Scilab Textbook Companion for Digital Image Processing by S. Jayaraman, S. Esakkirajan And T. Veerakumar[1]

Created by
R.Senthilkumar
M.E., Assistant Professor
Electronics Engineering
Inst. of Road and Transport Tech., Erode
College Teacher
Dr. R.K.Gnanamurhty, Principal,V. C. E. W.
Cross-Checked by
Anuradha Amrutkar, IIT Bombay

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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List of Scilab Codes

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Chapter 1

Introduction to Image Processing System

Scilab code Exa 1.3 Program to calculate number of samples required for an image

```
1 //Caption:Program to calculate number of samples
    required for an image
2 //Example1.3
3 //page 12
4 clc;
5 close;
6 //dimension of the image in inches
7 m = 4;
8 n = 6;
9 N = 400; //number of dots per inch in each direction
10 N2 = 2*N; //number of dots per inch in both
    horizontal & vertical
11 Fs = m*N2*n*N2;
12 disp(Fs,'Number of samples reuqired to preserve the
    information in the image=')
13 //Result
14 //Number of samples reuqired to preserve the
    information in the image=
```

```
15 //15360000.
```

check Appendix AP 4 for dependency:

gray.sci

check Appendix AP 5 for dependency:

grayslice.sci

Scilab code Exa 1.13 False contouring Scilab code

```
1  //Caption: False contouring Scilab code
2  //Fig1.13
3  //page 13
4  clc;
5  close;
6  a =ReadImage('E:\DIP_JAYARAMAN\Chapter1\tigerpub.jpg
       ');
7  a = uint8(a);
8  figure
9  imshow(a)
10 title('Original image');
11 //using 128 gray levels
12 figure
13 a_128 = grayslice(a,128);
14 gray_128 = gray(128);
15 ShowImage(a_128,'Image with 128 gray levels',
       gray_128);
16 //using 64 gray levels
17 figure
18 a_64 = grayslice(a,64);
19 gray_64 = gray(64);
20 ShowImage(a_64,'Image with 64 gray levels',gray_64);
21 //using 32 gray levels
22 figure
23 a_32 = grayslice(a,32);
```

Figure 1.1: False contouring Scilab code

```
gray_32 = gray(32);
ShowImage(a_32,'Image with 32 gray levels',gray_32);
//using 16 gray levels
figure
a_16 = grayslice(a,16);
gray_16 = gray(16);
ShowImage(a_16,'Image with 16 gray levels',gray_16);
//using 8 gray levels
a_8 = grayslice(a,8);
gray_8 = gray(8);
ShowImage(a_8,'Image with 8 gray levels',gray_8);
```

Chapter 2

2D Signals and Systems

Scilab code Exa 2.12 Frequency Response

```
1 //Caption: Frequency Response
2 //Fig2.12
3 //page 60
4 clc;
5 close;
6 [X, Y] = meshgrid(-%pi:.09:%pi);
7 Z = 2*cos(X)+2*cos(Y);
8 surf(X,Y,Z);
9 xgrid(1)
```

Scilab code Exa 2.16 Frequency Response

```
1 //Caption: Frequency Response
2 //Fig2.16
3 //page 64
```

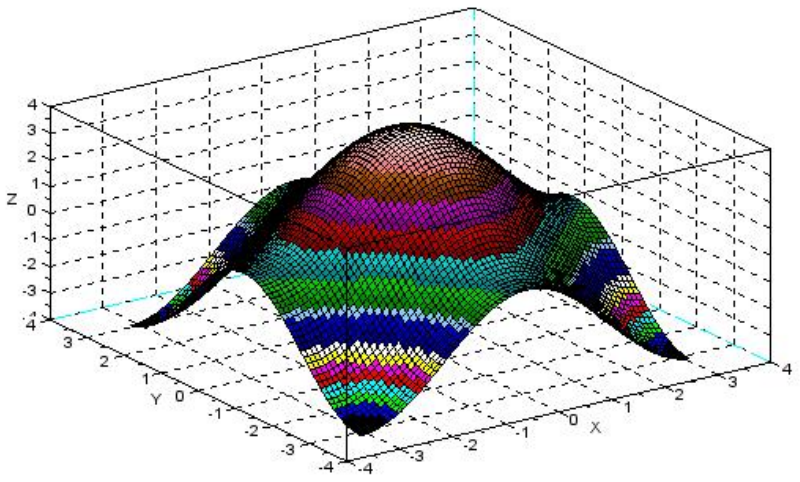


Figure 2.1: Frequency Response

```
4 clc;
5 close;
6 [X, Y] = meshgrid(-%pi:.05:%pi);
7 Z = 2-cos(X)-cos(Y);
8 surf(X,Y,Z);
9 xgrid(1)
```

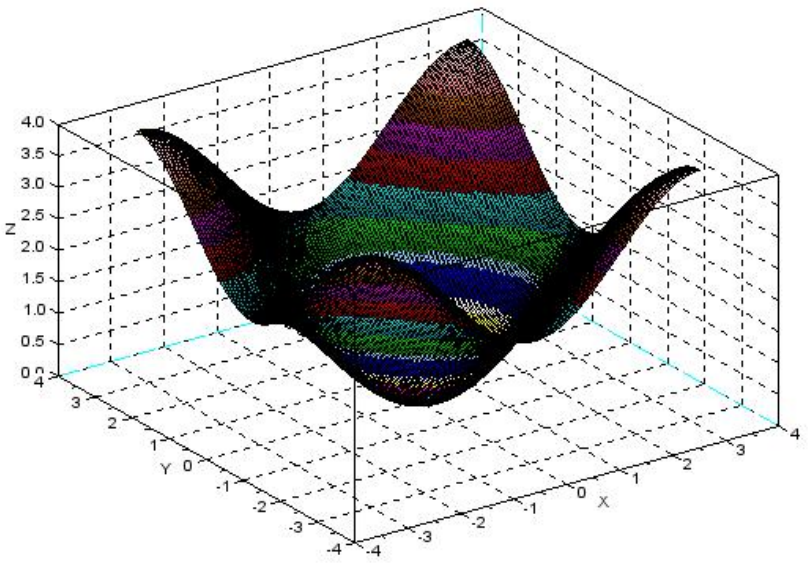


Figure 2.2: Frequency Response

Chapter 3

Convolution and Correlation

Scilab code Exa 3.1 2D Linear Convlolution

```
1 //Caption: 2-D Linear Convolution
2 //Example3.1 & Example3.4
3 //page 85 & page 107
4 clc;
5 x =[4,5,6;7,8,9];
6 h = [1;1;1];
7 disp(x,'x=')
8 disp(h,'h=')
9 [y,X,H] = conv2d2(x,h);
10 disp(y,'Linear 2D convolution result y =')
11 //Result
12 //Linear 2D convolution result y =
13 //
14 //    4.    5.    6.
15 //    11.   13.   15.
16 //    11.   13.   15.
17 //    7.    8.    9.
```

Scilab code Exa 3.2 2D Linear Convolution

```
//Caption: 2-D Linear Convolution
//Example3.2 & Example3.5 & Example3.9
//page 91 & page 108 & page 116
clc;
x =[1,2,3;4,5,6;7,8,9];
h = [1,1;1,1;1,1];
y = conv2d2(x,h);
disp(y,'Linear 2D convolution result y =')
//Result
// Linear 2D convolution result y =
//
//    1.    3.    5.    3.
//    5.    12.   16.   9.
//    12.   27.   33.   18.
//    11.   24.   28.   15.
//    7.    15.   17.   9.
//
```

Scilab code Exa 3.3 2D Linear Convolution

```
//Caption: 2-D Linear Convolution
//Example3.3 & Example3.6 & Example3.10
//page 100 & page 109 & page 119
clc;
x =[1,2,3;4,5,6;7,8,9];
h = [3,4,5];
y = conv2d2(x,h);
disp(y,'Linear 2D convolution result y =')
//Result
//Linear 2D convolution result y =
//
//    3.    10.   22.   22.   15.
//    12.   31.   58.   49.   30.
//    21.   52.   94.   76.   45.
```

Scilab code Exa 3.7 2D Linear Convolution

```
1 //Caption: 2-D Linear Convolution
2 //Example3.7
3 //page 111
4 clc;
5 x =[1,2;3,4];
6 h = [5,6;7,8];
7 y = conv2d2(x,h);
8 disp(y,'Linear 2D convolution result y =')
9 //Result
10 // Linear 2D convolution result y =
11 //Linear 2D convolution result y =
12 //
13 //    5.    16.    12.
14 //    22.    60.    40.
15 //    21.    52.    32
```

Scilab code Exa 3.8 2D Linear Convolution

```
1 //Caption: 2-D Linear Convolution
2 //Example3.8
3 //page 113
4 clc;
5 x =[1,2,3;4,5,6;7,8,9];
6 h = [1;1;1];
7 y = conv2d2(x,h);
8 disp(y,'Linear 2D convolution result y =')
9 //Result
10 // Linear 2D convolution result y =
11 //// 1.    2.    3.
12 //    5.    7.    9.
```

```
13 //     12.     15.     18.
14 //     11.     13.     15.
15 //     7.      8.      9.
```

Scilab code Exa 3.11 Linear Convolution of any signal with an impule signal given rise to the same signal

```
1  //Caption: Linear COnvolution of any signal with an
       impulse signal gives
2  //rise to the same signal
3  //Example3.11
4  //page 121
5  clc;
6  x =[1,2;3,4];
7  h = 1;
8  y = conv2d2(x,h);
9  disp(y,'Linear 2D convolution result y =')
10 //Result
11 //Linear 2D convolution result y =
12 //// Linear 2D convolution result y =
13 //
14 //     1.     2.
15 //     3.     4.
```

Scilab code Exa 3.12 Circular Convolution between two 2D matrices

```
1  //Caption: Circular Convolution between two 2D
       matrices
2  //Example3.12
3  //page 122
4  clc;
5  x = [1,2;3,4];
6  h = [5,6;7,8];
```

```
7  X = fft2d(x); //2D FFT of x matrix
8  H = fft2d(h); //2D FFT of h matrix
9  Y = X.*H;  //Element by Element multiplication
10 y = ifft2d(Y);
11 disp(y,'Circular Convolution Result y =')
12 //Result
13 //Circular Convolution Result y =
14 //
15 //    70.    68.
16 //    62.    60.
```

Scilab code Exa 3.13 Circular Convolution exspressed as linear convolution plus alias

```
1  //Caption: Circular Convolution expressed as linear
      convolution plus alias
2  //Example3.13
3  //page 123
4  clc;
5  x = [1,2;3,4];
6  h = [5,6;7,8];
7  y = conv2d(x,h);
8  y1 = [y(:,1)+y(:,$),y(:,2)];
9  y2 = [y1(1,:)+y1($,:);y1(2,:)]
10 disp(y,'Linear Convolution result y=')
11 disp(y2,'circular convolution expessed as linear
      convolution plus alias =')
12 //Result
13 // Linear Convolution result y=
14 //
15 //    5.    16.    12.
16 //    22.    60.    40.
17 //    21.    52.    32.
18 //
19 // circular convolution expessed as linear
```

```
   convolution plus alias =
//
//     70.     68.
//     62.     60.
//
```

Scilab code Exa 3.14 Linear Cross correlation of a 2D matrix

```
//Caption: linear cross correlation of a 2D matrix
//Example3.14
//page 129
clc;
x = [3,1;2,4];
h1 = [1,5;2,3];
h2 = h1(:,$:-1:1);
h = h2($:-1:1,:);
y = conv2d(x,h)
disp(y,'Linear cross Correlation result y=')
//Result
//Linear cross Correlation result y=
//
//     9.      9.      2.
//     21.     24.     9.
//     10.     22.     4.
```

Scilab code Exa 3.15 Circular correlation between two signals

```
//Caption: Circular correlation between two signals
//Example3.15
//page 131
clc;
x = [1,5;2,4];
h = [3,2;4,1];
```

```
h = h(:,$:-1:1);
h = h($:-1:1,:);
X = fft2d(x);
H = fft2d(h);
Y = X.*H;
y = ifft2d(Y);
disp(y,'Circular Correlation result y=')
//Result
//Circular Correlation result y=
//
//    37.    23.
//    35.    25.
```

Scilab code Exa 3.16 Circular correlation between two signals

```
//Caption: Circular correlation between two signals
//Example3.16
//page 134
clc;
x = [5,10;15,20];
h = [3,6;9,12];
h = h(:,$:-1:1);
h = h($:-1:1,:);
X = fft2d(x);
H = fft2d(h);
Y = X.*H;
y = ifft2d(Y);
disp(y,'Circular Correlation result y=')
//Result
// Circular Correlation result y=
//
//    300.    330.
//    420.    450.
```

Scilab code Exa 3.17 Linear auto correlation of a 2D matrix

```
1 //Caption: linear auto correlation of a 2D matrix
2 //Example3.17
3 //page 136
4 clc;
5 x1 = [1,1;1,1];
6 x2 = x1(:,$:-1:1);
7 x2 = x2($:-1:1,:);
8 x = conv2d(x1,x2)
9 disp(x,'Linear auto Correlation result x=')
10 //Result
11 //Linear auto Correlation result x=
12 //
13 //    1.    2.    1.
14 //    2.    4.    2.
15 //    1.    2.    1.
```

Scilab code Exa 3.18 Linear Cross correlation of a 2D matrix

```
1 //Caption: linear cross correlation of a 2D matrix
2 //Example3.18
3 //page 141
4 clc;
5 x = [1,1;1,1];
6 h1 = [1,2;3,4];
7 h2 = h1(:,$:-1:1);
8 h = h2($:-1:1,:);
9 y = conv2d(x,h)
10 disp(y,'Linear cross Correlation result y=')
11 //Result
12 //Linear cross Correlation result y=
```

```
13 //
14 //      4.      7.      3.
15 //      6.     10.      4.
16 //      2.      3.      1.
```

Chapter 4

Image Transforms

Scilab code Exa 4.4 DFT of 4x4 grayscale image

```
1 //Caption: 2D DFT of 4x4 grayscale image
2 //Example4.4
3 //page 170
4 clc;
5 f = [1,1,1,1;1,1,1,1;1,1,1,1;1,1,1,1];
6 N =4; //4-point DFT
7 kernel = dft_mtx(N);
8 F = kernel*(f*kernel');
9 disp(F,'2D DFT of given 2D image =')
10 //Result
11 //2D DFT of given 2D image =
12 //
13 //    16.    0    0    0
14 //    0      0    0    0
15 //    0      0    0    0
16 //    0      0    0    0
```

Scilab code Exa 4.5 2D DFT of 4X4 grayscale image

```
1  //Caption: 2D DFT of 4x4 grayscale image
2  //Example4.5
3  //page 171
4  clc;
5  F = [16,0,0,0;0,0,0,0;0,0,0,0;0,0,0,0];
6  N =4; //4-point DFT
7  kernel = dft_mtx(N);
8  f = (kernel*(F*kernel'))/(N^2);
9  f = real(f);
10 disp(f,'Inverse 2D DFT of the transformed image f =')
11 //Result
12 //Inverse 2D DFT of the transformed image f =
13 //
14 //     1.     1.     1.     1.
15 //     1.     1.     1.     1.
16 //     1.     1.     1.     1.
17 //     1.     1.     1.     1.
```

---

check Appendix AP 1 for dependency:

`fft2d.sce`

check Appendix AP 2 for dependency:

