BOGAZICI UNIVERSITY

IE423

Quality Engineering

Project 3 – Quality Control on Images

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Introduction

Linen is a textile made from the fibers of the flax plant. Linen is laborious to manufacture, but the fiber is very absorbent and garments made of linen are valued for their exceptional coolness and freshness in hot weather. Just like any process of any product, we as quality engineers want our products to satisfy customer requirements and would like to produce quality clothes.

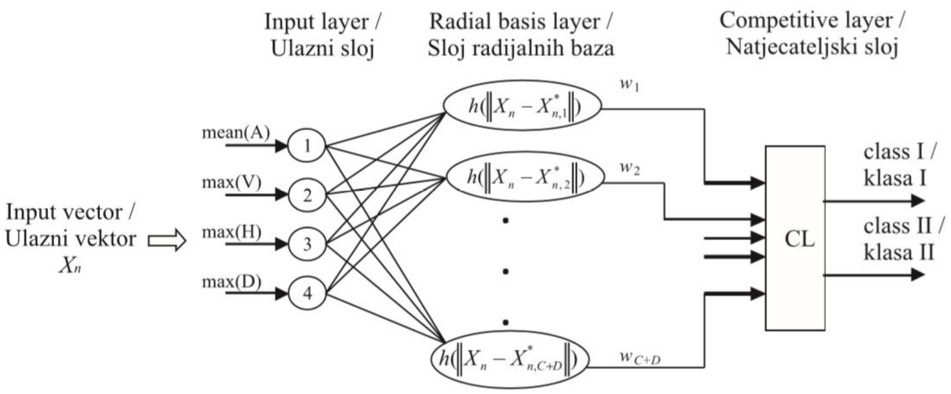
Moreover, we do not want to sell defective linens to our customers. Hence, we need to know if a linen is defective or not. So, we need to process them by creating control charts to see if we are outside of the limits specified by the customer or the process itself. There are many ways to monitor a processing of linens. For example, we can have an employee taking a sample and analyzing it to see if it is defective or not. However, it is not trustable since humans can make mistakes. So, we need more reliable statistic. We can take pictures of linens and analyze them with the help of computers. Use of images is not only reliable but also less costly and easy to do. Therefore, we can use images to process the manufacturing of linens.

Background information

Because there are large of inspection the factors such as noise, non-uniform illumination and variety of defect types in tile make the defect detection a challenging problem. This difficulty becomes even more when tiles are random textured. In the literature we can find several approaches to that problem.

There are lots of detecting methods and filtering algorithms such as DWT in a radial neural network, Local Binary Pattern (LBP) operator for defect detection, Fourier-domain features, multi-resolution analysis and Gabor filtering.However these methods may not be useful for all types of defects. Discrete Wavelet Transform (DWT) method can identify a larger group of defect but it’s not suitable for random texture patterns, Fourier analysis is not suitable for detection of local defects and for Fourier analysis multi-resolution decomposition of images for several scales are required and Gabor filters can decompose the image into components corresponding to different scales and orientations. The impressive property of Gabor filters which allows optimal localization in both spatial and frequency domain is a main reason for using Gabor wavelet for texture analysis. Gabor filters have been used extensively for texture analysis, document analysis and object detection.

There is also one algorithm to detect the defects in the textile images.That is the SFD algorithm which consists of three stages like Multi-resolution analysis, Feature extraction, Failure detection (classification by neural networks).In the Multi-resolution analysis, four matrix is created ad those are ;Approximation matrix which presents the image approximation at the lower resolution; Vertical matrix which is calculated by lowpass filtering in vertical direction and high-pass filtering in horizontal direction; Horizontal matrix which is calculated by low-pass filtering in horizontal direction, and highpass filtering in vertical direction and Diagonal matrix which is calculated by high-pass filtering in both directions.In the feature extraction part, a feature vector is constructed for the input of the probabilistic neural network by taking features from the image.In the failure detection part the defect or non-defect classes are predicted by using neural network classification(Figure 1).



1.Figure 1

Approach

When we look at our images we can see that almost all of them have some patterns,and we know that not all filtering methods are good in the images that have patterns.This is because we choosed Gabor filtering method to implement on our images.Firstly we tried to implement multi resolution analysis and constructed 4 matrices (A,V,H,D) and by using these four matrix we tried to find defects but while we find defects for some image ,we were not be able to find the defects.Therefore,we changed our method and choosed Gabor Filtering. Our primary experiments showed that the selected filter based on the multi resolution analysis was not able to detect properly defects in tile images.This is because the variety for type of tile defects prevents to characterize all defects in unsupervised manner and also this method is detecting defects on random textured tiles.And then we proposed a method which aims to detect defects on textured tiles using Gabor wavelet filtering. When a Gabor filter is applied to an image, it gives the highest response at edges and at points where texture changes.

Galbor filter in R language:

```
gabor.filter(data, lamda, theta, bw, phi, asp)
```

Where

lamda= Wavelength of the cosine part of Gabor filter kernel in pixel. Real number greater than 2 can be used. However, lamda=2 should not be used with phase offset (phi) = -90 or 90.

theta=The orientation of parallel stips of Gabor function in degree

bw=Half responce spatial frequency bandwidth of a Gabor filter. This relates to the ratio sigma/lamda, where sigma is the standard deviation of Gaussian factor of Gabor function

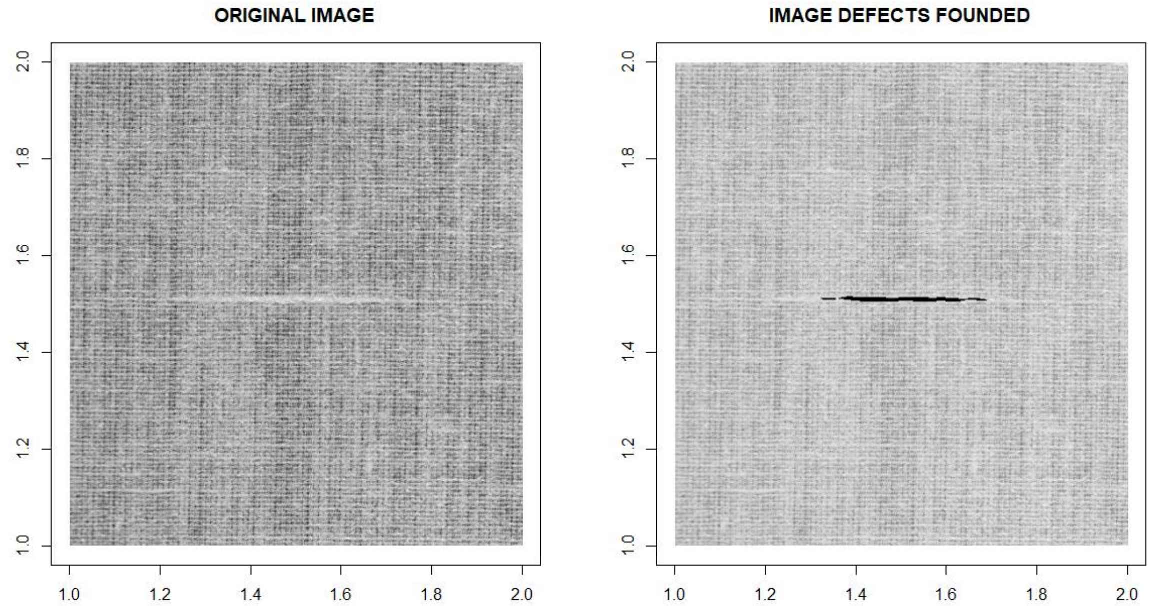
phi=Phase offset of the cosine part of Gabor filter kernel in degree

