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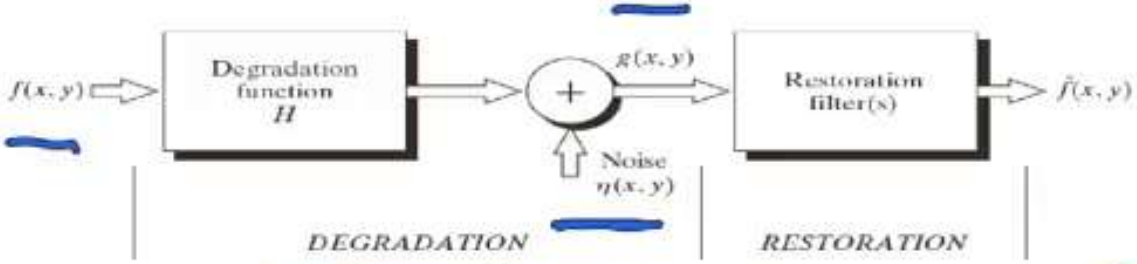

FIGURE 5.1 A model of the image degradation/restoration process.

$$\hat{f}(x,y) \approx f(x,y)$$

$$g(x,y) = [f(x,y) * H(x,y)] + \eta(x,y)$$

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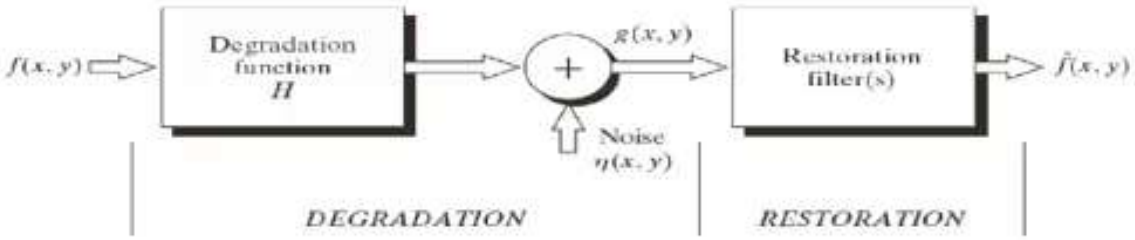

FIGURE 5.1 A model of the image degradation/restoration process.

$$\log(a \cdot b) = \log a + \log b$$

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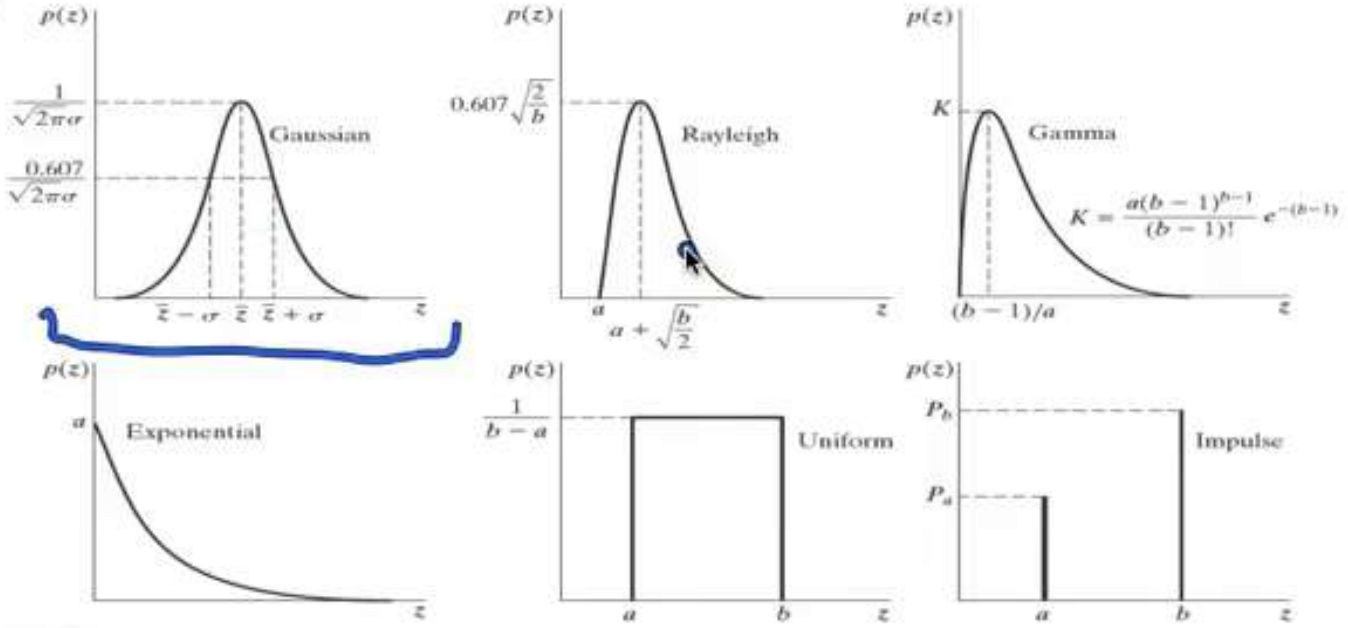
$$p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(z-\bar{z})^2/2\sigma^2}$$



a b c
d e f

FIGURE 5.2 Some important probability density functions.

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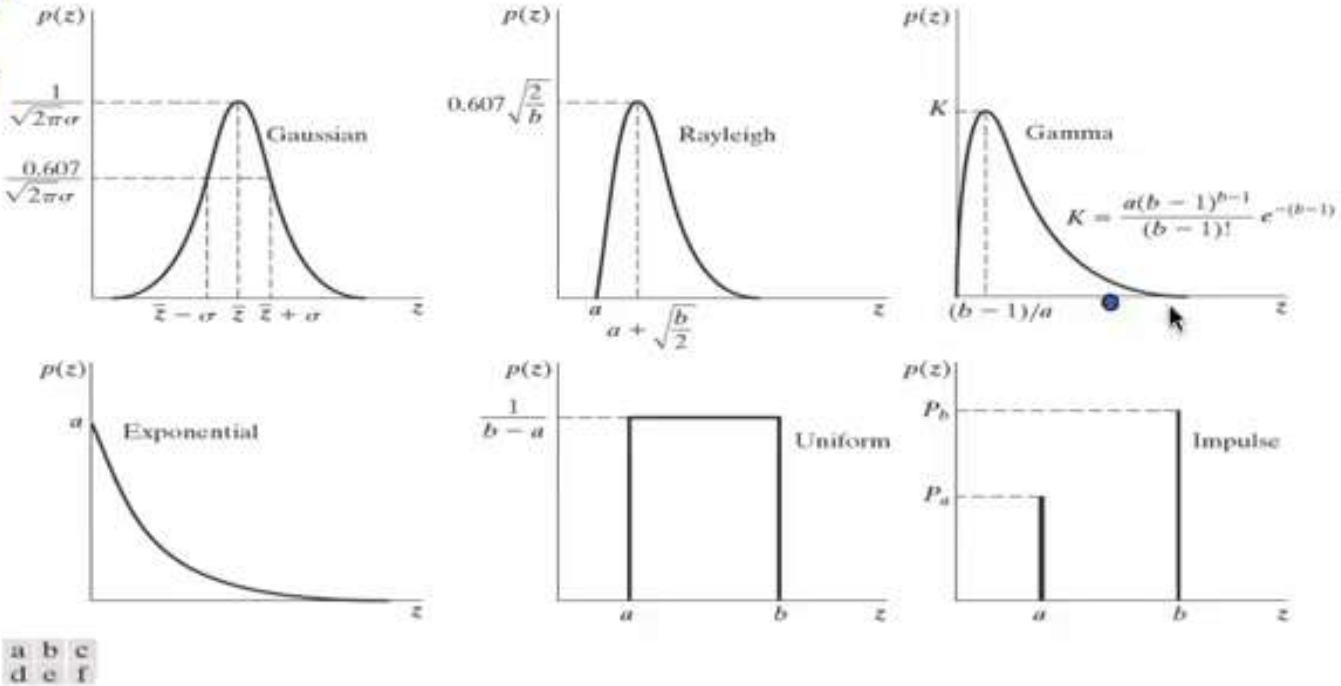
$$p(z) = \begin{cases} \frac{2}{b}(z-a)e^{-(z-a)^2/b} & z \geq a \\ 0 & z \leq a \end{cases}$$

