Fabric Flaw Ferreting

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***Abstract*--The main focus in this study is to do texture segmentation for fault detection and classification of faults in textile texture images. Initially the low frequency and high frequency components of the image are separated and feature is extracted using Gabor filter. Also Statistical features can be calculated based Wavelet transformation on the grey level co-occurrence matrices (GLCM). The statistical features used in this study are Energy, Correlation, Contrast, and Homogeneity, Entropy, Inertia, Cluster shade & prominence. To post-process the image, artificial neural network (ANN), K-Nearest neighbour (K-NN) and Minimum Distance classifier (D-min) had been proposed to do classification on the extracted features from GLCM and Wavelet Transformation. ANN, D-min and KNN were trained by training data set and then used as diagnostic classifiers. The roles of the classifier techniques were studied. Comparison is also made between GLCM and Gabor filter. Performance evaluation is made from the results and it is shown that GLCM with ANN yields proficient results than GLCM with other classifiers and also Gabor Wavelet transformation with all three classifiers. The experimental results demonstrate that the proposed method can reliably separate different fault conditions in textile texture images.**

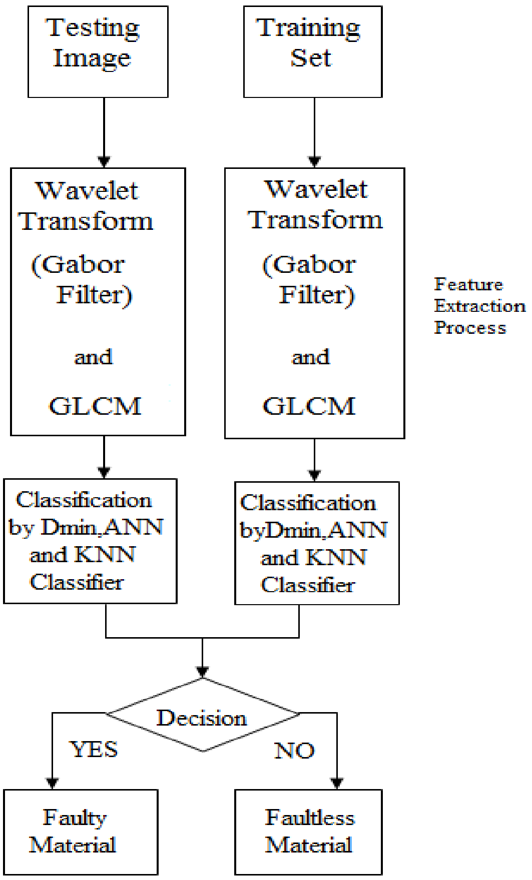
Keywords—GLCM, Gabor Wavelet Transformation, KNN, ANN, and D-min

I. INTRODUCTION

In textile industry, automated visual inspection systems are highly needed owing to the very slow speed of human inspection compared to the production rate in modern manufacturing industries. Digital image processing is increasingly applied to textured sample analysis in past few years. In that way, Fabric Flaw Ferreting is a quality check process that aims at identification of regions that differ from uniform background (high degree of periodicity) in-order to prevent defects in fabric production and to change process parameters to improve product quality. This computational technique which is an attractive alternative to human vision inspection for detection, classification and segmentation of defects like missing yawn, hole, scratch, oil spot, etc in addition to defects due to change in operating conditions (temperature, humidity, etc) reduces labour cost. Besides classifying a certain appearance of the fabric, registering the exact location of the defects and their type determination are also important to prevent defects from reoccurring which adds advantage of getting a warning when a certain defect or imperfection occurs during the production and precautionary measures can be taken by the manufacturer before the product hits the market. Since a garment with textile defects usually sells with a massive discount, in harsh economic times, first quality fabric (totally free of major defects and virtually free of minor structural defects) plays the main role to insure survival in a competitive marketplace. The various fault detection approaches for textile web material are statistical, structural and model based approach from which an idea about fabric inspection method is proposed.