asp=Elliptcity of the Gabor function. asp=1 means circular.

Results

The result for defects on images are:

Image 1:



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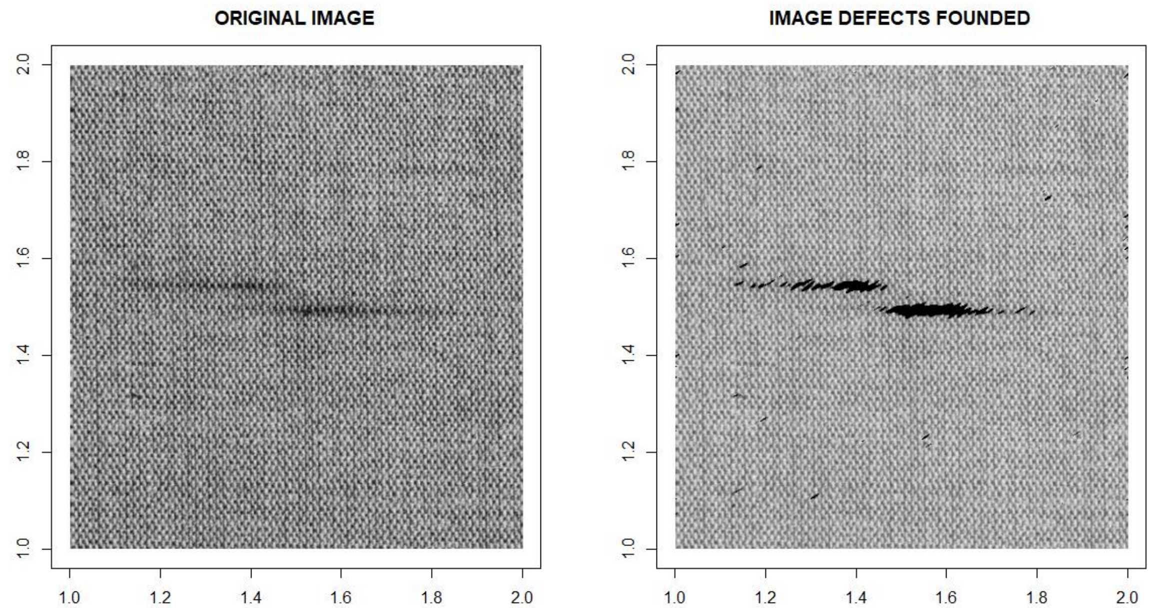

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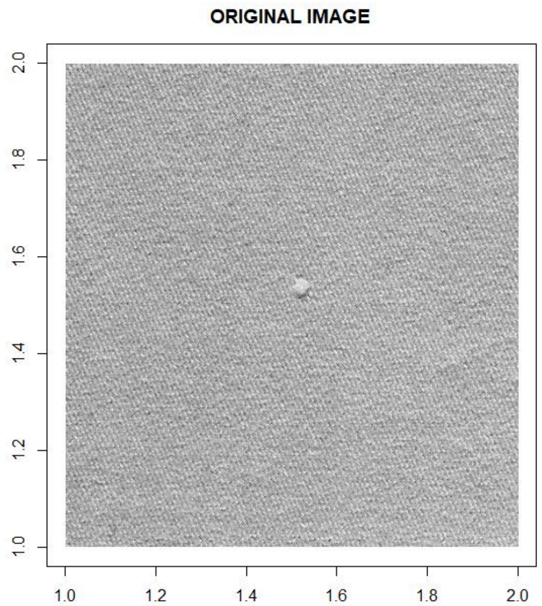

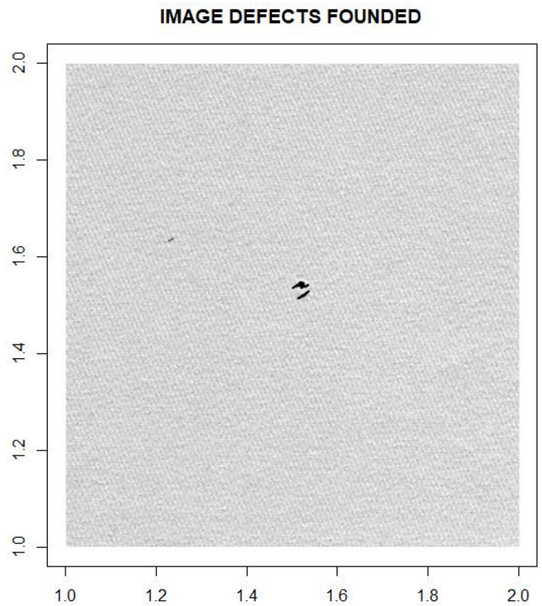

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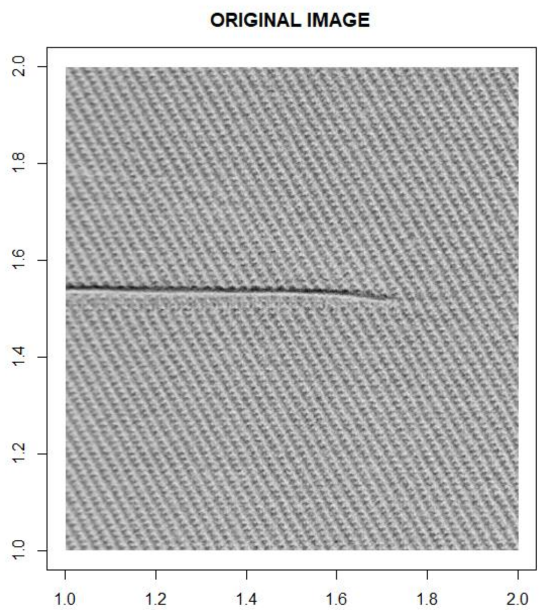

