BOGAZICI UNIVERSITY

IE 423
Project Part 3

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Introduction

Linen is a textile made from the fibers of the flax plant.This versatile and durable material has been used for centuries for its smooth texture. Linen is renowned for its ability to keep individuals cool in warm temperatures. Due to its environmentally friendly production process, linen has gained popularity as a sustainable and eco-friendly fabric.

Monitoring the processing of linens is crucial, particularly in the context of finding defects, as it directly impacts the quality and longevity of the final products. Timely process monitoring helps detect flaws such as wrong colorations, or imperfections in the fabric, which might otherwise compromise the appeal and functionality of the linen. By proactively addressing these issues, manufacturers can reduce waste, and enhance customer satisfaction and increase overall quality.

The use of images and defect identification in linen manufacturing is motivated by the need for comprehensive and efficient quality control. High-resolution images enable a detailed analysis of defects, going beyond what manual inspection methods can achieve. This approach allows for the early detection of defects, enabling timely corrective measures and minimizing material wastage.

Aim of the Study

The aim of this study is to investigate and validate a robust, efficient image processing technique—specifically, a moving average filter—for the automated detection and analysis of defects in textile manufacturing. The study seeks to systematically assess the filter's capability to smooth stochastic textured surfaces, thereby enhancing the visual contrast of anomalies against the regular textile pattern. We aim to optimize the filter parameters, including kernel size and shape, to cater to various defect sizes and types, improving the manufacturing process's overall effectiveness and efficiency. This study also intends to bridge the gap between traditional quality control methods and advanced image processing techniques, providing a scalable solution that can be integrated into existing quality control systems. The ultimate goal is to achieve a substantial reduction in manual inspection workload, minimize the rate of defective products, and ensure a consistent quality standard in the final output, thus contributing to the economic and environmental sustainability of textile production.

Background Information

There are various approaches on process monitoring linen. One of them is Reducing Linen Loss in Hospital Using Lean Six Sigma Approach. The research integrates Lean and Six Sigma, applying DMAIC(Define-Measure-Analyze-Improve-Control).Implementation of the monitoring and control system achieved a 100% Minimum Service Standard, indicating the Lean Six Sigma approach's effectiveness in reducing linen loss.

Murino et al. (2004), discussed the classification problem of defects in textile manufacturing. A new classification scheme was designed using different features extracted from the gray level histogram, shape, and concurrency matrices. The designed system has been tested using two textile databases showing promising results.

Mozafary and Payvandy (2014), examined the raw material testing and yarn quality parameters using the data from the worsted yarn mill. They estimated the yarn quality with the K-means algorithm, one of the artificial neural networks and clustering methods, and compared the results with the results obtained by the traditional method. The performance of data mining methods has been better .

Habib et al. (2016) have determined and classified various defects in textile fabrics in their studies. They extracted features using statistical techniques and used images of textile fabrics as an example. Using a suitable Bayes classifier to classify images into different defect property classes, they have achieved acceptable accuracy in the field of textile defect detection and classification

In his studies in 2017, Tagluk emphasized the importance of determining the defects of fabrics woven on looms in textile, on a full-time basis and argued that fabric defects vary depending on the sources. For defect detection, they recommended a special filtering system considering the color, texture and morphological properties of the fabric, and defective products were separated at a rate of 99.10%

Our Approach

For our first approach, we observed the pixel values of the grayscale image using a histogram and then decided on the normal distribution to fit the histogram. We assumed that all parts of the image are normally distributed with the same parameters. Then we estimated the mean and variance parameters for pixel values. We identified the pixels that are out of the 0.001 probability limits and set their value to 0 (black). We then utilized an approach to perform the image operations on patches of the image. A window size of 51x51 is set and the same operation is performed on all patches. We observed that in both methods results are consistent.

