DIP Lab 4 Report

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I. Question 1

Figure Q4_1_1 are distorted by pepper noise, while Q4_1_2 by salt noise. For this two figures, I use median filter to reduce the noise.

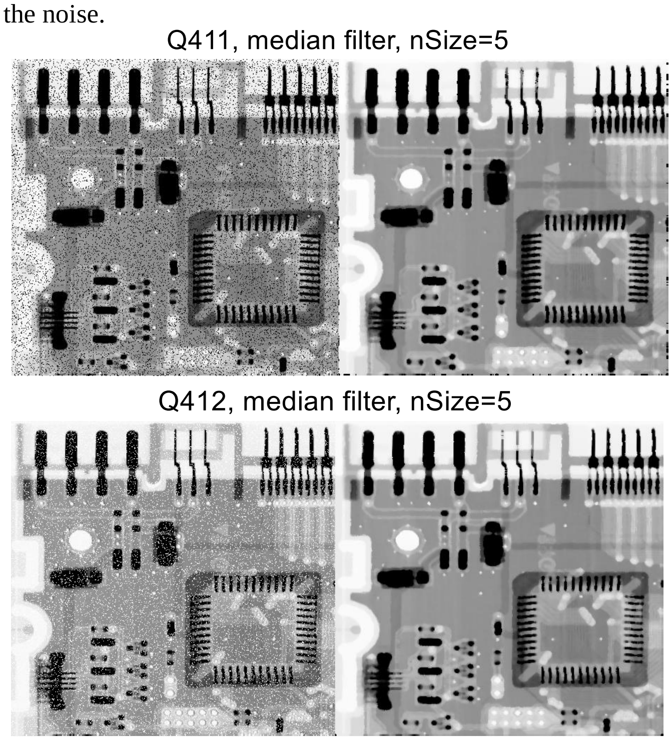

Figure 1, Q411 and Q412

For figure Q4_1_3, it seems to be the Gaussian noise, so I use adaptive median filter to reduce the noise.

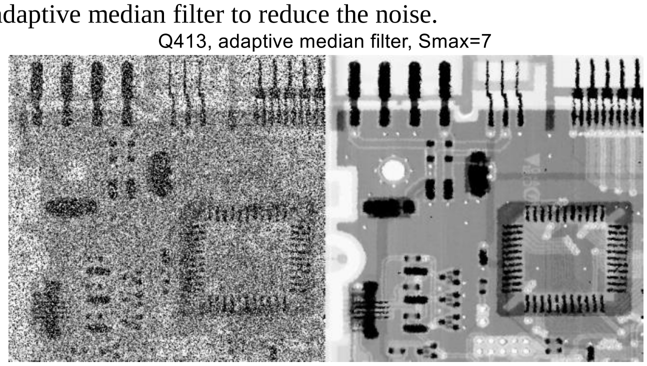

Figure 2, Q413_11510478.tif

For figure Q4_1_4, it is likely to be the combination of Gaussian and SAP noise. My first idea is to use the cascade of adaptive median filter, then arithmetic median filter. However, the result doesn't seem to be acceptable. A better result can be made by altering the second median filter by a geometric mean filter.

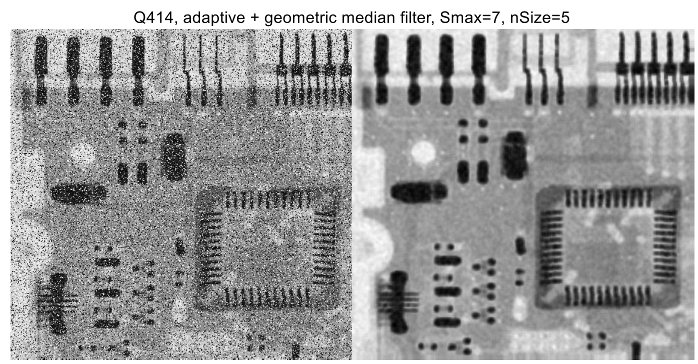

Figure 3, Q414_11510478.tif

I didn't use the contraharmonic mean filter, because this filter needs to be manually adjusted for pepper or salt noise,
For contraharmonic mean filter, when $Q > 0$, the numerator is greater than denominator, so it is suitable for pepper noise; When $Q < 0$, it is the opposite circumstance.

For adaptive, local noise reduction filters, according to slide 36's behaviors, the global variance σ_n^2 is to be compared with the local variance. If the estimated global variance $\sigma^{2\prime}$ is larger than actual value, the local variance needs to be larger to return a value close to the original value. Since the noise are more likely to have high variance, more noise components will be remained not reduced.

II. Question 2

The full inverse filtering is simply implemented by multiplying the inverse of the degradation function.

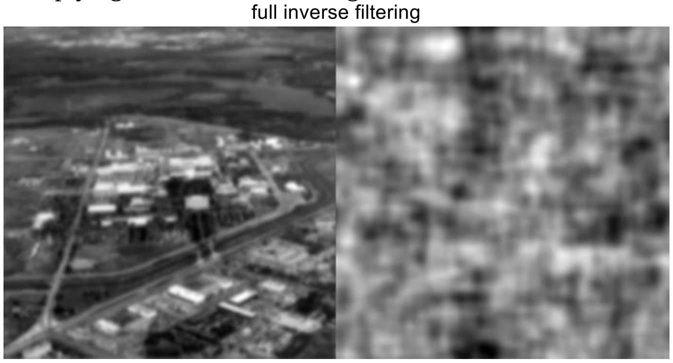

Figure 4, Q421_11510478.tif

As discussed in the slides, direct multiplication will act as a highpass filter, hugely amplifies the high frequency noise. Therefore, we use a Butterworth lowpass filter to limit the frequency components.

