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Quantification of emotional evaluation by establishing quantitative evaluation method of textile products using digital signal

Jungtaek Oh* and Kyeongeun Lee **

** FITI Testing & Research Institute, 79, Magokjungang 8-ro 3-gil, Gangseo-gu, Seoul, South Korea*
jws635@fiti.re.kr
*** FITI Testing & Research Institute, 79, Magokjungang 8-ro 3-gil, Gangseo-gu, Seoul, South Korea*
kelee@fiti.re.kr

Abstract: Although the degree to which a human visually sense a wrinkle of a textiles product is graded on the basis of a visual evaluation called a sensory test, there are differences in the results depending on the condition of the judge, the personal experience, and the surrounding environment. Therefore, the 3D image of the wrinkle shape was obtained by using the 3D scanner for the AATTCC 3-Dimensional Wrinkle Recovery Replicas, and the wrinkle degree (height, change amount, etc.) was quantified through the digital image analysis. We aim to provide quantitative data for the development of textile products by establishing a system that can objectively evaluate the degree to which persons feel about wrinkles.
Keywords: *Textile product, Wrinkles, Sensory test, 3D scanner, Digital signal*

1. INTRODUCTION

The dictionary definition of emotion can be defined as the as "the any conscious experience characterized by intense mental activity and a certain degree of pleasure or displeasure". Because of the well-being trends, lifestyle changes and the emotional consumption which emphasizes high sensitivity and comfort, not only the functionality (good performance, quality and reliability) of the product but also the emotional satisfaction (the five senses) is a critical factor in consumer's purchase of product. As the importance of emotional quality increase, an objective evaluation method should be established and emotional factors affecting the preference and satisfaction of product should be derived.

Wrinkle o fabric is a part of form maintenance and functional characteristics of clothes; it is an important factor of emotional satisfaction classified by visual sense from the five senses. The method of evaluating the wrinkles of the fabric is divided into the appearance method and the recovery angle method, and the recovery angle method is again divided into the Monsanto method and the T.B.L method. In the Appearance method[1], a wrinkle tester is used to wrinkle the fabric, and the wrinkle shape of the fabric after a period of time is compared with the visual replicas. Three trained observes judge the three samples to obtain nine results, the average value is displayed.

However, in the case of appearance judgment by human eyes, they may be a difference in results depending on personal factors (ages, gender and psychological status), social factors (family relations, local committee and environment) and cultural factors (tradition, race and life culture). The observer's subjective evaluation and the generalization of the subjective evaluation results may face situation where the improvement factor of the product is unknown. Therefore, it is necessary to build an evaluation system based on digital data instead of the sensory evaluation method.

In this pager, 3D image corresponding to each grade is acquired with 3D scanner for AATCC 3-Dimensional wrinkle recovery replicas which is used for sensory evaluation and classified into 5 grades according to wrinkle shape. The image analysis program was used to analyze 3D image to quantify the height of wrinkles and the amount of change. For the change of surface of fabric such as wrinkle, digital measurement system using digital signal was established to evaluate emotional quality more objectively and to quantify.

2. EXPERIMENTS

2.1 AATCC 3-Dimensional Wrinkle Recovery Replicas

In order to analyze and compare the measurement results, the AATCC 3-Dimentional Wrinkle Recovery Replicas were used, as shown in **Figure 1**. A No. 5 rating is equivalent to the WR-5 Replica and represents the smoothest appearance and best retention of original appearance, while a No. 1 rating is equivalent to the WR-1 Replica and represents the poorest appearance and poorest retention of original appearance.

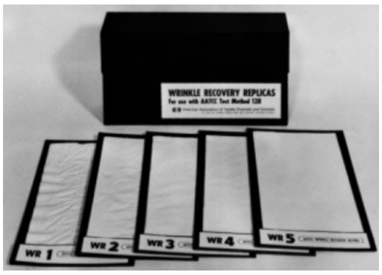


Figure 1: AATCC 3-Dimensional Wrinkle Recovery Replicas

2.2 3D Scanner

The measuring system of AATCC 3-Dimensional Wrinkle Recovery Replicas, shown in ***Figure 2***, consisted of a 3D scanner (Go!SCAN 50 by Creaform) and a computer for image processing. Details of the 3D scanner are shown in ***Table 1***. The 3D scanner used in this study displays scanned data images in real time while scanning, and generates highly accurate mesh data.