`ifft2d.sce`

Scilab code Exa 4.6 Scilab code to intergchange phase information between two images

```
1  //Caption:Scilab code  to intergchange phase
   information between two images
2  //Example4.6
3  //page 174-175
4  clc;
5  close;
```

```
a = imread('E:\DIP_JAYARAMAN\Chapter4\lena.png');
    //SIVP toolbox
b = imread('E:\DIP_JAYARAMAN\Chapter4\baboon.png');
a = rgb2gray(a);
b = rgb2gray(b);
a = imresize(a,0.5);
b = imresize(b,0.5);
figure(1)
ShowImage(a,'Original lena Image');     //IPD toolbox
title('Original lena Image');
figure(2)
ShowImage(b,'Original baboon Image');
title('Original baboon Image')
ffta = fft2d(double(a));
fftb = fft2d(double(b));
mag_a = abs(ffta);
mag_b = abs(fftb);
ph_a = atan(imag(ffta),real(ffta));
ph_b = atan(imag(fftb),real(fftb));
newfft_a = mag_a.*(exp(%i*ph_b));
newfft_b = mag_b.*(exp(%i*ph_a));
rec_a = ifft2d(newfft_a);
rec_b = ifft2d(newfft_b);
figure(3)
ShowImage(uint8(rec_a),'lena Image after phase
    reversal');
title('lena Image after phase reversal')
figure(4)
ShowImage(uint8(rec_b),'baboon Image after phase
    reversal');
title('baboon Image after phase reversal')
```

Scilab code Exa 4.10 Program to compute discrete cosine transform

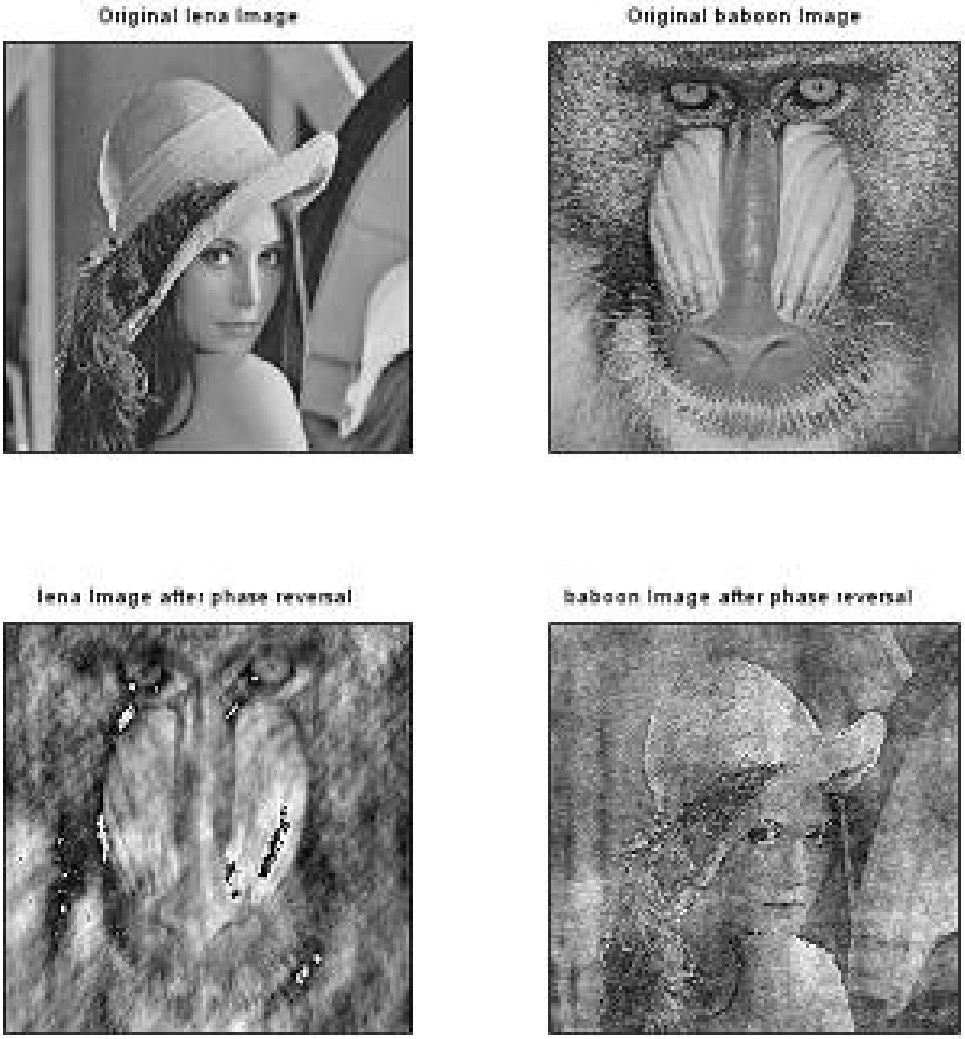


Figure 4.1: Scilab code to intergchange phase information between two images

```
1 //Caption: Program to compute discrete cosine
     tranform
2 //Example4.10
3 //page 198
4 clc;
5 N =4; //DCT matrix of order four
6 X = dct_mtx(N);
7 disp(X,'DCT matrix of order four')
8 //Result
9 //DCT matrix of order four
10 //
11 //    0.5          0.5          0.5          0.5
12 //    0.6532815    0.2705981  - 0.2705981  -
     0.6532815
13 //    0.5        - 0.5        - 0.5          0.5
14 //    0.2705981  - 0.6532815    0.6532815  -
     0.2705981
```

Scilab code Exa 4.12 Program to perform KL tranform for the given 2D matrix

```
1 //Caption: Program to perform KL transform for the
     given 2D matrix
2 //Example4.12
3 //page 208
4 clear;
5 clc;
6 X = [4,3,5,6;4,2,7,7;5,5,6,7];
7 [m,n]= size(X);
8 A = [];
9 E = [];
```

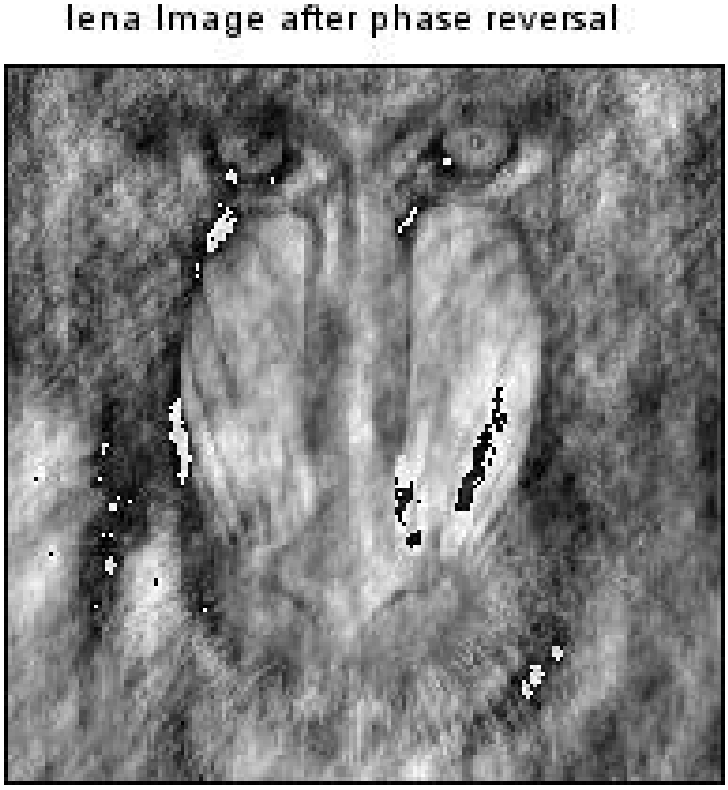


Figure 4.2: Program to compute discrete cosine transform

Figure 4.3: Program to compute discrete cosine transform

```
for i =1:n
    A = A+X(:,i);
    E = E+X(:,i)*X(:,i)';
end
mx = A/n;    //mean matrix
E = E/n;
C = E - mx*mx';//covariance matrix C = E[xx']-mx*mx'
[V,D] = spec(C); //eigen values and eigen vectors
d = diag(D); //diagonal elements od eigen values
[d,i] = gsort(d); //sorting the elements of D in
   descending order
for j = 1:length(d)
    T(:,j)= V(:,i(j));
end
T =T'
disp(d,'Eigen Values are U = ')
disp(T,'The eigen vector matrix T =')
disp(T,'The KL tranform basis is =')
//KL transform
for i = 1:n
    Y(:,i)= T*X(:,i);
end
disp(Y,'KL transformation of the input matrix Y =')
//Reconstruction
for i = 1:n
    x(:,i)= T'*Y(:,i);
end
disp(x,'Reconstruct matrix of the given sample
   matrix X =')
//Result
// Eigen Values are U =
//    6.1963372
//    0.2147417
//    0.0264211
// The eigen vector matrix T =
//    0.4384533    0.8471005    0.3002988
//    0.4460381  - 0.4951684    0.7455591
//  - 0.7802620    0.1929481    0.5949473
```

```
46 // The KL tranform basis is =
47 //    0.4384533    0.8471005    0.3002988
48 //    0.4460381  - 0.4951684    0.7455591
49 //  - 0.7802620    0.1929481    0.5949473
50 // KL transformation of the input matrix Y =
51 //    6.6437095    4.5110551    9.9237632
      10.662515
52 //    3.5312743    4.0755729    3.2373664
      4.4289635
53 //    0.6254808    1.0198466    1.0190104
      0.8336957
54 // Reconstruct matrix of the given sample matrix x =
55 //    4.    3.    5.    6.
56 //    4.    2.    7.    7.
57 //    5.    5.    6.    7.
```

Scilab code Exa 4.13 Program to find the singular value decomposition of given matrix

```
1  //Caption: Program to find the singular value
      decomposition of given matrix
2  //Example4.13
3  //page 210
4  clear;
5  clc;
6  A = [1,-2,3;3,2,-1];
7  [U,S,V]= svd(A);
8  A_recon = U*S*V';
9  disp(U,'U =')
10 disp(S,'S =')
11 disp(V,'V =')
12 disp(A_recon,'A matrix from svd =')
13 //Result
14 // U =
15 //
```

```
16 //   - 0.7071068    0.7071068
17 //     0.7071068    0.7071068
18 //
19 // S =
20 //
21 //     4.2426407    0.           0.
22 //     0.           3.1622777    0.
23 //
24 // V =
25 //
26 //     0.3333333    0.8944272  - 0.2981424
27 //     0.6666667  - 2.776D-16    0.7453560
28 //   - 0.6666667    0.4472136    0.5962848
29 //
30 // A matrix from svd =
31 //
32 //     1.   - 2.     3.
33 //     3.     2.   - 1.
```

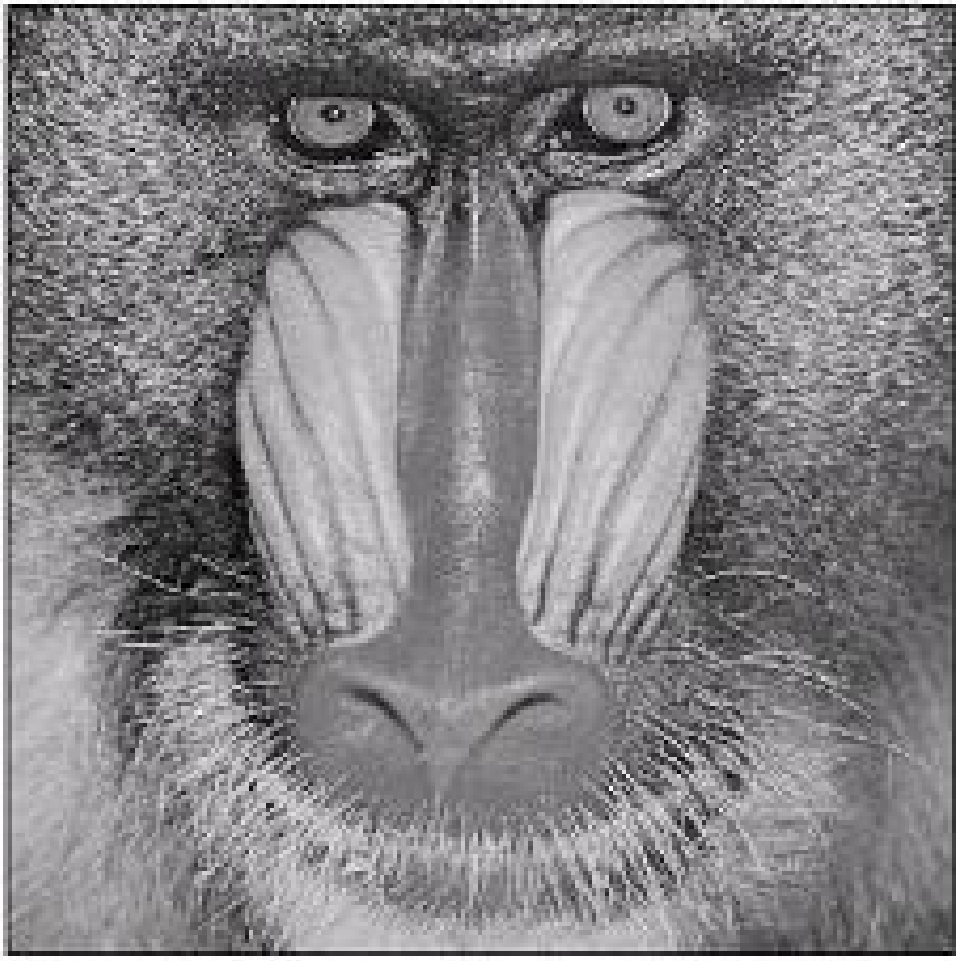
Chapter 5

Image Enhancement

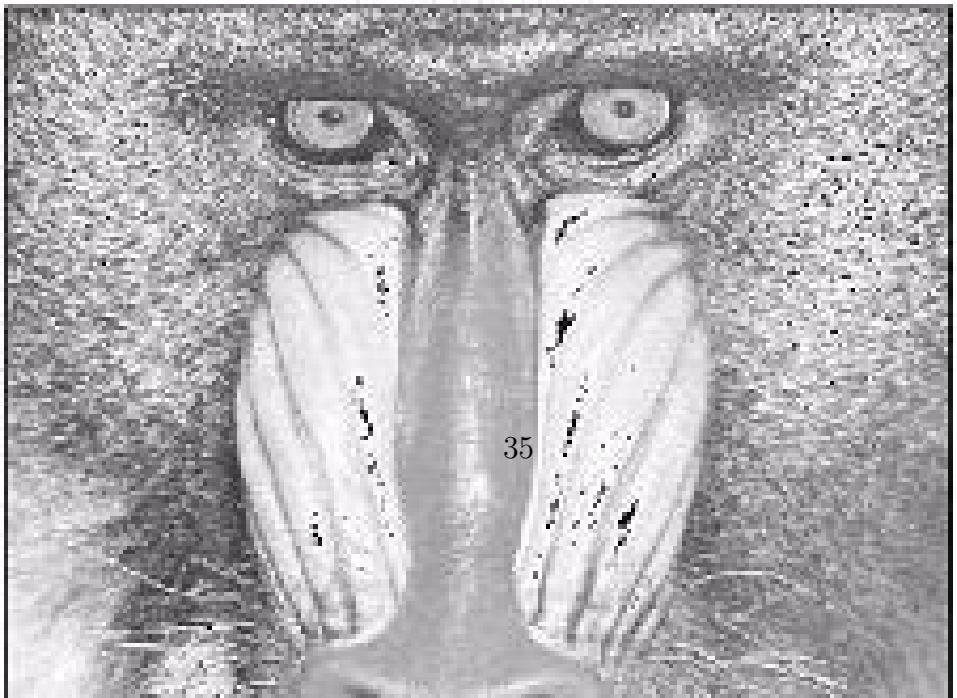
Scilab code Exa 5.5 Scilab code for brightness enhancement

```
1  //Caption:Scilab code for brightness enhancement
2  //Fig5.5
3  //page 246
4  clc;
5  close;
6  //a = imread('E:\DIP_JAYARAMAN\Chapter5\plate.GIF');
       //SIVP toolbox
7  a = imread('E:\DIP_JAYARAMAN\Chapter4\baboon.png');
8  a = rgb2gray(a);
9  b = double(a)+50;
10 b = uint8(b);
11 figure(1)
12 ShowImage(a,'Original Image');
13 title('Original Image')
14 figure(2)
15 ShowImage(b,'Enhanced Image');
16 title('Enhanced Image')
```

