Fabric Defect Detection by the Method of Bollinger Band

Jyoti Nikam
Siddhant College of Engg. Pune.

M. S. Biradar
Siddhant College of Engg. Pune.

ABSTRACT
Regularity is one of the main features for many Patterned texture material inspection. This paper shows the new approach called Bollinger Band (BB) method. Bollinger Band method originally used for financial technical analysis, based on Moving average and standard deviation. It was originally extended from 1-D approach to 2-D approach for jacquard fabric inspection. The BB Method is shift invariant across patterned texture material and its mathematical definition was simple. Bollinger Band method based on the idea of periodicity.

Keywords
Bollinger Band, Defect Detection, Histogram Equalization, Moving Average, Standard Deviation.

1. INTRODUCTION
Fabric is a flexible artificial material that is made by natural and artificial fibers. It is widely used material in daily life in textile fibers. It can be made by cotton, wool and composite of different elements such as cotton wool, nylon or polyester. In automated industry defect inspection is most effective technique because on-loom machine material is move around a speed of 200dpi/ meter so human inspection is not possible having some errors that is human fatigue error and fine defect error. Quality assurance and quality control is necessary to retain the existence in the market and maintain the status. Quality control is nothing but the locating and detecting the defect. Defect is nothing but the flaw on the fabric. Human errors are minimized by automated inspection and it increases the efficiency. This will reduce the labor cost [8] and computational time which is most effective measures for the improvement of fabric quality [5, 9].

Fabric is a 2-D pattern texture so 2-D texture is underlined lattice with its symmetry properties governed by its 17 wallpaper groups. In mathematical algebra the wallpaper groups also known as the crystallographic groups. Pattern texture of such a wallpaper group can be generated by at least one of its symmetry rules on lattice among translational, rotational, reflectional and glide reflectional symmetries [1, 6]. These 17 wallpaper groups are named as p1, p2, pm, pg, cm, pmm, pmg , pgg, cmm, p4, p4m, p4g, p3, p3m1, p3mp6, and p6 while letter p refers to primitive and c is a centered cell. The integer that follows p or c denotes the highest order of symmetry that is 1-fold, 2-fold, 3-fold, 4-fold, or 6-fold. Where symbol m indicates a reflectional symmetry and g is a glide reflectional symmetry [5, 11]. Generally the patterned fabric inspection methods are depends upon the spectral methods, statistical methods [10], model based methods [10], learning methods and structural methods. This is a natural study about the underlying patterned fabric and the geometrical defective objects in fabric images. For defect detection some previous techniques used are wavelet transform, Fourier transform which uses a simple plain twill and fabric images. But in this process having transformation and reconstruction process which is not give a correct result for dot, star, and box patterned fabric which is a complicated patterned fabric [7]. Whereas for the grey relational analysis, (DT) Direct Thresholding [16], (WGIS) Wavelet Golden Image Subtraction [2, 9, 14], (LBP) Local Binary Pattern [17], (BB) Bollinger band methods are developed for complicated pattern fabrics [2]. Out of that Direct Thresholding, and Local Binary Pattern belongs to spectral approach and Bollinger Band, Wavelet Golden Image Subs traction belongs to mixture of statistical and filtering approach. In this the BB having a regularity property in the patterned texture which is further used to detect the defects in the simple patterned texture of (p1 wallpaper group) that means all above approaches are classified under non -motif based approach which treat whole input image for fabric inspection[4].

2. PROPOSED METHOD
2.1 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 [15]. Bollinger band consists of Middle band with only moving average, lower band and upper band having moving average and standard deviation [11]. 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 defects after detection [3,4].

Fabric defect detection Bollinger Band mainly consists of two stages:-

1) Training stage
2) Testing stage

2.1.1 Training Stage
Training stage consists of defect free image (reference image) the threshold values are determined from the Bollinger band of the reference defect free image. The flow diagram for training for reference free image is shown in Fig 1.

