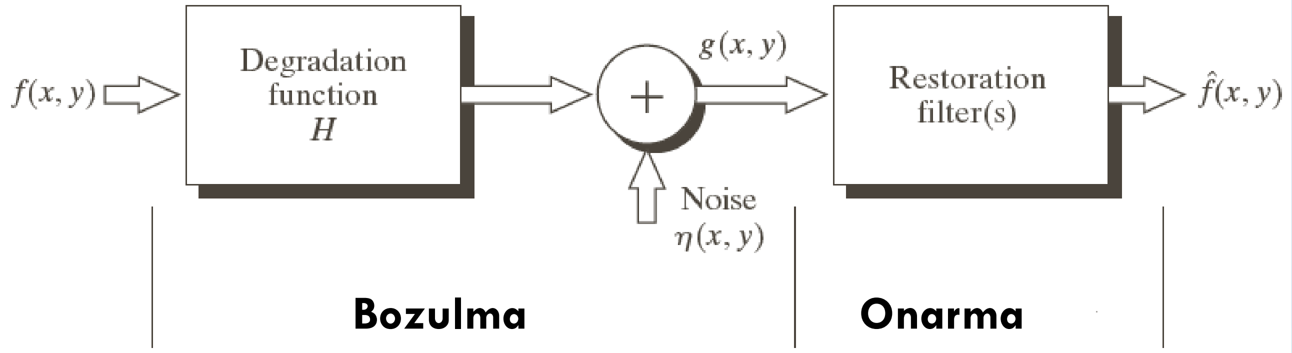
AREL ÜNİVERSİTESİ
BİYOMEDİKAL GÖRÜNTÜ İŞLEME

GÖRÜNTÜ ONARMA VE GERİÇATMA

DR. GÖRKEM SERBES

Görüntü Bozulma ve Onarma Süreci Modeli

FIGURE 5.1
A model of the image degradation/ restoration process.



H = Bozulma Fonksiyonu
$f(x, y)$ = Giriş Görüntüsü (Orijinal Görüntü)
$\eta(x, y)$ = Gürültü
$g(x, y)$= Bozulmuş İşaret
$\hat{f}(x, y)$ = Orijinal Görüntü Kestirimi

$$g(x, y) = h(x, y) * f(x, y) + \eta(x, y)$$ Uzamsal Düzlem

$$\mathrm{G}(u, v) = H(u, v)F(u, v) + N(u, v)$$ Frekans Düzlemi

Gürültü Olasılık Fonksiyonları

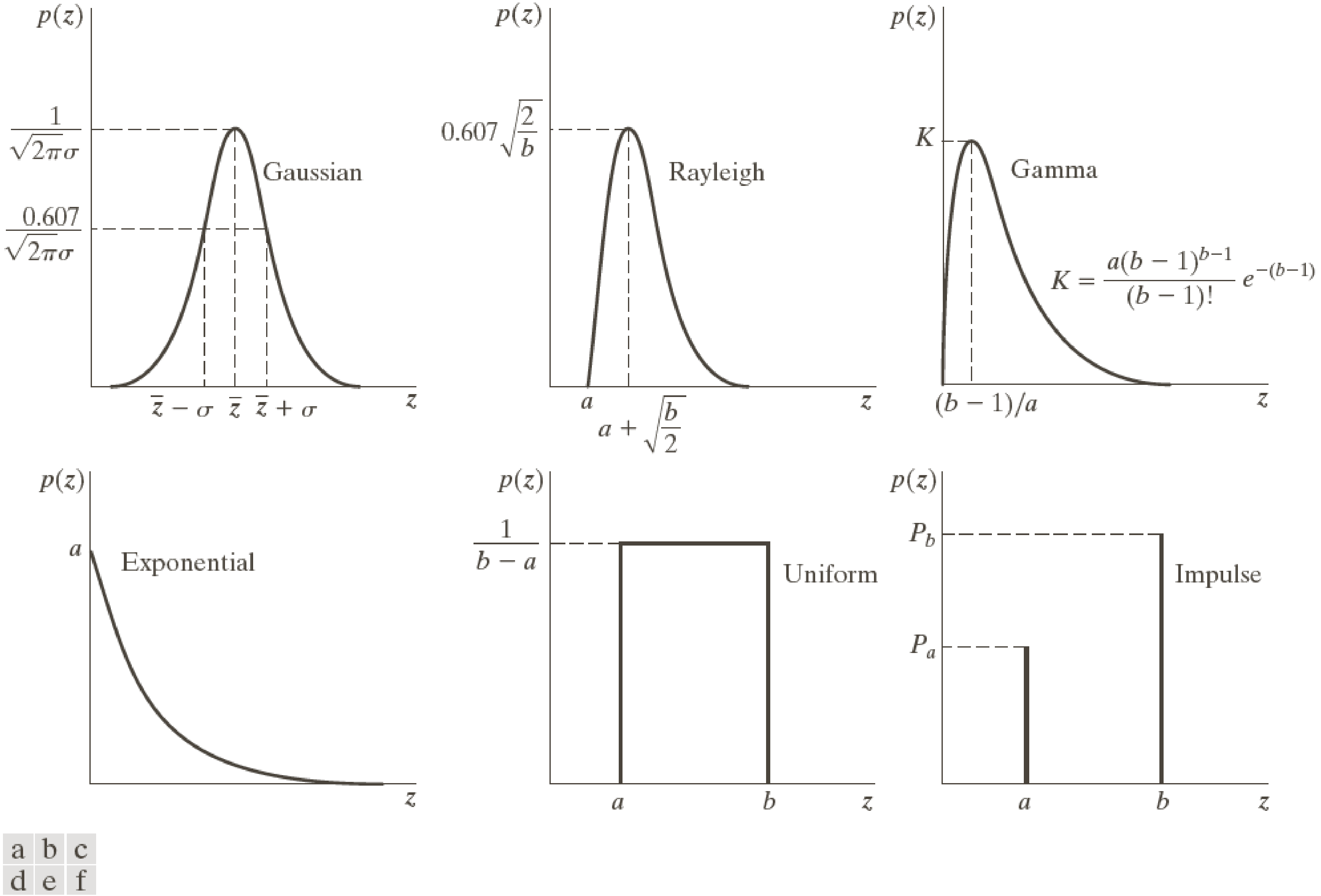
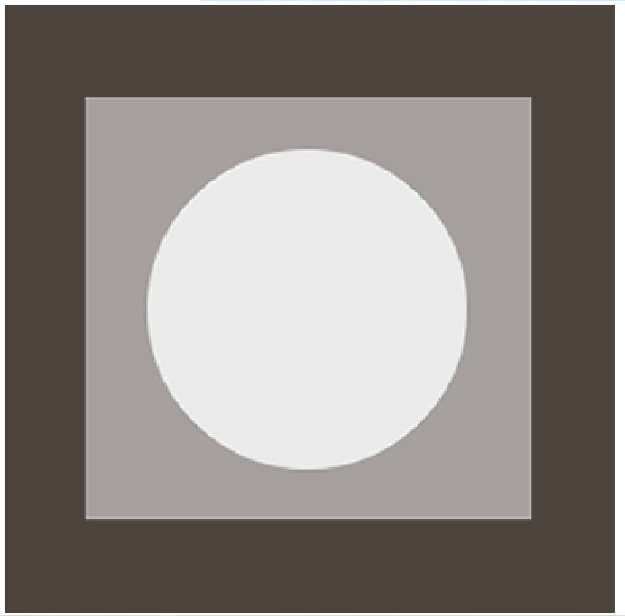


FIGURE 5.2 Some important probability density functions.

Gürültü ve Histogram

FIGURE 5.3 Test pattern used to illustrate the characteristics of the noise PDFs shown in Fig. 5.2.



