Textile Defect Detection for Reflective Material using Spectral Transform

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Abstract- Fabric defect detection system plays a major role in any textile industry. This paper aims to find a novel approach to detect defects of different nature using an effective image processing software .Until recently fabric defect detection system was done by manual inspection. Even today in many small places the normal practice is manual detection of fabric faults. The major drawback in such manual process is that the fiber fault detection is left to the individual ability of the person in charge of inspection. Continuous inspection by the person may lead to tiredness, inattentiveness; absence from the work place to due to some reason, fatigue, tension due to personal issues which may lead to improper inspection.

Keywords – FFT, Feature Extraction, Threshold,OSTU

I. INTRODUCTION

The Textile Industry occupies a vital place in the Indian economy and contributes substantially to its exports earnings [1]. Textiles exports contribute to a major portion of the country's total exports. It has a high weightage of over 20 per cent in the National production. It provides direct employment to millions of people in the mill, power loom and handloom sectors. India is the world's second largest producer of textiles after China. It is the world's third largest producer of cotton-after China and the USA-and the second largest cotton consumer after China. The textile industry in India is one of the oldest manufacturing sectors The Textile industry occupies an important place in the Economy of the country because of its contribution to the industrial output, employment generation and foreign exchange earnings. The textile industry encompasses a range of industrial units, which use a wide variety of natural and synthetic fibers to produce fabrics. The textile industry can be broadly classified into two categories, the organized mill sector and the unorganized mill sector. Considering the significance and contribution of textile sector in national economy, initiative and efforts are being made to take urgent and adequate steps to attract investment and encourage wide spread development and growth in this sector. Defects in the textile can lead to a serious impact in the revenue generation, wastage of resource and time. Textile defects can be of various types and can occur at different stages and processes. They can occur during Spinning, weaving, knitting, printing, dyeing, stitching etc.We have proposed an approach to detect defects in textile materials using Fast Fourier Transform.

II. Proposed Technique

2.1 Fast fourier Transfomr with adaptive segmentation –

The usual purpose of applying a transformation is to help make more obvious or explicit some desired information. The transformation is often followed by a thresholding operation, which is intended to select the most prominent or relevant features.

Based on spatial-frequency domain features which are less sensitive to noise and intensity variations than the features extracted from spatial domain, spectral approaches occupy a big part of the latest computer vision research work. It simulates the human vision system where the psychophysical research has indicated that human visual system analyzes the textured images in the spatial frequency domain. Spectral approaches require a high degree of periodicity thus, it is recommended to be applied only for computer vision of uniform textured materials like fabrics. For automated defect detection, such approaches are developed to overcome the efficiency drawbacks of many low-level Statistical methods. Therefore, these approaches were rendered as a robust solution for online fabric defect detection. The primary objectives of these approaches are firstly to extract texture primitives, and secondly to model or generalize the spatial placement rules. In the following part, a survey of the most popular spectral approaches is presented.

Fourier analysis is a global approach that characterizes the textured image in terms of frequency components. Fourier techniques have desirable properties of noise immunity, translation invariance and the optimal characterization (enhancement) of the periodic features [2] .They can be used to monitor the spatial-frequency spectrum of a fabric and compare the power spectrum of an image containing a defect with that of a defect-free one. Many researchers [3, 4, 5, 6, 7, and 8] proposed a simulated fabric model to understand the relationship between the fabric structure in the image space and that in the frequency space.

To implement Fourier analysis for fabric defect detection, various methods are available; Optical Fourier Transforms (OFT) obtained in optical domain by using lenses and spatial filters can be used, but most techniques, digitally implemented, are derived from Discrete Fourier Transforms (DFT) and/or its Inverse (IDFT) which recovers the images in the spatial domain: classic Fast Fourier Transforms (FFT) or Windowed Fourier Transforms (WFT) versions which have the ability to localize and analyze the features in spatial as well as frequency domain.

Since Fourier transform is known to be a computationally expensive method i.e. for instance, the time of two-dimensional DFT is proportional to the square of the image size. Therefore, in order to reduce the computation time, FFT is used. It is a discrete Fourier transform with some reorganization that can save an enormous amount of time. In this case, the computational time is proportional to 2N2 log2 N for while providing exactly the same result.

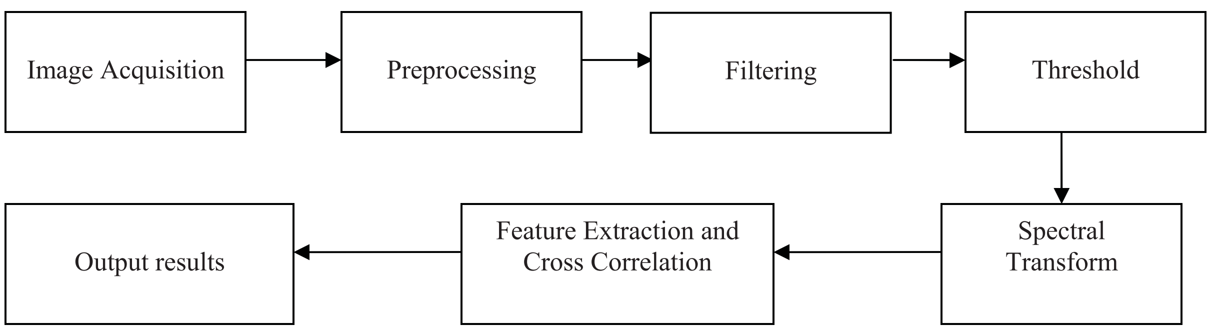

Figure1:Block diagram of textile defect detection

In the image acquisition step we capture an image of size 512 x 512 pixels. The camera used is a 2D camera and is placed at a distance of 50 cm orthogonally from the textile. The image is then converted to grayscale to reduce the memory size. The image is further filtered to remove noise. A Gaussian filter is used considering the nature of the noise.