In this research paper, the time and frequency information of an image is separated using Gabor wavelet transform. The potential of the Gray Level Co-occurrence Matrix (GLCM) is also investigated and we use classifiers like neural networks, K nearest neighbours and minimum distance classifiers that classify the identified textile defects. GLCM is a widely used texture descriptor whose statistical features are based on gray level intensities of the image. Such features of the GLCM are useful in texture recognition & analysis, image segmentation & retrieval, colour image analysis, object recognition etc. The neural networks are used as a classifier to detect the presence of defects in textiles fabric products. K-nearest neighbour algorithm (k-NN), a non-parametric method in statistical estimation and pattern recognition is used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space, by storing all available cases and classifying new cases based on a similarity measure like distance functions. The minimum distance classifier classifies unknown image data to classes which minimize the distance (index of similarity) between the image data and the class in multi-feature space, so that the minimum distance is identical to the maximum similarity.

II. BLOCK DIAGRAM



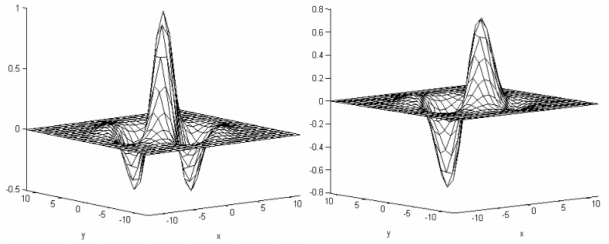
III. GABOR WAVELET TRANSFORM

Kruger and Sommer proposed the concept of Gabor Wavelet Networks (GWN), on the basis of wavelet networks. Gabor wavelet function is used as a transfer function. The mapping form of the network can be governed by

$$F(x,y) = \sum_{i=1}^{N} w_i\, g_o^i(x,y) + \bar{f}$$

where f is introduced to eliminate the DC value of an objective function and w_i is a network weight from the hidden layer to the output layer. A 2-D Gabor function can form complete but non-orthogonal basis set. It controls the radial frequency bandwidths (σ_x, σ_y), the orientation θ and the central frequencyω_x.

The schematic diagram of a Gabor filter in spatial domain is shown in the fig II. The real part of the Gabor wavelet is even symmetric and imaginary part is odd symmetric. The real part is an excellent blob detector whereas the imaginary part is used to represent the imaginary part of Gabor function to simplify the explanation.



(a) (b)

Schematic diagram for real(a) and imaginary(b) parts of a typical Gabor Filter

IV. GREY LEVEL COOCURRENCE MATRIX

In our work, we are using GLCM for image extraction. The extracted features represent the image properties such as energy, entropy, contrast, correlation, homogeneity, Inertia, Cluster Shade and Prominence. Entropy gives a measure of complexity of an image.

$$\text{Entropy}=-\sum_{i=1}^{N}\sum_{j=1}^{N} P[i,j]\log P[i,j]$$

Energy provides the sum of squared elements in GLCM known as uniformity or angular second moments. And its range lies within range [0 1].

$$\text{Energy}:\sum_{i=1}^{N}\sum_{j=1}^{N} P(i,j)^2$$

Contrast is a measure of gray level variation between reference pixel and its neighbour in an image.

$$\text{Contrast}:\frac{1}{(N)^2}\sum_{i=1}^{N}\sum_{j=1}^{N}(i-j)^2 P(i,j)$$

Correlation measures the linear dependency of grey levels of an image with those of neighbouring pixels.

$$\text{Correlation}:\frac{\sum_{m=1}^{N}\sum_{n=1}^{N} mnp(m,n)-\mu_x\mu_y}{\sigma_x\sigma_y}$$

Homogeneity measures how close the distribution of elements in the GLCM is to the diagonal of GLCM.

$$\text{Homogeneity}:\sum_{m=1}^{N}\sum_{n=1}^{N}\frac{P(m,n)}{(1+|m-n|)}$$

V. CLASSIFIER

K-NEAREST NEIGHBOUR ALGORITHM

K-Nearest Neighbour algorithm is most widely used in classification problems in industry. Both classification and regression predictive problems use KNN classifier. The distance $d(X_i, X_j)$ between query points on testing image X_i and a set of training samples X_j is measured and thus a new object based on K-NN category of Y attribute of training samples is classified.

Query points $X_i = X_1, X_2, X_3 \ldots\ldots X_n$.

Training samples $X_j = X_1, X_2, X_3 \ldots\ldots X_n$.

$$\text{Dist}(c_1,c_2)= \sqrt{\sum_{i=1}^{N}(\text{attr}_i(c_1)-\text{attr}_i(c_2))^2}$$

The KNN algorithm works as follows,

Step 1: Analyse the data. Shown in fig V(a), to classify the grey points into a class (Lime green, green, Orange)

Step 2: calculate the distance between grey point and all other points fig V(b).