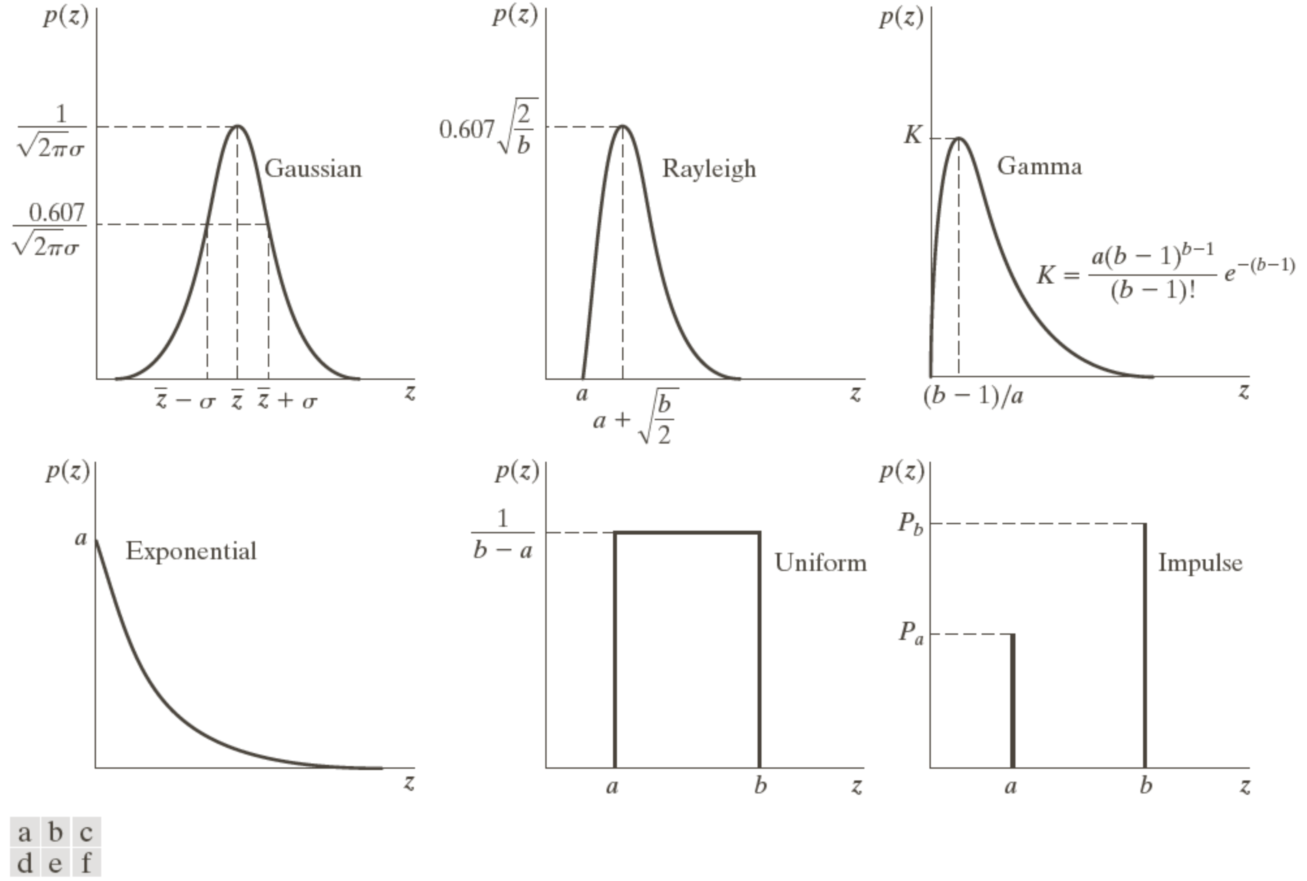


FIGURE 5.2 Some important probability density functions.

Gürültü ve Histogram

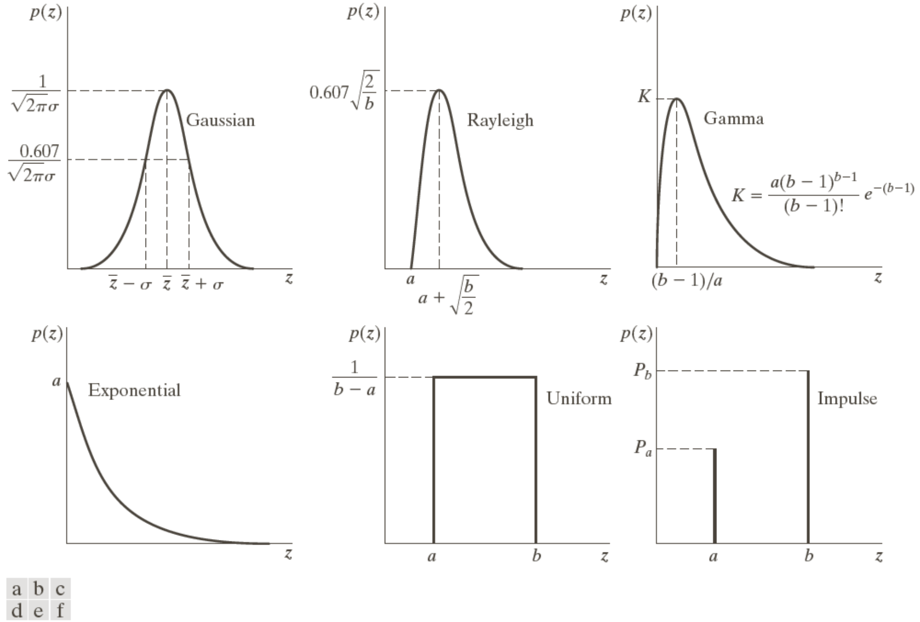


FIGURE 5.2 Some important probability density functions.

