

8. SUMMARY AND CONCLUSION

The aim of production line enhancement in any industry is to improve quality and reduce operating costs by applying various kinds of advanced technology. In order to become more competitive, many sensing, monitoring and control approaches have been investigated in textile industry. Automated visual inspection is one area of improvement where tremendous cost savings can be realized over traditional inspection techniques. Manual visual inspection of textile products is expensive and error-prone because of the difficult working environment near the weaving machine. Automated visual detection of fabric defects is particularly challenging due to the large variety of fabric defects and their various degrees of vagueness and ambiguity.

Among the two categories of fabrics, patterned and non-patterned, this research work focuses on the design and development of defect detection system on patterned fabrics. The techniques used for defect detection on patterned fabrics are grouped, as motif-based or non-motif-based techniques. This research study focuses on enhancing the operation of both these groups to improve the defect detection process.

The proposed system consists of two main steps, namely, preprocessing and defect detection. Preprocessing step consists of algorithms to enhance the quality of the input image, so as to improve the process of defect detection. The preprocessing step adjusts brightness and contrast variations in the fabric image and also removes the impulse noise that may be present. For the purpose of noise removal, an enhanced directional switching median filter is proposed. This technique first uses a directional detector to detect noise and noise free pixels, using which a binary image is created in the next step. Analysis of the binary image by using enhanced directional switching median filter the noise present in the fabric image is removed. This enhanced image is used as input to the second step.

In the defect detection step, under the non-motif based group, two techniques are proposed. The first technique combines edge information with image data fusion technology for detecting defects. Three algorithms edges are used during the extraction edge information from the fabric image. They are sobel edge operator, wave profile and seam line detection algorithm, which are fused together using an union feature relationship. A segmentation process with dynamic thresholding is then used to detect defect in the patterned fabric images.

The second method of non-motif-based algorithm focuses on improving a wavelet based Golden Image Subtraction technique. The algorithm first performs histogram equalization and then extracts wavelet coefficients. For this purpose, two variants of wavelets, namely, optimal wavelet tree and Gabor wavelets were considered. Optimal coefficients were selected using two selection algorithms. They are, Vector Quantization combined with Principal Component Analysis, Independent Component Analysis. A multiple projection selection algorithm that combines the above two algorithms was also proposed. These optimal features were then used during defect detection. For detecting defects, two methods were proposed. The first method is based on golden image subtraction combined with direct thresholding method. The second method is based on MultiLayer Perceptron Neural Network. To remove any noise that might be introduced during defect detection, the proposed denoising was applied again. Thus, a total of 12 wavelet based were designed that combine techniques like wavelets, optimal coefficients selection and defect detection.

The proposed enhanced non-motif-based algorithm performs defect detection using a series of steps combining image processing and pattern recognition algorithms. The lattices and motifs are automatically detected using an autocorrelation algorithm. The detected lattices and motifs are then extracted, from which circular shift matrices and spatial relationships are extracted. The average intensity difference between the current motif and its corresponding first circular shift matrix and last circular shift matrix is estimated. From this the energy and variance (EV) values were determined. Decision boundaries are then

formulated using max-min EV values, represented as an EV plot, from which defects are detected.

Experiments were conducted to evaluate the performance of the proposed models using 600 patterned fabric images. The experiments were conducted separately to evaluate the performance of the preprocessing and defect detection algorithms. The preprocessing algorithm was evaluated using performance metrics like Peak Signal to Noise Ratio, Figure of Merit, Mean Structural Similarity Index and Speed of enhancement. Four performance metrics were used during experimentation to evaluate the performance of the motif and non-motif-based defect detection systems. They are sensitivity, specificity, detection accuracy and speed of defect detection.

During defect detection, five types of defects, namely, broken end, hole, netting multiple, thick bar and thin bar defects were considered. The results showed that the performance of motif based algorithm is better than non-motif based algorithm and among the non-motif based algorithm, the wavelet based algorithm working is superior to fusion based method. Among the wavelet based model, the model that used Gabor wavelets with VQ + PCA + ICA multiple projection based selection algorithm using MLP Neural Network produced maximum efficiency when compared to other models.

All the experimental results proved that while all proposed models performed better than existing algorithms, the GVPIN model in non-motif based group and EMBMAS model in motif-based group showed maximum efficiency in terms of defect detection accuracy and can be used for reliable and safe detection of defects in patterned fabrics.

FUTURE RESEARCH DIRECTIONS

The following points can be considered in future to improve the performance of the proposed patterned fabric defect detection models.

- The present study considers images which are not severely misaligned or distorted and the illumination of input images of patterned fabric is considered to be nearly uniform. Future research can be extended to accommodate these variations.
- In motif based algorithm, extraction of lattices and motifs are considered only for rectangular matrix. In future, non-rectangular shapes like parallelogram, rhombus or triangle can also be considered by transforming it into rectangular matrix.
- In non-motif based algorithms, different decomposition levels can be analyzed and their effect on defect detection can be studied.
- A method that can fuse the segmented defect regions from different algorithms can also be probed.