Original Image



Enhanced Image



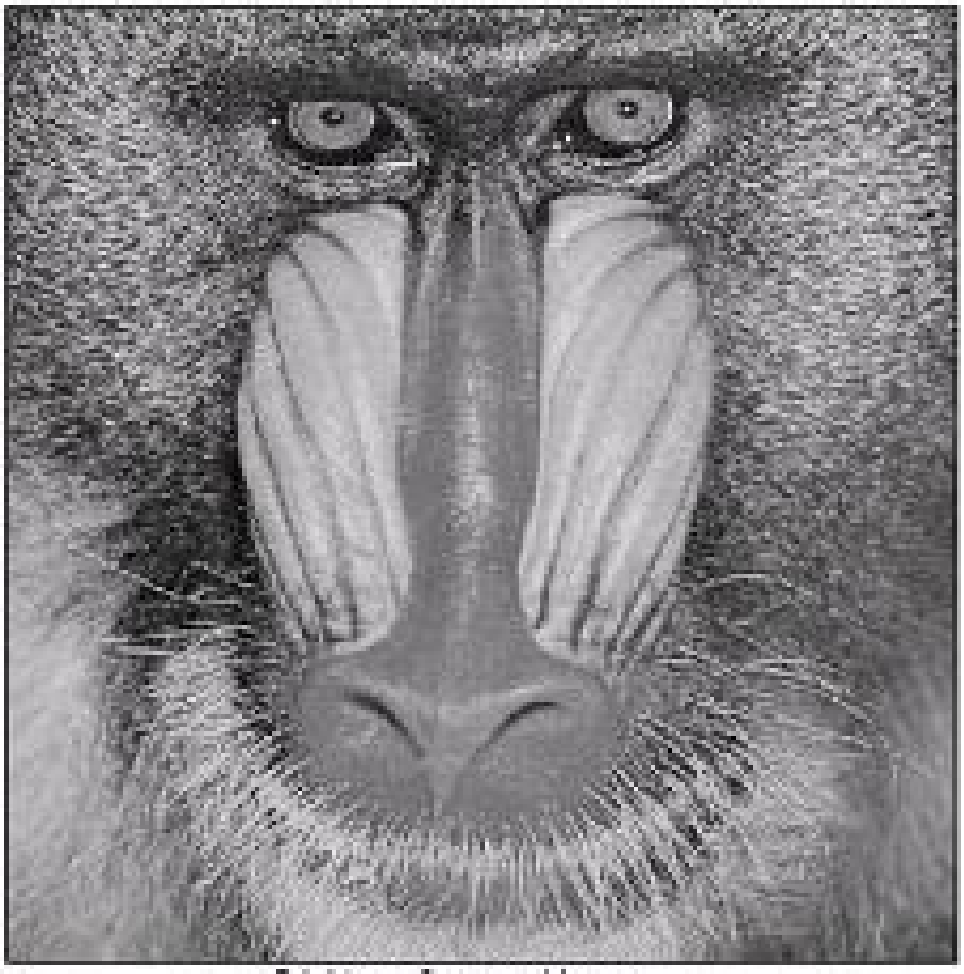
Scilab code Exa 5.7 Scilab code for brightness suppression

```
1 //Caption:Scilab code for  brightness suppression
2 //Fig5.7
3 //page 247
4 clc;
5 close;
6 a = imread('E:\DIP_JAYARAMAN\Chapter4\baboon.png');
7 a = rgb2gray(a);
8 b = double(a)-50;
9 b = uint8(b);
10 figure(1)
11 ShowImage(a,'Original Image');
12 title('Original Image')
13 figure(2)
14 ShowImage(b,'Brightness Supressed Image');
15 title('Brightness Supressed Image')
```

Scilab code Exa 5.9 Scilab code for Contrast Manipulation

```
1 //Caption:Scilab code for  Contrast Manipulation
2 //Fig5.9
3 //page 248
4 clc;
5 close;
6 a = imread('E:\DIP_JAYARAMAN\Chapter4\lena.png');
7 a = rgb2gray(a);
8 b = double(a)*0.5;
9 b = uint8(b)
10 c = double(b)*2;
```

Original Image



Brightness Supressed Image

```
11 c = uint8(c)
12 figure(1)
13 ShowImage(a,'Original Image');
14 title('Original Image')
15 figure(2)
16 ShowImage(b,'Decrease in Contrast');
17 title('Decrease in Contrast')
18 figure(3)
19 ShowImage(c,'Increase in Contrast');
20 title('Increase in Contrast')
```

Scilab code Exa 5.13 Scilab code to determine image negative

```
1 //Caption:Scilab code to determine image negative
2 //Fig.5.13
3 //page 252
4 clc;
5 close;
6 a = imread('E:\DIP_JAYARAMAN\Chapter5\label.jpg');
7 k = 255-double(a);
8 k = uint8(k);
9 imshow(a);
10 title('Original onca Image')
11 imshow(k);
12 title('Negative of Original Image')
```

Scilab code Exa 5.16 Scilab code that performs threshold operation

Figure 5.3: Scilab code for Contrast Manipulation

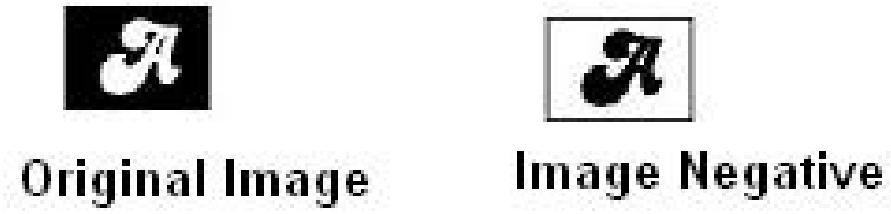


Figure 5.4: Scilab code to determine image negative

```
1  //Caption:Scilab code that performs threshold
       operation
2  //Fig5.16
3  //page 254
4  clc;
5  close;
6  a = imread('E:\Digital_Image_Processing_Jayaraman\
       Chapter5\lena.png');
7  a = rgb2gray(a);
8  [m n] = size(a);
9  t = input('Enter the threshold parameter');
10 for i = 1:m
11     for j = 1:n
12         if(a(i,j)<t)
13             b(i,j)=0;
14         else
15             b(i,j)=255;
16         end
17     end
18 end
19 figure(1)
20 ShowImage(a,'Original Image');
21 title('Original Image')
22 figure(2)
23 ShowImage(b,'Thresholded Image');
24 title('Thresholded Image')
25 xlabel(sprintf('Threshold value is %g',t))
26 //Result
27 //Enter the threshold parameter 140
```

Scilab code Exa 5.20 Program performs gray level slicing without background

Original Image

Thresholded Image

```
1  //Caption: Program performs gray level slicing
       without background
2  //Fig.5.20
3  //page256
4  clc;
5  x = imread('E:\Digital_Image_Processing_Jayaraman\
       Chapter5\lena.png');
6  x = rgb2gray(x);
7  y = double(x);
8  [m,n]= size(y);
9  L = max(max(x));
10 a = round(L/2);
11 b = L;
12 for i =1:m
13     for j =1:n
14         if(y(i,j)>=a & y(i,j)<=b)
15             z(i,j) = L;
16         else
17             z(i,j)=0;
18         end
19     end
20 end
21 z = uint8(z);
22 figure(1)
23 ShowImage(x,'Original Image');
24 title('Orginal Image')
25 figure(2)
26 ShowImage(z,'Gray Level Slicing');
27 title('Gray Level Slicing without preserving
       background')
```

Figure 5.6: Program performs gray level slicing without background

Chapter 6

Image Restoration and Denoising

Scilab code Exa 6.1 Scilab code to create motion blur

```
1  //Caption:Scilab code to create motion blur
2  //Fig6.1
3  //page 326
4  clc;
5  close;
6  a = imread('E:\DIP_JAYARAMAN\Chapter6\humm.jpg');//
     SIVP toolbox
7  //filter coefficients of fspecial('motion',10,25)
8  H =[0,0,0,0,0,0,0,0.0032,0.0449,0.0865,0.0072;...
9  0,0,0,0,0,0.0092,0.0509,0.0925,0.0629,0.0213,0;...
10 0,0,0,0.0152,0.0569,0.0985,0.0569,0.0152,0,0,0;...
11 0,0.0213,0.0629,0.0925,0.0509,0.0092,0,0,0,0,0;...
12 0.0072,0.0865,0.0449,0.0032,0,0,0,0,0,0,0];
13 Motion_Blur = imfilter(a,H);
14 Motion_Blur =uint8(Motion_Blur);
15 ShowImage(a,'original Image')
16 title('original Image')
17 figure
18 ShowImage(Motion_Blur,'Motion Blurred Image')
```

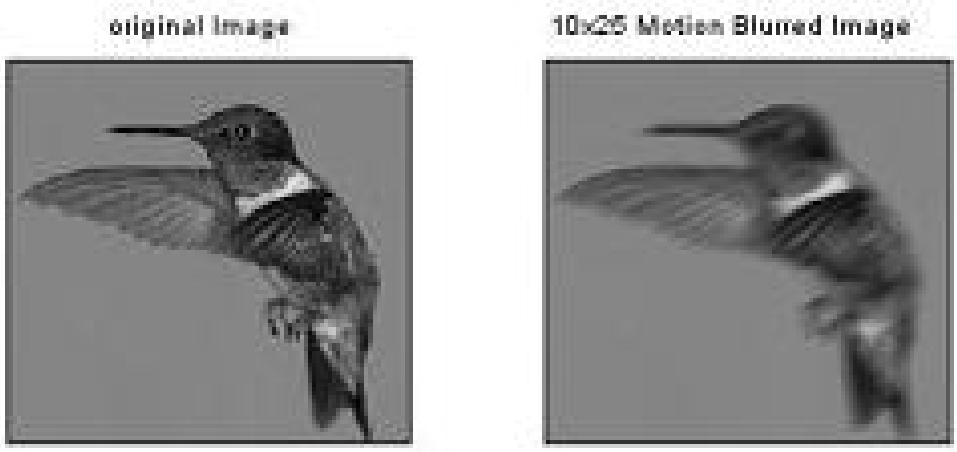


Figure 6.1: Scilab code to create motion blur

```
19 title('10x25 Motion Blurred Image')
```

check Appendix AP 1 for dependency:

`fft2d.sce`

check Appendix AP 2 for dependency:

`ifft2d.sce`

Scilab code Exa 6.5 Scilab code performs inverse filtering

```
1 //Caption:Scilab code performs inverse filtering
2 //Degrade the image by means of a known blur
3 //Apply inverse filter to the blurred image and see
    the restored image
4 //Fig6.5
5 //page 330
6 clc;
7 close;
```

```
x =imread('E:\DIP_JAYARAMAN\Chapter6\flower2.jpg');
x=double(rgb2gray(x));
[M N]=size(x);
h = zeros(M,N);
for i = 1:11
    for j = 1:11
        h(i,j) = 1/121;
    end
end
sigma = sqrt(4*10^(-7));
freqx = fft2d(x); //Fourier transform of input image
freqh = fft2d(h);//Fourier transform of degradation
y = real(ifft2d(freqh.*freqx));
freqy = fft2d(y);
powfreqx = freqx.^2/(M*N);
alpha = 0.5; //Indicates inverse filter
freqg = ((freqh.')').*abs(powfreqx)./(abs(freqh.^2)
   .*abs(powfreqx)+alpha*sigma^2);
Resfreqx = freqg.*freqy;
Resa = real(ifft2d(Resfreqx));
x = uint8(x);
y = uint8(y);
Resa = uint8(Resa)
ShowImage(x,'Original Image')
title('Original Image')
figure
ShowImage(y,'Degraded Image')
title('Degraded Image')
figure
ShowImage(Resa,'Restored Image')
title('Restored Image')
```

check Appendix AP 1 for dependency:

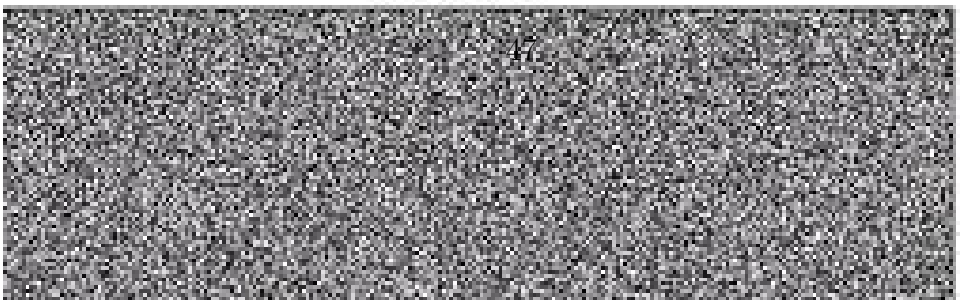
`fft2d.sce`

check Appendix AP 2 for dependency:

Original Image

Degraded+noise Image

Restored Image



ifft2d.sce

Scilab code Exa 6.7 Scilab code performs inverse filtering

```
1  //Caption:Scilab code performs inverse filtering
2  //Degrade the image by means of a known blur and
       white noise
3  //The image is degraded as well as corrupted by
       noise
4  //Apply inverse filter to restore the  image
5  //Fig6.7
6  //page 332
7  clc;
8  close;
9  x =imread('E:\DIP_JAYARAMAN\Chapter6\flower2.jpg');
10 x=double(rgb2gray(x));
11 [M N]=size(x);
12 h = zeros(M,N);
13 for i = 1:11
14     for j = 1:11
15         h(i,j) = 1/121;
16     end
17 end
18 sigma = sqrt(4*10^(-7));
19 freqx = fft2d(x); //Fourier transform of input image
20 freqh = fft2d(h);//Fourier transform of degradation
21 y = real(ifft2d(freqh.*freqx))+10*rand(M,N,'normal')
       ;
22 freqy = fft2d(y);
23 powfreqx = freqx.^2/(M*N);
24 alpha = 0.5; //Indicates inverse filter
25 freqg = ((freqh.')').*abs(powfreqx)./(abs(freqh.^2)
       .*abs(powfreqx)+alpha*sigma^2);
26 Resfreqx = freqg.*freqy;
```

Original Image

Degraded Image

Restored Image

```
27 Resa = real(ifft2d(Resfreqx));
28 x = uint8(x);
29 y = uint8(y);
30 Resa = uint8(Resa)
31 ShowImage(x,'Original Image')
32 title('Original Image')
33 figure
34 ShowImage(y,'Degraded+noise Image')
35 title('Degraded+noise Image')
36 figure
37 ShowImage(Resa,'Restored Image')
38 title('Restored Image')
```

---

check Appendix AP 1 for dependency:

`fft2d.sce`

check Appendix AP 2 for dependency:

`ifft2d.sce`

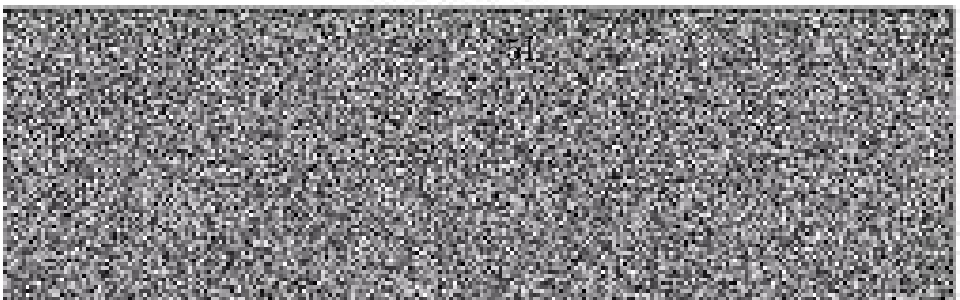
Scilab code Exa 6.9 Scilab code performs Pseudo inverse filtering

```
1 //Caption:Scilab code performs Pseudo inverse
    filtering
2 //Degrade the image by means of a known blur and
    white noise
3 //The image is degraded as well as corrupted by
    noise
4 //Apply Pseudo inverse filter to restore the  image
5 //Fig6.9
6 //page 333
7 clc;
8 close;
9 x =imread('E:\DIP_JAYARAMAN\Chapter6\flower2.jpg');
```

Original Image

Degraded+noise Image

Restored Image



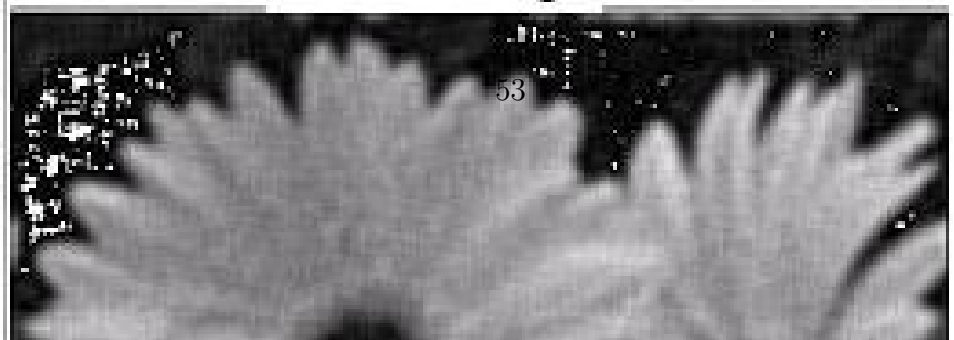
```
x=double(rgb2gray(x));
[M N]=size(x);
h = zeros(M,N);
for i = 1:11
    for j = 1:11
        h(i,j) = 1/121;
    end
end
mask_b = ones(11,11)/121;
[m1,n1] = size(mask_b);
Thr_Freq = 0.2;
freqx = fft2d(x); //Fourier transform of input image
freqh = fft2d(h);//Fourier transform of degradation
y = real(ifft2d(freqh.*freqx))+25*rand(M,N,'normal')
   ;
freqy = fft2d(y);
psf=zeros(M,N);
psf(M/2+1-(m1-1)/2:M/2+1+(m1-1)/2,N/2+1-(n1-1)/2:N
   /2+1+(n1-1)/2) = mask_b;
psf = fftshift(psf);
freq_res = fft2d(psf);
Inv_filt = freq_res./((abs(freq_res)).^2+Thr_Freq);
z = real(ifft2d(freqy.*Inv_filt));
x = uint8(x);
y = uint8(y);
z = uint8(z)
ShowImage(x,'Original Image')
title('Original Image')
figure
ShowImage(y,'Degraded+noise Image')
title('Degraded+noise Image')
figure
ShowImage(z,'Restored Image')
title('Restored Image')
```

check Appendix AP 1 for dependency:

Original Image

Degraded+noise Image

Restored Image



fft2d.sce

check Appendix AP 2 for dependency:

ifft2d.sce

Scilab code Exa 6.13 Scilab code to perform wiener filtering of the corrupted image

```
1 //Caption: Scilab code to perform wiener filtering
     of the corrupted image
2 //Fig6.13
3 //Page 339
4 close;
5 clc;
6 x = imread('E:\DIP_JAYARAMAN\Chapter6\flower2.jpg');
     //SIVP toolbox
7 x=double(rgb2gray(x));
8 sigma = 50;
9 Gamma = 1;
10 alpha = 1; // It indicates Wiener filter
11 [M N]=size(x);
12 h = zeros(M,N);
13 for i = 1:5
14     for j = 1:5
15         h(i,j) = 1/25;
16     end
17 end
18 Freqa = fft2d(x);
19 Freqh = fft2d(h);
20 y = real(ifft2d(Freqh.*Freqa)) //image degradation
21 y = y+25*rand(M,N,"normal"); //Adding random noise
     with normal distribution
22 Freqy = fft2d(y);
23 Powy = abs(Freqy).^2/(M*N);
24 sFreqh = Freqh.*(abs(Freqh)>0)+1/Gamma*(abs(Freqh)
     ==0);
```

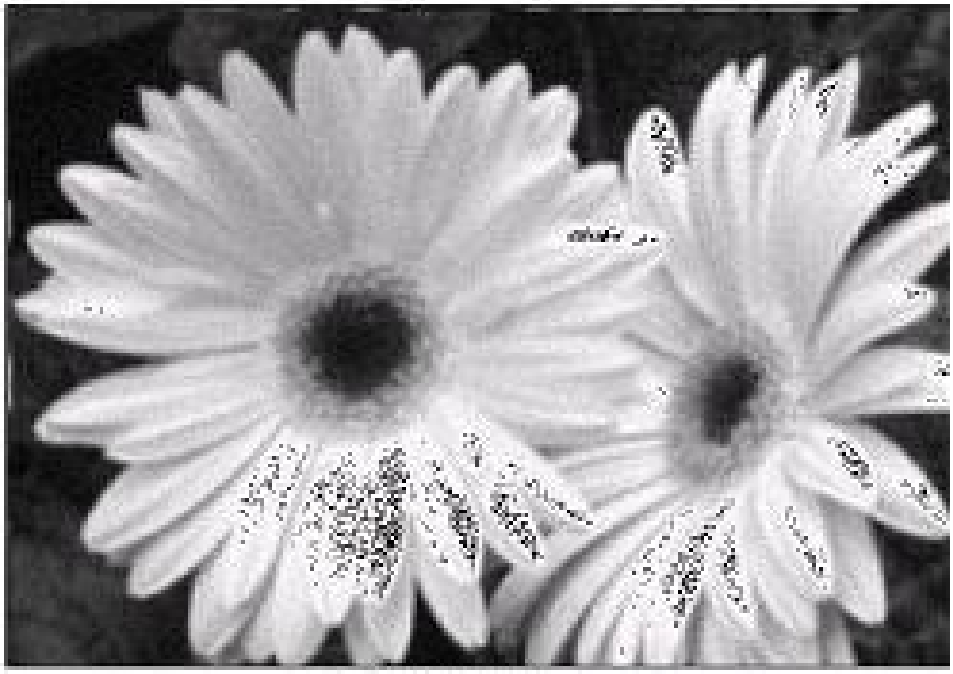
```
25 iFreqh = 1/sFreqh;
26 iFreqh = iFreqh'.*(abs(Freqh)*Gamma>1)+Gamma*abs(
     sFreqh)*iFreqh*(abs(sFreqh)*Gamma<=1);
27 iFreqh = iFreqh/(max(max(abs(iFreqh))));
28 Powy = Powy.*(Powy>sigma^2)+sigma^2*(Powy<=sigma^2);
29 Freqg = iFreqh.*(Powy-sigma^2)./(Powy-(1-alpha)*
     sigma^2);
30 ResFreqa = Freqg.*Freqy;
31 Resa = real(ifft2d(ResFreqa));
32 x = uint8(x);
33 y = uint8(y);
34 Resa = uint8(Resa);
35 ShowImage(x,'Original Image')
36 title('Original Image')
37 figure
38 ShowImage(y,'Degraded Image')
39 title('Degraded Image')
40 figure
41 ShowImage(Resa,'Restored Image')
42 title('Restored Image')
```

Scilab code Exa 6.18 Scilab code to Perform Average Filtering operation

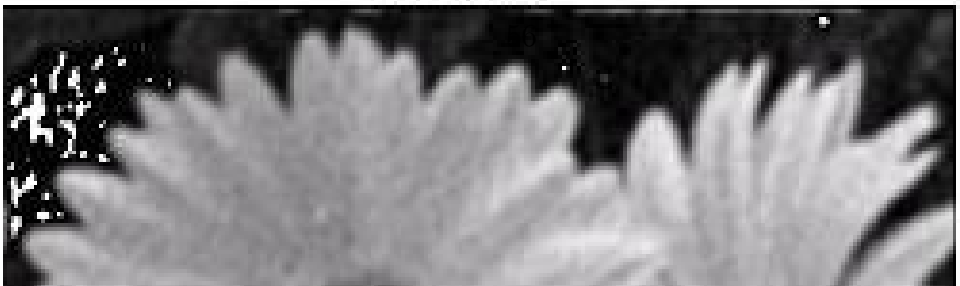
```
1 //Caption:Scilab code to Perform Average Filtering
    operation
2 //Fig6.18
3 //page 349
4 clc;
5 close;
6 a= imread('E:\DIP_JAYARAMAN\Chapter6\lenna.jpg');//
    SIVP toolbox
7 a=imnoise(a,'salt & pepper', 0.2); //Add salt&pepper
    noise tothe image
```

Original Image

Degraded Image



Restored Image



```
a=double(a);
[m n]=size(a);
N=input('enter the window size='); //The window size
    can be 3x3,5x5etc
Start=(N+1)/2;
Out_Imag=a;
for i=Start:(m-Start+1)
for j=Start:(n-Start+1)
    limit=(N-1)/2;
    Sum=0;
    for k=-limit:limit,
        for l=-limit:limit,
            Sum=Sum+a(i+k,j+l);
        end
    end
    Out_Imag(i,j)=Sum/(N*N);
end
end
a = uint8(a);
Out_Imag = uint8(Out_Imag);
ShowImage(a,'original Image')
title('Noisy Image')
figure
ShowImage(Out_Imag,'average filtered Image')
title('5x5 average filtered Image');
```

Scilab code Exa 6.21 Scilab code to Perform median filtering

```
//Caption:Scilab code to Perform median filtering
//Fig6.21
//page 352
clc;
close;
```

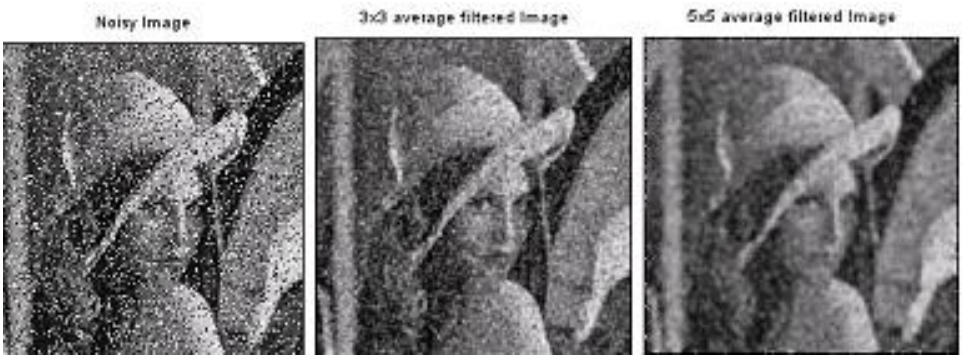


Figure 6.7: Scilab code to Perform Average Filtering operation

```
c = imread('E:\DIP_JAYARAMAN\Chapter6\cameraman.jpg'
    );//SIVP toolbox
N = input('Enter the window size');
a = double(imnoise(c,'salt & pepper',0.2));
[m,n] = size(a);
b = a;
if(modulo(N,2)==1)
  Start = (N+1)/2;
  End = Start;
  limit1 = (N-1)/2;
  limit2 = limit1;
else
  Start = N/2;
  End = Start+1;
  limit1 = (N/2)-1;
  limit2 = limit1+1;
end
for i = Start:(m-End+1)
    for j = Start:(n-End+1)
        I =1;
        for k = -limit1:limit2
            for l = -limit1:limit2
                mat(I)= a(i+k,j+1)
                I = I+1;
            end
```

```
30          end
31          mat = gsort(mat);
32          if(modulo(N,2)==1)
33          b(i,j) = (mat(((N^2)+1)/2));
34          else
35          b(i,j) = (mat((N^2)/2)+mat(((N^2)/2)+1))/2;
36          end
37      end
38  end
39  a = uint8(a);
40  b = uint8(b);
41  figure
42  ShowImage(c,'Original Image')
43  title('Original Image')
44  figure
45  ShowImage(a,'noisy image')
46  title('noisy image')
47  figure
48  ShowImage(b,'Median Filtered Image')
49  title('5x5 Median Filtered Image')
```

check Appendix AP 3 for dependency:

`Func_medianall.sci`

Scilab code Exa 6.23 Scilab code to Perform median filtering of colour image

```
1  //Caption:Scilab code to Perform median filtering of
       colour image
2  //Fig6.23(a)
3  //page 353
4  clc;
5  close;
```

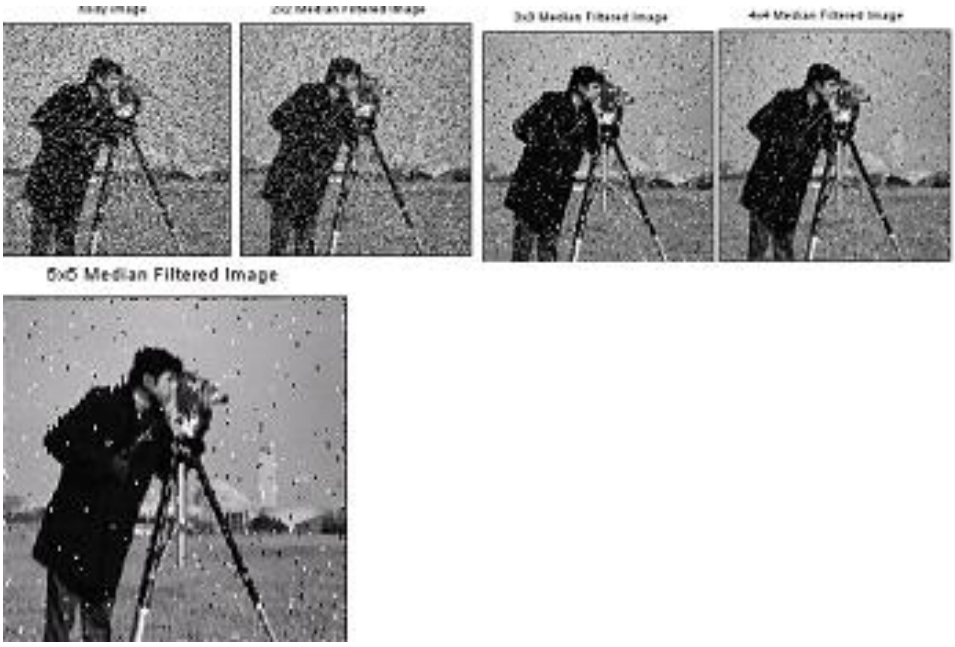


Figure 6.8: Scilab code to Perform median filtering

```
6  a=imread('E:\DIP_JAYARAMAN\Chapter6\peppers.png');
     //SIVP toolbox
7  N=input('enter the window size');
8  b=imresize(a,[256,256]);
9  b=imnoise(b,'salt & pepper',.1);
10 [m n]=size(b);
11 R=b(:,:,1);
12 G=b(:,:,2);
13 B=b(:,:,3);
14 Out_R=Func_medianall(R,N);//Applying Median filter
     to R plane
15 Out_G=Func_medianall(G,N);//Applying Median filter
     to G plane
16 Out_B=Func_medianall(B,N);//Applying Median filter
     to B plane
17 Out_Image(:,:,1)=Out_R;
18 Out_Image(:,:,2)=Out_G;
19 Out_Image(:,:,3)=Out_B;
```

