Evaluating the Evenness of Patterned Nonwoven Fabrics

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1. INTRODUCTION

The nonwoven fabric is replacing the conventional fabrics in various products. The reason is that the nonwoven fabric has low cost and good physical properties. However, the quality of nonwoven fabric should be improved to replace all conventional fabrics. To enhance the quality of product is needed in nonwoven industry. In nonwoven process, the fiber is converted into the web and then the web is converted into the fabric. So the quality of nonwoven fabric is largely determined by the quality of the web. It is not concerned with the yarn. But the detection and control of quality fault is very difficult in the web phase. Presently, no standard or widely accepted method for characterizing in it exists in the nonwoven industry, although a need for such is greatly felt.[1,2] There is presently no control or check except visual by the operator during actual process. And the testing method is only to measure the weight on the end product. Fabric inspection and grading, which depends on human sight, greatly influenced by the mental and physical condition of an inspector. The method measuring the weight is not exact.

Generally speaking, the reason the image of an object can be observed by human vision is the light intensity reflected from it. In fabric, the variation of density of fabric can be evaluated by the naked eyes. Optical sensor can convert light intensity reflected from the surface of fabric into the variation of current or voltage. The variation can be converted into numerical data. This data is used to evaluate the evenness of the fabrics. This method was applied to evaluate the evenness of patterned nonwoven fabrics in this paper.

2. EXPERIMENTAL

2.1 Samples and Image Capturing

Nonwoven fabrics used in this study were all commercially produced web. The details of these fabrics are in Table 1. The color of fabric was white. A EPSON GT-8500 scanner was used to capture the image. The scanning options were fixed as follows. Brightness, Contrast and sharpness was zero, highlight was 128, resolution was 72 DPI. To capture a clear image, a backside of specimen was covered with black

paper as shown in Figure 1. Scanned images were digitized as 8bits and stored as a 2-dimensional array. 256×256 elements of this array was used to analysis.

Table 1 Details of nonwoven fabric samples

fabric	PA015 N	PA020 N	PA030 N	PA040 N	PA050 N	PA060 N	PA070 N	PA080 N	PA090 N	PA100 N	PA150 N
weight (g/m^2)	15	20	30	40	50	60	70	80	90	100	150
thickness (mm)	0.21	0.24	0.28	0.38	0.48	0.50	0.52	0.55	0.59	0.61	0.72

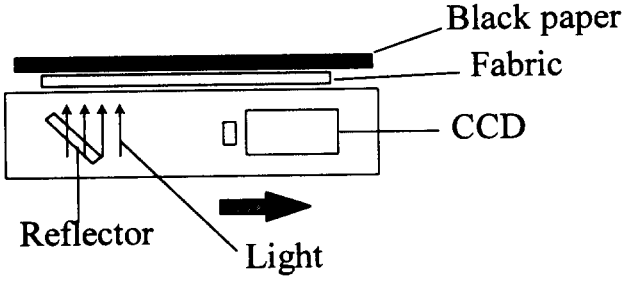

Fig. 1 Image scanning system

2.2 Reconstruction of Image

The stored images were first histogram equalized. Histogram equalization is to reduce high scale of image to low scale. In this study, 256 gray scale of image was changed into 2, 4, 16 gray scales. At total, four scale(2, 4, 16, 256) was used. The histogram equalized images have the advantage of saving time in calculation and unifying the distribution of the gray values of images as the gray scale.[3,4] Next, each image was displayed on the screen. And the histogram of image, mean value and CV% were plotted on the same screen.

2.3 Image Processing

The image of every nonwoven fabric sample used in this study has a pattern. So it is not proper to analysis the evenness of fabrics. The pattern should be reduced to analysis the image. To reduce the pattern, in this study, smoothing filter was applied.

3. RESULTS AND DISCUSSION

The relationship between web thickness and gray value was investigated. As shown in figure 2, there is a good linear relationship between web thickness and gray value. The result confirms that the gray value from scanner is reliable and the scanner is sensitive to measure the thickness.

