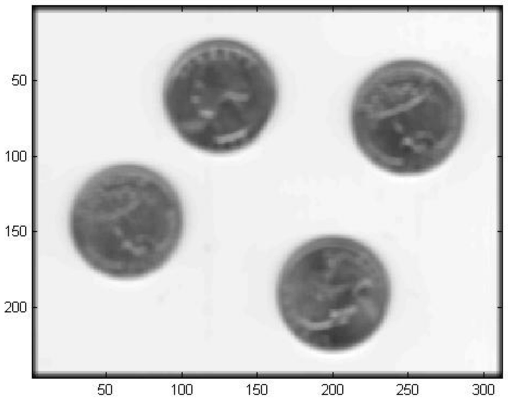
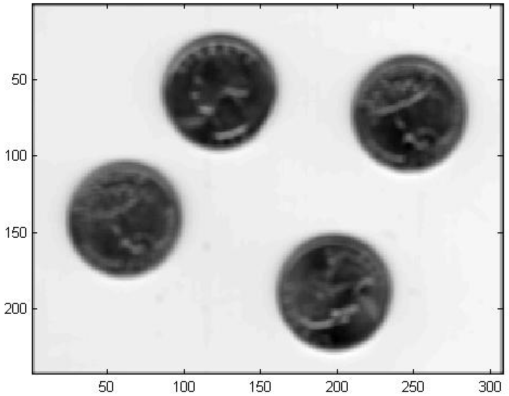
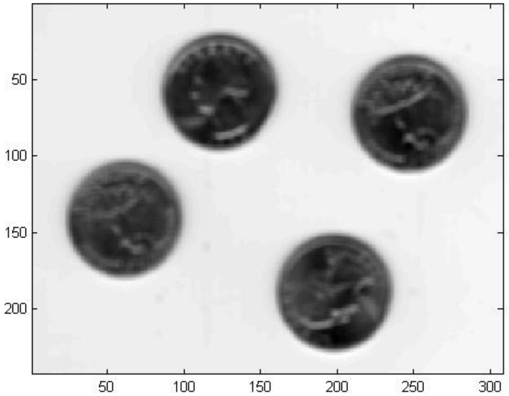
A (Original image)



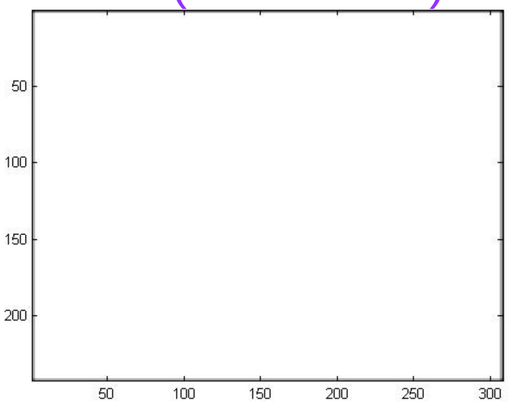
B (convolution)



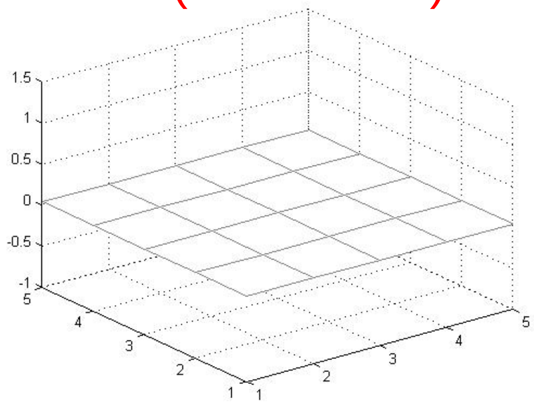
B (convolution)



B (convolution)

