Scilab Manual for
Digital Signal and Image Processing
by Ms chhaya
Computer Engineering
Xavier Institute Of Engineering[1]

Solutions provided by
Mr R Senthilkumar
Electronics Engineering
Institute of Road and Transport Technology

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Experiment: 1

To find Linear Convolution, Circular Convolution

Scilab code Solution 1.1 Linear Convolution

```
1 //Caption: Program to find the Convolution Sum [
     Linear Convolution]
2 //of two discrete sequences
3 //Software version
4 //For: OS Windows7 and 8
5 //Scilab5.4.1 and above
6 //Image Processing Design Toolbox 8.3.1 and above
7 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
8 //For: OS Ubuntu Linux 14.04 and above
9 //Scilab5.5.1
10 //Image Processing Design Toolbox 8.3.1 and above
11 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
12 clear all;
13 close;
14 clc;
```

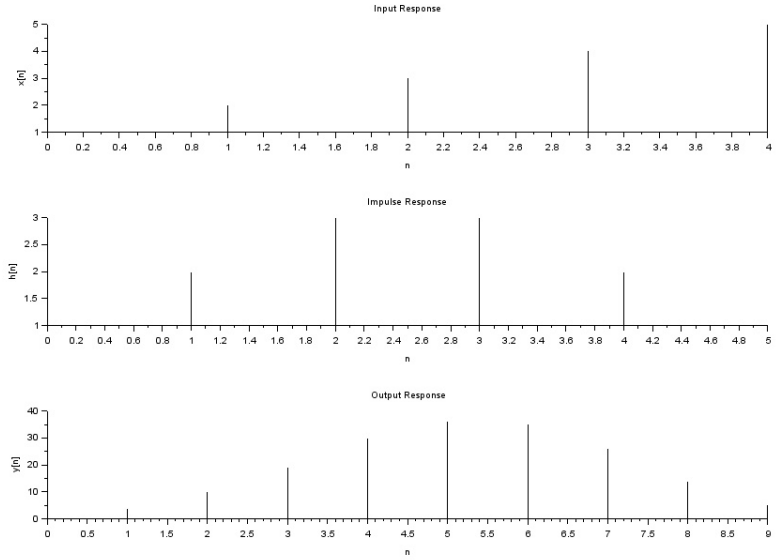


Figure 1.1: Linear Convolution

```
15 h = input('Enter the input sequence1=')
16 //h = [1,2,3,3,2,1];
17 x = input('Enter the input sequence2=')
18 //x = [1,2,3,4,5];
19 y = convol(x,h);
20 for i = 1:length(y)
21   if (y(i)<=0.0001)
22     y(i)=0;
23   end
24 end
25 disp(y,'Linear Convolution Output y[n]=')
26 subplot(3,1,2)
27 a=gca();
28 a.thickness = 2;
29 plot2d3('gnn',[0:length(h)-1],h)
30 xtitle('Impulse Response','n','h[n]');
31 subplot(3,1,1)
32 a=gca();
33 a.thickness = 2;
```

```
34 plot2d3('gnn',[0:length(x)-1],x)
35 xtitle('Input Response','n','x[n]');
36 subplot(3,1,3)
37 a=gca();
38 a.thickness = 2;
39 plot2d3('gnn',[0:length(y)-1],y)
40 xtitle('Output Response','n','y[n]');
41 //Result
42 //Enter the input sequence1=[1,2,3,3,2,1]
43 //Enter the input sequence2=[1,2,3,4,5]
44 //
45 // Linear Convolution Output y[n]=
46 //
47 //
48 //          column 1 to 8
49 //
50 //    1.    4.    10.    19.    30.    36.    35.
       26.
51 //
52 //          column  9 to 10
53 //
54 //    14.    5.
55 //
```

