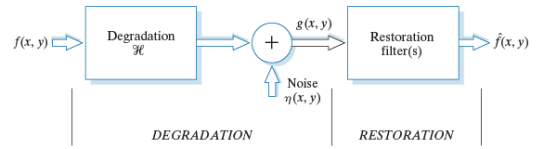


Image Restoration

Image Processing
CSE 166
Lecture 8

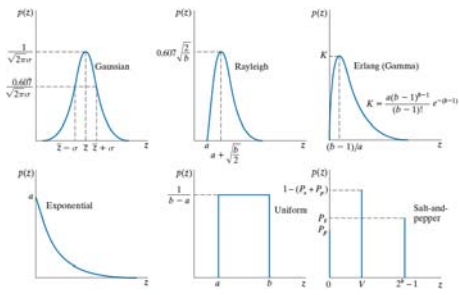
Model of image degradation, then restoration



CSE 166, Fall 2017

2

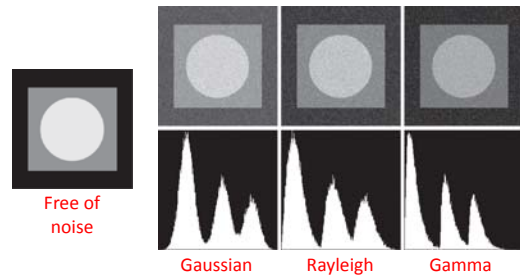
Noise modeled as different probability density functions



CSE 166, Fall 2017

3

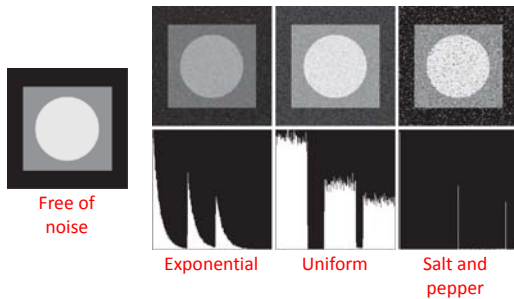
Adding noise from different models



CSE 166, Fall 2017

4

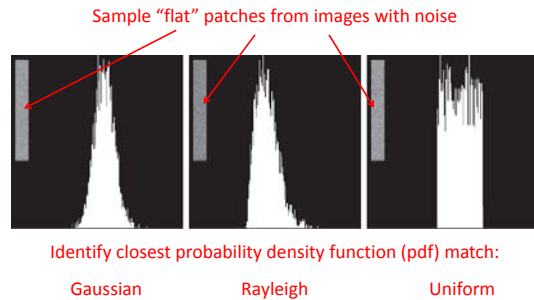
Adding noise from different models



CSE 166, Fall 2017

5



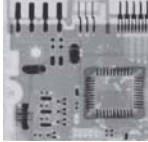
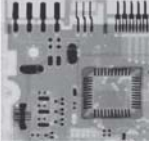
Histograms of sample patches



CSE 166, Fall 2017

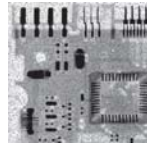
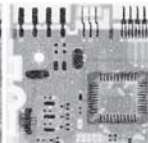
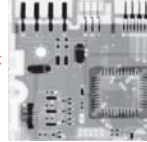
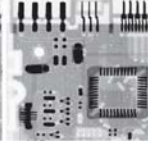
6

Mean filters

X-ray image			Additive Gaussian noise
Arithmetic mean filtered			Geometric mean filtered

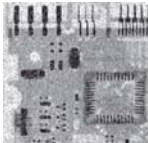
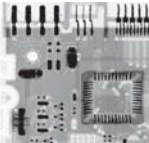
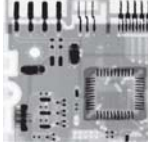
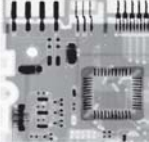
CSE 166, Fall 2017 7

Mean filters

Additive pepper noise			Additive salt noise
Contra-harmonic mean filtered			Contra-harmonic mean filtered


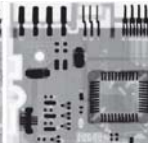
CSE 166, Fall 2017 8

Order-statistic filters

Additive salt and pepper noise			1x median filtered
2x median filtered			3x median filtered




CSE 166, Fall 2017 9

Order-statistic filters

Max filtered			Min filtered
--------------	---	--	--------------

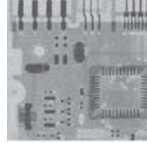
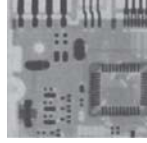
CSE 166, Fall 2017 10

