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Artificial Intelligence Techniques in Textile Fabric Inspection

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Abstract - Defects in textile products reduce the value of textile industry in the world. Artificial Intelligence techniques applied for defect identification in fabric inspection of textile industry. An Artificial Neural Network (ANN) technique is used in this paper for identifying defects in textile products. The images to be analyzed is obtained from image acquisition system and saved them in Joint Photographic Experts Group (JPEG) format. Features are extracted from the acquired image and feature selection method is used to reduce the dimensionality of feature set by creating new feature set of smaller size that are a combination of old features. Multi Layer Back Propagation algorithm is used to train and test the ANN.

Keywords - *Artificial Neural Network (ANN), Multi Layer Back Propagation Algorithm, Image Acquisition, Feature Extraction and Selection.*

1. Introduction

Artificial Neural Network (ANN) model is used to train and test whether the defect is present in the fabric or not. Multi Layer Feed forward Back Propagation Network (MLBPN) network model is identified as best suitable network model for defect identification. The MLBPN produces high percentage of accuracy in defect identification, among the available training algorithms; back propagation algorithm is identified as most suitable algorithm for the proposed work, which produces better result. The defect identification system identifies defect in the fabric by analyzing whether a fabric image contains a defect or not. The statistical feature extraction methods are used to extract feature from the acquired image. The features based on horizontal gray level co-occurrence matrix are extracted. Furthermore, feature selection method is used for selecting optimal features for defect identification.

2. Literature Review

P.Banumathi, Dr.G.M.Nasira [2] discussed histogram based defect detection system for identifying defects in textile fabrics. Dr.P Chellasamy, K.Karuppaiah [3] briefed the growth and development of textile industry in India especially in TamilNadu. Dr.G.M.Nasira, P.Banumathi [4] discussed about an intelligent system for fabric defect identification. YH Zhang, WK Wong [5] mentioned about the detection and classification of color-textured fabric defects using genetic algorithm and elman neural network. Jayanta K. Chandra, Pradipta K. Banerjee & Asit K. Datta [6] briefed the morphological processing which is used for the detection of defects in woven fabric. Lu Yun, Zhang Jingmiao [9] explained image distance difference used for Fabric Defect Detection. Arivazhagan S., Ganesan L. and Bama S [10] [11] discussed the Gabor wavelet transform based fabric fault segmentation. The literature survey illustrates a variety of algorithms with less accuracy and more time consumption.

3. Proposed Approach

Image acquisition is the first step in the proposed workflow sequence. The acquired images if necessary, can be reviewed for elimination of defects. The present framework adopts two types of image acquisition known as

- Real time image acquisition and
- Offline image acquisition

Both of these types of acquisition help us in identifying the defects. In real time image acquisition a stream of frames that can be created, processed and queued for later work. In Offline image acquisition retrieving images from a source and saving it in a database for further processing.

The system updates the database in offline image acquisition. Figure 3.1 shows the framework architecture of image acquisition.