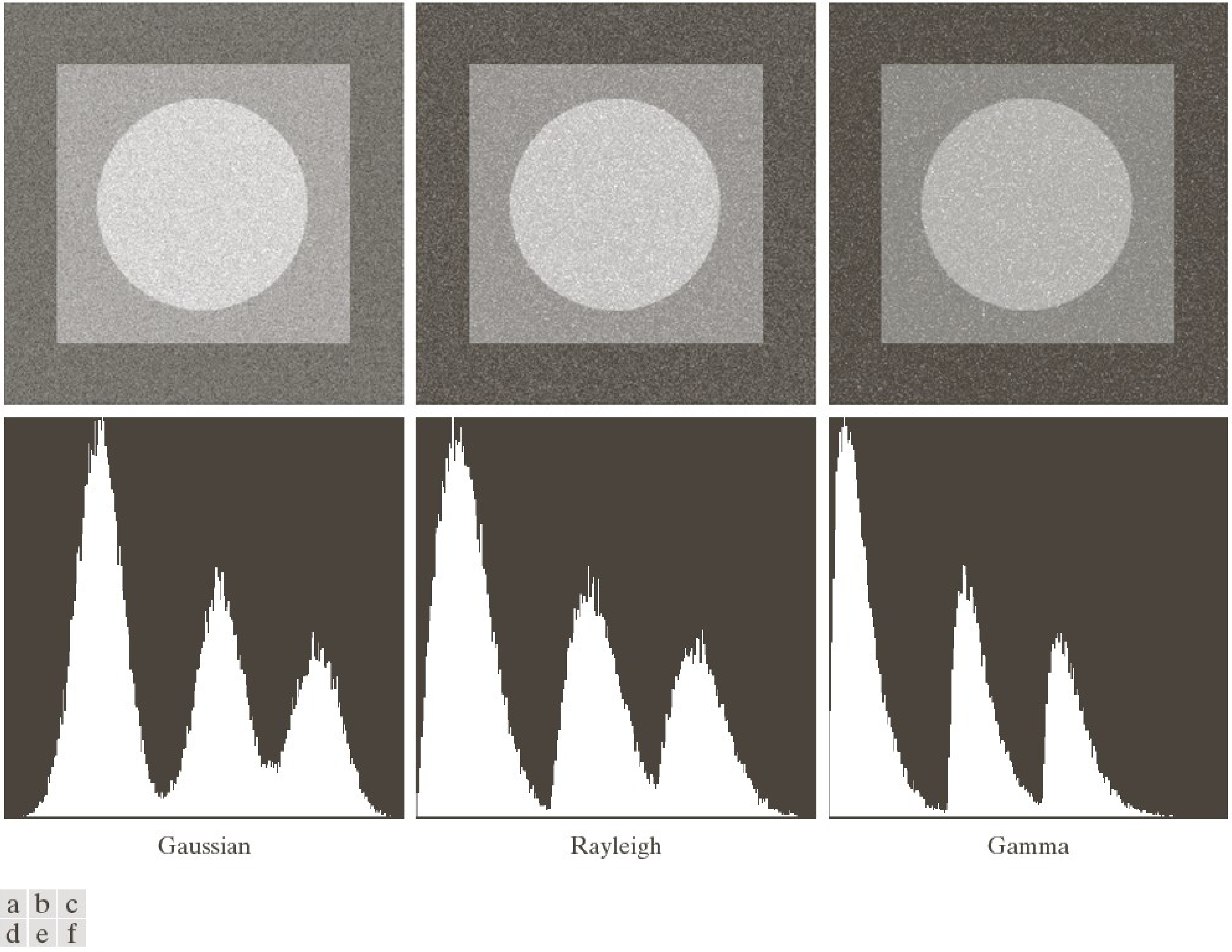


FIGURE 5.4 Images and histograms resulting from adding Gaussian, Rayleigh, and gamma noise to the image in Fig. 5.3.

Gürültü ve Histogram

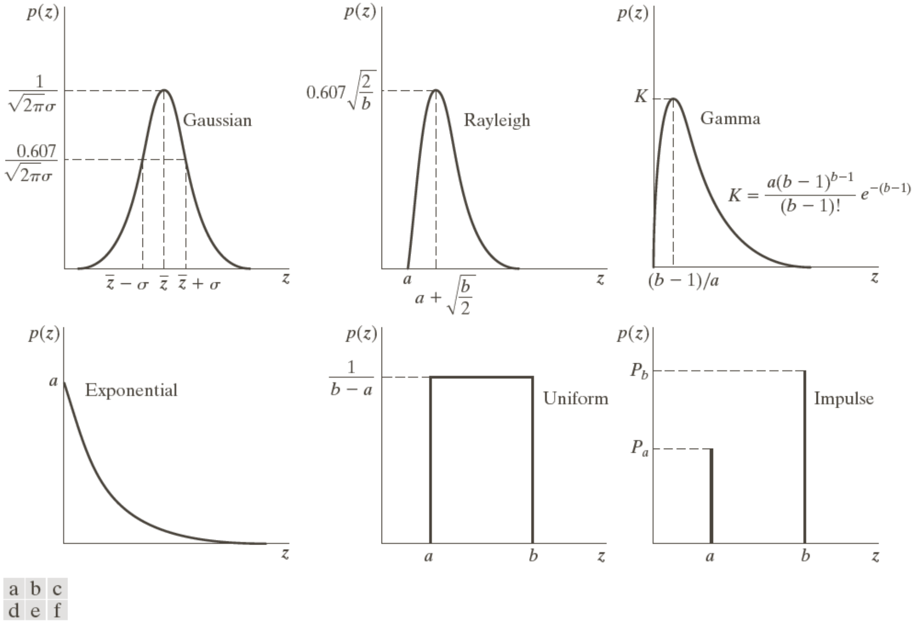


FIGURE 5.2 Some important probability density functions.

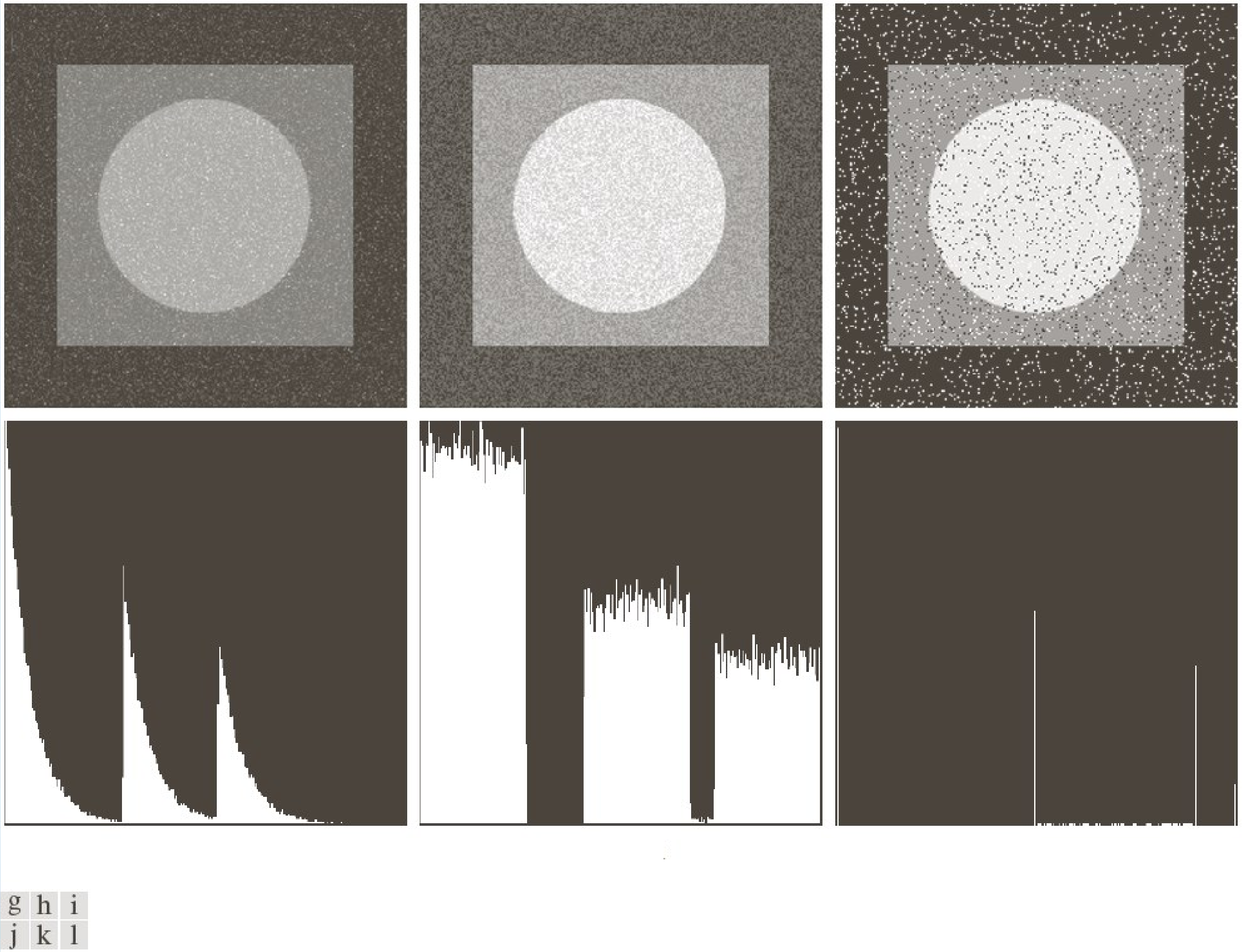
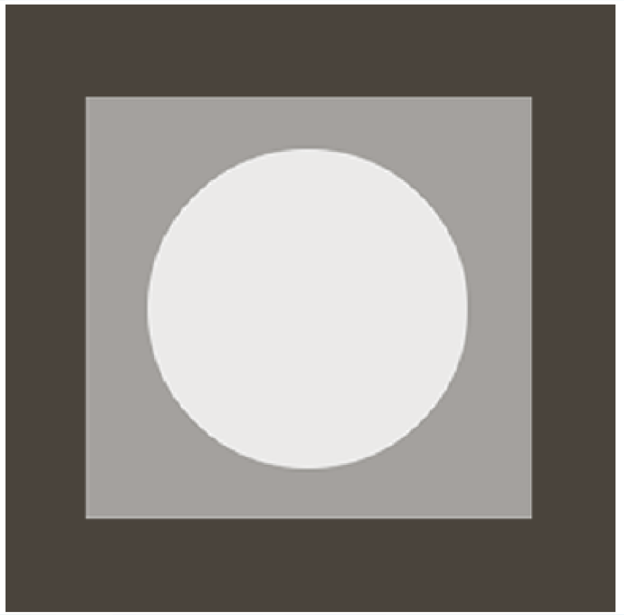
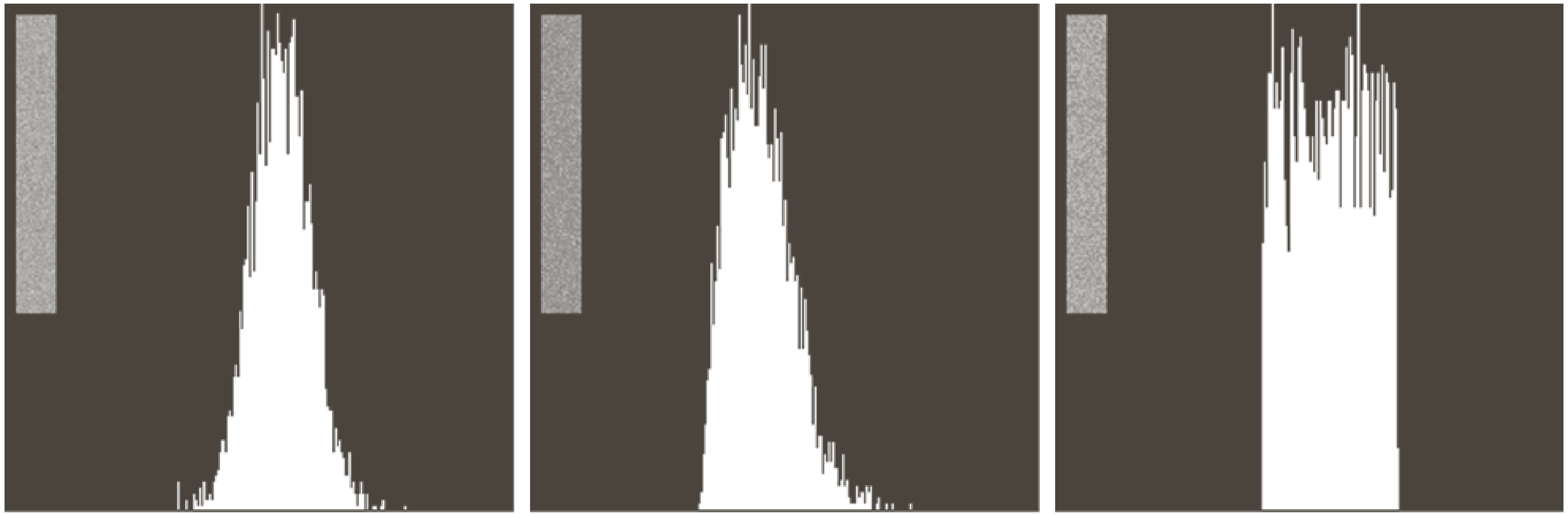