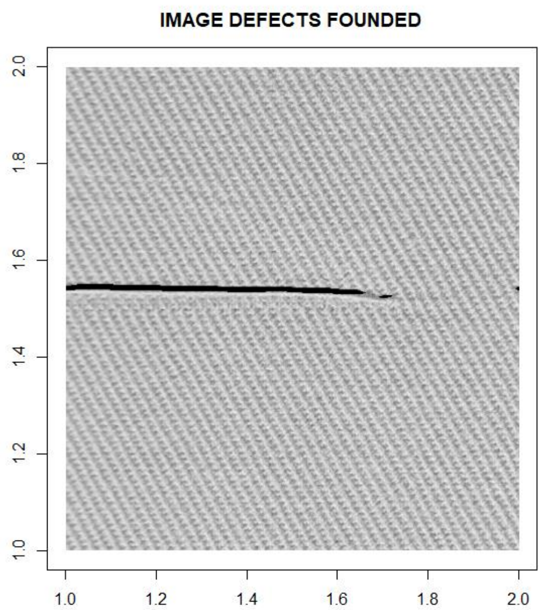

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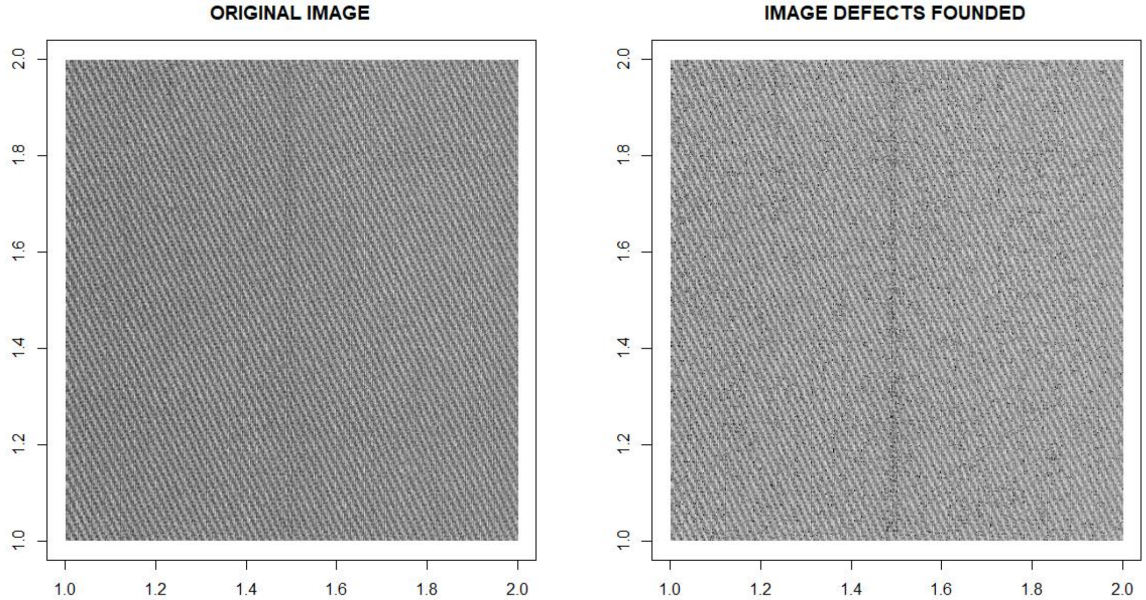

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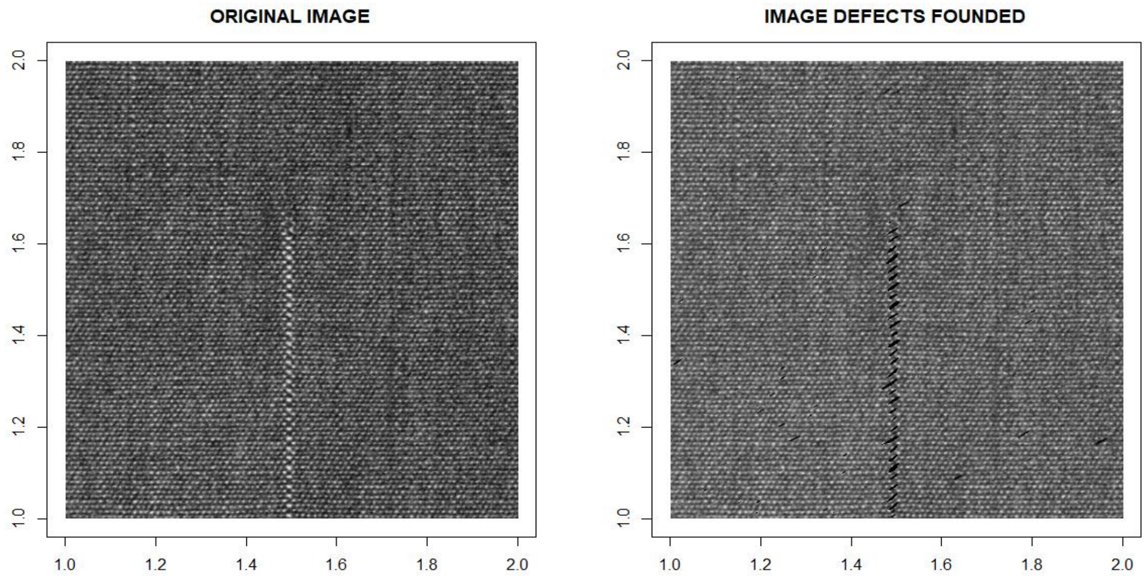

