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Evaluation of diamond bar patterns on fabric surface using an image analysis technique

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The main aim of this work is to study of the effect of yarn periodic irregularities on the plain weave fabric appearance using an image analysis method. The pattern of fabric faults was simulated using a prepared computer program. In the experimental stage, two different types of yarn were prepared. The first yarn was produced with a certain wavelength and the second yarn was prepared with a strong periodic irregularity using an open-end spinning machine. The wavelength of the open-end yarn fault was measured by using an Uster 4 automatic evenness tester. For practical examination, the yarns were used as weft in a shuttle loom machine and two types of fabrics were produced. Using image processing, the number and size of the diamond bar patterns, and also the theoretical wavelength of the weft yarn, were calculated. The wavelengths calculated theoretically were compared with the actual wavelengths of the weft yarns. The results showed an acceptable accuracy of the method.

Keywords: yarn periodic faults; wavelength; fabric effective width; fabric appearance; diamond bar

Introduction

In recent years, the improvement of computer technology has been positively effective on different parts of textile industry such as on-line monitoring and automation, but some of the textile processes such as identifying the yarn periodic defects in fabric and assessing fabric surface, are carried out manually leading to fatigue, low speed, less accuracy, etc. Yarn defects have a dominant effect on the fabric properties such as luster, handle, and esthetic. Some factors, i.e. weft and warp density, width of fabric, fabric weave, wavelength of weft yarn faults, weft and warp yarn contraction, and the kind of take-up mechanism have been known as the source of surface irregularities in the final fabrics.

Many researchers have studied the effect of different kinds of yarn irregularities on fabric surfaces (Furter, 1982; Keisokki Kogyo Co. Ltd., 1986). In some cases, the relation between the wavelength of defects and the shape and pattern of defects on the fabric have been considered (Catling, 1958; Seyam & El-Shiekh, 1990). The application of the Fourier transform and an image analysis technique on the evaluation of the fabric surface was also studied (Bugao, 1996; Cardamone, 2002). Due to the periodic nature of patterns on the fabric surface, the use of the Fourier transform is feasible (Sakaguchi, Wen, Matsumoto, Toriumi, & Kim, 2001).

In this research, the construction parameters of the weft yarn, i.e. wavelength irregularity, yarn count, and the fabric parameters; weft density and fabric width, were used to predict and evaluate the number and size of the diamond bar patterns on the fabric surface. On the other hand, the image analysis technique was applied to the fabric surface and the periodic variation of the weft yarn was calculated theoretically and compared with the actual value of the weft yarn irregularities.

Definitions

Considering a fabric produced by a shuttle loom weaving machine, the relation between fabric width and periodic wavelength of the weft yarn is defined as follows:

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

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

It can be shown that with different values of r, different kinds of patterns will appear on the fabric surface. When the r value is nonzero between $[-0.5, +0.5]$, a kind of pattern called diamond bar is formed in the weft-wise and warp-wise of the fabric surface. The accumulation of the thick places of the weft yarn form thick diamonds and

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