FIGURE 5.4 *(Continued)* Images and histograms resulting from adding exponential, uniform, and salt and pepper noise to the image in Fig. 5.3.

Gürültü Parametrelerinin Kestirimi

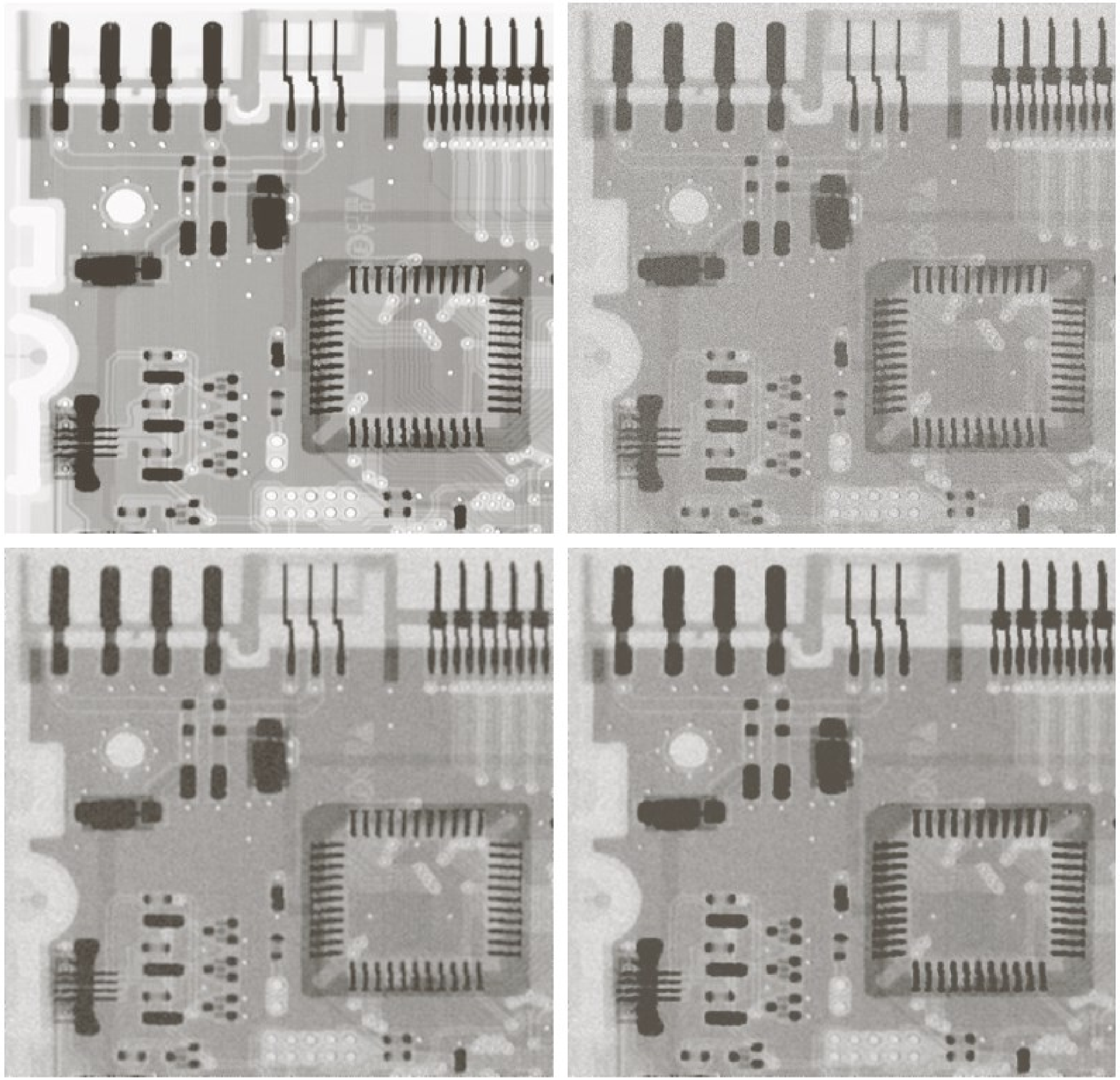




a b c

FIGURE 5.6 Histograms computed using small strips (shown as inserts) from (a) the Gaussian, (b) the Rayleigh, and (c) the uniform noisy images in Fig. 5.4.

