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A Study on Material Analysis with Usability for Virtual Costume Hanbok in Digital Fashion Show

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디지털 패션쇼를 위한 가상 한복 재질분석 및 사용성 연구

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Abstract This study seeks to propose the virtual costume's pipeline production in digital fashion show which is based on the unique characteristic combining computer graphic technology and traditional fashion design. This study analyzed the fabric materials based on Korean traditional costume to create a virtual Hanbok for the digital fashion show, and conducted the group of professional's satisfaction statistics through the experiment to verify the realistic usability. The contents of primary process of producing virtual Korean costume is analyzed by summarizing the thickness, weight, and color as the three essential fabric properties required for virtual Hanbok. In addition, virtual costumes are compared with real Hanbok based on the usability survey to evaluate the positive research result by forty graphic experts. The purpose of this study is to present the guideline of essential material analysis of the fabrication to digital fashion show in the virtual clothing production.

Key Words : Computer Graphic, Digital Fashion Show, Virtual Hanbok, Material Analysis, Usability Survey

요 약 본 연구는, 기존의 전통적인 패션쇼를 근간으로 빠르게 발전하는 컴퓨터 그래픽 기술을 접목, 새로운 형식의 패션쇼로 최근 연구되는 디지털 패션쇼를 위한 가상 한복 제작과 관련된 연구이다. 한국의 대표적인 전통의상을 소재로, 디지털 패션쇼를 진행하기 위한 가상의 한복의 제작을 위하여 필수적으로 적용되어야 하는 재질들을 분석하고, 사실성 검증을 위하여 전문집단 그룹을 통한 사용성 통계를 진행하였다. 이를 위해 선행연구로 가상 한복 제작에 요구되는 세 가지 필수 재질인 두께, 무게 그리고 색상을 정리한 후, 3D 한복의상을 제작하여 실재 복원된 한복 의상들과 비교, 40명의 피실험자들의 평가를 기준으로 만족도를 조사하여 사용성 통계수치를 통한 분석연구를 진행하였다. 최종적으로 사용성 통계의 분석을 통한 매우 긍정적인 만족도 결과는, 향후 디지털 패션쇼 가상의복의 제작에 필요한 구체적인 재질분석 가이드라인을 제시함에 본 연구의 목적과 의의를 두었다.

주제어 : 컴퓨터 그래픽, 디지털 패션쇼, 가상 한복, 재질분석, 사용성 조사

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1. Introduction

1.1 Research background

The virtual reality using 3D graphic has been developed mainly in the game design and production design industry along with the animation movie industry, thereby the immersion feedback of public audience had been influenced by the modern virtual media as the computer graphic technology is rapidly developed[1,2]. Modern fashion industry was also attracted by the interest of the general public by integrating both fashion and 3D graphic.

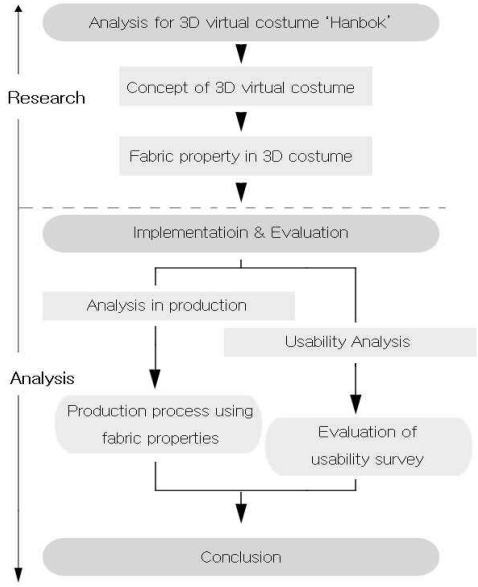
The 3D digital fashion show, which mainly utilizes 3D images, is common to apply the core factors from the traditional fashion show since digital components are still based on the format of fashion industry. The component perspective of the 3D digital fashion show is similar to the basic form of existing fashion shows although there is a difference in media as a virtual fashion show using computer graphic generated 3D images rather than real live action[3,4]. However, in terms of production perspective, 3D digital fashion show can be evaluated its similarity to the 3D animation development where they mainly use 3D graphics to build the contents. Therefore, virtual fashion show relies on 3D graphic designers rather than fashion designers to produce the essential graphic elements such as model, costume, and animation using 3D graphic softwares[5].

