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Fabric Defect Detection Using Homogeneity

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Abstract— Fabric defect detection algorithm based on local neighborhood is proposed to improve the accuracy and real-time of Fabric defect detection. A local neighborhood window moves over the entire inspection image. For homogeneity measurethe coefficient of variation is used. A defect-free region will generate a smaller value of Variation Coefficient than that of a defective region. To extract and segment the defective regions a simple threshold can be used and to increase the computational efficiency the integral image is introduced. The proposed algorithm is used for detecting only one single discrimination feature. It could avoid sample learning and complicated Spectral decomposition. Experimental results from fabric detection in the industry, has shown the feasibility and effectiveness.

Keywords*-Fabric defect detection,Local Neigborhood Analysis,Coefficient of variation,Homogeneity.*

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I. INTRODUCTION*(HEADING 1)*

Without good quality any product leads to loss in revenue and lack of customer satisfaction. Best example is Textile industries. The defects in fabric lead to bad surface appearance which leads to large rejection. This has bad impact on benefits of companies. The 80% of defect in textile industry is due to fabric defect [1].The price of fabric reduce by 40% to 60% due to defects [2].Defects caused due to machine faults, yarn problems, poor finishing, and excessive stretching among others. There are many types of defects like broken end,thin bar, thick bar, hole, stain, loose pick, multiple netting and knot etc.

Manual inspection is a traditional methodfor defect detection which has low detection rate, needs high inspection time, low efficiency, less consistency and high labor cost. They require training. Very small defects are difficult to identify due to human limitations. The nature of work is dull and repetitive, difficult to achieve 100% fabric inspection.

The advantages like high speed, high precision, low cost, non-contactgets from machine inspection[3,4].Automated inspection requireslower labor cost, minimum floor space. It issimple to operate and maintain, reliable, moreefficient &maintain quality.The automatic detection has aim to acquire the locations and shapes of any possible defects in fabric without manual intervention. Automated detection algorithm is efficient and real time. In textile industry image processing is technique used todetect defects in fabric[5,6].Some defect detect techniques are Fourier analysis [7].wavelet transform [8-10], Gabor filtering [11],which can be classified into two categories. One is to use a filter bank [12, 13] and second is to use optimal filter[14-16].

In this study, we propose a simple and rapid detection method based on local neighborhood. The coefficient of variation is used as defect detection and localization of homogeneity measure.The local homogeneity analysis is the method to detect discontinuities [17, 18]. To reduce computing time the integral image technology is used. The proposed measure has high inspection speed and high accuracy, and insensitive to uneven illumination.

II. FABRIC DEFECT DETECTION ALGORITHM BASED ON LOCAL NEIGHBORHOOD ANALYSIS.

The block diagram of proposed system is shown in figure 1.

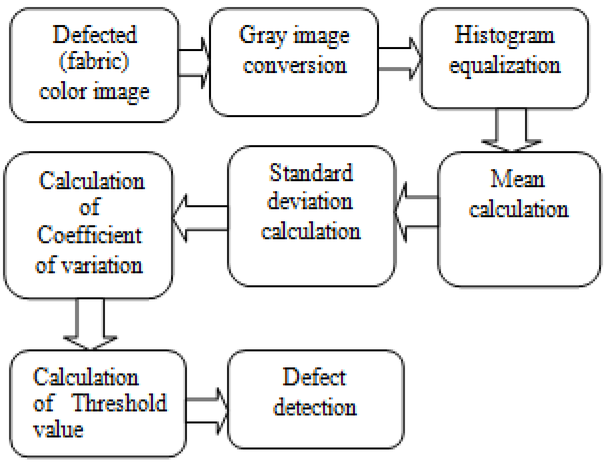


Figure1:- Block diagram of proposed system

Image is captured using CMOS sensor (Row image). The defected image is converted into RGB to gray level. It reduces required memory and time. But the disadvantage is no color information. Removes unwanted parameters by median filter & improve image quality. To remove unwanted parameters like contrast, blur, shadow & improve image qualityHistogram Equalization is used. By calculating standard deviation and mean Coefficient of variation is calculated. If coefficient of variation is greater than threshold value it represents that region is defective and if coefficient of variation is less than threshold than region is defect free.

A. *Coefficient of variation*

The coefficient of variation is also known as dispersion coefficient. It is used to measure homogeneity.Homogeneity is used to detect discontinuities. The coefficient of variation is the ratio of the standard deviation of the mean. The coefficient of variation is given by

$$C_v = \frac{\sigma}{\mu} \times 100\% \qquad (1)$$

Where, σ is standard deviation and μ is mean.Standard deviation cannot be negative.