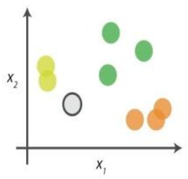


Fig V (a)

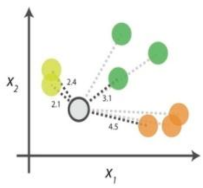


Fig V (b)

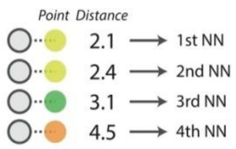


Fig V (c)

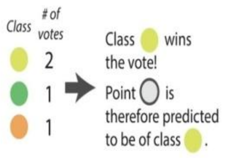


Fig V (d)

Step 3: Find neighbours fig V(c). Nearest neighbours are ranked by increasing distance i.e. the nearest neighbours of the grey points are the ones closest in datasets.

Step 4: Vote on labels fig V(d). Vote on the predicted class labels based on the classes of the K nearest neighbours. Here K=3.

ARTIFICIAL NEURAL NETWORK

Artificial Neural Network (ANN) or Neural Network (NN) has provided an exciting alternative method for solving a variety of problems in different fields of science and engineering. It has incredible characteristics such as massive parallelism, distributed representation and computation, learning and generalization ability, adaptively, which seems simple but is really complicated.

BACK PROPAGATION MODEL

Back Propagation is a feedback network. It is done until the error rate is low and has a reference value in hidden layer for changing in weights to learn train set.

Here it follows supervised learning.
It has 2 modes:

A) Pattern mode:
In the network for each iteration every node is updated to back propagate the network.
B) Batch mode:
In the network after all nodes are updated, the back propagation is done. And it has some parameters are as follows:

1) Epoch: It is a measure of the number of times all of the training vectors are used once to update the weights.
2) Iterations: It is an every single repetition of a process of Back propagation.
3) Error rate: It is done until low error as keeping the reference value in hidden.

The steps are to be followed:
1) Select a set of images with the faulty textile textures.
2) The input is the extracted features for those set of images.
3) Calculate the overall net trained value for these features.
4) A sample image is taken as test image.
5) Calculate the difference between trained image and the test image.
6) Set the average value as threshold value and according to the value the classify images by neural network.