Here we use two types of threshold i.e adaptive and non adaptive threshold. For global threshold we have used OSTU's method and for local threshold we have used the Niblacks method. The threshold helps in reducing the no. of false alarms. Hence finding a suitable technique was very important. Incase cases for some materials it was found that since the pixels reflected light differently because of the reflective nature of the material finding a single global threshold was difficult for the entire image because it gave false alarms for certain defects like miss pick.

For global threshold we have used the OSTU method, a threshold is calculated that minimizes the intra class variance which is the weighed sum of the variance of two classes as given below

$\sigma_w^2(t)=w_1(t)\,\sigma_1^2 t + w_2(t)\,\sigma_2^2 t$ 1

$\sigma_b^2 t= \sigma_2- \sigma_w^2 (t)=w_1(t)w2(t)\,[\mu1\,(t)- \mu2\,(t)]^2$ 2

The segmentation states that minimizing the infraclass variance is maximizing the interclass variance

$\sigma_b^2 t= \sigma^2- \sigma_w^2 t=w_1\,(t_0-w_2\,(t))\,[\mu_1 t- \mu_2 t]^2$ 3

The class probability is computed from the histogram as
$w_1(t) = \sum tp(i)$ where the mean class $\mu_1(t) = \sum p(i)\, x(i)$ where x(i) is the center of the i^{th} histogram bin. The algorithm is as follows

1. Compute the histogram and probabilities of each histogram level
2. Set up the initial $w_i(0)$ and $\mu_i(0)$.
3. Step through all the possible thresholds
4. Update w_i and μ_i
5. Compute $\sigma_b{}^2 t$
6. Desired threshold corresponds to the maximum $\sigma_b{}^2 t$
7. Two maximums and two corresponding thresholds can be computed $\sigma_{b1}{}^2 t$ is the greater max and $\sigma_{b2}{}^2 t$ is the greater or equal maximum.
8. Threshold desired =(threshold1 + threshold2) /2

The next step that is spectral transform uses a fast Fourier transform because it is faster than the normal Fourier transform. The fast Fourier transform converts the image pixel intensities as different frequencies. For a defect free textile the frequencies spectrum appears homogeneous because of the fixed pattern of the textile material but for a textile with defect the spectrum will not match with that of a defect free textile. The cross correlation helps to search a known pattern.

Table1: FFT using global threshold

Defect	Wool	Terecot	Silk
Hole	100%	100%	99%
Stain	99%	98%	97%
Miss-pick	97%	97%	94%
Miss-end*	97%	98%	95%
Double-pick	96%	96%	95%
Double-end	96%	95%	94%
Weft-float	97%	97%	92%
Warf-float	95%	95%	93%
Coarse-pick	95%	96%	94%
Coarse-end	95%	95%	95%
Jammed-picks	94%	94%	90%
Open-picks	94%	94%	90%

III. Experiment and Result

The below table shows the percentage success achieved in detecting different defects.

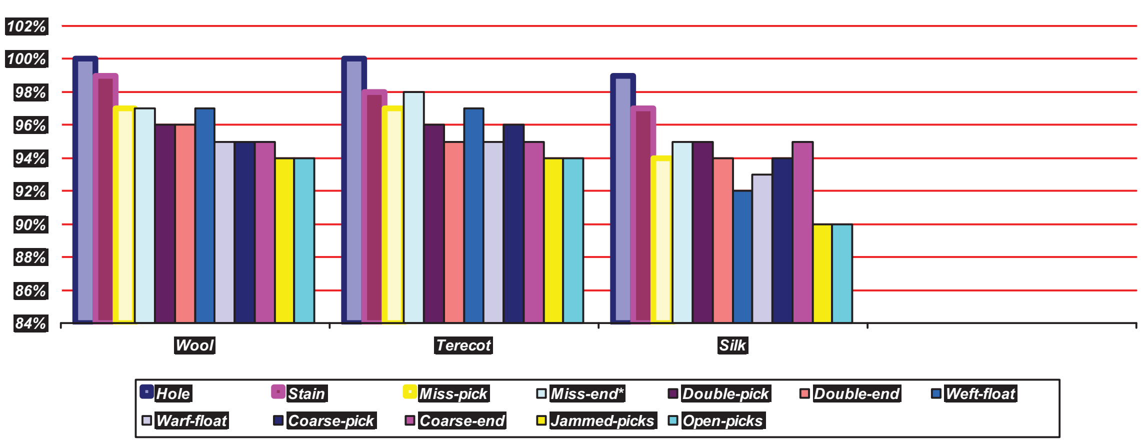

Figure 2: FFT using global threshold

IV. CONCLUSION

From the results we can conclude that for defects such as Hole, Stain, Miss-pick and Miss-end we have a higher percentage of defect detection. Also the percentage of success of defect detection is more for material such as terecot, wool etc but it reduces for reflective materials such as silk. The OSTU method of thresholding has been used. The local threshold techniques such as Niblacks are also used for providing better results because it uses local segmentation technique. The computation time of Niblacks technique is slightly larger since the segmentation has to be performed over different areas but it provides slightly better results.

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