Filter (Denoising)

이진영

Noise Generation

- Additive noise generation, based on a random function
- Image quality, depending on magnitude of error

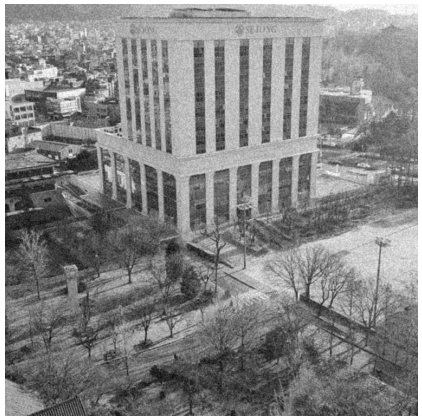
$$Y = Y \pm \alpha$$

```
Y += rand() % Err - (Err >> 1);
```

AICenterY.bmp

Err=15

Err=35



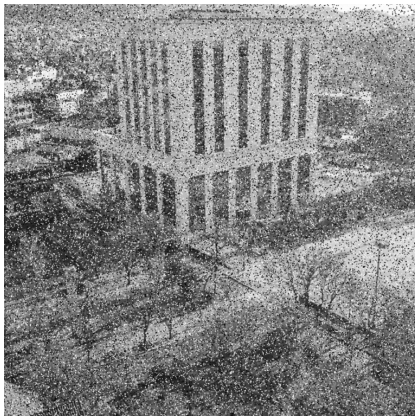
Err=55

PSNR?

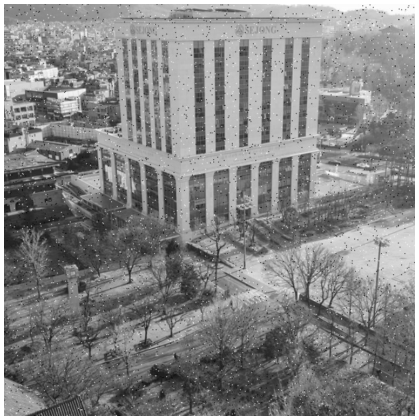
Salt-and-Pepper Noise

- Impulse noise
- White and black pixels

```
if ((rand() % prob) == 0) Y = 255;
else if ((rand() % prob) == 1) Y = 0;
else Y = Y;
```



prob=10



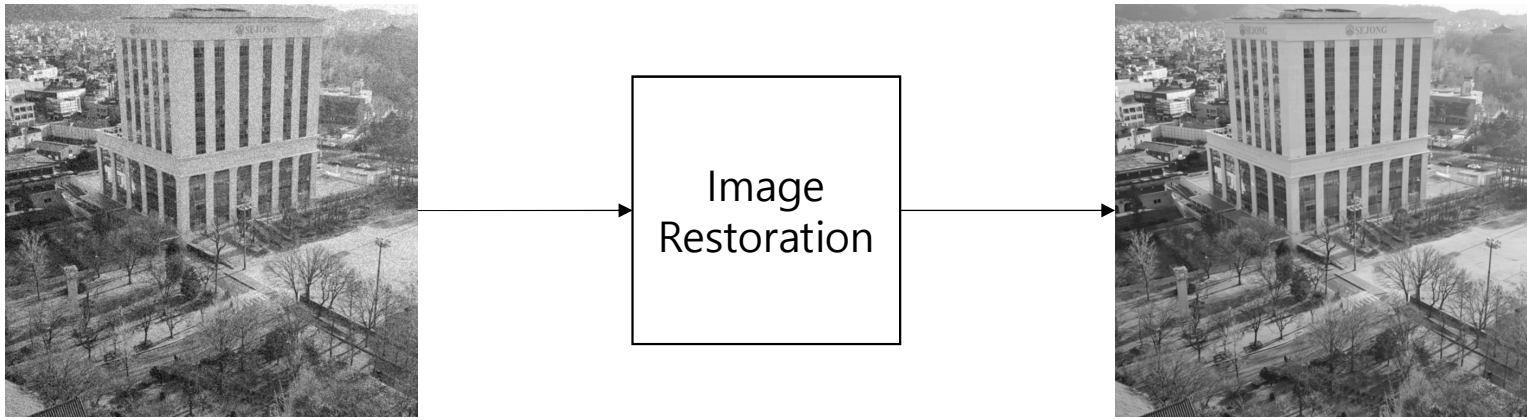
prob=100

prob=1000

PSNR?

