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Report

Digital Image Processing

« Assignments »

2014-2015

Summary

A. Image restoration

A.1 Problem statement

Suppose a blurring degradation function as

$$H(u,v) = T \times sinc(ua + vb) \times e^{-j\pi(ua+vb)} \tag{A.1}$$

(a) Implement a blurring filter using the equation above.

(b) Blur the test image book_cover.jpg using parameters $a = b = 0.1$ and $T = 1$.

(c) Add Gaussian noise of 0 mean and variance of 650 to the blurred image.

(d) Restore the blurred image and the blurred noisy image using the inverse filter, Wiener deconvolution filter and the parametric Wiener filter, respectively.

(e) Add Gaussian noise of 0 and different variances to the blurred image and repeat (d), investigate the performance of the Wiener deconvolution filter.

A.2 Python implementation

Usage : **problem5.py [-h] [–blurred BLURRED] [–noise] [-s S] [–inv] [–wiener] [-a A] [-b B] [-T T] [-K K] image_path**

Use **python problem5.py -h** to see the help.

A.3 Blurring and noising

python problem5.py book_cover.jpg

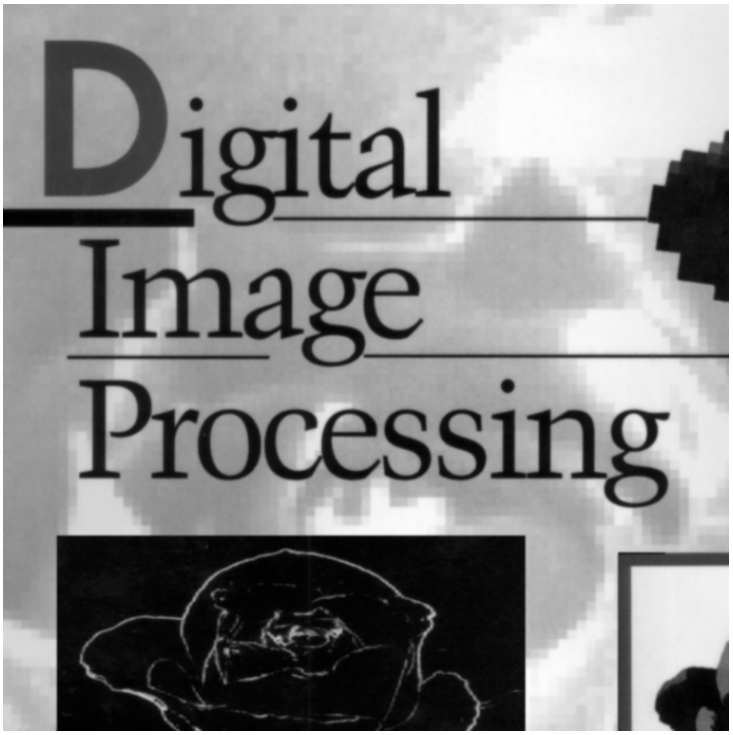

Figure A.1 – Original image

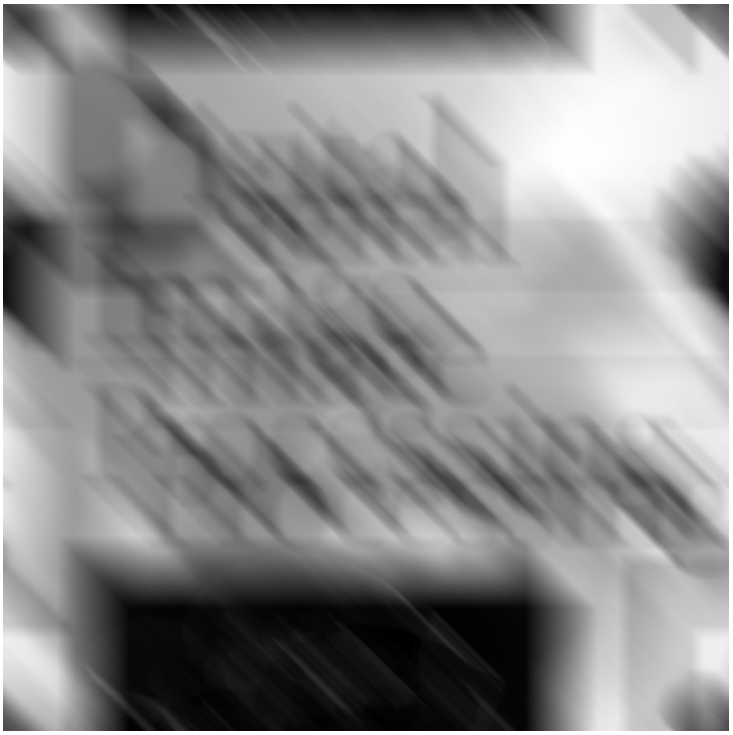

Figure A.2 – Blurred image ($a = b = 0.1; T = 1$)