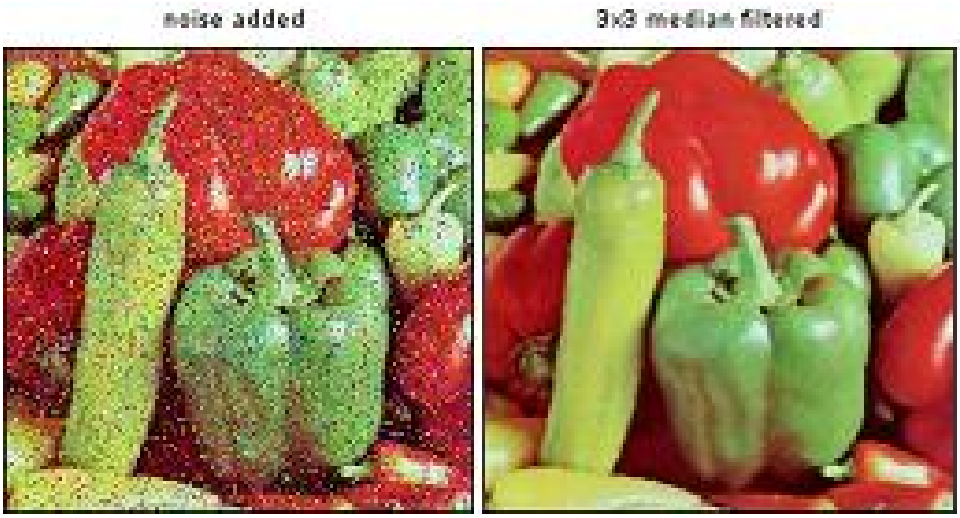


Figure 6.9: Scilab code to Perform median filtering of colour image

```
20 b = uint8(b);
21 Out_Image = uint8(Out_Image);
22 //ShowColorImage(b,'noise added')
23 //title('noise added')
24 figure
25 ShowColorImage(Out_Image,'3x3 median filtered')
26 title('3x3 median filtered')
```

Scilab code Exa 6.24 Scilab code to Perform Trimmed Average Filter

```
1 //Caption:Scilab code to Perform Trimmed Average
    Filter
2 //Alpha trimmed average filter
3 //Fig6.24
4 //page 355
5 clc;
6 close;
```

```
c = imread('E:\DIP_JAYARAMAN\Chapter6\lenna.jpg');//
    SIVP toolbox
s = 1; //s denotes the number of values to be left
    in the end
r = 1;
N = 9; //3x3 window
a = double(imnoise(c,'gaussian'));
[m,n] = size(a);
b = zeros(m,n);
for i= 2:m-1
    for j = 2:n-1
        mat = [a(i,j),a(i,j-1),a(i,j+1),a(i-1,j),a(i
            +1,j),a(i-1,j-1),...
                a(i-1,j+1),a(i-1,j+1),a(i+1,j+1)];
        sorted_mat = gsort(mat);
        Sum=0;
        for k=r+s:(N-s)
            Sum = Sum+mat(k);
        end
        b(i,j)= Sum/(N-r-s);
    end
end
a = uint8(a);
b = uint8(b);
//figure
//imshow(c)
//title('Original Image')
figure
ShowImage(a,'noisy image')
title('noisy image')
figure
ShowImage(b,'Trimmed Average Filtered Image')
title('Trimmed Average Filtered Image')
```

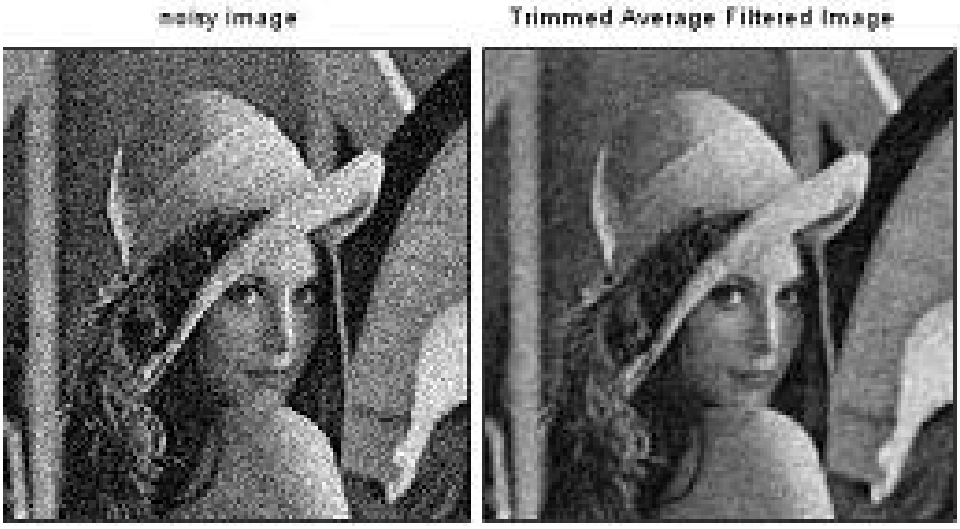


Figure 6.10: Scilab code to Perform Trimmed Average Filter

Chapter 7

Image Segmentation

Scilab code Exa 7.23 Scilab code for Differentiation of Gaussian function

```
1 //Caption: Scilab code for Differentiation of
     Gaussian function
2 //Fig7.23
3 //page388
4 clc;
5 close;
6 sigma=input('Enter the value of sigma:')
7 i=-10:.1:10;
8 j=-10:.1:10;
9 r=sqrt(i.*i+j.*j);
10 y=(1/(sigma^2))*(((r.*r)/sigma^2)-1).*exp(-r.*r/2*
     sigma^2);
11 plot(i,y)
12 legend(sprintf('The sigma value is %g',sigma))
13 xtitle('Differentiation of Gaussian function')
```

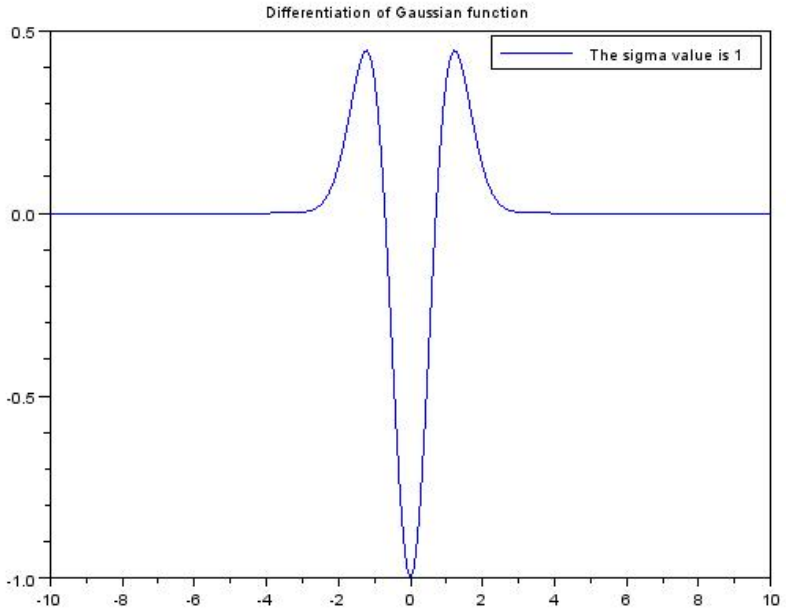


Figure 7.1: Scilab code for Differentiation of Gaussian function

Figure 7.2: Scilab code for Differentiation of Gaussian function

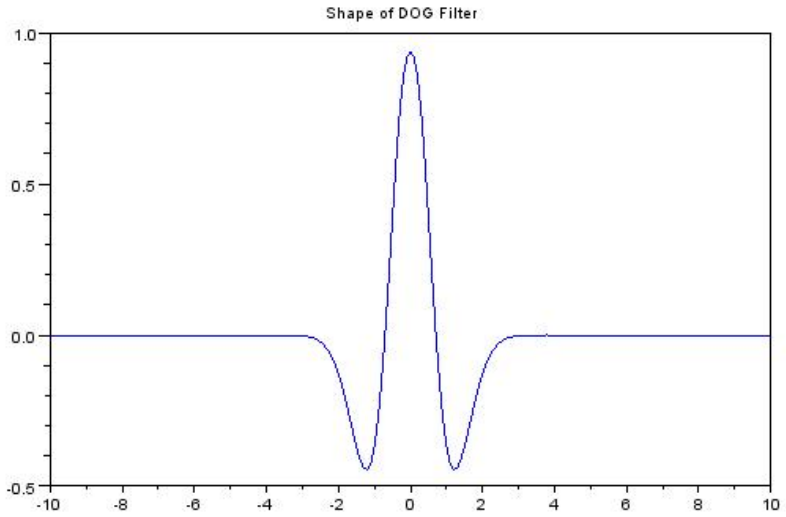


Figure 7.3: Scilab code for Differentiation of Gaussian Filter function

Scilab code Exa 7.25 Scilab code for Differentiation of Gaussian Filter function

```
1 //Caption: Scilab code for Differentiation of
     Gaussian Filter function
2 //Fig7.25
3 //page389
4 clc;
5 close;
6 sigma1 = input('Enter the value of sigma1:')
7 sigma2 = input('Enter the value of sigma2:')
8 i=-10:.1:10;
9 j=-10:.1:10;
```

Figure 7.4: Scilab code for Differentiation of Gaussian Filter function

```
10 r=sqrt(i.*i+j.*j);
11 y1 = (1/(sigma1^2))*(((r.*r)/sigma1^2)-1).*exp(-r.*r
      /2*sigma1^2);
12 y2 = (1/(sigma2^2))*(((r.*r)/sigma2^2)-1).*exp(-r.*r
      /2*sigma2^2);
13 y = y1-y2;
14 plot(i,y)
15 xtitle('Shape of DOG Filter')
16 //Result
17 //Enter the value of sigma1: 4
18 //Enter the value of sigma2: 1
19 //
```

Scilab code Exa 7.27 Scilab code for Edge Detection using Different Edge detectors

```
1 //Caption: Scilab code for Edge Detection using
     Different Edge detectors
2 //[1]. Sobel [2]. Prewitt [3]. Log  [4]. Canny
3 //Fig7.27
4 //page389
5 close;
6 clc;
7 a = imread('E:\DIP_JAYARAMAN\Chapter7\sailing.jpg');
8 a = rgb2gray(a);
9 c = edge(a,'sobel');
10 d = edge(a,'prewitt');
11 e = edge(a,'log');
12 f = edge(a,'canny');
13 ShowImage(a,'Original Image')
14 title('Original Image')
15 figure
16 ShowImage(c,'Sobel')
17 title('Sobel')
18 figure
19 ShowImage(d,'Prewitt')
20 title('Prewitt')
21 figure
22 ShowImage(e,'Log')
23 title('Log')
24 figure
25 ShowImage(f,'Canny')
26 title('Canny')
```

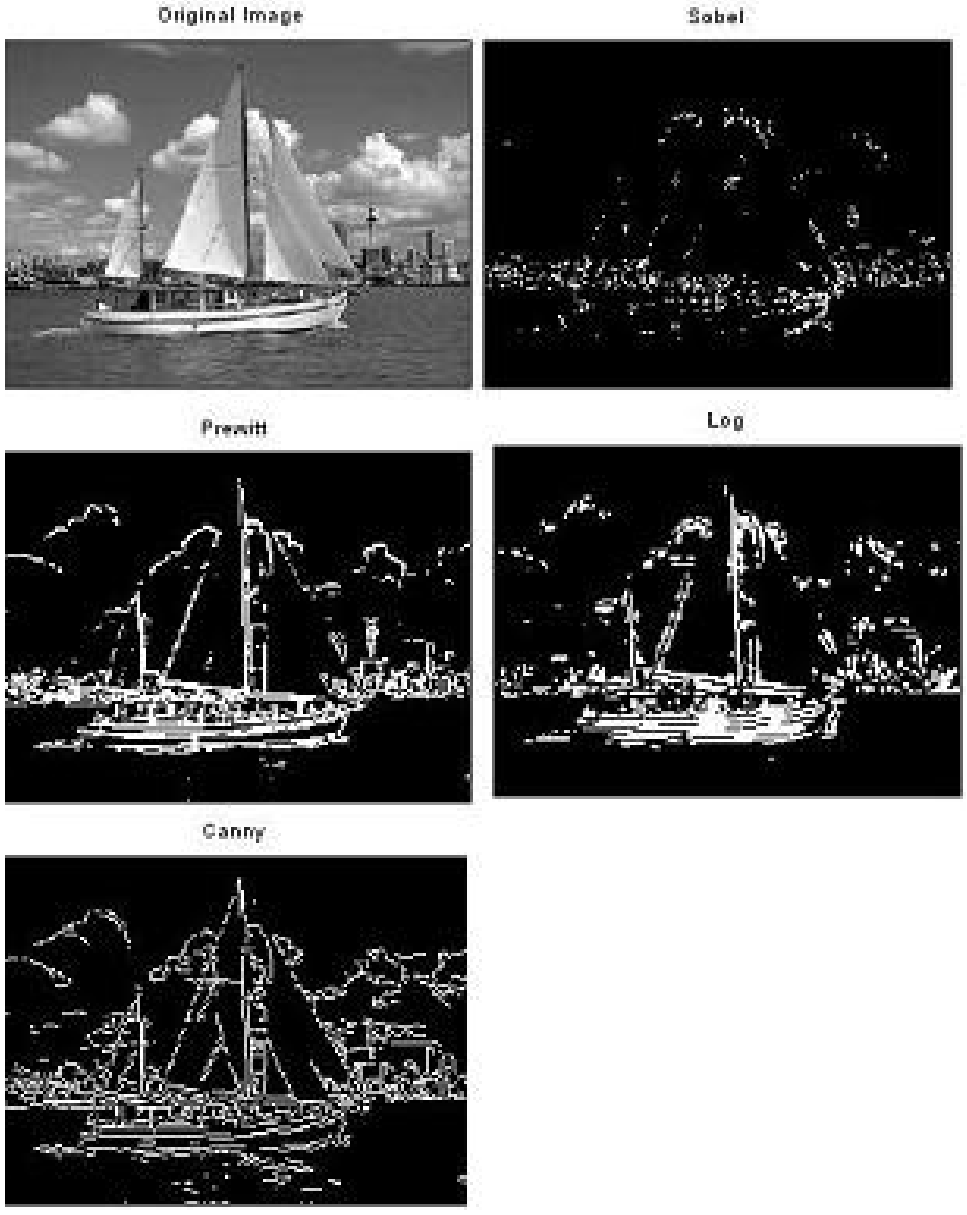


Figure 7.5: Scilab code for Edge Detection using Different Edge detectors

Scilab code Exa 7.30 Scilab code to perform watershed transform

```
1 //Caption: Scilab code to perform watershed
     transform
2 //Fig7.30
3 //Page396
4 clc;
5 close;
6 b = imread('E:\DIP_JAYARAMAN\Chapter7\teaset.png');
7 a = rgb2gray(b);
8 global EDGE_SOBEL;
9 Gradient = EdgeFilter(a, EDGE_SOBEL);
10 Threshold1 = CalculateOtsuThreshold(Gradient); //
     determine a threshold
11 EdgeImage = ~SegmentByThreshold(Gradient,Threshold1)
     ;
12 DistanceImage = DistanceTransform(EdgeImage);
13 Threshold2 = CalculateOtsuThreshold(DistanceImage)
     // determine a threshold
14 ThresholdImage = SegmentByThreshold(DistanceImage,
     Threshold2);
15 MarkerImage = SearchBlobs(ThresholdImage);
16 SegmentedImage = Watershed(Gradient,MarkerImage);
17 figure
18 ShowColorImage(b,'teaset')
19 title('teaset.png')
20 figure
21 ColorMapLength = length(unique(SegmentedImage));
22 ShowImage(SegmentedImage,'Result of Watershed
     Transform',jetcolormap(ColorMapLength));
```