$$\bar{z} = a + \sqrt{\frac{\pi b}{4}}$$

$$\sigma^2 = \frac{b(4-\pi)}{4}$$



a b c
d e f

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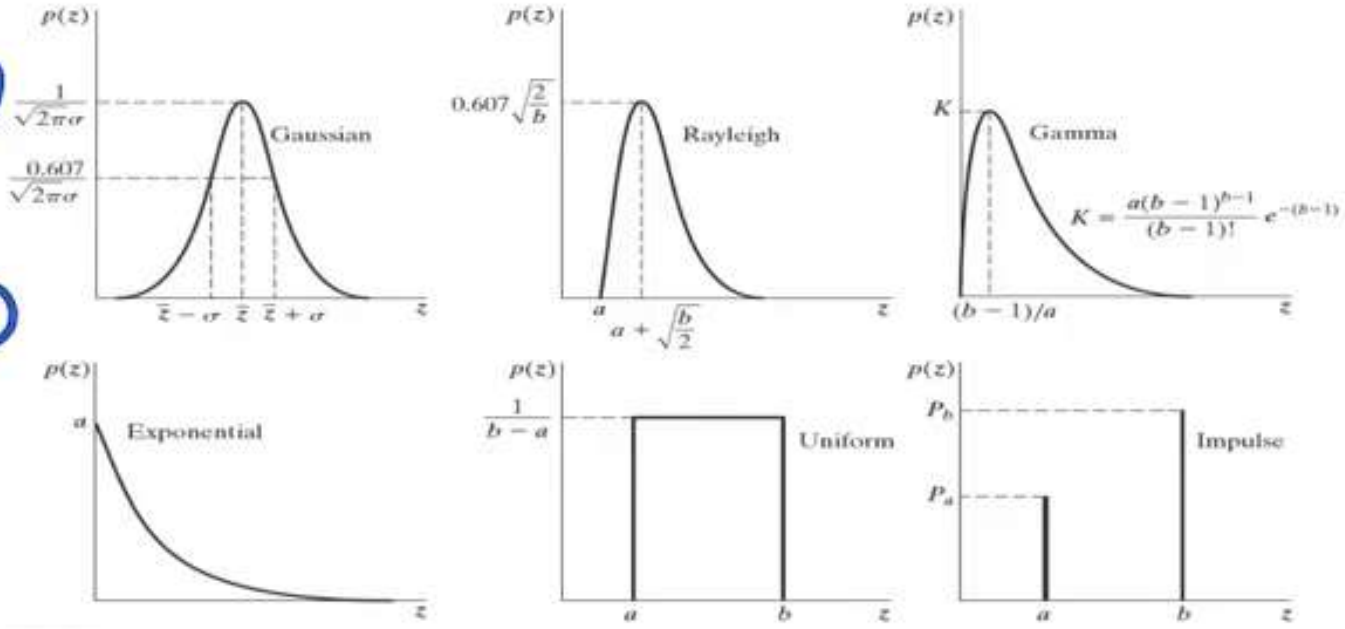
$$p(z) = \begin{cases} a e^{-az} & z \geq 0 \\ 0 & z < 0 \end{cases}$$

$$\bar{z} = \frac{1}{a}$$

$$\sigma^2 = 1/a^2$$



a b c
d e f

FIGURE 5.2 Some important probability density functions.

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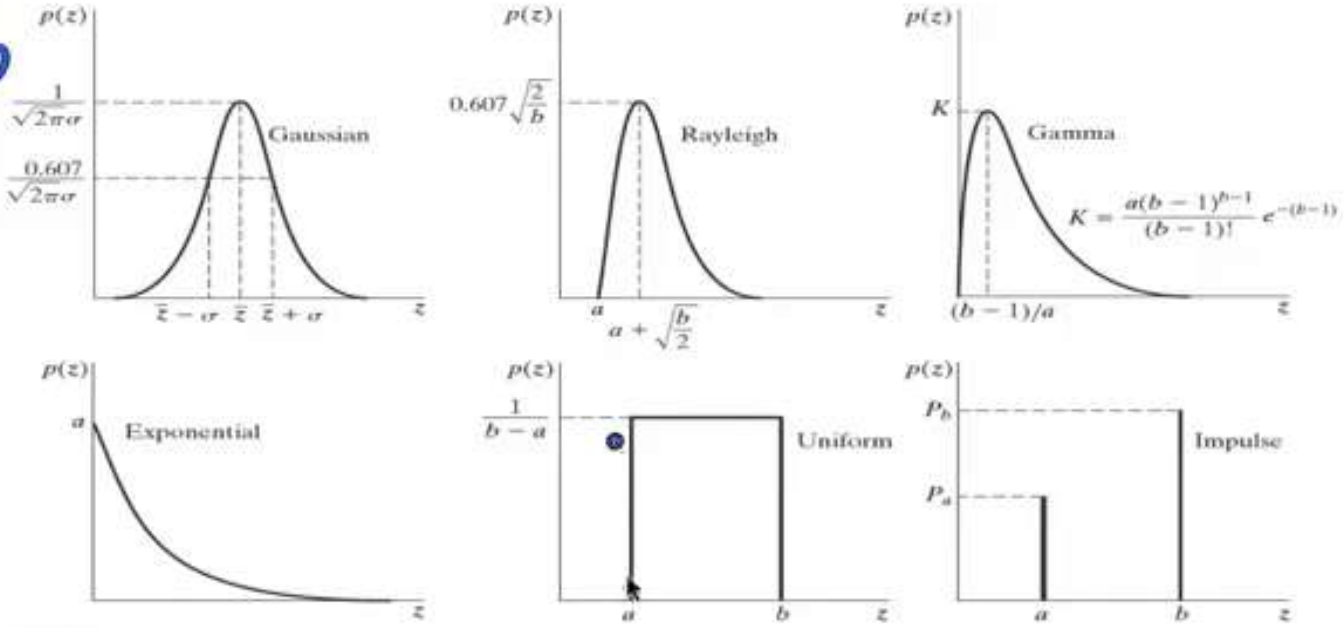
$$p(z) = \begin{cases} \frac{1}{b-a} & a \le z \le b \\ 0 & \text{other} \end{cases}$$

$$\bar{z} = \frac{a+b}{2}$$

$$\sigma^2 = ?$$



a b c
d e f

FIGURE 5.2 Some important probability density functions.

