Identification and Classification of Defects in Fabric Web Material

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Abstract- Textile manufacturing is a process of converting various types of fibres into yarn, which is in turn woven into fabric. Weaving is a textile craft in which two distinct sets of yarns or threads are interlaced to form a fabric or cloth. The threads which run lengthways are called the warp and the threads which run across from side to side are the weft or filling. Quality plays a vital role in fabric manufacturing. Automated fabric inspection would seem to offer a number of potential advantages, including improved safety, reduced labour costs, and the elimination of human error. Therefore, automated visual inspection is gaining increasing importance in weaving industry.

This paper proposes a automated fabric inspection system with benefit of high detection rate. Four types of faults are considered for analysis. Both normal and faulty images are processed and features are extracted using Gray Level Co-occurrence Matrix (GLCM).Further fuzzy rule based classification is done.

Keywords-Fabric Inspection , Defect Identification, Feature Extraction, Fuzzy if-then rules, Classification.

I. INTRODUCTION

The Indian textile industry has a major impact on the world economy through millenniums. At present all the textile industries aim to produce good quality fabrics with high production rate[3]. In the textile sector, there are huge losses due to faulty fabrics. The fabric is obtained by interweaving of warp and weft yarn. The raw material for the garment industry is available in the form of continuous rolls. Nearly 85% of the defects in the garment industry are due to the faults found in the fabrics .These faults are obtained in the fabrics due to irregular weaving of warp and weft yarn in the weaving process. Hence fabric inspection is utmost important for maintaining its quality. Therefore, the best possibility of objective and consistent evaluation is through the application of an automated inspection system.

II. FABRIC DEFECTS

Textile manufacturing is a process of converting various types of fibres into yarn, which is in turn woven into fabric. Cotton fibre is considered for processing and analysis. There are various processes like spinning and weaving coupled with the finishing and colouration processes for the production of a wide range of fabric products. Most defects in cloth occur while it is woven on the loom. Some of these fabric defects are visible, while others are not. Again some fabric defects may be rectified during weaving and some after weaving. The common fabric defects are further explained.

Missing Yarn - Missing yarn appears as a thin striped shade of the color of fabric. It is usually long. It is of two types, namely vertical and horizontal.

Holes - If there is any small hole present in the fabric , then it is a major fabric defect .Hole appears like a circle with background color. Its size varies from small to medium.

Oil Spot - Oil Spot on the fabrics are caused due to spillage of oil from the loom parts or from other sources. Spot does not appear in any specific shape. It usually appears in a scattered form. A camera of high resolution and proper lighting are required in order to clearly capture the image of the defect of spot. However, oil stains in most fabrics may be removed by scouring process.

Needle line: Needle Line is caused by bent needle forming distorted stitches in a vertical line. It may be major or minor fabric defect.

Fig. 2.1 Web Material with Missing yarn, Hole, Oil Spot and Needle Line

III. IMPORTANCE OF THE AUTOMATED INSPECTION METHOD

The inspection process relies strictly on the human eye and is done after the fabric manufacturing process.

Human inspection consists of many drawbacks. It is a time consuming process, requires skilled and efficient labours and it is extremely difficult to achieve 100% fabric inspection with this traditional method. In order to overcome these drawbacks an automated inspection system was proposed.

An automated inspection system usually consists of a computer-based vision system. Because they are computer-based, these systems do not suffer the drawbacks of human visual inspection. Automated systems are able to inspect fabric in a continuous manner without pause. Automated system are reliable, reproducible and free from the subjective deficiencies of the manual fabric inspection. The system can increase the efficiency of production lines and improve quality of product as well. A good system means lower labour cost and shorter production time[7].

The proposed system will be of low cost with inspection. It is capable of identifying all defects. Because the defect-free fabric has a periodic regular structure. So the occurrence of a defect in the fabric will break the regular structure. Hence, the fabric defects can be detected by monitoring fabric structure.

IV. PROPOSED TECHNIQUE

The purpose of this project is to fully inspect the fabric during weaving process in the textile industry. Digital images of fabric products are obtained using a Standard High resolution CCD Camera. The captured image is considered for preprocessing and then it is subjected to wavelet transform. Five different Gray Level Cooccurrence Matrices (GLCM) are calculated for the preprocessed, transformed image and statistical features are extracted from each matrix.

The proposed scheme will provide high defect detection success rate as statistical and spectral approach are combined. Three major steps are involved in defect detection. The first step is to preprocess the input image .The second is to take wavelet transform for the preprocessed image[12]. The third is to formulate GLCM for the transformed image. In the proposed scheme, the input image obtained from frame grabber is preprocessed and analyzed for fault detection. During preprocessing, the fabric image is histogram equalized and then converted into wavelet transformed image, so that the resultant image will have the defect in an enhanced form. Thus the resultant image will be more suitable with distinct defect for detection.

