Noise Suppression

Testing the Effects of 3 Noise Suppression Algorithms

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CIS4720 Assignment 1
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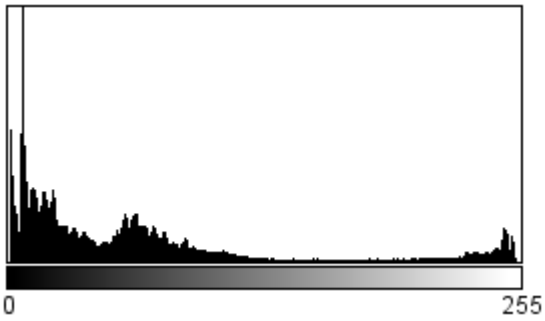
PART I

<table>
<tr>
<td>  </td>
<td> 

This image is slightly under exposed, equalising the histogram to improve contrast made the image brighter.</td>
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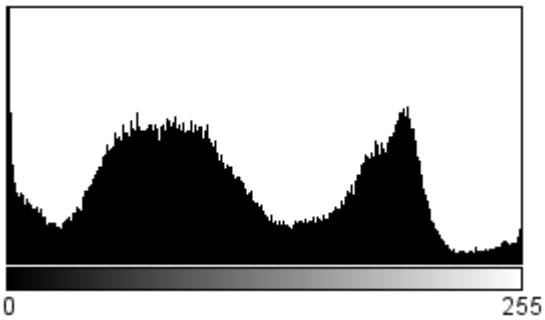
<td> 

Due to the dog’s motion, this image is blurry. Some processing could be done to make it better but the blurriness is too severe to fully correct it automatically.</td>
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This image is noticeably tinted blue, indicating improper white balance. Colours could be rebalanced to remove some of the blue tint.</td>
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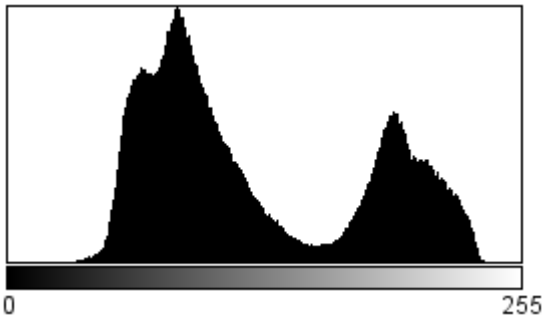
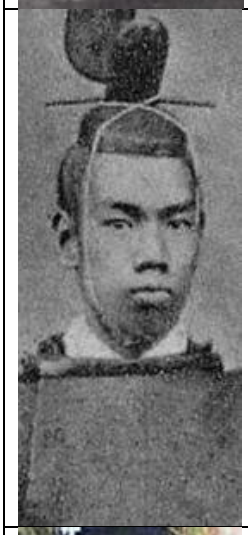
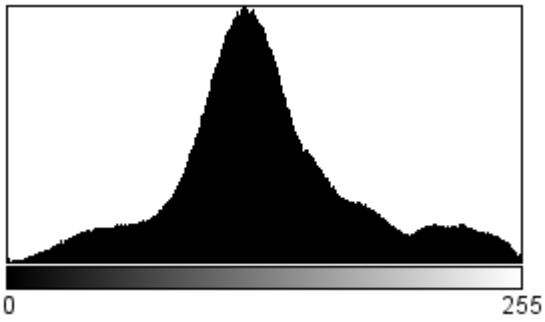
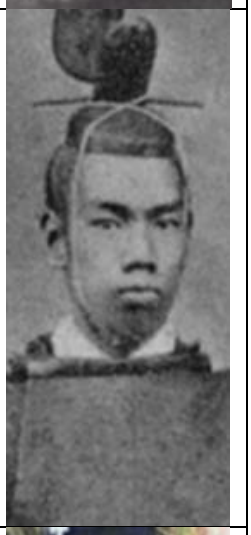
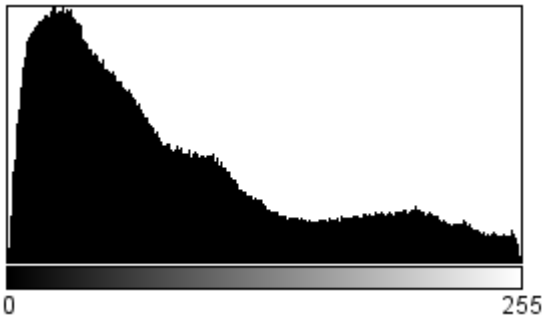
	 Like many old images, a lot of capture noise is present as well as many compression artifacts. Running a smoothing algorithm will reduce this noise.	
	 Again, old image, but just capture noise, no compression artifacts. Same smoothing algorithm.	
	 The enemy when trying to find good wallpapers, compression artifacts. They're everywhere on this image, and smoothing makes it sort of better.	

PART II

I tested three different algorithms on six images to observe the differences between them. The algorithms tested where a truncated median filter, a mean filter, and the Nagao-Matsuyama smoothing.

Truncated Median Filter

This filter functions by measuring the values of the pixels present in a window that slides across the image being processed. The value of the pixel the window is centred on will be replaced with the truncated median of those values (truncated meaning that outliers have been trimming off the ends of the list of values.)