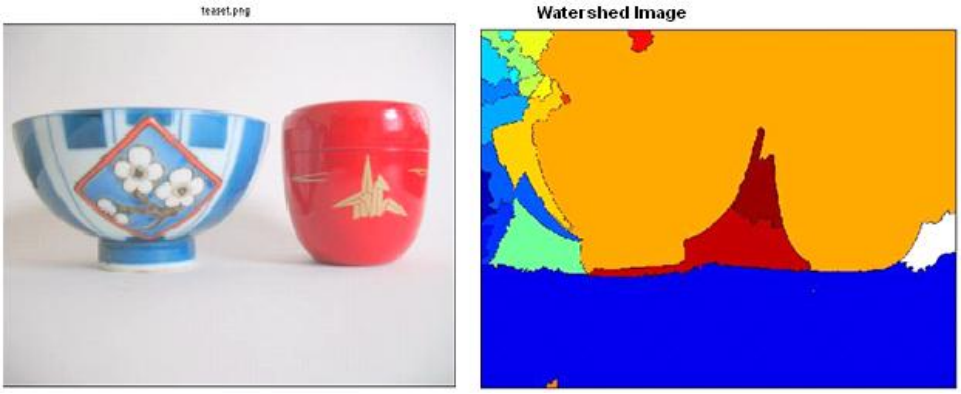


Figure 7.6: Scilab code to perform watershed transform

Chapter 8

Object Recognition

Scilab code Exa 8.4 To verify the given matrix is a covaraince matrix

```
1 //Caption: To verify the given matrix is a
     covaraince matrix
2 //Problem 4
3 //page438
4 close;
5 clear all;
6 clc;
7 K = [37,-15;-15,37];
8 evals = spec(K);
9 evals = gsort(evals);
10 disp(evals,'Eigen Values are =')
11 if (evals==abs(evals)) then
12     disp('Both the eigen values are non-negative and
           the given matrix is a covariance matrix');
13 else
14     disp('non-covariance matrix')
15 end
```

Scilab code Exa 8.5 To compute the covariance of the given 2D data

```
1  //Caption: To compute the covariance of the given 2D
       data
2  //Problem 5
3  //page439
4  close;
5  clear all;
6  clc;
7  X1 = [2,1]';
8  X2 = [3,2]';
9  X3 = [2,3]';
10 X4 = [1,2]';
11 X = [X1,X2,X3,X4];
12 disp(X,'X=');
13 [M,N] = size(X); //M=rows, N = columns
14 for i =1:N
15   m(i) = mean(X(:,i));
16   A(:,i) = X(:,i)-m(i);
17 end
18 m = m';
19 disp(m,'mean =');
20 K = A'*A;
21 K = K/(M-1);
22 disp(K,'The Covaraince matix is K =')
23 //Result
24 //X=
25 //     2.     3.     2.     1.
26 //     1.     2.     3.     2.
27 //mean =
28 //     1.5     2.5     2.5     1.5
29 //
30 //The Covaraince matix is K =
31 //     0.5     0.5   - 0.5   - 0.5
32 //     0.5     0.5   - 0.5   - 0.5
33 //   - 0.5   - 0.5     0.5     0.5
34 //   - 0.5   - 0.5     0.5     0.5
```

Scilab code Exa 8.9 Develop a perceptron AND function with bipolar inputs and targets

```
1  //Caption: Develop a perceptron AND function with
       bipolar inputs and targets
2  //Problem 9
3  //page441
4  close;
5  clear all;
6  clc;
7  X1 = [1,-1,1,-1]; //X1 and X2 are input vectors to
       AND function
8  X2 = [1,1,-1,-1];
9  //b = [1,1,1,1];     //Biasing vector
10 T = [1,-1,-1,-1]; //Target vector for AND function
11 W1 = 0; //Weights are initialized
12 W2 = 0;
13 b = 0;  //bias initialized
14 alpha = 1; //learning rate
15 for i = 1:length(X1)
16     Yin(i) = b+X1(i)*W1+X2(i)*W2;
17     if (Yin(i)>=1)
18         Y(i)=1;
19     elseif((Yin(i)<1)&(Yin(i)>=-1))
20         Y(i)=0;
21     elseif(Yin(i)<-1)
22         Y(i)=-1;
23     end
24     disp(Yin(i),'Yin=')
25     disp(Y(i),'Y=')
26     if(Y(i)~=T(i))
27         b = b+alpha*T(i);
28         W1 = W1+alpha*T(i)*X1(i);
29         W2 = W2+alpha*T(i)*X2(i);
```

```
30            disp(b,'b=')
31            disp(W1,'W1=')
32            disp(W2,'W2=')
33        end
34    end
35    disp('Final Weights after one iteration are')
36    disp(b,'Bias Weigth b=')
37    disp(W1,'W1=')
38    disp(W2,'W2=')
```

Chapter 9

Image Compression

Scilab code Exa 9.9 Program performs Block Truncation Coding BTC

```
1 //Caption: Program performs Block Truncation Coding(
    BTC)
2 //Example 9.9
3 //page512
4 close;
5 clear all;
6 clc;
7 x =
    [65,75,80,70;72,75,82,68;84,72,62,65;66,68,72,80];

8 disp(x,'Original Block is x =')
9 [m1 n1]=size(x);
10 blk=input('Enter the block size:');
11 for i = 1 : blk : m1
12 for j = 1 : blk : n1
13         y = x(i:i+(blk-1),j:j+(blk-1)) ;
14         m = mean(mean(y));
15         disp(m,'mean value is m =')
16         sig=std2(y);
17         disp(sig,'Standard deviation of the block is
             =')
```

```
18          b = y > m ; //the binary block
19          disp(b,'Binary allocation matrix is B=')
20          K = sum(sum(b));
21          disp(K,'number of ones =')
22                  if (K ~= blk^2 ) & ( K ~= 0)
23                   ml = m-sig*sqrt(K/((blk^2)-K));
24                   disp(ml,'The value of a =')
25                   mu = m+sig*sqrt(((blk^2)-K)/K);
26                   disp(mu,'The value of b =')
27                   x(i:i+(blk-1), j:j+(blk-1)) = b*mu
                        +(1- b)*ml;
28          end
29  end
30  end
31  disp(round(x),'Reconstructed Block is x =')
32  //Result
33  //Original Block is x =
34  //
35  //    65.    75.    80.    70.
36  //    72.    75.    82.    68.
37  //    84.    72.    62.    65.
38  //    66.    68.    72.    80.
39  //
40  //Enter the block size:4
41  //mean value is m =  72.25
42  //Standard deviation of the block is =  6.6282225
43  //Binary allocation matrix is B=
44  //
45  //  F T T F
46  //  F T T F
47  //  T F F F
48  //  F F F T
49  //
50  //number of ones =  6
51  //The value of a =  67.115801
52  //The value of b =  80.806998
53  //Reconstructed Block is x =
54  //
```

```
55 //     67.     81.     81.     67.
56 //     67.     81.     81.     67.
57 //     81.     67.     67.     67.
58 //     67.     67.     67.     81.
```

Scilab code Exa 9.59 Program performs Block Truncation Coding

```
1  //Caption: Program performs Block Truncation Coding(
       BTC) by choosing different
2  //block sizes
3  //Fig.9.59: MATLAB Example1
4  //page514
5  close;
6  clc;
7  x =imread('E:\Digital_Image_Processing_Jayaraman\
       Chapter9\lenna.jpg');  //SIVP toolbox
8  //x=imresize(x,[256 256]);
9  x1=x;
10 x=double(x);
11 [m1 n1]=size(x);
12 blk=input('Enter the block size:');
13 for i = 1 : blk : m1
14 for j = 1 : blk : n1
15          y = x(i:i+(blk-1),j:j+(blk-1)) ;
16          m = mean(mean(y));
17          sig=std2(y);
18          b = y > m ; //the binary block
19          K = sum(sum(b));
20                  if (K ~= blk^2 ) & ( K ~= 0)
21                   ml = m-sig*sqrt(K/((blk^2)-K));
22                   mu = m+sig*sqrt(((blk^2)-K)/K);
23                   x(i:i+(blk-1), j:j+(blk-1)) = b*mu
                        +(1- b)*ml;
24          end
25 end
```

Figure 9.1: Program performs Block Truncation Coding

```
26 end
27 //imshow(uint8(x))
28 //title('Reconstructed Image')
29 x = uint8(x);
30 figure(1)
31 imshow(x1)
32 title('Original Image');    //IPD toolbox
33 figure(2)
34 ShowImage(x, 'Reconstructed Image');    //IPD toolbox
35 title('Block Size = 8')
```

Chapter 10

Binary Image Processing

Scilab code Exa 10.17 Scilab Code for dilation and erosion process

```
1 //Caption: Scilab Code for dilation and erosion
     process
2 //Fig.10.17
3 //Page553
4 close;
5 clear all;
6 clc;
7 a = imread('E:\DIP_JAYARAMAN\Chapter10\morph1.bmp');
       //SIVP toolbox
8 //b =[1,1,1;1,1,1;1,1,1];
9 StructureElement = CreateStructureElement('square',
     3) ;
10 a1 = DilateImage(a,StructureElement);
11 a2 = ErodeImage(a,StructureElement);
12 //Displaying original Image
13 //imshow(a)
14 figure(1)
15 ShowImage(a,'Original Image');
16 //Displaying Dilated Image
17 //imshow(a1)
18 figure(2)
```

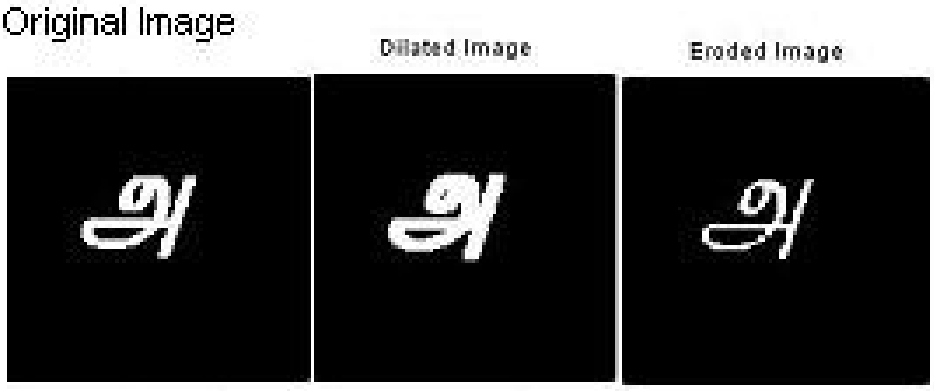


Figure 10.1: Scilab Code for dilation and erosion process

```
19 ShowImage(a1,'Dilated Image');
20 xtitle('Dilated Image')
21 //Displaying Eroded Image
22 //imshow(a2)
23 figure(3)
24 ShowImage(a2,'Eroded Image');
25 xtitle('Eroded Image')
```

Scilab code Exa 10.19 Scilab Code to perform an opening and closing operation on the image

```
1 //Caption: Scilab Code to perform an opening and
     closing operation on the image
2 //Fig.10.19
3 //Page555
4 close;
5 clear all;
6 clc;
7 a = imread('E:\DIP_JAYARAMAN\Chapter10\morph2.bmp');
```

```
      //SIVP toolbox
8  //b =[1,1,1;1,1,1;1,1,1];
9  StructureElement = CreateStructureElement('square',
       3) ;
10 //Opening is done by first applying erosion and then
       dilation operations on image
11 b1 = ErodeImage(a,StructureElement);
12 b2 = DilateImage(b1,StructureElement);
13 //Closing is done by first applying dilation and
       then erosion operation on image
14 a1 = DilateImage(a,StructureElement);
15 a2 = ErodeImage(a1,StructureElement);
16 //Displaying original Image
17 figure(1)
18 ShowImage(a,'Original Image');
19 //Displaying Opened Image
20 figure(2)
21 ShowImage(b2, 'Opened Image');
22 xtitle('Opened Image')
23 //Displaying Closed Image
24 figure(3)
25 ShowImage(a2, 'Closed Image');
26 xtitle('Closed Image')
```

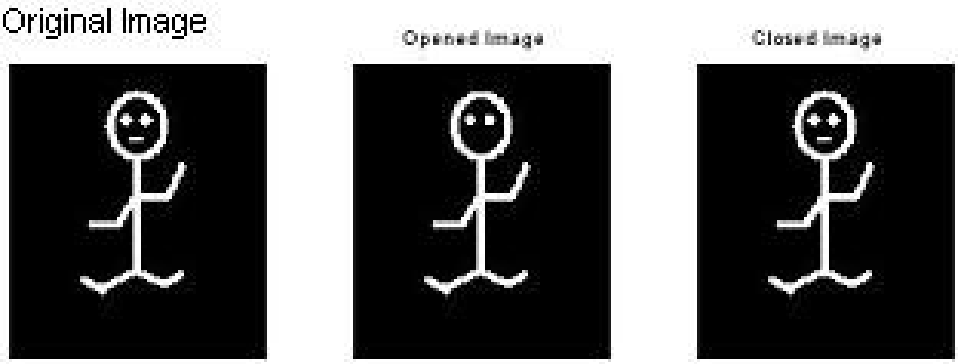


Figure 10.2: Scilab Code to perform an opening and closing operation on the image

Chapter 11

Colur Image Processing

Scilab code Exa 11.4 Read an RGB image and extract the three colour components red green blue

```
1 //Caption:Read an RGB image and extract the three
     colour components: red,green
2 //and blue
3 //Fig.11.4: MATLAB Example1
4 //page588
5 clc;
6 close;
7 RGB = imread('E:\DIP_JAYARAMAN\Chapter11\peppers.png
     '); //SIVP toolbox
8 R = RGB;
9 G = RGB;
10 B = RGB;
11 R(:,:,2)=0;
12 R(:,:,3)=0;
13 G(:,:,1)=0;
14 G(:,:,3)=0;
15 B(:,:,1)=0;
16 B(:,:,2)=0;
17 figure(1)
18 ShowColorImage(RGB, 'Original Color Image'); //IPD
```

```
    toolbox
19 title('Original Color Image');
20 figure(2)
21 ShowColorImage(R, 'Red Component');
22 figure(3)
23 ShowColorImage(G, 'Green Component');
24 figure(4)
25 ShowColorImage(B, 'Blue Component');
```