Figure 5, Q422_11510478.tif

Now we can clearly see the details from this restored image. It is important to mention that the cutoff radius can hugely affect the result:

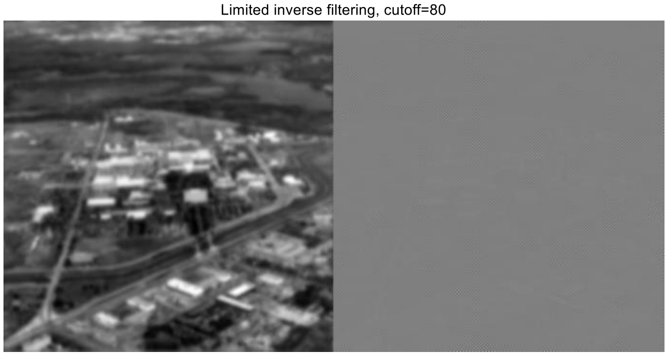

Figure 6, bad example

This happens we our cutoff frequency mistakenly allowed the noise signal frequency to be remained. When using limited inverse filtering, we must be careful of the range, and precisely select the part we want.

We can also use Wiener filtering to implement image restoration. Since we have the degradation function already, now we have to change the algorithm of computing the estimated original value.

Figure 7, Q423_11510478.tif

The value of K refers to the ratio of the noise power spectrum and the original image's power spectrum. Since we have no method to obtain these two parameters, we have to manually adjust the value of K to obtain the best result.

I chose K=0.001 after testing many values. This shows that the noise signal only has a small power, comparing to the image signal, which we can see from the blurred signal that the noise doesn't take the dominant.

Comparing the result of limited inverse filtering, we can see the Wiener filter gives a more sharpened, detailed result.

Another advantage is that the parameter of Wiener filter does not change the result so abruptly. The result of K = 0.1 to K = 0.00001 are all acceptable, not like limited inverse filtering.

III. QUESTION 3

The figures of question 3 are blurred images further corrupted by AWGN signal. However, even though the text book say that they can be restored by a single blurring degradation function, I failed to do so. I've tested K values from 1e-10 to 1e10, and only the third image could be slightly restored.

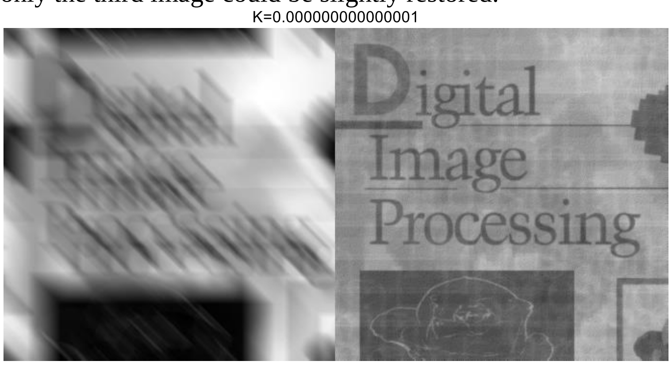

Figure 8

Then I tried to use an adaptive mean filter before Wiener filter, in order to remove the AWGN signal first. The results are also unsatisfying:

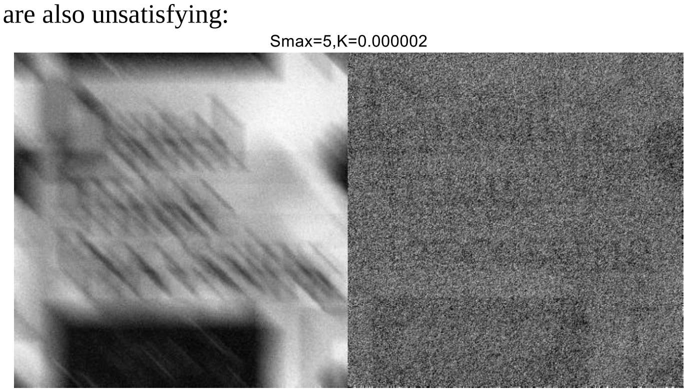

Figure 9, Q432_11510478.tif

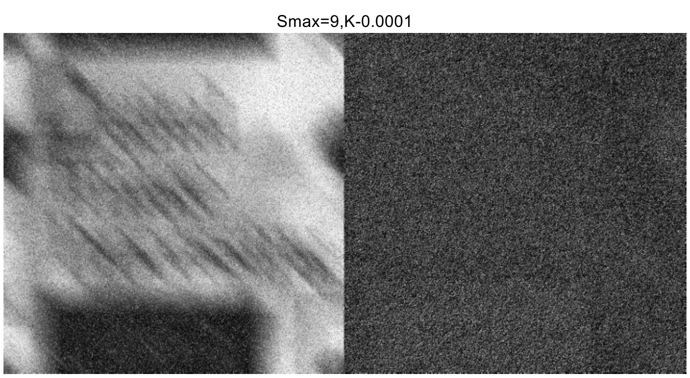

Figure 10, Q431_11510478.tif

The images are not recognizable.

I've tried to let the degradation function be the product of two functions, one for AWGN, and another for blurring, but the result is not good either.