A Knowledge Based Modeling of Virtual Costume (Virtual Hanbok)

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Abstract

Though there have been garment simulation tools, it is difficult for general users to know how to design a virtual costume that meets some requirements of its specific clothing pattern. In particular, hanbok has many characteristics different from western clothes in terms of its pattern design and of draping. This paper presents a knowledge based approach that carries out multi-step measurement adjustment process for virtual hanbok design. This allows users design virtual hanbok without knowing the details of hanbok specific shaping method.

Keywords: Draping Simulation, Virtual Costume, Knowledge-Driven Approach

1. Introduction

Garment simulation for virtual characters is now demanding in movies, animation, game and others. There have been several CAD systems developed for fashion industry, but they require fashion designer's expertise to complete the detail patterns of a given garment type. In particular, Korean traditional costume reveals great organizational difference against western clothing.

This paper proposes a knowledge driven approach for modeling 3D hanbok. We focused on the easy-to-use support for general users for creating hanbok draping simulation. Our approach can be summarized as three phases: First, based on the traditional hanbok design method, we provide *standard database of hanbok patterns*. By using this pattern database, general users without the knowledge of hanbok's design pattern can easily create virtual hanbok. Secondly, we constructed a knowledge-base on how to determine *major garment gauges* from a few body measurements. By this knowledge base, hanbok in several levels of sizes can be created from the same silhouette pattern. We also suggest the third step of *adjusting local measurements of hanbok* so that they reflect various characteristics of individual body shapes that is far from standard body proportions. This detail adjustment level is required because someone can have a body shape that does not fit well with any of the standard levels of body proportion. This is important when we consider that some exaggerated or abnormal body features are often generated on purpose for synthetic characters. For example, hanbok resized by one of standard levels in the previous steps will be still awkward for a thin man with a big belly. The hanbok might be tight or torn around the belly and very loose for all other body parts. Supported by knowledge-base reflecting expert designer's experience, this third step enables individual body-shape dependent hanbok resizing without complex process of measurement re-evaluation.

2. Related Works

Generally, garment design process can be decomposed into several steps as in Fig.1. Among these, our major concern is given to the steps of *pattern design, grading and draping*. *Pattern design* step is to design the garment cutting pattern. The next step is *grading* step where several standard levels of gauges are generated from a given pattern. The final *draping* step provides the correction of the design or the measurements by putting the garments on a human or mannequin body[1].

Hanbok modeling also follows these steps where each of them involves various parameters and their application rules. However, expert's help is required for designing the cutting pattern and also for adjusting sizes according to the grading and draping rules[2,3,4].

Amongst the computer animation research of western clothes modelling, online clothing store done in Miralab is one of the recent remarkable works[5]. Though this work covered most of the process of garment modelling, it does not provide the draping step where the fine adjustment are carried out on the garment measurements according to the local body characteristics such as big belly, short neck, etc. Also, the reference gauges and method of measuring are different from those for hanbok. Therefore, it is not appropriate for applying their method to virtual hanbok modeling.

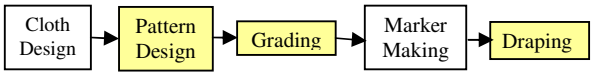

Fig. 1 Garment design steps [1]

On the other hand, we appreciate the existing studies on real hanbok creation done by traditional costume designers. Some of these work give us applicable hints on hanbok grading rules [6,7,8,9]. To use them for digital hanbok creation, however, the rules should be analyzed in terms of body measurements and

reconstructed as a retrievable knowledge-base.

3. Knowledge-Bases for Hanbok Grading and Draping

This chapter introduces the proposed knowledge-driven modelling scheme that finally creates hanbok measurements according to body shape characteristics. As introduced in chapter 1, the knowledge base consists of two steps: the first one is calculating the standard levels of gauges for a given garment type (*grading*) and the second one is adjusting measurements according to the local characteristics of specific body shape (*draping*).

3.1 *Grading* knowledge-base : resizing rules in standard gauge levels

Real hanbok pattern can be constructed from just two or three body measurements as its input parameters. Table 1 lists up those body sizes that their measuring is required for each of hanbok *Jogori* that corresponds to western shirt or jacket, and hanbok trousers, and skirt. However, specifying hanbok shape is related to more gauges than just a few input measurements. Meaning of terms representing each part of *Jogori* is indicated in Fig. 2. For helping non-designer's creation of hanbok pattern, we constructed a knowledge-base that provides how to produce garment gauges from a few body measurements.

Table 2 shows female *Jogori*'s case of fuzzy mapping rules between a few body measurements and the evaluation method for resulting garment gauges. Group 1,2,3 are classified according to which body measurements are used for calculating the gauge values.