III. THE DETERMINATION OF LOCAL NEIGHBORHOOD ALGORITHM

A defect images consists of defective region and defect-free region. The defective region is abnormal region, its presence pixel gray mutation or unevenly distributed. Homogeneity, also known as homogeneousness, it is largely associated with the image of local information, it reflects the distribution of gray scale [19]. The coefficient of variation described above can be very good reflection of the distribution of data. Therefore, the coefficient of variation can be used to test whether there are defects in the image. For an image I of size M × N, it can be seen as an image matrix of N rows and M columns. I (x, y) is a corresponding gray value at the coordinates (x, y), where x = 1, 2, . . . , M, y = 1, 2, . . . N. Define local homogeneity measure (LHM) of the pixel P(x, y). Let W × W be the neighborhood window size and centeris the pixel P(x, y), where W = 2w + 1 for some integer w, calculate coefficient of variation of pixel gray value in this neighborhood $C_v(x,y)$ which is given by

$$\mu_{x,y} = \frac{\sum_{i=w}^{w}\sum_{j=-w}^{w} I(x+i,y+j)}{W \times W} \qquad (2)$$

$$\sigma_{x,y} = \sqrt{\frac{\sum_{i=-w}^{w}\sum_{j=-w}^{w}(I(x,y)-\mu_{x,y})^2}{W \times W}} \qquad (3)$$

$$C_v(x,y) = \frac{\sigma_{x,y}}{\mu_{x,y}} \times 100\% \qquad (4)$$

Where, $\mu_{x,y}$ is the gray value of pixels which within the neighborhood window, $\sigma_{x,y}$ is standard deviation, $C_v(x,y)$ is the local homogeneity measure value. For a homogeneously textured or uniformly non-textured Fabric image, gray distribution on any local neighborhood uniform, its LHM value will be small. The gray distribution of defective region is not uniform for image which contains defects, its LHM value will be relatively large and for defect-free region the LHM is small. Using neighborhood window of size 25 ×25, the LHM value of each pixel can be calculated according to Eq. (4). Figure 2 shows a fabric image which contains the hole defect. Figure 3 shows the distribution of LHM, the large value of LHM at two peaks represents defective region and small value of LHM at flat area represents defect free region. So LHM value is as discriminating feature to distinguish the defect region and the defect-free region. The greater the LHM values of pixels, it means defective region is larger. When LHM value of a pixel is above the threshold, the region belongs to the defective region. If LHM value is less than the threshold value, then that it is defect-free region. The threshold is given by

$$T_{cv} = \mu_{cv} + w \qquad (5)$$

Where μ_{cv} is the mean of LHM values of all the pixels in an image, w is the control variable. Different images have different thresholds (T_{cv}). It is self-adaptive variable with different images. Control variable is usually according to different object detection and takes different values.

Fig. 2 Defected Fabric image

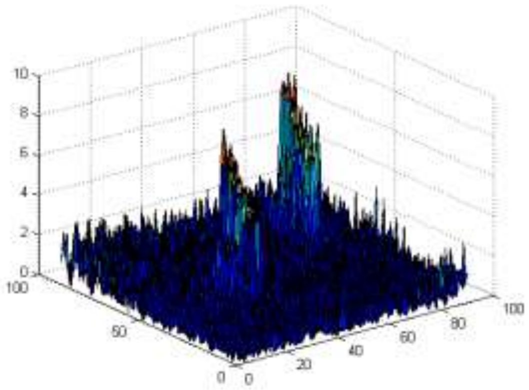
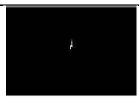


Fig3. Surface plot for distribution of LHM

IV. EXPERIMENTAL RESULTS

Broken end, multiple netting defects, holes, thick bar. Detection results for various types of defect detection are given in following table.

TABLE I. EXPERIMENTAL RESULT

Type of defect	Defected image	Detected defect
Broken end		
Multiple Netting defect		
Hole defect		
Yarn removal(Thick bar)		

The effectiveness of algorithm is measured on basis of detection success rate, also known as detection accuracy, is givenas,

$$\text{Accuracy} = \frac{\text{Number of samples correctly detected}}{\text{Total number of samples}} * 100\ \%$$

V. CONCLUSION AND FUTURE SCOPE

In this paper, local neighborhood analysis algorithm is demonstrated to fabric defect detection. This method is effective, less time consuming unlike spectral decomposition techniques and learning methods. This algorithm captures the irregularities caused by defect in local homogeneous region offabric material. The experiments conducted on different types of defects and different kinds of fabrics have yielded promising results, which have shown that this method achieves great detection accuracy and a low cost for fabric inspection successfully.

This algorithm still faces challenges in detecting defects in pattern fabrics and motif based fabrics due to lots of variations in texture.

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