python problem5.py book_cover.jpg –noise -s 650

Figure A.3 – Blur + Gaussian noise ($\mu = 0, \sigma^2 = 650$)

A.4 Restoration

A.4.1 Inverse filter

python problem5.py –inv book_cover.jpg
python problem5.py –noise -s 650 –inv book_cover.jpg

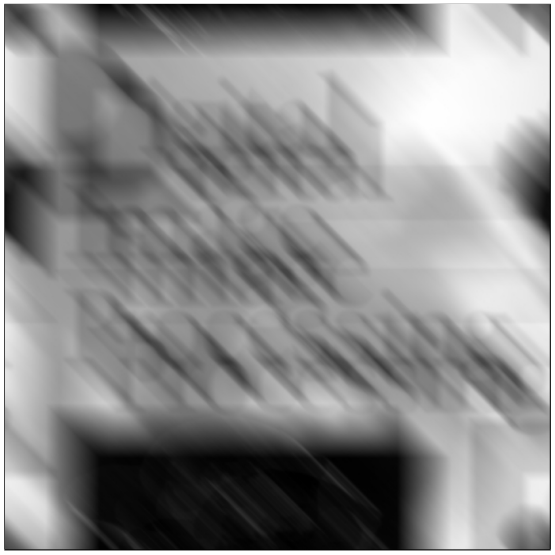

Figure A.4 – Blurred image

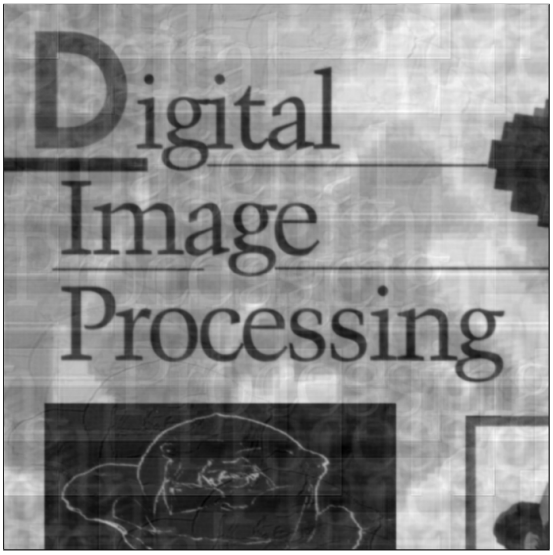

Figure A.5 – Inverse blurred image

Figure A.6 – Blur + noise

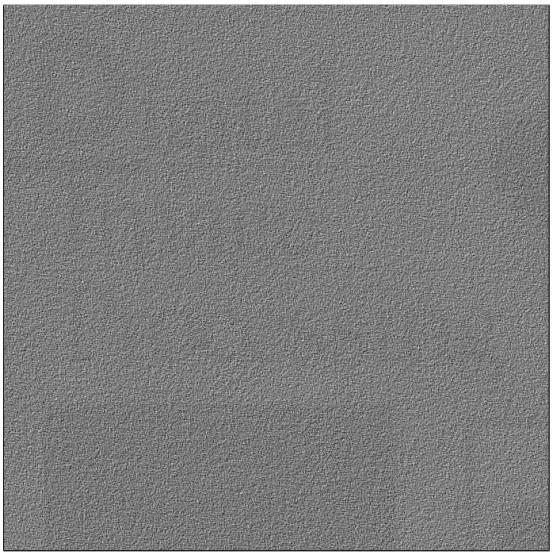

Figure A.7 – Inverse 'blur + noise'

The inverse filter is really affected by the noise because it ignores it (does not inverse it).