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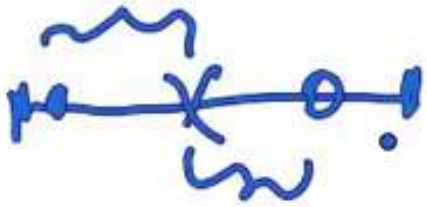
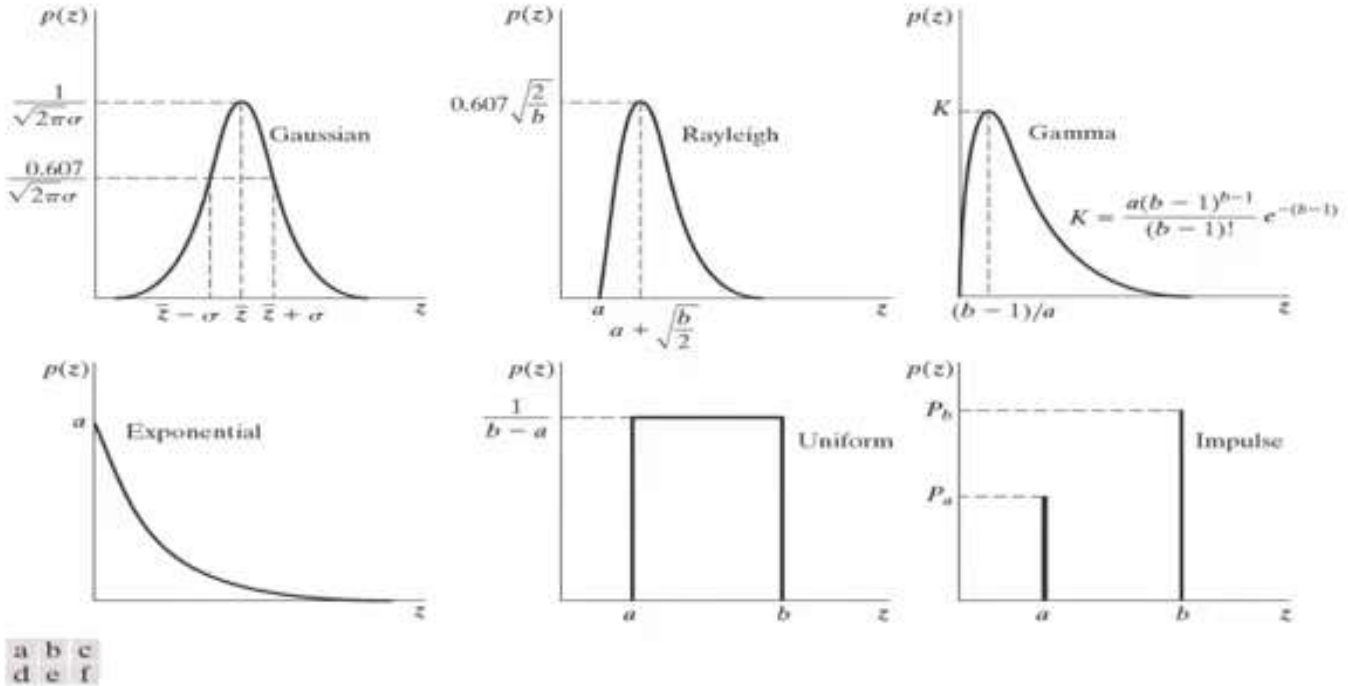
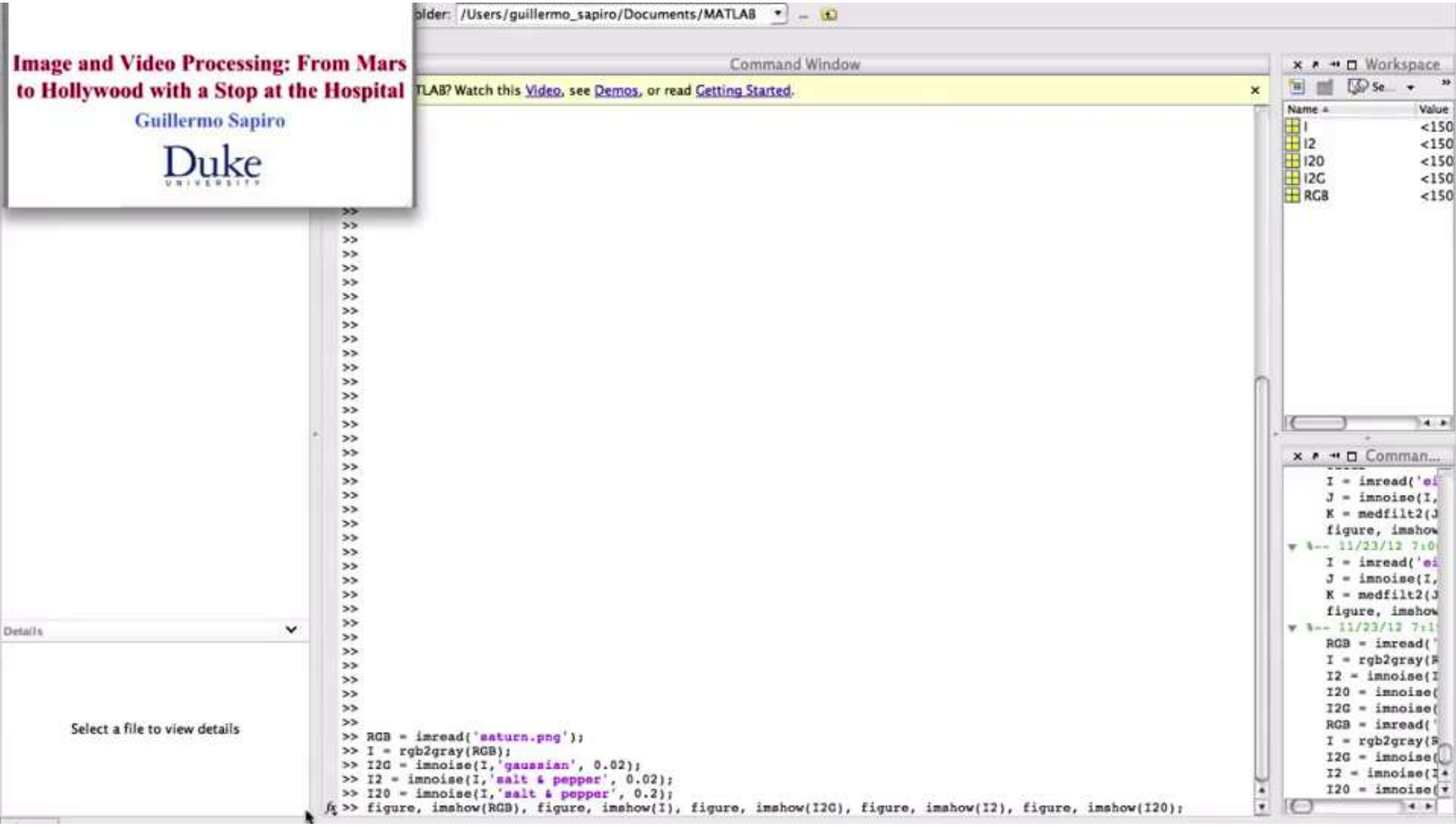




a b c
d e f

FIGURE 5.2 Some important probability density functions.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Guillermo Sapiro
Duke
UNIVERSITY
Folder: /Users/guillermo_sapiro/Documents/MATLAB
Command Window
TLAB? Watch this Video, see Demos, or read Getting Started.
Workspace
Name
Value
I
I2
I20
I2G
RGB
Details
Select a file to view details
>> RGB = imread('saturn.png');
>> I = rgb2gray(RGB);
>> I2G = imnoise(I,'gaussian', 0.02);
>> I2 = imnoise(I,'salt & pepper', 0.02);
>> I20 = imnoise(I,'salt & pepper', 0.2);
>> figure, imshow(RGB), figure, imshow(I), figure, imshow(I2G), figure, imshow(I2), figure, imshow(I20);

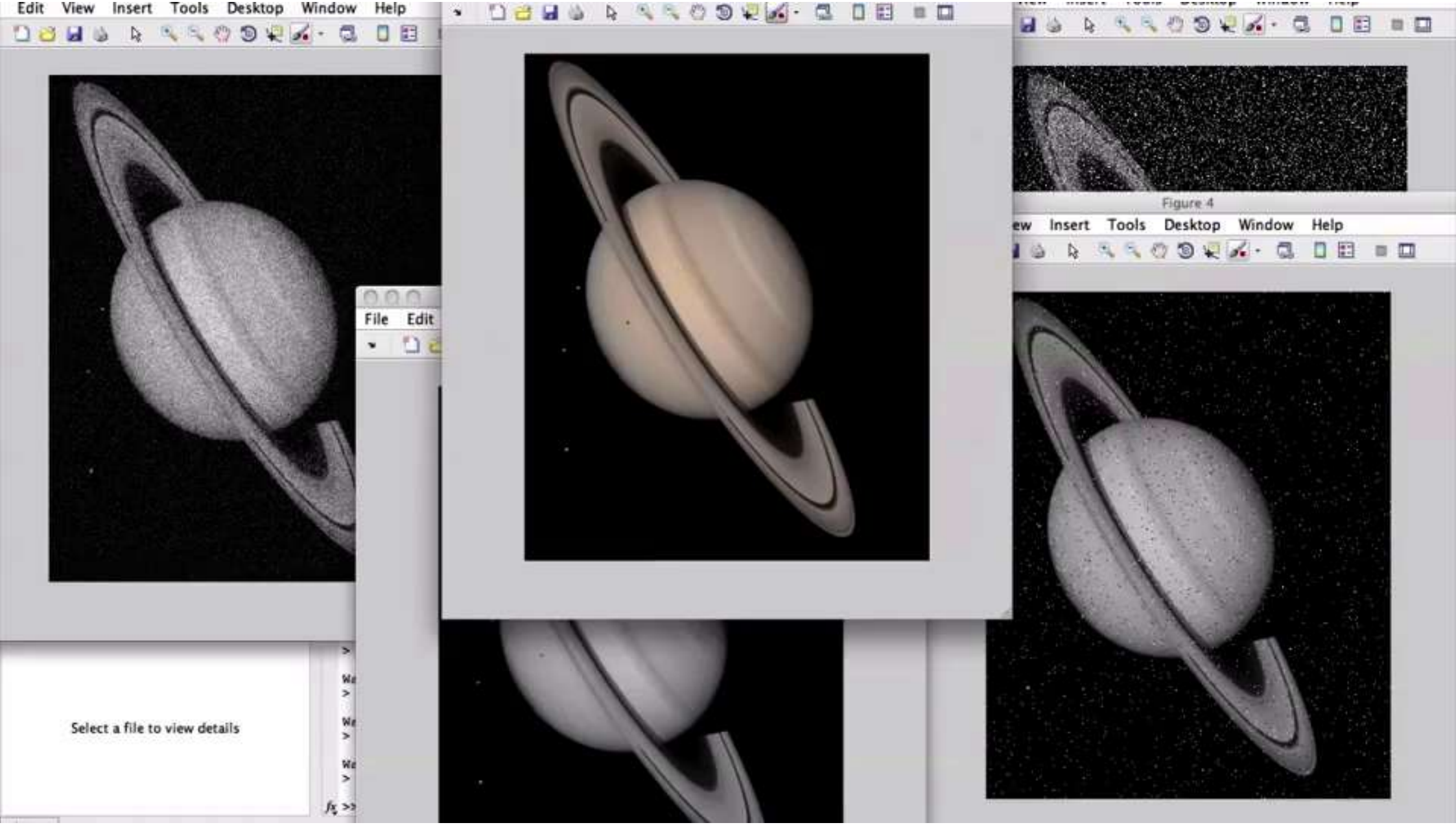
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Figure 4
ew Insert Tools Desktop Window Help

