IE 423 Quality Engineering

Part - III
Quality Control on Images

Group – IX

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1. Introduction:

Linen is a textile made from the fibers of the flax plant. It is valued for its natural luster, smooth texture, and excellent breathability. Linen has been used for centuries to make a variety of products, including clothing, bed linens, tablecloths, and towels. It is known for its durability, absorbency, and ability to keep the body cool in hot weather.

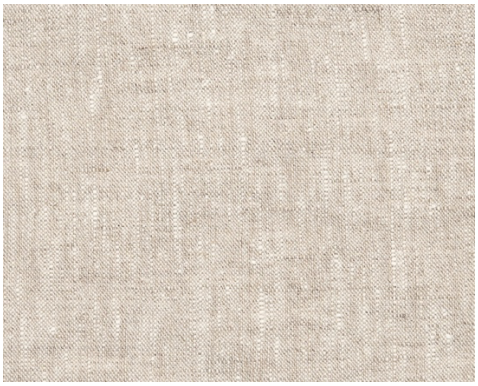


figure-1:Linen

Manufacturing linen is more difficult process then manufacturing of other textiles like cotton. Therefore, to reduce time and resource consumption and meet with the demand linen manufacturing process requires more monitoring. Moreover, monitoring of linen production is essential for maintaining and improving product quality, ensuring consistency, meeting standards, and ultimately satisfying customers.

The motivations for using the images and defect identification in linen manufacturing include improving efficiency, ensuring precision and consistency, and enabling real time inspection. The automation process streamlines the inspection process, reducing the manual work and extra labor force. Also, automated systems can detect defects with high precision. That is nearly impossible with manual inspection to achieve sustainable precision. This high precision can be achieved during the manufacturing process, so automated image-based systems can provide real-time inspection.

2. Background Information:

Linen production monitoring dates to the past. In previous ages, due to difficulty of linen production only royal classes can reach linen, so the inspection was made detailly and manually. Thanks to advances in technology, nowadays monitoring process is made by computer inspection and other sophisticated methods. Computer vision and image processing, machine learning and pattern recognition are one of significant example of the inspection process for linen and any other textiles.

3. Approaches:

Approaches used in the monitoring linen production are explained briefly in the following part.

1- **Plotting Histogram and Estimating Probability Distribution:** The distribution of pixel values are plotted and the appropriate probability distribution is chosen that fits to the plotted data. After selecting appropriate distribution the parameters of the distribution are estimated such as mean, variance.

   After constructing a distribution, determine outliers fall out of the confidence interval range 0.01% and 99.99%. Normally, this method is applied to whole pixels, however this method applied that to the patches of images.

2- **Control Chart Approach:** In this method parameters are calculated for each row and column. Control charts such as X-bar Chart and R Chart are constructed based on the parameters. Then, the pixels that falls out-of-control zone are determined. LCL and UCL are calculated by 3 sigma rule.

3- **Proposed Solution:** The solution is derived from the control chart approach. Combination of control chart approach with the computer vision technology can provide a comprehensive and effective control system. Therefore, Lower control and upper control limits will determined in a optimal way that satisfy maximum precision in the monitoring process.

4. **Results:**

Method-1: Statistical Data Analysis

The first method includes all pixel point into the statistical control limits. Therefore, in this part a histogram plot is printed to understand statistical distribution of the pixels. As shown below the data is distributed normally.

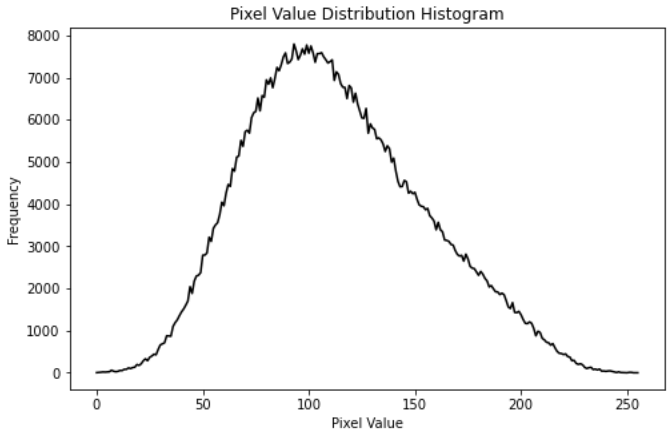


figure-2: Pixel Distribution

The data is assumed to be normally distributed. After that assumption the mean and variance values are calculated. Based on the estimated parameters upper and lower tails are estimated.