Scilab code Exa 11.12 Read a Colour image and separate the colour image into red green and blue planes

```
1  //Caption:Read a Colour image and separate the
       colour image into: red,green
2  //and blue planes
3  //Fig.11.12: MATLAB Example2
4  //page592
5  clc;
6  close;
7  RGB = imread('E:\DIP_JAYARAMAN\Chapter11\peppers.png
       '); //SIVP toolbox
8  a1 = RGB;
9  b1 = RGB;
10 c1 = RGB;
11 a1(:,:,1)=0;
12 b1(:,:,2)=0;
13 c1(:,:,3)=0;
14 figure(1)
15 ShowColorImage(RGB, 'Original Color Image'); //IPD
       toolbox
16 figure(2)
17 ShowColorImage(a1, 'Red Missing');
18 figure(3)
```

Figure 11.1: Read an RGB image and extract the three colour components red green blue

```
19 ShowColorImage(b1, 'Green Missing');
20 figure(4)
21 ShowColorImage(c1, 'Blue Missing');
```

Scilab code Exa 11.16 Compute the histogram of the colour image

```
1  //Caption:Compute the histogram of the colour image
2  //Fig.11.16: MATLAB Example3
3  //page595
4  clc;
5  close;
6  I = imread('E:\DIP_JAYARAMAN\Chapter11\lavender.jpg'
      ); //SIVP toolbox
7  figure(1)
8  ShowColorImage(I, 'Original Color Image');   //IPD
      toolbox
9  J = im2double(I);
10 [index,map] = RGB2Ind(I); //IPD toolbox
11 pixels = prod(size(index));
12 hsv = rgb2hsv(J);
13 h = hsv(:,1);
14 s = hsv(:,2);
15 v = hsv(:,3);
16 //Finds location of black and white pixels
17 darks = find(v<0.2);
18 lights = find(s<0.05 & v>0.85);
19 h([darks lights])=-1;
20 //Gets the number of all pixels for each colour bin
21 black_pixels = length(darks)/pixels;
22 white_pixels = length(lights)/pixels;
23 red = length(find((h > .9167 | h <= .083) & h ~= -1)
      )/pixels;
24 yellow = length(find(h > .083 & h <= .25))/pixels;
```

Figure 11.2: Read a Colour image and separate the colour image into red green and blue planes

```
25 green = length(find(h > .25 & h <= .4167))/pixels;
26 cyan = length(find(h > .4167 & h <= .5833))/pixels;
27 blue = length(find(h > .5833 & h <= .75))/pixels;
28 magenta = length(find(h > .75 & h <= .9167))/pixels;
29 //Plots histogram
30 figure(2)
31 a=gca();
32 a.data_bounds=[0,0;8,1]
33 n = 0:0.1:1;
34 plot2d2(n,red*ones(1,length(n)),5)
35 n1 = 1:0.1:2;
36 plot2d2(n1,yellow*ones(1,length(n)),7)
37 n2 = 2:0.1:3;
38 plot2d2(n2,green*ones(1,length(n)),8)
39 n3 = 3:0.1:4;
40 plot2d2(n3,cyan*ones(1,length(n)),9)
41 n4 = 4:0.1:5;
42 plot2d2(n4,blue*ones(1,length(n)),2)
43 n5 = 5:0.1:6;
44 plot2d2(n5,magenta*ones(1,length(n)),3)
45 n6 = 6:0.1:7;
46 plot2d2(n6,white_pixels*ones(1,length(n)),0)
47 n7 = 7:0.1:8
48 plot2d2(n7,black_pixels*ones(1,length(n)),5)
```

Scilab code Exa 11.18 Perform histogram equalisation of the given RGB image

```
1 //Caption:Perform histogram equalisation of the
    given RGB image
2 //Fig.11.18: MATLAB Example4
3 //page596
4 clc;
5 close;
6 a = imread('E:\DIP_JAYARAMAN\Chapter11\peppers.png')
```

```
    ;  //SIVP toolbox
7 //conversion of RGB to YIQ format
8 b = rgb2ntsc(a);
9 //Histogram equalisation of Y component alone
10 b(:,:,1) =
11 //conversion of YIQ to RGB format
12 c = ntsc2rgb(b);
13 figure(1)
14 ShowColorImage(a, 'Original Image');   //IPD toolbox
15 figure(2)
16 ShowColorImage(c, 'Histogtram equalized Image');
    //IPD toolbox
```

Scilab code Exa 11.21 This program performs median filtering of the colour image

```
1 //Caption:This program performs median filtering of
    the colour image
2 //Fig.11.21: MATLAB Example5
3 //page598
4 clc;
5 close;
6 a = imread('E:\DIP_JAYARAMAN\Chapter11\peppers.png')
    ;  //SIVP toolbox
7 b = imnoise(a, 'salt & pepper', 0.2);
8 c(:,:,1)= MedianFilter(b(:,:,1), [3 3]);
9 c(:,:,2)= MedianFilter(b(:,:,2), [3 3]);
10 c(:,:,3)= MedianFilter(b(:,:,3), [3 3]);
11 figure(1)
12 ShowColorImage(a, 'Original Image');   //IPD toolbox
13 figure(2)
14 ShowColorImage(b, 'corrupted Image');   //IPD
    toolbox
15 figure(3)
16 ShowColorImage(c, 'Median Filtered Image');   //IPD
```

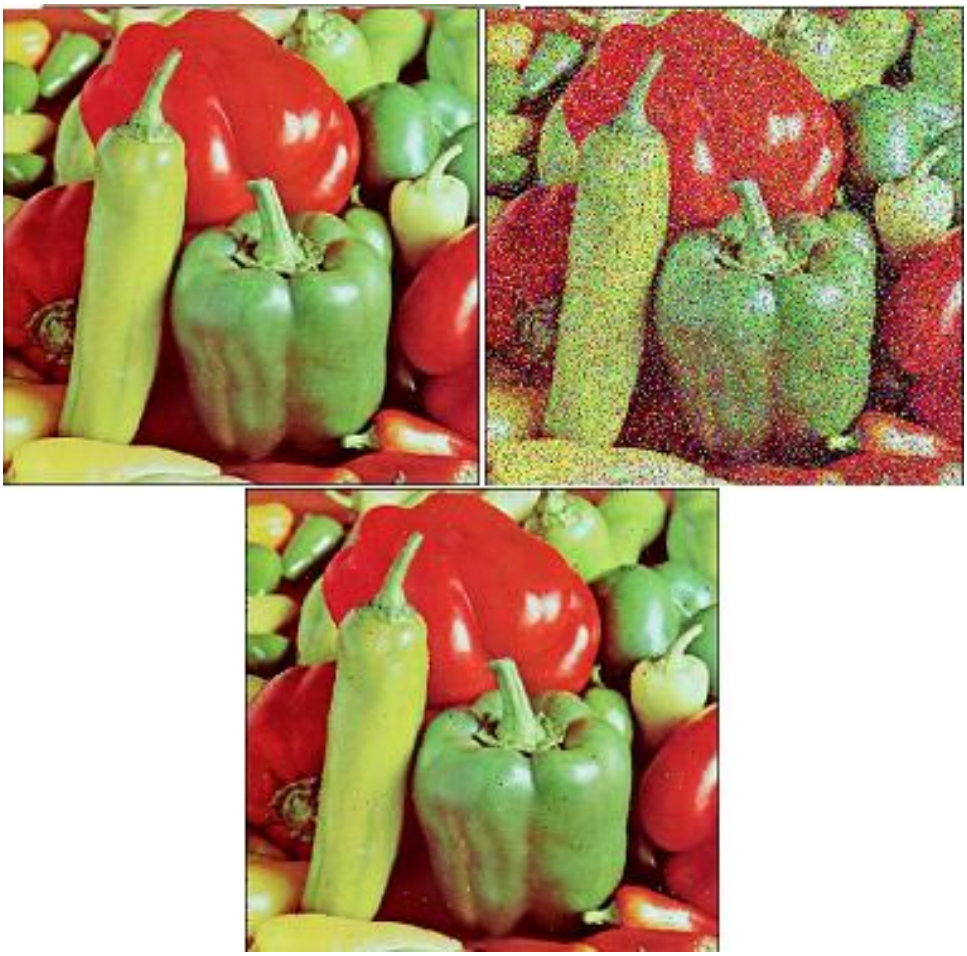


Figure 11.3: This program performs median filtering of the colour image

toolbox

Scilab code Exa 11.24 Fitlering only the luminance component

```
1 //Caption:Fitlering only the luminance component
```

```
//Fig.11.24: MATLAB Example6
//page599
clc;
close;
a = imread('E:\DIP_JAYARAMAN\Chapter11\peppers.png')
    ;  //SIVP toolbox
//conversion of RGB to YIQ format
yiq = rgb2ntsc(a);
//Extract the Y component alone
b = yiq(:,:,1);
h = [-1,-1,-1;-1,8,-1;-1,-1,-1];
//Perform high pass filtering only on Y component
c1 = conv2d2(b,h);
[m,n]= size(b);
for i =1:m
    for j=1:n
        D(i,j)= c1(i,j);
    end
end
yiq(:,:,1)=D;
//convert YIQ to RGB format
a1 = ntsc2rgb(yiq);
figure(1)
ShowColorImage(a, 'Original Image');    //IPD toolbox
figure(2)
ShowColorImage(a1, 'High Pass filtered Image');    //
   IPD toolbox
```

Scilab code Exa 11.28 Perform gamma correction for the given colour image

```
//Caption:Perform gamma correction for the given
   colour image
```

Figure 11.4: Fitlering only the luminance component

```
2  //Fig.11.28: MATLAB Example7
3  //page603
4  close;
5  clear all;
6  clc;
7  I = imread('E:\DIP_JAYARAMAN\Chapter11\ararauna.png'
       );  //SIVP toolbox
8  gamma_Value = 0.5;
9  max_intensity = 255; //for uint8 image
10 //Look up table creation
11 LUT = max_intensity.*(([0:max_intensity]./
       max_intensity).^gamma_Value);
12 LUT = floor(LUT);
13 //Mapping of input pixels into lookup table values
14 K = double(I)+1;
15 J = zeros(I);
16 [m,n,p]= size(K);
17 for i = 1:m
18  for j =1:n
19      for k = 1:p
20           J(i,j,k)= LUT(K(i,j,k));
21       end
```

Figure 11.5: Perform gamma correction for the given colour image

```
22      end
23  end
24  figure(1)
25  ShowColorImage(I, 'Original Image');    //IPD toolbox
26  figure(2)
27  ShowColorImage(uint8(J), 'Gamma Corrected Image');
        //IPD toolbox
```

Scilab code Exa 11.30 Perform Pseudo Colouring Operation

```
1  //Caption:Perform Pseudo-Colouring Operation
2  //Fig.11.30
3  //page604
4  close;
5  clear all;
6  clc;
7  K = imread('E:\DIP_JAYARAMAN\Chapter11\lenna.jpg');
       //SIVP toolbox
8  [m,n]= size(K);
9  I = uint8(K);
```

```
for i = 1:m
    for j =1:n
        if (I(i,j)>=0 & I(i,j)<50)
            J(i,j,1)=I(i,j)+50;
            J(i,j,2)=I(i,j)+100;
            J(i,j,3)=I(i,j)+10;
        elseif (I(i,j)>=50 & I(i,j)<100)
            J(i,j,1)=I(i,j)+35;
            J(i,j,2)=I(i,j)+128;
            J(i,j,3)=I(i,j)+10;
        elseif(I(i,j)>=100 & I(i,j)<150)
            J(i,j,1)=I(i,j)+152;
            J(i,j,2)=I(i,j)+130;
            J(i,j,3)=I(i,j)+15;
        elseif(I(i,j)>=150 & I(i,j)<200)
            J(i,j,1)=I(i,j)+50;
            J(i,j,2)=I(i,j)+140;
            J(i,j,3)=I(i,j)+25;
        elseif(I(i,j)>=200 & I(i,j)<=256)
            J(i,j,1)=I(i,j)+120;
            J(i,j,2)=I(i,j)+160;
            J(i,j,3)=I(i,j)+45;
        end
    end
end
figure(1)
ShowImage(K, 'Original Image');    //IPD toolbox
figure(2)
ShowColorImage(J, 'Pseudo Coloured Image');    //IPD
   toolbox
```

Scilab code Exa 11.32 Read an RGB image and segment it using the threshold method

Figure 11.6: Perform Pseudo Colouring Operation

```
1  //Caption:Read an RGB image and segment it using the
       threshold method
2  //Fig11.32
3  //Page605
4  close;
5  clc;
6  I = imread('E:\DIP_JAYARAMAN\Chapter11\ararauna.png'
       );  //SIVP toolbox
7  //Conversion of RGB to YCbCr
8  b = rgb2ycbcr_1(I); //SIVP toolbox
9  [m,n,p]=size(b);
10 b = uint8(b);
11 //Threshold is applied only to Cb component
12 mask = b(:,:,2)>120;
13 figure(1)
14 ShowColorImage(I,'Original Image');    //IPD toolbox
15 figure(2)
16 ShowImage(mask, 'Segmented Image');    //IPD toolbox
```

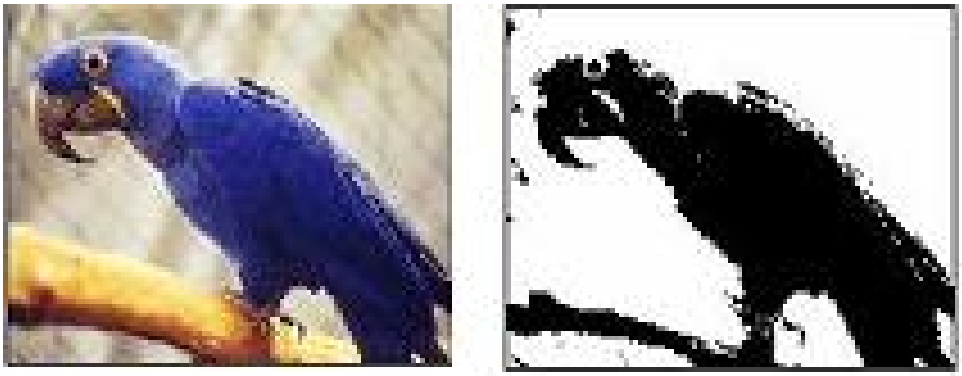


Figure 11.7: Read an RGB image and segment it using the threshold method

Chapter 12

Wavelet based Image Processing

Scilab code Exa 12.9 Scilab code to perform wavelet decomposition

```
1 //Caption: Scilab code to perform wavelet
    decomposition
2 //Fig12.10
3 //Page624
4 clc;
5 close;
6 x = ReadImage('E:\DIP_JAYARAMAN\Chapter12\lenna.jpg'
    );
7 //The image in unsigned integer or double has to be
    converted into normalized
8 //double format
9 x = im2double(x);
10 //First Level decomposition
11 [CA,CH,CV,CD]=dwt2(x,'db1');
12 //Second level decomposition
13 [CA1,CH1,CV1,CD1]=dwt2(CA,'db1');
14 CA = im2int8(CA);
15 CH = im2int8(CH);
16 CV = im2int8(CV);
```

```
CD = im2int8(CD);
CA1 = im2int8(CA1);
CH1 = im2int8(CH1);
CV1 = im2int8(CV1);
CD1 = im2int8(CD1);
A = [CA,CH;CV,CD];
B = [CA1,CH1;CV1,CD1];
imshow(B)
title('Result of Second Level Decomposition')
```