This study analyzed core graphical materials of Korean traditional costume Hanbok by examining the three fabric components between the thickness, weight, and color to provide practical guidelines in the production of 3D digital fashion show. This study has its purpose to extend the knowledge of essential forms of digital fashion costume's usability by enhancing the virtual fabric materials in order to provide the most efficient production methods for both fashion and graphic designers who are planning to produce the virtual Hanbok in 3D fashion show.

1.2 Scope and method of research

In order to present design guidelines for efficient production methods during digital fashion show's costume usability, this study researched on the related studies of digital fashion show and the material analysis in virtual costume creation process as the conduction of precedent research[6]. Next, the study proceeded visual processing experiment of the virtual costume Hanbok's development by coordinating three components in thickness, weight, and color through the material analysis in relation to the digital fashion show. Then the study evaluated the validation of the usability research by conducting the survey from the participants of fashion and design industry.

The following [Fig. 1] is a summary of the scope of the research through the overall analysis study.



[Fig. 1] Research procedure

2. 3D Virtual Costume

2.1 Concept of virtual costume

With the intention of defining the concept of virtual

costume, it can be defined as a 3D garment used in a fashion show realized through a digital clothing technology using computer graphics[7,8]. Virtual costume is expected to be the mainstream of future fashion show based on the analysis of attempt to incorporate digital technology will continue, and it can be the potential business type not only the fashion shows industry but also virtual marketing industry[9].

The following [Fig. 2] is a picture of virtual costume in digital fashion show by Harriette Kim[10].

[Fig. 2] Digital fashion show by Harriette Kim

2.2 Fabric property in 3D virtual costume

Classifying the fabric property of the garment by compositing elements is necessary to verify the preset of virtual costume, so the study used the properties into the three components such as Thickness(T), Weight(W), and Color(C). The following <Table 1> is a brief summary analysis of three main components of the fabric properties required for the implementation of virtual costume for this study[11].

In the case of the thickness property, the thicker the material, the stronger the sagging silhouette of the fabric and the greater the bending of the wrinkles. In addition, the fabric material's inflation silhouette could be implemented by the correlation from the number of wrinkles since the frictional force between the wrinkle-forming faces is reduced in the fabric density when the wrinkles are reduced.

In the case of the weight property, the density becomes higher as the material becomes heavier, and the fabric silhouette is strongly influenced by both air resistance and environment gravity along with the model's runway movement. Therefore, it is essential to understand the interrelationship between property weight and setting of virtual environment along with physical effects on gravity and wind.

In the case of the color property, it is possible to adjust the component independently in the multiple stages unlike thickness and weight, since there is less interrelation between the constituent element of the attributes and visual finalizations process.

<Table 1> Fabric property in virtual costume

Property	Element	Description
Thickness	Stretch	Regulating the contraction and relaxation of the slack from garment thickness
	Bend	Adjust the strength of bending strength for the turnaround in garment thickness
	Friction	Adjust the strength of the change in the deformation upon impact on the garment thickness
Weight	Density	Adjust the density of the weight of garment weight
	Air Drag	Resistant strength adjustment for the change in the environmental garment weight
	Gravity	Strain control on the ground from the garment weight
Color	Primary color	Adjust the primary colors of garment in design concepts
	Reflection	Reflectance value adjustment for the light emission color in garment
	Opacity	Control the intensity of the transparency in garment

In addition, this study selected silk fabric property as the main material of costume Hanbok to emphasize the realistic garment expression of high color density and reflection of colorful glossy effects[12]. Therefore, the study mainly represented virtual fabric of silk which has a characteristic from dense wrinkles with bending and stretching on wrinkle impression to the material flows naturally downward by enhancing the density.

3. Implementation and Evaluation

This study focuses on the manufacturing steps of virtual Hanbok where the thickness, weight, and color are adjusted in the materials through the experimental procedure development in order to extract the sources for the usability survey research based on graphical comparison result between the four different virtual costume of Hanbok. This study also provides the satisfaction result of virtual fabric material attributes through the range of selected group of forty fashion and graphic experts.

