Introduction to Multimedia Computing

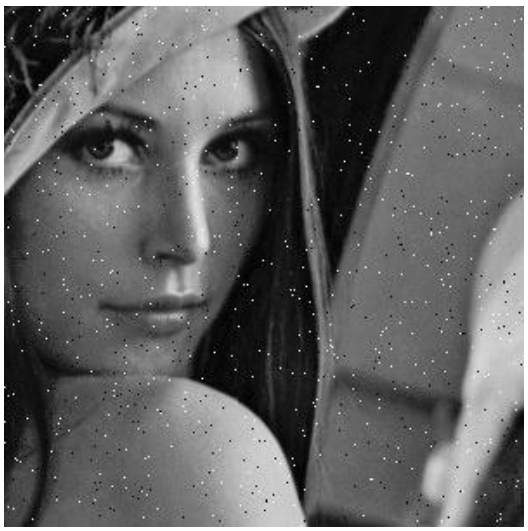
Project 4 Report

Shivam Patel and Mason Simpson

Introduction

The purpose of this project was to calculate different metrics for Lena.jpg and Lena_noise.jpg, as well as implement different noise reduction techniques as well as our own noise detection algorithm. The original images are shown below:

Lena.jpg



Lena_noise.jpg

MSE, SNR, PSNR Calculation

The first part of the program computed the following metrics for Lena_noise.jpg:
MSE - Noise distortion error
SNR - Noise relative signal strength
PSNR - Visual quality degradation

These metrics will be used to compare the effectiveness of the different noise reduction techniques. The results for Lena_noise.jpg are shown below:

```
===== Lena_noisy.jpg =====
MSE: 235.088144
SNR: 16.881154 dB
PSNR: 24.418496 dB
```

3x3 Average Filter to Reduce Noise

The first noise reduction technique applied to Lena_noise.jpg was a 3x3 average filter. The result of this filter is shown below:

The metrics for this filter are shown below:

```
===== Lena_averaged.jpg =====
MSE: 40.043867
SNR: 24.568101 dB
PSNR: 32.105444 dB
```

As you can see, the MSE value decreased while the SNR and PSNR values increased, meaning that the filter was successful in reducing noise from Lena_noise.jpg.

3x3 Median Filter to Reduce Noise

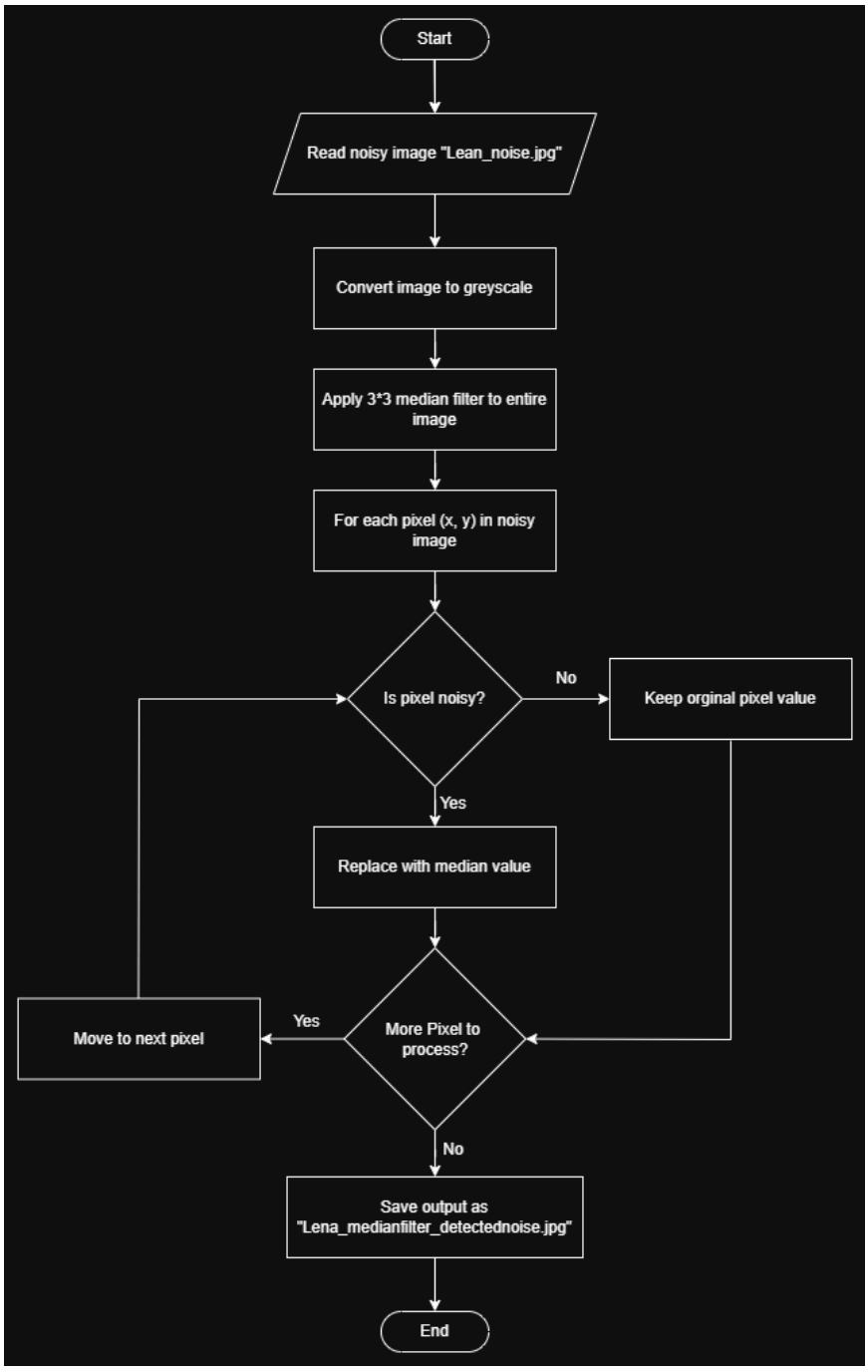
The second technique was a 3x3 median filter. The image and metrics for this filter are as follows:

```
===== Lena_median.jpg =====
MSE: 15.734956
SNR: 28.624806 dB
PSNR: 36.162148 dB
```