A.4.2 Wiener filter

python problem5.py –wiener book_cover.jpg
python problem5.py –noise -s 650 –wiener book_cover.jpg

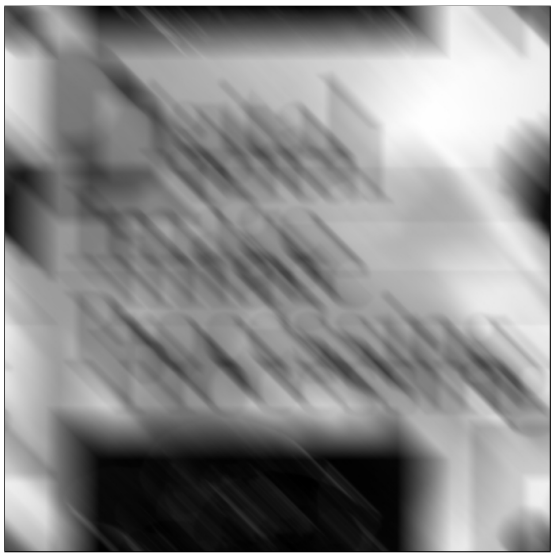

Figure A.8 – Blurred image

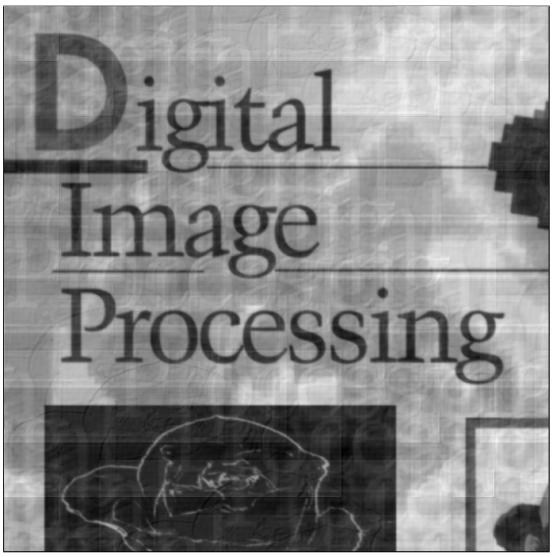

Figure A.9 – Wiener blurred image

Figure A.10 – Blur + noise

Figure A.11 – Wiener 'blur + noise'

The Wiener filter on the blurred image without noise is equivalent to the inverse filter (power spectrum of noise equals to 0).
The Wiener filter is more efficient to remove the noise as it takes it into consideration during the restoration process.

A.4.3 Parametric Wiener filter

TODO

A.4.4 Experimentations

Gaussian noise ($\mu = 0, \sigma^2 = 300$)