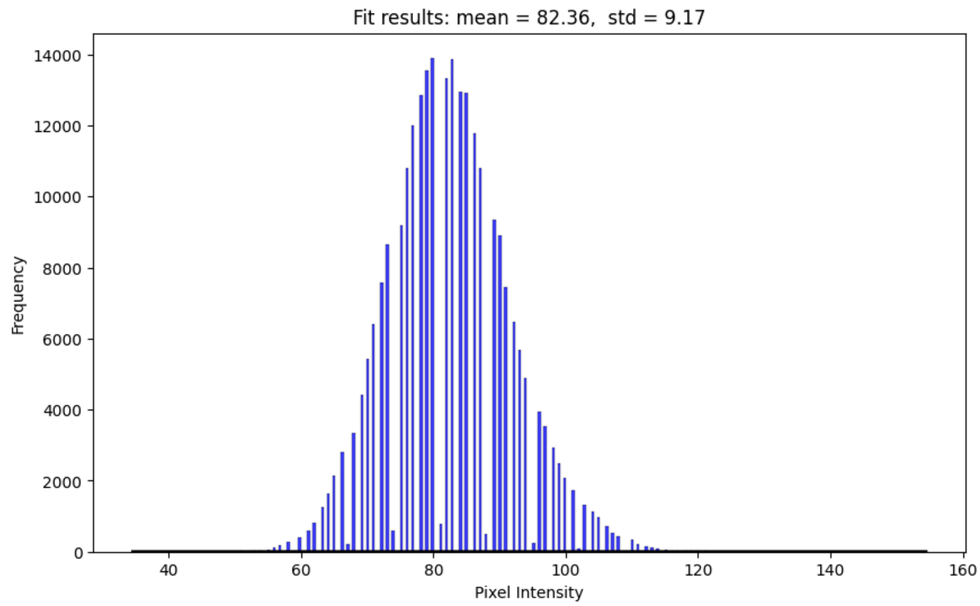
The second approach was using Control Charts. Other than using Control Charts, a different approach is used in this one. In the first approach, pixel values were taken as a whole. In this approach, pixel values are used under the assumption that the distribution of pixels should be the same horizontally and vertically. Mean and deviation values are calculated for every column and row and with these values, Control Charts are constructed and out of control signals are detected and their values are set to black[0].

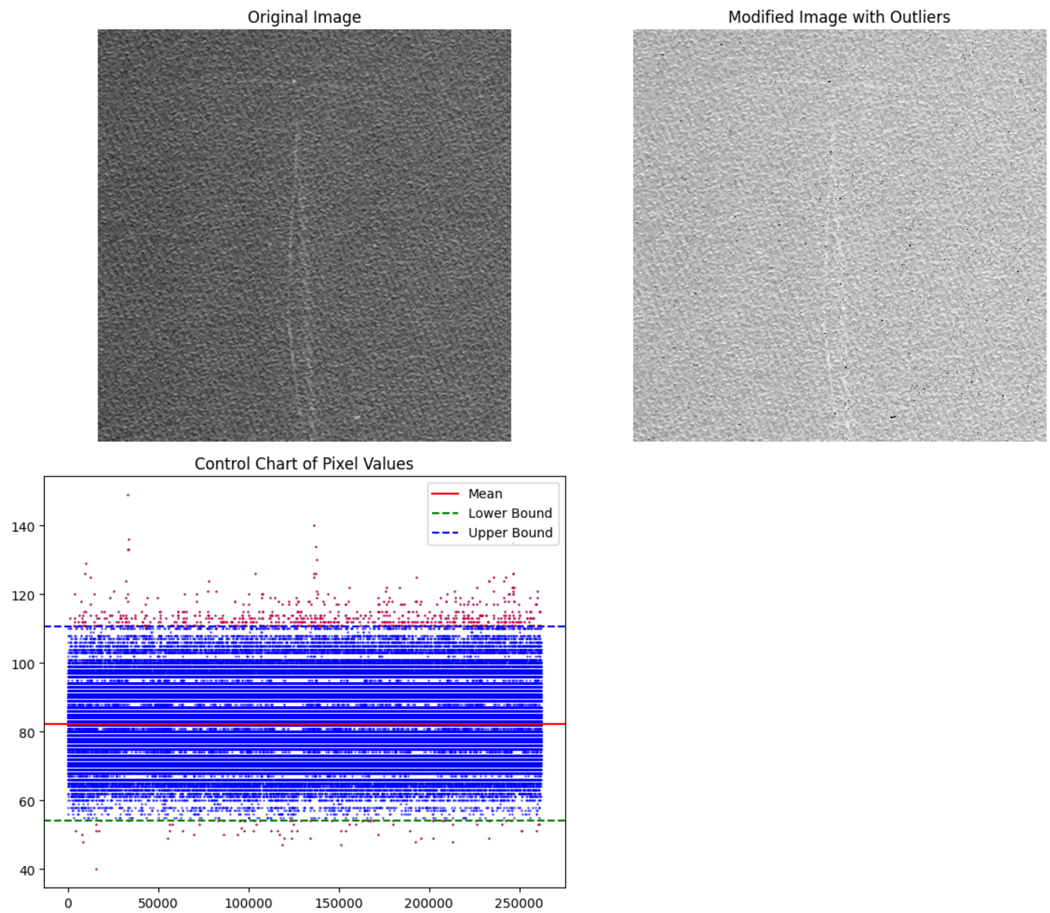
In response to the need for an improved quality control process in linen manufacturing, we propose the implementation of a moving average filter technique for the automated detection of textile defects. This method is selected for its robustness and simplicity, making it highly effective for stochastic textured surfaces where defects are often indicated by interruptions in the texture pattern. The moving average filter operates by smoothing the image, averaging the pixels' values within a specified window or kernel. This smoothing effect highlights discrepancies in texture by dampening the noise and emphasizing areas where the pixel intensity deviates significantly from the local average. The result is a processed image where areas of inconsistency are more apparent, thus allowing for easier identification of potential defects.
We tried window sizes of 3,4 and 5 and observed that different window sizes are appropriate for different cases. In our case, window size of 5 was the most sensible option.
Furthermore, the versatility of the moving average filter allows for adjustments in kernel size, which can be optimized based on the common defect sizes anticipated in the production line.
By implementing this technique, we aim to achieve a more consistent quality assurance process, reduce waste, and improve overall product quality. The proposal will be subjected to a rigorous validation process using historical defect data to tune the parameters of the filter for optimal performance.