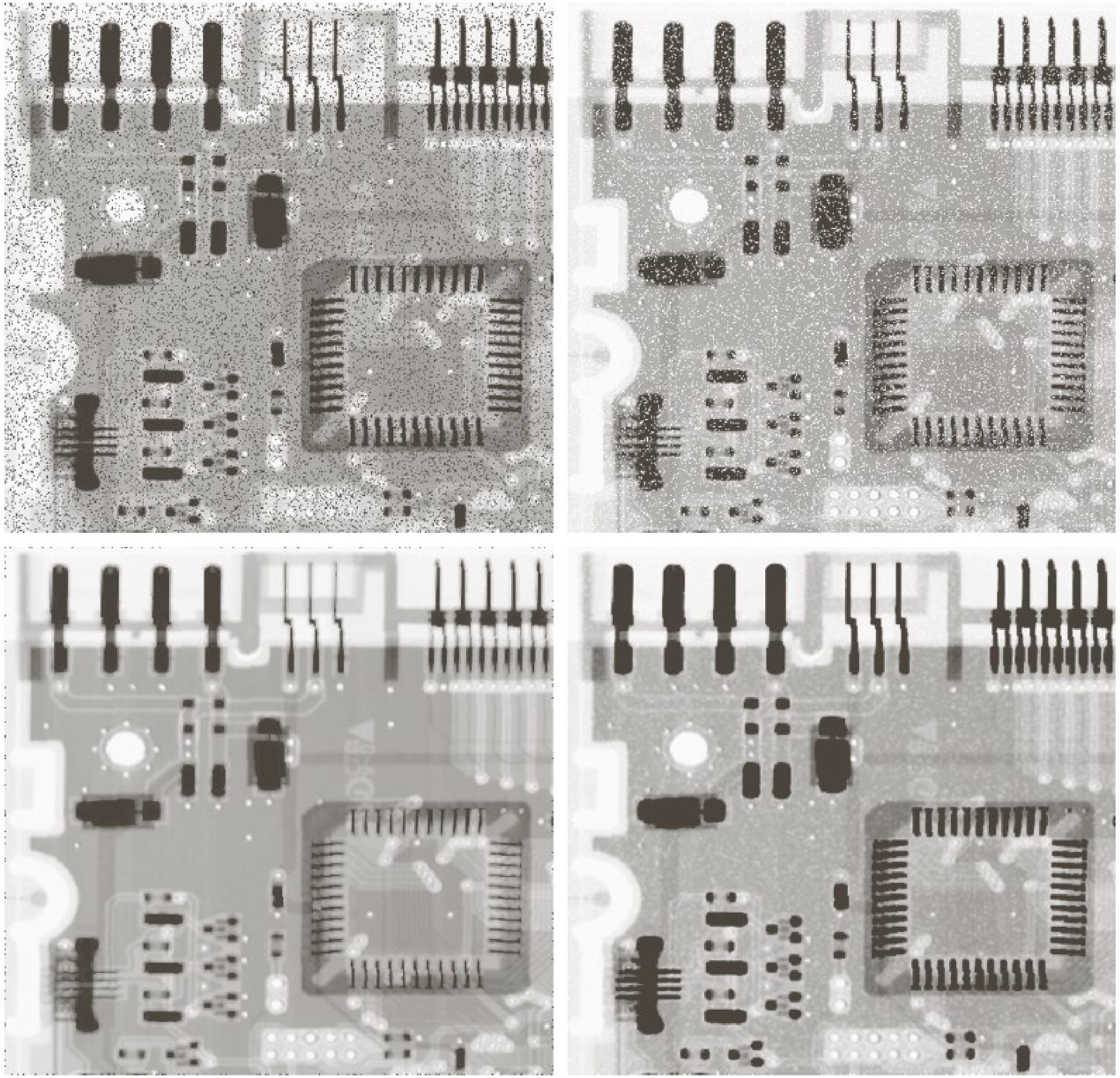
Ortalama Süzgeçleri



a b
c d

FIGURE 5.7 (a) X-ray image. (b) Image corrupted by additive Gaussian noise. (c) Result of filtering with an arithmetic mean filter of size 3 × 3. (d) Result of filtering with a geometric mean filter of the same size. (Original image courtesy of Mr. Joseph E. Pascente, Lixi, Inc.)

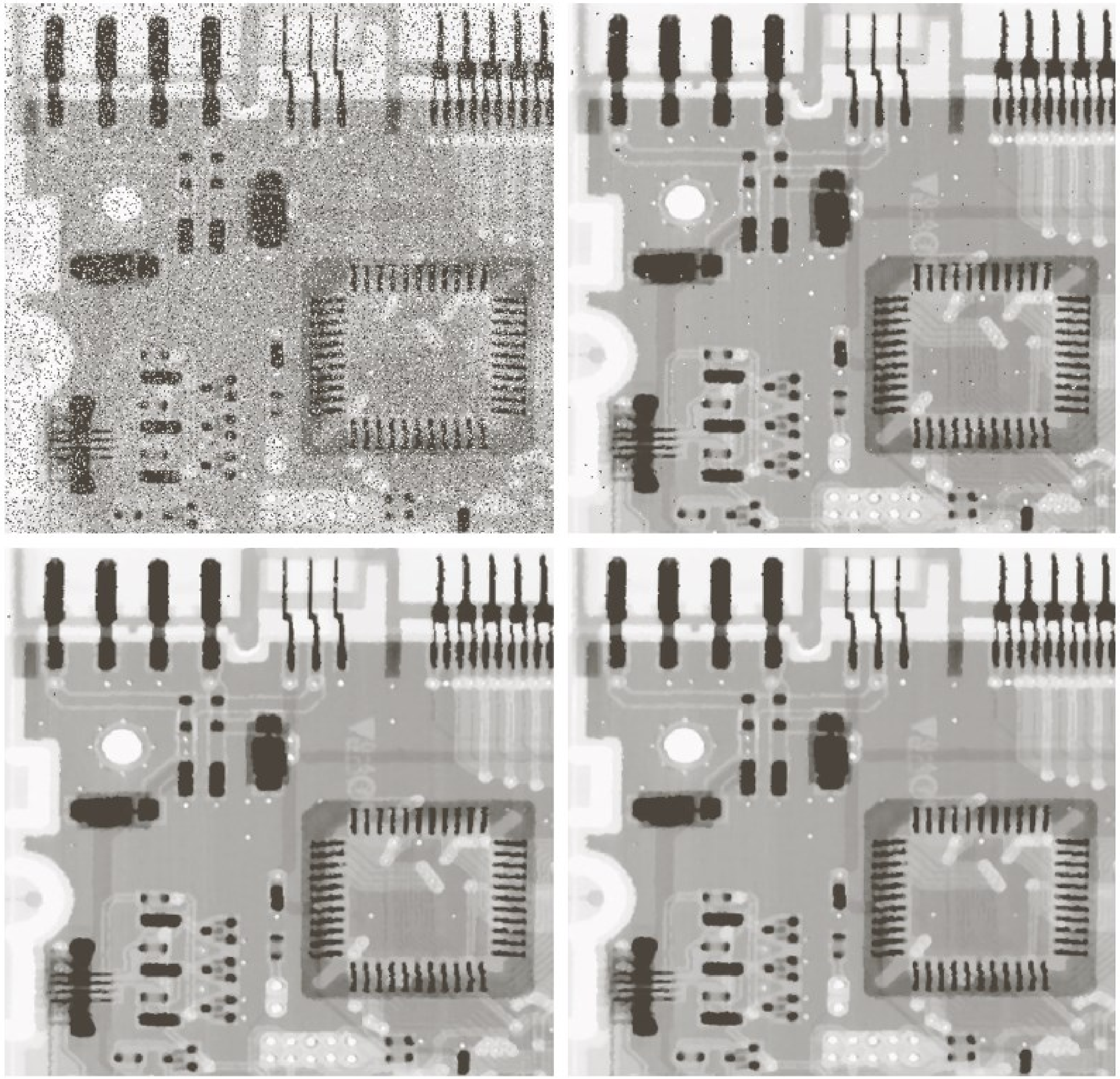
Ortalama Süzgeçleri



a b
c d

FIGURE 5.8 (a) Image corrupted by pepper noise with a probability of 0.1. (b) Image corrupted by salt noise with the same probability. (c) Result of filtering (a) with a 3×3 contraharmonic filter of order 1.5. (d) Result of filtering (b) with $Q = -1.5$.

