# AUTOMATED FABRIC DEFECT DETECTION USING MATLAB

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## ABSTRACT

*Quality control at each stage of production in textile industry has become a key factor to retaining the existence in the highly competitive global market. Problems of manual fabric defect inspection are lack of accuracy and high time consumption, where early and accurate fabric defect detection is a significant phase of quality control. Vision based inspection of industrial products offers low-cost, high-speed, and high-quality detection of defects. Some of the most challenging industrial inspection problems deal with the textured materials such as textile web, paper, and wood. The inspection problem encountered in textured materials become texture analysis problems at microscopic levels. Textured materials take many forms and while there is a remarkable similarity in overall automation requirements for visual inspection, the cost-effective solutions are application specific and generally require extensive research and development efforts. The fabric has a regular pattern and texture properties. The regions that deform the regular pattern and cause the change on the appearance and physical properties of the fabric are called as 'defect'. The defects may be evaluated as 'major' and 'minor' types. Some of them are encountered commonly and some of them are seen rarely. There is a growing need for automated fabric defect inspection system in the textile industry. Many attempts are made to replace the traditional human inspection by automated visual systems; An image of woven fabric sample can be regarded as a typical textured image. The detection of local fabric defects is one of the most intriguing problems in computer vision. This project aims at developing a system to automatically detect the defects in Fabric Texture.*

***Keywords: Fabric Defect, Computer Vision, Defect Classification, Performance Metrics, MATLAB***

## I. INTRODUCTION

The primary requirments of such a system will be greater accuracy, minimum time and minimum cost. The fabric image could be captured through a camera and from the image obtained the defect could be identified. The fabric image could be considered as a regular textured image. Once the fabric is identified as defective, the location and the area of defects needs to be identified. Advanced loom machines are able to detect some faults by themselves , however, there is still significant amount of defects, that need to be inspected later, after the weaving stage. Defects like broken pick or coarse yarn are sorts of defects that can be detected directly on the loom. In contrast, those defects like appearance fault, a stain, a hole or a weft kinks, belong to class of defects that remain unnoticed by any other systems than the visual. It should be noted that the inspection problems encountered in uniforms webs become texture analysis problems at microscopic levels. Differences in the mean gray level or in color in small Neighbourhoods alone are not always sufficient for defect detection. Rather, one has to rely on differences in the spatial arrangement of gray level values in the neighbouring pixels. Defect segmentation involves identification of regions with uniform texture in a given image. Appropriate measures of texture are needed in order to decide whether a given region has uniform texture. A region in an image has a constant texture if a set of local statistics or other local properties of texture are constant, slowly varying, or approximately periodic .Gabor filters are used to identify different textures. The texture with high intensity will get smoothened and also the texture with low intensity will get isolated. After this method a simple Thresholding is applied to segregate the defective area in the image and further the image is converted into binary image .Morphological operations are done on the thresholded image in order to remove the errors like holes.

## II. LITERATURE REVIEW

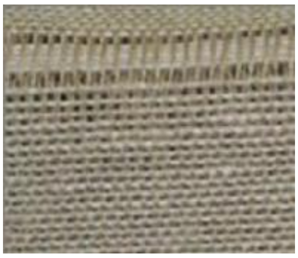
Various approaches for fabric defect detection have been proposed in the past two decades. The texture analysis techniques for fabric defect detection are intuitively appealing, because they allow us to capture texture features, which are statistically used to segment fabric defects. Gray-level texture features extracted from co-occurrence matrix , mean and standard deviations of sub-blocks, autocorrelation of sub-images, and Karhunen–Loève (KL) transform have been used for the segmentation of local fabric defects. Cohen et al. have characterized the fabric texture using the Gauss Markov random field (GMRF) model and the textile web inspection process is treated as a hypothesis-testing problem on the statistics derived from this model. Campbell et al. use model based clustering to segment defects from the denim fabric. The fabric texture exhibits a high degree of periodicity and, hence, Fourier-domain features have been used for the detection of fabric defects, Since the Fourier bases are of infinite length, the contribution from each of the spectral components is difficult to quantify. Therefore, Fourier analysis is not suitable for detection of local defects. Instead, detection of local fabric defects requires multi-resolution decomposition of fabric images across several scales. A feature vector composed of significant features at each scales is used for the identification of defects. Such a multi-resolution analysis of fabric using Discrete wavelet transform (DWT) has been detailed in – . Jasper et al. use texture-adapted wavelet bases whose response is close to zero for normal fabric texture and significantly different for fabric defect, thereby enabling detection. Escofet et al. use multi-scale Gabor filters for textile web defect detection. Ajay and Pang have demonstrated fabric defect detection using only real Gabor functions. Also, in paper, Ajay and Pang investigate various approaches for automated inspection of textured materials using Gabor wavelet features. A new supervised defect detection approach to detect a class of defects in textile webs is proposed. Unsupervised web inspection using multichannel filtering scheme is investigated.