Results

First Part

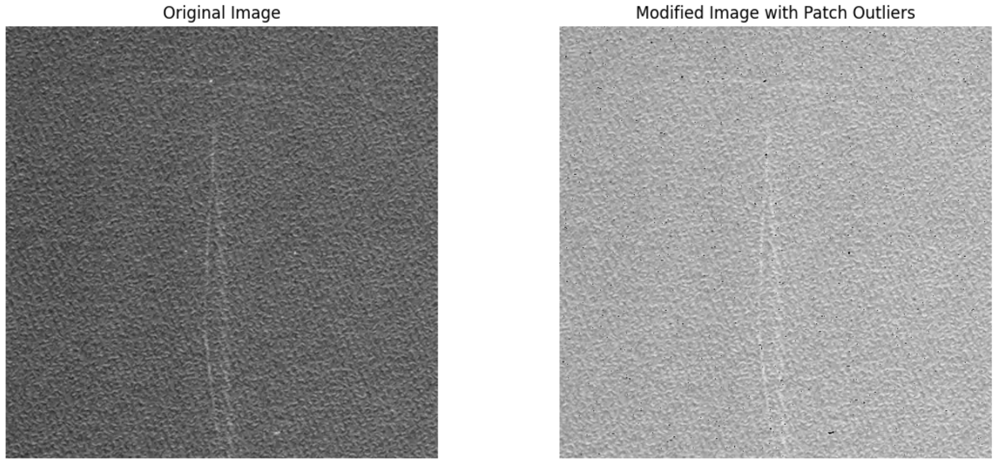
A histogram of pixel values is printed. It is decided that pixel values have normal distribution. Using this distribution, a control chart was constructed and 846 out of control points were found and painted to black.





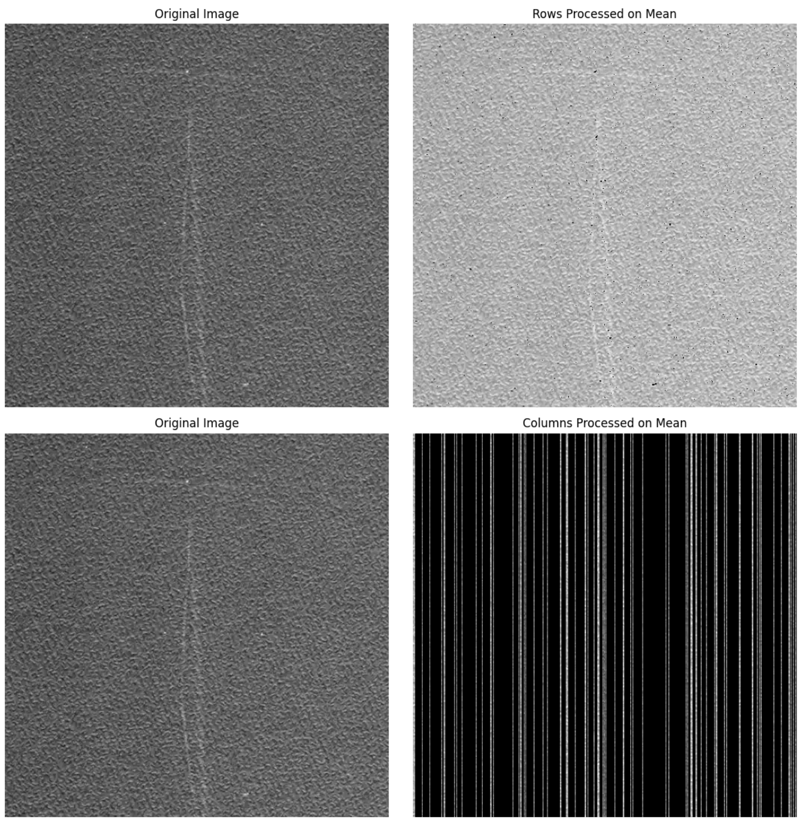
Window Size

This time, pixel values are not taken one by one, instead, windows of size 51x51 are used. After this step, the same procedure as before has been applied.