Image Restoration

- Image processing for noise reduction (Denoising)
- Operation that obtains a high quality image from a corrupted image



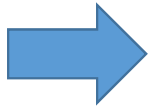
Low quality
(Corrupted)

High quality

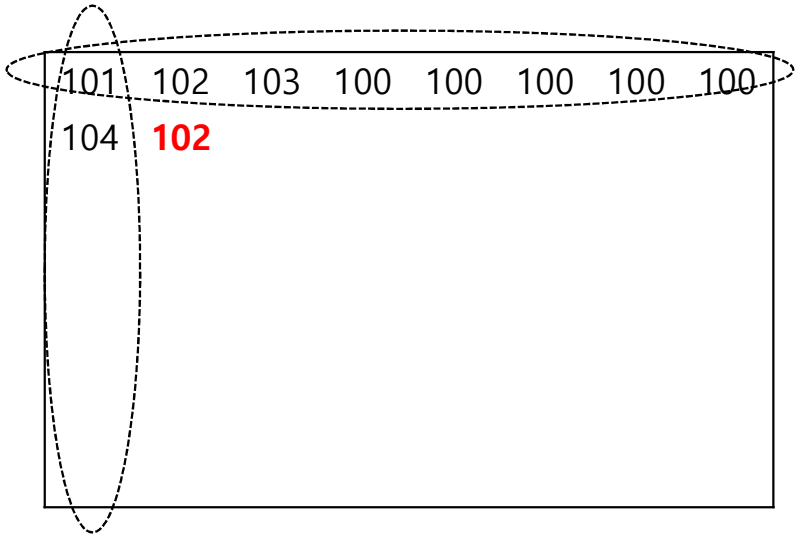
Median Filter

- Median of all pixels within a predefined window as a sliding-window spatial filter
- Mainly noise reduction, in particular, for salt-and-pepper noise

101	102	103	100	100	100	100	100
104	50	103	100	100	100	100	100
100	100	105	110	100	100	100	100
100	110	100	100	100	100	120	125
130	140	100	100	100	100	111	100
150	130	255	255	100	100	109	107
100	120	255	255	255	100	100	101
110	100	220	255	255	255	255	100



Additional processing for the boundary

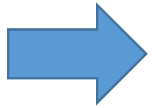


50, 100, 100, 101, 102, 103, 104, 103, 105

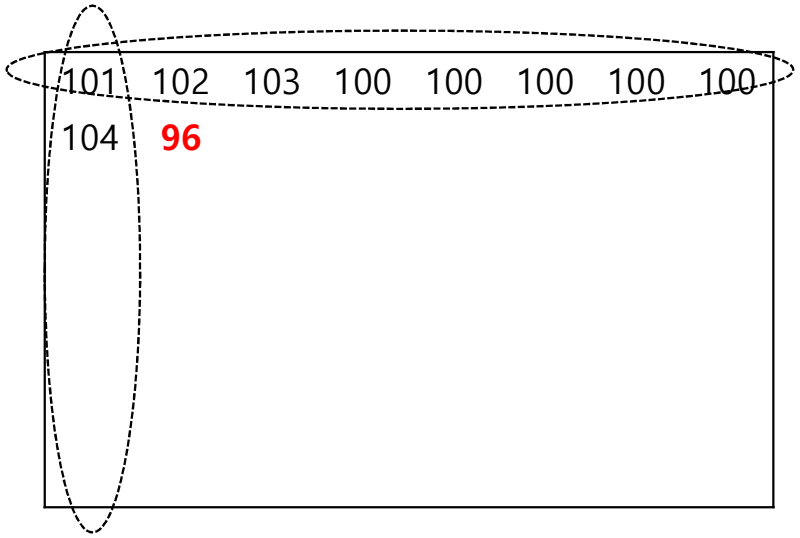
Mean Filter

- Average of all pixels within a predefined window as a sliding-window spatial filter
- Mainly noise reduction and smoothing