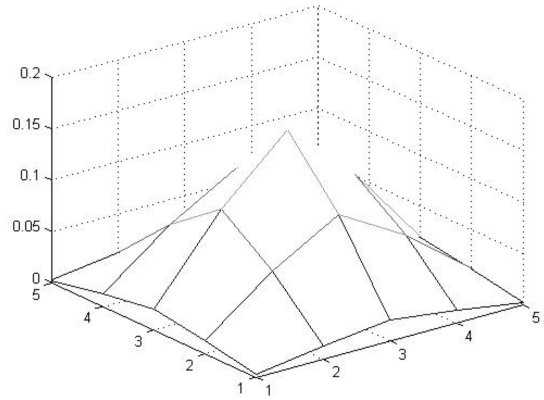


C1

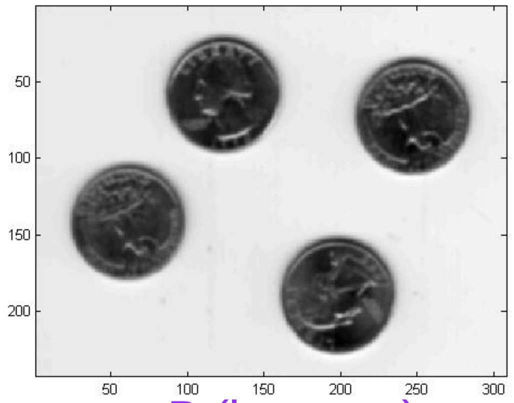


M

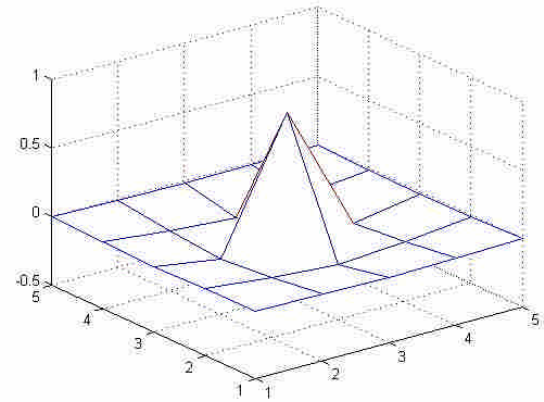
```
A=imread('eight.tif');
A=double(A);
imagesc(A)
colormap(gray)
M=ones(5)/25;
B=conv2(A,M);
figure
imagesc(B)
colormap(gray)
B=conv2(A,M,'same');
imagesc(B)
colormap(gray)
C=ones(size(B));
B=conv2(A,M,'same')./
conv2(C,M,'same');
imagesc(B)
colormap(gray)
C1=conv2(C,M,'same');
figure
colormap(gray)
imagesc(C1*255)
mesh(M)
```



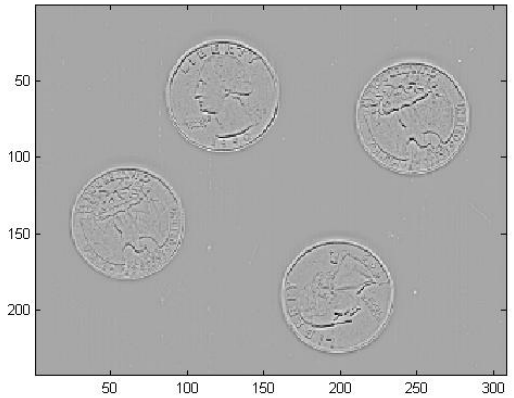
M1



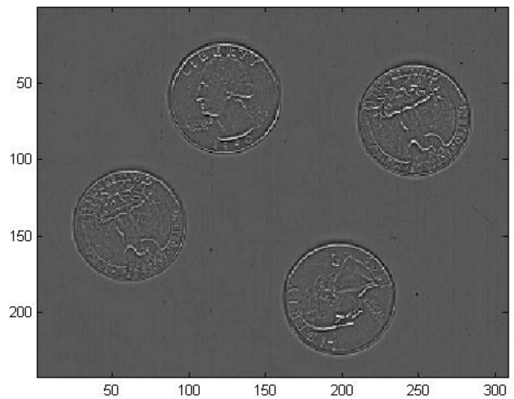
B (lowpass)



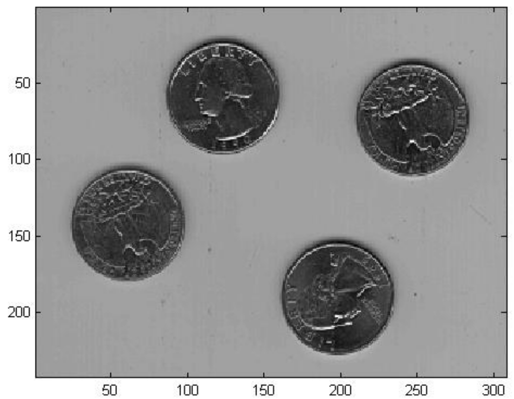
M2



B (highpass)



C (highpass=1-lowpass)



C+A (highboost)

```
f=[.05 .25 .4 .25 .05];
M1=f'*f;
mesh(M1)
B=conv2(A,M1,'same')./
conv2(C,M1,'same');
figure
imagesc(B)
colormap(gray)
D=zeros(5);
D(3,3)=1;
M2=D-M1;
mesh(M2)
B=conv2(A,M2,'same')./
conv2(C,M2,'same');
imagesc(B)
B=conv2(A,M1,'same')./
conv2(C,M1,'same');
C=A-B;
imagesc(C)
imagesc(C+A)
```

a
b c
d e

FIGURE 3.44 A 3 × 3 region of an image (the z's are gray-level values) and masks used to compute the gradient at point labeled z_5. All masks coefficients sum to zero, as expected of a derivative operator.