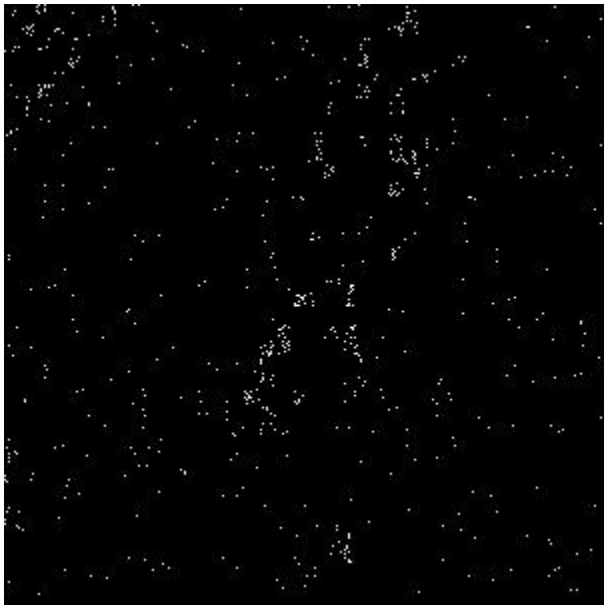
These results show that the median filter was more effective than the average filter, as the MSE value is lower and the SNR and PSNR values are higher.

Noise Detection and Removal Algorithm

The next portion of the project asked us to design an algorithm to detect the noises and then remove them using a median filter. The flowchart for the algorithm that we designed is shown below:



Our algorithm removed the noise from Lena_noise.jpg and saved that noise as a separate image, which you can see below:



We then applied the median filter on the detected pixels from above, and the resultant image is shown below as well as the metric values for the image:

```
===== Lena_median_selective.jpg =====
MSE: 122.008578
SNR: 19.729557 dB
PSNR: 27.266900 dB
```

While our algorithm did succeed in removing some noise (the metrics are better than the original image), it was not as effective as the other filters we applied to it earlier. The effectiveness of our filter in comparison to the original image is shown below:

```
===== Effectiveness Assessment =====
Difference in MSE: 113.079567 (48.100923%)
Difference in SNR: 2.848404 dB (16.873276%)
Difference in PSNR: 2.848404 dB (11.664943%)
```

Based on these metrics, our algorithm is partially effective. While it succeeded in removing 48% of the noise from the image, it could be a lot more effective as it left behind 52% of the noise. It works, but it needs to work a lot better for it to be useful.

	Lena_noise.jpg	Lena_average	Lena_median	Lena_medianfilter_detectednoise
MSE	235.088144	40.043867	15.734956	122.008578
SNR	16.881154	24.568101	28.624806	19.729557
PSNR	24.418496	32.105444	36.162148	27.266900

	Lena_noise.jpg	Lena_medianfilter_detecednoise	Difference	Difference%
MSE	235.088144	122.008578	113.079567	48.100923%
SNR	16.881154	19.729557	2.848404	16.873276%
PSNR	24.418496	27.266900	2.848404	11.664943%