Scilab code Solution 1.2 Circular Convolution

```
1 //Caption: Program to find the Cicrcular Convolution
     of given discrete sequences
2 //Software version
3 //For: OS Windows7 and 8
4 //Scilab5.4.1 and above
5 //Image Processing Design Toolbox 8.3.1 and above
6 //Scilab Image and Video Proccessing toolbox
    0.5.3.1-2 and above
7 //For: OS Ubuntu Linux 14.04 and above
```

```
8  //Scilab5.5.1
9  //Image Processing Design Toolbox 8.3.1 and above
10 //Scilab Image and Video Proccessing toolbox
       0.5.3.1-2 and above
11 clear all;
12 clc;
13 x1 = input('Enter the first sequence x1[n]=')
14 x2 = input('Enter the second sequence x2[n]=')
15 //x1 = [1,3,5,7];
16 //x2 = [2,4,6,8];
17 m = length(x1)
18 n = length(x2)
19 a = zeros(1,max(m,n))
20 if (m >n)
21    for i = n+1:m
22      x2(i) = 0;
23    end
24 elseif (n>m)
25   for i = m+1:n
26     x1(i) = 0;
27   end
28 end
29 N = length(x1)
30 x3 = zeros(1,N);
31 a(1) = x2(1);
32 for j = 2:N
33   a(j) = x2(N-j+2);
34 end
35 for i =1:N
36   x3(1) = x3(1)+x1(i)*a(i);
37 end
38 for k = 2:N
39  for j =2:N
40    x2(j) = a(j-1);
41  end
42    x2(1) = a(N);
43    x2
44  for i = 1:N
```

```
45      a(i) = x2(i);
46      x3(k) = x3(k)+x1(i)*a(i);
47   end
48 end
49 disp(x3,'Circular Convolution Result x3 = ')
50 //RESULT
51 //Input Sequence x1 =
52 //
53 //     1.     3.     5.     7.
54 //
55 // Input Sequence x2 =
56 //
57 //     2.     4.     6.     8.
58 //
59 // Circular Convolution Result x3 =
60 //
61 //     84.     92.     84.     60.
```

Experiment: 2

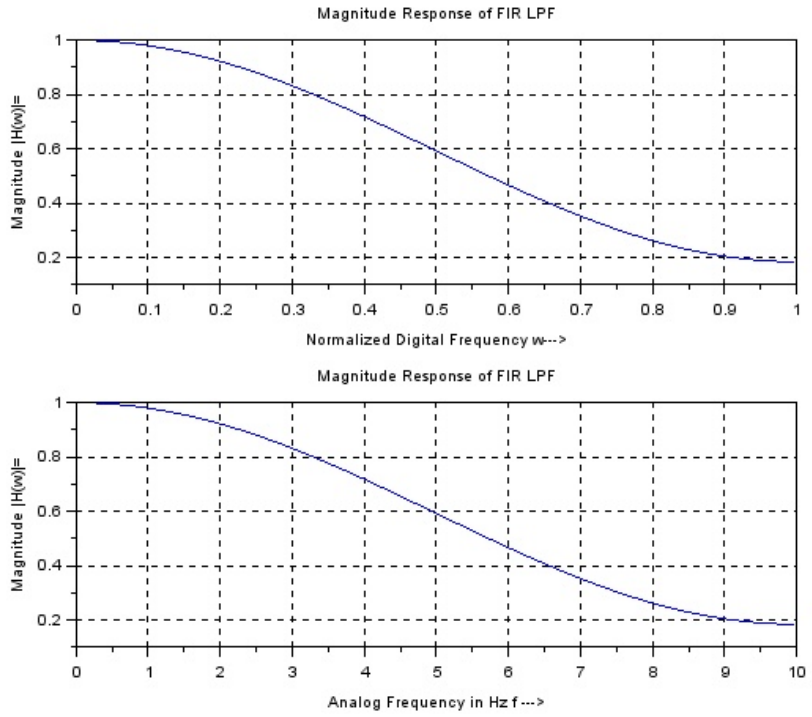
To find output of Digital FIR filter using convolution principle