The gray level co-occurrence matrix , is one of the most popular statistical texture analysis tools for fabric defect detection. The principle is based on repeated occurrences of different gray level configurations in a texture. The gray level co-occurrence matrix contains information about the positions of pixels having similar gray level values. The second order statistics approximate the probability distribution function of the given texture.

To do that, it is accumulated into a set of 2D matrices, each of which measures the spatial dependency of two gray-levels, given a displacement vector.The block diagram of proposed methodology of fabric defect detection is illustrated in the following Figure 4.1.

Fig. 4.1 Block diagram for proposed methodology

4.1. Preprocessing

Pre-processing is done to enhance recognition performance in the presence of illumination variations, pose/expression/scale variations and resolution enhancement. The input image is obtained from the frame grabber. Isolation of minor fault is difficult as the image obtained from frame grabber is of smaller size . In order to overcome this, the image has to be preprocessed. Preprocessing involves Histogram Equalization.

4.2. Histogram Equalization

The input image is subjected to histogram equalization to enhance the quality of image .Histogram Equalization is applied to assign the intensity values of pixel in the input image such that the output image contains uniform distribution of gray values. The result is displayed below in figure 4.2.

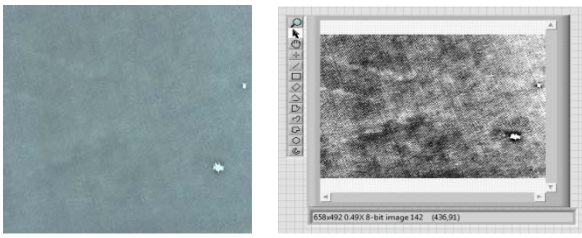

Fig. 4.2 Preprocessing

4.3. Wavelet Transformation

The preprocessed image is subjected to wavelet transform. The transformed image will provide more accurate result. Discrete wavelet Transform was performed. In DWT four bands are available. More information is available in Low-Low band .This band is considered for feature extraction. The transformed image is shown in the following Figure 4.3.

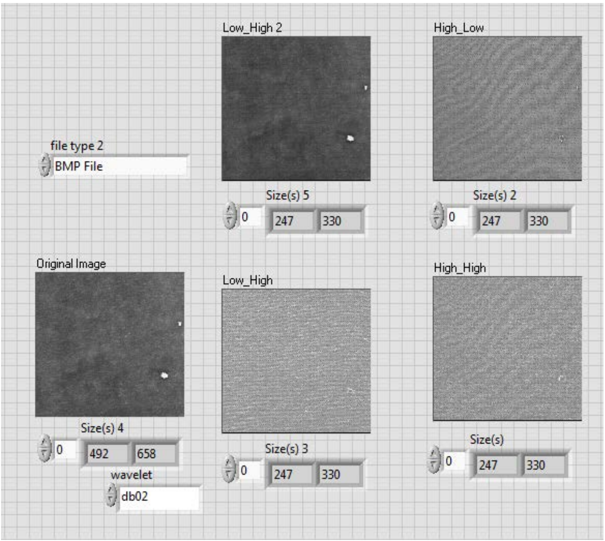

Fig. 4.3 Wavelet Transform of the image

4.4. Feature extraction using GLCM

The co-occurrence matrix is one of the most popular statistical texture analysis tools for fabric defect detection . It is known also as the spatial gray-level dependence. The principle is based on repeated occurrences of different grey level configurations in a texture. The co-occurrence matrix contains information about the positions of pixels having similar gray level values. These second order statistics approximate the probability distribution function of the given texture. To do that, it is accumulated into a set of 2D matrices, each of which measures the spatial dependency of two gray-levels, given a displacement vector.. Zero orientation is considered here for extracting the textural features. The input image after preprocessing and wavelet transform is taken for feature extraction by using GLCM technique. 12 features are extracted to identify and classify the faults. The extracted features are Autocorrelation, Contrast, Cluster Shade, Dissimilarity, Energy, Entropy, Homogeneity, Sum average, Inverse Different Moment, Sum of squares, Correlation and Cluster Prominence.

4.5. Fuzzy Logic System

Fuzzy logic is much more general than traditional logical systems. The greater generality of fuzzy logic is needed to deal with complex problems in the realms of search, question-answering decision and control[1]. Fuzzy logic provides a foundation for the development of new tools for dealing with natural languages and knowledge representation. A fuzzy expert system is an expert system that uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data. The set of rules in a fuzzy expert system is known as the rule base or knowledge base [4]. Fuzzy Logic system consists of three steps namely fuzzification, fuzzy inference method, defuzzification [10]. The block diagram of the fuzzy logic system is shown below

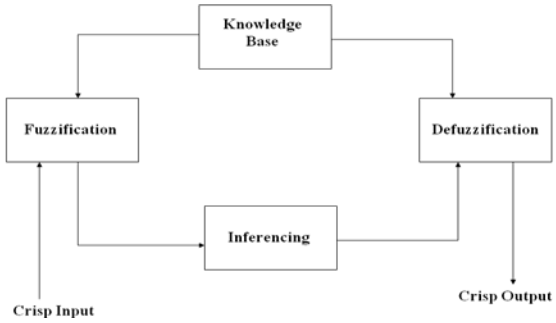

Fig. 4.4 Fuzzy Logic System

The general inference process proceeds in three (or four) steps.

