Pattern Fabric Defect Detection Using Regular Band and Classification by Neural Network

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Abstract : Regularity is one of the main features for many Patterned texture material inspection. A new approach called Regular Band (RB) method is used to inspect patterned texture. A Regular Band method is based on the idea of periodicity. The change in a periodicity is considered as a defect. The Bollinger Band (BB) method will not detect the light color variation and this difficulty is overcome by RB method where (LRB) Light Regular Band and (DRB) Dark Regular Band is calculated for each row and column of an image. In this paper fabric defect detection is done with RB method and classification is done with the help of Neural Network. Regular Band calculated is based on standard deviation and moving average. Abnormal changes in the pattern lead to large variation in the standard deviation.

Keywords—Bollinger Band, Defect Detection, Moving Average, Standard Deviation, Patterned fabric, Regular Band.

I. INTRODUCTION

In automated industry defect inspection is the most effective technique because on-loom machine material will move around a speed of 200dpi/ meter so human inspection is not possible with this speed. Errors are caused by human fatigue. Quality assurance and quality control is necessary to retain the stability in the market. Quality control is nothing but the manufacturing the fabric without defect. Defect is the flaw on the fabric. So due to automated inspection human errors are minimized and efficiency has increased, this will reduce the labor cost and computational time which is most effective measures for the improvement of fabric quality [5]. Textures are broadly classified into patterned regular textures and irregular textures. Texture analysis can be categorized into four main types which are texture segmentation, texture synthesis, texture classification and texture shape studies. Out of these texture segmentation can be done by using properties like uniformity, coarseness, roughness, linearity, directionality and regularity [19]. Among these properties regularity analysis of patterned texture has received growing attention [3]. Regularity can be considered important feature because of its highly invariant and perceptually motivated feature [18],[3]. Regularity analysis for pattern textures involves two basic methods: the special relationship between the values of intensities of pixels and the repeat distance of repetitive unit. Generally the fabric inspection methods depend upon the spectral, statistical, model based, learning and structural approach [1]. For defect detection some previous methods like grey relational analysis, (DT) Direct Thresholding [16], (WGIS) Wavelet Golden Image Subtraction [2],[6] and (LBP) Local Binary Pattern [17] etc. were used. The above mentioned methods are designed mainly for unpatterned fabric defect detection. All above approaches are classified under non motif based approach and considered as total input image for fabric inspection. In the proposed method RB having regularity property is used to detect the defect in the simple pattern texture. Bollinger Band methods are developed for complicated pattern fabrics .It consists of Lower Band, Upper Band, and Middle band. By the method of Bollinger Band the patterned rows and columns will generate periodic upper bands and lower bands. Defective region in patterned fabric means there would be Change in periodicity or break of periodicity in the pattern. Abnormal changes in the Upper Band and Lower Band leads to large variation in standard deviation [4],[11]. The Bollinger band method will not detect the light color variation so we go for RB method [3]. Regular Band method has two bands, Light Regular Band and Dark Regular Band for each row and column which detects the defect created due to light color variations. It is very important to classify the type of the defect to give feedback to the manager that which type of defect has been occurred. Two layer feed forward network with sigmoid function is used for the classification of defects [14],[10]. Sigmoid is a smooth, differentiable, non-linear and saturating function. It also admits a linear model if the network weights are small. After detection of defect in patterned fabric, the defect area is segmented. This segmented defect is then classified into thin bar, thick bar, multiple netting, hole, loose pick and broken end by using neural network [14],[15]. In this paper star pattern, box pattern and dot pattern fabric database is used for defect detection. We have created our own database. All images used for result evaluation are 100 100 pixels in grey levels scale and computation is carried out in MATLAB (12b). Seven types of defects have been classified in the paper.

This paper is organized as described below, in section II Literature review of patterned and unpatterned fabric is presented. Section III shows proposed Regular band method with its mathematical representation. Result evaluation using above said methods are given in section IV which includes the detection for box, dot and star patterned fabrics. Finally in section V conclusion is derived.

II. LITERATURE REVIEW OF PREVIOUS METHODS

Many Researchers have focused on defect detection of unpatterned fabric. Traditional methods used for unpatterned defect inspection cannot be used for patterned fabric inspection, because the yarn structure of pattern fabric is more complicated than unpatterned fabric. During acquisition of images in patterned fabric distortion of patterns and shift in patterns will occur. These problems increases the difficulties and affect on feasibility to apply the traditional methods such as co-occurrence matrix approach [24], Auto-correlation approach [23], Traditional image subtraction approach [16] [8], Hash function approach [22],[23] and Near-Infrared (NIR) imaging method approach [20],[21]. To overcome the problems associated with the traditional methods, the methods like Direct Thresholding (DT)[16], Wavelet Golden Image Subtraction (WGIS) [6],[8],[16] and Bollinger Band method (BB) [3],[4] are used for patterned fabric inspection and these methods are based on the principle of measuring the periodicity of the input images.