Scilab code Exa 12.42 Scilab code to generate different levels of a Gaussian pyramid

```
//Caption: Scilab code to generate different levels
   of a Gaussian pyramid
//Fig12.42
//Page651
clc;
close;
a = imread('E:\DIP_JAYARAMAN\Chapter12\apple3.bmp');
a = rgb2gray(a);
b = a;
kernelsize = input('Enter the size of the kernel:');
sd = input('Enter the standard deviation of hte
   Gaussian window:');
rf = input('Enter the Reduction Factor:');
//Routine to generate Gaussian kernel
k = zeros(kernelsize, kernelsize);
[m n] = size(b);
t = 0;
for i = 1:kernelsize
    for j=1:kernelsize
        k(i,j) = exp(-((i-kernelsize/2).^2+(j-
           kernelsize/2).^2)/(2*sd.^2))/(2*%pi*sd
           .^2);
```

```
19          t = t+k(i,j);
20      end
21  end
22  for i = 1:kernelsize
23      for j = 1:kernelsize
24          k(i,j) = k(i,j)/t;
25      end
26  end
27  for t = 1:1:rf
28      //convolve it with the picture
29      FilteredImg = b;
30      if t==1
31          FilteredImg = filter2(k,b)/255;
32      else
33          FilteredImg = filter2(k,b);
34      end;
35      //compute the size of the reduced image
36      m = m/2;
37      n = n/2;
38      //create the reduced image through sampling
39      b = zeros(m,n);
40      for i = 1:m
41          for j = 1:n
42              b(i,j) = FilteredImg(i*2,j*2);
43          end;
44      end;
45   end;
46  figure
47  ShowImage(a,'Original Image')
48  figure
49  ShowImage(b,'Different Levels of Gausain Pyramid')
50  title('Different Levels of Gausain Pyramid Level 2')
```

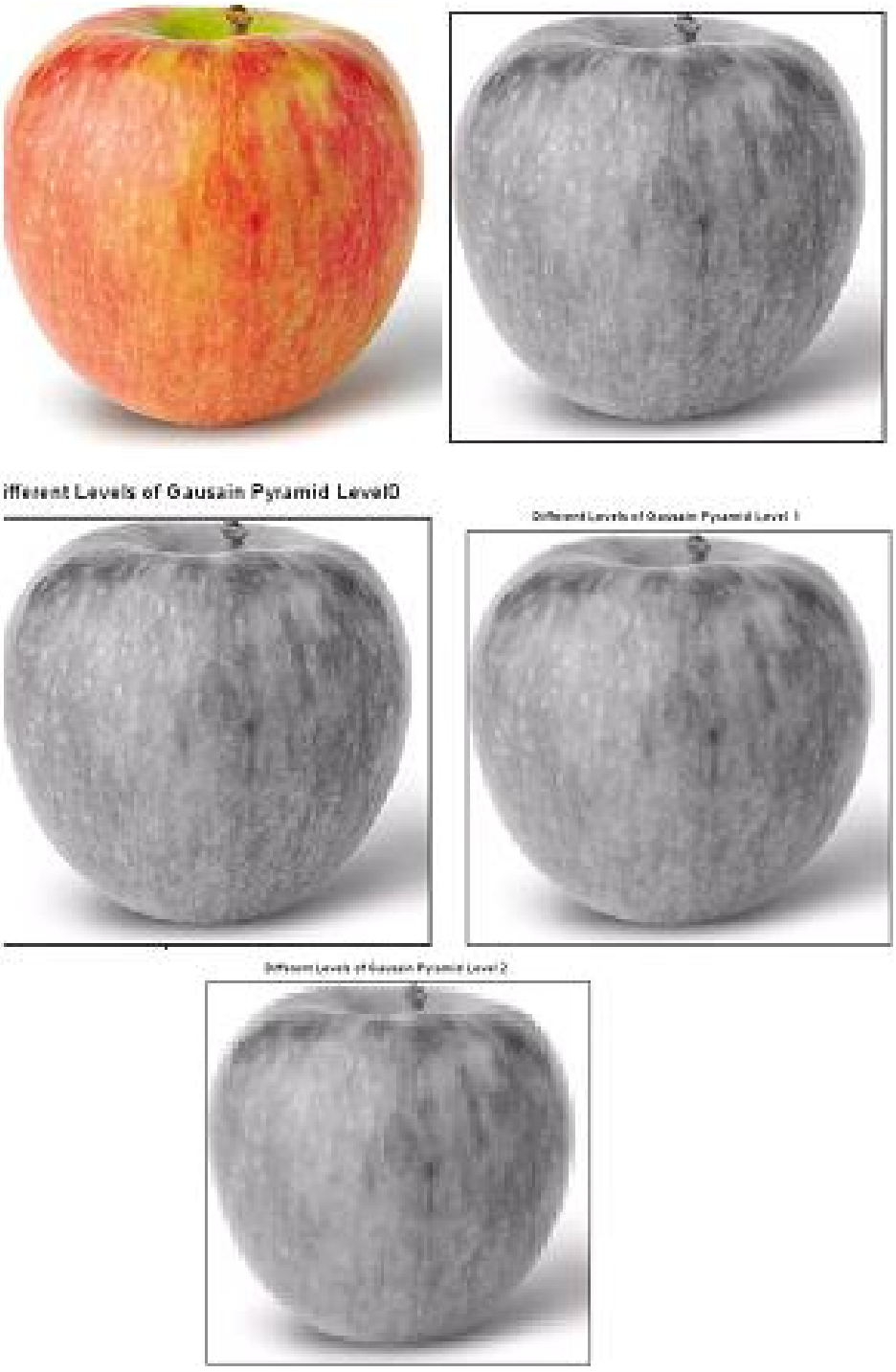


Figure 12.1: Scilab code to generate different levels of a Gaussian pyramid

Scilab code Exa 12.57 Scilab code to implement watermarking in spatial domain

```
1  //Caption: Scilab code to implement watermarking in
       spatial domain
2  //Fig12.57
3  //Page662
4  clc
5  close
6  a = imread('E:\DIP_JAYARAMAN\Chapter12\cameraman.jpg
       ');
7  figure
8  imshow(a)
9  title('Base Image');
10 b = imread('E:\DIP_JAYARAMAN\Chapter12\keyimage.jpg'
       );
11 b = rgb2gray(b);
12 b = imresize(b,[32 32],'bicubic');
13 [m1 n1]=size(b);
14 figure
15 imshow(b)
16 title('Mark Image');
17 [m n]=size(a);
18 i1 = 1;
19 j1 = 1;
20 p = 1;
21 c = a;
22 iii = 1;
23 jjj = 1;
24 a = uint8(a);
25 b = uint8(b);
26 for ff = 1:8
27     for i = 1:32
28         jjj = 1;
29         for j = j1:j1+n1-1
30             a(i,j) = bitand(a(i,j),uint8(254)); //
                   LSB of base image is set to zero.
31             temp = bitand(b(i,jjj),uint8((2^ff)-1));
```

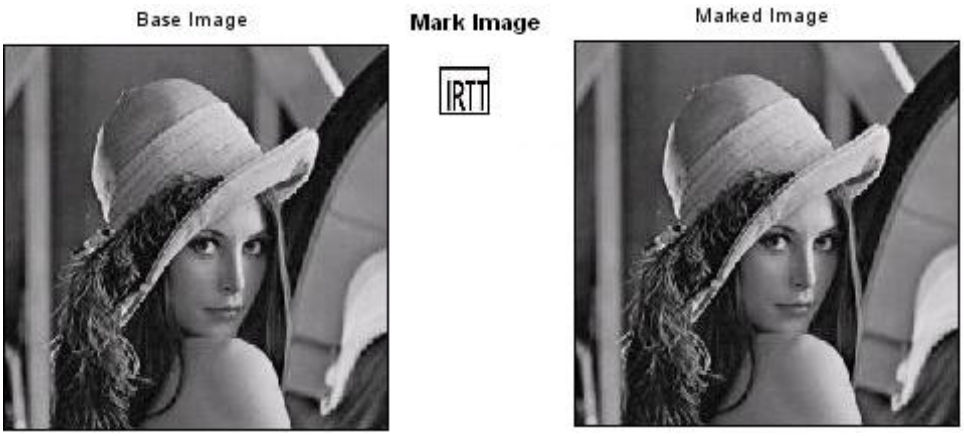


Figure 12.2: Scilab code to implement watermarking in spatial domain

```
                    //MSB of the mark is extracted.
32              temp = temp/((2^ff)-1);
33              c(i,j) = bitor(a(i,j),uint8(temp));//MSB
                    of mark is inerted into the %LSB of
                   the base
34              jjj = jjj+1;
35          end
36      end
37      j1 = j1+32;
38  end
39  imshow(c)
40  title('Marked Image');
41  imwrite(c,'E:\DIP_JAYARAMAN\Chapter12\markimg.jpg');
```

Scilab code Exa 12.63 Scilab code to implement wavelet based watermarking

```
1  //Caption: Scilab code to implement wavelet-based
       watermarking
```

```
2  //Fig12.63
3  //Page666
4  clc;
5  close;
6  //Original Image
7  img = imread('E:\DIP_JAYARAMAN\Chapter12\cameraman.
     jpg');
8  figure
9  imshow(img)
10 title('Original Image');
11 [p q] = size(img);
12 //Generate the key
13 //key = imread('E:\DIP_JAYARAMAN\Chapter12\keyimg1.
     png');
14 //key = imresize(key,[p q]);
15 key = imread('E:\DIP_JAYARAMAN\Chapter12\keyimage.
     jpg');
16 key = rgb2gray(key);
17 c = 0.001; //Initialise the weight of Watermarking
18 figure
19 imshow(key)
20 title('Key');
21 //Wavelet transform of original image (base image)
22 img = double(img);
23 key = double(key);
24 [ca,ch,cv,cd] = dwt2(img,'db1');//Compute 2D wavelet
     transform
25 //Perform the watermarking
26 y = [ca ch;cv cd];
27 Y = y + c*key;
28 p=p/2;
29 q=q/2;
30 for i=1:p
31     for j=1:q
32         nca(i,j) = Y(i,j);
33         ncv(i,j) = Y(i+p,j);
34         nch(i,j) = Y(i,j+q);
35         ncd(i,j) =  Y (i+p,j+q);
```

```
36      end
37  end
38  //Display the Watermarked image
39  wimg = idwt2(nca,nch,ncv,ncd,'db1');
40  wimg1 = uint8(wimg);
41  figure
42  imshow(wimg1)
43  title('Watermarked Image')
44  //Extraction of key from Watermarked image
45  [rca,rch,rcv,rcd] = dwt2(wimg,'db1'); //Compute 2D
       wavelet transform
46  n1=[rca,rch;rcv,rcd];
47  N1=n1-y;
48  N1 = N1*4;
49  N1 = im2int8(N1);
50  figure
51  imshow(N1)
52  title('Extract the key from watermarked image')
```

Appendix

Scilab code AP 1 2D Fast Fourier Transform

```
function [a2] = fft2d(a)
//a = any real or complex 2D matrix
//a2 = 2D-DFT of 2D matrix  'a'
m=size(a,1)
n=size(a,2)
// fourier transform along the rows
for i=1:n
a1(:,i)=exp(-2*%i*%pi*(0:m-1)'.*.(0:m-1)/m)*a(:,i)
end
// fourier transform along the columns
for j=1:m
a2temp=exp(-2*%i*%pi*(0:n-1)'.*.(0:n-1)/n)*(a1(j,:))
   .'
a2(j,:)=a2temp.'
end
for i = 1:m
    for j = 1:n
        if((abs(real(a2(i,j)))<0.0001)&(abs(imag(a2(
           i,j)))<0.0001))
            a2(i,j)=0;
        elseif(abs(real(a2(i,j)))<0.0001)
            a2(i,j)= 0+%i*imag(a2(i,j));
        elseif(abs(imag(a2(i,j)))<0.0001)
            a2(i,j)= real(a2(i,j))+0;
        end
    end
```

```
25 end
```

Scilab code AP 2 2D Inverse FFT

```
1  function [a] =ifft2d(a2)
2  //a2 = 2D-DFT of any real or complex 2D matrix
3  //a = 2D-IDFT of a2
4  m=size(a2,1)
5  n=size(a2,2)
6  //Inverse Fourier transform along the rows
7  for i=1:n
8  a1(:,i)=exp(2*%i*%pi*(0:m-1)'.*.(0:m-1)/m)*a2(:,i)
9  end
10 //Inverse fourier transform along the columns
11 for j=1:m
12 atemp=exp(2*%i*%pi*(0:n-1)'.*.(0:n-1)/n)*(a1(j,:)).'
13 a(j,:)=atemp.'
14 end
15 a = a/(m*n)
16 a = real(a)
17 endfunction
```

Scilab code AP 3 Median Filtering function

```
1  //The input to the function are the corrupted image
       a    and the dimension
2  function [Out_Imag] = Func_medianall(a,N)
3  a=double(a);
4  [m n]=size(a);
5  Out_Imag=a;
6  if(modulo(N,2)==1)
7  Start=(N+1)/2;
8  End=Start;
9  else
10     Start=N/2;
11     End=Start+1;
12 end
13 if(modulo(N,2)==1)
```

```
14      limit1=(N-1)/2;
15      limit2=limit1;
16  else
17      limit1=(N/2)-1;
18      limit2=limit1+1;
19  end
20  for i=Start:(m-End+1),
21      for j=Start:(n-End+1),
22          I=1;
23          for k=-limit1:limit2,
24              for l=-limit1:limit2,
25                  mat(I)=a(i+k,j+l);
26                  I=I+1;
27              end
28          end
29          mat=gsort(mat);          //Sort the elements to
                find the median
30          if(modulo(N,2)==1)
31              Out_Imag(i,j)=(mat(((N^2)+1)/2));
32          else
33             Out_Imag(i,j)=(mat((N^2)/2)+mat(((N^2)/2)
                  +1))/2;
34          end
35      end
36  end
```

Scilab code AP 4 To caculate gray level

```
1  function [g] = gray(m)
2      g = (0:m-1)'/max(m-1,1)
3  g = [g g g]
4  endfunction
```

Scilab code AP 5 To change the gray level of gray image

```
1  function [bout] = grayslice(I,z)
2
```

```
3  // Output variables initialisation (not found in
       input variables)
4  bout=[];
5
6  // Number of arguments in function call
7  [%nargout,%nargin] = argn(0)
8
9  if %nargin==1 then
10   z = 10;
11 elseif ~type(z)==1 then
12   z = double(z);
13 end;
14 n = z;
15 if typeof(I)=="uint8" then
16  z = (255*(0:n-1))/n;
17 elseif isa(I, 'uint16') | isa(I, 'int16') then
18  z = 65535*(0:(n-1))/n;
19 else // I is double or single
20  z = (0:(n-1))/n
21 end;
22 [m,n] = size(I);
23 b = zeros(m,n);
24 // Loop over all intervals, except the last
25 for i = 1:length(z)-1
26   // j is the index value we will output, so it
       depend upon storage class
27     if typeof(b)=='uint8'
28       j = i-1;
29    else
30       j = i;
31    end
32    d = find(I>=z(i) & I<z(i+1));
33    if ~isempty(d),
34       b(d) = j;
35    end
36 end
37
38 // Take care of that last interval
```

```
39 d = find(I >= z($));
40 if ~isempty(d) then
41   // j is the index value we will output, so it
       depend upon storage class
42   if typeof(b)==”uint8” then
43    j = length(z)-1;
44   else
45    j = length(z);
46   end;
47   b(d) = j;
48 end;
49 bout = b;
50 bout = double(bout);
51 endfunction
```