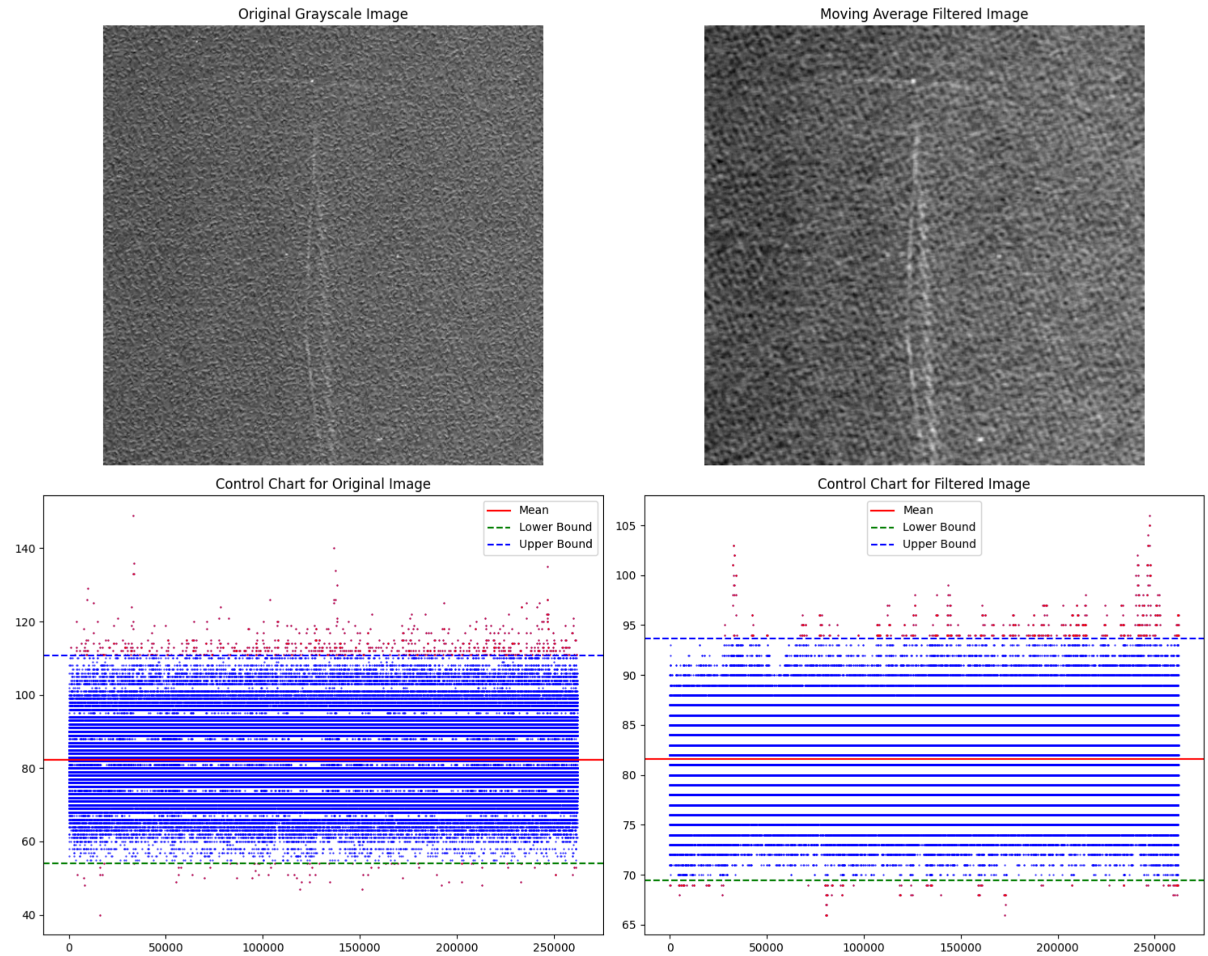


Part 2

In this part, pixels are under the assumption that the distribution of them should be the same horizontally and vertically. There were 1776 out of control points detected horizontally. The number for the vertical aspect was 1882.