Table 1: Details of the 3D scanner

Measurement Rate	550,000 measures/sec
Resolution	0.500 mm
Accuracy	0.100 mm
Distance of point	400 mm
Scanning Area	380 × 380 mm
Positioning Methods	Geometry and/ or color and/ or targets

Figure 2: 3D scanner

2.3 Used software: VXelement and VXmodel, Polyworks

2.3.1 VXelement

The mesh data is generated in Vxelement, which is software connected with the 3D scanner.

2.3.2 VXmodel: SCAN-TO-CAD software module

VXmodel is post-treatment software that directly integrated into VXelements, and enables finalizing 3D scan data to use directly in any CAD software. VXmodel provides the simplest and fastest path from 3D scans to computer-aided design or additive manufacturing workflow. Table 2 compares the VX model and software specifications.

Table 2: Comparison of VXelements and VXmodel

Contents	VXelements	VXmodel
Multiple Measurement Mode	√	
Mesh Editing		√
Alignment	√	√
Geometric Entities	√	√
NURBS Surface		√
Transfer to CAD software		√
CAD import		√

2.4 PolyWorks

PolyWorks is 3D measurement software that is compatible with a wide range of 3D measurement instruments and is used for inspection and reversing engineering. The PolyWorks process consists of three sub-processes, as shown in the workflow of ***Figure 3***.

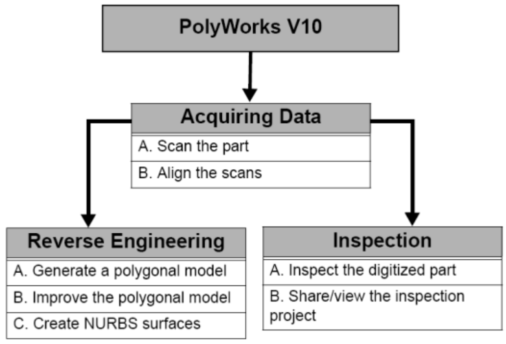


Figure 3: Typical PolyWorks Workflow

2.5 Measurement Method

2.5.1 Threshold value in height

When 3D scanning of the AATCC 3-Dimentional Wrinkle Recovery Replicas is complete, optimized mesh data is automatically generated in the VXelement software. Analysis is performed based on the image of the obtained mesh data. The generated image is focused and arranged at the center. An image of size 180cm×100cm is cut around the center of the focus, and the analysis proceeds based on this image.

After export the generated image sample mesh data from VXmodel, import it into PolyWorks software. The flattened CAD image of the same size is used as the baseline, and the mesh data sample and the best fitting image is obtained.

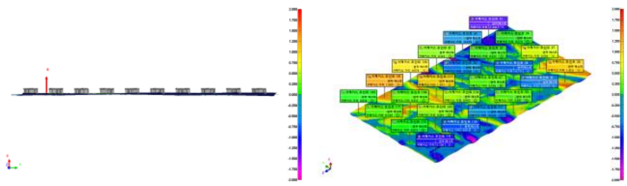
In this order, each AATCC 3-Dimentional Wrinkle Recovery Replicas are the same task, which is the basis for data comparison. In the best-fit image, calculate the change in error rate by using the PolyWorks function to change the threshold value.

2.5.2 Surface comparison point creation tool

The height of a point on the sample, Xi is calculated from the 3D image by PolyWorks functions. Using the surface comparison point creation tool, the sampling was made in a grid pattern. A total of 180 points were measured at intervals of 10 mm. (***Figure 4***)

The height was measured above the surface of the projection axis, and the radius was set at 2.5.

With these figures, results was derived from the three calculation methods (Mean heights, Standard deviation, Mean deviation) expressed in Mirjalili(2010) paper[2],[3].