Parameters for Normal Distribution:
mean: 113.1
stdev: 41.4
var: 1717.6

1% and 99% quantiles:
Lower bound: -14.9
Upper bound: 241.2

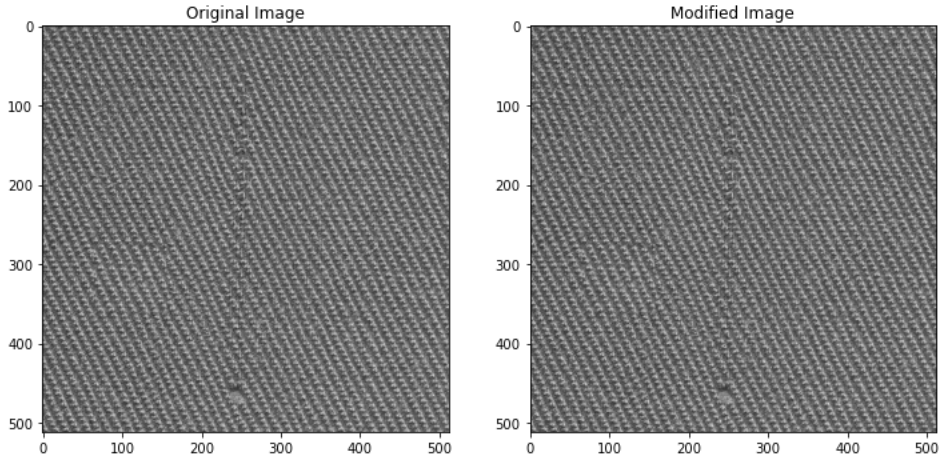


figure-3: Comparison of the whole pixels

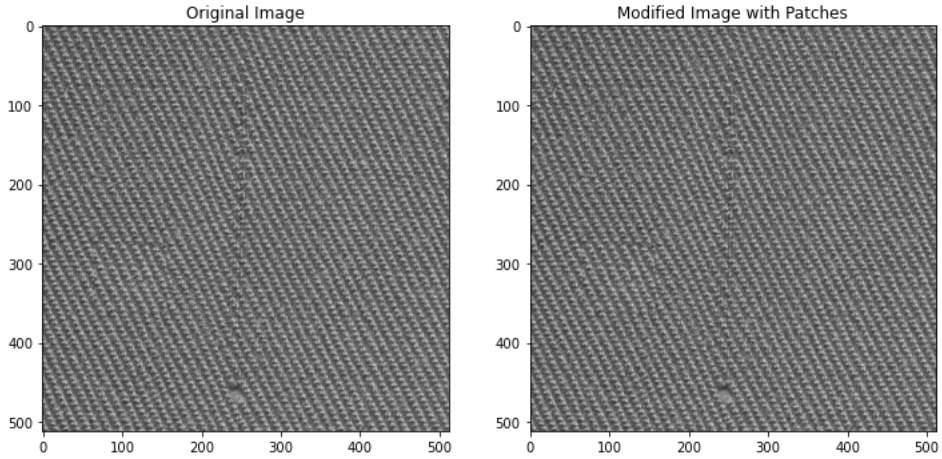
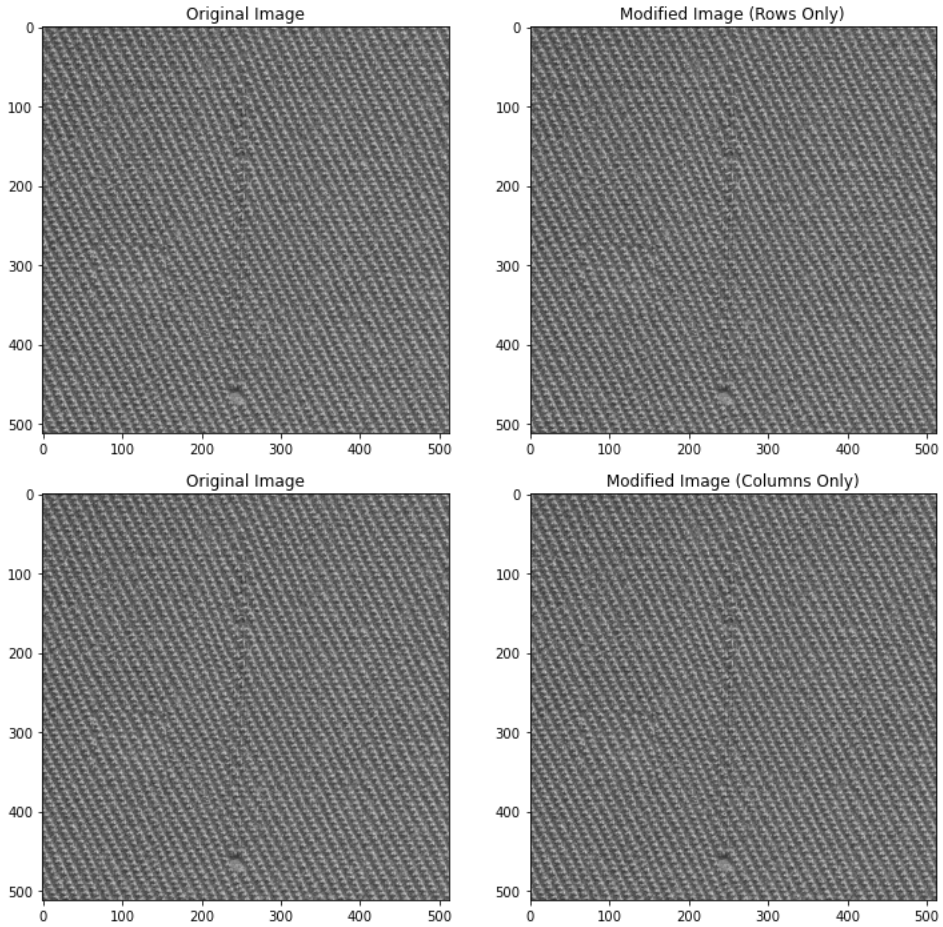