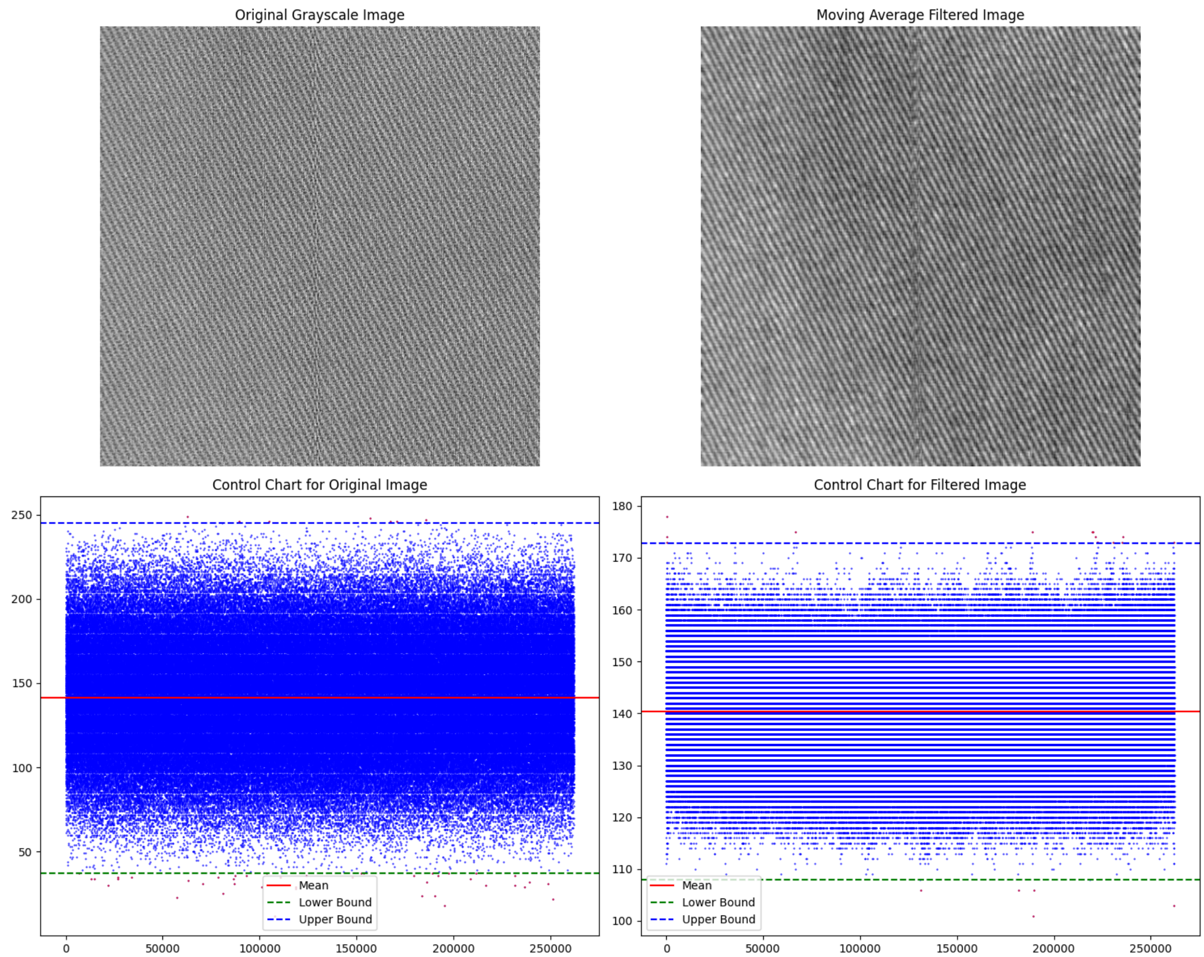


Moving Average Filtering Method

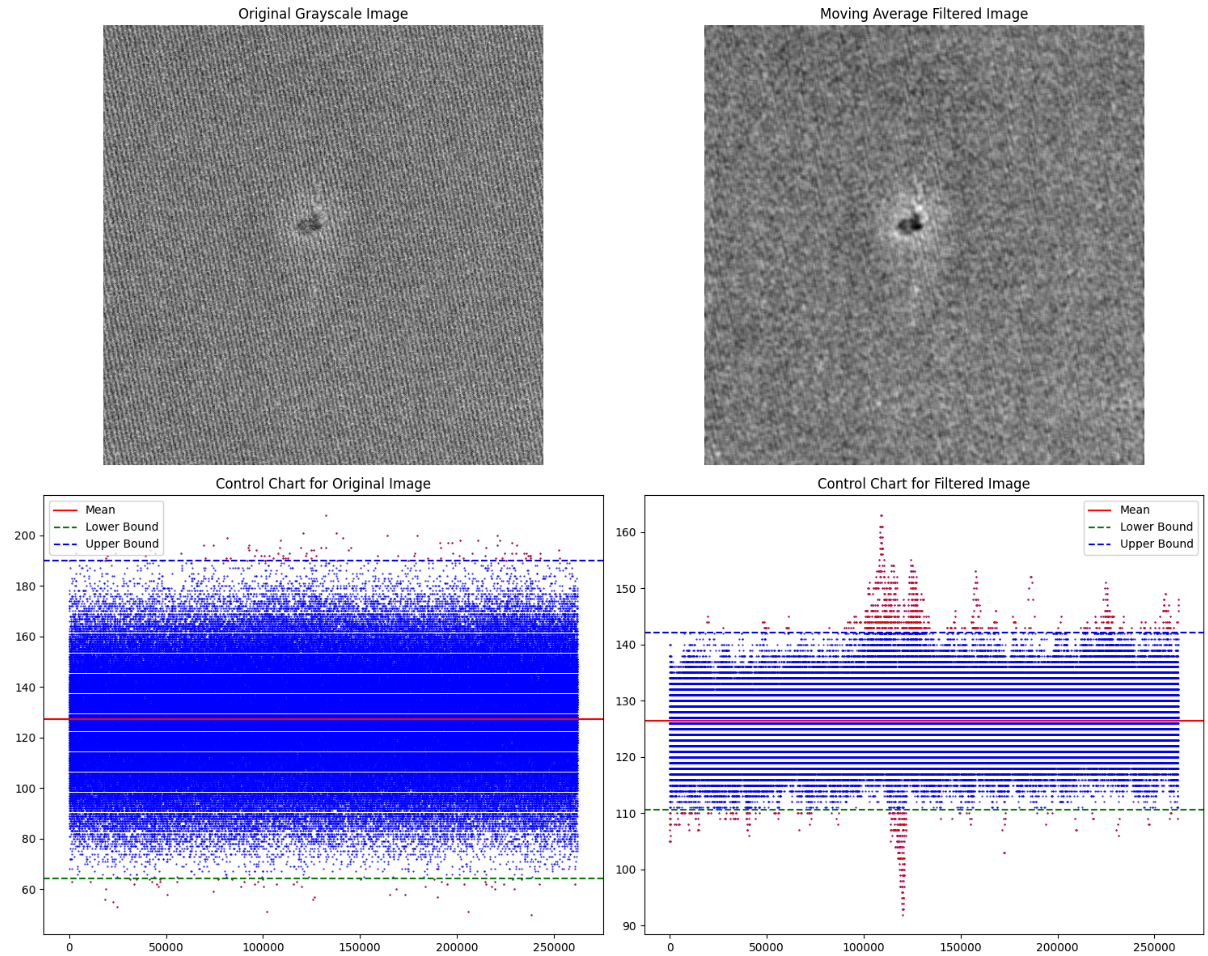


Comparison with Alternative Images

img0109

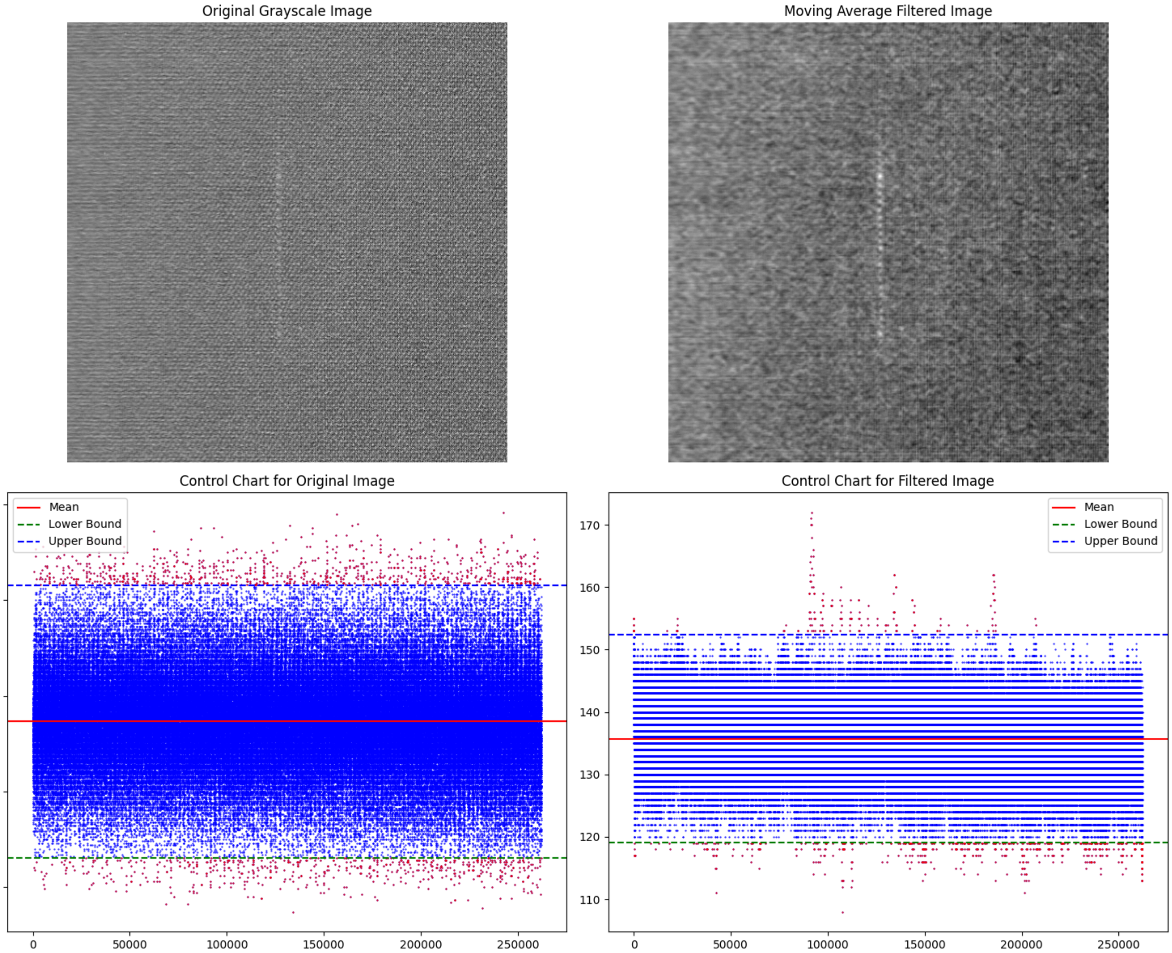


