IDENTIFICATION OF DEFECTS IN TEXTILES BASED ON STATISTICAL ANALYSIS OF DCT COEFFICIENTS OF TEXTILE IMAGES

Rishav Dewan

ECE Deptt., Bhai Gurdas Institute of Engg. & Tech. Sangrur.

Monika Aggarwal

ECE Deptt., Bhai Gurdas Institute of Engg. & Tech. Sangrur.

Abstract

This paper presents a novel approach to the fast detection and extraction of fabric defects from the images of textile fabric based on statistical analysis of the dct coefficients of the textile pattern images. Most defects arising in the production process of a textile material are still detected by human inspection. The work of inspectors is very tedious and time consuming. They have to detect small details that can be located in a wide area that is moving through their visual field. The identification rate is about 70%. In addition, the effectiveness of visual inspection decreases quickly with fatigue. However, the inspection process could be automated with machine vision techniques supported by defect identification algorithm. An image processing based machine vision system for visual inspection of fabric quality determination is proposed in the p[resented thesis work.

Keywords: ***Textile,***

I. INTRODUCTION

Automated visual inspection systems are much needed in the textile industry, especially when the quality control of products in textile industry is a significant problem. In the manual fault detection systems with trained inspectors, very less percentage of the defects are being detected while a real time automatic system can increase this to a maximum number .Thus, automated visual inspection systems play a great role in assessing the quality of textile fabrics. Texture analysis refers to the characterization of regions in an image by their texture content. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky, or bumpy as a function of the spatial variation in pixel intensities. In this sense, the roughness or bumpiness refers to variations in the intensity values, or gray levels.

II. BRIEF LITERATURE SURVEY

In general, fabric analysis is performed on the basis of digital images of the fabric. Alternatively, there are some works (Ciamberlini et al. [1]) based on the optical Fourier transform directly obtained from the fabric with optical devices and a laser beam. Digital image processing techniques have been increasingly applied to textured samples analysis over the last ten years. Several authors have considered defect detection on textile materials. Kang et al. [5, 6] analyzed fabric samples from the images obtained from transmission and reflection of light to determine its interlacing pattern. Tsai and Hu [3] used Fourier transforms of solid plane fabric images as the inputs to an artificial neural network for fabric defect detection. They trained the neural network to identify four types of defects: missing pick, missing end, oil fabric stains and broken fabric. In a recent paper, Hu and Tsai [9] have also used wavelet packet bases and an artificial neural network for the stated goals. Wavelets had been previously applied to fabric analysis by Jasper et al. [1,5]. Escofet et al. [3, 4] have applied Gabor filters (wavelets) to the automatic segmentation of defects on non solid fabric images for a wide variety of interlacing patterns. In the following sections we revise part of this work. Defects can be classified as local or global. Global defects cause an overall distortion of the basic structure of the fabric and can be detected by means of Fourier analysis. Local defects only affect a small area of the image of the fabric under inspection. The performance of the Fourier transform based techniques for defect detection is illustrated by two examples, one corresponding to a global defect, the second representing a local defect.