Scilab code Solution 2.1 To design and test the FIR Filter output

```
1
2 //Caption: To Design an Low Pass FIR Filter and find
      out the output for sine wave
3 //input
4 //Filter Length =5, Order = 4
5 //Window = Hamming Window
6 //Software version
7 //For: OS Windows7 and 8
8 //Scilab5.4.1 and above
9 //Image Processing Design Toolbox 8.3.1 and above
10 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
11 //For: OS Ubuntu Linux 14.04 and above
12 //Scilab5.5.1
13 //Image Processing Design Toolbox 8.3.1 and above
14 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
```

```
clc;
clear;
xdel(winsid());
fc = input("Enter Analog cutoff freq. in Hz=")
fs = input("Enter Analog sampling freq. in Hz=")
M = input("Enter order of filter =")
w = (2*%pi)*(fc/fs);
disp(w,'Digital cutoff frequency in radians.cycles/
   samples');
wc = w/%pi;
disp(wc,'Normalized digital cutoff frequency in
   cycles/samples');
[wft,wfm,fr]=wfir('lp',M+1,[wc/2,0],'hm',[0,0]);
disp(wft,'Impulse Response of LPF FIR Filter:h[n]=')
   ;
//Plotting the Magnitude Response of LPF FIR Filter
subplot(2,1,1)
plot(2*fr,abs(wfm)/max(abs(wfm)))
xlabel('Normalized Digital Frequency w--->')
ylabel('Magnitude |H(w)|=')
title('Magnitude Response of FIR LPF')
xgrid(1)
subplot(2,1,2)
plot(fr*fs,abs(wfm)/max(abs(wfm)))
xlabel('Analog Frequency in Hz f --->')
ylabel('Magnitude |H(w)|=')
title('Magnitude Response of FIR LPF')
xgrid(1)
t = 0:0.01:1;
f = fc;//maximum frequency of sine wave
A = 5; //Amplitude of sine wave
X = A*sin(2*%pi*f*t);
N = rand(X)
N = N/max(N)
X_N = X+N;
Y = convol(X_N,wft)
figure
subplot(3,1,1)
```

```
plot(t*f,X)
title('FIR Filter input sine wave')
xgrid(1)
subplot(3,1,2)
plot(t,X_N)
title('Random Noise+Sine Wave')
xgrid(1)
subplot(3,1,3)
t = 0:1/(length(Y)-1):1
plot(t*f,Y)
title('FIR Filter output ')
xgrid(1)
//Example
//Note: Use Low cutoff freq inorderto
//clearly visible the output waveform
//Enter Analog cutoff freq. in Hz=5
//Enter Analog sampling freq. in Hz=20
//Enter order of filter =4
//Digital cutoff frequency in radians.cycles/samples
//    1.5707963
//Normalized digital cutoff frequency in cycles/
   samples        0.5
//Impulse Response of LPF FIR Filter:h[n]=
//column 1 to 4
// 1.559D-18    0.1718873    0.5    0.1718873
//column 5
// 1.559D-18
```


Magnitude Response of FIR LPF
Magnitude |H(w)|=
1
0.8
0.6
0.4
0.2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Digital Frequency w--->
Magnitude Response of FIR LPF
Magnitude |H(w)|=
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
Analog Frequency in Hz f--->
Figure 2.1: To design and test the FIR Filter output