Step1. Histogram equalization helps in reducing the noise on the images and makes the later threshold process more reliable. Mainly this block is used for contrast enhancement to show equalization of the signal. Which is shown in Fig 3 (a).Defect on the fabric is usually characterized by high frequency changes in pixel intensities within an image. Fig 3. Shows a comparison of two defective samples with and without histogram equalization as a preprocessing step. The resultant image show better results with histogram equalized preprocessing than those without.

Step2. Calculation of moving average or mean:-
The input image is first converted into the 1-d vector, then the moving average is calculated for the period of n=20 and n=40 with the help of following formula [3, 4]

$$\mathbf{M_r = \frac{\sum_{j=r1}^{rn} X_j}{n}}$$

Where Mr = moving average for input image.

n = row diamention of repeatative unit.

Xj = Value of image pixel for the given period. The moving average for n = 20 is shown in Fig 4.

Step3. Calculation of Upper band and Lower band:-
For input image calculation of Upper band and Lower band depends upon the moving average and standard deviation which is calculated by following formula and shown in Fig 5. (a) and (b)

Upper band is defined as

$$\mathbf{U\,B_r = M_r + d * \delta_r} \qquad (2)$$

Lower band is defined as

$$\mathbf{L\,B_r = M_r - d * \delta_r} \qquad (3)$$

The standard deviation is defined as (4)

$$\boldsymbol{\delta_r = \sqrt{\frac{\sum_{j=r1}^{rn}(X_j - M_r)^2}{n}}} \qquad \mathbf{(4)}$$

Step 4: Obtained the threshold values
In this calculation of Upper band is maximum (UBmaxl) and Minimum of (UBMinl), and for lower band is Maximum of (LBMaxl) and Minimum of (LBMinl). Combination of Upper Band, Lower Band and Moving average is shown in Fig 6.

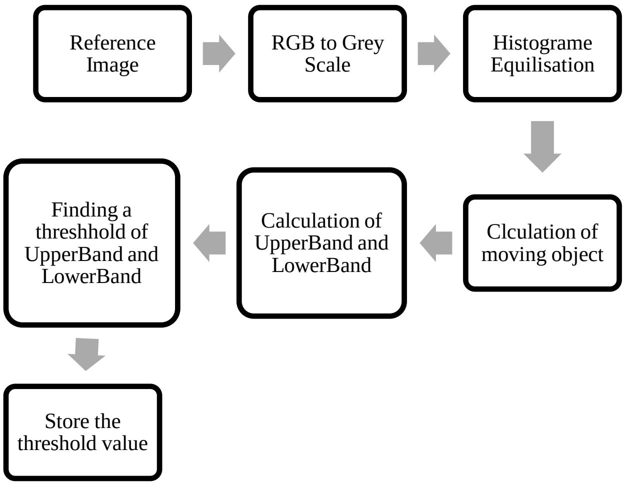

Fig 1: Flow diagram for training of fabric defect detection using Bollinger Band.

2.1.2 Testing Stage

The testing stage consists of similar stages of training and calculation of Bollinger band, the values of Upper band are compared with the threshold values of upper band of training stage (reference image) and the values of lower band are compared with threshold values of lower band of training stage (reference image). But for testing stage take a defected image. The flow diagram for testing stage is shown in Fig 2.

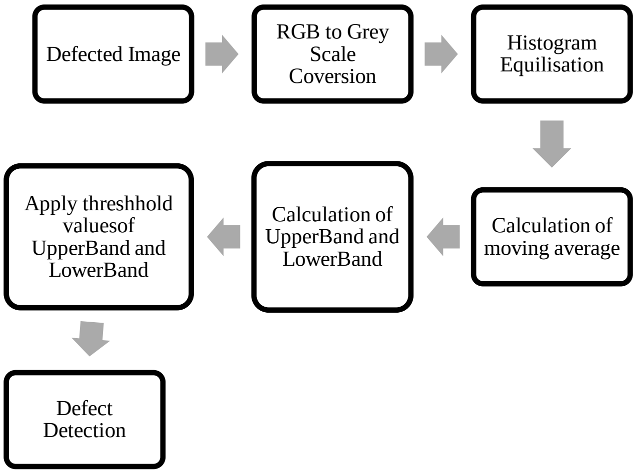

Fig 2: Flow diagram of testing stage of defected image for the representation of Bollinger Band.