img0151

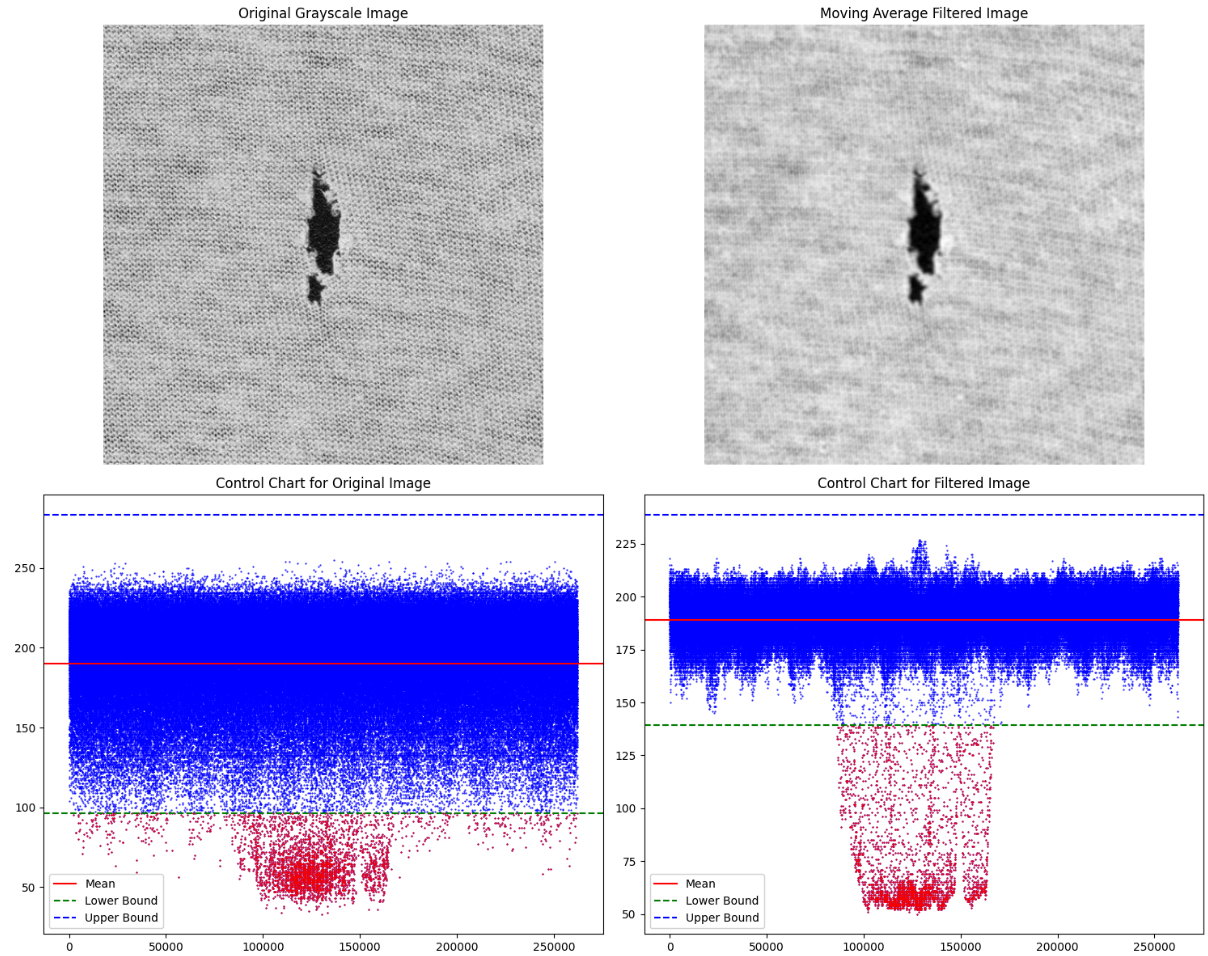


Original Grayscale Image
Moving Average Filtered Image
Control Chart for Original Image
Mean
Lower Bound
Upper Bound
200
180
160
140
120
100
80
60
0
50000
100000
150000
200000
250000
Control Chart for Filtered Image
Mean
Lower Bound
Upper Bound
160
150
140
130
120
110
100
90
0
50000
100000
150000
200000
250000