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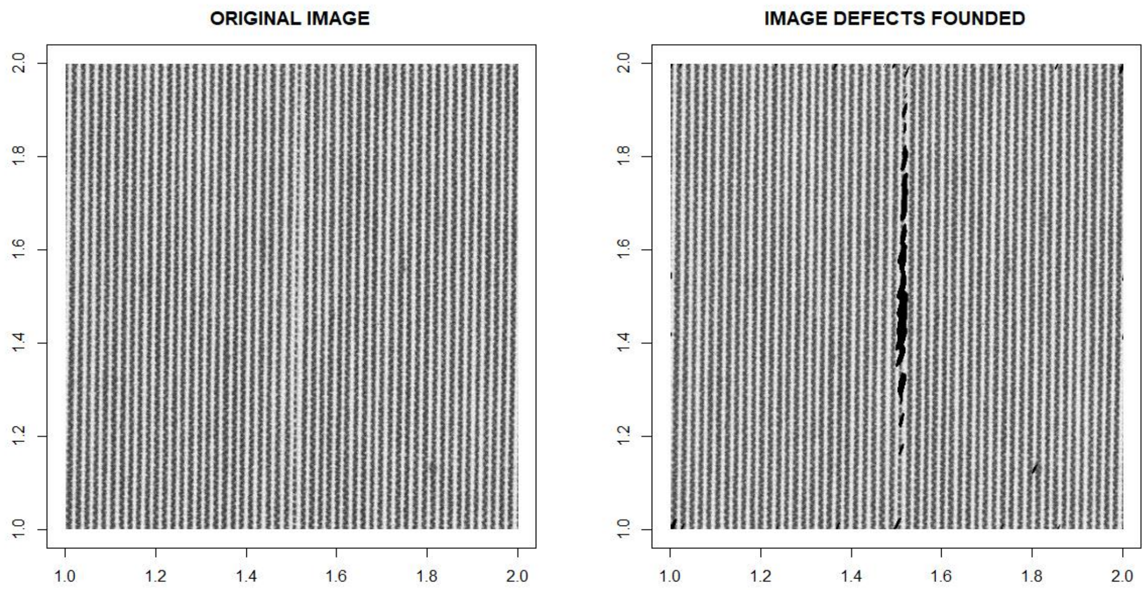

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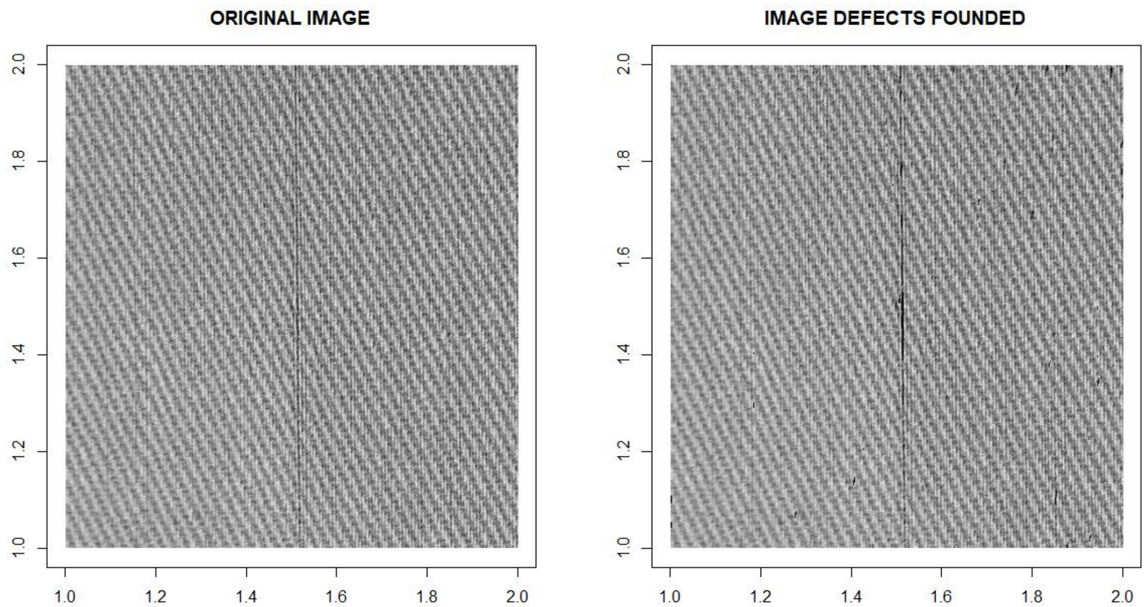

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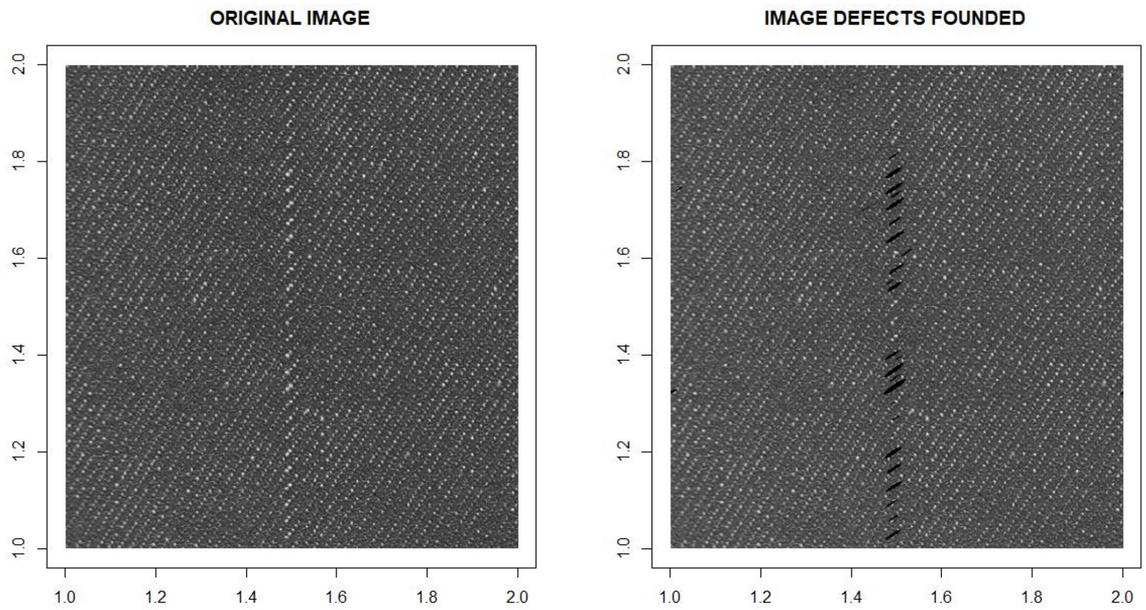