## III. MATERIALS USED AND METHODS

### 3.1 Description

The image of the fabric under test is taken as input. The image frame is converted to 8 bit gray level format. The noises are occurred because of illumination change, fabric structure and impurities in the fabric. They are removed by using Wiener low-pass filter and mean filter.The noise removed image is convolved with Gabor filter. Thus, the defective area is accentuated and the regular fabric texture is attenuated. In order to make the image smooth, the image is then convolved with Gaussian operator. The filtered image is converted into the binary form. Thus, the defective area is identified and clarified. The binarization process is achieved by using double thresholding method. Two thresholding values; upper and lower thresholds are determined by using the defect-free fabric image.

**OIL STAIN**



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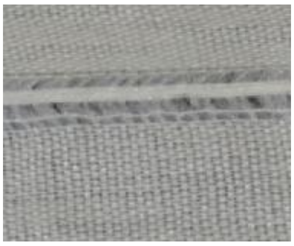

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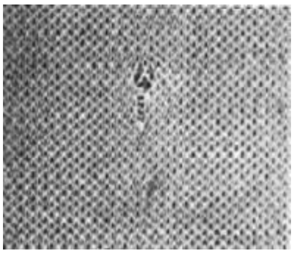


**HOLES**

**FIGURE 1**

### 3.2 Texture Boundary Detection

• Edge extraction using 2-D Gabor filters smears the edge information

• The magnitude of the 1-D Gabor filter output is used as a feature to detect boundaries for texture-like images

• Advantage of 1-D processing: Feature extraction and edge extraction are applied along orthogonal directions. The Gaussian function (1-D) of the Gabor filter will not effect the edge information in the orthogonal direction

• The edge evidence obtained from a set of Gabor filters are combined using a constraint satisfaction neural network to obtain the final output

### 3.3 Fourier Transform

Although the Fourier transform of the entire time series does contain information about the spectral components in time series, it cannot detect the time distribution of different frequency, so for a large class of practical applications, the Fourier transform is unsuitable. So the time-frequency analysis is proposed and applied in some special situations. The STFT is most often used.

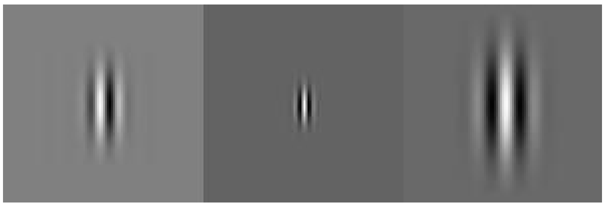
### 3.4 Gabor Filters

Gabor filters are used to identify different textures. In the process of filtering, the texture with high intensity will get smoothened and also the texture with low intensity will get isolated. The parameters of the Gabor filter needs to be chosen appropriately to isolate the defective region in the fabric image. After tuning the parameters a simple thresholding method is applied to segregate the defective area in the image. Gabor filters can decompose the image into components corresponding to different scales and orientations. Gabor filters achieve optimal joint localization in spatial and spatial frequency domain and, therefore, have been used extensively for texture analysis – and document analysis , and object detection .

#### 3.4.1 Gabor Filter Parameters

- Wavelength ($\lambda$ )

This parameter represents the cosine factor of the Gabor filter kernel. Its values are specified in pixels which hold the real number value greater than or equal to 2. The value =2 should not be used in combination with phase offset =-90 or =90 because in these cases the Gabor function is sampled in its zero crossings. Then in order to avoid the undesired effects at the image borders and to get the better result, the wavelength value should be smaller than or equal to one fifth of the input image size. The images shown in Figure 3.1a,b,c, shows the Gabor filter kernels with values of the wavelength parameter of 5, 10 and 15 respectively. The values of the other parameters are orientation 0, phase offset 0, aspect ratio 0.5, and bandwidth 1.