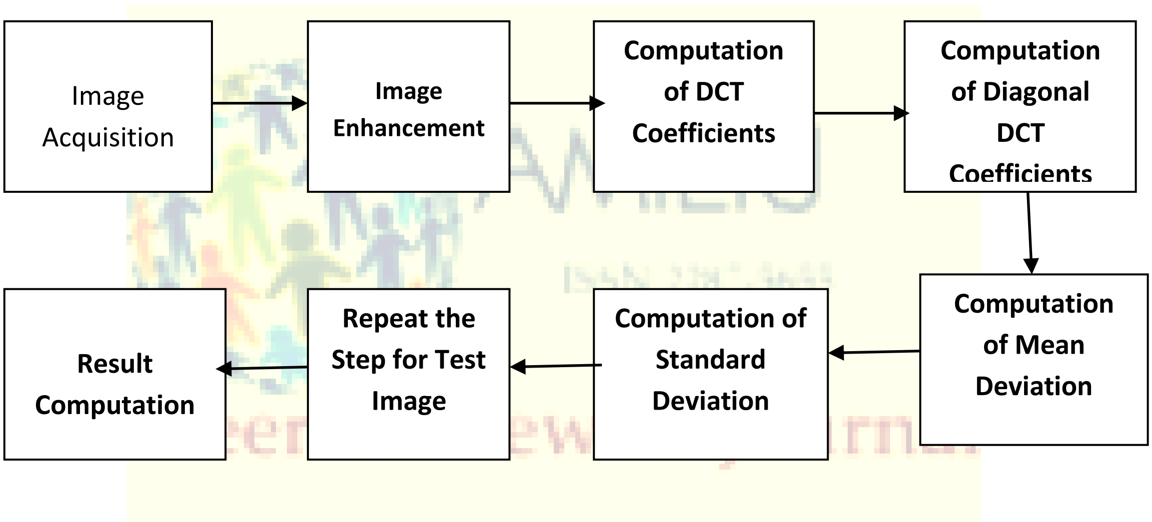
III. METHODOLOGY

In DCT based approach for textile defect identification, it is proposed to determine the dct coefficients of the textile images. For a MxN textile image, we get a MxN dct coefficients matrix. The lower half of the DCT coefficients matrix contains the frequency variation of the background image i.e. the background, while the upper half of the DCT coefficients matrix contains the high frequency part i.e. noise. The diagonal elements of the DCT coefficients matrix contains the maximum information of the textile pattern or design. The diagonal DCT coefficient of the matrix are rearranged in a single column matrix to find out the mean deviation, standard deviation and covariance. By analysis of the standard deviation of the dct coefficients, the variations in textile images are computed.

The system of digital image processing may be presented schematically as shown in below Figure. The following operations are carried out during image quality improvement:

1. Image Acquisition
2. RGB to Gray Color Conversion
3. Image Enhancement (Thresholding)
4. Defect Identification

Block Diagram of the proposed System:



IV. IMAGE ACQUISITION

Textile/fabric surface image is acquired by using the CCD camera from top of the surface from a distance adjusted so as to get the best possible view of the surface. Below figures show the quality of the acquired fabric images. The textile images under test are of size 256x256 (64KB). For proper imaging, uniform lighting system is to be maintained to avoid any illusive defect by virtue of light reflection properties falling on surface.


Fig. 1


Fig. 2

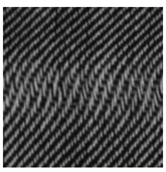


Fig. 3

Different Fabric/Textile Images Originally, the images are acquired at RGB color scale. The images then are converted to gray scale using rgb2gray function in matlab.

V. IMAGE THRESHOLDING

The image after noise removal is brought under image thresholding algorithm. Here, a threshold level is selected which divides the image into two color. i.e. we get a binary image with white as back ground and black as the object of interest. In the presented work, Histogram equalization method is adopted to enhance the contrast of the fabric surface.

Histogram Equalisation algorithm works good in this case as the fabric texture. Below figures show the result after Histogram equalization algorithm for thresholding.

The general histogram equalization formula is:

$$h(v) = \mathrm{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right)$$

where cdf_{min} is the minimum value of the cumulative distribution function, M x N are the image's number of columns and rows, and L is the number of gray levels used (in most cases 256).

VI. ALGORITHM

The algorithm has been implemented by using Matlab version 7.5 (Release 2009 b) and is found to be reasonably fast and accurate than the existing computationally intensive methods. The results are promising even when it is applied to localize defects on images with varying lighting or exposure levels.

The proposed algorithm is dived into no. of steps discussed below:

Image Acquisition: The high definition camera is used for capturing the images from the fabric. The grabbed image of size (256x256 in jpg format) is made input to the developed matlab code here.

Gray Scale Image: The acquired rgb image is converted to gray scale image by using the rgb2gray command in matlab. A gray scale image (0 – 255gray shades) is obtained.

Image Enhancement:

The gray level image is enhanced by using the histogram equalization method. A sharp contrasted image is obtained. Salt and pepper type noise are removed by the noise removal program as discussed in previous section.

Histogram: A histogram of the enhanced image is obtained by using the imhist command in matlab.

Image Thresholding:

Otsu algorithm is used for thresholding of the gray image. It has been observed that Otsu algorithm works good in case of fabric image and fairly bnarized image is obtained.