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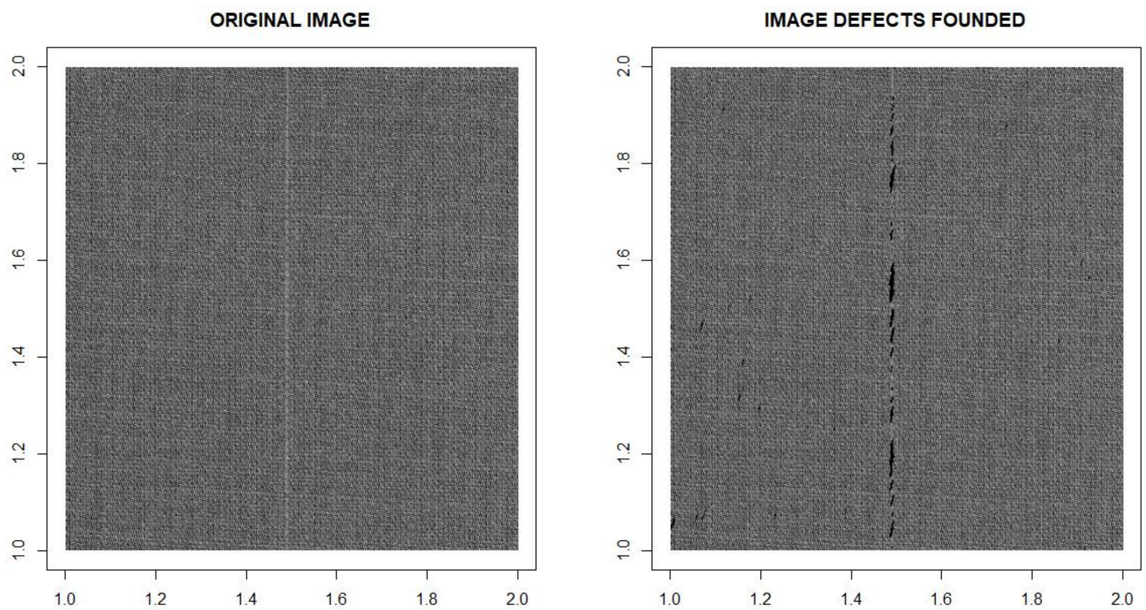

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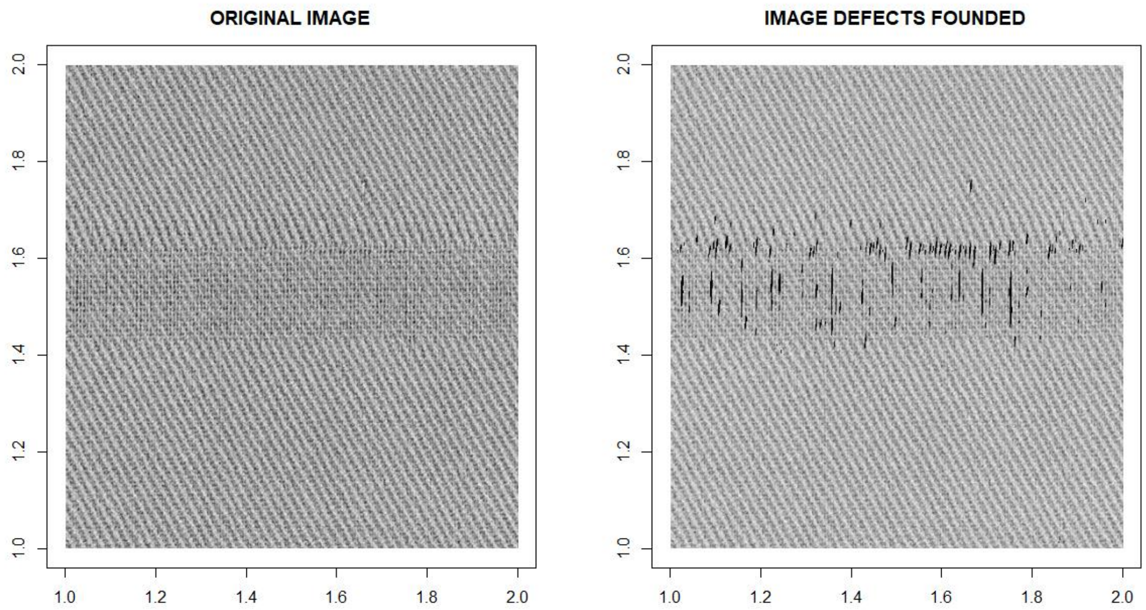

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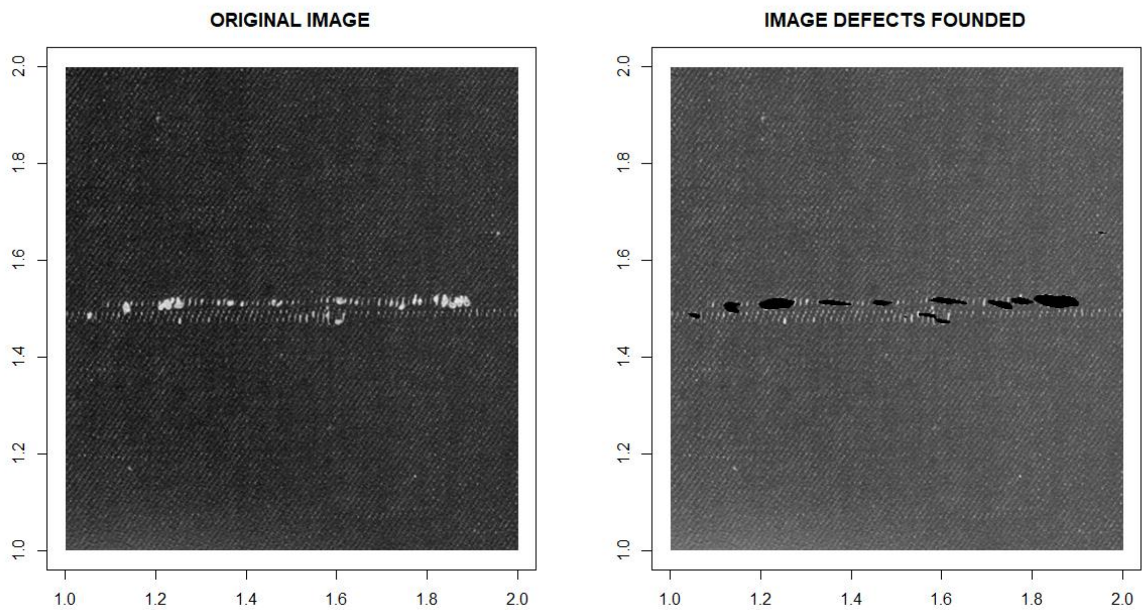