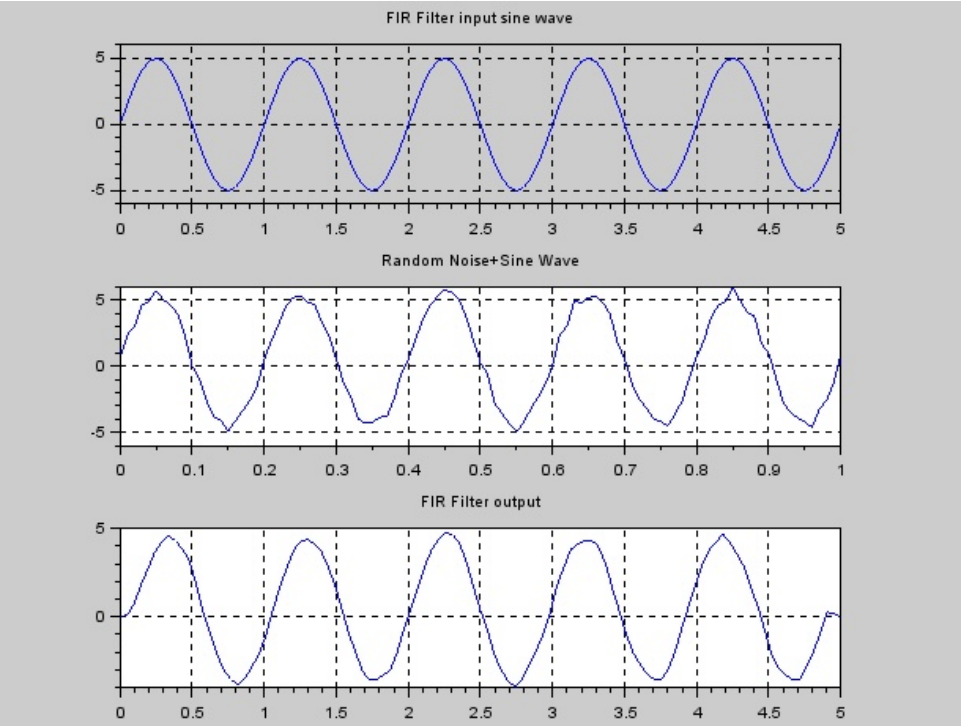


Figure 2.2: To design and test the FIR Filter output

Experiment: 3

To find DFT/FFT forward and Inverse Transform of Image

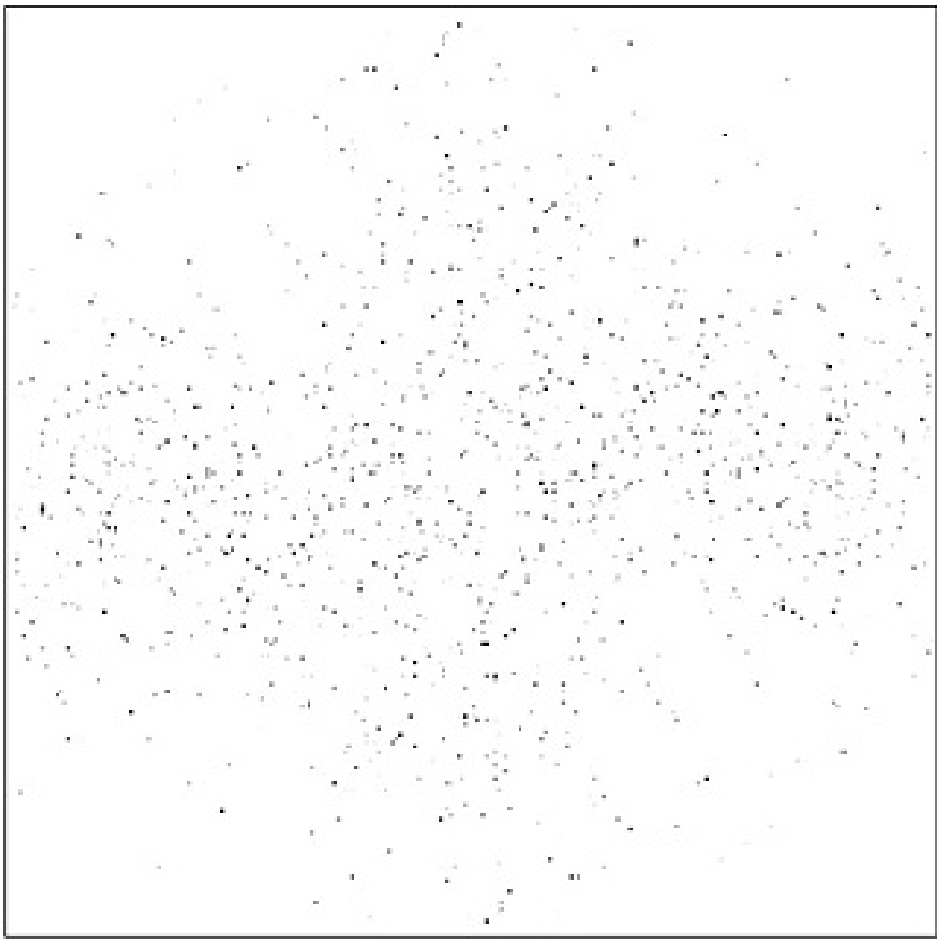
check Appendix AP 6 for dependency:

`Exp3lena.jpg`

Scilab code Solution 3.1 DFT and IDFT of 2D Image

```
1 //Caption: 2D-Discrete Fourier Transform using
    inbuilt fast fourier transform
2 //function fft2()
3 //Software version
4 //For: OS Windows7 and 8
5 //Scilab5.4.1 and above
6 //Image Processing Design Toolbox 8.3.1 and above
7 //Scilab Image and Video Proccessing toolbox
    0.5.3.1-2 and above
8 //For: OS Ubuntu Linux 14.04 and above
9 //Scilab5.5.1
```