figure-4: Comparison of the Patches

Method-2: Control Chart Approach:

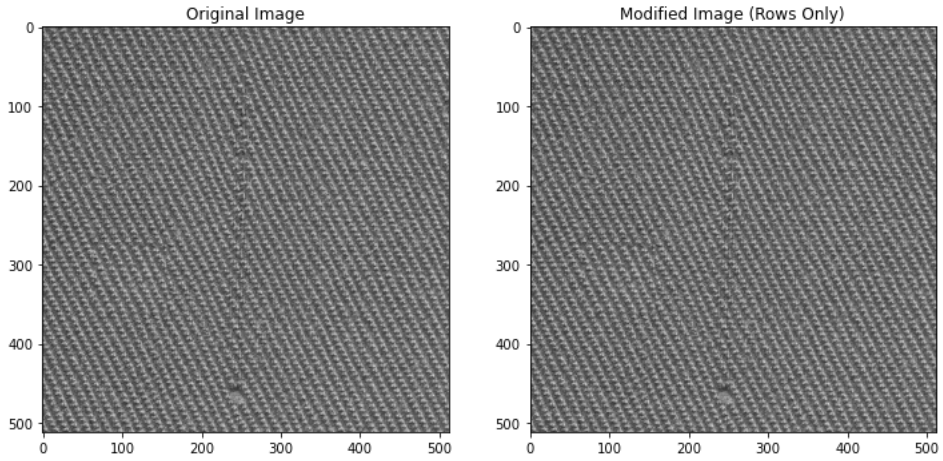
This approach creates control charts for pixel values across the columns and rows. Control limits are established based on the distribution of the pixels.



