Artificial Neural Network Techniques used for Identifying Defects in Woven Fabric Images

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Abstract- In Textile industry automatic fabric inspection is important to maintain the quality of fabric. Fabric defect detection is carried out manually with human visual inspection for a long time. The work of inspectors is very tedious and consumes time and cost. To reduce the wastage of time and cost automatic fabric defect detection is required. This paper proposes an automotive approach to recognize fabric defects in textile industry for minimizing production cost and time. Fabric analysis is performed on the basis of digital images of the fabric. The recognizer acquires digital fabric images by image acquisition device, converts the image into gray scale image, normalize and filter the image using interpolation and adaptive median filtering techniques and then convert the image into binary image by thresholding techniques. From the binary image, fourier coefficient is extracted by using fast fourier transform techniques, The average of extracted fourier coefficient is given as an input to the Artificial Neural Network (ANN) which uses back propagation algorithm to calculate the weighted factors and generates the desired classification of defects as an output.

Keywords – Artificial Neural Networks(ANN), Back Propagation Algorithm, Defect Identification, Fast Fourier Transform, Feature Extraction, Image Processing

I. Introduction

Quality is an important aspect in the production of textile fabrics. Fabric quality is consisting of two components, i.e, fabric properties and fabric defects. Fabric property depends on the raw material, construction parameters and processing methods. Whereas a fabric defect can occur right from raw material selection to finishing stage, because of improper input parameters with respect to material, machine and man. Any variation to the weaving process needs to be investigated and corrected. Defects fall into this category. Since when they appear, repair is needed, this is time consuming and sometimes results in fabric rejection. Fabric defect detection has been a long – felt need in the textile and apparel industry. Surveys carried out in the early 1975 shows that inadequate or inaccurate inspection of fabrics has led to fabric defects being missed out, which in turn had great effects on the quality and subsequent costs of the fabric finishing and garment manufacturing processes.

Measurement of quality during the production of woven fabrics is highly important to the textile industry in lowering the cost. Presently, much of the fabric inspection is performed manually by human inspectors and using off-line stations. Many defects are missed during the inspection and the inspection is inconsistent since it depends on the training and the skill level of the personnel and also the mental and physical conditions of the inspector [1]. As a result, the textile industry has been moving toward automated fabric inspection. An automated fabric inspection system can provide consistent results that correlate with the quality-control standards of the textile industry. Until now, most of the automated technologies provide off-line inspection, which inspect large rolls of fabric after they have been produced.

The weaving machine is one of the easiest and fastest ways of producing cloth and textile pieces. The fabric faults or defects are responsible for 85% of defect found by the garment industry [1]. The automated defect detection and identification system enhance the product quality and result in improved quality to meet both the customer demand and to reduce the cost associated with off-quality. This process also reduces the manual work load associated with the inspection process.

Off-line monitoring system has its own disadvantages when it is compared with that of on-line monitoring system is the time involved in the process. In the off-line monitoring system the produced fabric is taken to the inspection frame where the quality of the fabric is analyzed and the fabric is transfer to the successive process. But in the on-line monitoring system the inspection of the woven fabric is done simultaneously while the fabric is being produced.

This paper describes about automatic fault detection in the weaving machine during weaving by using the principle of image processing and artificial neural network techniques. An automatic fabric evaluation system, which enables computerized defect detection – analysis of weaved fabrics. This method involves the process of analyzing the fabric image capture by a digital camera. The advantage for the manufacturer here is to get a warning when a certain amount of defect or imperfection occurs during the production of the fabric so that precautionary measures can be taken before the product hits the market. Wastage reduction through accurate and early stage detection of defects in fabrics is an important aspect of quality improvement. The problem of web inspection, particularly, is very important and complex and the research in this field is widely open [2].

The rest of the paper is organized as follows. Proposed algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. Proposed Algorithm

A. Image Acquisition

The woven fabric images of without defect and with defect are acquired and then processed. The most important parameter used in the image acquisition is the resolution. The resolution of an image can be referred either by the size of one pixel or the number of pixels per inch. The lower the image resolution, the less information is saved and higher resolution means more information is saved but larger memory size is required to store [5]. The scanning of fabric images begins from 300 dpi resolution because human vision is approximately 300 dpi at maximum contrast. The scanned image is stored in 'jpg' format. Initially the resolution level is set to 300 dpi and then gradually increased by step of 100 dpi till 1000 dpi as a maximum resolution [6]. The image acquisition is performed by different types of camera like CCD (Charged Coupled Device), CMOS (Complementary Metal Oxide Semiconductor), digital camera etc.,

B. Image Preprocessing

The aim of pre-processing is an improvement of the image data to enhance image features relevant for further processing and analysis task. The image obtained from CCD camera is converted into gray scale image then resized using interpolation technique. Interpolation technique is used to calculate the unknown pixel value by using the known pixel values. Interpolation techniques are grouped into two categories: Adaptive and non-adaptive. Adaptive methods change depending on what they are interpolating, whereas non-adaptive methods treat all pixels equally. In our paper bilinear interpolation method is used, this method operates on the closest 2x2 neighborhood of known pixel values surrounding unknown pixel. It then takes a weighted average of these four pixels to arrive the final interpolated value. The resulting images are much smoother looking images than nearest neighbor method.

