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Fabric Inspection System using Artificial Neural Networks

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Abstract--- Fabric inspection system is important to maintain the quality of fabric. Fabric inspection 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 cost and time, automatic fabric inspection is required. This paper proposes an approach to recognize fabric defects in textile industry for minimizing production cost and time. The Fabric inspection system first acquires high quality vibration free images of the fabric. Then the acquired images are subjected to defect segmentation algorithm. The output of the processed image is used 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 Network (ANN), Defect detection, Fabric Inspection,, Wavelet transform, Feature Classifier.

1. Introduction

Quality measurement is an important aspect during the production of textile fabrics in lowering costs and improving the finished product. Much of the fabric inspection is performed manually by human inspectors. Many defects are missed, and the inspection is inconsistent, the output depending on the training and the skill level of the human inspectors and also the mental and physical conditions of the inspector. Hence the textile industry has been moving towards automated fabric inspection system. An automated fabric inspection system can provide consistent results that correlate with the quality control standards of the textile industry. 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 [1].

The weaving machine is one of the easiest and fastest ways of producing cloth and textile pieces. 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. 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 fabric is done simultaneously while the fabric is being produced. This paper describes about fault detection, positioning and classification of the faults occur in the weaving machine during weaving by using the principle of image processing, an automatic fabric evaluation system, which enable 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, articularly, is very important and complex and the research in this field is widely open [2].

Fabric texture refers to the feel of the fabric [3]. It is smooth, rough, soft, velvety, silky, lustrous, and so on. The different textures of the fabric depend upon the types of weaves used. Textures are given to all types of fabrics, cotton, silk, wool, leather etc., There are more than 50 categories of fabric defects in the textile industry. Many of these defects have preferred orientation; either in the direction of motion (warp direction) or perpendicular to it (pick direction). Many defects are caused by machine malfunctions; others are due to faulty yarns. In textile, different types of defects are available i.e. hole, scratch, stretch, fly yarn, dirty spot, slub, cracked point,color bleeding etc; if not detected properly these faults can affect the production process massively. The objective of the proposed work is to identify whether the fabric is defective or not. If it is defective then identify the location and the type of the defect.

2. Defects in Weaving

The various types of defects of weaving are given below.

2.1 **Broken Ends-** If a warp is absent in the fabric for a very short or long distance and then this fabric defect is called broken ends..

2.2 **Broken Picks-** If a warp is absent in the fabric for a very short or long width and then this fabric defect is called broken picks.

2.3 **Float-**A float is a kind of defect where a warp or weft yarn floats over the fabric surface for a few container lengths due to missing of interlacement of two series of yarns..

2.4 **Slugs-**When the weft yarn is unclean and contains slugs and its diameter is irregular,

2.5 **Holes-**If there is any small holes present in the fabric and then it is a major fabric defect.The occurrence of hole, cut or tear which is self explanatory.

2.6 **Oil Spot-**Oil Spot on the fabric are caused by too much oiling on loom parts from other sources. Oil stains in most fabrics may be removed by scouring process.

2.7 **Irregular Pick Density-**If the pick density that is pick per inch varies due to mechanical fault then thick or thin place may be formed in the fabric.

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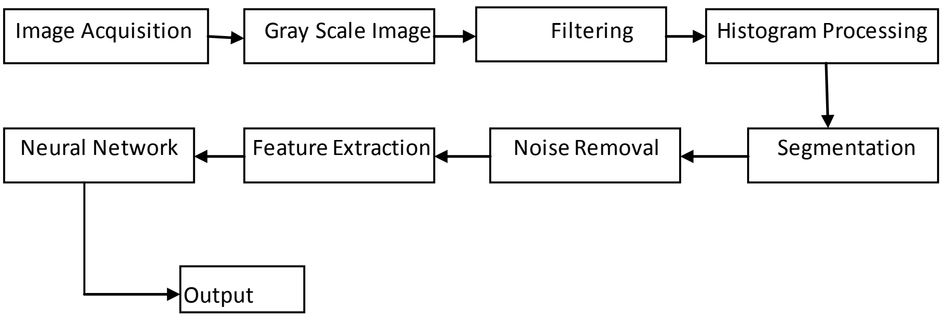
3. Overview of the Proposed System



3.1 Image Acquisition

The first stage of any vision system is the image acquisition stage. Different types of camera can be used for this application such as CCD (Charged Coupled Device) camera, CMOS (Complementary Metal Oxide Semiconductor) camera, Digital camera, etc. The pixel value of these cameras is around 320 × 420 pixels. After the image has been obtained, various methods of processing can be applied to the image to perform different tasks. If the image has not been acquired satisfactorily then the intended tasks may not be achievable. The following are the various methods for image acquisition.

Laser Ranging Systems
Structured Light Methods
Moire Fringe Methods
Shape from Shading Methods
Active and Passive Stereoscopic Methods

3.2 **Gray Scale Image**

The acquired image must be converted into gray scale to eliminate the hue and saturation information while retaining the luminance.

3.3 **Filtering & Histogram Processing**

A filter is defined by a kernel, which is a small array applied to each pixel and its neighbors within an image. In most applications, the center of the kernel is aligned with the current pixel, and is a square with an odd number of elements in each dimension. The process used to apply filters to an image is known as convolution, and may be applied in either the spatial or frequency domain. The CONVOL function performs this convolution process for an entire image

The histogram of a digital image with intensity levels in the

$h(r_k) = n_k$

where

r_k = kth intensity value

n_k = Number of pixels in the image with intensity r_k

Histograms are frequently normalized by the total number of pixels in the image. Assuming a M x N image, a normalized histogram

$$p(r_k) = \frac{n_k}{MN} \quad , K = 0,1,\ldots\ldots L-1$$

is related to probability of occurrence of r_k in the image. The histogram provides a convenient summary of the intensities in an image.

