Fabric Defect Detection Based on Computer Vision

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Abstract. Broken ends, missing picks, oil stain and holes are the most common fabric defects. To deal with the situation that manual fabric detection will affected by the subjective factors of inspectors, an automatic computer vision based fabric defect detection method is introduced in this paper. The system uses threshold segmentation method to identify if there are any defects existed in the fabric, adopts image feature based approach to recognize oil stain and holes, and uses training based technique to detect broken ends and missing picks. Experimental results show that the proposed approach has the advantage of easy implementation, high inspection speed, good noise immunity, greatly meeting the needs for automatic fabric defect inspection.

Keywords: fabric detect, computer vision, automatic detection.

1 Introduction

Fabric defect detection is a crucial process of quality control in the textile production, fabric inspection by human sight easily affected by the physical quality and mental status of the inspectors. Under the fierce competition in textile industry recently, quality assurance being an essential premise to promote competitive advantage of product, therefore automatic fabric defect detection has become one of the most enlivened areas in the domain of textile industry. Ref. [1] derived a method of fuzzy label co-occurrence matrix set. In this method, gray levels with same tone are classified into one class, and using categories instead of gray level to decrease dimension as well as taking the “abnormal” gray level as one class so as to formulate a larger component, resulting the highlighted features of fabric defect. Chi-ho Chan et al. [2] developed a method for defect detection by means of Fourier analysis. Gabor filters are a set of narrow ban-pass filters, which not only have ideal discriminate abilities both in spatial and frequency domains, but also have obvious characteristics of direction and frequency selection, thus can achieve optimal joint localization in spatial and frequency domains. In view of this, [3-4] utilized Gabor filter transformation which is highly suitable for texture image analysis to attain the goal of defect inspection and recognition. Neural network means the simulation of the function of biological neurons whose most distinguishing characteristic being the capability to approximate to any complicated linear relations as well as dynamically adjust network parameters by learning, so [5-6] applied this method in defect inspection. In this paper, computer vision technology is exploited to complete the

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detection of the common fabric defects such as broken ends, missing picks, oil stain and holes.

2 Image Acquisition

The nature of real-time fabric detection requires not only rapid inspection speed but also intense clarity and high resolution of the captured images, which makes it necessary for computer vision system to employ high quality graphic grabbing card. First, we use CCD camera to capture images of the weaving cotton grey fabric, then segment them into frames with 512*512 pixels in size, and the number of ends and picks are 340*160 threads/100cm2. Finally, we convert them into binary images.

3 Experimental Method

For the captured fabric images, different kind of defect leads to different distribution on gray level. In the case of defects such as broken ends, missing picks and holes, there exist larger gaps in the fabric resulting in more backlighting transmission, so these types of defects in the fabric image showing higher intensity. With the similar reason, those types of defects such as oil stain revealing smaller intensity for there are less backlighting transmission. In the mean time, the four classes of defects such as broken ends, missing picks, oil stain and holes appear drastic spatial distribution feature with clear direction which helps to distinguish the four types. Broken picks can be judged as horizontal defects, broken ends as vertical defects, oil stain and holes as regional distributed defects but they are quite different in the distribution of intensity.

Generally speaking, what a computer vision inspection system analyzes and manipulates is that of specific objects. Therefore, we can choose adequate technology and simplify the execution process based on the prior knowledge of the performed objects which is also sufficiently understood to achieve the goal of automatic operation. According to the prior knowledge extracted from the shape of fabric defect, we introduced an approach based on local fabric defect inspection and recognition described as follows: first, carry out binary segmentation to get two-level image which is then taken a morphological opening operation to remove noise, second, extract parameters such as shape characteristic factor. Through local analysis, we effectively distinguish the common defects such as oil stain and holes. As for the other kind of defects aside from the discussed ones we use training based methodology which does like this: first, run binary segmentation to get two-level image, then extract parameters such as shape characteristic factor, after that, acquire classification parameter by training to make classification and as a result we can distinguish broken ends and missing picks.