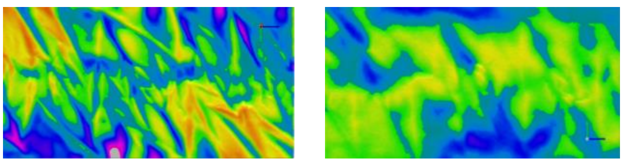
(a) (b)

Figure 4: Sampling method in a grid pattern

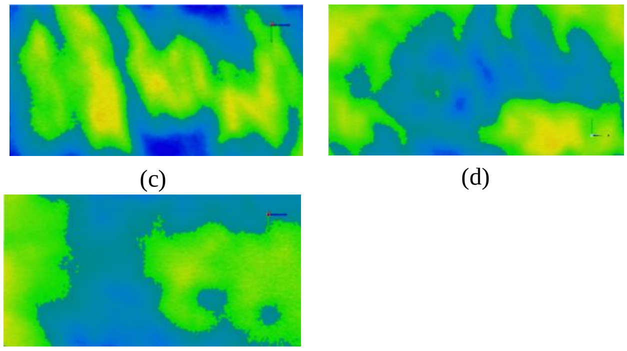
3. RESULTS AND DISCUSSION

3.1 Acquisition of 3D image

A 3D image of the AATCC replicas was obtained by using a 3D scanner and the height of the image was expressed in color like the contour line by the "data color map" function. By setting the maximum value to 2 mm and the minimum value to -2 mm through the "color scale editing" function, the color ranges of the five images are set to be the same. The final image format is shown in ***Figure 5***. From the measured 3D image, the lower the grade, the more clearly the shape of the wrinkles was, and the height of the wrinkles and the degree of the change were confirmed.



(a) (b)



(c) (d)

(e)

Figure 5: 3D image of AATCC Replicas, (a) WR-1 Replica, (b) WR-2 Replica, (c) WR-3 Replica, (d) WR -4 Replica, (e) WR-5 Replica

3.2 Analysis of Height of wrinkles

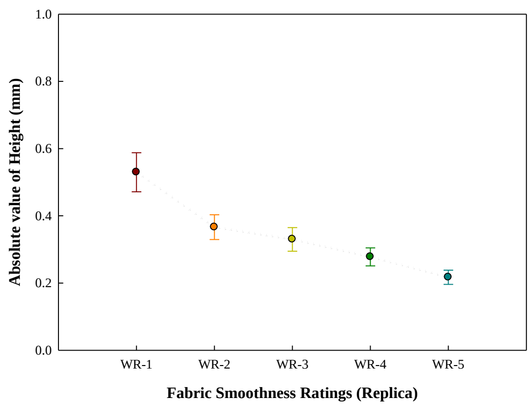


Figure 6: Comparison with height values of 5 levels

Table 3: Statistical value for the heights of the Replicas

	WR-1	**WR-2**	**WR-3**	**WR-4**	**WR-5**
Mean.	0.530	0.366	0.330	0.278	0.217
S.D	0.395	0.250	0.238	0.182	0.144
Confidence level (95%)	0.0487	0.0308	0.0294	0.0224	0.0177

As shown in **Figure 6**, the AATCC replicas average height was the highest in the WR-1 and the lowest in WR-5. In addition, the standard deviation range of 95% confidence level was the largest in the WR-1 and decreased to WR-5. The values are shown in **Table 3**.

This is because there are many wrinkles with a large height difference in the WR-1, which is consistent with the wrinkle reduction in the WR-5.

Both average height and standard deviation range of 90% confidence level showed the same tendency.

In conclusion the results show that these factors applied in this study, is suitable for the wrinkle assessment grade.