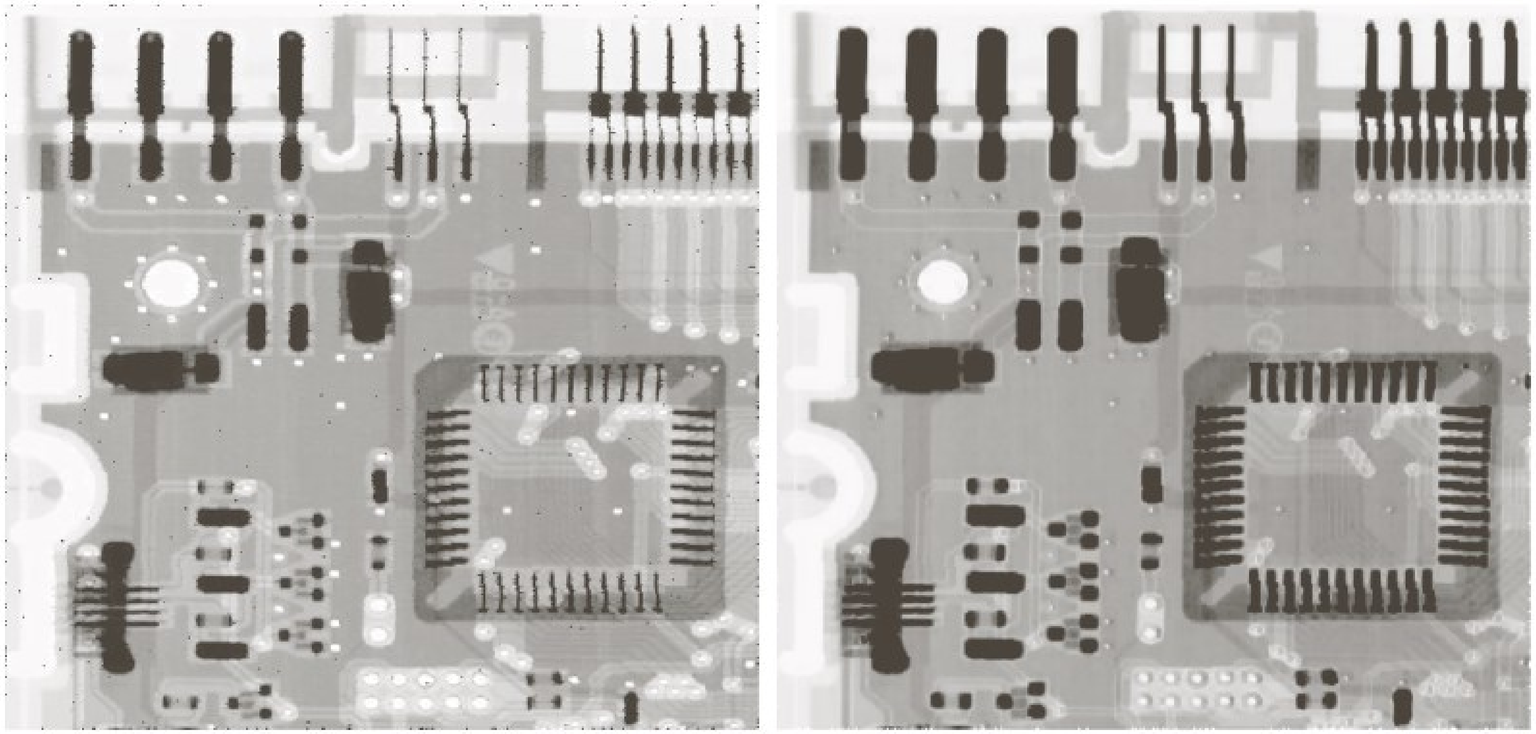
Sıra İstatistiği Süzgeçleri



a b
c d

FIGURE 5.10 (a) Image corrupted by salt-and-pepper noise with probabilities $P_a = P_b = 0.1$. (b) Result of one pass with a median filter of size 3×3. (c) Result of processing (b) with this filter. (d) Result of processing (c) with the same filter.

Sıra İstatistiği Süzgeçleri

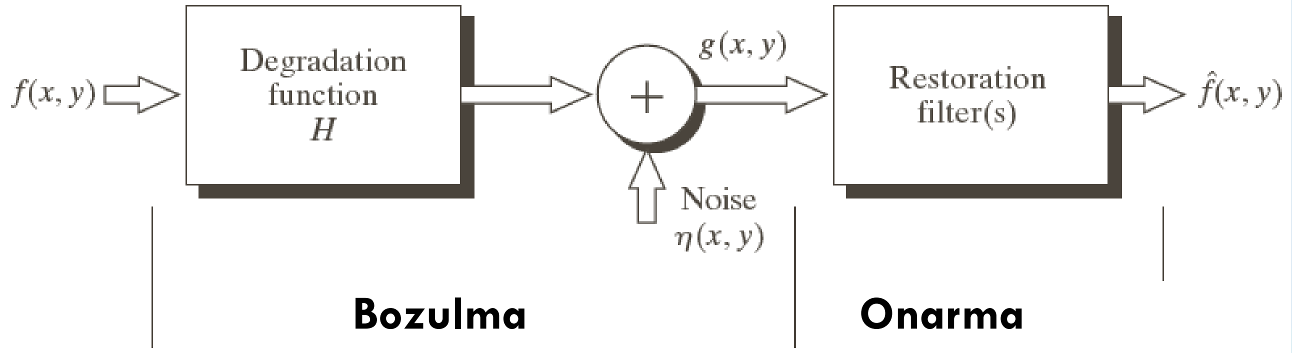


a b

FIGURE 5.11 (a) Result of filtering Fig. 5.8(a) with a max filter of size 3 × 3. (b) Result of filtering 5.8(b) with a min filter of the same size.

Bozulma Fonksiyonu Kestirme

FIGURE 5.1 A model of the image degradation/restoration process.



$$g(x, y) = h(x, y) * f(x, y) + \eta(x, y)$$ Uzamsal Düzlem

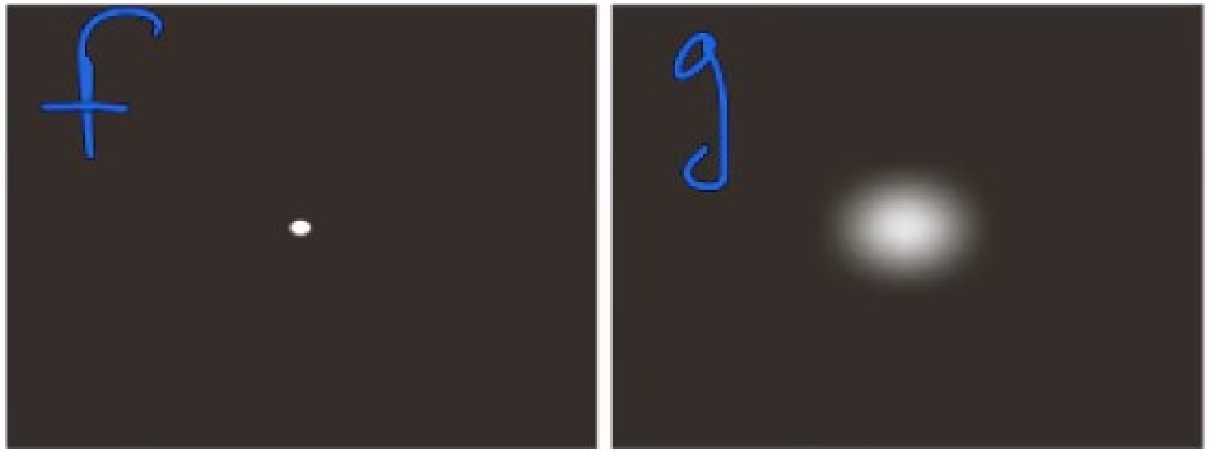
$$G(u, v) = H(u, v)F(u, v) + N(u, v)$$ Frekans Düzlemi

$$\hat{F}(u, v) = \frac{G(u, v)}{H(u, v)}$$

Ters Süzme

a b

FIGURE 5.24 Degradation estimation by impulse characterization. (a) An impulse of light (shown magnified). (b) Imaged (degraded) impulse.