Step1:-Histogram equalization of input images.
The defected images with hole, its histogram, the histogram equalized image and its histogram is given in Fig 7.

Step2. Calculation of moving average or mean is shown in Fig 8.

Step3. Calculation of the upper band and lower band is shown in Fig 9. (a) and (b). In this the value of upper band and lower band of the Bollinger band representation of the defected image is shown. In this the value of upper band and lower band will cross the threshold value (determined in training stage) at the position of defect.

Step4. Threshold the Upper band and Lower band with corresponding threshold values determined during testing stage as shown in Fig 10.

f (x) = 1   UB Max1 > UB Max

Step5. Detect the defect in defected image using threshold values. Shown in Fig 11.

3. EXPERIMENTAL RESULTS

3.1 Training Stage

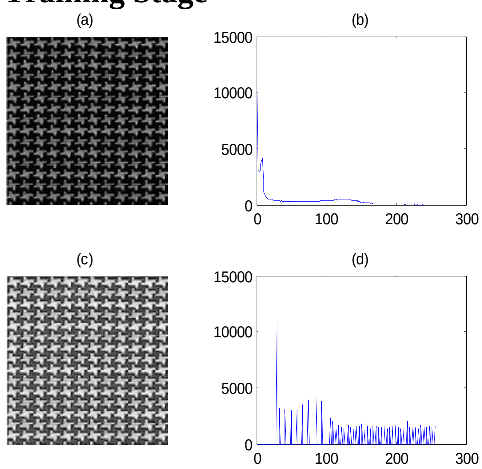

Fig 3: (a) Defect-free sample of star-patterned fabric without histogram equalization, (b) the histogram of (a), (c) defect-free sample of Star-patterned fabric with histogram equalization, (d) the histogram of (c).

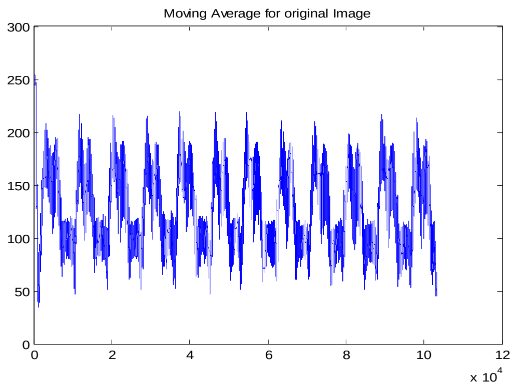

Fig 4: Moving average for the original image for n=20

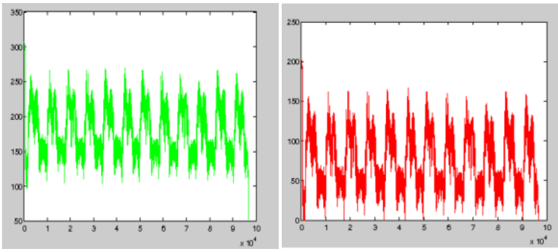

Fig 5: (a) Upper Band for non defected training image. (b) Lower Band for non defected training image

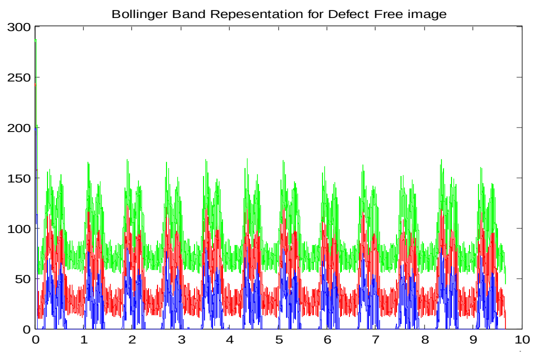

Fig 6: Bollinger Band representation for original reference image, Upper Band in green, Mid Band in red and Lower Band in blue colour.