1. Under fuzzification, the membership functions defined on the input variables are applied to their actual values, to determine the degree of truth for each rule premise.

The crisp input values are tabulated in the below table.

TABLE 1 CRISP INPUT VARIABLES

S.No	Input Variables	Range
1	Contrast	0-0.8
2	Auto Correlation	20-35
3	Sum Average	10-18
4	Sum of Squares	8-20
5	Cluster shade	-15-0
6	Cluster prominence	150-300
7	Dissimilarity	0-0.6
8	Energy	0-0.16
9	Entropy	2.5-4
10	Homogeneity	0.5-1

2. Under inference, the truth value for the premise of each rule is computed, and applied to the conclusion part of each rule. This results in one fuzzy subset to be inferencing, the output membership function is clipped off at a height corresponding to the rule premise's computed degree of truth (fuzzy logic AND). In PRODUCT inferencing, the output membership function is scaled by the rule premise's computed degree of truth.

3. Under COMPOSITION, all of the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable. Again, usually MAX or SUM are used. In MAX composition, the combined output fuzzy subset is constructed by taking the point wise maximum over all of the fuzzy subsets assigned to variable by the inference rule (fuzzy logic OR). In SUM composition, the

combined output fuzzy subset is constructed by taking the point wise sum over all of the fuzzy subsets assigned to the output variable by the inference rule.

4. Finally is the (optional) DEFUZZIFICATION, which is used when it is useful to convert the fuzzy output set to a crisp number. There are more defuzzification methods than you can shake a stick at (at least 30). Two of the more common techniques are the CENTROID and MAXIMUM methods. In the CENTROID method, the crisp value of the output variable is computed by finding the variable value of the center of gravity of the membership function for the fuzzy value. In the MAXIMUM method, one of the variable values at which the fuzzy subset has its maximum truth value is chosen as the crisp value for the output variable.The output variables are tabulated in the below table.

Table 3 Output Variables

S.No	Output Variables	Output Range
1	No Defect	0-1
2	Hole	0.6-2
3	Missing Yarn	1.5-3
4	Oil Spot	2.5-4
5	Needle Drop	4.2-5

V. RESULTS AND DISCUSSIONS

5.1. Defect Identification

For validating the result for the proposed method, 40 fabric samples are considered, in which 30 are defect fabric samples. The proposed Fuzzy rule based method produces better result. Table 4 shows the defect identification results for the proposed method.

Table 4 Defect Identification Results

Inspection Method	No.of samples	No of defect images	No of defect identified
Fuzzy Rule Based Method	40	30	28

5.2. Defect Classification

In defect classification, when less no of features are considered the accuracy of classification is less. When more number of features are considered the accuracy of classification is best. Front panel diagram for defect classification is shown in Figure 5.1.

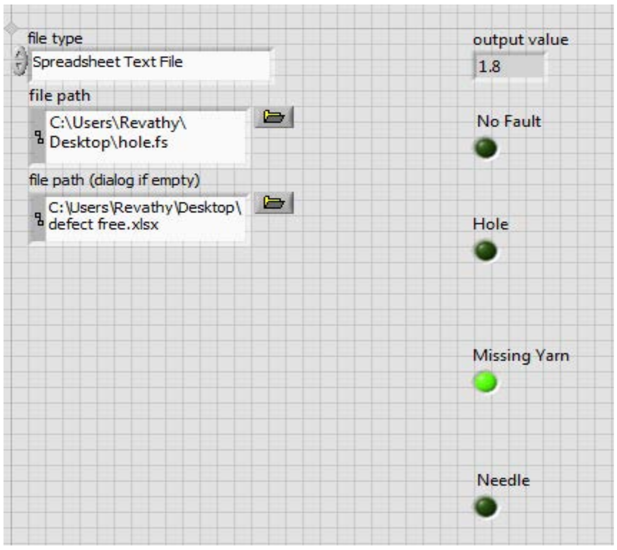

Fig 5.1 Defect Classification

Table 5 shows the classification result of the proposed method with different no of features considered.

Table 5 Classification Results

Inspection Method		No of Sample Images	No of defect images	No of images identified	No of images classified
Fuzzy Rule Based Method	5 features considered	40	30	28	25
	10 features considered	40	30	28	28

VI. CONCLUSION

Thus the proposed fabric fault inspection using Fuzzy logic implemented with LabVIEW provides better result in identifying the types of faults and classifying them. The above proposed system produces an overall accuracy of 83.33% by considering the 5 textural features whereas the same proposed system produces an accuracy of 93.33% considering 10 textural features.So the classification accuracy is characterized by textural features.

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