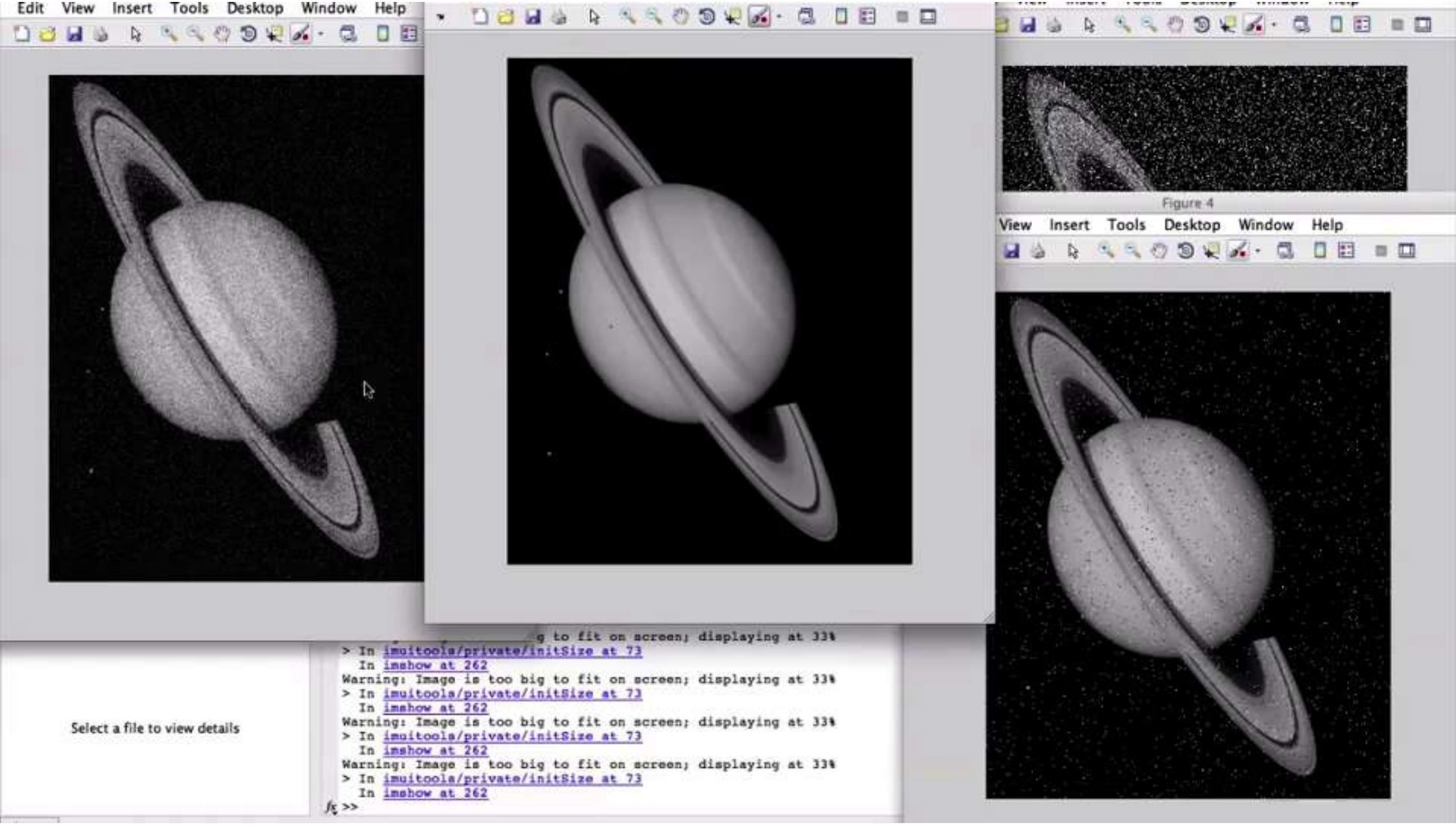
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Figure 4
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g to fit on screen; displaying at 33%
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In imshow at 262
Warning: Image is too big to fit on screen; displaying at 33%
> In imuitools/private/initSize at 73
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In imshow at 262
Warning: Image is too big to fit on screen; displaying at 33%
> In imuitools/private/initSize at 73
In imshow at 262
fx >>

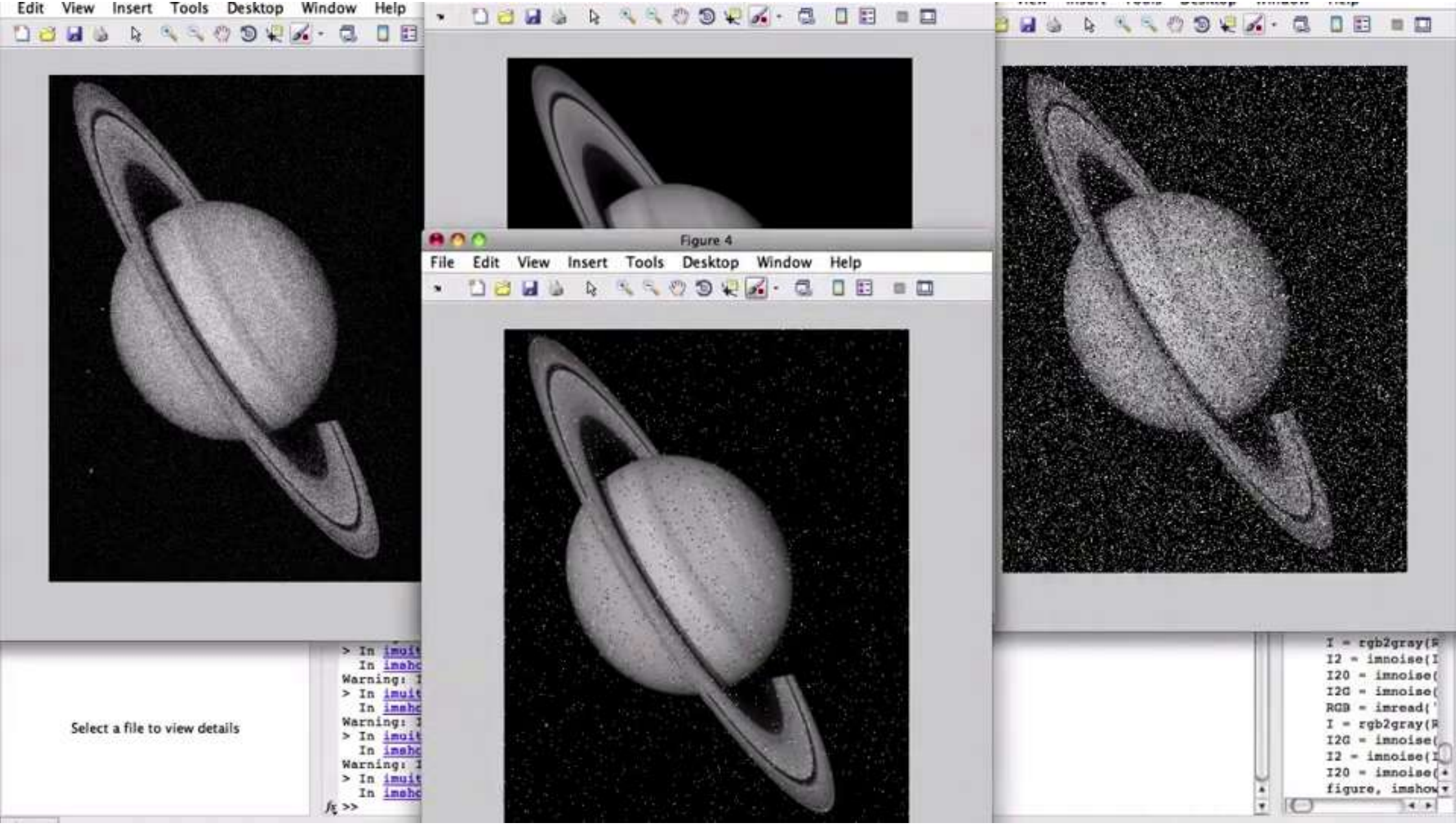
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Figure 4
File Edit View Insert Tools Desktop Window Help
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Warning: I
> In imsh
In imshc
>>
I = rgb2gray(R
I2 = imnoise(I
I20 = imnoise(
I2G = imnoise(
RGB = imread('
I = rgb2gray(R
I2G = imnoise(
I2 = imnoise(I
I20 = imnoise(
figure, imshow