3.1 Analysis in production

In order to embody the productional method, this study classified the productional process of virtual Hanbok into the five procedures in the development process. The criterion of the five sections during the development is oriented to the core procedure where the fabric material can be implemented along with differentiation of application in the material properties such as thickness(T), weight(W), and color(C).

First, in the case of pattern process, it processes of a virtual pattern creation to the similar types of costume fabric development process in a real Hanbok production. During this process, material properties such as thickness, weight, and color are not applied, however it is initial step of generating fabric patterns.

Second, in the case of modeling process, it processes of placing the virtual fabric patterns in the one piece costume of Hanbok by applying the patterns into the virtual character model. This study used the thickness adjustment in 70 percentage to control on the basic length of top Jegori and bottom dress for Hanbok and weight adjustment in 30 percentage to limit the number of wrinkles.

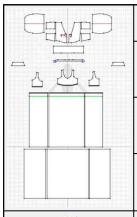
Third, in the case of shading process, it processes of assigning the proper shape and color to the basic fabric costume of Hanbok by shader property. This study used the thickness adjustment in 50 percentage to sort out the number of inner layers from the top Jegori, and color adjustment in 50 percentage to control the transparency by polishing the multiple layers in the bottom dress of Hanbok.

Fourth, in the case of texture process, it processes of applying the graphic textures into the shaded costume which was created in the previous stages. This study used color adjustment in 70 percentage while applying the multiple textures to implement the relationship between multiple textures and lighting refraction, and weight adjustment in 30% to strain the physical control of gravity and air in order to express the initial look of virtual Hanbok with texture.

Finally, in the case of posing process, it processes final polishing the overall look of virtual costume by simulating the character model with virtual Hanbok. This study used all the property elements from thickness adjustment in 20 percentage, weight adjustment in 50 percentage, and color control in 30 percentage to coordinate the final look of Hanbok with runway animation.

The following <Table 2> is a brief summary of the coordinated appearance process using the material properties of virtual Hanbok based on the production pipeline. The modeling process is based on the thickness and weight to generate the basic model while shading process is focusing on the basic color of the costume. Texture process is oriented to the overall theme color and opacity adjustment with implementation of textiles. In the posing process, it is essential for graphic designers to adjust overall material properties based on thickness(T), weight(W), and color(C) with certain motion to the character model with proper understanding of basic pattern making methods from the traditional fashion design industry[13,14,15].

<Table 2> Summary of process in virtual Hanbok

	#1 Pattern Process		
	T	0%	Not applied in this stage
	W	0%	Not applied in this stage
	C	0%	Not applied in this stage
	#2 Modeling Process		
	T	70%	Thickness contraction and relaxation adjustment
	W	30%	Wrinkle thickness and length adjustment
	C	0%	Not applied in this process
	#3 Shading Process		
	T	50%	Penetration of character and costume adjustment
	W	0%	Not applied in this stage
	C	50%	Basic color (RGB) adjustment
	#4 Texture Process		
	T	0%	Not applied in this stage
	W	30%	Draining of wrinkle between costume adjustment
	C	70%	Texture color and transparency in layer adjustment
	#5 Posing Process		
	T	20%	Overall thickness through silhouette shape adjustment
	W	50%	Wrinkles creeping and flowing down between upper and lower garment in motion
	C	30%	Overall color adjustment in walking motion

3.2 Usability analysis of virtual Hanbok

Based on the analysis of the material production described from the previous study 3.1, this study selects positively restored Josen dynasty female Hanbok to compare the visual likeness by simulating the four sets of virtual Hanboks. This study processes a statistic survey involving forty fashion and graphic design specialists to verify the visual likeness since usability of Hanbok's silk fabric can be evaluated by audience for its realism through the similar pose of natural wearing style. This study produced the four types of virtual Hanbok costumes of Queen's White Hanbok, Court Lady's Hanbok, Princess's Green Hanbok, and Queen's Red Hanbok as shown in the following <Table 3>.

The left side photo of first Hanbok (A) is restored by Kim, Jung Mi to establish the original Queen's White Hanbok. The shape of this Hanbok expresses the split of two sides under the armpit, and the length of the front and back of Jeogori jacket is three times longer than normal Jeogori jacket. The skirt has trace of straight lines, and it looks easy to be wrinkled since the property of the material is composed of thin silk fabric. The basic shader of the Jegori used color set of Red(243), Green(232), and blue(226) to reflect the real Hanbok.