Comparing filters

Additive uniform + salt and pepper noise		
Arithmetic mean filtered		Geometric mean filtered
Median filtered		Alpha-trimmed mean filtered

CSE 166, Fall 2017 11

Adaptive filters

Additive Gaussian noise		Arithmetic mean filtered
Geometric mean filtered		Adaptive noise reduction filtered

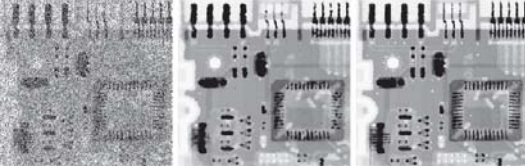
CSE 166, Fall 2017 12

Adaptive filters

Additive salt and pepper noise

Median filtered

Adaptive median filtered

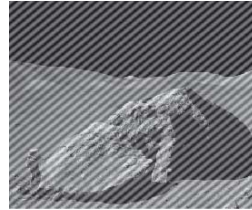


CSE 166, Fall 2017

13

Periodic noise

DFT magnitude



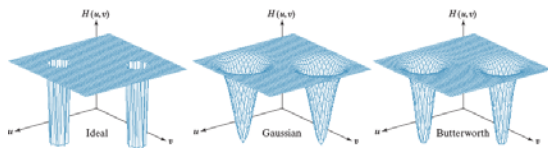
Additive sinusoidal noise

Conjugate impulses

CSE 166, Fall 2017

14

Notch reject filters



CSE 166, Fall 2017

15

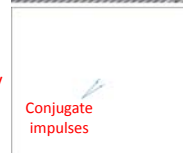
Notch reject filter

Degraded image



DFT magnitude

Filter in frequency domain



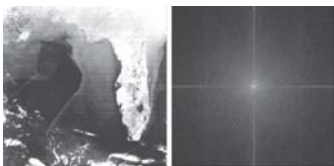
Estimate of original image

CSE 166, Fall 2017

16

Notch reject filter

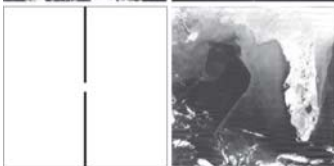
Degraded image



DFT magnitude



Filter in frequency domain



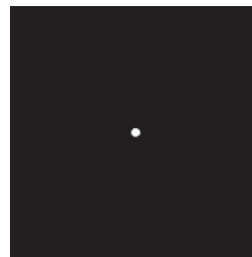
Estimate of original image



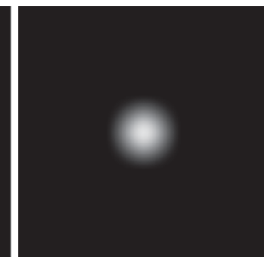
CSE 166, Fall 2017

17

Estimation of degradation function by experimentation



Impulse of light

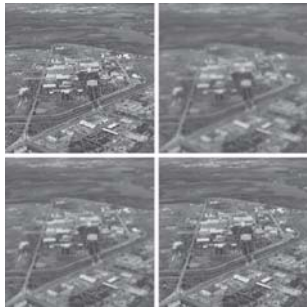


Imaged (degraded) impulse

CSE 166, Fall 2017

18

Estimation of degradation function by mathematical modeling

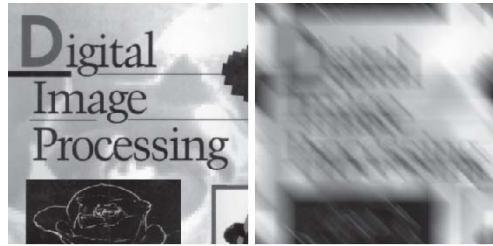


Atmospheric turbulence model

CSE 166, Fall 2017

19

Estimation of degradation function by mathematical modeling

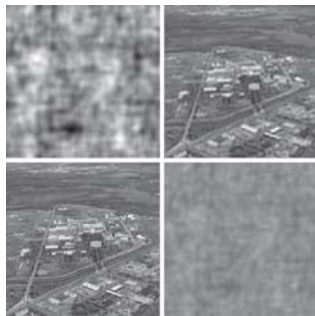


Motion blur model

CSE 166, Fall 2017

20

Image restoration



Inverse filtering

CSE 166, Fall 2017

21

Image restoration



Inverse filtering

Wiener filtering

CSE 166, Fall 2017

22

Image restoration

Degraded image Inverse filtering Wiener filtering Constrained least squares filtering

Motion blur and additive noise



23