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Automatic Classification of Woven Fabric Structure Based on Computer Vision Techniques ⋆

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Abstract

Traditionally woven fabric structure classification is based on manual work in textile industry. This paper proposes an automatic approach to classify the three woven fabrics: plain, twill and satin weave. Firstly 2-D wavelet transform is used to obtain low frequency sub-image in order to reduce the analysis of fabric images. Then graylevel co-occurrence matrix (GLCM) and Gabor wavelet are adopted to extract the texture features of pre-processing fabric images. Finally Probabilistic Neural Network (PNN) is applied to classify the three basic woven fabrics. The experimental results demonstrate that the proposed method can automatically, efficiently classify woven fabrics and obtain accurate classification results (93.33%).

Keywords: Woven Fabric Structure; Automatic Classification; 2-D Wavelet Transform; GLCM; Gabor Wavelet; PNN

1 Introduction

In traditional textile industry, analysis and recognition of woven fabric structure mostly depend on manual inspection, which requires a long time and many professional workers. To improve work efficiency, it is necessary to propose an innovative and efficient method for fabric structure recognition. With the development of technology, the application of computer vision and image processing is becoming more dominant. Image processing has been introduced into texture classification, which can automatically and accurately classify woven fabric structure [1].

The analysis of fabric texture [2] has been studied since the mid-1980s in Japan, which progresses from optical computing to digital image processing. Recently, some relevant researches have been developed for automatic analysis of woven fabric structure. Haralick et al. [3] proposed a method of image graylevel co-occurrence matrix, and took its four feature parameters of energy, contrast, correlation, entropy as image features to identify fabric images. Melendez et al. [4] used

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the convolution images by Gabor filters as texture features. These feature extraction methods have good recognition results. Hu [5] put forward a method of fabric automatic classification based on Bayesian statistics. Shin et al. [6] developed an unsupervised recognition method using fuzzy c-means clustering in the spatial domain. Salem et al. [7] used support vector machine to classify fabric weave patterns. Another identification method [8, 9] analyzed warp and weft floats to determine the fabric weave patterns. These methods can successfully classify several woven fabrics. However, real-time and fault-tolerant abilities of current woven fabric classification methods are low.

Hence, this paper introduces an approach for recognition and classification of woven fabrics with real-time and fault-tolerant abilities based on computer vision technique. Firstly, pre-processing image is decomposed into 7 sub-images by two layer wavelet transform, and low frequency sub-image LL2 are taken as processing sample to reduce the analysis of fabric images. Then, GLCM and Gabor wavelet are used to extract texture features of woven fabrics. Finally, an appropriate classifier, probabilistic neural network, is applied to recognize woven fabrics in the classification phase. The flow chart of fabric texture image recognition is shown as Fig. 1, and it illustrates the recognition process.

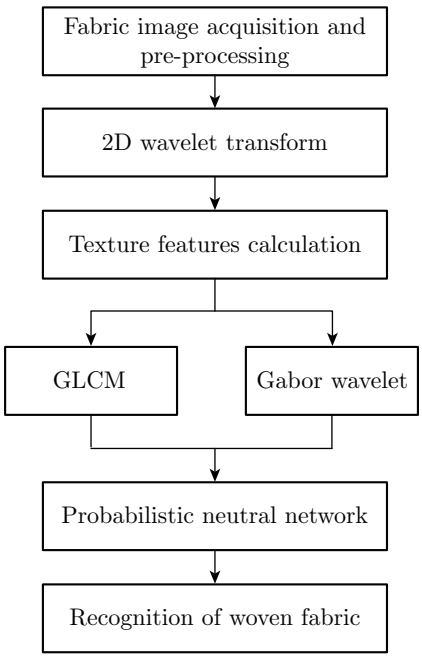

Fig. 1: Flow chart of fabric texture image classification

2 Experimental Methods

2.1 2-D Wavelet Transform

In order to reduce the amount of calculation and remove noise, 2-D wavelet transform [10] is adopted to process woven fabric images. Wavelet transformation is a local transformation between time domain and frequency domain, which can extract information from the signal effectively. It can conduct multi-scale detail analysis for function and signal by flex and translation, and solve