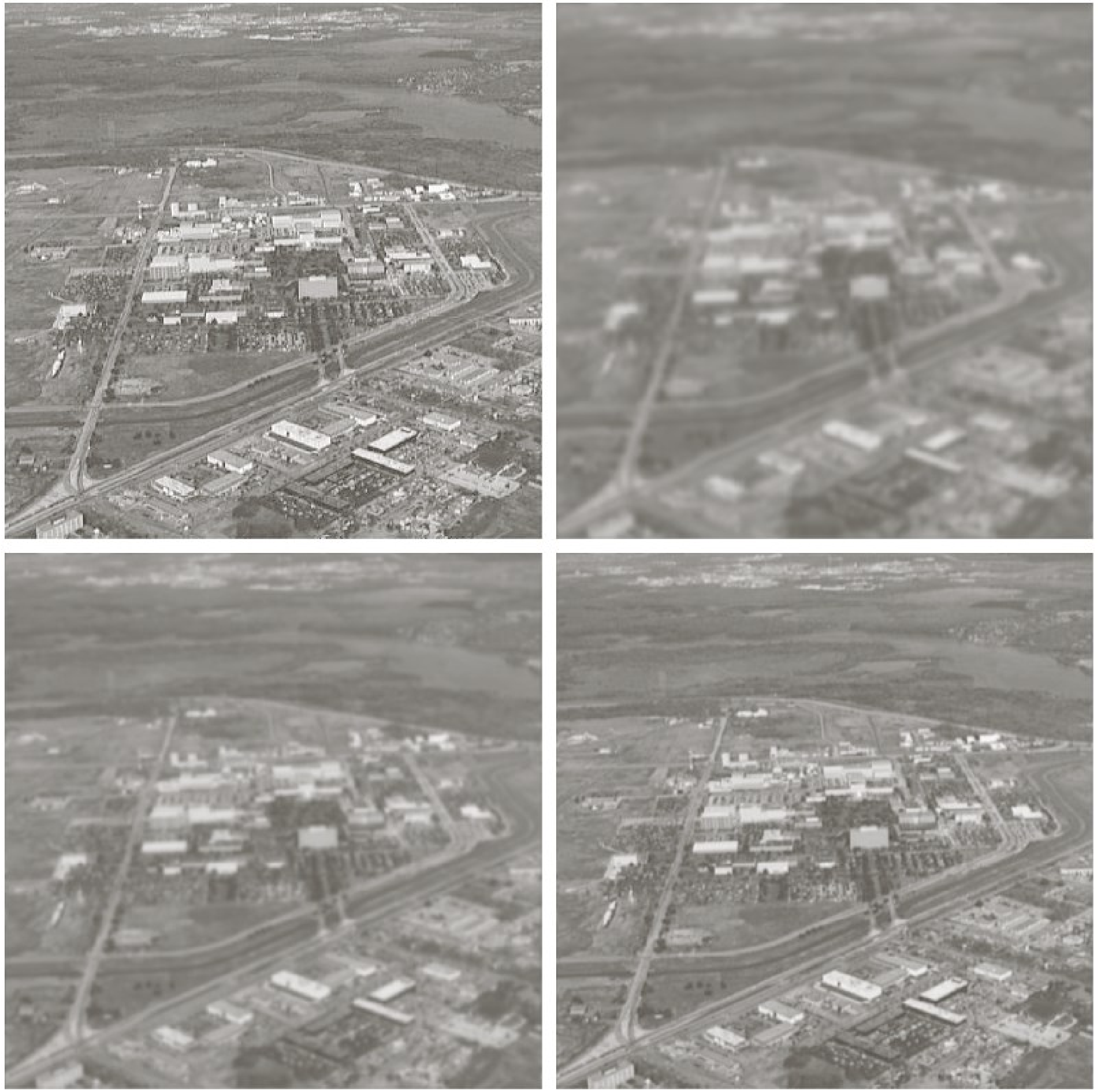


$$H = G(0,\sigma)$$

$$g(x,y) = f(x,y) * G(0,\sigma)$$

$$G = \delta(x,y) * G$$

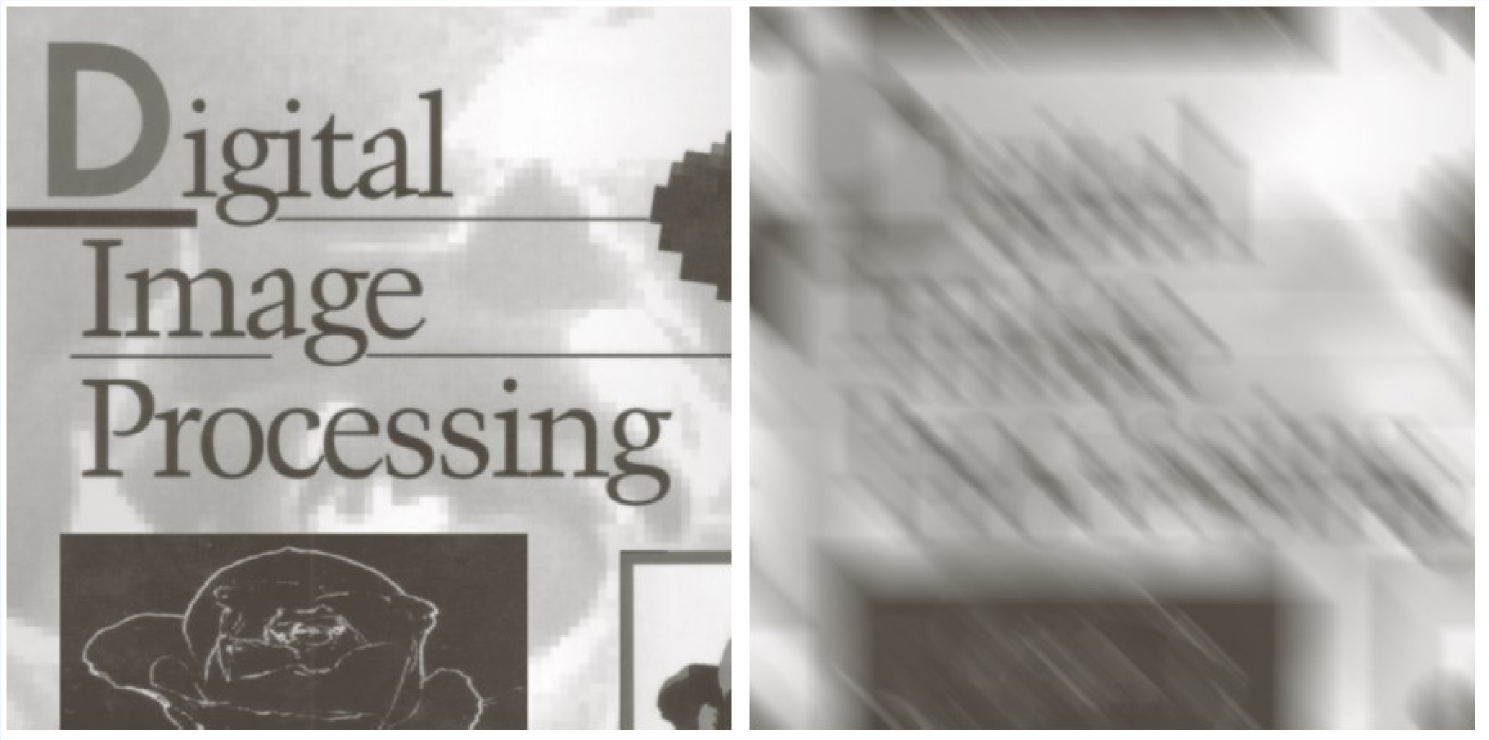
Gauss Filtresi Modeli



a b
c d

FIGURE 5.25 Illustration of the atmospheric turbulence model. (a) Negligible turbulence. (b) Severe turbulence, $k = 0.0025$. (c) Mild turbulence, $k = 0.001$. (d) Low turbulence, $k = 0.00025$. (Original image courtesy of NASA.)