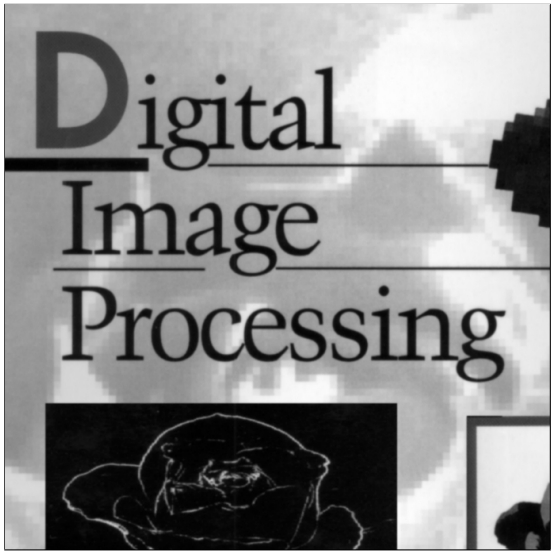

Figure A.12 – Original image

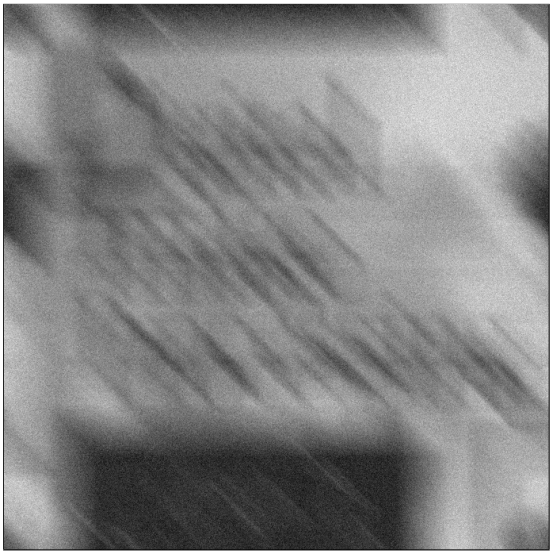

Figure A.13 – Blur + noise

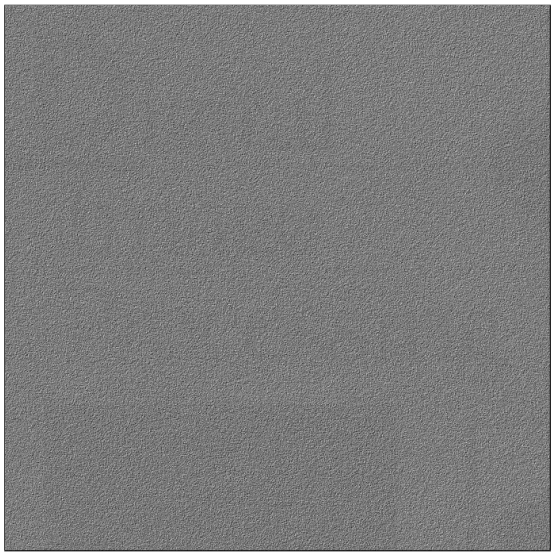

Figure A.14 – Inverse 'blur + noise'

Figure A.15 – Wiener 'blur + noise'

Gaussian noise ($\mu = 0, \sigma^2 = 100$)

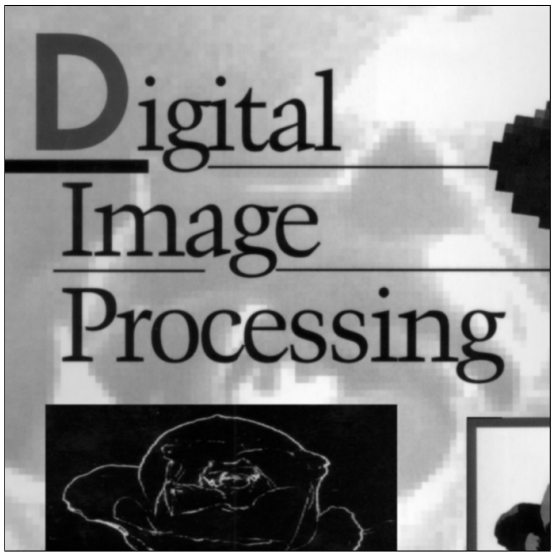

Figure A.16 – Original image

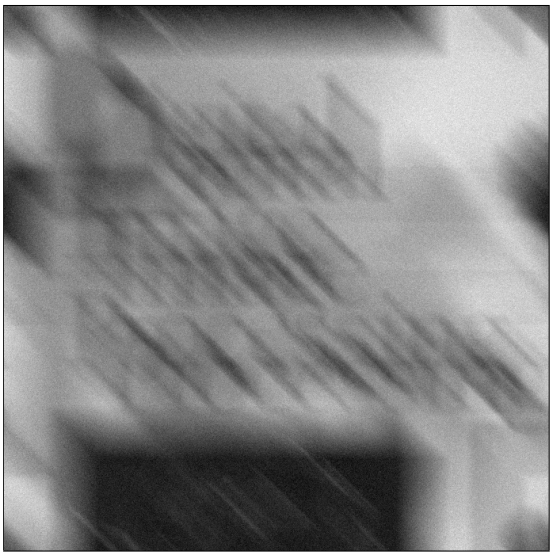

Figure A.17 – Blur + noise

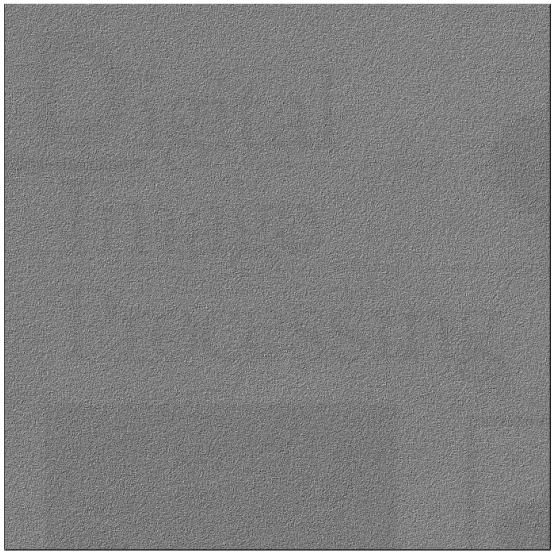

Figure A.18 – Inverse 'blur + noise'