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Roberts Cross-Gradient

−1	0
0	1

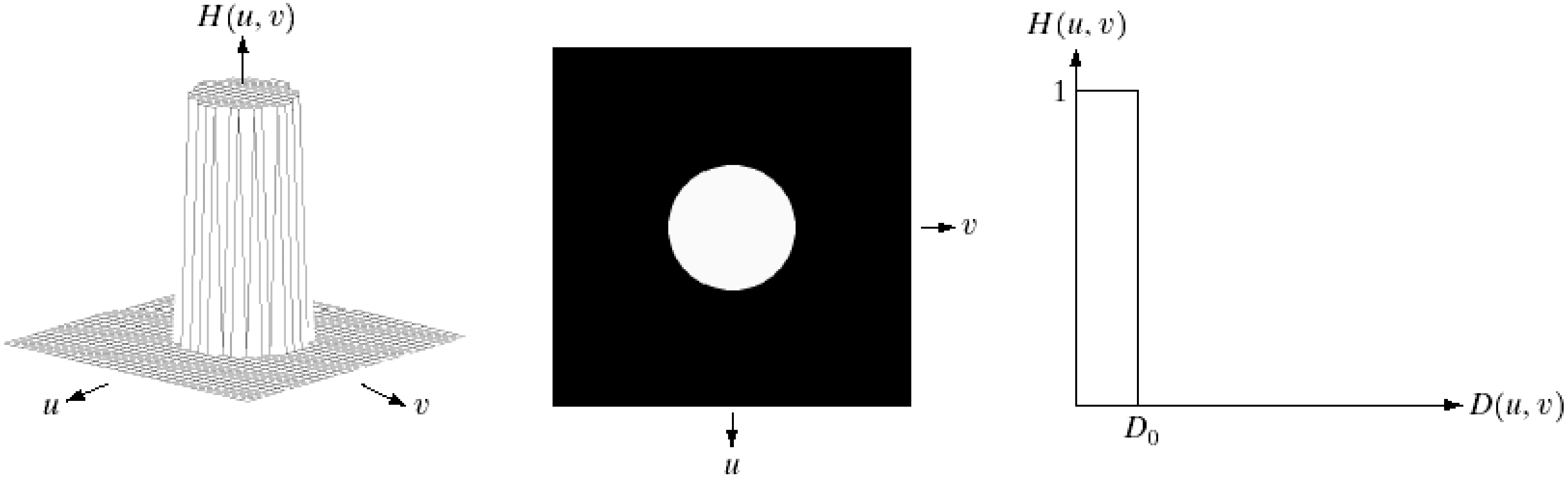
0	−1
1	0

Sobel Operators

−1	−2	−1
0	0	0
1	2	1

−1	0	1
−2	0	2
−1	0	1

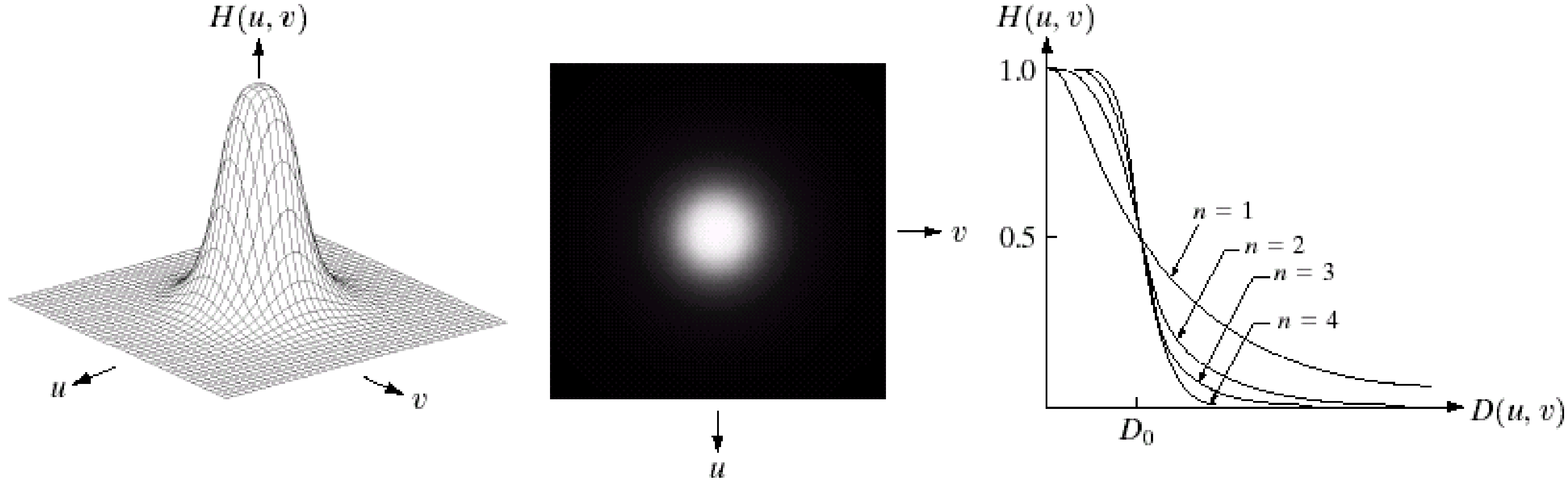
Ideal lowpass filters



a b c

FIGURE 4.10 (a) Perspective plot of an ideal lowpass filter transfer function. (b) Filter displayed as an image. (c) Filter radial cross section.

Butterworth Lowpass Filter



a b c

FIGURE 4.14 (a) Perspective plot of a Butterworth lowpass filter transfer function. (b) Filter displayed as an image. (c) Filter radial cross sections of orders 1 through 4.

Butterworth Lowpass Filter

- This filter does not have a sharp discontinuity establishing a clear cutoff between passed and filtered frequencies.

$$H(u,v) = \frac{1}{1 + [D(u,v) / D_0]^{2n}}$$

where D_0 is the cutoff frequency , and D(u,v) is

$$D(u,v) = [(u - M/2)^2 + (v - N/2)^2]^{1/2}$$

- This is more appropriate for image smoothing than the ideal LPF, since this does not introduce ringing.

