Comparison of the Image Processing and Optical Method in the Calculation of Weft Yarn Wavelength from Woven Fabric Appearance

Meysam Moezzi
Textile Engineering Group, Department of Engineering, University of Bonab, Bonab, 55517-61167, Iran

Abstract

Yarn irregularity and its effects on the appearance of fabric are among the most important subjects in textile research. The defects of yarn are often periodic. Therefore, they can be detected by the image processing method. It is usual to determine the wavelengths of these defects by the optical method, but it cannot be creditable because of eye-tiredness, low speed, low attention and the operator's bear. The main aim of this research was to analyze and compare the two methods, the optical and the image processing methods, in the detection of these defects. In the experimental stage, ten different types of faulty yams were prepared through the dying process. For practical examination, the yarns were used as the weft in a shuttle loom machine and ten types of fabrics were produced. Wavelengths of the weft yarns were calculated by optical and image processing methods. Finally, the results obtained by the two methods were compared. The results of statistical comparison showed that the image processing method was more exact than the optical method, and the calculation of wavelength in this method was closer to the real wavelength.

Keywords — *image processing method, optical method, periodic yarn irregularity, statistical analysis.*

I. INTRODUCTION

In the past, the appearance of woven fabrics was considered by optical methods and simple instruments. These techniques are still used in many fabric production mills that don't have modern technologies [1]. Some of the defects that happen on the fabric surface come from the periodic defects of yarn. They appear in different forms like diamond bars on the fabric appearance [2]. One of the usual methods for the detection of these defects is the optical technique. In this method, the operator considers the surface of fabric on a special light table, and tries to detect and subjectively measure these defects. The problems with the optical technique, such as low attention, eye-tiredness, high costs and low speed of control, cause this method not to be very useful [1, 3]. So, a new method based on image processing technique, as introduced in a previous paper, can be used for the calculation of these defects. [4].

The main aim of this research was to analyze the efficiency of the image processing method in comparison with another usual technique.

II. MATERIALS AND METHODS

A. *Yarn wavelengths calculation theory with fabric appearance*

By considering a fabric produced by a shuttle loom weaving machine, the relation between fabric width and periodic wavelength of the weft yam can be defined as:

$$W = (p + r)\frac{\lambda}{2} \tag{1}$$

where:
W= effective fabric width,
λ = periodic wavelength of the weft yarn,
P = a real value larger than 2, and
r = between -0.5 and +0.5

It can be shown that with different values of r, different kinds of patterns can appear on the fabric surface. When r value is not zero, between [-0.5, +0.5], a kind of pattern called diamond bars is formed in the weft wise and the warp wise of the fabric surface. The accumulation of the thick places of the weft yarn form thick diamonds and the thin places of the weft yarn make thin diamonds. The periodic wavelength of the weft yarn fault is [5]:

$$\lambda = \frac{P_B \times W}{(P_B \times R_A) \pm 1} \tag{2}$$

where R_A , is the number of repeated patterns in fabric width, including one thick and one thin diamonds, and P_B is the number of inserted picks in relation to each repeated pattern or the number of picks from the center of one thick diamond to the next one [4].

B. Sample preparation method by the dyed yarn

The simplest method to simulate the periodic faulty yarns, with various wavelengths, is described below:

For example, a 100% cotton Ring yarn, Ne =10 , was dyed with direct fast blue B2R in such a manner that a 20 cm part was dyed and the following 20 cm one was not dyed. Consequently, a defect with 40 cm wavelength on the yam surface was achieved. Ten different yarns were produced with 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 centimeter wavelengths. Then, this yarn was subjected as a weft yarn in the shuttle loom weaving machine to 100 centimeter width of a fabric.

C. Calculated wavelength of defects by the optical method

In this method, λ was calculated by the equation 2. The obtained results are shown in table 1.

D. Calculated wavelength of defects by the image processing method

In this method, the images of fabrics were captured using a scanner with 200 and 200 pixels per inch (PPI) resolution for all fabric. Fig. 1 shows a typical image of the fabric with 40 cm wavelength in the weft yarn.

To obtain the distance between the two successive diamonds in the weft direction, first, discrete Fourier transform was used according to the Equation 3. Then, the power spectrum of the fabrics was calculated by the Equation 4 and the low frequency of the power spectrum was filtered.

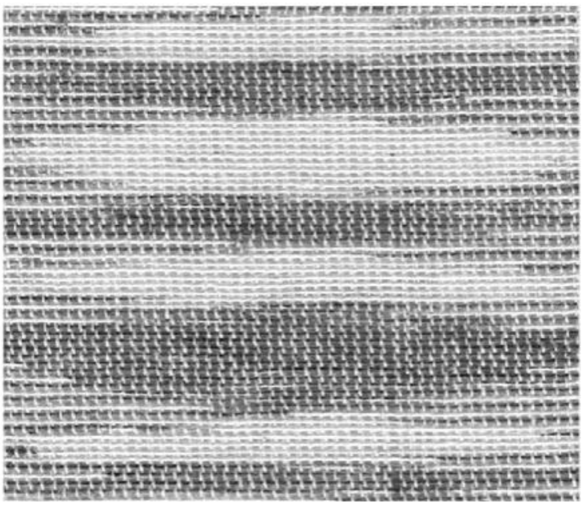

Fig. 1 The patterns in the fabric with 40 cm wavelength in the weft yarn

$$F(u,v) = \frac{1}{N^2}\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\, exp[-2j\pi(ux+vy)/N] \quad (3)$$

$$u,v = 0,1,2,3,\ldots\ldots,N-1$$

$$P(u,v) = |F(u,v)|^2$$
$$u,v = 0,1,2,3,\ldots\ldots,N-1 \quad (4)$$

To obtain the distance between the two successive diamonds of an image with N * N cells, Equation 5 could be used as follows [4, 6, and 7]. The results are shown in table 1.