Harekete Bağlı Bulanıklaşma



a b

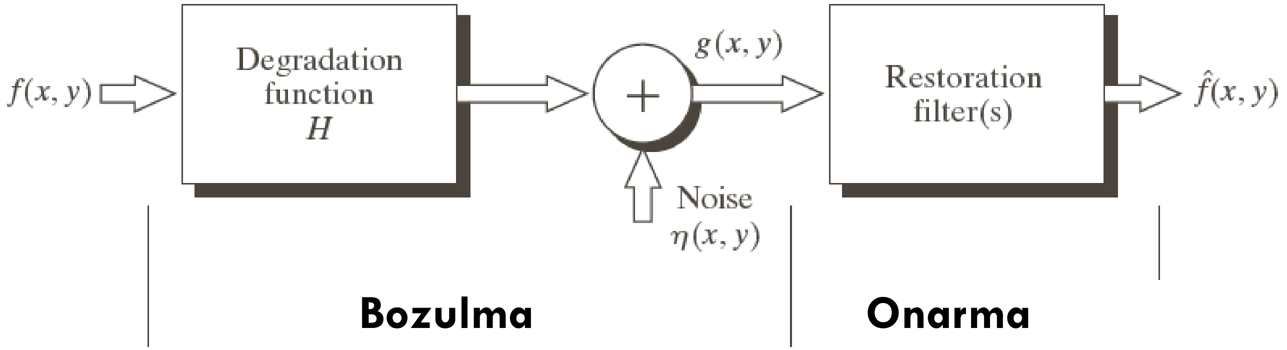
FIGURE 5.26 (a) Original image. (b) Result of blurring using the function in Eq. (5.6-11) with $a = b = 0.1$ and $T = 1$.

$$\underline{g(x,y)} = \int_0^T f(x-x(t), y-y(t))\,dt$$

$$G = H F$$

Wiener Filtresi

FIGURE 5.1 A model of the image degradation/ restoration process.



$$e^2 = E\left[\left(f(x,y) - \hat{f}(x,y)\right)^2\right]$$

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)}{H^2(u,v) + S_\eta / S_f}\right] G(u,v)$$

Wiener Filtresi

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)S_f(u,v)}{S_f(u,v)|H(u,v)|^2 + S_\eta(u,v)}\right]G(u,v)$$

$$= \left[\frac{H^*(u,v)}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)}\right]G(u,v)$$

$$= \left[\frac{1}{H(u,v)}\frac{|H(u,v)|^2}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)}\right]G(u,v)$$

$H(u,v)$ = bozma fonksiyonu

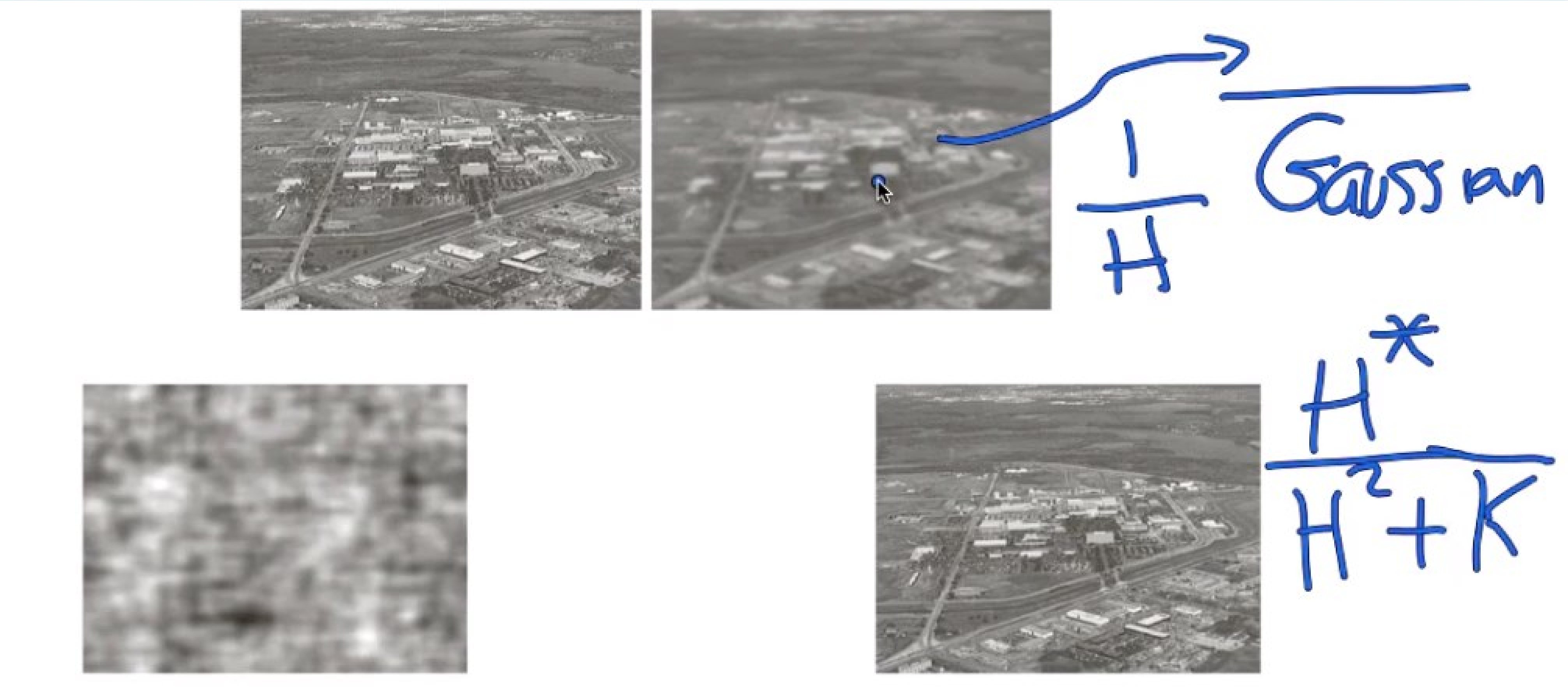
$H^*(u,v) = H(u,v)$'nin karmaşık eşleniği

$|H(u,v)|^2 = H^*(u,v)H(u,v)$

$S_\eta(u,v) = |N(u,v)|^2$ = gürültünün güç spektrumu

$S_f(u,v) = |F(u,v)|^2$ = bozulmamış görüntünün güç spektrumu

Wiener Filtresi



Wiener Filtresi

$$\frac{1}{H}$$

$$\frac{H^*}{H^2 + K}$$

FIGURE 5.29 (a) 8-bit image corrupted by motion blur and additive noise. (b) Result of inverse filtering. (c) Result of Wiener filtering. (d)–(f) Same sequence, but with noise variance one order of magnitude less. (g)–(i) Same sequence, but noise variance reduced by five orders of magnitude from (a). Note in (h) how the deblurred image is quite visible through a "curtain" of noise.