Given this evaluation rules, the hanbok grading can be automatically established from a few body measurement inputs while keeping custom hanbok style. Table 2 shows female *Jogori*'s case of fuzzy mapping rules between a few body measurements and the evaluation method for resulting garment gauges. Group 1,2,3 are classified according to which body measurements are used for calculating the gauge values. Given this evaluation rules, the hanbok grading can be automatically established from a few body measurement inputs while keeping custom hanbok style.

Table 1. Kinds of Body Measurements

Garment Type	Required Measurements
Jogori (shirt)	Chest size (male) or Upper chest size (female), Back length, *Hwa-jang* (i.e. arm length)
Trousers	Hip size, Trousers length
Skirt	Upper chest size, Skirt length

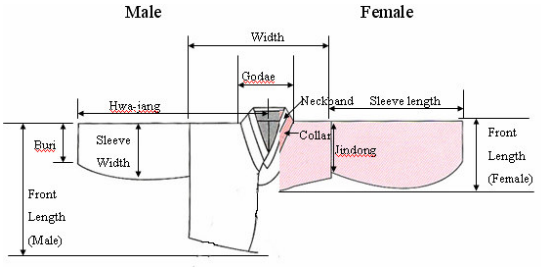

Fig. 2 Standard gauges of hanbok *Jogori*

Table 2. The Relationship Between Body Measurements And Gauges for *Jogori*

Body measurements for *Jogori* : Chest size(**A**), Back length(**B**), Hwa-jang(**C**)		
Group	Gauges	For female
1	Width of Jogori	**A**/4 +1.5~2
	Jindong (Width of a shoulder)	**A**/4
	Godae (Width between the right and left sides of the neck)	**A**/10 -0.5
	Width of a sleeve	Jindong +3 ~ 4
	Buri (Width of a cuff)	Jindong × 3 / 5
2	Jogori back length	**B**
	Jogori front length	(Jogori back length) +3~4
3	Length of a sleeve	**C** − (Jogori width)

3.2 *Draping* knowledge-base : resizing rules reflecting individual body characteristics

Even though the standard garment gauges are created in several levels, many of actual people do not have body shapes well matched to a body size in any of standard levels. Thus, though the grading rules given in the previous section enables gauge value construction for generally big or normal or small sizes, they do not work well with, for instance, short but fat body style or, in opposition, tall but thin body shape. In particular, *Jogori* style, for instance, is traditionally depending much on the shapes of face, neck and the line from chest to shoulder. Therefore, we need a second step resizing for such various characteristics of body shapes.

To provide this draping rules, we studied designer's guides where their empirical knowledge is expressed quite vaguely as : "for the fat body shape while short in height, the length of Jogori shouldn't be too long or short". Since such expert's knowledge is not computationally applicable, we classified the rules according to body characteristics: (1) global body shape (2) local body characteristics (3) face shape. In each category, we constructed a fuzzy knowledge base on how to adjust detail measurements of hanbok accordingly. To do this, we first classify the given character shape into

Table 3. Local adjustment according to the individual body shape. (Note: 'F.L.', 'B.L.'– front/back length, 'F.W.' ,'B.W.'– front/back width)

1. Categories of whole body shape
(**a**=Narrowing, **b**=Narrowing a little, **c**=Widening a little, **d**=Widening)

Measure / Whole -ments / Body Shape	Length of Jogori	Width of Jogori	Jindong (arm hole)	Width of Sleeve	…
Short and fat	1	× ***b***	× ***b***	× ***b***	
Short and thin	1	1	1	1	
Tall and fat	1	1	1	1	
Tall and thin	× c	× ***c***	× ***c***	× ***c***	
Body shape with its chest pushed out	F.L. × ***d*** B.L. × ***a***	F.W. × ***d***	1	1	
Body shape with its chest bent in	F.L. × ***a*** B.L. × ***d***	F.W.× ***d***	1	1	

2. Categories of local body shape

Measurments / Local / Body Shape	Shou -lder	Collar	Width	Skirt	…
High shoulders	× ***c***	Width × ***d*** Length× ***d***	1	1	
Drooping shoulders	× ***b***	× ***d***	1	1	
Big chest	1	1	F.W. × ***d***	Waist× ***c***	
Big chest & belly	1	1	F.W. × ***d***	1	
Big belly	1	1	Lower width × ***d***	Waist× ***c*** Length× ***d***	
Long neck	1	Width × ***a*** Length× ***d***	1	1	
Short neck	1	Width × ***d*** Length× ***a***	1	1	

3. Categories of ' face' shape

Measurements / Face Shape	Collar	Neck band	…
Round shape	Width × ***a***, Length × ***d***	× ***a***	
Long face	Width × ***d***, Length × ***a***	× ***d***	
Square shape	Width × ***d***	1	
Inverse triangle shape	Width × ***d***	× ***d***	
With high cheekbones	Width × ***a***, Length × ***d***	× ***a***	

one of the fuzzy descriptions in that category. This is accomplished by comparison of the standard and the given body shapes and clustering into fuzzy descriptions based on the difference scale. Once we find the given character's fuzzy description category, we apply the adjustment rules presented in Table 3. This table is the summary of final draping rules regarding various characteristic body shapes. In these rules, descriptive expressions such as `reduce the length', `reduce it a little', `make it wider a bit' are transformed into the rules with fuzzy scale factor labeled as *`a, b, c, d'* respectively. These fuzzy-scale factors are applied for adjusting the garment measurements evaluated in the previous section in multiplicative manner.