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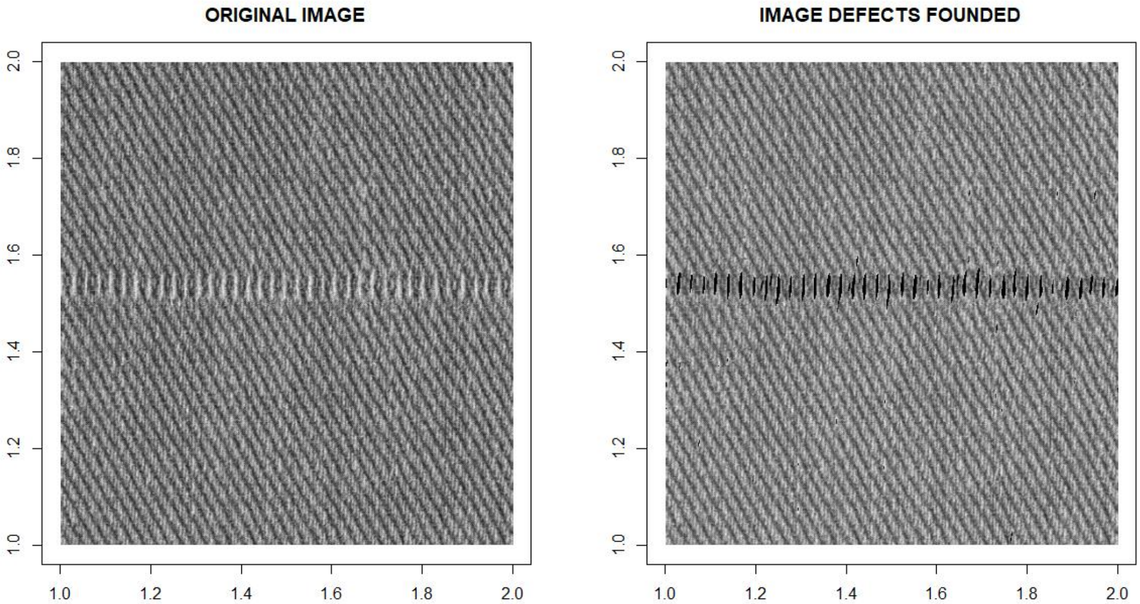

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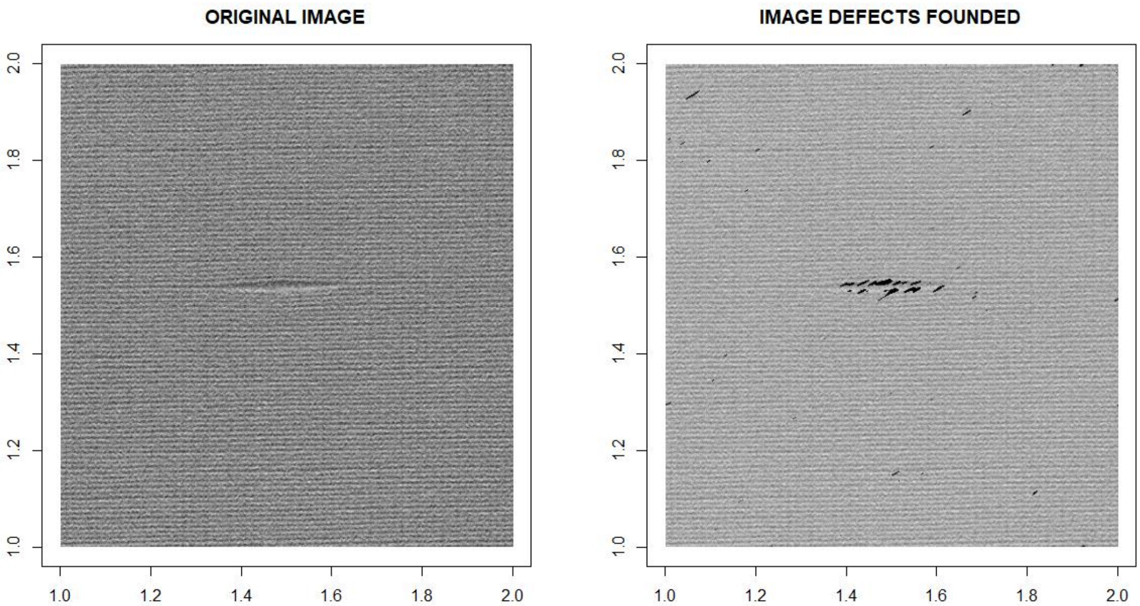

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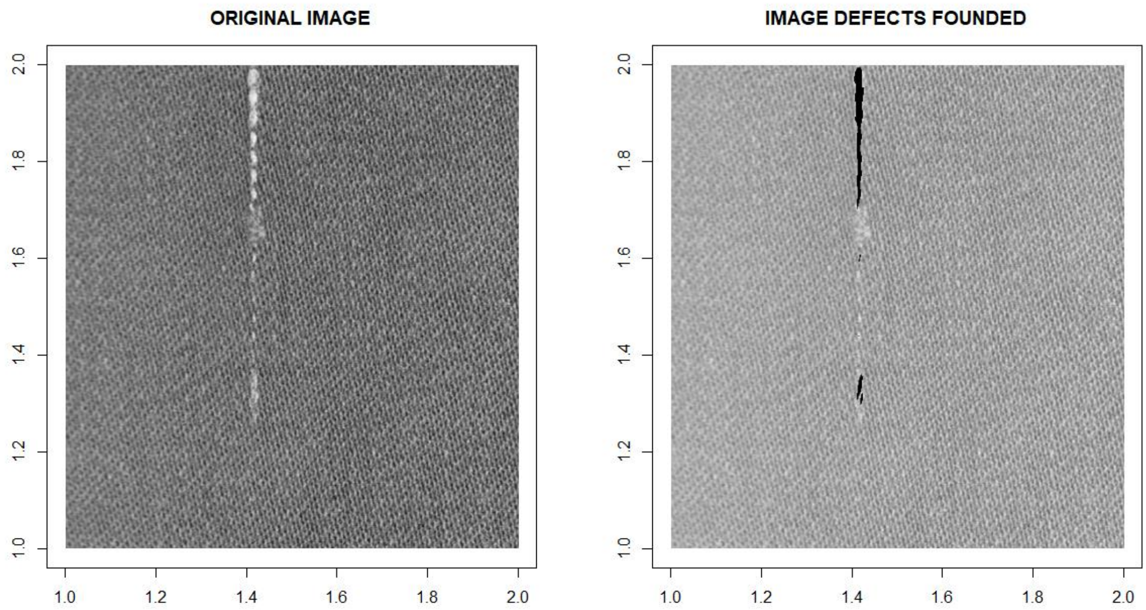