2D-Discrete Fourier Transform of Lena Image



2D DFT-fftshifted

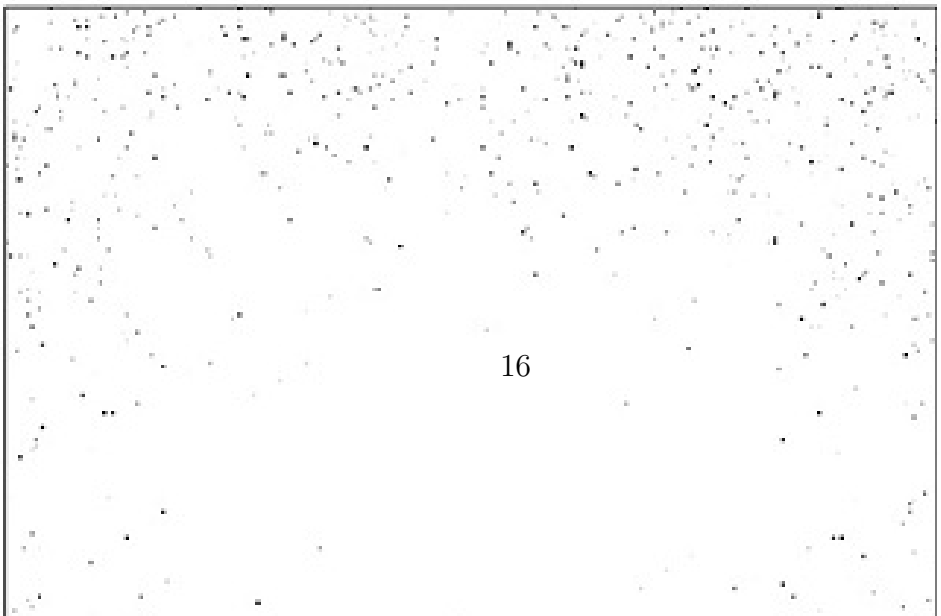


Figure 3.2: DFT and IDFT of 2D Image

```
10 //Image Processing Design Toolbox 8.3.1 and above
11 //Scilab Image and Video Proccessing toolbox
      0.5.3.1-2 and above
12 //To read and write in the correct folder
13 //change the current directory in scilab console
14 clc;
15 clear;
16 close;
17 a = ReadImage('Exp3lena.jpg');
18 [m,n]= size(a);
19 ShowImage(a,'Original lenna Image');
20 //2D-DFT using FFT
21 A = fft2(double(a));
22 figure(1)
23 ShowImage(abs(A),'2D-Discrete Fourier Transform of
      Lena Image');
24 //fftshifted image
25 B = fftshift(A)
26 figure(2)
```

```
27 ShowImage(abs(B),'2D-Discrete Fourier Transform of
      Lena Image-fftshifted');
28 //2D-IDFT using FFT
29 a_inv = fft2(A')
30 a_inv = a_inv'/(m*n);
31 figure(3)
32 ShowImage(uint8(abs(a_inv)),'2D-Inverse Discrete
      Fourier Transform ');
```

Experiment: 4

To find DWT forward and Inverse Transform of Image

check Appendix AP 5 for dependency:

`Exp4cameraman.jpg`

Scilab code Solution 4.1 DWT and IDWT of 2D Image

```
1 //Caption: Scilab code to implement Discrete Wavelet
    Transform
2 //Software version
3 //For: OS Windows7 and 8
4 //Scilab5.4.1 and above
5 //Image Processing Design Toolbox 8.3.1 and above
6 //Scilab Image and Video Proccessing toolbox
    0.5.3.1-2 and above
7 //For: OS Ubuntu Linux 14.04 and above
8 //Scilab5.5.1
9 //Image Processing Design Toolbox 8.3.1 and above
10 //Scilab Image and Video Proccessing toolbox
    0.5.3.1-2 and above
11 //To read and write in the correct folder
12 //change the current directory in scilab console
```

```
clc;
clear;
close;
//Original Image
img = imread('Exp4cameraman.jpg');
figure(1)
ShowImage(img,'Original Image')
title('Original Image');
[p q] = size(img);
[CA,CH,CV,CD] = dwt2(double(img),'db1');//Compute 2D
    wavelet transform -daubcheis wavelet
figure(2)
ShowImage(uint8(CA),'LPF-LPF output')
title('LPF-LPF output')
figure(3)
ShowImage(uint8(CH),'LPF-HPF output')
title('LPF-HPF output')
figure(4)
ShowImage(uint8(CV),'HPF-LPF output')
title('HPF-LPF output')
figure(5)
ShowImage(uint8(CD),'HPF-HPF output')
title('HPF-HPF output')
img_inv = idwt2(CA,CH,CV,CD,'db1');
img_inv = uint8(img_inv);
figure(6)
ShowImage(img_inv,'Reconstructed Image')
title('Reconstructed Image')
```

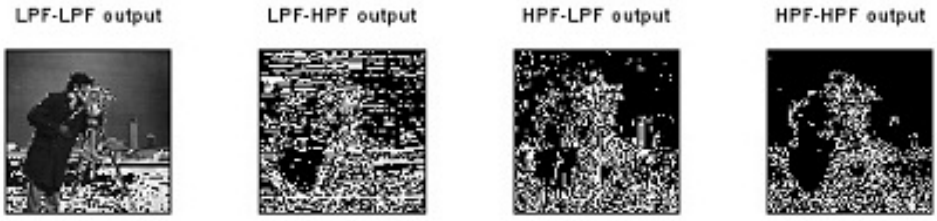


Figure 4.1: DWT and IDWT of 2D Image

Figure 4.2: DWT and IDWT of 2D Image

Experiment: 5

To enhance image using Histogram Equalization

check Appendix AP 4 for dependency:

`Exp5pout.jpg`

Scilab code Solution 5.1 Image Enhancement using Histogram Equalization

```
1 //Program Title: Image Enhancement - Image Histogram
      Equalisation
2 //For Gray Image
3 //Software version
4 //For: OS Windows7 and 8
5 //Scilab5.4.1 and above
6 //Image Processing Design Toolbox 8.3.1 and above
7 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
8 //For: OS Ubuntu Linux 14.04 and above
```