A. Direct Thresholding

In Direct Thresholding, Wavelet Transform (WT) is used for segmentation in patterned fabric for defect detection [16]. It chooses a simple Haar Wavelet type WT and length of decomposition filter is two [2]. Then input images are decomposed into horizontal detailed images, vertical detailed images and diagonal detailed images to get the best result [3]. Therefore selecting appropriate level defected region would be enhanced and non-defective region would be suppressed. B. Golden Image Subtraction The Golden Image Subtraction (GIS) method is mainly used to detect the defects like holes and thick bars in pattern fabrics, and improved version of GIS method has been developed is known as Wavelet Golden Image Subtraction (WGIS) [4]. In WGIS small defects like small holes and loose picks have been difficult to detect. BB method is used to overcome the limitations of WGIS. C. Bollinger Band Method Mostly it is used for financial technical analysis based on Moving Average and Standard Deviation. It provides a relative definition of high and low prices mainly in stock market for oversold and over brought shares [8]. Bollinger band consists of Middle band with only Moving Average, Lower Band and Upper Band having Moving Average and Standard Deviation. It was extended from 1-D approach to 2-D approach for jacquard fabric inspection [5]. Bollinger band method was shift invariant across patterned fabric material in addition it was able to outline the shape of defects [3],[4]. Fabric defect detection in Bollinger Band mainly consists of two stages:-

1) Training stage 2) Testing stage

Training stage consists of defect free image as a reference image. The threshold values are determined from the Bollinger band of the reference image. In the training stage defect free image is preprocessed, then the processed image is converted into 1D vector to calculate Moving Average for period of n=20 where n denotes row dimension of repetitive unit. Moving Average and Standard Deviation are considered to calculate Upper Band and Lower Band which are defined as below Moving Average is for n = 20

$$M_r = \frac{\sum_{j=r1}^{rn} X_j}{n} \quad (1)$$

Where M_r = Moving Average for input image, n = Row dimension of repetitive unit,
xj = Value of image pixel for the given period so Standard Deviation is

$$\delta_r = \sqrt{\frac{\sum_{j=r1}^{rn} (X_j - M_r)^2}{n}} \quad (2)$$

Upper Band is

$$UB_r = M_r + d * \delta_r \quad (3)$$

Lower Band is

$$LB_r = M_r - d * \delta_r \quad (4)$$

Where d = Total Standard Deviation of a period. By using Upper Band and Lower Band threshold values are calculated and are stored. Testing Stage is similar as training stage. The threshold values of Testing Stage and Training Stage are compared, if threshold values of Testing Stage are greater than Training stage then it is considered as defect has occurred [4],[3]. Defect smaller than one repetitive unit may not be detected by BB method [4] and light color variation is also not detected because BB is applicable only for grey scale images. RB method is used to overcome the above problems.

III. PROPOSED METHOD

Regularity is the new principle of measurement. Here the fundamental component of a patterned texture is a repetitive unit which can be shown as either 1D (periodic signal) or 2D (patterned image). Regular Band (RB) [3] has two sub bands,Light Regular Band (LRB) and the Dark Regular Band (DRB). Regular Band method also has two stages that are training Stage and Testing Stage. The structural characteristic is obtained by using the repetitive unit as a convolution filter sliding on the test signal. For defective region the numerical value will exceed the normal range of the signal therefore applying thresholding the abnormal part (defective region) is segmented out [9].

RB method [13],[3] gives a new approach on the classical statistical method of Standard Deviation and Moving Average which is applied for patterned texture inspection. It is most

effective for variation in the different pixel intensities like thick bar and broken end. It uses period length single parameter for obtaining correct result. But it only suited for the patterned textures and defects near to the border are not detected.

1) Training Stage

In the Training Stage first defect free image (reference image) is acquired. Then preprocessing is done to dampen the bad effects. Preprocessing also includes histogram equalization for contrast enhancement [7]. After that row wise and column wise Light Regular Bands and Dark Regular Bands are calculated From the preprocessed image [3],[9]. Then apply the thresholding technique to calculate the values of LRB and DRB to get threshold. Calculation of LRB is defined as

$$LRB = |M_r - \delta_r| + M_r \quad (5)$$

$$DRB = |M_r + \delta_r| + M_r \quad (6)$$

And the Moving Average and Standard Deviation are same as shown in equation (1) and (2). The block diagram of Training Stage is shown in Fig. 1.