3.2 Testing Stage

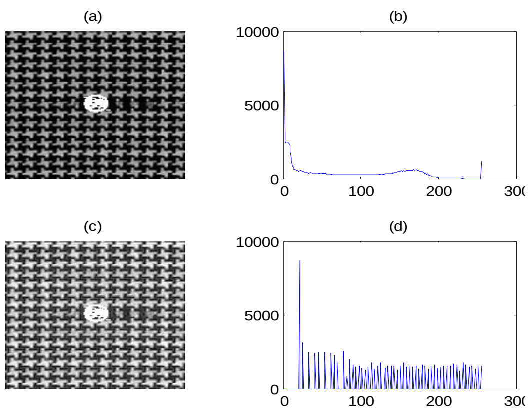

Fig 7: (a) Defected sample of star-patterned fabric without histogram equalization, (b) the histogram of (a), (c) defect- free sample of Star-patterned fabric with histogram equalization, (d) the histogram of (c).

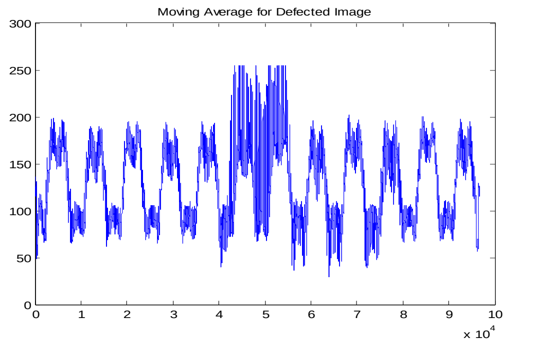

Fig 8: Moving average for the defected image for n=20

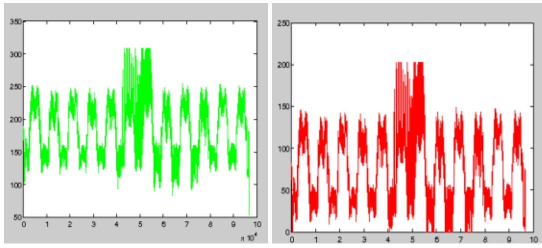

Fig 9: (a) Upper Band for defected testing image, (b) Lower Band for testing image (defected image)

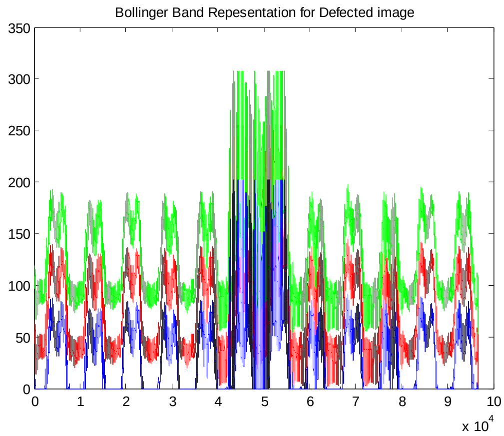

Fig 10: Bollinger band representation for defected image, Upper Band in green, Mid Band in red and Lower Band in blue color

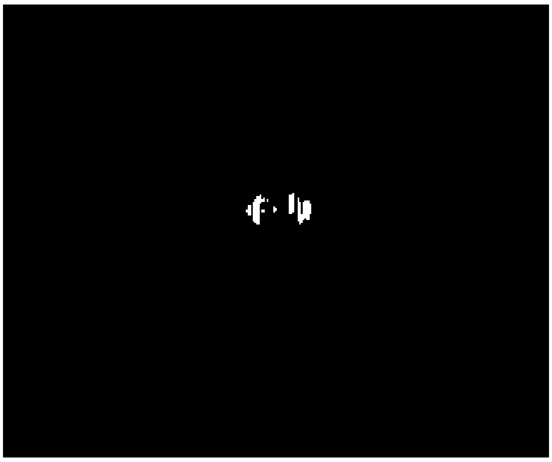

Fig 11: Detected defect in the test image

4. CONCLUSION

Bollinger band method used for patterned fabric defect detection is very effective and robust for regular patterned fabric. Its strength is periodic in nature and any change in the periodic signal will affect the output. As compared to other patterned fabric defect detection methods. Its 1-D approach is suitable to optimizing the period lengths (that is n) if it select a larger than repetitive unit. By using BB the alignment problem occurred in wavelet Subtraction method is solved. It require less computation time. BB method is simple to implement and the mathematical definition was very simple. Its efficiency is also high as compared to DT and WGIS. While using BB method light color differences such as light shade not detected by the Bollinger Band method because it is only applicable for gray scaled images not to the RGB scaled images but it gives clean and clear shape of the defect.