VI. RESULTS AND DISCUSSION

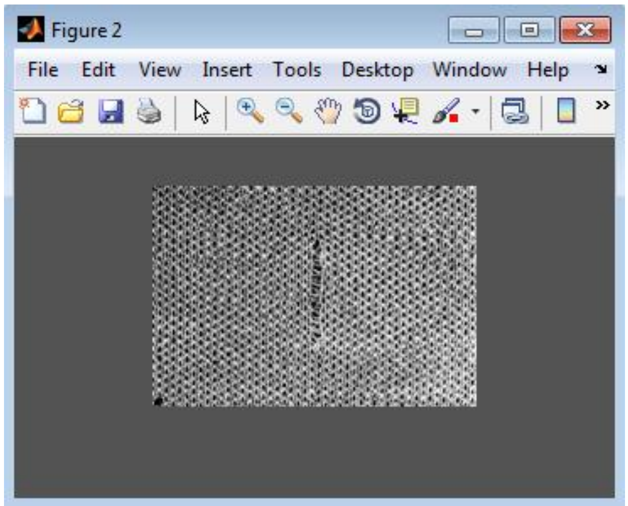


Fig 6.1 input

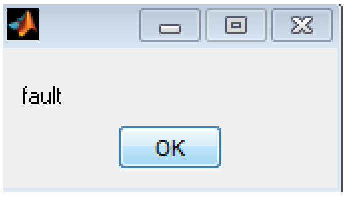


Fig 6.2 GLCM output

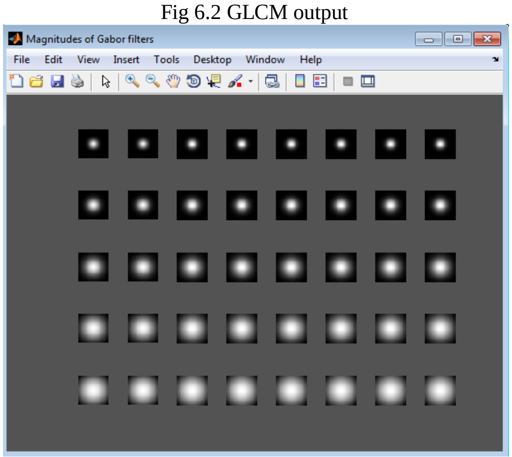


Fig 6.3(a) Gabor filter output

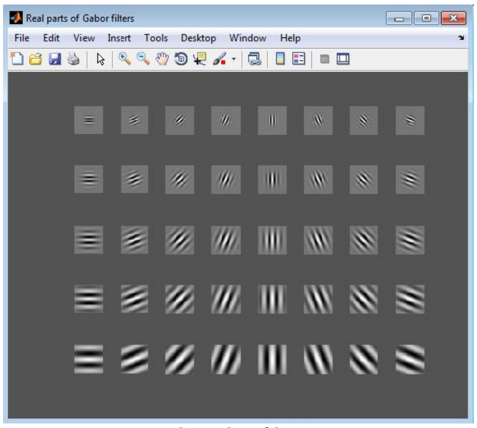


Fig 6.3(b) Gabor filter output

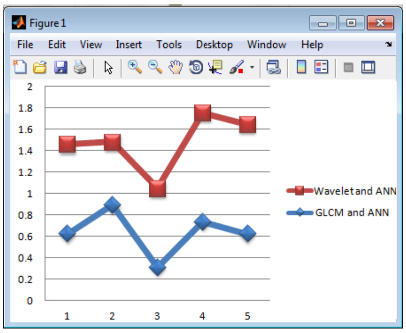


Fig 6.4 Gabor vs GLCM output

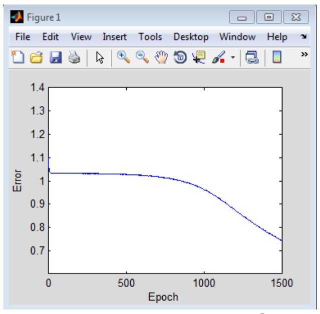


Fig 6.5 ANN output graph

```
Command Window
Test accuracy = 9.8765%
Test accuracy = 9.8765%

C =

    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    17     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    16     0     0     0     0     0     0     0     0     0
    17     0     0     0     0     0     0     0     0     0
```

Fig 6.6 KNN output

```
Command Window
epoch=1500 error=0.71319 eta=0.25
fault
    3.7672    0.3064    0.0324    0.5087       NaN         0         0         0

Accuracy
   94.2853
```

Fig 6.7 GLCM parameters and ANN output

Initially the test image is fed to the software, which converts the colour image into a gray scale picture as shown in Fig 6.1, following which the gray scale image is converted into matrices by the GLCM algorithm and the statistical features are extracted and the fault is identified as in Fig 6.2. Now the same gray scale image is also processed by wavelet transformation technique which uses Gabor filter to extract the same features. The gabor filter outputs are shown in Fig 6.3(a) and 6.3(b). On comparing the outputs, the features of GLCM is more desirable which is in Fig 6.4. The post-process of our work is to classify the features of the faults identified using three different classifiers as ANN, KNN and Dmin classifiers. Of the three classifiers, ANN is found more efficient than other two classifiers which is shown in Fig 6.5 and Fig 6.6. So our proposed work is to extract the features of textile images using the GLCM algorithm for fault identification and classify the fault using ANN classifier as shown in Fig 6.7 which yields 94.285% efficiency.

VII. CONCLUSION

In this project, the features are extracted using wavelet transform method by Gabor filter as well as GLCM and we found that the GLCM method produces more desirable output when compared to Gabor filter. KNN and ANN were trained by training data set and then used as defect classifiers. We use the back propagation neural network for image classification and use optimum method to train it. Actually we test the performance of our proposed system with data base of different kind of objects. Variable K value and hidden neuron count (N) with a step size of 1 for KNN and ANN were used in the range of 1 to 20, to gain the best classification results. The roles of wavelet transform GLCM, KNN, ANN and Dmin techniques were studied. From the results, it is shown that the performance of ANN is better than KNN and Dmin. The results show that the KNN and ANN were able to classify the texture image with 87.5% to 94.285% accuracy respectively for the textile application. The experimental results demonstrate that the proposed method can reliably separate different fault conditions in texture images of textiles.

VIII. REFERENCES

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