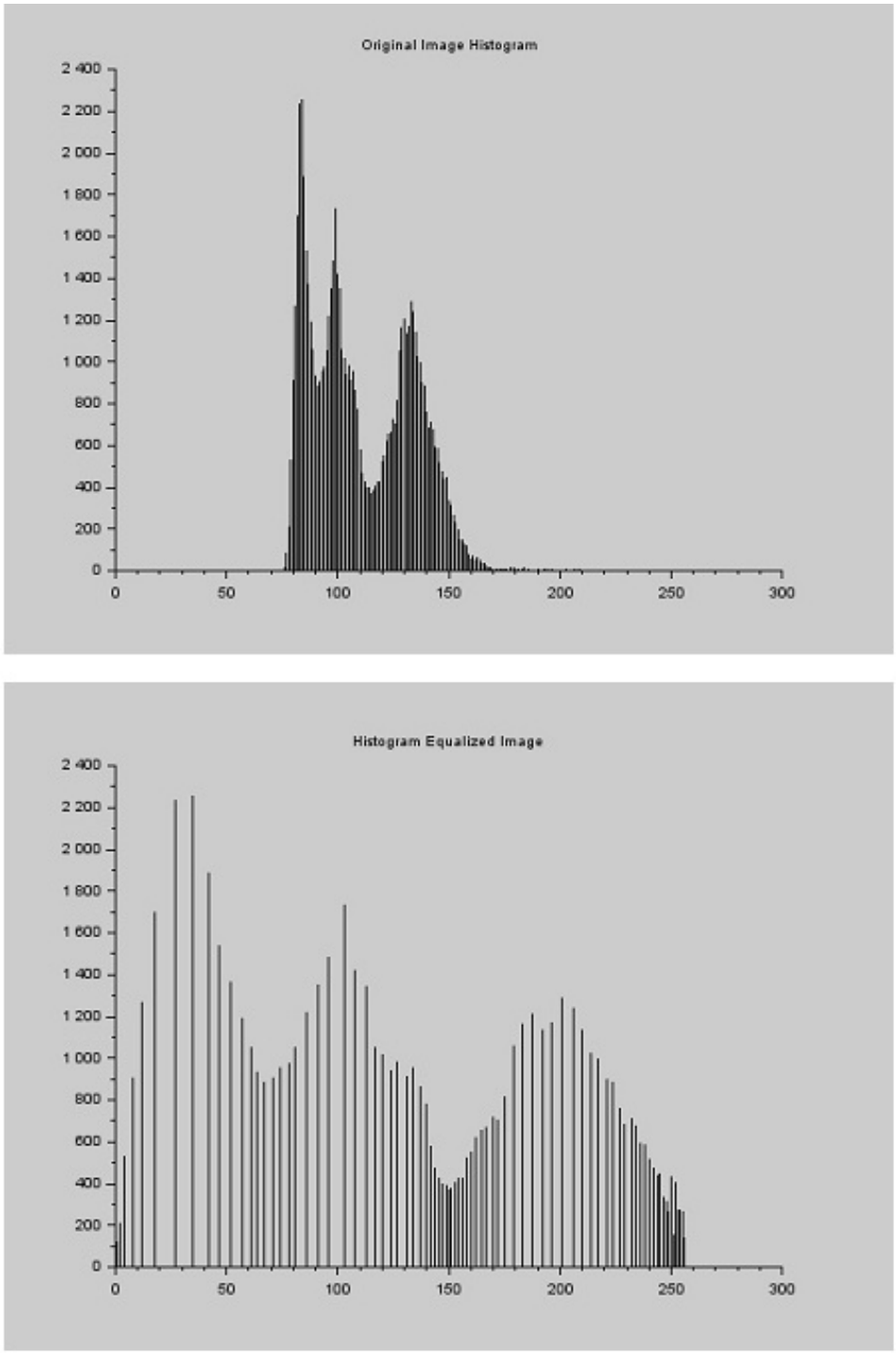


Figure 5.1: Image Enhancement using Histogram Equalization

Figure 5.2: Image Enhancement using Histogram Equalization

```
9  //Scilab5.5.1
10 //Image Processing Design Toolbox 8.3.1 and above
11 //Scilab Image and Video Proccessing toolbox
      0.5.3.1-2 and above
12 //To read and write in the correct folder
13 //change the current directory in scilab console
14
15 clc;
16 clear all;
17
18 f=ReadImage('Exp5pout.jpg');// Get image (Keep image
      file in same folder)
19 OrigSize=size(f);//Get size of original image
20 OrigRow=OrigSize(1);//Get number of rows in original
      image
21 OrigCol=OrigSize(2);//Get number of colomns in
      original image
22
23 figure
24 ShowImage(f,'Original Image Pout')
25 WriteImage(f,'Exp6OriginalImagePout.jpg') //Comment
      out if you do not want o/p file to be written on
      disk
26
27 OrigHist=CreateHistogram(uint8(f));//Create
      Histogram
28 figure
29 plot2d3(OrigHist)//Show Histogram
30 title('Original Image Histogram')
31
32 P=OrigHist/(OrigRow*OrigCol);//get average pixel
      value
33
34 C=zeros(1,256);
35
36 for i=2:256
37     C(1,i)=C(1,i-1)+P(1,i);
38 end
```

```
39
40 Cdash = round(C*255);
41
42 EqImage=[]//Empty matrix for output image
43 for i=1:OrigRow
44     for j=1:OrigCol
45         EqImage(i,j)=Cdash(1,f(i,j)+1);
46     end
47 end
48
49 figure
50 ShowImage(uint8(EqImage),'Image Histogram
      Equalisation')
51 WriteImage(uint8(EqImage),'
      Exp6ImageHistogramEqualisation.jpg') //Comment
      out if you do not want o/p file to be written on
      disk
52
53 EqHist=CreateHistogram(uint8(EqImage));//Create
      Histogram
54 figure
55 plot2d3(EqHist)//Show Histogram
56 title('Histogram Equalized Image')
```

Experiment: 6

To enhance image using Contrast Stretching

check Appendix AP 3 for dependency:

`Exp6Pout.jpg`

Scilab code Solution 6.1 Image Enhancement using Contrast Stretching

```
1 //Program Title: Image Enhancement - Image Contrast
     Stretching
2 //For Gray Image
3 //Sample Input:-
4 //Set value r1 (0<r1<255):75
5 //Set value r2 (r1<r2<255:175
6 //Set value s1 (0<s1<255):10
7 //Set value s2 (s1<s2<255:245
8 //Software version
9 //For: OS Windows7 and 8
10 //Scilab5.4.1 and above
```