101	102	103	100	100	100	100	100
104	50	103	100	100	100	100	100
100	100	105	110	100	100	100	100
100	110	100	100	100	100	120	125
130	140	100	100	100	100	111	100
150	130	255	255	100	100	109	107
100	120	255	255	255	100	100	101
110	100	220	255	255	255	255	100



Additional processing for the boundary



(101+102+103+104+50+103+100+100+105) / 9 = 96.4

Various Filters

- Median filter
- Loss-pass filter, such as mean filter, Gaussian filter, weighted average filter…

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

Mean Filter

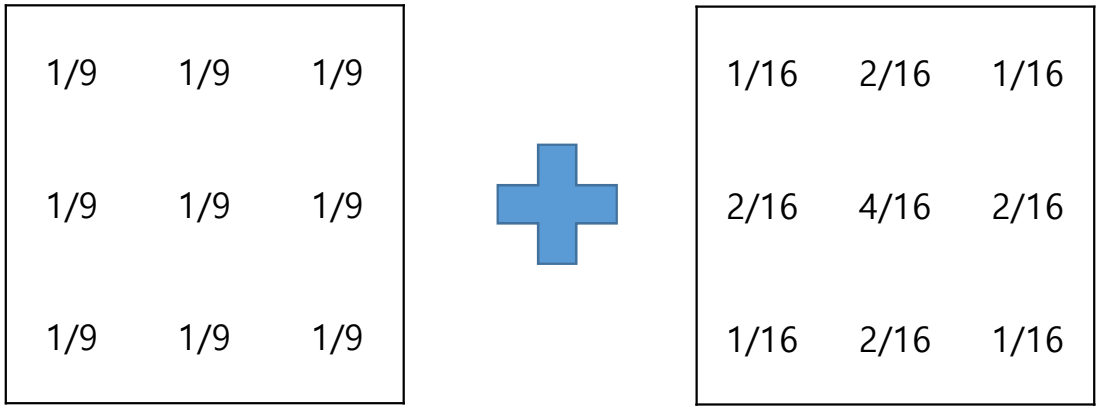
1/16	2/16	1/16
2/16	4/16	2/16
1/16	2/16	1/16

Gaussian Filter

1/273	4/273	7/273	4/273	1/273
4/273	16/273	26/273	16/273	4/273
7/273	26/273	41/273	26/273	7/273
4/273	16/273	26/273	16/273	4/273
1/273	4/273	7/273	4/273	1/273

Combination

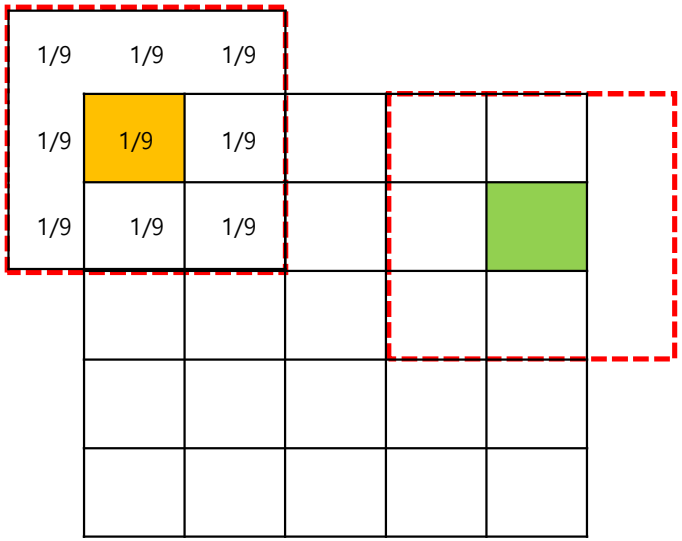
- Multiple filters for various noises within one image
- Multiple filtering on the image, for example, median filter and then mean filter…
- Filter combination, such as A+B filters, A+B+C filters, D+C+B+A filters…



