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Defect Detection on Printed Fabrics Via Gabor Filter and Regular Band ⋆

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Abstract

Two methods are proposed in this paper to inspect printed fabrics. One method is to apply a genetic algorithm to select parameters of optimal Gabor filter. Optimal Gabor filter can reduce the noise information of printed fabrics, which can achieve defect detection of printed fabrics. The other is in utilizing distance matching function to determine the unit of printed fabrics. Extracting features on a moving unit of printed fabrics can realize defect segmentation of printed fabrics. Two approaches of defect detection have their own advantages. Detecting method with Gabor filter using genetic algorithm has perfect detection results of random printed fabrics, the other method based on statistical rule can receive better defect detection results of regular printed fabrics. Both methods can be realized in practice and detection time of proposed methods can occupy little in total detection time.

Keywords: Defect Detection; Gabor Filter; Regular Band; Textile Fabrics

1 Introduction

Defects of textile fabrics can influence selling price and resulting in the reduction of pricing by about 45% to 65% [1] of the original product. Artificial detection has a key role in real fabric detection, while artificial detection has a lower of success rate at the speed of only 15-20 m/min [2]. Accuracy of artificial detection only can reach 60-70% [3].

Numerous algorithms are currently proposed in fabric detection. Fabric detection approaches are classified into the statistical, the model [4] and the spectral [5, 6]. The statistical approach is based on texture features of fabrics and is defined as a measurement of "energy" [7] in a window of each fabric pixel. Model method applies semblable textures to match the captured textures. Cohen of Drexel University of American used Gauss Markov Random Filed (GMRF) [8] to obtain parameters of defect-free fabrics with perfect detection results, and complexity of analysis on fabrics is its fault. Spectral method is suitable for directional textured fabrics. Tsai and

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Heish [9, 10] utilized a combination of DFT to detect directional textured images. Operating the frequency components of homogenous non-defective regions could influence frequency components of defective regions.

Genetic algorithm is a general framework of solving complex system optimization, which does not depend on specific areas of problems and has a strong robustness of problem species. Genetic algorithm is mainly used in function optimization, combinatorial optimization, scheduling problem of production, robotics and image processing and so on. Function optimization of image processing with genetic algorithm is applied in this paper. Distance matching function is used to inspect the period of fabrics in [11], but the accuracy of inspection results is low.

Gabor filter is widely used in fabric defect detection. In general, defect detection methods of Gabor filter are classified into two parts: one is in applying Gabor filters to describe channels to obtain detection results on fabrics. The other is to select optimal Gabor filter.

Ngan and Pang [12, 13] used a golden image as a convolution filter on testing image. The periodic waveforms of resultant matrix prove that fabric defect could be segmented. Henry Y. T. Ngan [14] proposed LBP operator of window and corresponding feature vector to detect defects of patterned fabrics in [15]. Ngan and Pang put forward regular band to complete defect detection of patterned fabrics. Period length is selected to obtain perfect detection results.

In fact, one method of this paper is building optimal Gabor filter via selecting Gabor parameters. Gabor filters are trained by non-defective fabrics in goal function, and genetic algorithm is a method to receive the minimum of goal function, thus optimal Gabor filters can be generated. Optimal Gabor filters can extract defective information of textile fabrics, thus defect segmentation can be achieved. The other method is combining regular band and distance matching function to realize defect detection of fabrics. Distance matching function is to determine the fabric unit. Regular band is to extract features of fabric unit. Proposed methods have comparisons of various fabrics. It is concluded that detecting methods of Gabor filter has better results of inspecting random textured fabrics, and regular band of proposed methods could receive perfect results in detection of patterned fabrics.

The whole paper can be classified into four sections: The first section is an introduction covering previous research of printed fabrics. The second section describes detection method of Gabor filter. The third section offers another detection method of regular band. The final section provides experimental results and resultant comparisons of proposed methods.

2 Detection Method with Gabor Filter

2.1 Gabor Function

Gabor function is an exponential function that defines the sinusoidal wave frequency u_0 and rotated orientation θ, meanwhile, Gabor function is defined by modulating 2-D Gaussian function [16, 17]. The real part of 2-D Gabor function is used as Gabor filter. Because the imaginary part demands a mass of calculations and has little influence on detection results. Gabor filter function can be formulated as Eq. (1):

$$g_e(x,y) = \exp\left\{-\frac{1}{2}\left[\left(\frac{x'}{\sigma_x}\right)^2 + \left(\frac{y'}{\lambda\sigma_x}\right)^2\right]\right\}\cos\left(2\pi u_0 x'\right) \tag{1}$$