The left side photo of second Hanbok (B) is restored by Cho, Jung Hwa to establish the original Court Lady's Green Hanbok. The shape of this Hanbok expresses the low saturated color of green and blue with splitted armpit area while straight lines of lower bows are descend to the front and back of the Jeogori jacket. The characteristic of the fabric is presented by a thick material silk property to illuminate roundy curve shape of the skirt with less wrinkled fabric material. The basic shader of the Jegori used color value of Red(191), Green(181), and blue(122) to reflect the real Hanbok.

The left side photo of third Hanbok (C) is restored by Km, So Hyun to establish the original Princesse's Light Green Hanbok. The shape of this Hanbok expresses a form of deep curve on the bottom front lower bows splitted under the armpit area on the Jeogori with high dilatable skirt silhouette while color set composed the medium and high brightness. The characteristic of the fabric is used thin silk material with a colorful pattern added by micaceous textile reflection. The basic shader of the Jegori used color value of Red(209), Green(198), and blue(80) to reflect the real Hanbok.

Finally, the left side photo of forth Hanbok (D) is restored by Seo, Young Lim to establish the original

Queen's Red Hanbok. The shape of this Hanbok expresses a forms of splitted lines under the armpit area while triangle shaped curve on the lower bows of Jeogori with dilatable unfurl skirt silhouette. The characteristic of the fabric is used a layered thin silk material with both high saturation and brightness on the color set of micaceous textile's high reflection. The basic shader of the Jegori used color value of Red(243), Green(35), and blue(48) to reflect the real Hanbok.

<Table 3> Comparison chart for usability survey

	Photo	3D Front	3D Side	3D Back
A				
B				
C				
D				

Next, usability evaluation survey was processed to compare with the existing Hanbok to the results from the four types of virtual Hanbok costumes. The usability evaluation was based on the survey analysis of visual satisfaction range of zero to ten scale as shown in the following <Table 4>.

<Table 4> Survey of satisfaction scale

Scale 0 ~ 2	Very dissatisfied
Scale 2 ~ 4	Dissatisfied
Scale 4 ~ 6	Neutral
Scale 6 ~ 8	Satisfied
Scale 8 ~ 10	Very satisfied

In the case of virtual Queen's White Hnabok (A), satisfaction scale was analyzed with average score of 7.34 on the front, 8 on the side, and 8.01 on the back as shown in the similarity of overall silhouette survey in <Table 5>. In terms of fabric properties of thin silk, Hanbok (A) increased the fit of the Jeogri silhouette from model's body shape through the adjustment of both weight and thickness, therefore the Hanbok shape received high score on Jegori's shoulder and chest areas in front view. Hanbok (A) was also received a high satisfaction score from naturalness between the shoulder and hip's overall silhouette on the side view since the spreading material of the thin silk property continued the smoother transition from the front shape throughout the back shape with translucent white and opaque dark blue set in color.

In the case of virtual Court Lady's Green Hnabok (B), satisfaction scale was analyzed with average score of 7.4 on the front, 8.02 on the side, and 7.85 on the back as shown in the survey <Table 5>. Hanbok (B) was received high satisfaction score on shoulder areas of Jegori since the thicker silk material was expressed by less number of wrinkle bending with low saturated opaque green color. In both side and back view, Hanbok (B) was interpreted smoother fabric property to express the thicker silk material by expressing heavier and rounder shape of wrinkles, therefore the study analyzed the high average satisfaction score was established on side view.

In the case of virtual Princesse's Light Green Hanbok (C), satisfaction scale was analyzed with average score of 7.73 on the front, 8.12 on the side, and 7.99 on the back as shown in the survey <Table 5>.