Figures 5-6: Control Chart Comparsion for rows and columns

Method-3: Control Chart with 6 sigma

The method is very similar with the previous method (explained in method-2)



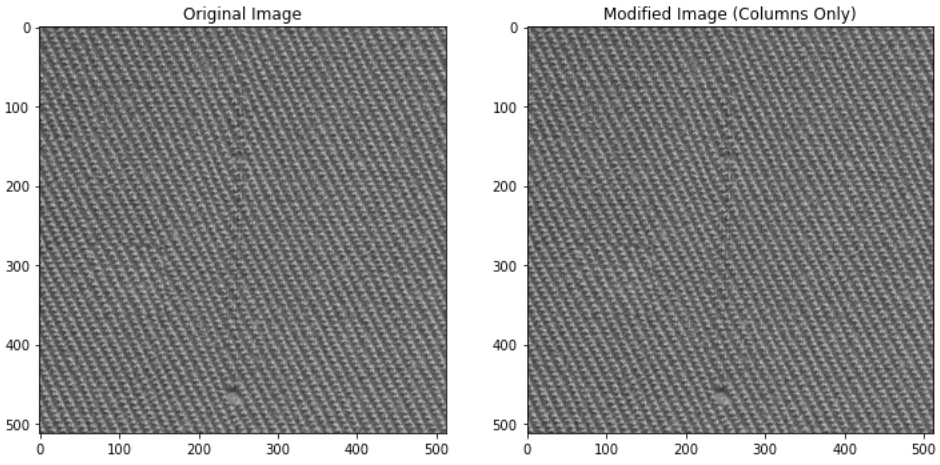


Figure-7: image 45

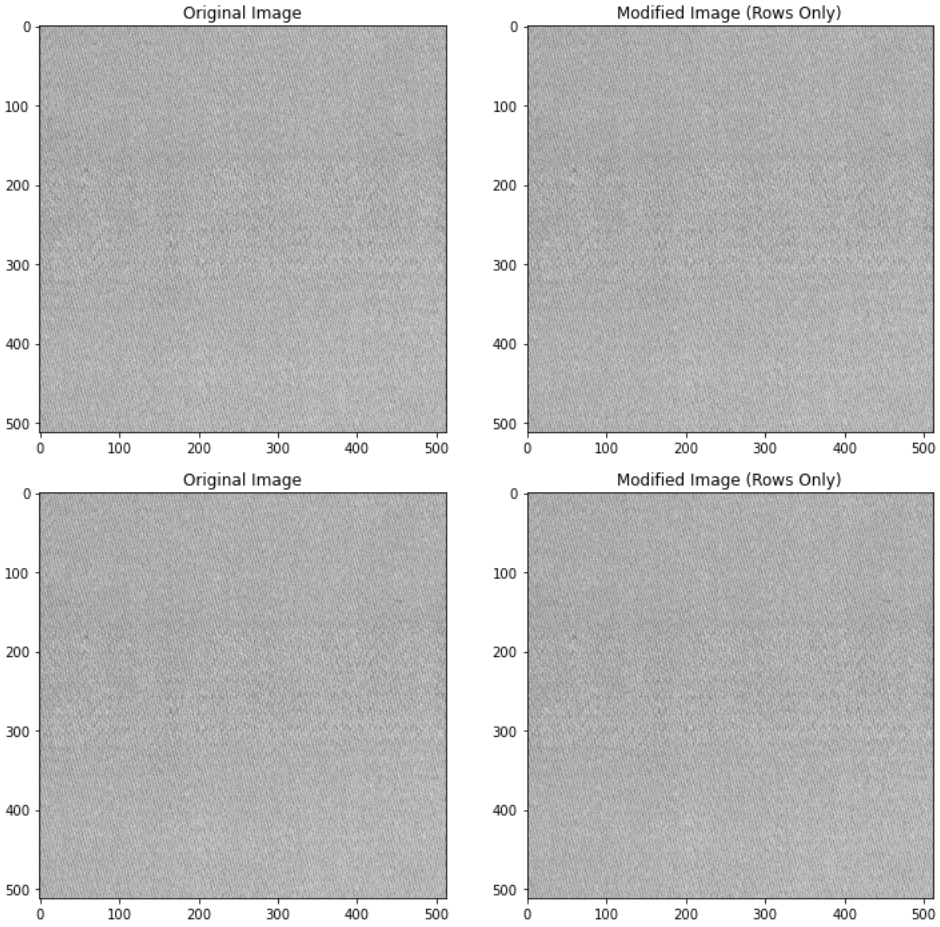


Figure-8: image 44

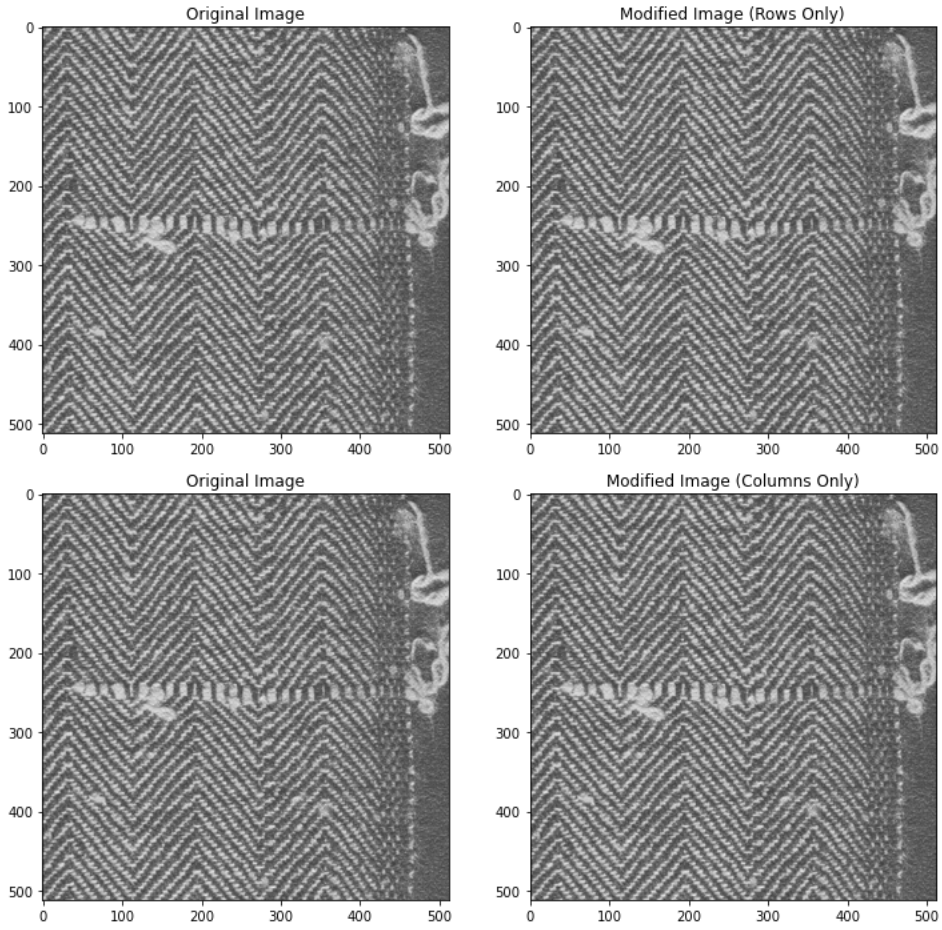


Figure-9: image 46

5. Conclusion and Future Work:

There are 3 different methods used to reduce unnecessary manual work during the linen production monitoring and increase efficiency to meet with sustain quality of the textile and meet with the customer needs. On the other hand, the precision and capability of the methods are variates.

Statistical Analysis Approach: If the distribution of the pixel values obtained from the linen picture fits any statistical distribution, then estimating parameters and control limits are very easy when compared to other methods used in this study. However, due to global distribution assumption any local pattern or correlation in the image can be missed. Even if patches are used global estimates decreases the efficiency.

Control Chart & Proposed Approach: This approach is more robust than previous approach because these two methods take local patterns and relationship into account when determining

control limits. Base control chart method uses 3 sigma limit when proposed solution using 6 sigma limits.

Future Work:

1. **Autocorrelation:**

Methods used in above are not sufficient to catch correlation between the pixel values. Both methods try to detect patterns in small window or restricted area.