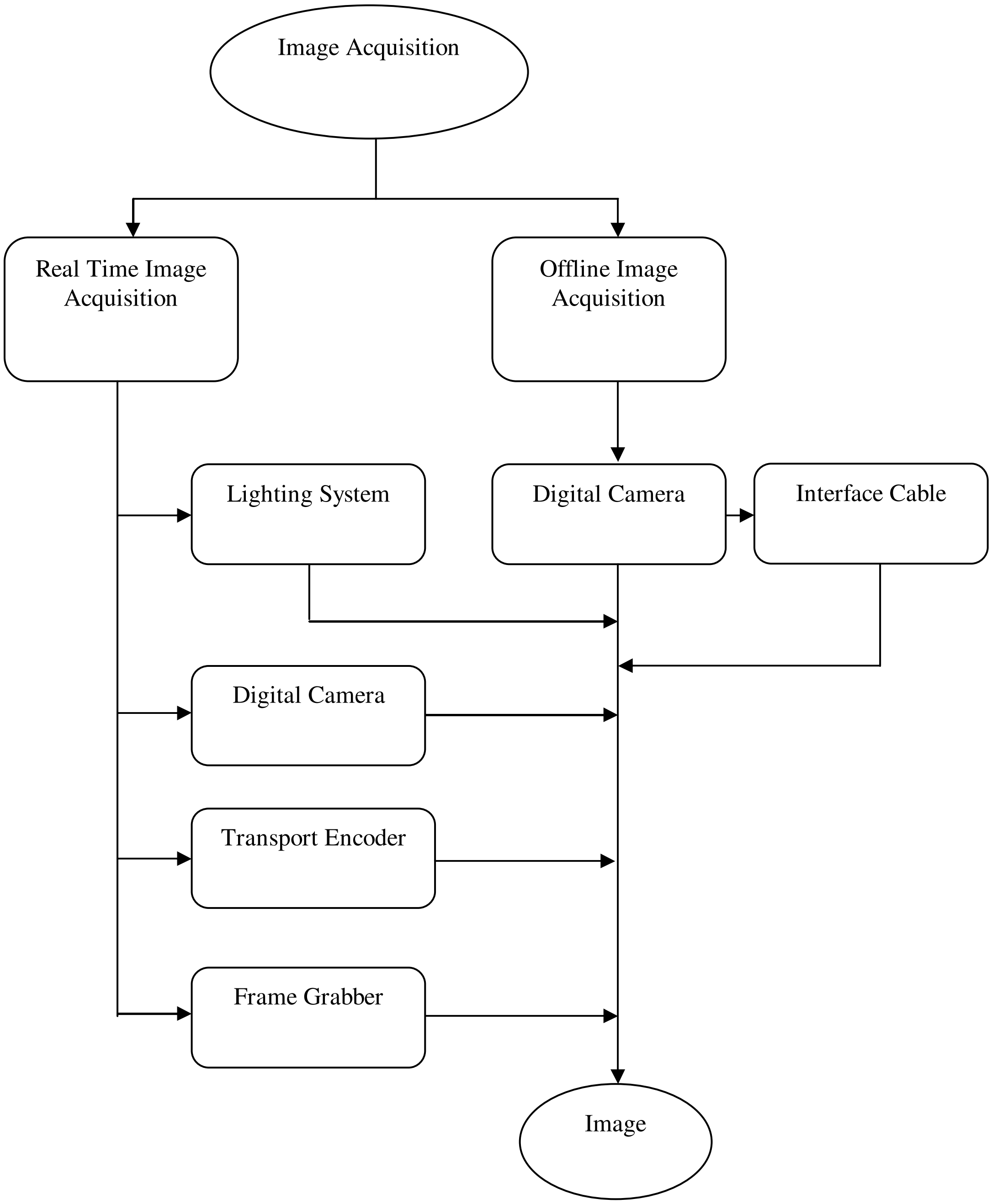

Figure 3.1 Framework architecture of image acquisition

Figure 3.2 Acquired fabric images

In this paper, when the resolution is 1000 dpi good percentage has been achieved for defect identification with minimum time and less computational complex. Therefore, the optimum resolution identified is 1000 dpi which is shown in figure 3.3.

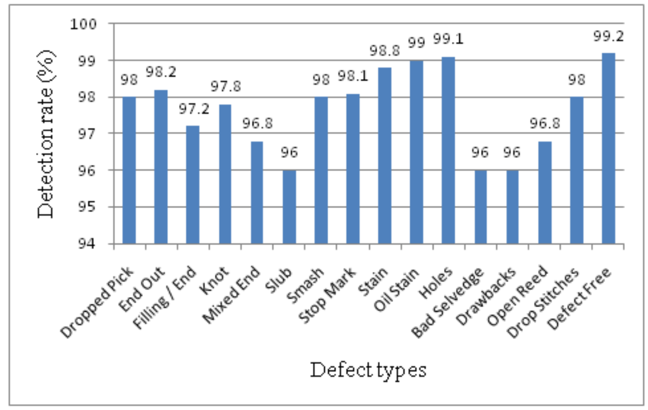

Figure 3.3 Detection rate for various types of defects and defect free fabric images on 1000 dpi resolution.

4. Feature Extraction and Selection

Feature Extraction is a process of conversion of image into a set of features or rather features vectors (at a considerably lower information rate) for further analysis. From the extracted feature vector a subset of features, which are more predictive, are selected. Unlike other existing methods of dimensionality reduction, feature selection method preserves the actual meaning of the features after reducing dimension.

The advantages of feature selection methods are twofold: it considerably reduces the running time of the algorithm, and improves the accuracy of the resulting system. Statistical method for feature extraction method is implemented in this proposed system. The main objective of statistical approach is to separate the fabric image of the inspected fabric into regions of distinct statistical behavior.

An important assumption in this statistical approach is that the statistics of defected regions of fabric image are not stationary whereas the statistics of defect free regions of fabric images are stationary and extend the defect free region for certain portion of fabric image.