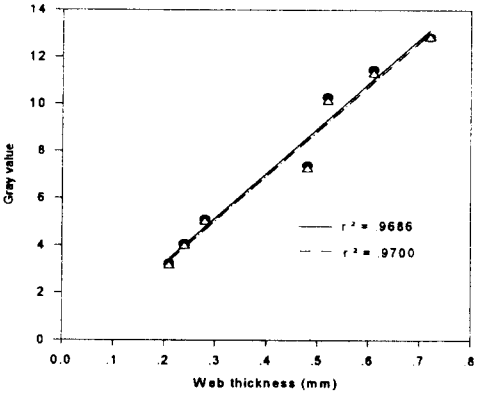

Fig. 2 Relationship between web thickness and gray value
● : Non-filtered image (r^2=.9686), △ : filtered image (r^2=.9700)

The images reconstructed in 4, 16 and 256 gray scale were similar to the image of nonwoven fabric, when they were compared by the naked eyes. In 2 gray scale, the image was less similar to the image. The CV% of this images was very large.(Fig. 4) It was thought that it was caused by the pattern of nonwoven fabrics.

To reduce the pattern of image, a smoothing filter was applied to this image. The filter kernel used was designed by experience. Figure 3 shows various kernel and filtered image. The kernel (c) was better than any other. But the kernel (c) may reduce patterns and a part of variation.[4,7] In this study, the kernel (b) was used.

In 2 and 4 scale, the filtered image was not proper to analyze the distribution of gray values, because the distribution was not clear. The distribution of gray scale was shown clearly in 16 gray scale. In 256 scale the efficiency of filtration was not good because the distribution of image data was large. After filtration in 16 and 256 scale, the CV% was decreased and the value of low gray level in histogram was reduced.(Fig. 4) It means that the pattern was reduced. The image reduced pattern makes it easy to analyze the evenness of nonwoven fabric, and make the CV% closer to the real CV%.

4. CONCLUSIONS

The evenness of patterned nonwoven fabric was evaluated by the image based method. In 16 gray scale, the image was proper to evaluate the evenness of nonwoven fabric. There exists a good linear relationship between web thickness and gray value.

The pattern was reduced by the image processing. The filtered image shows the distribution of thickness clearly. After filtration the CV% was decrease.