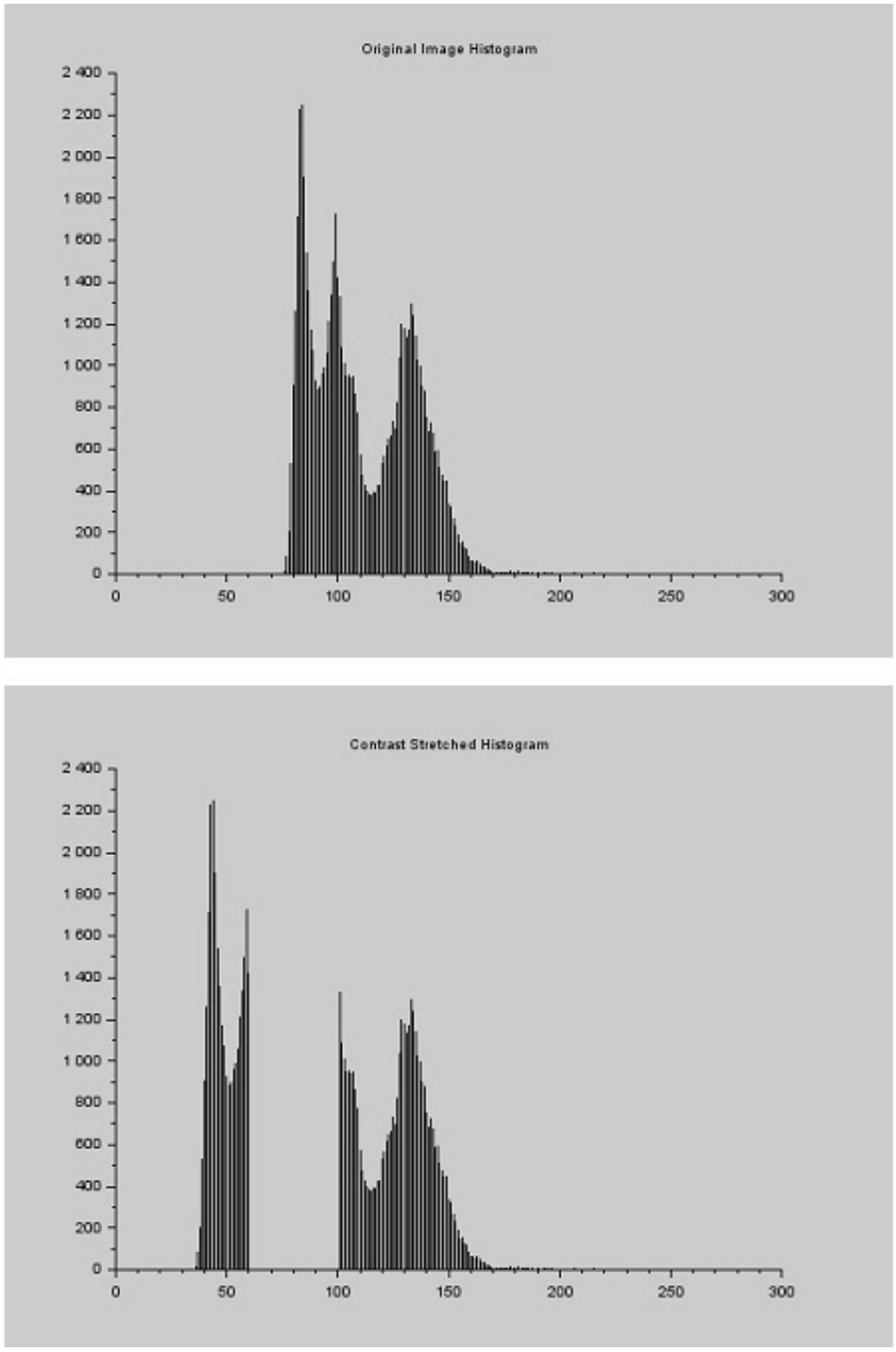


Figure 6.1: Image Enhancement using Contrast Stretching

Figure 6.2: Image Enhancement using Contrast Stretching

```
11 //Image Processing Design Toolbox 8.3.1 and above
12 //Scilab Image and Video Proccessing toolbox
      0.5.3.1-2 and above
13 //For: OS Ubuntu Linux 14.04 and above
14 //Scilab5.5.1
15 //Image Processing Design Toolbox 8.3.1 and above
16 //Scilab Image and Video Proccessing toolbox
      0.5.3.1-2 and above
17 //To read and write in the correct folder
18 //change the current directory in scilab console
19
20 clc;
21 clear all;
22
23 f=ReadImage('Exp6pout.jpg');// Get image as 16 bit
      unsigned integer
24 OrigSize=size(f);//Get size of original image
25 OrigRow=OrigSize(1);//Get number of rows in original
       image
26 OrigCol=OrigSize(2);//Get number of colomns in
      original image
27
28 figure
29 ShowImage(f,'Original Image Pout')
30 WriteImage(f,'OriginalImagePout.jpg') //Comment out
      if you do not want o/p file to be written on disk
31
32 OrigHist=CreateHistogram(uint8(f));//Create
      Histogram
33 figure
34 plot2d3(OrigHist)//Show Histogram
35 title('Original Image Histogram')
36
37 //Image Contrast Stretching
38
