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Measurement of Fuzz Fibers on Fabric Surface Using Image Analysis Methods

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Abstract: Fuzz on the fabrics, which is the fibers protruded from the fabric surface, is very important in view of appearance quality, since it causes unpleasant appearance on the fabrics and also leads to pilling which makes fabric appearance and softness worse. However, fuzz on fabric surface is measured mostly by subjective methods (human vision) rather than objective methods. Thus, in this study, objective method using image analysis techniques has been developed for the measurement of fuzz on fabric surface. Fuzz on the fabric has also been ranked and rated by experts in order to see the reliability of the results obtained from the fuzz measurement. It was observed that correlation coefficient (r) between rating value and objective measurement value was 0.9 and this correlation coefficient value confirmed the reliability of this method.

Keywords: Fuzz fiber, Measurement, Image analysis, Erosion-Dilation, Knitted fabric

Introduction

Fuzz on the fabrics (Figure 1) is the fibers that protrude from the fabric surface. It is very important for the visual quality of fabric. If the amount of fuzz is larger than a certain value, it causes unpleasant appearance on the fabrics and also leads to pilling which makes fabric appearance and softness worse. During the use of fabric as a garment, the fibers on the fabric surface begin to entangle by friction to form small pills on the fabric surface, which are the fiber entanglements in spherical shapes.

Fuzz on the fabric surface is mostly evaluated by human vision (subjectively) rather than by objective measurement. Recently, there have been several valuable studies related to objective measurement technique for both fuzz [1,2] and pilling [3,4-8]. All of these studies have been done using image analysis techniques. In the study of Hsi *et al.* [1], thin slices near the fabric surface have been imaged. They evaluated fabric fuzz with three terms, i.e., fuzz density, fuzz height and fabric-fuzz separation. However, there are some difficulties to determine the place, where the fabric surface begins, during computing the fuzz measurement of image captured for different fabric thickness and different fabric design with different surface curvature. This difficulty can affect the computed result of fuzz density, fuzz height and fabric fuzz separation. Jensen *et al.* [4], took an image from fabric surface. They used fourier mask to filter the knitted stitch background from the fuzz and pill. In this study, fuzz has not been separated from the pills, thus; fuzz and pilling on the fabric surface were evaluated together.

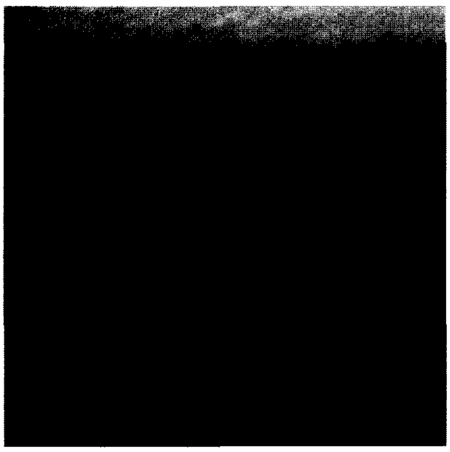

Figure 1. Fuzz on the fabric surface.

As described above, very limited studies have been done on the measurement system for fuzz on fabric surface. Thus, it is desirable to develop an objective, fast, accurate method to evaluate the fuzz on the fabric surface. In this study, a very basic image analysis algorithm has been proposed to segment the fabric fuzz region from the fabric surface. After this separation, percentage of area occupied by fuzz has been calculated to measure of fuzziness level of the fabric surface. Fuzz on the fabric has also been ranked and rated by experts in order to see the reliability of the results obtained from the fuzz measurement.

Methods

Twenty cotton-knitted fabric samples with different design have been used in this study. Thin slices in the course direction near the fabric surface are imaged with black and white camera with magnification lens. Captured image size is 15 times larger than original (9 x 9 mm.), due to magnification. Image size is 512 x 512 pixels with 8-bit gray level values (0-255). The camera and lens are positioned above the fabric, whereas the illumination sources were positioned above of

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the fabric. Illumination sources were set to the both side of the fabric with the angle 45 degree. A plate with black color was placed under the fabric in order to see the fabric better. A schematic illustration of the instrument is shown in Figure 2.

Captured images were processed by flow chart shown in Figure 3. Images are processed with the algorithm written using Matlab. Basic morphological operations were used in order to segment the fabric surface from the fuzz structure. Erosion was used to erode the fuzz structure and make the fabric surface apparent. Then the dilation was implemented. After these operations, the fuzz on the surface was lost (Figure 5). The next step is the subtraction of fabric surface image (Figure 5) from the original image (Figure 4). Thus, resulting image that contains only the fuzz structure could be obtained. Fuzz on this image has been converted into white pixels by threshold process in order to get final image

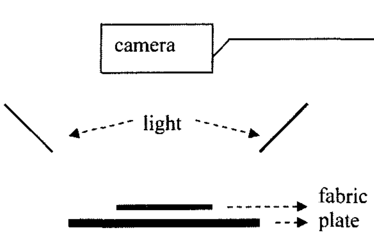

Figure 2. A schematic illustration of the instrument.