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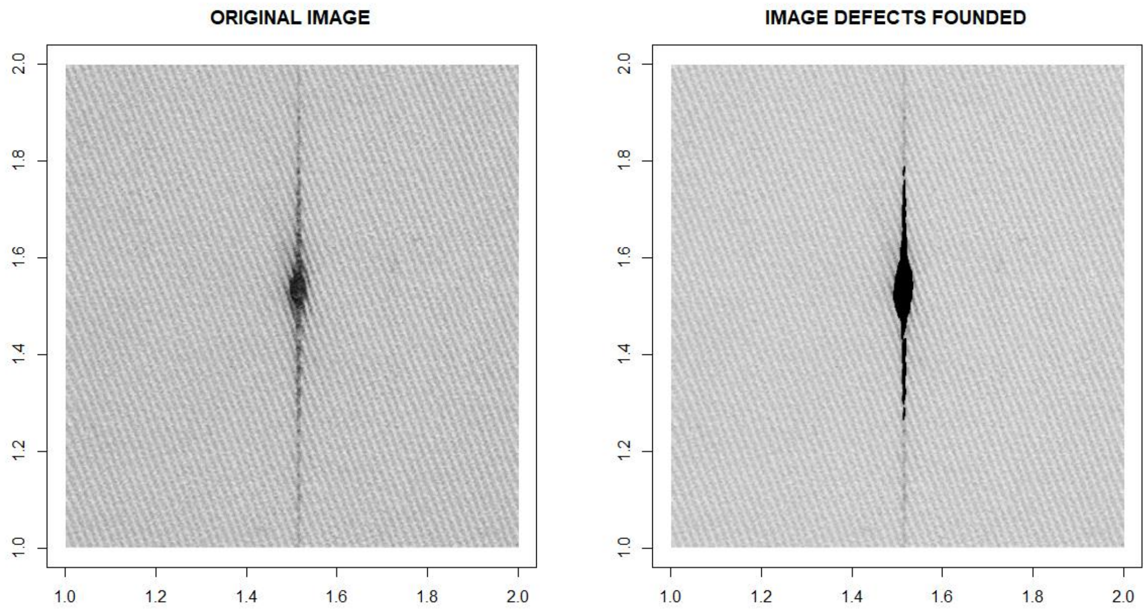

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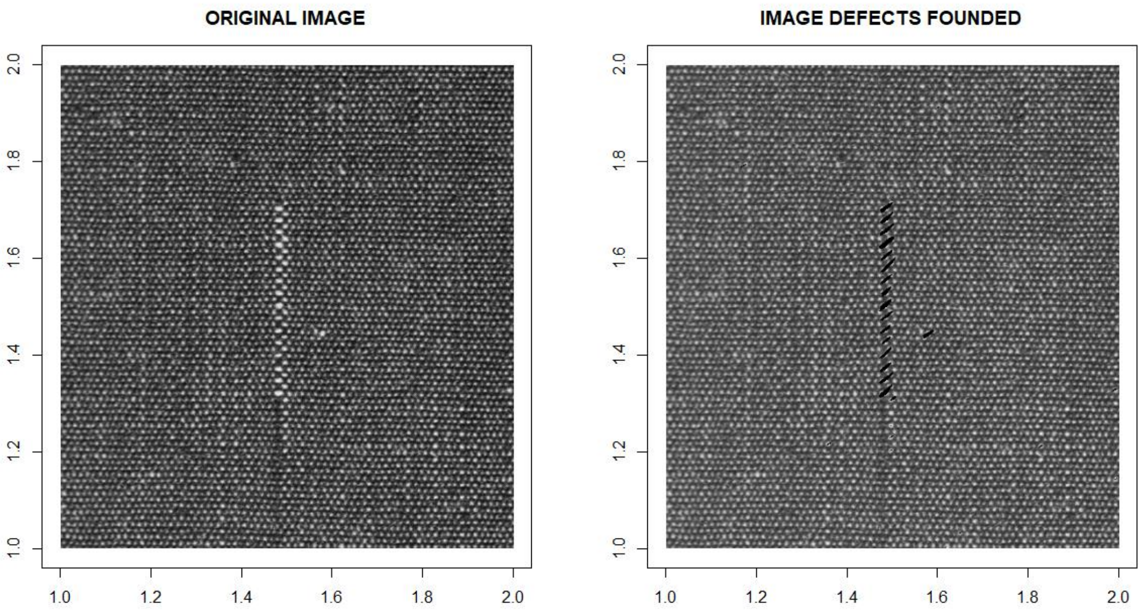

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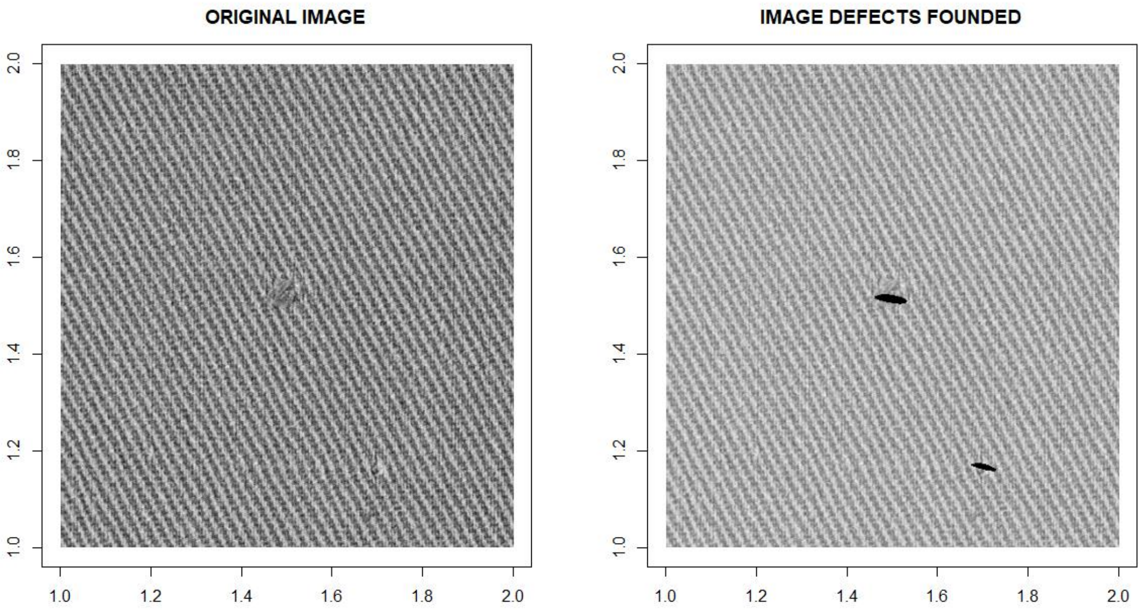

