15EEE337 Digital Image Processing

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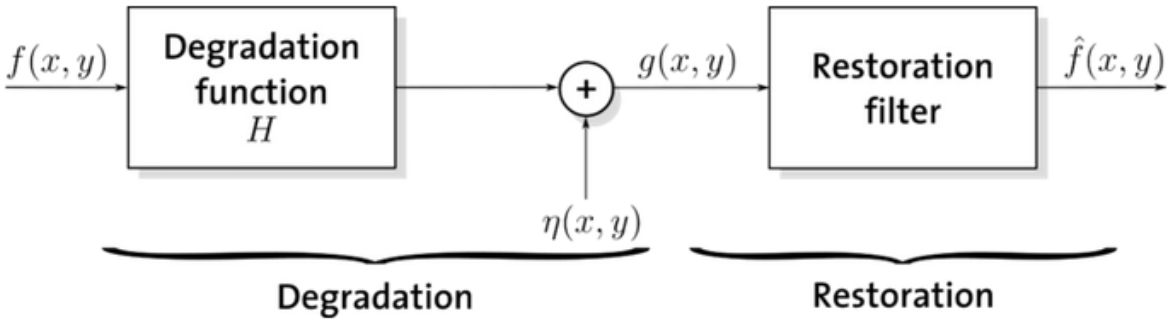
Last Lecture

- Image Transform
- Fourier Transform on Images
- Smoothing frequency domain filtering, sharpening frequency domain filtering

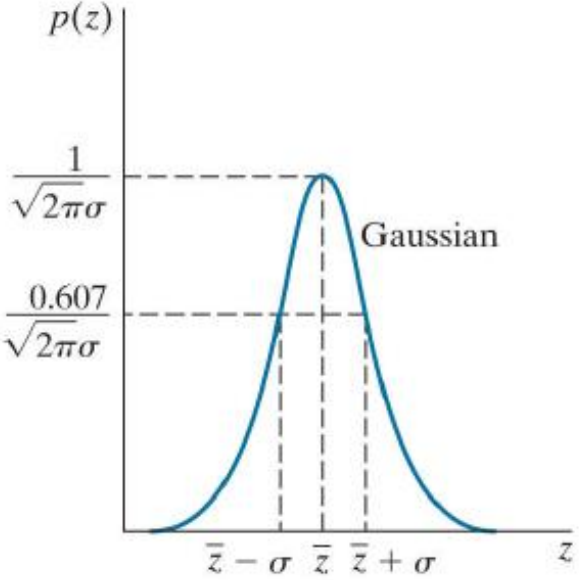
Image restoration

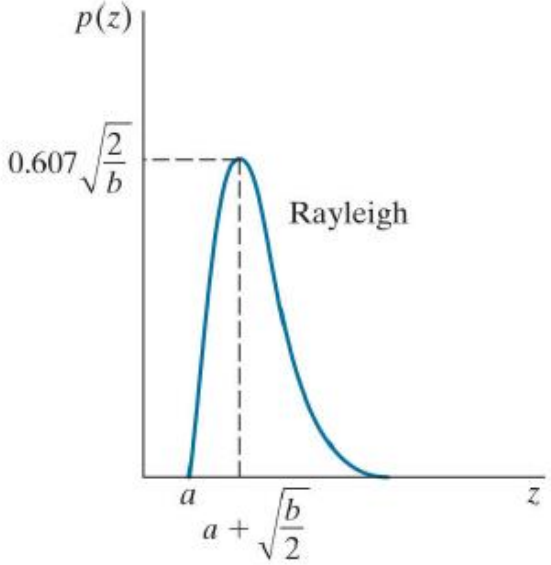
- Restoration-improve an image in some predefined sense.
- Image enhancement –Subjective
- Image restoration – Objective process
- Knowledge of the degradation process.
- Model the degradation and apply inverse process & recover original image