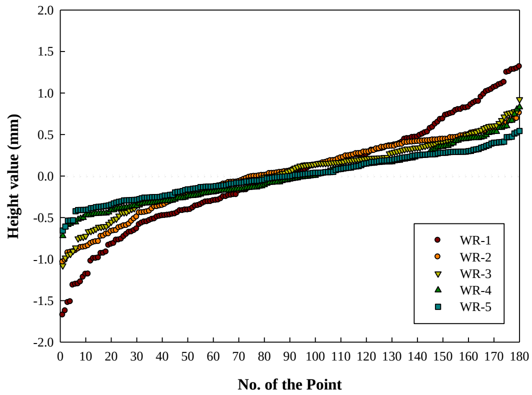


Figure 7: Height distribution of total data

When the height of 180 points was observed in the whole distribution, the value of the height showed a minimum height value between -2 and maximum height value 1.5. The most steep slope was observed at the WR-1 Replica with the largest wrinkles, and the slightest slope was observed at the WR-5 Replica with smooth wrinkles. (**Figure 7**)

Therefore, it was found that the wrinkles of the fifth grade can be judged by the height value. It is suggested that after the height of the sample is measured by 3D scanning, the grades can be selected by comparing the numerical data.

3.3 Threshold value setting

The level of wrinkles, along with the number and height of wrinkles, can be expressed in changed amount based on the initial shape. In order to quantify the changed amount, it is necessary to set a threshold value to recognize as a change, and it can distinguish the difference between the AATCC replicas. There the threshold value was varied between 0.1 and 1.0 at intervals of 0.1, and the changed amount was calculated for each interval. The measurement results are shown in ***Table 4***.

Table 4: Changed amount (%) of Replicas

Threshold (mm)		WR-1	WR-2	WR-3	WR-4	WR-5
UO	DOWN					
1.0	-1.0	13.2	1.60	0.96	0.00	0.00
0.9	-0.9	17.7	3.96	2.12	0.00	0.00
0.8	-0.8	23.2	6.90	4.51	0.46	0.01
0.7	-0.7	28.9	10.5	8.44	2.20	0.08
0.6	**-0.6**	**35.8**	**17.3**	**14.3**	**5.84**	**1.07**
0.5	**-0.5**	**43.6**	**27.9**	**22.7**	**13.1**	**4.66**
0.4	**-0.4**	**52.4**	**40.9**	**34.4**	**25.1**	**11.7**
0.3	**-0.3**	**62.1**	**53.9**	**48.4**	**41.0**	**29.1**
0.2	-0.2	73.6	67.7	63.4	61.0	51.6
0.1	-0.1	86.7	83.8	81.9	79.4	75.1

The changed amount of WR-4 and WR-5 was 0.00% or very low at threshold value of 0.7~-0.7 mm or more, Wrinkle height of WR-4 and WR-5 was found to be less than 0.7~-0.7 mm. When the threshold value of 0.2~-0.2 mm or less, the difference of the changed amount between the replicas is not large, and it is considered that it is difficult to grade the degree of wrinkles based on the measured values. There, it is possible to quantitatively classify the Replicas graded by the threshold value at the upper limit value of 0.3 to 0.6 mm and the lower limit value of -0.3 to -0.6, and it can be utilized as the guideline value for the wrinkle judgment.

4. CONCLUSION

In this study, the wrinkles were quantified by 3D scanning in order to minimize the error by the appearance test. After considering various factors, it was confirmed whether the numerical data could be graded.

1. The 3D image of ATTCC 3-Dimensional Wrinkle Recovery Replicas through 3D scanner was obtained.
2. The height of the sample was quantified through the acquisition of the 3D image, and this figure provided the foundation for grading the wrinkles.
3. The threshold value that can distinguish numerically the changed amount of wrinkle of the Replicas is calculated.

After that, it is expected that the application range can be extended to other evaluation methods for the change of surface of textile products by accumulating digital data on wrinkles.

ACKNOWLEDGMENTS
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REFFERENCES

[1] AATCC; Wrinkle Recovery of Fabrics: Appearance Method, AATCC Test Method 128-2009, 2010

[2] Seyed Abbas Mirjalili, Esfandiar Ekhtiyari; Wrinkle Assessment of Fabric Using Image Processing, FIBRES & TEXTILES in Eastern Europe, Vol. 18, No. 5 (82) pp. 60-63. 2010

[3] Chengxia Liu; New Method of Fabric Wrinkle Measurement Based on Image Processing, FIBRES & TEXTILES in Eastern Europe, 22, 1(103), pp.51-55, 2014