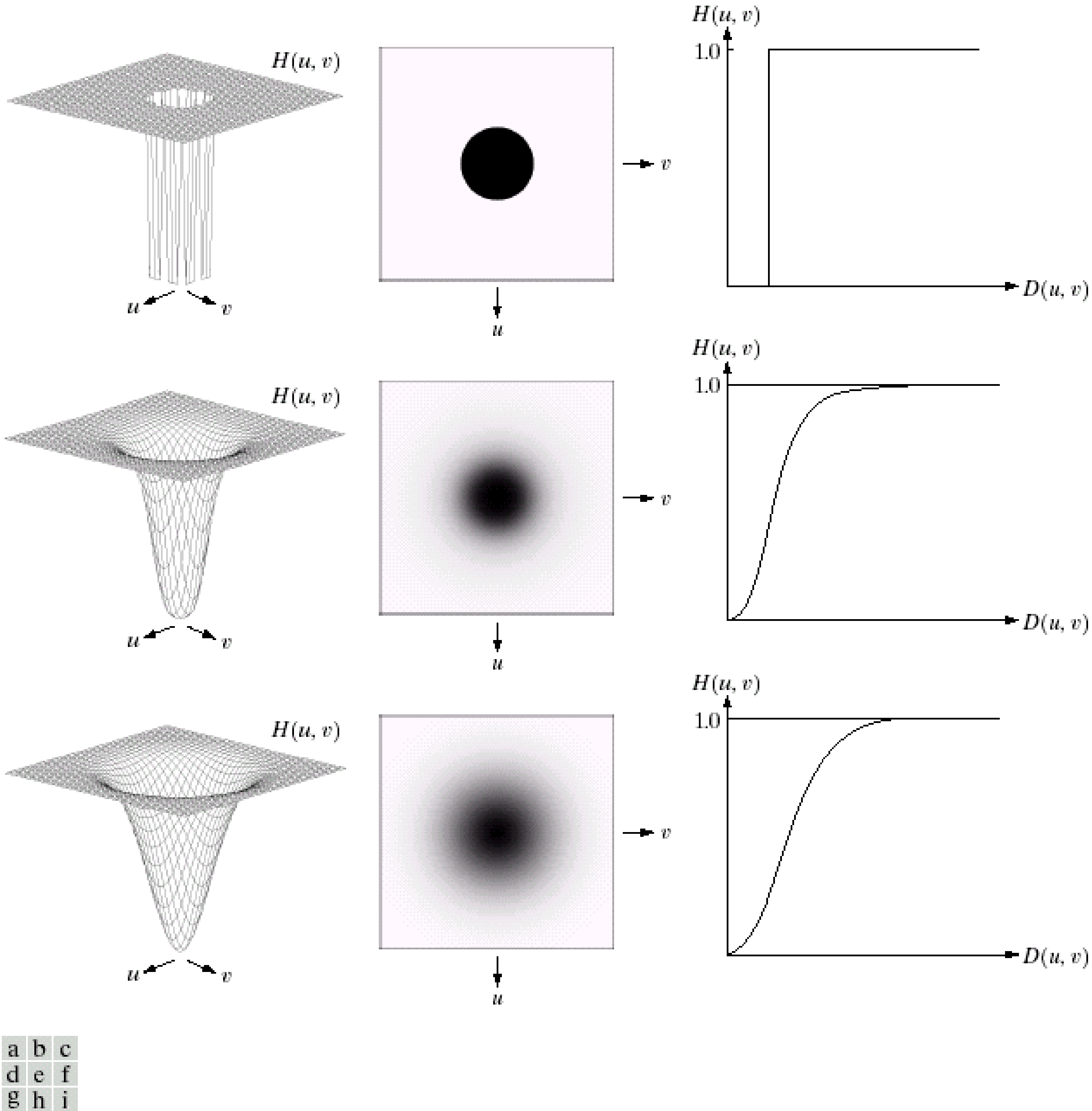


FIGURE 4.22 Top row: Perspective plot, image representation, and cross section of a typical ideal highpass filter. Middle and bottom rows: The same sequence for typical Butterworth and Gaussian highpass filters.

Gaussian Lowpass Filter

- Gaussian lowpass filter is defined by

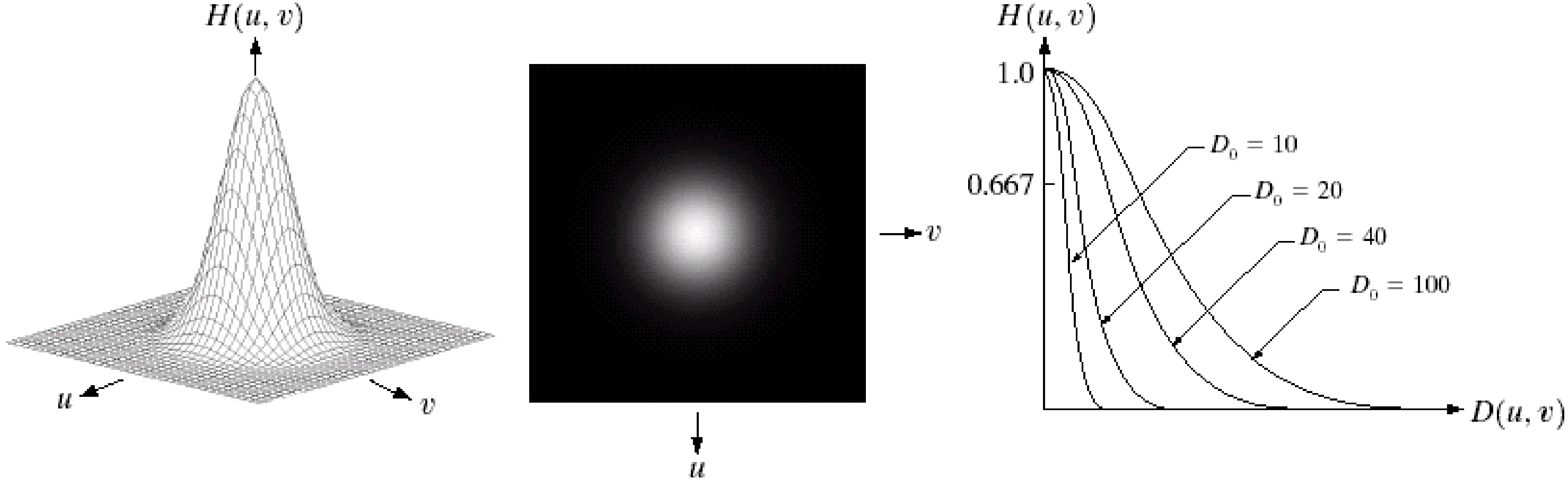
$$H(u,v) = e^{-D^2(u,v)/2\sigma^2}$$

D(u,v) is the distance from the origin of the Fourier transform.
by letting σ =D_0, we have

$$H(u,v) = e^{-D^2(u,v)/2D_0^{\,2}}$$

where D_0 is the cutoff frequency.

Gaussian Lowpass Filter



a b c

FIGURE 4.17 (a) Perspective plot of a GLPF transfer function. (b) Filter displayed as an image. (c) Filter radial cross sections for various values of D_0.