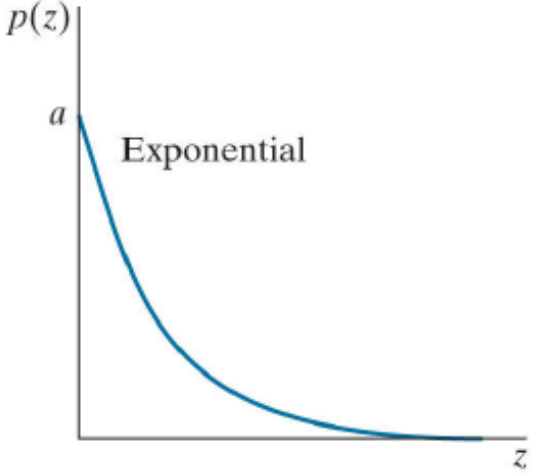


Noise Models

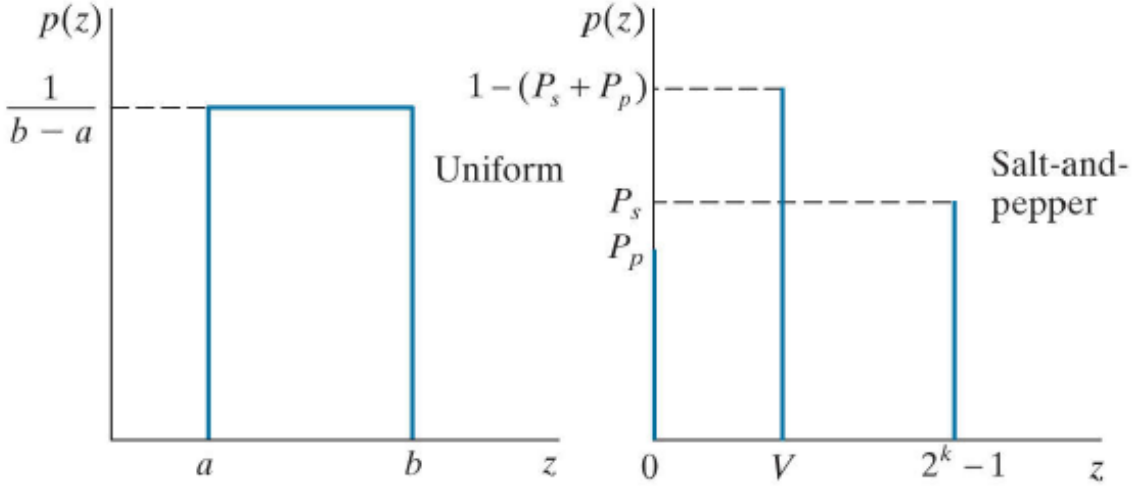
- Noise in images-image acquisition and/or transmission.
- Spatial & frequency characteristics of noise.
- Various noise probability density functions.
  - Gaussian
  - Uniform
  - Salt and pepper noise
- Noise component –same size as the input image.
- Array with intensity values –random numbers with a specified density function.







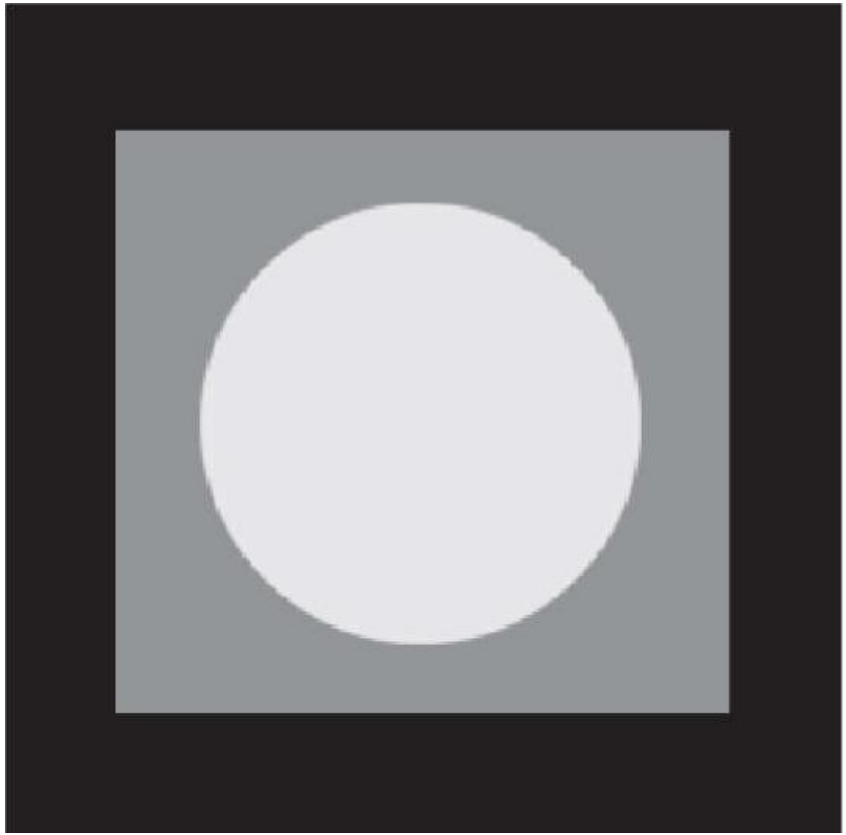
$$p(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(z-\bar{z})^2}{2\sigma^2}} \qquad -\infty < z < \infty$$



$$p(z) = \begin{cases} P_s & \text{for } z = 2^k - 1 \\ P_p & \text{for } z = 0 \\ 1 - (P_s + P_p) & \text{for } z = V \end{cases}$$

Two problems arise when trying to create the noise for a salt and pepper effect. Which pixels are to be changed with noise? How are these pixels changed?