Mean Filter

Like the above, a window is iterated across an image, but the value of the pixel the window is centred on is replaced with the simple mean (average) of the pixels in the window.

Nagao-Matsuyama

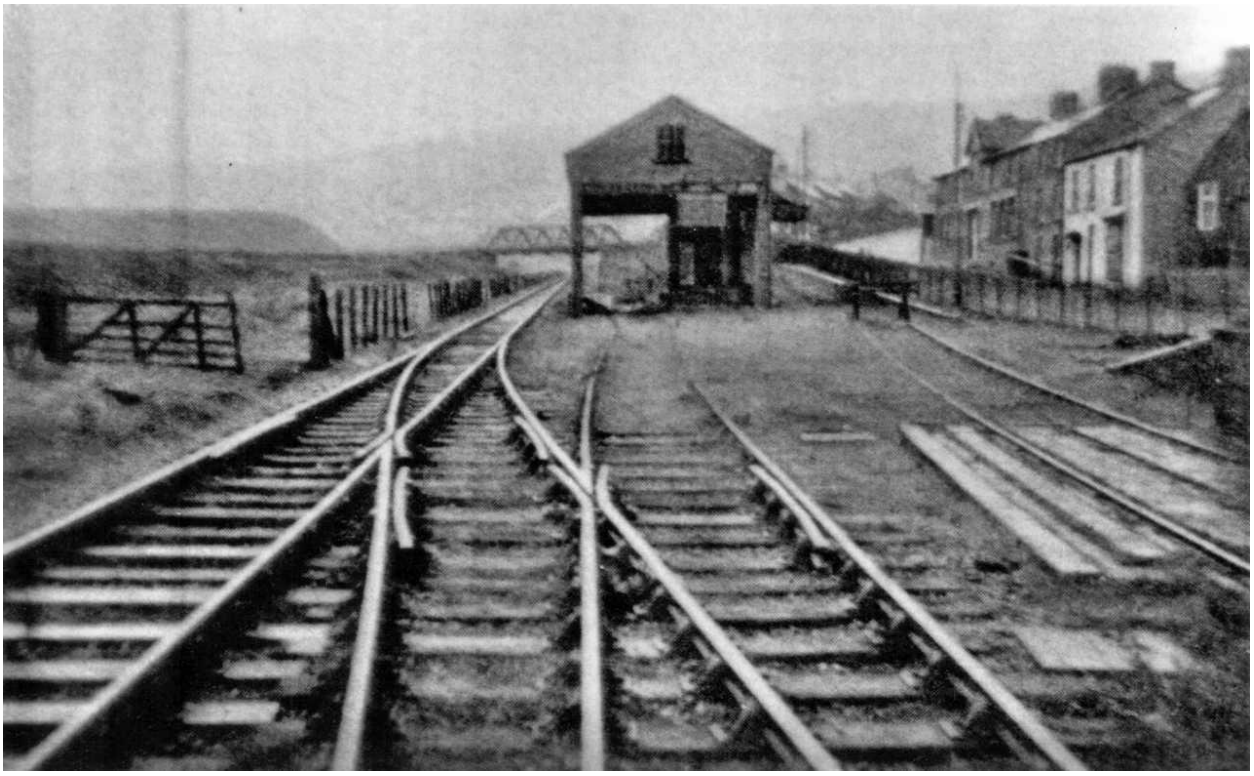
Uses a window centred on a pixel that is further segmented in smaller subwindows. The mean value of each of these subwindows is calculated, as well as the variance between the values of the pixels. The mean value from subwindow that is the most homogenous (has the lowest variance) is used to set the value of the centre pixel.

Images

Now we can examine the affects these algorithms had on different images. First, beginning on the following page I'll show the images used and their processed results, following which I'll discuss the results and the metrics derived from each of the images.

Image 1 – noisy1.jpg

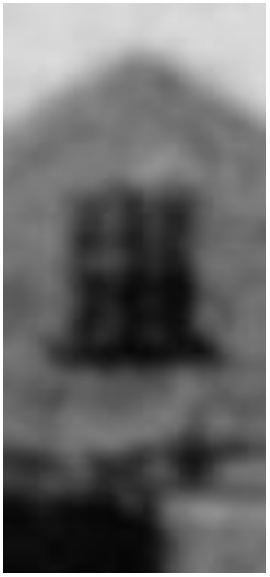
Here we have an image of set of rails and a what looks to be a basic freight station and some houses on the right. This image is absolutely inundated with compression induced noise and artifacts.



Base Image

Truncated Median

Mean



Nagao-Matsuyama

Image 2 – noisy2.jpg

Here, an image of a store front accompanied by three people contains a fair amount of Gaussian noise.