All the fabric image has a regular and repetitive structure; therefore, the statistical approach is identified as well suitable approach for defect identification. A Gray Level Co-occurrence Matrix (GLCM) is a widely used robust statistical tool, which is used for extracting second order statistic values from fabric images. The gray level spatial distribution of fabric image is characterizes by GLCM.

Table 4.1 Statistical features

ASM or Energy
Contrast
Correlation
Variance
Homogenity
Sum Average
Entropy
Sum Entropy
Difference Variance
Sum Variance
Difference Entropy
Information Measure of Correlation1
Information Measure of Correlation2
Maximum Correlation Coefficient
Smoothness
Skewness
Kurtosis

An element in GLCM, Pd,θ(i,j), specifically represents the probability of occurrence of pair of gray values (i,j) separated by d (distance) and θ (direction). The above table (4.1) shows the extracted statistical features. The main aim of feature selection method is to select a subset of features from the features obtained through feature extraction approach. The subset of features supports in minimizing the prediction error (E).

PCA is mostly used as a tool in exploratory data analysis because it is used to find the most significant variables that explain most of the variance in the data. Therefore, when there is lots of data to be analyzed, PCA can make the task a lot easier. PCA is a tool for analyzing statistics used to sort, group and explore data. It transforms data into a smaller number of uncorrelated variables (principal components) from a large number of correlated (interrelated) variables, for making the operation easier to make prediction by retaining maximal amount of variation.

Principal Component Analysis Algorithm used in this proposed work is described below:

i. *Take the whole extracted features consisting of d-dimensional (1600x17) feature matrix.*
ii. *Compute the mean vector (1x1600)*
iii. *Compute the covariance matrix from the feature vector of size 1600x17.*
iv. *Eigen values and eigenvectors are Computed.*
v. *The eigenvectors are sorted such that having decreasing eigenvalues and eigenvectors with highest eigenvalues selected to form a d x k matrix,where each column in the matrix represents an eigenvector.*
vi. *The features are transformed into a new subspace from the d x k eigenvector.*
vii. *Y is calculated by multiplying transposing matrix and vector representing fabric image features (f1 to f17).*
viii. *So the extracted seventeen features f1 to f17 is reduced into f1 to f6 features.*

Table 4.2 Features selected by PCA method

Sl.No.	f1	f2	f3	f4	f5	f6
1	0.747522	1.236985	-0.108	1.450675	-0.09958	0.09222
2	1.551272	0.340993	0.054895	-0.00445	0.177604	-0.00491
3	-1.142	0.492484	-0.16489	-0.05683	0.125516	-0.01903
4	7.755969	-1.16836	-0.86588	0.334929	-0.10203	-0.07959
5	-2.70352	0.841075	-0.489	-0.10542	0.210224	-2.43E-05
6	-3.48029	0.906701	-0.53579	-0.13398	0.175555	-0.00217
7	2.001173	0.381655	0.01505	0.010669	0.249625	0.010919
8	-3.03787	0.639646	-0.30433	-0.11127	0.07312	-0.0223
9	-12.3788	0.893573	-0.52546	-0.30765	-0.28974	-0.0202
10	3.554261	0.295205	0.497738	-0.13728	-0.10041	0.003648
11	7.290756	-1.07272	-0.93655	0.388148	-0.07187	-0.07081
12	-9.33392	1.287652	-0.72809	-0.3274	-0.13129	-0.00567
13	3.554253	0.29521	0.497693	-0.13733	-0.10045	0.003695
14	3.031147	0.303122	0.222941	-0.02067	0.151778	0.012741
15	9.372804	-1.86261	-0.90203	-0.60946	-0.04182	0.146789
16	3.031147	0.303122	0.222941	-0.02067	0.151778	0.012741
17	3.554261	0.295205	0.497738	-0.13728	-0.10041	0.003648
18	3.554261	0.295205	0.497738	-0.13728	-0.10041	0.003648
19	3.554261	0.295205	0.497736	-0.13729	-0.10041	0.003651
20	-1.42027	-0.64353	0.33966	0.033753	-0.00756	-0.04971
21	-20.9672	-2.1662	0.309141	0.220935	0.016927	0.056036
22	-3.28865	-1.67857	0.483162	0.138558	0.086108	-0.03778
23	-1.90905	-1.10146	0.428237	0.081292	0.028685	-0.04498
24	3.55425	0.295212	0.497675	-0.13734	-0.10046	0.003713
25	3.55425	0.295212	0.497675	-0.13734	-0.10046	0.003713

The features f1 to f6 is selected as subset features using PCA method from the extracted seventeen features f1 to f17. The selected features are shown in table 4.2.