Segmentation:

Segmentation algorithm is applied over the binarized image to get the segmented patterns. Bwlabel command is used to segment the fabric image

Defects Identification:

Segmented patterns are identified based on the data base of the regular pattern design. Say, a segmented pattern is matching from the regular [pattern data base, then it is assumed that it is part of the design.

However, if the pattern parameters are not matching with any of the stored pattern data base parameters, then it is assumed that the segmented pattern is a defect and should be analysed for its type of defect.

DCT Coefficients:

In many cases, fabric have regular patterns of design. And discontinuity in regular pattern can be identified by analysing DCT coefficients. For, the image is spitted into 8x8 blocks and DCT coefficients of each block is stored in single column a matrix. For a 8x8 block matrix, we get 8x8matrix of DCT coefficients. However, the maximum information is available in the diagonal elements of 8x8 dct coefficients matrix. This is because, only diagonal elements of dct coefficients matrix have the maximum frequency variation components and they are design or patterns in the fabric image. Therefore, by making the statistical analysis of the diagonal elements of the dct coeff. Matrices of test and reference fabric image, variation in fabric may be checked.

The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The dct2 function computes the two-dimensional discrete cosine transform (DCT) of an image. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that developed the standard: the Joint Photographic Experts Group.) The two-dimensional DCT of an M-by-N matrix A is defined as follows.

$$B_{pq} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_{mn} \cos\frac{\pi(2m+1)p}{2M} \cos\frac{\pi(2n+1)q}{2N}, \quad \begin{matrix} 0 \le p \le M-1 \\ 0 \le q \le N-1 \end{matrix}$$

$$\alpha_p = \begin{cases} 1/\sqrt{M}, & p = 0 \\ \sqrt{2/M}, & 1 \le p \le M-1 \end{cases} \quad \alpha_q = \begin{cases} 1/\sqrt{N}, & q = 0 \\ \sqrt{2/N}, & 1 \le q \le N-1 \end{cases}$$

The values Bpq are called the DCT coefficients of A.

VII. Results

Irregularity in the fabric design pattern can be determined by analysing the DCT coefficients of the test and referenced image. DCT coefficients are discussed in the previous chapter of the report. DCT coefficients are extracted from the 8x8 block of the images and aligned in a single column matrix vector for both test and reference images. The two matrices are now analysed statistically to get the variations in the design pattern.

Standard deviation is computed for the variation in the dct coefficients of both the fabric images. It is understood that if both the ref. and test images are same, then the standard deviation should be zero. However, if the design pattern varies, then the standard deviation will be a non-zero quantity. The range of the non-zero standard deviation depends upon the variability in the design pattern.

Following two images show the variation in the design pattern. The dct coefficient analysis is given below:

Fig.4

Fig. 5 Fig. 6

In fig. 11.5 and 11.6, there are offset defects in the design pattern. One of the check print is shifted in fig. 11.5 from that of the fig. 11.4. The standard deviation of dct coefficients of above images are given below:

Std. Dev. Fig. 11.4 and Fig. 11.5	1.30
Std. Dev. Fig. 11.20 and Fig. 11.6	1.21

Low value of std. dev. In case-2 is due to the fact that offset print defect is less visible in case-2 as compared with the case-1.

Standard Deviation is given by:

$$s_N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}.$$

Where $\overline{x}$, is the mean deviation and xi is ith dct coefficient. And N is the total no. of dct coefficients.

Conclusion

We, human beings, have a unique capability to easily fmd imperfections in spatial structures. This visual mechanism works even when we do not know what the ideal pattern is and what the possible types of defects are. Just looking at a relatively regular structure containing an imperfection, we can usually tell what is wrong there. But human inspector based defect detection is subject to errors for many reasons. There are large influences of human errors and subjectivity on the results of inspection. One of the most important advantages of the method is that it is multipurpose without requiring any adjustment. Furthermore, it can be applied to composite patterns with elements of different brightness without any particular adaptation. The versatility of the method has been demonstrated not only by its applicability to different regular textures but also, for a given texture, the method allows to detect a variety of defects. The method does not need human supervision nor previous knowledge about the texture or defect.

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