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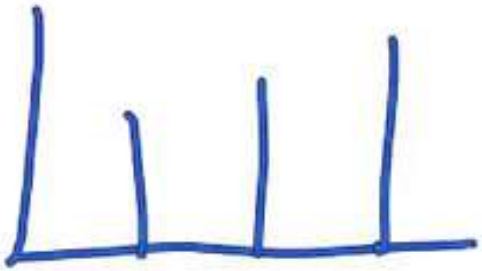

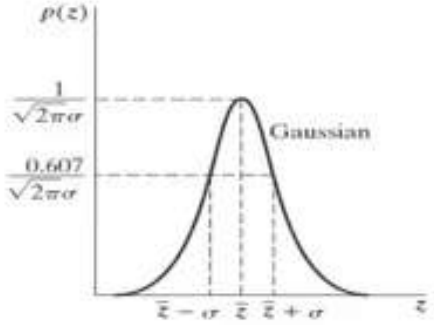

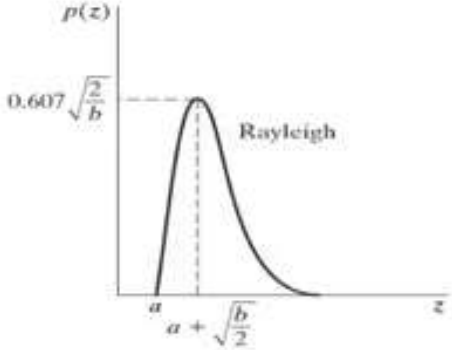

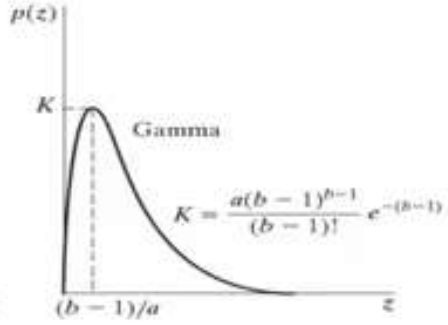

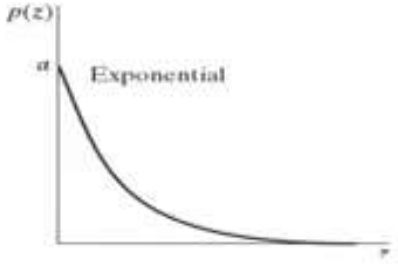

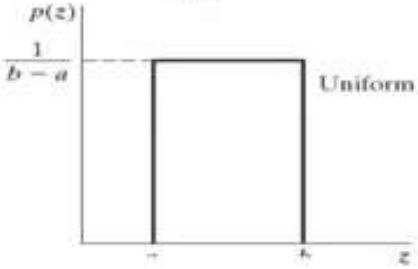

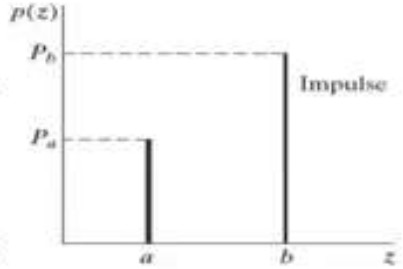

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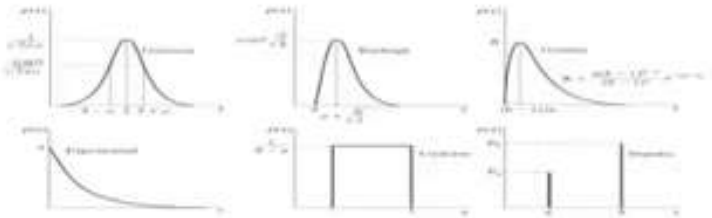

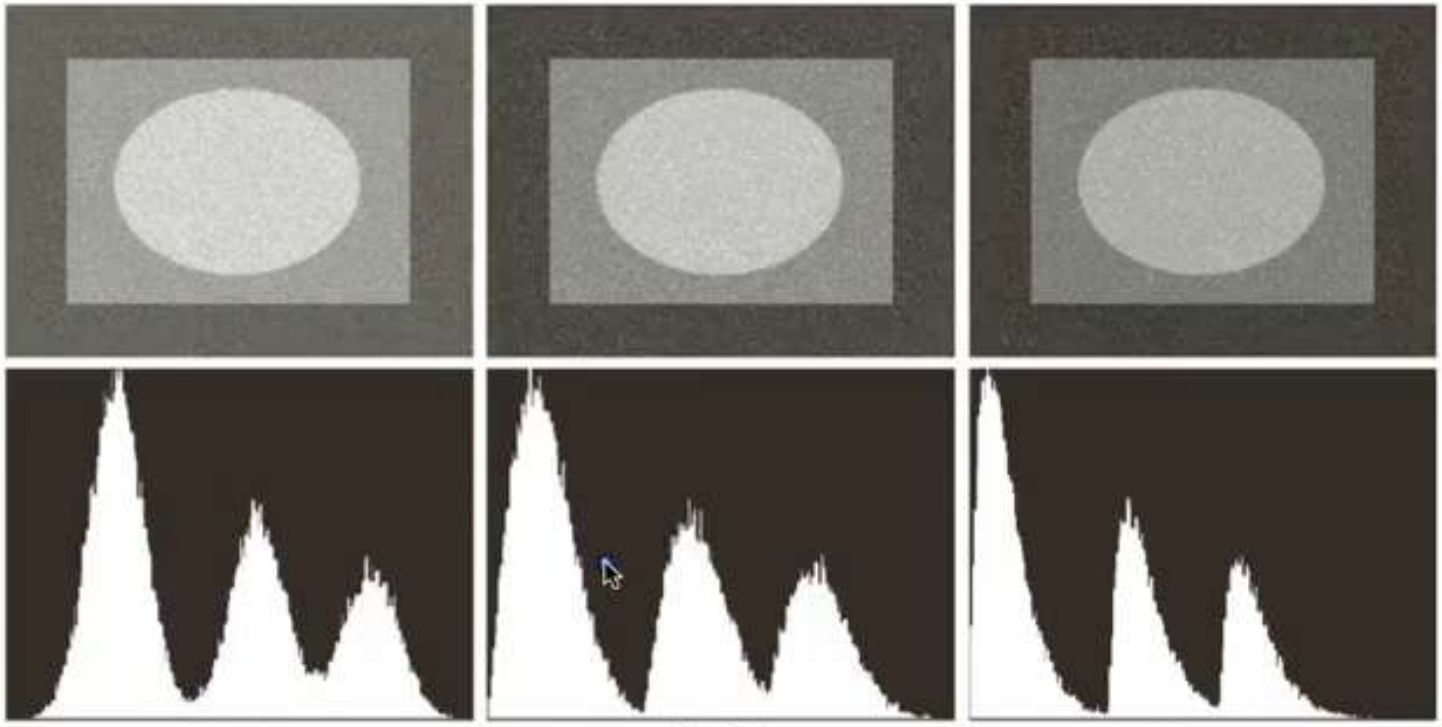

a b c
d e f

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

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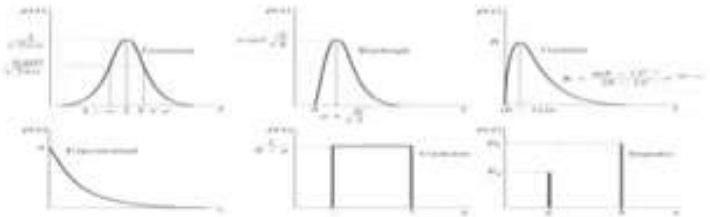

