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Skew Correction and Density Detection of Knitted and Woven Fabric

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Abstract

Automatic identification of fabric structure is a vital area of research. The skewing phenomenon is inevitable during the scanning process, so the fabric skew correction method based on projection profile analysis is proposed. First, Butterworth low-pass filter is applied to remove noises after skew correction of the fabric image. Then, power spectrum is obtained by Fast Fourier Transform (FFT), in which the peaks are extracted from the vertical and horizontal direction, respectively. Finally, the reconstructed image is obtained via Inverse Fast Fourier Transform (IFFT) according to the peaks, so that the information of warp and weft can be separated to calculate the warp and weft density. Experimental results show that the accuracy of the skew correction can be controlled within $[-1^\circ, 1^\circ]$, and the detection accuracy of yarn density can reach 98%. The proposed method can accurately detect skew angle and density of woven and knitted fabrics.

Keywords: Skew Correction; Projection Profile Analysis; FFT; Density Detection

1 Introduction

Fabric density is an important parameter to measure the quality of the fabric. As people continue to improve the requirements of textile quality, fabric density detection has become one of the most important steps to ensure the fabric quality in the textile, printing and dyeing industry. The traditional method of density detection takes advantage of the fabric density mirror artificially, which is time-consuming, inefficient and sensitive to subjective factors of human inspectors. Therefore, many researchers have tried to develop a new objective method to measure the yarn density automatically, thereby the efficiency of textile production can be improved.

At present, domestic and foreign scholars have proposed lots of methods to detect the fabric density. J. J. Lin [1] proposed a method based on GLCM to detect fabric density, but it confirmed that the method only applies to the plain fabric density detection. In [2], X. Wang et al. utilized the secondary local maxima for fabric density detection which is only effective for solid color fabric. Dejun Zheng et al. [3] employed a method which combined Radon transform with gray projection to locate and segment the yarn. Then, they completed the calculation of fabric density

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and classification based on fabric woven structure. R. R. Pan et al. [4] made use of gray projection obtained directly from the reflected images to get fabric density. Under this condition, some hairiness among the yarns interstice would lead to large errors for fabric density detection. Wavelet transform was utilized to measure woven fabric density [5]. In [6-8], Fourier transform was applied to get spectrum to extract relevant information, thereby analyzing warp and weft density. Fourier transform was also used to extract vertical and horizontal density of knitted fabric. However, fabric skew was not taken into account [9-11].

A method, which combines FFT with Projection profile analysis, is presented in this paper. The influence of fabric skew is eliminated by this method, and the fabric density can be obtained accurately. The frame of this article is divided into four parts: skew correction, density detection, experimental results analysis and conclusion.

2 Skew Correction

2.1 Projection Profile Analysis Principles

Weft knitted fabric is formed by one or more yarns winding along the vertical and horizontal each other. The cyclical characteristics are obvious, and points which reflect cyclical characteristics can be found in the spectrum [11]. Woven fabrics are usually intertwined by two mutually perpendicular yarn systems, and the yarns are distributed evenly [12].

The situation of skew is inevitable during the scanning process, which will bring considerable difficulties to subsequent image processing. Although the operator can adjust the fabric to right position during the scanning process, there is a certain degree because of the error of the human eyes.

The Projection profile analysis [13, 14] is proposed to correct fabric skew, and the largest amplitude of fluctuation is treated as fabric skew angle. Projection profiles were detected by calculating the standard deviation (SD) between adjacent elements. First, the vertical projection profile (VPP) and horizontal projection profile (HPP) are calculated out. We take average of the sum of the pixel gray-scale in each row and column of the image to obtain HPP and VPP of an image. The image size is M*N, and HPP and VPP are the size of M*1 column vector and 1*N row vector, respectively. The calculation processes are shown in Eq. (1) and Eq. (2) :

$$HPP(x) = \frac{\sum_{y=1}^{N} I_{x,y}}{N}, x \in [1, 2, 3, \cdots, M] \tag{1}$$

$$VPP(y) = \frac{\sum_{x=1}^{M} I_{x,y}}{M}, y \in [1, 2, 3, \cdots, N] \tag{2}$$

where $I_{x,y}$ is the intensity of pixel gray-scale at coordinate(x, y).

HPP is considered in the experiment. Horizontal projection profile differential data vector ($HPPD$) can be computed by the difference between the elements adjacent of HPP. The SD of $HPPD$ and the mean ($\overline{HPPD}$) of $HPPD$ can be computed by using Eq. (3,5) :

$$HPPD = [HPP(2) - HPP(1), HPP(3) - HPP(2), \cdots, HPP(M) - HPP(M-1)] \tag{3}$$

$$\overline{HPPD} = \frac{1}{n} \sum_{i=1}^{n} HPPD \tag{4}$$