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Three Dimensional Pattern Grading Based on Deformable Body Features and 3D Developable Surface

Yingnan Wang, Haiqiao Huang*

School of Fashion Art and Engineering, Beijing Institute of Fashion Technology, Beijing 100029, China

Abstract

The garment pattern grading is a crucial procedure for manufacturing full sizes of clothing products. This procedure traditionally starts with an 'average' pattern and generates a set of sized garment patterns by extending the 'average' pattern. The quality of the graded patterns depends on the grading technique and the technician's experience. However, the garment patterns are often graded based on two-dimensional rules that hardly provide an accurate fit because of shape variations and complexity of 3D human bodies. Additionally, the traditional pattern grading is conducted manually and very time-consuming. In this paper, we propose a new automatic approach of generating full sizes of garment patterns by flattening 3D garments created from parameterized mannequins in fulfilling the requirements of body structures, sizing chart and garment fit. Firstly, a parametric human body model is introduced called Horizontal Piecewise B-spline Curves (HPBC) model. Three types of novel frames are developed from the HPBC model, namely feature frame, size frames, and ease frames. Based on these frames, a range of fit and flattenable 3D garments are established. Finally, the graded patterns can be generated by flattening these 3D garments.

Keywords: 3D Pattern Grading, Garment Grading, Developable Garment, Ease Distribution, Sizing Chart

1 Introduction

Pattern grading is the process used by clothing manufacturers to produce patterns for a garment in a range of sizes for ready-to-wear clothing [1]. Well graded patterns play a crucial role in garment fit. However, finding acceptable fit clothing takes a considerable amount of consumers' time and about 49 percent of women have difficulty finding garments that fit [2]. One main reason contributing to this problem is the unequal translation from sizing charts to pattern grading rules. Sizing charts are established through anthropometric body data collected in a 3D dimensional manner by manual measuring and recent 3D scanning. On the other hand, the pattern grading is conducted by translating some cardinal points on the 2D space. This inconsistent translation crucially influences the quality of garment patterns and clothing fit.

*Corresponding author.
Email address: fzyhhq@bift.edu.cn (Haiqiao Huang).

Challenges still remain to develop systematic 3D grading rules even though 3D digital body avatars can be created within seconds. The 3D grading rules mean that a range of sized 3D garments are firstly developed from 3D scans or human bodies and later flattened into different sizes of patterns. There are two major difficulties. Firstly, although body size surveys have been carried out and hundreds of body measurements for one subject are taken, how to opt for significant body features and key points on the body as the cardinal points is not easily decided. Secondly, the core of 3D grading technique is how to transform a digital human body model into different sizes, by which different sizes of 3D garments and patterns are developed. Some established deformable parametric human body model. But these models usually are applied for either individual pattern development or animation and film industry. Little research has been carried out on accurate and deformable parametric human body model for 3D garment development. This paper therefore aims to develop a systematic 3D pattern grading method with resolving the above problems.

2 Related Works

2.1 Pattern Development from 3D Scans and Models

Modeling 3D garments by developable surface have been studied by a number of researchers. Using silhouette sketches, 3D garments are modeled as locally best-fitting developable surfaces based on moving-least squares in [3] and flattened by ABF++ parameterization [4]. A modeling method of Flattenable Laplacian (FL) meshes was proposed by improving local flattenability of a triangulated surface in [5]. This method was extended to develop flattenable mesh fitting boundary curves [6], which was later applied in 3D compression garments [7] and garment pattern generations. Their method may be good for very tight-fitted garments, for instance pressure garments, or garment with defined style, for example shirts. However, in their research, 3D garment modeling does not consider the textile property constraints of the flattened patterns, so the resultant 2D patterns may tend to be fragmented and cannot be further adapted to create new styles. Every garment needs to be modeled anew.

It is important to model 3D garments properly, so that critical constraints of textile material property are fulfilled to ensure the resultant patterns are more adaptable for actual manufacturing production. One possible way is to align 3D garments with body features to guide the later flattening process. Tang and Chen [8] transformed an initial developable surface to a final mesh surface that interpolated some given points or/and curves. During the transformation process, zero-valued Gaussian curvature is maintained. Another classical method of approximating developable surface from a set of points or curves is by boundary triangulation development [9]. In other words, given a polyline with vertices sampled from an input piecewise smooth curve, a boundary triangulation is a manifold triangulation with no interior vertices whose boundary is the polyline [10]. In this paper, a method to generate developable 3D block garments is proposed by boundary triangulation, in which the structural lines and features of a human body are references to construct the boundaries of the 3D flattenable garment by carefully incorporating the garment ease. The 3D garments can be easily flattened as a customized and well fitted garment for further style adaption. The flattening process is computationally inexpensive and fit for industrial application.