3.1 Image Segmentation

Image segmentation means that to partition target image into several interested regions corresponding to various targets, intrinsically speaking, it is a process to make classification by means of various characteristic of pixels. For the reason that the effect of image segmentation will directly affect the extracting of the target characteristic and inspection accuracy, image segmentation ought to be the crucial process in computer vision inspection.

Here we use threshold segmentation combined with experiential value for there are great difference in the intensity between defects and normal fabric. The intensity of defects with the kind of oil stain are less than that of normal defects, so let the variation area of gray level be [0, Tmin]; While the intensity of defects with the kind of holes are greater than that of normal defects, so let the area be [Tmax, 255]. Then we get binary images as follows:

$$B(i,j)=\begin{cases}0 & T_{\min}\le I[i,j]\le T_{\max}\\ 1 & otherwise\end{cases}$$

Where Tmin, Tmax denote the experiential values which are set to 125 and 195 respectively. Meanwhile, label the intensity variation area [0, Tmin] and [Tmax, 255] to RGB (255, 0, 0) and RGB (0, 0, 255) respectively.

3.2 Filter Based on Mathematic Morphology

The Mathematic morphology refers to a technology dealing with shape features of image, which is to describe the nature attribute of image through designing a whole set of transformations (calculations), ideas and algorithms. Unlike the normal spatial and frequency domain algorithms, this method is based on differential geometry and stochastic theory. This is because differential geometry can get measurement of all kinds of geometry parameters indirectly, and can reflect the stereo property of the image. Motivated by the above reasons, we employ various kinds of transformation and calculation in mathematic morphology to depict the essential attribute or key structure of the image, that is, the relationship between elements or components in the image.

Firstly, we take morphological opening operation:

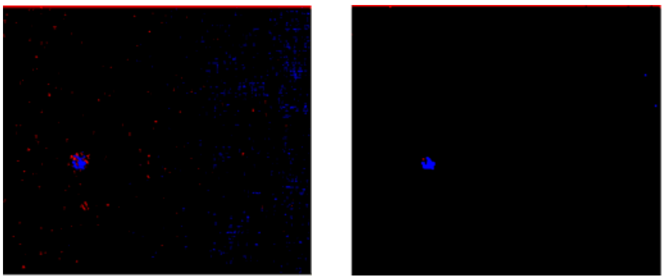
$$A\circ B=(A\Theta B)\oplus B$$

to eliminate discrete dots and “blur” to implement smoothness for binary image. Normally, the image after segmentation would embedded with some noise which are formed by the backlighting transmit from the gaps of weft and wrap yarns with uniform distribution, and similar intensity to the defects such as broken picks and taking up small area (usually one to two pixels) . However, when we take the former morphological operation, the isolated dots can be removed by the erosion manipulation and then the dilatation operation is carried to restore what the original image likes before erosion and smooth it. In this situation, the key factor is to choose appropriate structure element to ensure the elimination of noise but also to keep the original shape of image roughly.

3.3 Filter Based on Mathematic Morphology

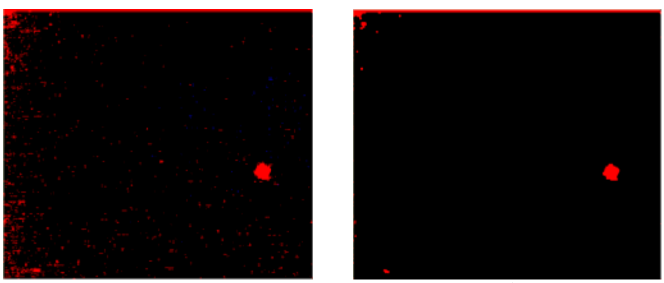
The algorithm is performed by using a 6*6 matrix to match the output image, that is, every pixel in the image is presented to see whether the corresponding 6*6 pixel matrix around it can match the given template matrix. If the match occurs, the pixel with RGB(255, 0, 0) is judged as oil stain defect and similarly the one with RGB(0, 0, 255) is identified as holes defect. Otherwise, we pass it to the feature-based training process to determine whether there exist defects such as broken ends and picks.