img0183

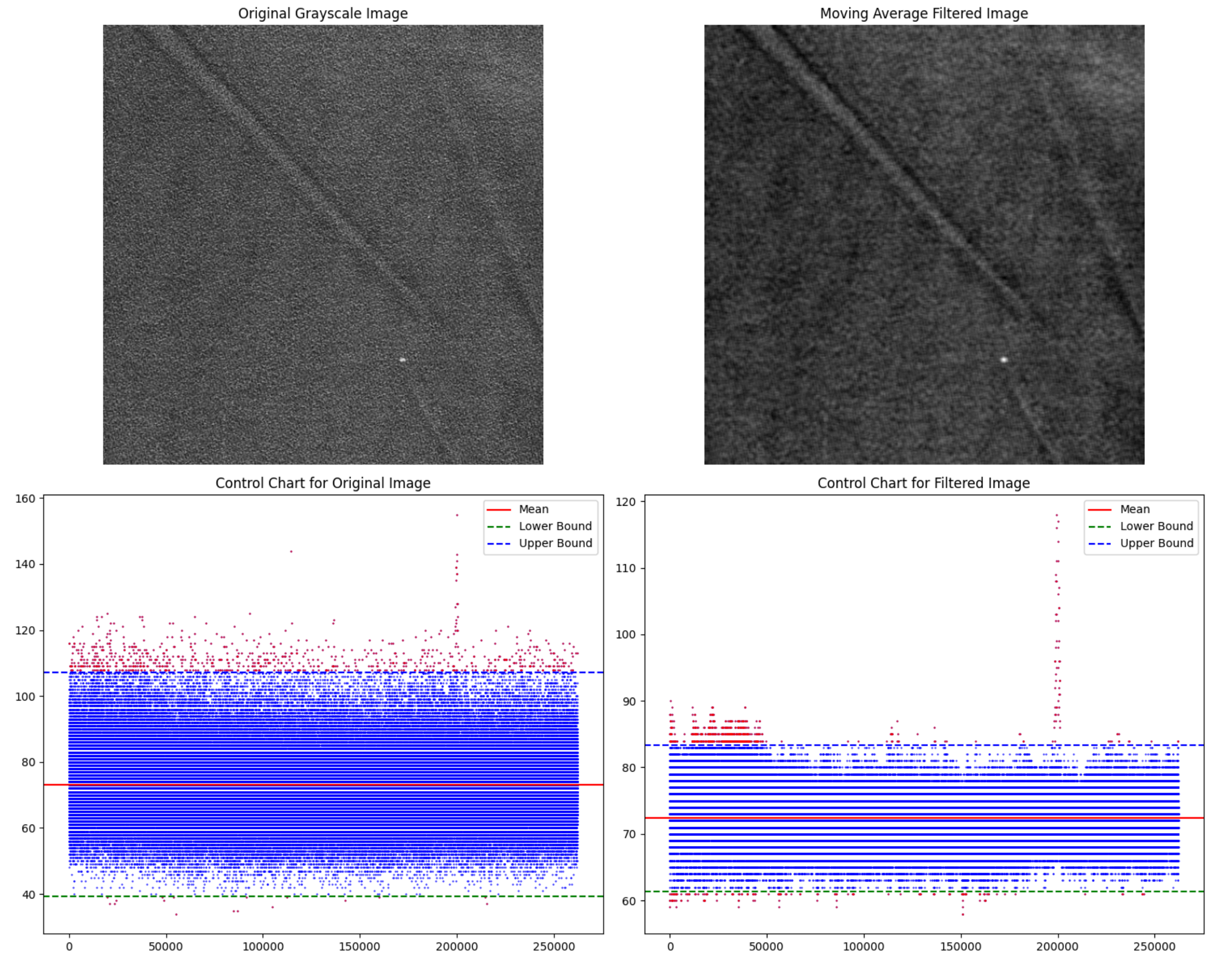

Original Grayscale Image
Moving Average Filtered Image
Control Chart for Original Image
Mean
Lower Bound
Upper Bound
250
200
150
100
50
0
50000
100000
150000
200000
250000
Control Chart for Filtered Image
Mean
Lower Bound
Upper Bound
170
160
150
140
130
120
110
0
50000
100000
150000
200000
250000

img0105



Original Grayscale Image
Moving Average Filtered Image
Control Chart for Original Image
Control Chart for Filtered Image
Mean
Lower Bound
Upper Bound
Mean
Lower Bound
Upper Bound

img0013



Conclusions and Future Work

As a conclusion, our Moving Average Filtering approach has detected more defects in the image than Statistical Analysis and Control Charts. As we applied to the alternative images, we observed that Moving Average Filtering works as it is planned.

One possible proposal for future work is to utilize machine learning methods to further enhance the detection capabilities. The goal is to develop a hybrid system that combines the simplicity and efficiency of traditional image processing methods with the predictive power of artificial intelligence.

References

- Fitriasari, N., Haryanto, T., & Yuliansyah, N. (2018). Reducing Linen Loss in Hospital Using Lean Six Sigma Approach. KnE Life Sciences, 4(9), 199–206. https://knepublishing.com/index.php/KnE-Life/article/view/3572/7478

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