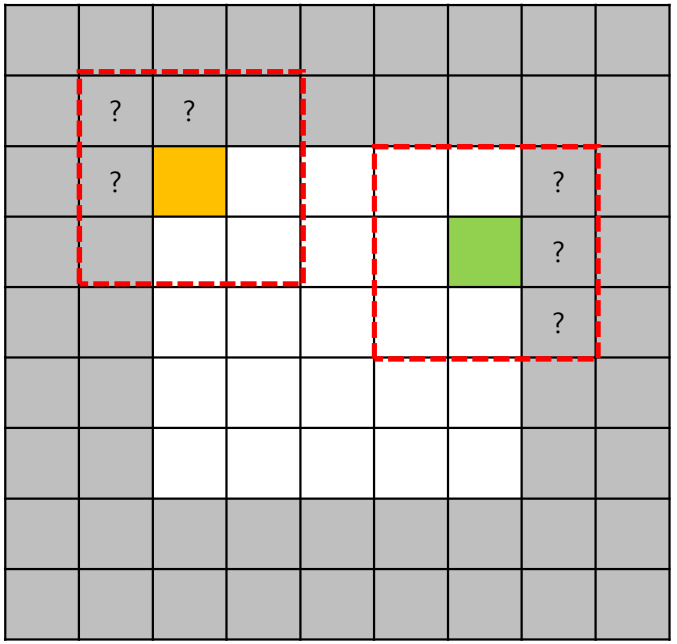
Filter Combination

Boundary Processing

- No processing or exceptional processing for image boundaries
- Various methods, depending on filter size, image characteristics…



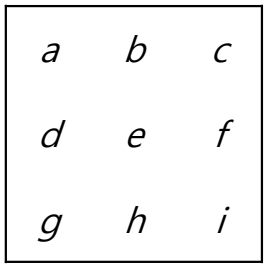
Padding



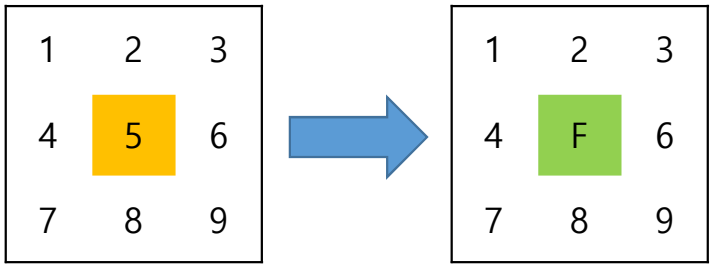
Filter Design

- Filter size and weight design, based on MSE and PSNR

No boundary processing



3×3 Filter



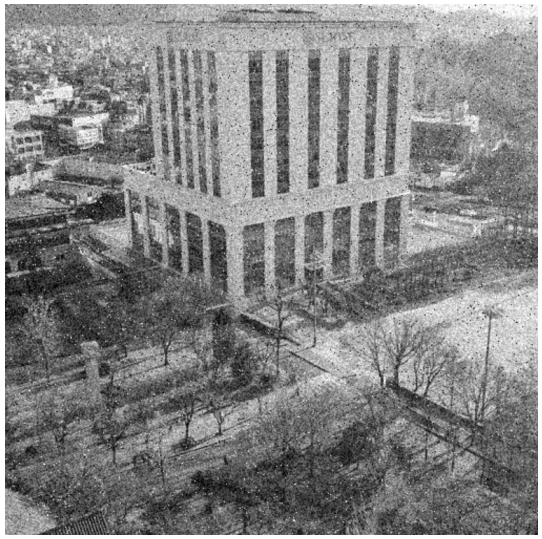
$F=1\times a+2\times b+3\times c+4\times d+5\times e+6\times f+7\times g+8\times h+9\times i$

$MSE=(5-F)^2/(3\times 3)$

Experiment

- AICenterY.bmp + Noise = AICenterY_CombinedNoise.bmp
- Please implement your filter and boundary processing method to reduce the noise

AICenterY.bmp



AICenterY_CombinedNoise.bmp

MSE = 999.35 (18.13dB)