$$\lambda_k = \frac{N\times 2.54}{PPI\times K} \quad (5)$$
$$K = N-1,\ldots.,2,1,0$$

Table I. Calculated λ from optical and image processing methods

Samples	Actual λ value (cm)	Calculated λ from the optical method (cm)	Calculated λ from the image processing method (cm)
1	10	9.99	9.98
2	15	15.78	15.66
3	20	21.89	21.86
4	25	26.21	25.77
5	30	30.91	30.70
6	35	37.82	37.23
7	40	43.20	42.10
8	45	49.99	49.97
9	50	53.24	52
10	55	57.80	57.70

III. RESULTS AND DISCUSSION

A. Statistical comparison of the two methods

In this research, we chose 10 pieces (10*10cm sized) as samples, from the production line. Each of these 10 pieces of fabric had a wavelength: 10, 15, 20, 25, 30, 35, 40, 45, 50, and 55.

Table 2 shows that both optical and image processing methods, in statiatical comparison with the base wavelength, had a significant difference with each other. This showed that

the wavelength of periodic defects of yarnwas more than that of the base wavelength, in the appearence of the fabric. This results obtained for the wavelength of periodic defects in the image processing method showed that the average wavelength in this method was more than that of the base wavelength. In order to check this hypothesis, the nature of the observed differences was considered [8, 9].

Table II. Summery Of Descriptive Statistics Related To The Two Methods

Group	Pieces	Average	Standard error
Optical method	10	34.02	15.5
Image processing method	10	33.67	15.27

As shown in table 2, the results of descriptive statistics of two groups showed that the averege of the optical method was more than that of image processing method. But the standard errors of two groupes showed that the measurement of the wavelength of periodic defects precision, as resulted by optical and image processing methods, was different from each other.

Table III. Correlation Test Between The Two Methods

Group	pieces	Average	Significant
Optical and image processing methods	10	1	0.00

As the data from the two groups was coupled and belonged to one model, there might be a correlation between the data obtained from the two methods. According to table 3, the amount of correlation coefficient between these data was 1, showing a direct and complete correlation.

The result of T-Test, as obtained by the comparison of the wavelengths in the two methods, showed that the amount of statistics of the test was 2.42, with 9 degrees of freedom. Also, the amount of P-value was 0.038, which was less than 0.05 errors. According to this result, it can be said that the above test was sinificant; in orther words, there was a statistically significant differencebetween the two methods. The comparison of the averages showed that the average of periodic defects in image processing methodwas closer to that in the optical method.

Table IV. Results of t-test

Average wavelength difference of the two methods	Standard division	Standard error	Confidence limit for Average defference		t-value	Df	P- value
			Up limit	Low limit			
0.35	0.455	0.144	0.676	-0.04	2.42	9	0.038

Table V. The Avrages Of Wavelength Obtained By The Two Methods (Optical Method And Image Processing)

Method		Number of samples	average	Standard division	t- value	Df	P-value
Optical method	Optical method	10	34.02	16.36	4.53	9	0.001
	Base	10	32.5	15.14			
Image processing method	Image processing method	10	33.67	15.27	0.003	9	0.003
	Base	10	32.5	15.14			

IV. CONCLUSIONS

The comparison of the averages showed that the average of periodic defects in image processing method was closer to the real amount of average in the optical method. This revealed that the image processing technique could be more exact and closer to the real amount of defect, in comparison tp the optical technique, for the detection of the periodic defects of fabric.

ACKNOWLEDGMENT

The authors would like to express their sincere thanks to the Deputy of research affairs at University of Bonab for the financial and technical support.

REFRENCESES

[1] H. Catling, "Some effects of sinusoidal periodic yarn thickness variations on the appearance of woven cloth," Journal of Textile Institute, vol. 49, T234-T246, 1958.

[2] Meishin-cho, Amagasaki-shi, Hyogo-kcn, Basic and practice of the evenness testing, pp. 66-69, Japan: Keisokki Kogyo Co., Ltd., 1986.

[3] R. Furter, Evenness testing in yarn production: Part I. Manchester: The Textile Institute, 1982.

[4] M. Ghane, S. A. Hosseini Ravandi, and M. Moezzi, "Evaluation of diamond bar patterns on fabric surface using an image analysis technique," Journal of the Textile Institute, vol. 101, pp. 2–7, 2010.

[5] R. Foster, "Weaving investigations - periodic patterning in fabrics," Journal of Textile Institute, vol.43, P742-P754, 1952.

[6] R.C. Gonzalez and P. Wintz, Digital image processing, Reading, MA: Addison-Wesley Publishing Company, 1987.

[7] Matlab Image Processing Tool box, Users Guide, Version 2, Mathworks, USA, 2005

[8] D. C. Montogomery, Design and analysis of experiments, 7th ed.,. Hoboken, NJ: John Wiley, 2008.

[9] D. C. Montogomery, Introduction of linear regression analysis, 5th ed., Hoboken, NJ: Wiley, 2012.