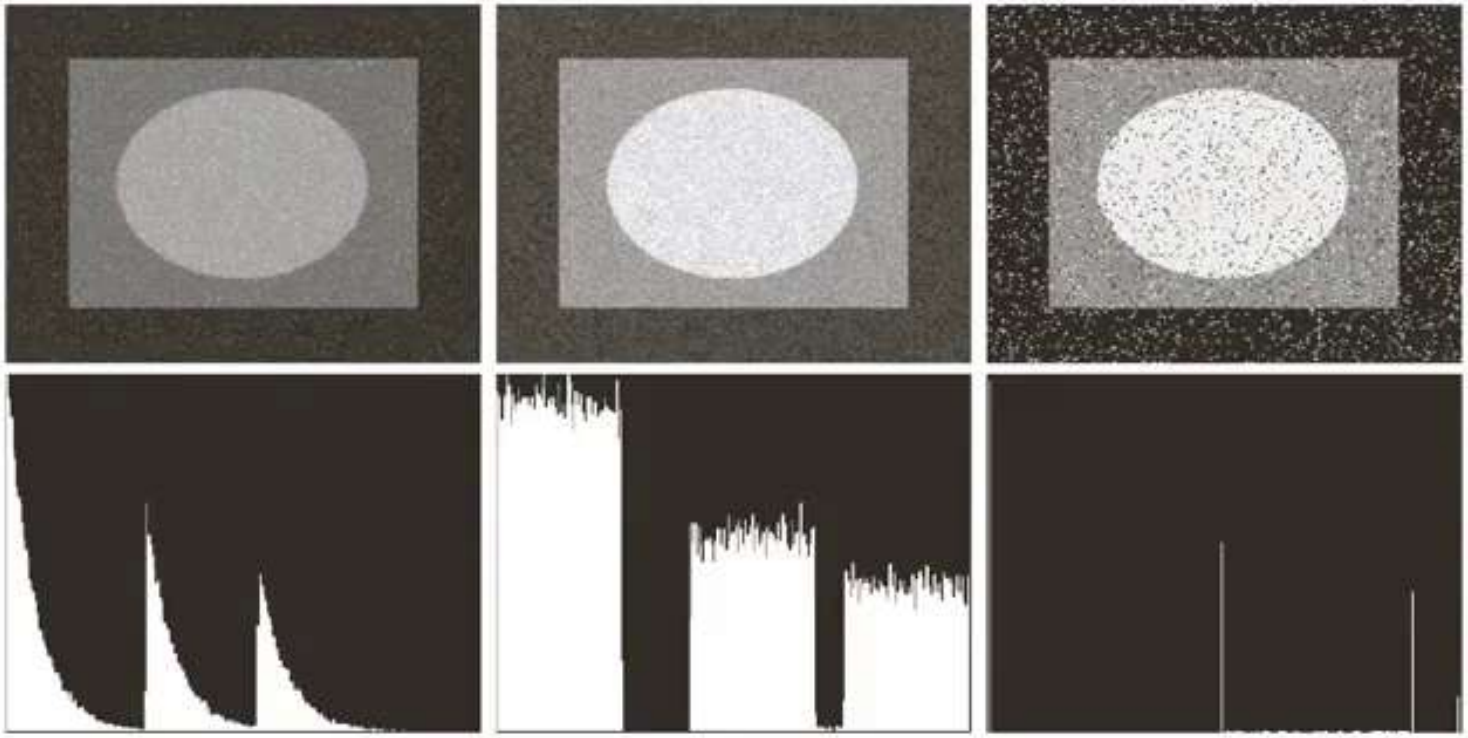

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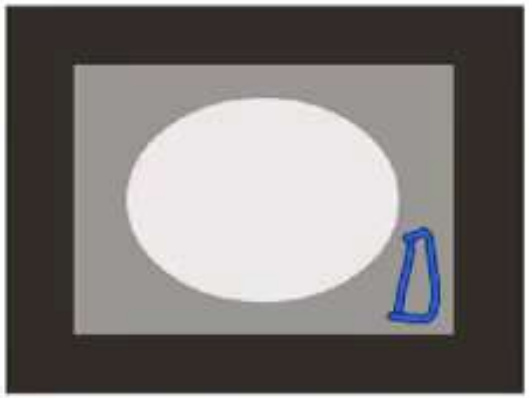

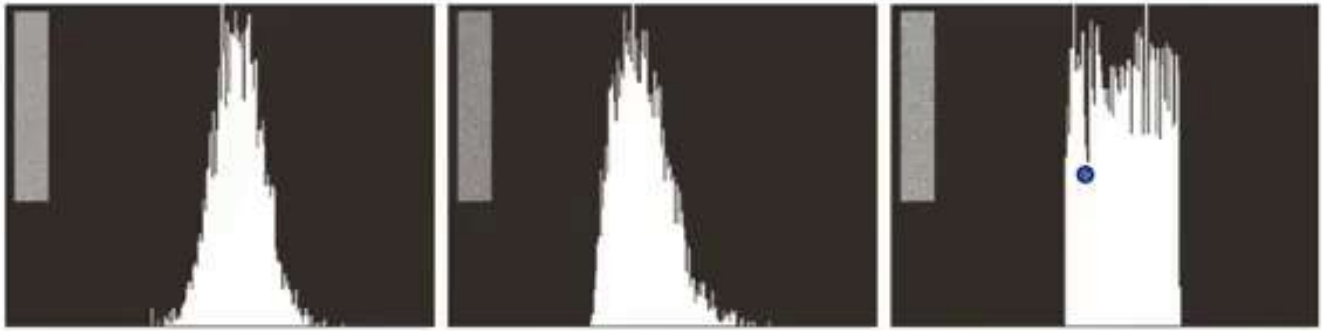

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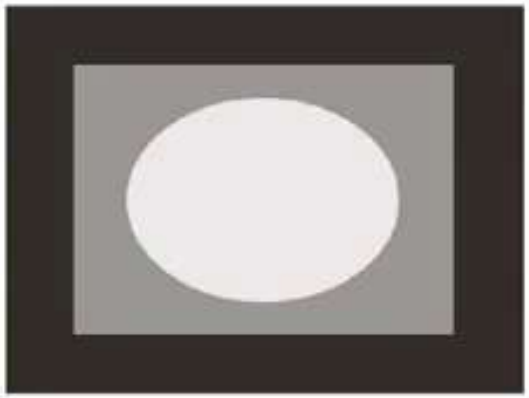

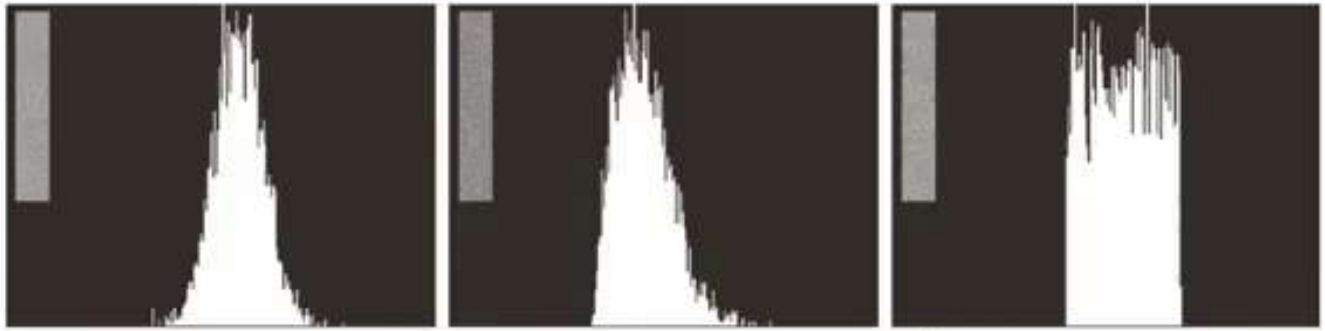

$$g(x,y) = f(x,y) + \eta(x,y)$$

$$\| \tilde{f}(x,y) - g(x,y) \|^2 \approx$$

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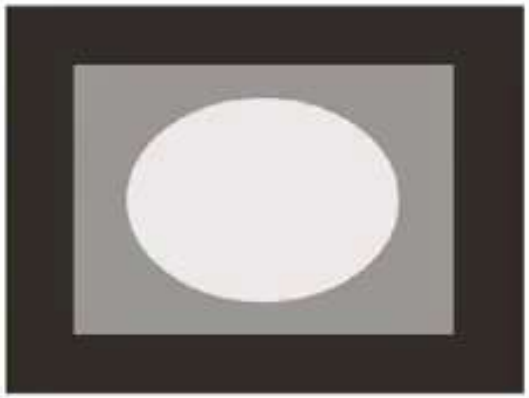