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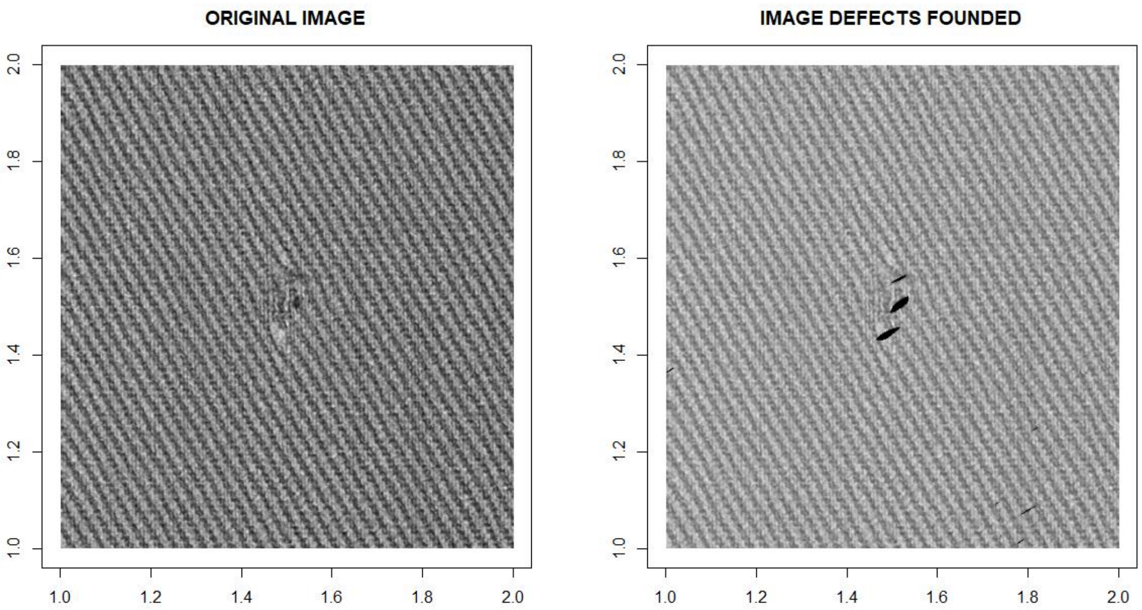

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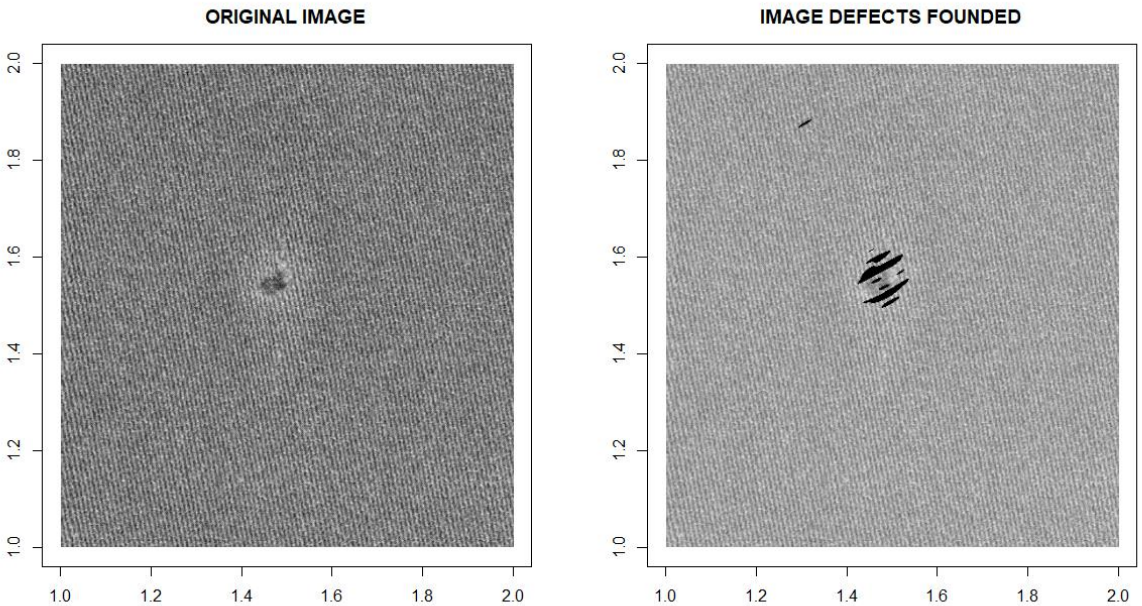

When we look at our founded defects we can say that almost all of them are classified as correct. When we constructed our filtered images and we firstly have done statical control charts for every row , we saw that the defected parts are detected correctly but the non defected parts are also assumed as defect so we changed our statical control charts.We measured mean and std values for all pixel data in filtered image and constructed one control chart for one image.Thus, we obtained good accuracy for defect ratios on the detected pixels.Therefore we implemented second method for all images in our Project.

While finding the defects, this method didn't worked well only on image 5 because of the reason that the defect ratio is very less in this image acording to other images.

The hardest part in using this method is to find the correct parameters for galbor.filter function. As we seen that if we use same parameters for all ımages model can find much more or less defects than it should be.Actually we thought that there is a way to minimize this problem.We mentioned this way in the conclusion and future work part.

Conclusions and Future Work

Throughout all the process that we have experienced, we see that, it's quite possible to process an image by taking advantage of several statistical methods.

We have seen that the sigma limits and function parameters are very imtortant effects in detecting the defect process. However we can not say an exact number for these variables and if we are a textile manufacturing firm either we should change these variables for different products or we should find an optimal parameters for our product range.As we know these parameters are effected from the variability on the pixels of the original image, so if we want to define optimal parameters, we should define those parameters according to the pixels values of all different images by using some machine learning algorithms so that we as a human will not perfom any implemantation to the parameters, the image processor will look at the original image that is wanted to perform a defect control process, and will define the function parameters and control limits by itself.

Also we can say that while we taking the picture of linen patterns if we keep the angle of the camera parallel to the linen surface and provide the surface with a uniform light at that moment.We can have a better probability of success and higher accuracy along with precision in the procedure of same analyzing methods. This also means the increase of experiment and analyze efficiency through a controllable factor.

References

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