process is rather long, leading to high costs in human resource and production. In this context, the concept of collaborative design or co-design has been widely introduced in many industrial sectors such as automobile, furnishing, architecture, manufacturing and civil engineering for quickly delivering user-centered new products to the market.

Collaborative design represents the experience or process of a collaborative construction of new content in a virtual environment represented as avatars by multiple users through their communication and shared exploration of 3D visualizations (Luo & Yuen, 2005). The basic element of collaborative design is the Internet-based visual platform showing interactions between the product, the designer and the customer (García-García, Chulvi, & Royo, 2017). Based on 3D visual models, new design methodologies, such as scenario-oriented design or

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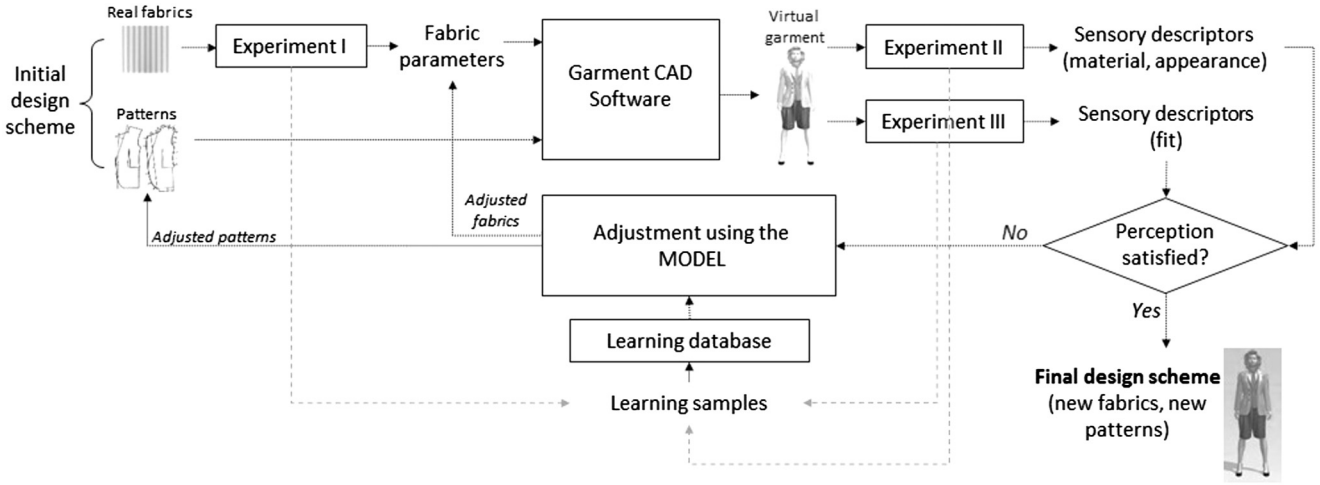

Fig. 1. Basic functions of the collaborative garment design process.

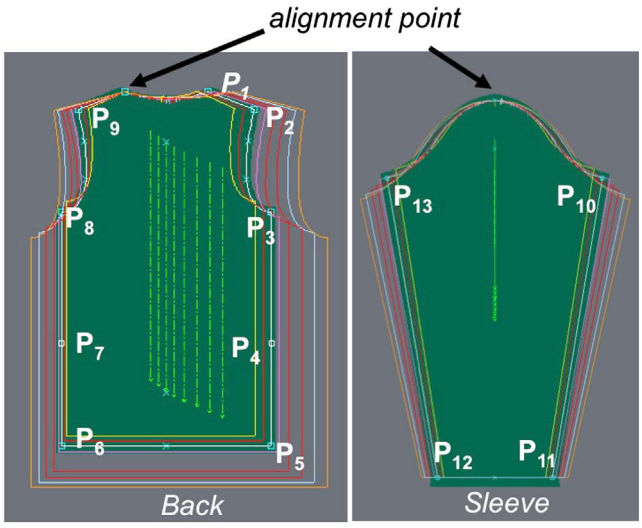

Fig. 2. Feature points in the patterns of a T-shirt.

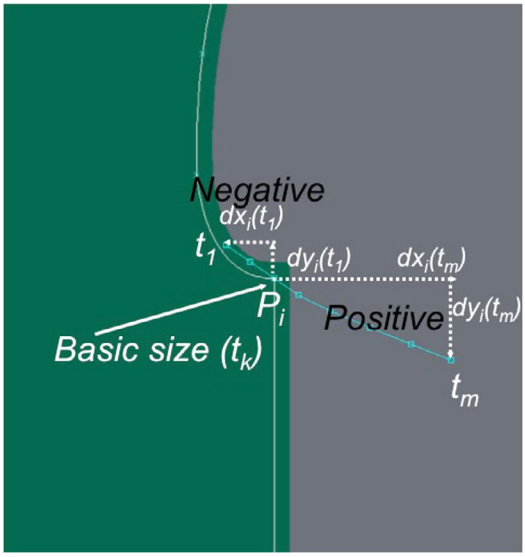

Fig. 3. Scheme of movements of a feature point for different sizes.

context-oriented design (Martinez-Maldonado et al., 2017), customized product design (Hosun, Istook, & Cassill, 2009), are developed for dealing with different application contexts. They permit to realize the product design by visualizing a virtual person using the virtual product in a virtual scenario.

Collaborative design is very significant in garment industry because, compared with other domestic products, garments and their accessories are more human-centered in terms of body fitting, comfort and aesthetics. Conventional CAD technology using the size table of standard body measurements can provide a short product development cycle. However, it cannot produce accurately fitting garment for individual customers. 3D virtual garment design using specific CAD software can be considered as an optimal combination of designers, computer technology and animation technology, permitting to realize and validate design ideas and principles within a very short time (Tao & Bruniaux, 2013; Volino & Magnenat-Thalmann, 2012). New knowledge and design elements on garments can be obtained from human-machine interactions. The application of virtual technology can effectively accelerate new product development, reduce design and production cost, and increase product quality in order to enhance the competitiveness of garment companies in the worldwide market (Chan, Yang, Wong, Chan, & Lam, 2015; Vuruskan, Ince, Bulgun, & Guzelis, 2015; Wang, Zeng, Koehl, & Chen, 2015).

The most appreciated CAD systems generating 3D virtual garments are based on mechanical models (Provot, 1995). These models, built according to the mechanical properties of real cloth measured on devices such as KES and FAST (Philippe, Schacher, Adolphe, & Dacremont, 2004), can effectively simulate fabric deformable structures and be accurate enough to deal with nonlinearities and deformations occurring in cloth, such as folds and wrinkles. Moreover, they can strongly interact with wearers or human body models. In practice, the perception of virtual garments can be modified by adjusting the fabric technical parameters and garment patterns of the corresponding garment CAD software so that their visual and tactile effects are as close as possible to those of real garments. In this way, consumers and designers can control or enhance some sensory criteria such as softness, smoothness, rigidity, draping and fitting effects in virtual products according to their requirements. This approach is particularly interesting for designing new personalized products.

In this paper, we propose a customized 3D garment collaborative design process by integrating interactions between the designer and the specific consumer in order to recursively control garment fitting to converge to the visual effect desired by the consumer. The human perception on garment fitting effects is quantitatively characterized by a normalized sensory evaluation procedure. By learning from experimental data measured on a set of representative garment samples, a mathematical model is built in order to characterize the relationship