4. Hanbok modeling and simulation : experimental results

Proposed hanbok animation system is implemented using MAYA API and MEL. The overall architecture is shown in Fig. 3. By selecting a character, initial body measurements are determined from the character. Since user also specifies hanbok type (*Jogori*, trousers, etc), the corresponding cloth pattern is loaded from pattern database. After this, the 1st step knowledge is applied to evaluate garment parameters from basic body measurements. Next step is adjusting the detail scale of local garment parameters according to characteristic body shapes and finally the created hanbok is shown as wearing simulation in MAYA.

Fig.4 and Fig.5 shows some of the experimental results for hanbok simulation based on our knowledge-driven approach. In the first picture of Fig.4, we observe the character's belly area protruded outside his *Jogori.* Though this problem is somewhat corrected in the second picture by evaluating standard gauges from the given character's body measurements, the belly and the bust area is still tight. After the final adjustment is carried out based on draping knowledge-base, the charac

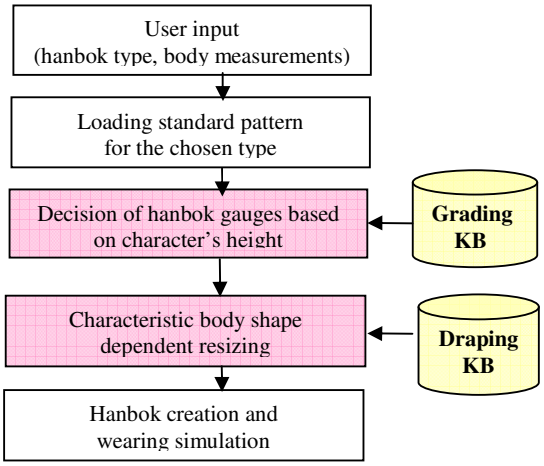

Fig. 3 Implementation architecture

-ter looks more comfortable and the hanbok silhouette is more natural as presented in the last figure to the character's body shape while keeping the inherent style of hanbok. Fig.5 shows the wearing simulation results, where our approach is applied to several characters with different body shape characteristics.

Fig. 4. Wearing simulation by sequentially applying 2-phase knowledge-bases

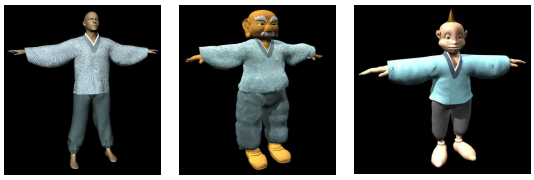

Fig. 5. Some results for different characteristic body shapes

5. Conclusions and Further Remarks

In summary, this paper proposed a knowledge-driven hanbok draping method that enables animators can create correct style of costume without hanbok design knowledge. Our knowledge based framework can further be enhanced by embedding learning methods. Also, inherent wearing style of hanbok such as 'wearing by folding' should be more studied to generate realistic digital hanbok draping simulation.

References

1. S. J., Kim et al, "Digital Fashion," KISS, vol. 21, no.2, pp. 35-42, 2003.
2. DressingSim PatternMaker (dressingsim.com)
3. Syflex -Cloth Simulator.(http://www.syflex.biz)
4. Pad system.(http://www.padsystem.com)
5. F. Cordier et al., "Made-to-Measure Technologies for Online Clothing Store," IEEE CG&A, vol.23, pp. 38-48, 2003.
6. M. J. Han and M. K. Song, "A studies on the automatic drawing and grading of Korean Man's hanbok durumagi using apparel CAD system," Journal of Korean society of clothing and textiles, vol.24, no.6, pp. 799-809, 2000.
7. J. W. Lee, "Revision: making hanbok(Korean)," Kyungchoon publishing co., 1999.
8. S. J. Kang et al, "Research on measurement standard for ready-made hanbok intended for women in their twenties," Journal of Korean Society of Costume, vol.43, 1999.
9. S. J. Kang et al, "Development of men's hanbok jacket(jogori) and trousers patterns for ready-made hanbok," Journal of Korean Society of Costume, vol.47, 1999.