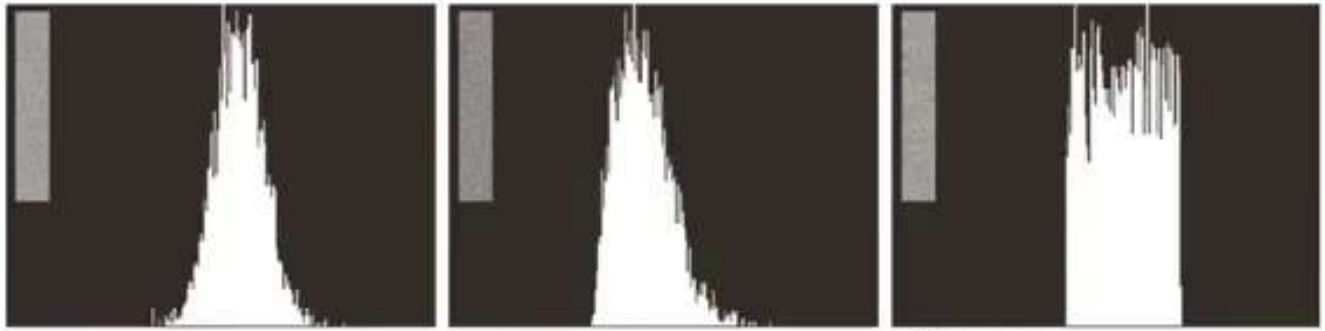

$$g(x,y) = f(x,y) + \eta(x,y)$$

$$\tilde{f} \approx f$$

$$\|\tilde{f}(x,y) - g(x,y)\|^2$$

$$|\tilde{f} - g|$$

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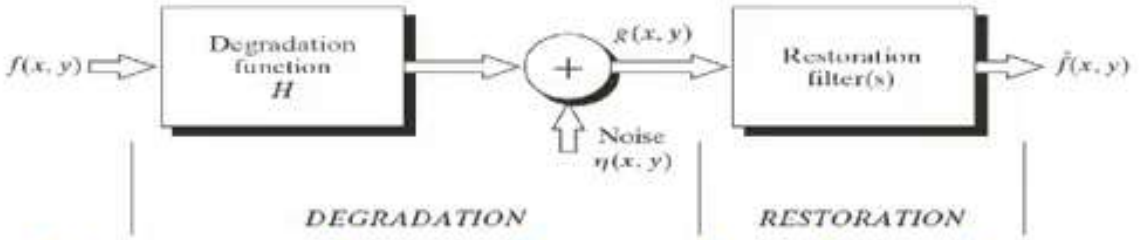

FIGURE 5.1 A model of the image degradation/restoration process.

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

$$G(u,v) = F(u,v) \cdot H(u,v)$$

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

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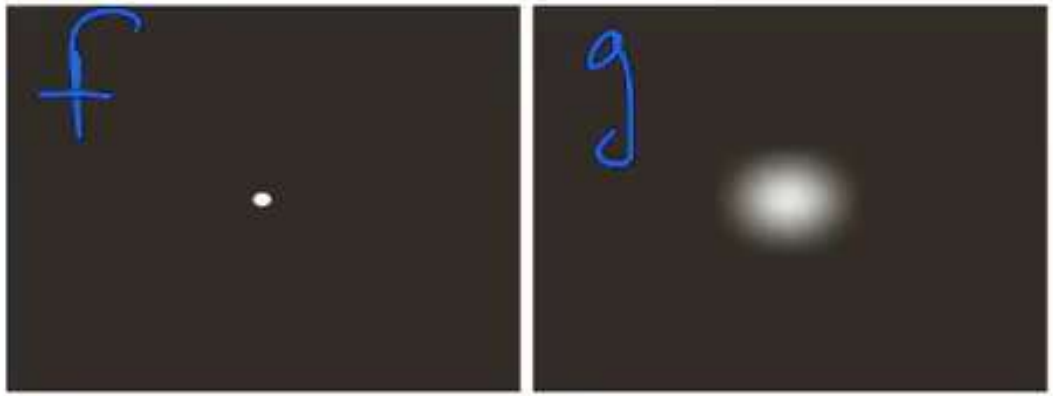
a b

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



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

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

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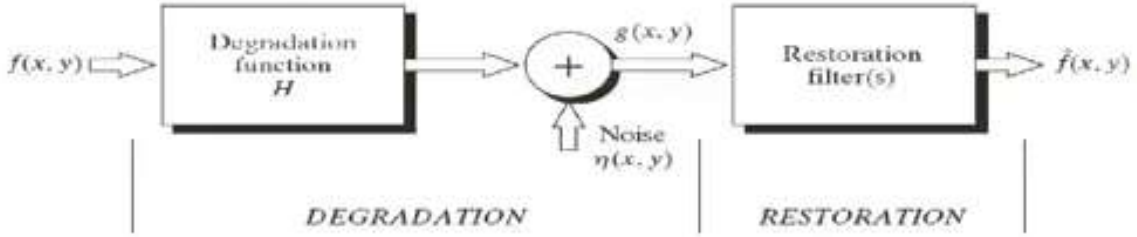
$$g(x,y) = \int_0^T f(x - x(t), y - y(t))\,dt$$

$$G = HF$$

Wiener Filtering



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

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

K

http://en.wikipedia.org/wiki/Wiener_filter

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$\frac{1}{H}$ Gaussian

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

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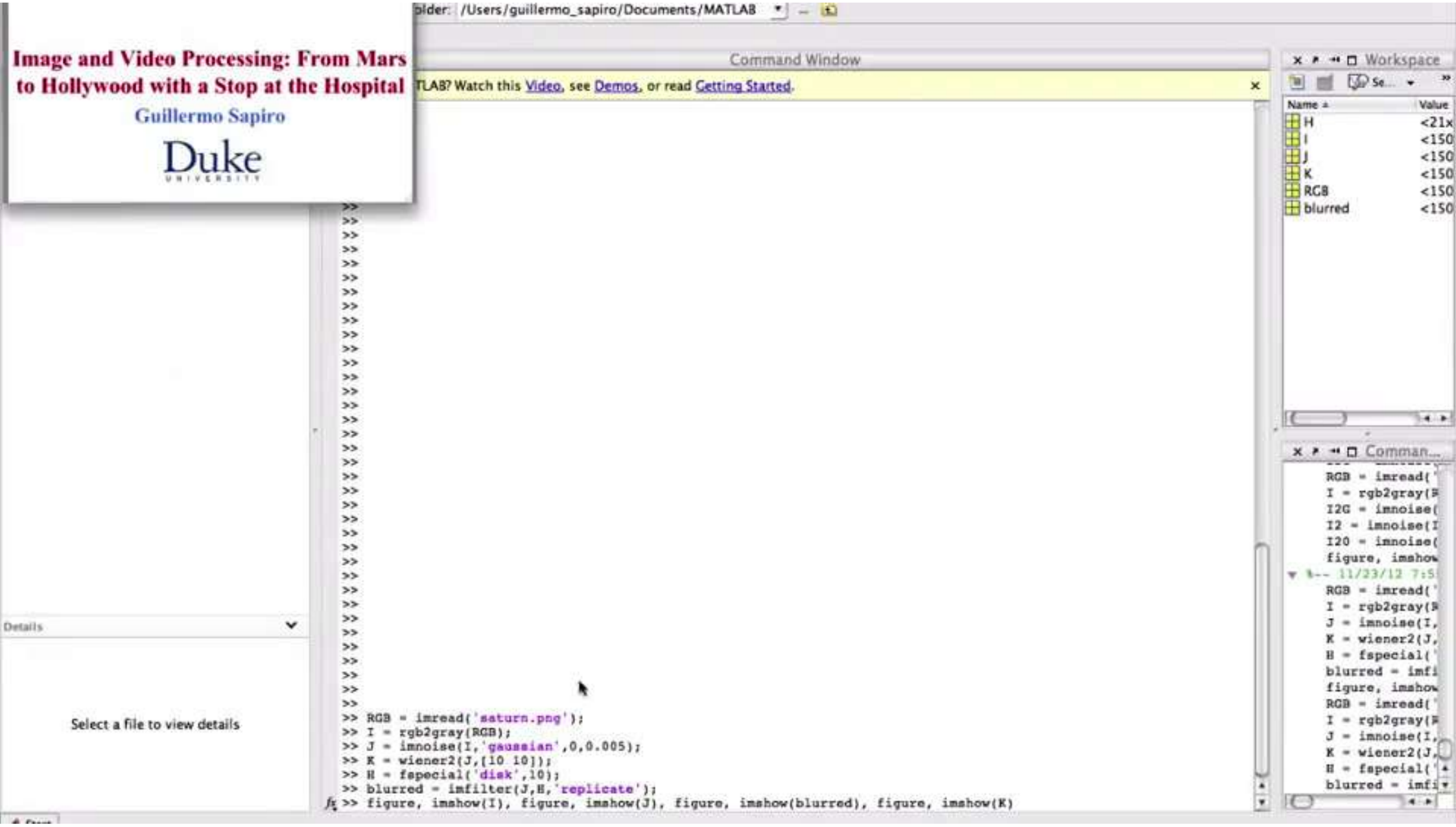
$$\frac{1}{H}$$