5. REFERENCE

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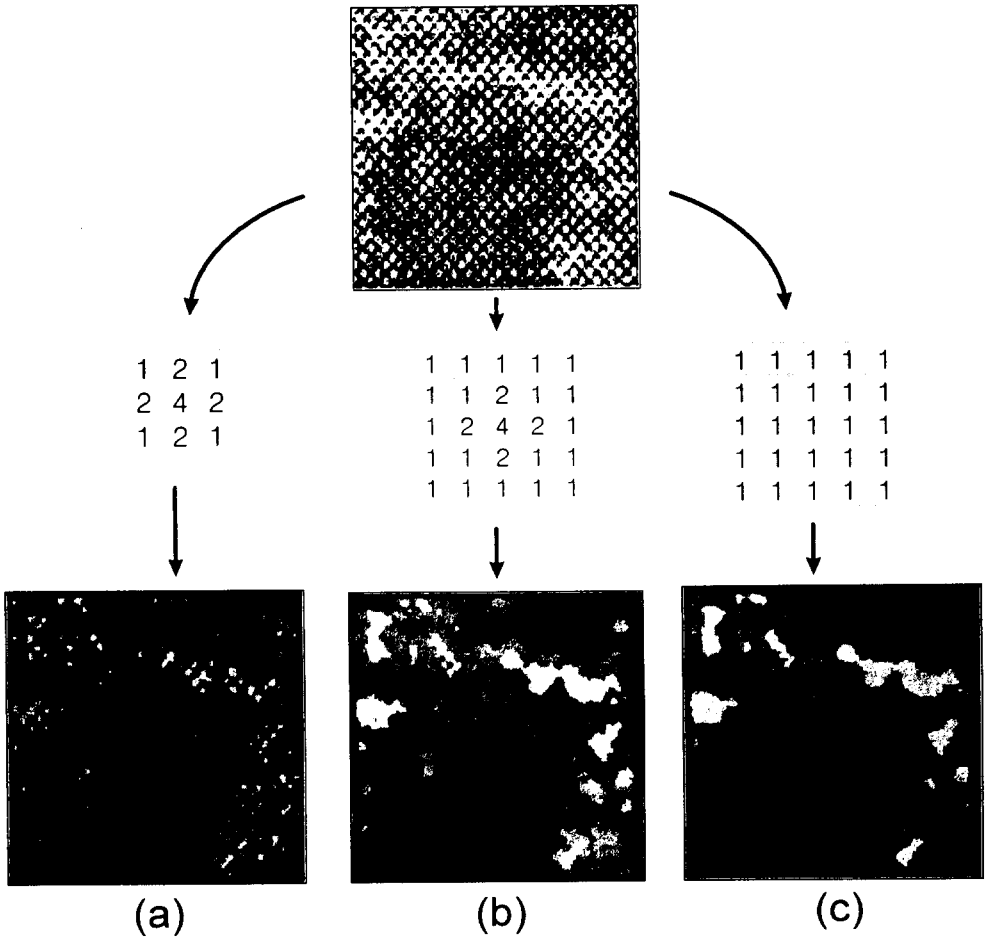
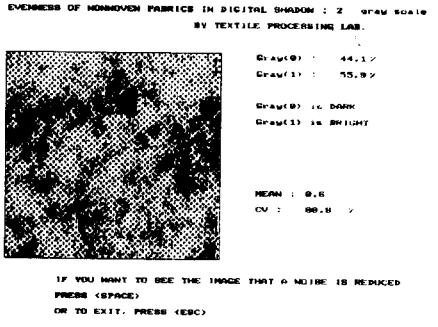
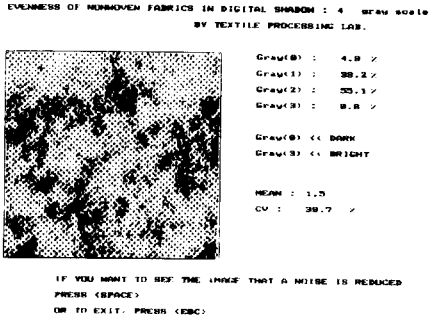


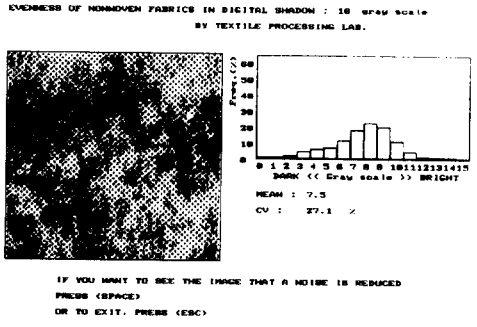
Fig. 3 Smoothing kernel and filtered image.



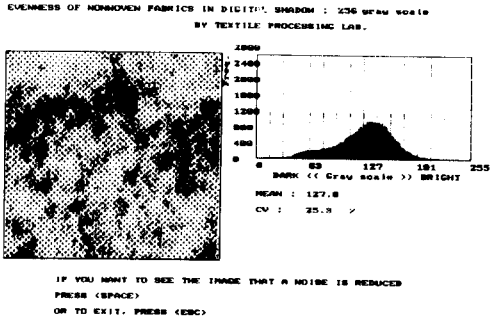
(a)



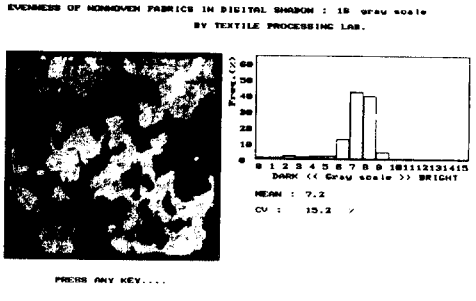
(b)



(c)



(d)



(e)

Fig. 4 Reconstructed image (a),(b),(c),(d) and filtered image (e).

(a) 2 gray scale, (b) 4 gray scale

(c) 16 gray scale, (d) 256 gray scale

(e) filtered image in 16 gray scale