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An Approach for Fabric Defect Detection from Video using Modified Wavelet Transform

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***Abstract* —** *In textile industry, quality of fabric material needs to be good. Therefore it is necessary to detect defects in fabric material. Nowadays this issue has drawn increasing attention of researchers because of growing population in large number. This visual inspection was done by human inspector in earlier time. Human inspection based method has many disadvantages. For this reason, machine vision based methods are designed. In this paper, modified wavelet transform based method has been proposed. Proposed method improves accuracy than the existing method.*

Keywords- Defect Detection, Wavelet Transform, Defect Classification

I. INTRODUCTION

Defect detection is a process that controls the quality of manufactured fabric material in textile industries. The fabric material that is manufactured needs to be of good quality because defective fabric material may reduce the benefits of industry. Therefore defect detection is most important step of textile industry. Initially, this task was performed by human inspector. But even if the inspectors are highly expert or highly trained for this task, this approach has led to many limitations. Because of boredom it may led to inconsistency or inefficiency in identifying the defects. It is also time consuming and high costly. For this reason, machine vision based fabric defect detection methods has been designed. With the help of pattern recognition and image processing it is possible to design automated defect detection techniques which are efficient and accurate in terms of detecting defects.

In digital image processing there are many techniques used for this purpose. These techniques can be classify into statistical approaches, structural approaches, model based approaches, filtering etc [5]. Statistical approach takes into account statistical characteristics of images and spatial distribution of gray value is defined by different representation such as auto-correlation function, co-occurrence matrix etc [5]. Spectral approach uses various transforms such as Fourier Transform, Gabor Transform, Wavelet Transform and Filtering approach. In model based approach random field of an image is randomly modeled by a simple function of an array of random variable.

Further this paper is organized as follow: Section II present literature done for the fabric defect detection methods. Section III presents the existing method. In section IV, proposed method is explained. Section V discusses the experimental results and finally Section VI concludes the paper.

II. RELATED WORK

There are many algorithms are proposed for the defect detection. These algorithms are presented in this literature. In [1] Mahmoud, Ali and Mohammed have proposed algorithm using morphological processing and DCT. They have considered the difference of light intensity on whole image. And DCT is used for the thresholding purpose.

In addition to this, another method was presented in [2]. Authors have compared two methods: Gray Level Co-occurrence Matrix (GLCM) based method and Gabor filter based method. They have conclude that GLCM based method has higher accuracy than the Gabor filter method. But GLCM based method works only in invariant environment condition.

In [3], authors have presented method for defect detection and classification using Principle Component Analysis (PCA) and Support Vector Machine Classifier (SVM). PCA method which is based on sub images is used for the feature extraction of fabric images from test set and training set. In next step, SVM classifier is used for the classification purpose. But in this method fabric images with the non-uniform illumination are difficult for the defect detection.

Another method used for fabric defect detection is wavelet decomposition [4]. In this method, fabric image will be decomposed into two levels with the use of wavelet decomposition. It has better efficiency and low complexity. It gives better results for the line defects. But it fails for the fabric images with the smooth edges present in it and also due to color variance in the image.

III. EXISTING SYSTEM

This section explains existing system briefly. It consists of five steps. Figure 1 shows the steps of existing system.

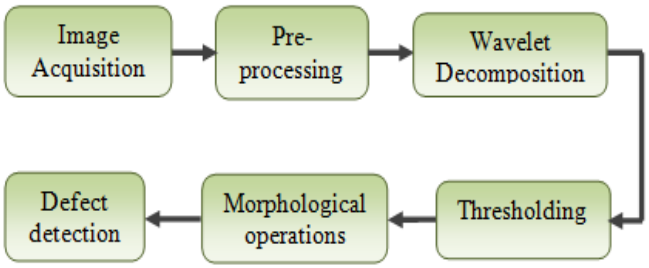

Fig 1. Basic steps of Existing system [4]

1. Image Acquisition and Pre-processing

Image to be processed will be acquired using line scan camera or CMOS sensors. Image captured by these sources are converted to the gray scale version of image. High intensity change in pixel value within in image can cause defects in image. Sometimes noise presents in the image may mix up with the defect in the image.

Sometimes Gaussian noise presents in image can mix up with defects which gives incorrect results. So for removing this Gaussian noise histogram equalization is used. While converting color image to gray-scale, sometimes gray scale range of pixel intensity is biased to one side of image. Histogram equalization is used also for equal intensity distribution. Median filter is also used for noise removal. It removes impulsive noise and reduces high frequency without blurring and also preserves edges.

2. Wavelet Decomposition

A wavelet is a fixed duration and compact signal which can be useful in image compression. In wavelet decomposition, signal is decomposed into two parts which are high and low frequency information. Then image will be inspected at different scales and a feature vector consisting of features at different scale is created. The image is decomposed of up to only two levels. If more than two level decompositions are performed than some information may get lost.