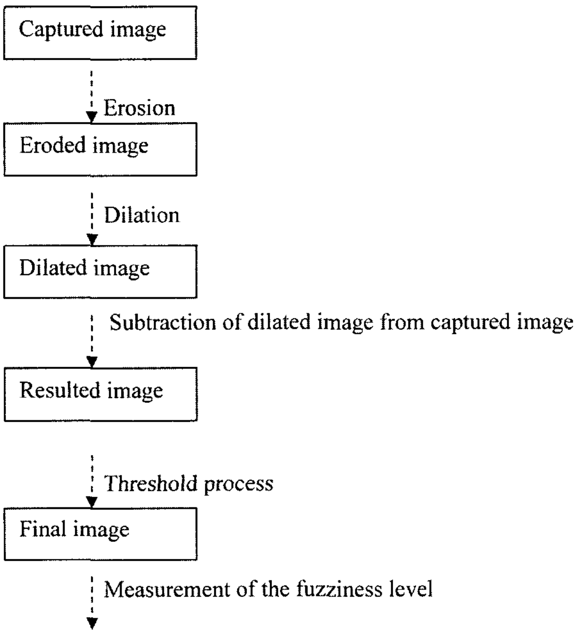

Figure 3. Flow chart.

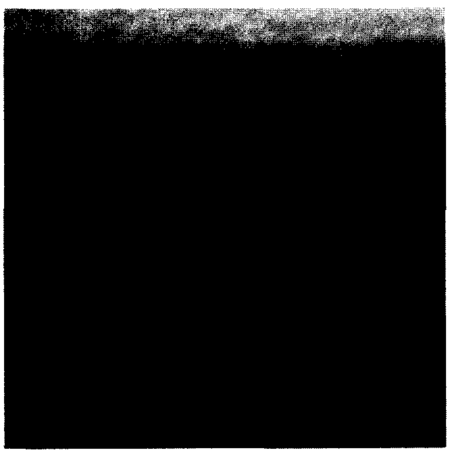

Figure 4. Captured image.

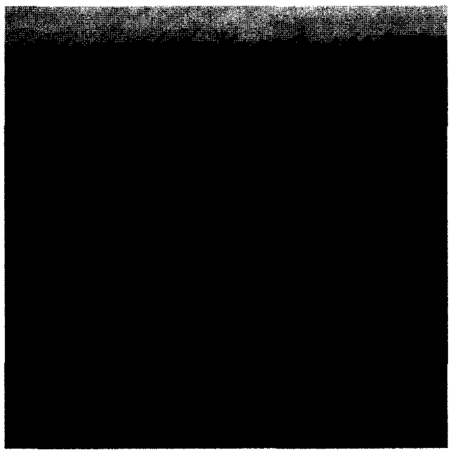

Figure 5. Eroded and dilated image.

Figure 6. Final image.

Table 1. Rating results and measured fuzz density

Sample no.	Fuzz density* (%)	Rating
1	0.4574	1
2	0.5357	2
3	0.7172	3
4	0.5890	4
5	0.6667	5
6	0.8084	6
7	0.6162	7
8	0.8394	8
9	0.9558	9
10	1.2939	10
11	1.3278	11
12	1.0000	12
13	1.0897	13
14	0.9816	14
15	1.2296	15
16	1.1300	16
17	1.3809	17
18	1.1793	18
19	1.4125	19
20	1.4827	20

*Mean value of ten measurements.

(Figure 6). Threshold value has been determined by choosing the most appropriate value for all samples from histogram of the images. The percentage of the white pixel occupied by fuzz in the image (fuzz density) has been calculated to measure the fuzziness level of fabric surface.

Fuzz on the fabric has also been ranked and rated by experts in order to see the reliability of the results obtained from the fuzz measurement. Twenty fabric samples were presented to five expert people for ranking and rating. First, twelve image were ranked according to the relative severity of fuzziness, from the least fuzziness to the most fuzziness. During ranking, at the beginning, each person ranked two fabrics as an independent from each other and then they compared and discussed their results before reaching the final result by the majority of judgment, for these two fabrics. Afterwards, third fabric was given for ranking to each person in addition to the first two fabrics. After each person gave their ranking result, a comparison and discussion were made again to reach final result. Same process was repeated for remaining fabrics, until the twentieth fabric was evaluated. Then, ranked fabric samples were rated from 1 to 20, where 1 indicates least fuzziness and 20 indicates most fuzziness. Fuzz density obtained from algorithm and rating values have been shown in Table 1.

Results and Discussion

To see the reliability of the measurement technique, correlation coefficient between rating value and objective measurement value (fuzz density) has been analyzed. From the statistical analysis, it was found that the correlation coefficient (r) between rating value and objective measurement value (fuzz density) was 0.9. This correlation coefficient value confirms that this method can be used reliably. Thus, it seems to be possible to measure fuzz on the fabric surface, objectively, fast and accurately.

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