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Skew Detection and Yarns Density Calculation for Woven Fabric ⋆

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Abstract

Automatic identification of fabric structure is a vital research according to the fabric texture. Due to the skewed phenomenon which is inevitable during the scanning process, Hough transform is utilized for skew detection. Then wavelet filter is proposed to separate warps from wefts to enhance the information in vertical and horizontal direction, respectively. Finally, the gray projection curve including peaks and valleys is obtained in warp and weft directions. According to the peaks, the yarns can be located and segmented apparently and the fabric density could be obtained. Experimental results show that the precision of skew detection could be controlled within 2° while the accuracy of yarns density detection can reach up to 100%, which demonstrate that the proposed method is effective in skew detection and fabric density calculation.

Keywords: Skew Detection; Fabric Density Detection; Hough Transform; Wavelet Transform; Gray Projection

1 Introduction

Woven fabric structure parameters, including yarn density, weave structure, the arrange of color yarns et al. are important parameters to evaluate the quality and level of woven fabrics, which have great influence on the mechanical response and the high-speed projectile impact under the condition of energy absorption characteristics of fabrics [1]. Then fabric density detection will be researched in this paper. Nowadays, density detection is often done artificially in textile industry, which consumes time and requires sustained attention by e human inspectors. In recent years,

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plenty of methods have been developed for fabric density detection. Fourier transform has been utilized for fabric density detection in many papers [2]-[4]. However, the disadvantages of Fourier transform are that the information in the spatial domain may lose and the types of interlacing points cannot be determined in a specified region. Gray level co-occurrence matrix has been proposed by Lin J J in [5] for fabric density detection, which is confirmed that the method is just available for plain fabric weaves. Based on quadratic local extremum, the recognition of fabric density detection is completed only for the solid color fabrics [6]. At present, a series of algorithms based on gray projection are presented for fabric density detection. A method based on Radon transform and gray projection to locate yarns and complete the segmentation of yarns is proposed in [7]. Then, the fabric density and the classification for woven structure of yarn-dyed fabric are achieved. Gray projection obtained directly from the reflected images without orientation enhancement is utilized to obtain fabric density [8]. Under the condition, some hairiness and pilings among the yarns interstice will lead to large errors for fabric density detection. Combining with steerable filters and fuzzy co-occurrence matrix, F Ajallouian et al. [9] have recognized the fabric weaves successfully via gray projection. The same method is also proposed in some other papers [10]-[13]. Since the skew phenomenon is inevitable during the scanning process, there will be great error for achieving gray projection curve. A method for automatic inspection of woven fabric density of solid color fabric density based on Hough transform is proposed in [14]. The Hough transform is used to detect the skew angles of warp and weft yarns, and then the pixels in the fabric image are projected along the skew-direction. Warp and weft yarns can be segmented successfully by locating the true minimum values which indicate the interstices between the yarns. Hence, another improved method combining Hough transform and wavelet filter to obtain the gray projection curve for fabric density detection is proposed in this paper. The frame structure of this article is divided into six parts: image acquisition and preprocessing, skewing detection for fabric images, wavelet transform, yarns location and segmentation, experiments analysis and conclusion.

2 Image Acquisition and Preprocessing

Three elementary weaves with different yarns density are respectively captured via Canon Scan 9000F scanner with resolution of 600 dpi. To reduce the calculating amount, RGB images with 256$\times$256 pixels are cut from the center of the captured images, which can be converted into gray images to improve the processing speed. In order to improve the visual effect and facilitate machine to analyze the images, image enhancement is carried out to reduce noise and make fabric texture more outstanding. Hence, changing the shape of histogram can enhance the fabric images contrast effect. The results of one plain woven fabric taken for example are shown in Fig. 1.

3 Skewing Detection for Fabric Images

During the processing of capturing fabric images, woven fabric samples are put into the scanner artificially. It is inevitable that the captured images will be skewed to a certain extent. Under the circumstances, fabric density detection via gray projection will not be accuracy. Therefore, skew rectification for the preprocessed images is required to keep warp vertical and weft horizontal. In this paper, Hough transform is used to complete the skew detection. The principle of Hough