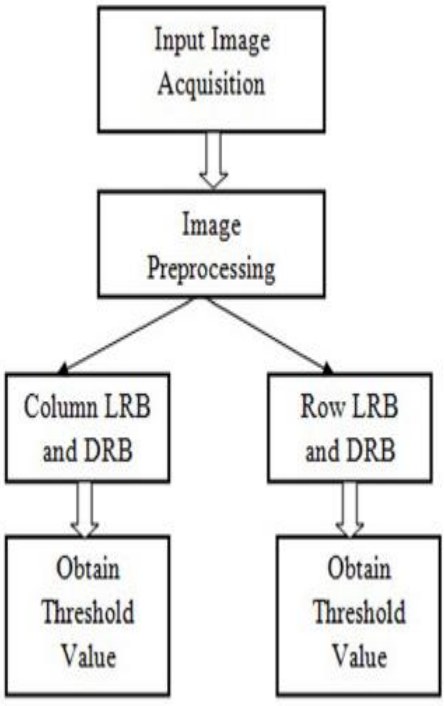

Fig. 1. Flow diagram for Training Stage

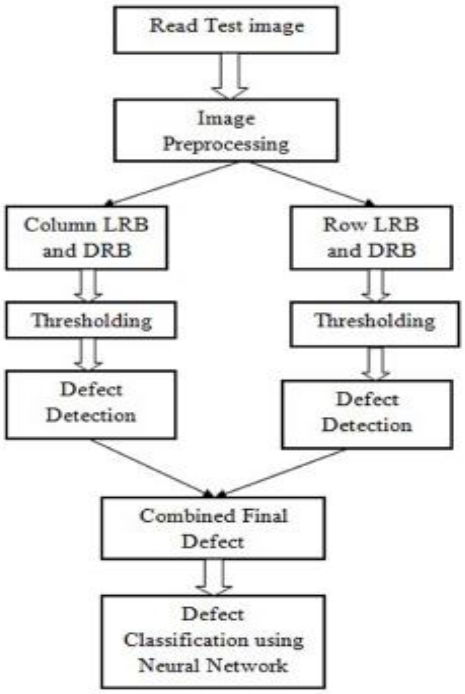

Fig. 2. Flow diagram for Testing Stage

IV. EXPERIMENTAL RESULTS

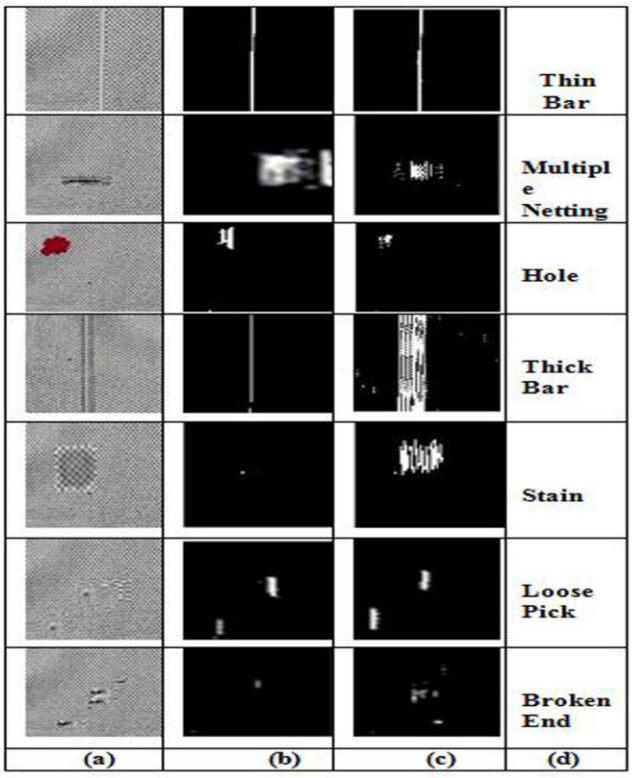

Fig. 3. (a) Defected image (b) BB results (c) RB Results (d) Defect Classification using Neural Network

V. CONCLUSION

The overall defect detection success rate of RB method is better than BB method for the patterned fabric. The problem of BB method which could not detect light color variation is overcome by RB method and also gives correct shape of the defect and perfectly outlines the border after detection of the defect. RB has advantage of easy implementation. The proposed method is only used for the patterned texture not for the irregular patterned texture. We have also classified the types of defects with a high rate of efficiency. Experiment also classified seven types of defects which are Thin Bar, Thick Bar, Hole, Stain, and Multiple Netting, Loose Pick and Broken End. Neural Network method is useful for textile industries to classify different defects in their products.

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