5. Inspection using ANN Techniques

A multi-layer feed forward neural network with one input layer of 6 neurons, one hidden layer of 5 neurons and an output layer of one neuron is implemented in this paper. The MLBPN works in two types of modes namely training mode and testing mode. For the training, training data set is used and for testing, testing data set is used by the MLBPN. The training mode begins with training data set and continues iteratively until it reaches the end of training data set. Each iteration is called an epoch in training. In each epoch the weight between layers are adjusted by MLBPN such that the error between layers reduces.

Procedure : Backpropagation algorithm.

(i) The weights are randomized to small random values to ensure that the network is not saturated by large values of weights.

(ii) Select an element from the training data set.

(iii) Apply the selected training input vector as network input.

(v) Output vector is calculated.

(vi) The error value is calculated for each output, from the difference between the desired output and the actual output.

(vii) Adjust weights between layers in a way that minimizes this Error.

(viii) The network weights are adjusted..

(ix) Repeat the above steps for each element in the training data set until the error of the network is acceptably low, or the pre-defined number of iterations(epochs) is reached.

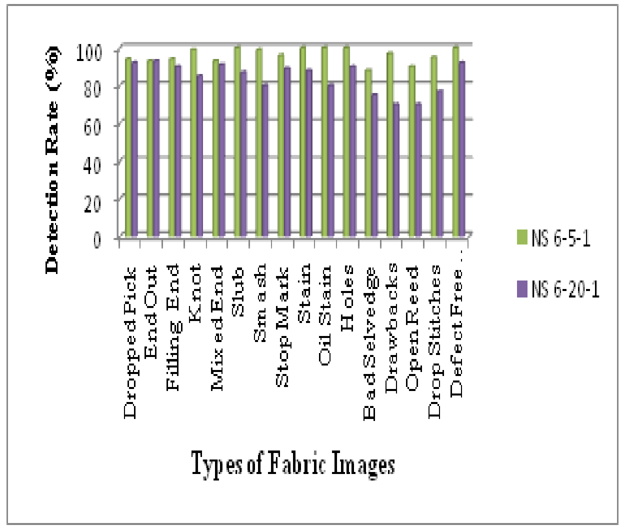

Figure 5.1 Training performance analysis of MLBPN

During the training phase, the detection rate of 96.13% is arrived by 6-5-1 architecture. During the testing phase of 6-5-1 network architecture the detection rate of 99% is achieved. The graphical representations of the detection rate obtained during training and testing through MLBPN is depicted in the following figures Figure 5.1 and Figure 5.2 respectively.

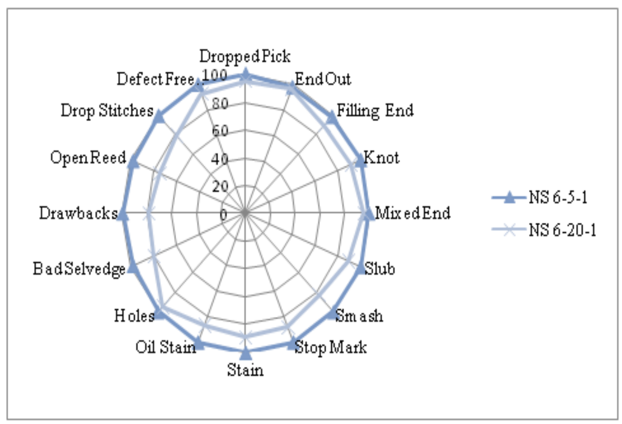

Figure 5.2 Testing performance analysis of MLBPN

From analysis, it can be concluded that the performance of MLBPN architecture 6-5-1 produces high percentage of defect identification. In MLBPN momentum factor α = 0.8, number of epochs = 100, learning rate η= 0.01, η decrease factor = 0.1, η increase factor = 10 is chosen to train the network and the network is trained with six features. The time taken to train the network is 617.422.

6. Conclusion and future Scope

In this paper, an Artificial Neural Network based defect identification system for fabric images was implemented. Creating an accurate method for fabric image analysis and defect identification is a major problem faced by the existing system. The implemented system identifies plain-woven fabric defects 99% accurately. From the results obtained by our proposed system indicate that a reliable fabric defect identification system for textile industries can be introduced.

In this paper all the acquired fabric images are of woven fabrics. But often textile industries process various pattern of fabrics. So, this fabric defect identification system can have the scope of getting implemented in other types of fabrics .

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Bibilography

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