After threshold the captured holes defective image, as shown in Fig. 1(a), there are many noises embedded in the image, caused by backlighting transmitting through the gaps between the weft and wrap yarn of the grey cloth. Fig. 1(b) illustrates the image after opening operation. The result of oil stain image after threshold is given in Fig. 2(a). And the image after opening operation is shown in Fig. 2(b).



(a) (b)

Fig. 1. Example of hole defects inspection: (a) image after binalization (b) image after opening operation



(a) (b)

Fig. 2. Example of oil stain defects inspection: (a) image after binalization (b) image after opening operation

3.4 Broken Ends, Missing Picks Detection Based on Direction Feature Training

Generally speaking, computing vision detecting system conducts analysis and implementation specific to a particular object, hence we can choose adequate technique and simplify the detecting procedure based on the prior knowledge of the discussed object coupled with sufficient understanding of which, and finally achieve the goal of automatic processing.

Once the binary image obtained as a result of threshold operator, the intensity property of broken ends and missing picks are extremely approximate, the only discrepancy lies in their direction: continuous white color emerge in vertical direction of the intensity of broken ends defect, while for mission picks defect it appears in horizontal direction. In view of this, detecting algorithm extracts this specific feature of broken ends and missing picks and applies to the training and identification procedures, which is described in detail as follow:

First we make summation of the intensity values of the two level output image in the horizontal direction, then take the row which reveals the largest summation value as the feature of the image and simultaneously record the characteristic value. After doing these the feature and output value are shown in Fig. 3:

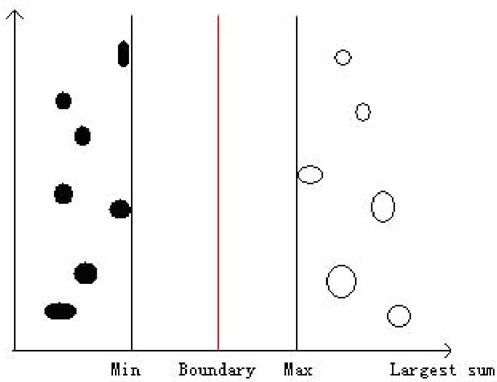


Fig. 3. Features and output values

As seen in Fig. 3, we set the maximum feature value in broken ends as Min, and the least feature value in broken picks as Max. From the fig, we can conclude that they are linear separable, so the line used for segmentation is set: X=MIN + (MAX-MIN)/2.

Through the above mentioned stages the classifier was trained, which can be devoted to perform recognition described as several steps. First we extract the maximum summation in the horizontal direction of the fabric to be performed, then carry out classification using the trained classifier, that is: when the feature lies in the left of the line, it can be judged as broken ends defect, while at right to be broken picks defect, as a result, the detection performance of broken ends and broken picks defects is completed.

4 Experimental Method

In our study, we choose cotton grey fabric as the detection object from which we obtain the original image with 512*512 pixels in size for each frame. Due to the intensive spatial distribution feature in direction shown in the four kinds of defects such as broken ends, missing picks, oil stain and holes, a simple but also practical detection algorithm is suggested in our paper. A simple interactive strategy adopting threshold to get binary defect image under practical circumstance is utilized to meet the need of real time inspection. Rely on the prior knowledge of defect shape, the fabric image is performed segmentation and mathematic morphologic opening operation to eliminate noise, which is afterwards manipulated rest on extracted local feature and the fabric shape factor is calculated to be taken as recognition parameters.

5 Conclusions

Computer vision based fabric defects inspection has been a challenging yet hard research area in nowadays automation of textile industry, so seeking an inspection algorithm with high detection speed and good accuracy has been the subject of study currently. This paper is narrowly focused on a detecting method including these procedures as segmentation and filtering of the defect image, feature extracting of the fabric defect, detecting based on local feature and training. Experimental results show that it is effective under common fabric defects such as broken ends, missing picks, oil stain and holes. However, in practical application, there are more types of fabric defect such as wrinkles generated by cloth self-weight resulting false defect, which will increase the difficulty of inspection. Thus, more reliability and stronger self-adaptation is needed and intensive study in automatic fabric defect inspection should be taken.

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