3.4 Segmentation

Segmentation involves partitioning an image into groups of pixels which are homogeneous with respect to some criterion. Different groups must not intersect each other and adjacent groups must be heterogeneous. The groups are called segments. Most digital images exist on a rectangular grid. This is primarily due to the arrangement of image sensors on camera and scanning equipment.

3.5 Noise Removal

Digital images consist of many types of noise. Noise is the result of errors in the image acquisition process. There are several ways that noise can be introduced into an image, depending on how the image is created. If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can also be the result of damage to the film, or be introduced by the scanner itself. If the image is acquired directly in a digital format, the mechanism for gathering the data (such as a CCD detector) can introduce noise. Electronic transmission of image data can introduce noise.

3.6 Feature Extraction

Feature Extraction is a method of capturing visual content of images for indexing & retrieval.

- feature construction
- feature subset generation
- evaluation criterion definition
- evaluation criterion estimation

Textures can be rough or smooth, vertical or horizontal etc generally they capture patterns in the image data. Example repetitiveness and granularity

- Texture features are
  - Statistical measures
    - Entropy
    - Homogeneity
    - Contrast
  - Wavelets
  - Fractals

3.7 **Artificial Neural Network**

Artificial Neural networks have been developed as generalization of mathematical models of human cognition and showed promise for solving difficult problems in areas such as pattern recognition and classification. A neutral network consists of a group of simple elements called neurons (as shown in the figure) which process the input information. These neutrons are connected to each other with links carrying the signals between them. There is a weight for each connection link (W) which acts as a multiplication factor the transmitted signal (Σθ). An activation function (F) is applied to each neuron's input to determine the output signal (O) as shown in the figure. Bias terms can be presented to solve specific problem with obvious result-tendencies.

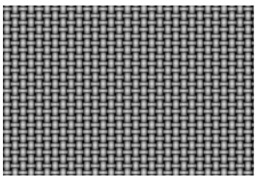
Using neural networks as a classifier requires two phases –a training phase and a testing phase. In the training phase, the neural network makes the proper adjustment for its weights (W) to produce the desired response. When the actual output response is the same as the desired one, the network has completed the training phase (i.e. it has acquired knowledge). In the testing phase the neural network is asked to classify a new set of images and its success is evaluated. In this work the neural networks were trained by the "backpropagation" algorithm to detect and classify the weaven fabric defects. The feature vectors were used as the input vectors to the Neural Network.

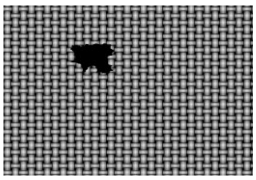
4. Experiments and Results

The performance of the proposed fabric defect detection scheme is evaluated by using a set of fabric images chosen from the Manual of Standard Fabric Defects in the textile Industry. These images are captured by a digital camera. There are some defect-free images in the database. The other images contain different types of fabric defects.

The fabrics in the database are mainly plain weaving fabric, although other types of fabrics are also included. In this paper, we select four types of defects images and all the images have a size of 300x300 pixels and an 8-bit gray level. And we select four images dealing results which are shown in the following figure. The number of neural nodes of the input layer was four corresponding to the four characteristic variables. The number of neural nodes of the output layer was two so that the output values, i.e. 00,01,10,and 11,corresponded to the four classes of samples images .

Structure without Defect and Defect hole





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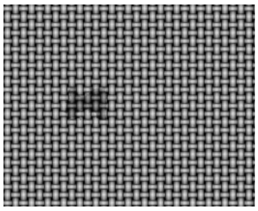
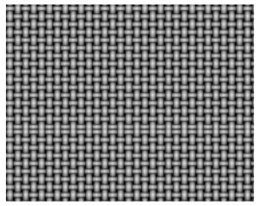
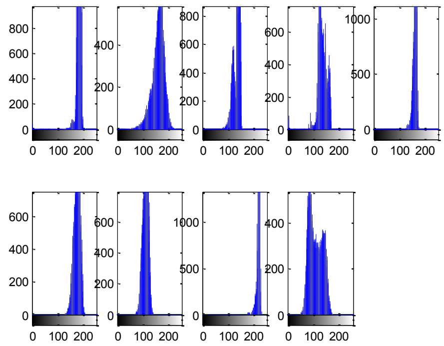
Defect – Stain and Defect double pick

Histogram



5. Conclusion

In this paper, a new intelligent fabric defect inspection model was presented. The recognizer acquires digital fabric images by image acquisition device and converts that image into binary image by restoration and threshold techniques. The output of the processed image is used as an input to the Neural Network (NN) which uses back propagation algorithm to calculate the weighted factors and generates the desired classification of defects as an output. The experiment results show that the proposed method is feasible and applicable in textile production factories for defect detection and classification.

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BIOGRAPHY

P.Banumathi received BE, MCA, M.Phil and MBA in the year 1994, 2004, 2007 and 2008. She is having 12 Years of teaching experience and 5 years of Industrial experience. Her area of interest is Neural Networks. She has presented 15 technical papers in various Seminars / National Conferences. She has presented 2 technical papers in International Conference. She has published 2 articles in International Journal. She is a member of Indian Society for Technical Education (ISTE) and Computer Society of India.

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