- To solve the first problem, **a random number is generated between 1 and a final value**.
- *If the number is the final value, then the pixel will be changed with noise*.
- If the final number is larger, fewer pixels will be changed. As the number decreases, more pixels will be changed, thus making a noisier picture.
- To determine how the pixel is changed, **a random number is generated between 1 and 256** (max for grayscale values). This algorithm is implemented when the given pixel is noted to be changed. Instead of the original value of the pixel, it is replaced by the random number between 1 and 256.
- By randomizing the noise values, the pixels can change to a white, black, or gray value, thus adding the salt and pepper colors.
- By randomizing which pixels are changed, the noise is scattered throughout the image. The combination of these randomizations creates the "salt and pepper" effect throughout the image.



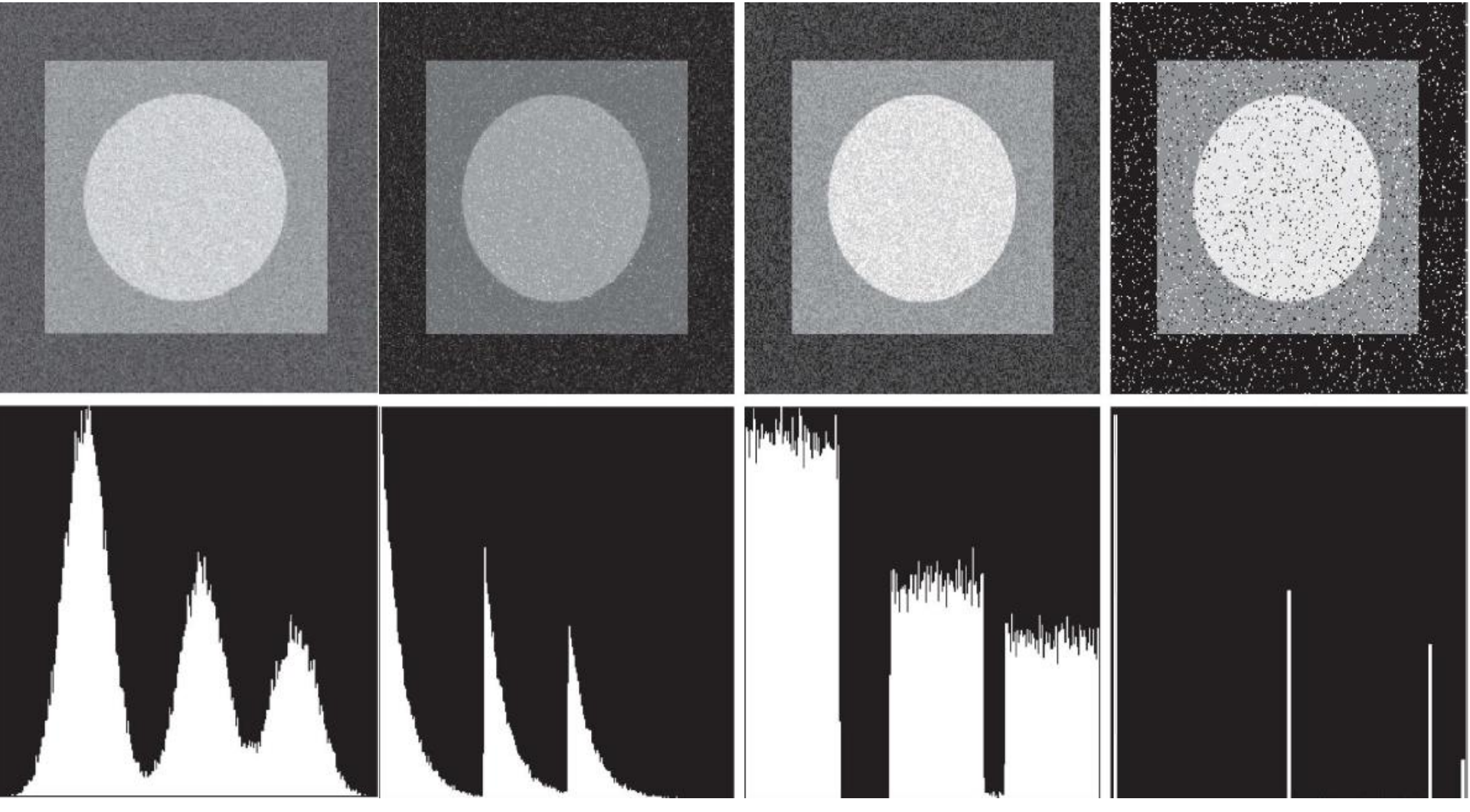


Image denoising

- When an image is degraded only by additive noise

$$g(x,y) = f(x,y) + \eta(x,y)$$

$$G(u,v) = F(u,v) + N(u,v)$$

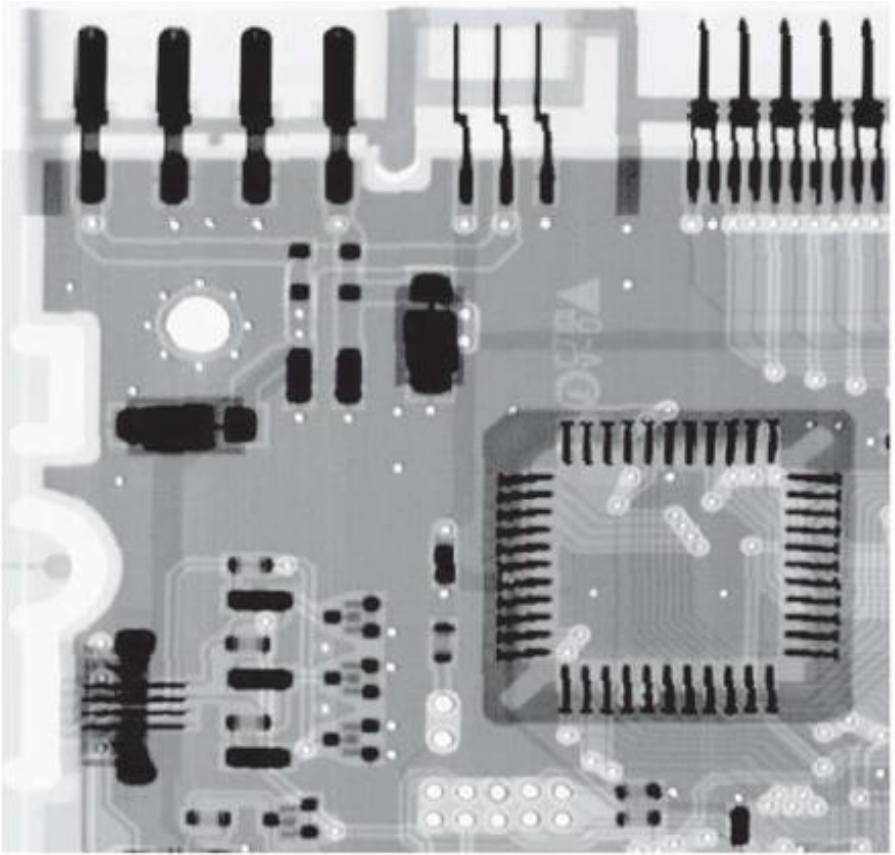
- The noise terms generally are unknown,
- Spatial filtering is the method of choice for estimating *f*(*x*, *y*) [i.e., *denoising* image *g*(*x*, *y*)] in situations when only additive random noise is present.