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

a b c
d e f
g h i

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.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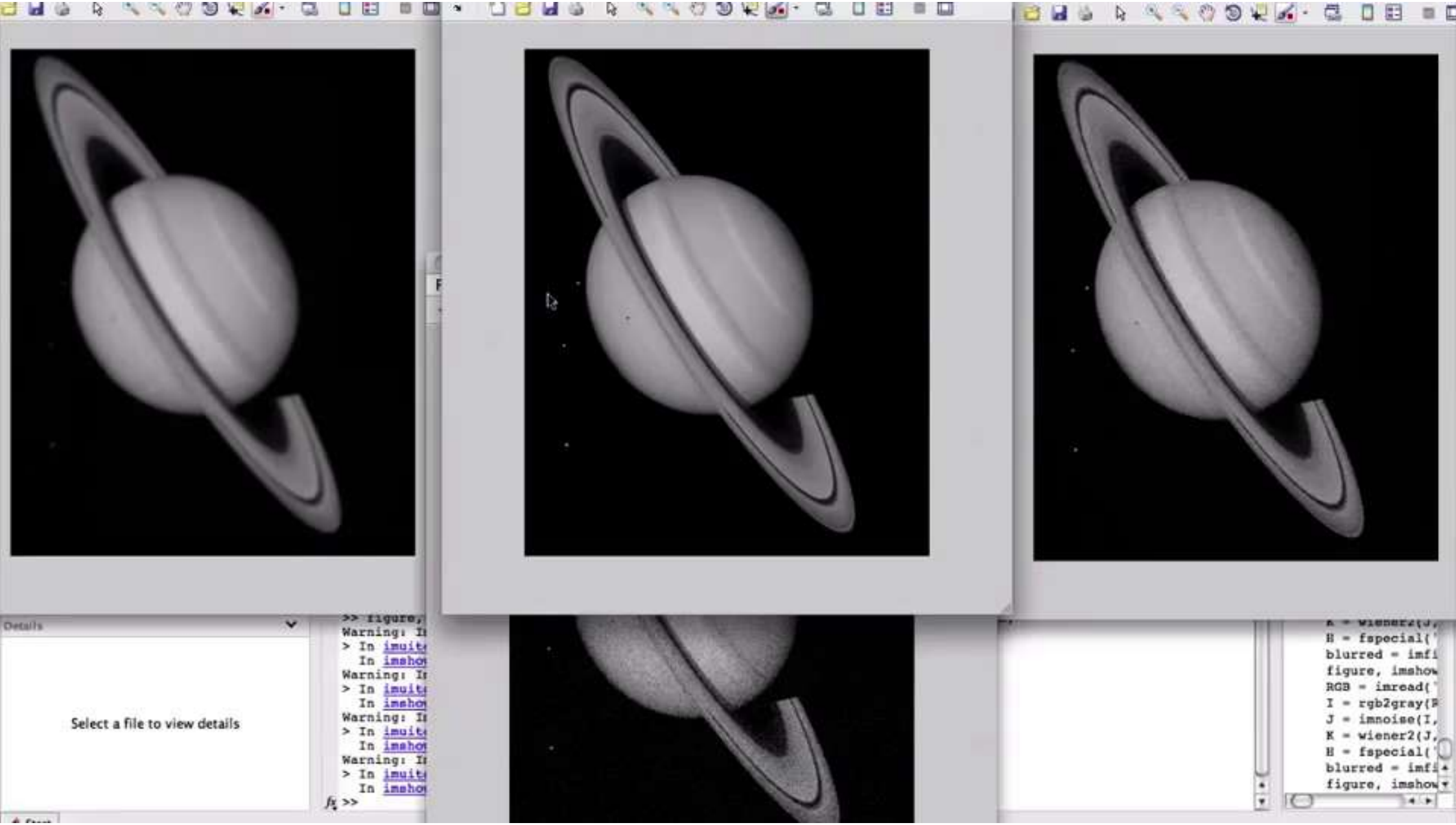
Guillermo Sapiro
Duke
UNIVERSITY
/Users/guillermo_sapiro/Documents/MATLAB
Command Window
TLAB? Watch this Video, see Demos, or read Getting Started.
Workspace
Name
Value
H
I
J
K
RGB
blurred
Details
Select a file to view details
RGB = imread('saturn.png');
I = rgb2gray(RGB);
J = imnoise(I,'gaussian',0,0.005);
K = wiener2(J,[10 10]);
H = fspecial('disk',10);
blurred = imfilter(J,H,'replicate');
figure, imshow(I), figure, imshow(J), figure, imshow(blurred), figure, imshow(K)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H = fspecial('
blurred = imfi
figure, imshow
RGB = imread('
I = rgb2gray(R
J = imnoise(I,
K = wiener2(J,
H = fspecial('
blurred = imfi
figure, imshow

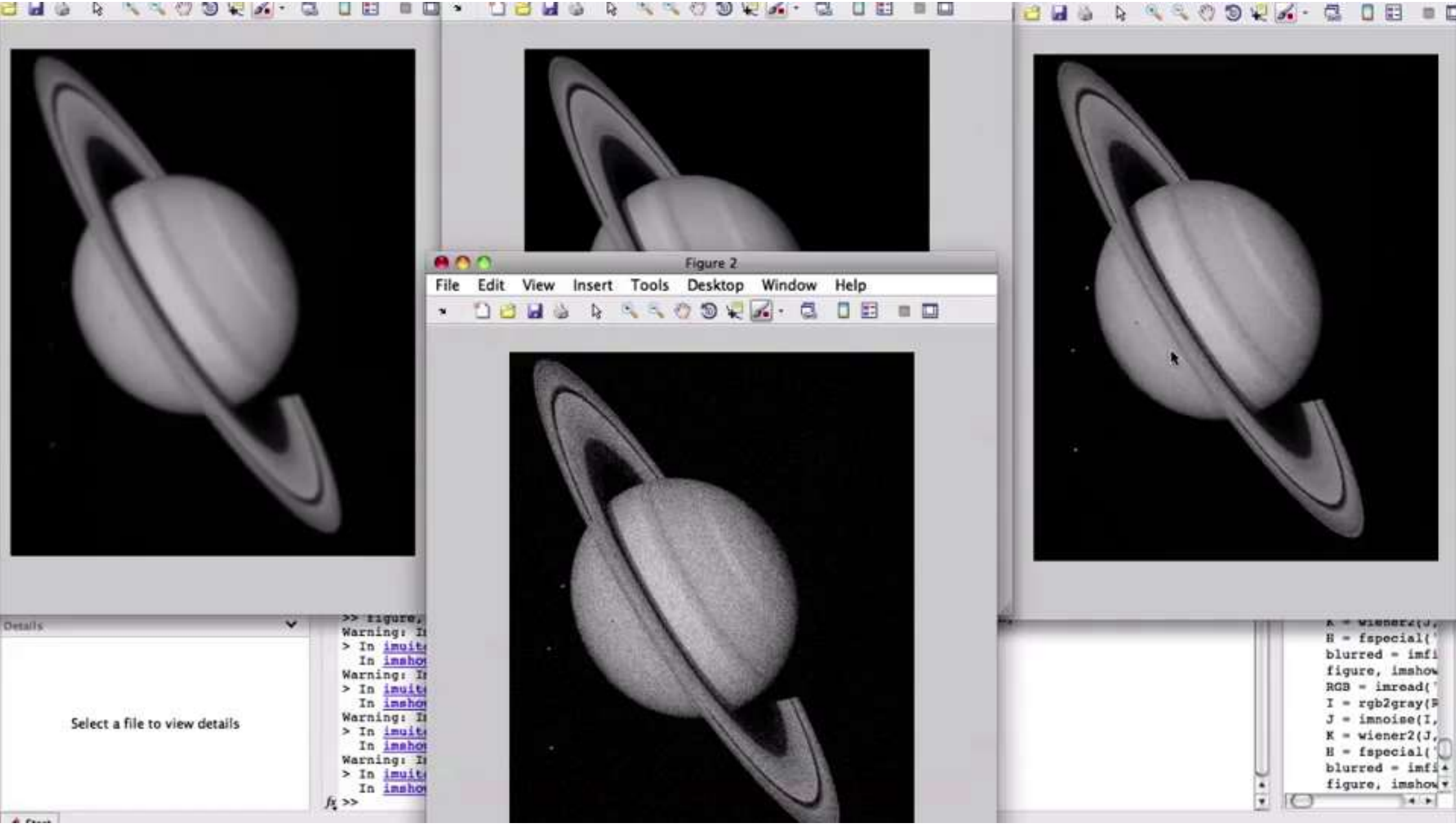
Figure 2
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figure, imshow
RGB = imread('
I = rgb2gray(R
J = imnoise(I,
K = wiener2(J,
H = fspecial('
blurred = imfi
figure, imshow