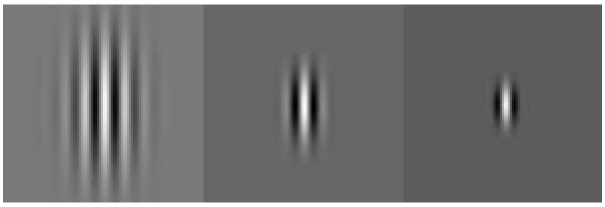


- Orientation (θ)

This parameter specifies the orientation of the normal to the parallel stripes of a Gabor function. Its value is specified in degrees and it can fall between 0 and 360. This orientation value depends upon the orientation of the edges in the image. Only for that particular theta value, the results will hold perfect. The images in Figure 3.2 shows the Gabor filter kernels with orientation 90, 45 and 0 respectively. The values of the other parameters are: wavelength 10, phase offset 0, aspect ratio 0.5, and bandwidth 1.

- Bandwidth (b)

The parameter, b depends on the ratio, where is the standard deviation of the Gaussian factor of the Gabor function and is the preferred wavelength The value of cannot be specified directly. It can only be changed through the bandwidth b. The bandwidth value must be specified as a real positive number. Default is 1, in which case and are connected as: = 0.56 . The smaller bandwidth results in larger , larger support of the Gabor function and larger number of visible parallel excitatory and inhibitory stripe zones. The images in Figure 3.5 shows Gabor filter kernels with bandwidth parameter 0.5, 1, and 2, from left to right, respectively. The values of the other parameters are wavelength 10, orientation 0, phase offset 0, and aspect ratio 0.5.



### 3.5 Thresholding

In the process the filtered image will have the texture regions as low energy points and the defected region as high energy points. A hard threshold is applied on the response of the filter bank, to identify the defective area. This process results in a binary image where black pixels correspond to defect free area and white pixels correspond to defective area. The algorithm is experimented on fabric images with 16 different defects that occur in the fabric industry. The defective images are taken from different fabric materials. The defect free portion is used for identifying the parameters. Among the parameters wavelength and bandwidth affect the response of the filter depending on the scale of the image (ie) when the thread is small and the defective area is restricted to few threads, the larger values of and smaller values of is required to identify the defective area.

Aspect ratio and phase offset has minimal effect in identifying the defective area. Hence these parameters are kept constant. The orientation parameter affects the response of the filter depending on the orientation of the threads and the defective thread orientation. Hence the parameters and are identified from the un-defective image .These parameters are then used for the filter bank to identify the defective area. The average response is taken and thresholded, which result in a binary image showing the defective area in white color. To calculate the accuracy of the algorithm the defective area is manually selected by the user. The difference between the location selected by the user and the location given by algorithm is calculated.

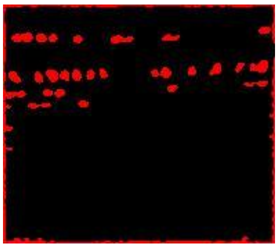
### 3.5 Specifications

| | | |
|---|---|---|
| Domain | - | Image processing |
| Software | - | MATLAB |
| System Requirements | - | 1. Minimum 1 GB RAM |
| | | 2 Dual core processor |

## IV. RESULTS

After putting the image under test, then converting it into RGB making it noise free, then smoothening the defect free region and isolating the defected region, then highlighting the low intensity and high intensity points ,then applying Gabor filter technique which is designed in MATLAB using commands from help, the detection of defects can be accurately done. Fig 1 represents the image under test through various sections. we can accurately detect the defected region.


OILSTAIN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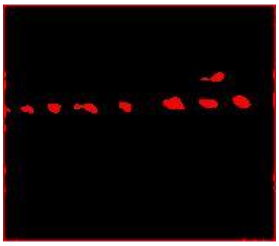
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HOLES

**Figure 2**

## V. CONCLUSION

In this paper, a supervised defect detection approach to detect a class of fabric defects has been demonstrated. The experimental results conducted on various defective images shows that locating the defects in a fabric image can be achieved with the parameters of Gabor filter. The Gabor filter followed by Thresholding helps to find the location of the defect. This algorithm gives 83.5% overall accuracy.

## VI. ACKNOWLEDGEMENTS

We are highly grateful to our guide Mrs. M.V PATIL (Electronic Engineering Department BVCOE) for allowing us to pursue this project at the college workshop and for her continuous intellectual support in the form of her valuable ideas, guidelines and constructive criticism. We are also thankful to our H.O.D Prof. SHINDE for allowing us to go ahead with this project. We are indebted to members of Electronic Engineering Department for showing trust in our ideas about the project. For all those who helped us directly or indirectly in completing this project, we would like to put across our sincere thanks.

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