<Table 5> Survey result of usability evaluation

	Evaluation item lists	A	B	C	D	Average
Front	1. Overall silhouette match	7.45	7.15	7.45	7.75	7.45
	2. Neck shape match	7.45	7.2	7.45	7.4	7.38
	3. Shoulder shape match	7.8	8.45	8.2	8.2	8.16
	4. Chest shape match	7.6	7.55	8.25	7.85	7.81
	5. Waist shape match	7.6	7.8	8.1	8.1	7.9
	6. Hip shape match	7.2	7.25	7.55	7.6	7.4
	7. Armpit shape match	7.1	7.45	7.95	8.35	7.71
	8. Hem shape match	6.1	7.3	7.25	7.75	7.1
	9. Seam line shape match	7.65	6.3	7.5	8.1	7.39
	10. Fabric look match	7.4	7.5	7.55	7.65	7.53
	Average of front	7.34	7.4	7.73	7.88	7.58
Side	1. Overall silhouette natural	8.25	7.9	7.9	8	8.01
	2. Neck shape natural	7.75	8	8.05	7.95	7.94
	3. Shoulder shape natural	8	8.3	8.15	8.25	8.18
	4. Chest shape natural	8.05	8.2	8.3	8.05	8.15
	5. Waist shape natural	8	8.4	8.3	8.25	8.24
	6. Hip shape natural	8.2	7.55	8.1	7.8	7.91
	7. Armpit shape natural	7.8	8.4	8.1	8.2	8.13
	8. Hem shape natural	7.9	7.7	8.1	8.25	7.99
	9. Seam line shape natural	8.3	7.65	8.2	7.75	7.98
	10. Fabric look natural	7.75	8.1	7.95	8.35	8.04
	Average of side	8	8.02	8.12	8.1	8.06
Back	1. Overall silhouette natural	8.1	7.75	7.8	7.7	7.84
	2. Neck shape natural	8.05	8.1	8.2	8.4	8.19
	3. Shoulder shape natural	8.2	8	8.1	8.25	8.14
	4. Chest shape natural	7.55	7.75	7.9	7.75	7.74
	5. Waist shape natural	8.05	7.8	7.95	8.15	7.99
	6. Hip shape natural	8.15	7.9	8	7.85	7.98
	7. Armpit shape natural	8.05	7.8	8.1	8.25	8.05
	8. Hem shape natural	8.1	7.75	8	8	7.96
	9. Seam line shape natural	8.1	7.75	7.8	7.85	7.88
	10. Fabric look natural	7.75	7.9	8.05	8.05	7.94
	Average of back	8.01	7.85	7.99	8.03	7.97
	Overall average	7.78	7.76	7.94	8	7.87

Hanbok (C) was received high satisfaction score on both chest, shoulder, and waist areas of Jegori since the thinner silk material was expressed by sharp wrinkled bending fabric with translucent green color set. In both side and back view, Hanbok (C) was received highest average satisfaction score comparing other Hanbok types because the fabric material and color adjustment of the Hanbok's skirt get widening toward the hem are expressed naturally.

In the case of virtual Queen's Red Hanbok (D), satisfaction scale was analyzed with average score of 7.88 on the front, 8.1 on the side, and 8.03 on the back as shown in the survey <Table 5>. Hanbok (D) was received high satisfaction score on shoulder, waist, armpit, and seam line shape areas of Jegori since the thinner silk material was expressed by both higher number and rounder shape of wrinkles. In addition, it raised the fabric property of inflation to the thin silk material, and the expression was analysed the positive evaluation. In both side and back view, Hanbok (D) was received high average satisfaction score since the fabric material and color adjustment of the Hanbok focused the hem shape and skirt color expression brought the brighter texture of the skirt material with high glossy silk reflection from the texture.

Overall, the total average score of all the Hanboks was reported 7.87 from the survey, and the evaluation of the high satisfaction scale can be analyzed as potential usability in the virtual fashion show. In addition, Hanbok (D) received the highest satisfaction score of overall average 8, and this evaluation proves audiences are more influenced by Hanbok's natural inflation effect of thinner silk material with higher texture reflection in general.

4. Conclusion

This study focused on restored Korean traditional costume Hanbok in virtual 3D format, and initiated on the usability evaluation through the virtual production process using specific material property from the highly restored real Hanbok, and the result clarified from the virtual fashion show designer's viewpoint. This usability evaluation study has importance of the research not only on the possibility of virtual reproduction in positively restored of Hanbok, but also analysing the fabric material property to reproduce the virtual costume reality in the fashion and marketing industry. Meanwhile, the result of the analysis are limited to the four specific restored Hanbok designs, which can be extended to consecutive analysis of different costume styles in the future researches.

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