Figure A.19 – Wiener 'blur + noise'

Gaussian noise ($\mu = 0, \sigma^2 = 30$)

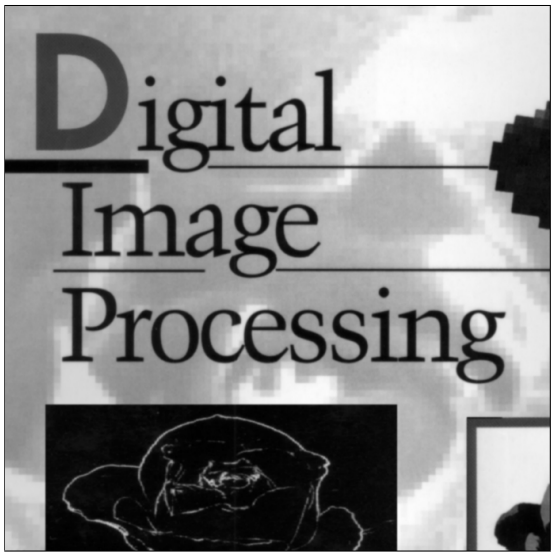

Figure A.20 – Original image

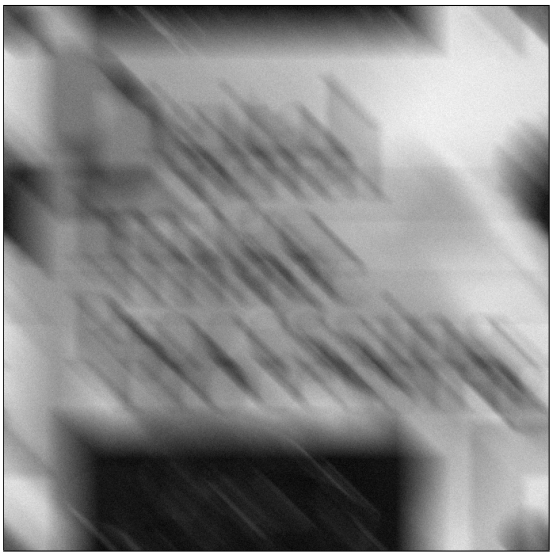

Figure A.21 – Blur + noise

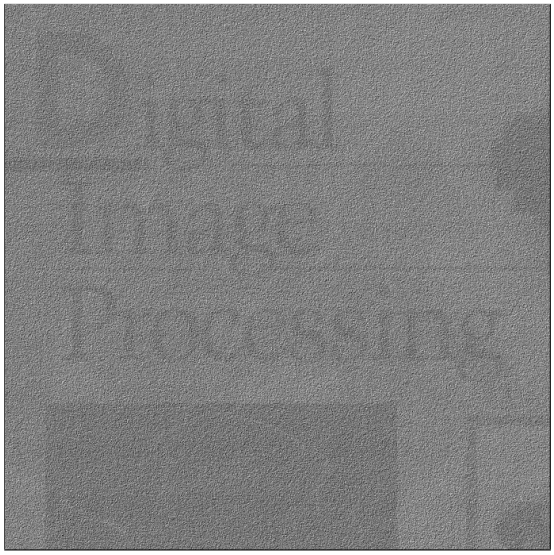

Figure A.22 – Inverse 'blur + noise'

Figure A.23 – Wiener 'blur + noise'

Wiener performance

Figure A.24 – Wiener 'blur + noise ($\sigma^2 = 30$)'

Figure A.25 – Wiener 'blur + noise ($\sigma^2 = 100$)'

Figure A.26 – Inverse 'blur + noise ($\sigma^2 = 300$)'

Figure A.27 – Wiener 'blur + noise ($\sigma^2 = 650$)'