Consider two signals C_k and h and g as low pass and high pass filter respectively. Decomposition can be performed as follow:

$$C_k^{(j)} = \sum_{n=-\infty}^{n=\infty} h(2k-1).C_k^{(j-1)}$$

where $C_k^{(j-1)}$ is the decomposed signal after low pass filtering. After applying wavelet decomposition image will be result in four sub-images: LL, LH, HL, and HH. The LH, HL and HH part gives information about texture in different direction vertical, horizontal and diagonal respectively. LL part is the approximation image.

3. Thresholding

Thresholding is applied on decomposed image to create binary image. Here thresholding will be applied on LH2 part. Then some specific threshold is used to compare with all pixel intensity value. Assuming that the object to be brighter than the background may be a fault pixel, it will be denoted by 1 and defect free pixels will be denoted by 0.

4. Morphological Operations

Dilation operation is performed on binary image so those gaps between the defective regions are closed. After that erosion operation is performed on binary image.

In this way defect will be detected from the input image and the output will be the image with the defect detected.

IV. PROPOSED SYSTEM

In this section, proposed system is discussed in detail. Figure 2 shows the diagram of proposed system. In this system, modification is done after applying wavelet transform on image. Proposed system takes video sequence of fabric material as input. Next, video will be converted into sequence of frames. Each frame is captured and goes under processing. First preprocessing steps are performed which are same as in existing system. After preprocessing, wavelet decomposition is performed using local maxima. The classification of image will be done using Support vector machine classifier.

Support Vector Machines are supervised learning algorithm that analyzes data used for classification. Given a training set examples, it marks each sample for belonging to one or two categories. In other words, it builds a model that assigns each new testing sample into one category or other [6].

Wavelet transform using Local Maxima

First the image is decomposed using wavelet transform. Two level decomposition is performed. It results in approximation image and images with the details in three different points, Vertical, horizontal and diagonal directions. These sub images in the different direction represents small intensity variation in corresponding directions because local contrast will be enhance in wavelet transformation. Therefore local maximum of the coefficients of sub images may indicate the possible defects present in image. So local maxima of coefficient is calculated. And also median of min coefficient is calculated. Considering this features, one feature vector of image will be constructed. Now this feature vector is compared with stored feature vector and image will be classified as either defective or non-defective.

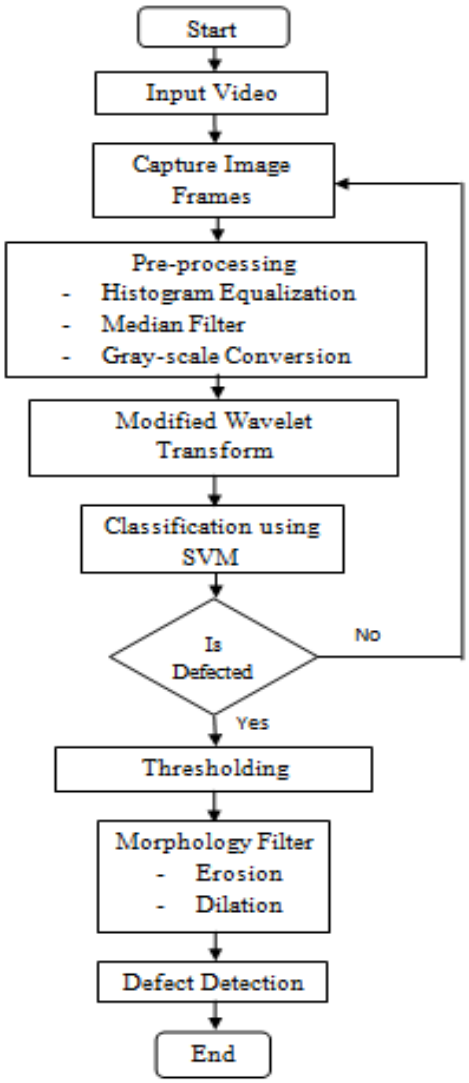

Fig. 2 Flow chart of proposed system

Classification using SVM

The feature vector of testing image frame and training image frame will be given as input to the SVM classifier. It will classify image frame as either defected or defect free. Then the next image frame will be captured and will processed through all these steps. Image frames with the defect will go through thresholding and morphological operations. The output of image frame with the defect will result.

V. EXPERIMENTAL RESULTS

This section discuss about the experimental parameters used and the comparison of results of existing and proposed systemin terms of the parameters considered.

The experimental parameters considered here are True Positive Rate (TPR) and False Positive Rate (FPR). True positive rate measures the proportion of positive results that are actually identified correctly. False positive rate measures the proportion of positive results that are incorrectly identified as positive. [7]

$$TPR = \frac{TP}{TP + FN}$$

$$FPR = \frac{FP}{FP + TN}$$

Where TP, FP, TN and FN represents true positive, false positive, true negative and false negative, respectively. The table 1 below shows the result comparison of existing and proposed system. The comparison is done on the three experiments. From the results it can be seen that proposed system has improved result over the existing system. Accuracy of proposed systemhas been improved than existing system.