The normalized image is filtered with adaptive median filtering. This median filter belongs to the class of edge preserving smoothing filters which are non-linear filters. For two images f1(x) and f2(x), $\mathrm{Median}[f1(x)+f2(x)] \neq \mathrm{median}(f1(x))+\mathrm{median}(f2(x))$. Adaptive median filter smoothens the image by keeping the small and sharp details. The adaptive median filter performs spatial processing to determine which pixels in an image have been affected by noise. This filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels and preserves detail of the image.

C.Fourier Transform

The Fourier transform(FT) has the property of noise immunity and enhancement of periodic features. The FT characterizes the textured image in terms of frequency components. The discrete fourier transform takes N^2 operations for N points. Since at any stage the computation required to combine smaller DFTs into larger DFTs is proportional to N, and there are log2(N) stages , the total computation is proportional to N * log2(N). Therefore, the ratio between a DFT computation and an Fast Fourier Transform (FFT) computation for the same N is proportional to N / log2(n). In cases where N is small this ratio is not very significant, but when N becomes large, this ratio gets very large.

$$F\{g(t)\} = G(f) = \qquad \text{-----} \ (1)$$

$$F^{-1}\{G(f)\} = g(t) = \qquad df \qquad \text{-----} \ (2)$$

Multiplication in the frequency domain implies convolution in the time domain.

$$F(u,v)H(u,v) = G(u,v) \text{ is equal to}$$

$$F(x,y) * h(x,y) = g(x,y)$$

Where h(x,y) is given in the spatial domain and H(u,v) is given in the frequency domain.

The given input image f(x,y) of size MxN, the padding parameters P and Q. The padded image $f_p(x,y)$ of size PxQ is multiply by $(-1)^{x+y}$ to center its transform. The discrete fourier transform is computed to generate H(u,v). Again we need to decentre its transform to get the image again. Pearson coorelation coefficient (r) is calculated and this coefficient can be used as one of the feature to artificial neural network.

r = ----- (3)

The filtered image is converted into binary image by using the intensity as threshold value. The fourier coefficient is calculated and this is given as input to the artificial neural network.

C.Artificial Neural Network

Artificial Neural Network with back propagation algorithm used to train the network. Multilayer feed forward network with input layer, hidden layer and output layer is used in our experiment. Input layer consists of one neuron because the fourier coefficient is the only input to the artificial neural network. Hidden layer consists of 5 hidden neurons and output layer consists of only one neuron. The output neuron gives the result as normal or defect.

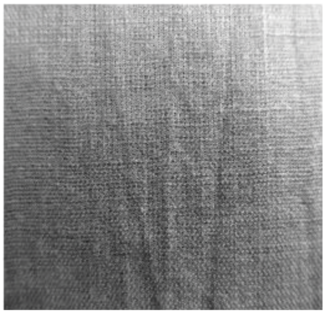
III. EXPERIMENT AND RESULT

The test set for this evaluation experiment woven fabric image is taken using digital camera. Matlab 7.0 software platform is use to perform the experiment. The PC for experiment is equipped with an Intel core 2 Duo 1.6GHz Personal laptop and 2GB memory.

The proposed scheme is tested using image processing and artificial neural networks. From the simulation of the experiment results, we can draw to the conclusion that this system is economical and high accuracy system for fabric defect identification in textile industry.

Figure 1. Original (a) Defect free woven fabric image (b) Stain degect woven fabric image

Figure 2. Normalized (a) Defect free woven fabric image (b) Stain defect woven fabric image



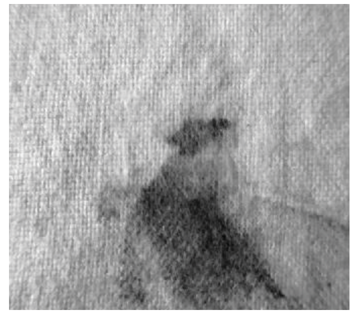


Figure 3. Filtered (a) Defect free woven fabric image (b) Stain defect woven fabric image

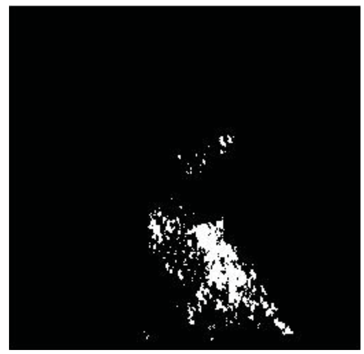


Figure 4. (a) Defect free Normalwoven fabric image (b) Defected woven fabric image

Table -1 Experiment Result

	Defect Free image	**Defected image**
Fourier coefficient	**0**	**2.6842e-014**
Result		

Table 1 show the fourier coefficient value of defect free image and defected image.

IV.CONCLUSION

In this paper a artificial neural network based fabric defect detection system was demonstrated. The problem is to identify and locate the defects in the fabric by using necessary image analysis techniques. Our system identify the defects 92% accurately. The results obtained by our proposed system indicate that a reliable fabric inspection system can be created for textile industries.

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