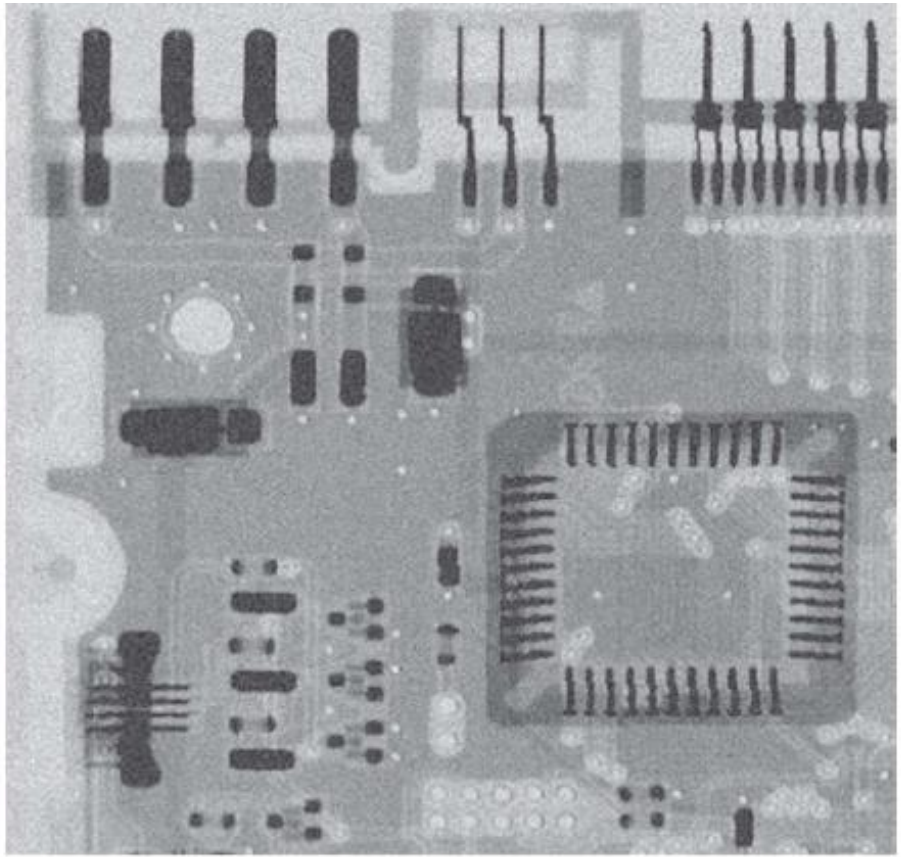
Mean Filters-Arithmetic Mean Filter

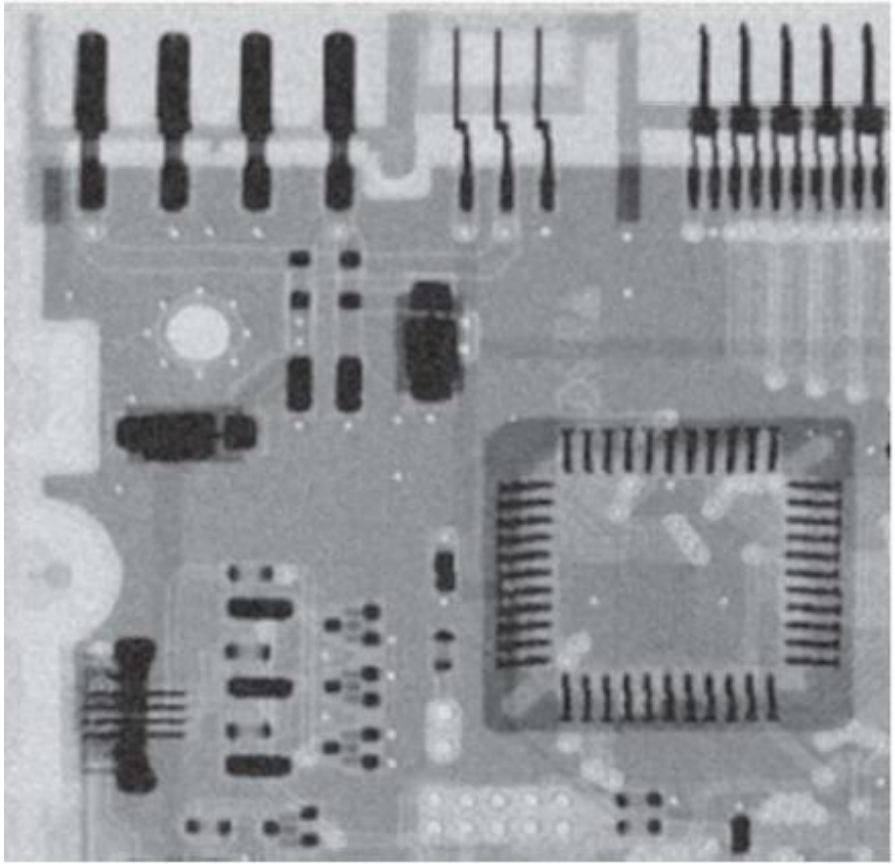
- The arithmetic mean filter is the simplest of the mean filters -same as the box filter.
- S_{xy} s

$$\hat{f}(x,y) = \frac{1}{mn} \sum_{(r,c) \in S_{xy}} g(r,c)$$

- A mean filter smooths local variations in an image,
- noise is reduced as a result of blurring.








THANK
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