Table 1 Comparison of existing system and proposed system

Sr. No.	Existing Method		Proposed Method	
	TPR %	FPR %	TPR %	FPR %
Experiment No.1	90.3	7.23	91.5	6.03
Experiment No.2	87.1	6.87	90.6	5.43
Experiment No.3	85.6	7.54	90.2	6.3

These experiments are performed on following examples. Figure 3 shows the captured defected frame. This frame will be preprocessed for noise removal and gray scale version of it will be obtained.

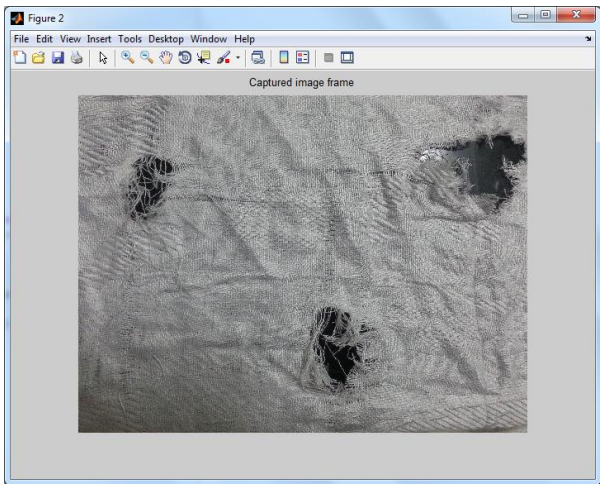

Fig. 3 Captured image frame

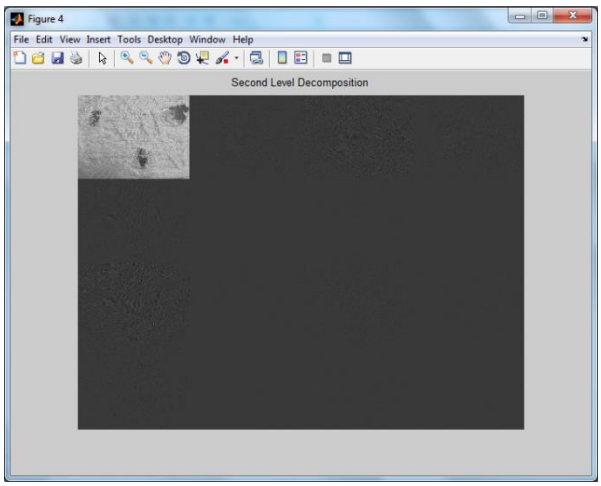

Fig. 4 Second level wavelet decomposition

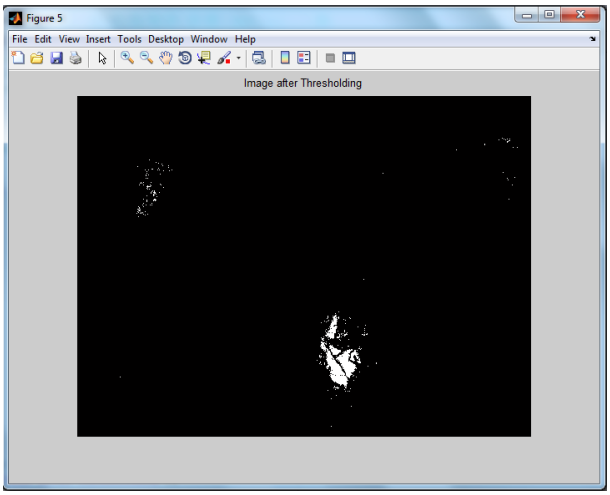

Fig. 5 Thresholded image

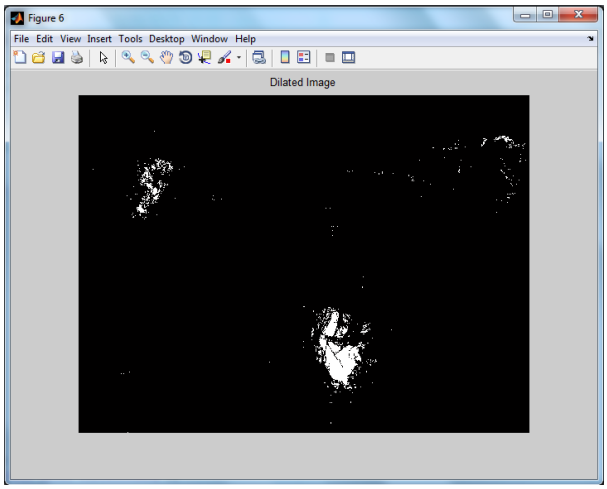

Fig. 6 Dilated image

IV. CONCLUSION

Video defect detection is an important technique used to improve quality of product in any industry. The wavelet transform method is used for this purpose among many other methods. In the proposed system, wavelet transform based method has been modified. Applying wavelet transform on image frames, results in three directional images in horizontal, vertical and diagonal directions and one approximation image. From this three directional images local maximum of intensity variation is obtained and one feature vector is created. Support vector machine is used to classify this feature vector of image frame as either defected or defect free. Accuracy of the results of proposed system is improved.

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