Base Image

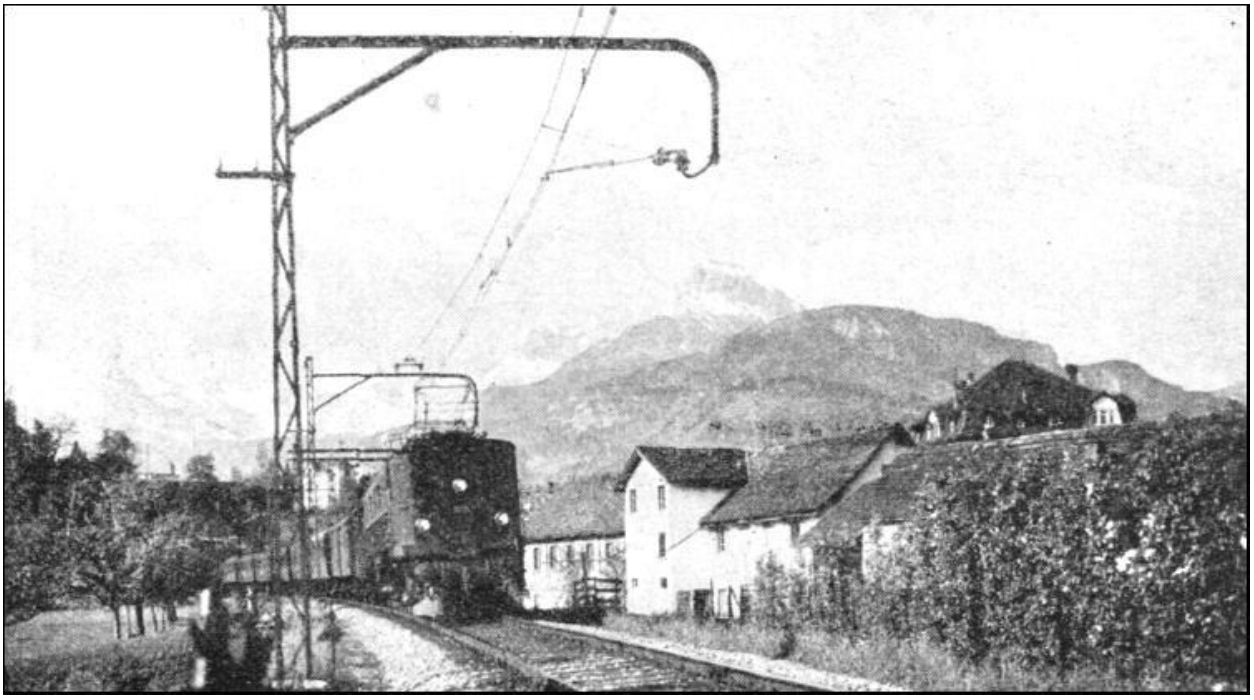
Truncated Median

Mean

Nagao Matsuyama

Image 3 – noise_1.jpg

Another set of rails, this time with a train on them. This image is also covered in compression artifacts.



Base Image

Truncated Median

Mean

Nagao-Matsuyama

Image 4 – noise_2.jpg

More train. This image contains a lot of Gaussian noise.

Base Image

Truncated Median

Mean

Nagao-Matsuyama

Image 5 – eg3_gaussianNoise.jpg

This image of an advertisement covered building has had Gaussian noise added to it artificially.

Original Image	Modified Image	Trunc. Median	Mean	N-M
				

Image 6 – photogravure.tif

The photo of this arch is much large than any of the other files used so far, and can give us a decent idea of the computation time difference between each of the algorithms. The image contains a fair bit of the graininess characteristic of old cameras.

Base Image

Truncated Median

Mean

Nagao-Matsuyama

Discussion

Each of the algorithms has a very different effect on the image they are applied to. The following table shows the Noise Estimation Index of all 24 images.

	noisy1	noisy2	noise_1	noise_2	photogravure	eg3
Base Image	4.26	217.25	5.80	14.14	19.68	569.86
Trunc. Med.	3.88	8.99	2.04	2.96	3.51	8.73
Mean	1.00	2.26	1.00	1.00	1.00	3.10
Nagao-M	9.85	48.85	4.88	7.85	11.29	56.98

In each image, all 3 algorithms reduced the amount of noise present. The one exception to this is noisy1, where Nagao-Matsuyama increased NEI. Mean filtering easily did the best job of reducing noise, but the price being significantly less detail. The smoothing created by mean made each image look very blurry, which is less than ideal. In the large photogravure.tif file, the blurriness created is “hidden” by the sheer number of pixels, allowing for dicernable features to still be found when the image is fully zoomed out, though the image still does look less harp.

Truncated median has a similar blurring effect, but is much better at maintaining edges and other features of each image. As well, it also does performs best in the large .tif file, where the drawback of the algorithm (still the quite noticeable blurriness) is obfuscated by the size of the image.

Nagao-Matsuyama does the best of maintaining edges and details, but at the cost of making the image look patchy. Patches of the same shade appear throughout the processed images, all with unique shapes that together form the basis of the image. It gives the processed images an almost painted look to them, even the .tif file looks more like a painting than a photo after being run through Nagao-Matsuyama

It seems to be difficult to devise an algorithm that runs in a reasonable amount of time to not introduce a defect into the image while eliminating the desired original defect. These three alone made the image blurry or look artificial, and while a sharpening algorithm can reduce the blurriness, that can just move the image further away from the reality it captured.