5. ACKNOWLEDGEMENTS

I would like to thanks especially to my husband, friend and my college give me support and guidelines for the completion of this paper work.

6. REFERENCES

[1] Henry Y. T. Nagan, Grantham K. H. Pang and Nelson H. C. Yung 2011. “Automated fabric defect detection-A review,” Image Vision Computing. Vol. 29, No 7, pp. 442-458.

[2] Henry Y.T. Nagan, Grantham K. H. Pang, S. P. Yung, Michael K. Ng. 29 July 2004. “Wavelet based methods on patterned fabric defect detection,” Pattern Recognition, Vol.38, No 4, pp. 559-576.

[3] Henry Y.T. Nagan, Grantham K. H. Pang 2009. “Regularity Analysis for Patterned Texture Inspection,” IEEE Transactions Aut. Sci. and eng, Vol 6, No1, pp.131-144.

[4] Henry Y.T. Nagan, Grantham K. H. Pang Aug 2006. “Novel method for patterned fabric inspection using Bollinger Bands,” Opt Eng, Vol 45, No 8.

[5] Henry Y.T. Nagan, Grantham K. H. Pang and Nelson H. C. Yung 12 Nov. 2007. “ Motif based defect detection using patterned fabric,” Pattern Recognition, Vol. 41, No. 6, pp. 1878-1894.

[6] Henry Y.T. Nagan, Grantham K. H. Pang and Nelson H. C. Yung 2007. “Patterned fabric defect detection using a motif- based approach,” IEEE Transaction.

[7] Michal K. Ng, Henry Y. T. Nagan, Xiaoming Yuan, and Wenxing Zhang 2014. “Patterned fabric inspection and visualization by the method of image decomposition,” IEEE Transactions on Aut. Sci. and Eng, Vol. 11, No. 3.

[8] Roland T. Chin, Charles A. Harlow. November 1982. “Automated visual Inspection: A Survey,” IEEE Transaction on Pattern Analysis and Machine Intelligence, Vol.PAMI-4, No. 6.

[9] Ali Javed, mirza A. Ullah, Aziz-ur-Rehman. 2013. “Comparative Analysis of different fabric defects detection techniques,” J. Image graphics and signal processing.

[10] Anil K. Jain, 1998. “Texture Analysis”, The Handbook of Pattern Recognition and computer vision (2nd Edition).

[11] Henry Y. T. Nagan, Grantham K. H. Pang. Jan 2010. “Performance Evaluation for Motif-Based Patterned Texture Defect Detection,” IEEE Transaction on Automation Science and Engg, Vol. 7, No 1.

[12] H. Sari-Sarraf and J .S. Goddard, 1999. “Vision System for on-Loom fabric inspection,” IEEE Trans. In, Appl.35 (6)

[13] Michal K. Ng, Xiaoming Yuan, and Wenxing Zhang. JUNE 2013. “Coupled Variational Image Decomposition and Restoration Model for Blurred Cartoon-Plus-Texture Images with Missing Pixels,” IEEE Transaction on image Processing, VOL.22, NO.6.

[14] Henry Y.T. Nagan, Grantham K.H. Pang, S.P. Yung ,Michael K. Ng. 2007.“Defect Detection on Patterned Jacquard Fabric,” IEEE Computer Society Proceedings of the 32nd Applied Imagery Pattern Recognition (AIPR03).

[15] John Bollinger. Bollinger on Bollinger bands Book.

[16] Henry Y. T. Nagan, Grantham K. H. Pang, S. P. Yung and , Michael K. Ng. April 2005. ’’Wavelet based methods on Patterned Fabric Defect Detection,”

[17] F. Tajeripour, E. Kabir, and A. Sheikhi, 2008. “Fabric defect Detection using modified local binary patterns,” EURASIP J. Adv. Sig. Pr., p. 12.