39 disp('Image Contrast Stretching')
40 r1=input('Set value r1 (0<r1<255):');
41 r2=input('Set value r2 (r1<r2<255:');
```

```
42 s1=input('Set value s1 (0<s1<255):');
43 s2=input('Set value s2 (s1<s2<255:');
44
45 Alpha=s1/r1;
46 Beta=(s2-s1)/(r2-r1);
47 Gamma=(255-s2)/(255-r2);
48
49 ContStr=[];//Empty matrix for output image
50
51 for x=1:OrigRow
52     for y=1:OrigCol
53         if f(x,y)<r1 then;
54             ContStr(x,y)=Alpha*f(x,y);
55         elseif (f(x,y)>r1)&(f(x,y)<r2);
56             ContStr(x,y)=Beta*(f(x,y)-r1)+s1;
57         else f(x,y)>r2;
58             ContStr(x,y)=Gamma*(f(x,y)-r2)+s2;
59         end
60     end
61 end
62
63 figure
64 ShowImage(uint8(ContStr),'Exp5 Image Contrast
     Stretching')
65 WriteImage(uint8(ContStr),'
     Exp5ImageContrastStretching.jpg')
66 ContStrHist=CreateHistogram(uint8(ContStr));//Create
      Histogram
67 figure
68 plot2d3(ContStrHist)//Show Histogram
69 title('Contrast Stretched Histogram')
70 //Result
71 //Image Contrast Stretching
72 //Set value r1 (0<r1<255):50
73 //Set value r2 (r1<r2<255: 100
74 //Set value s1 (0<s1<255):10
75 //Set value s2 (s1<s2<255: 100
```

Experiment: 7

To find edges using LOG and DOG

check Appendix AP 2 for dependency:

`Exp7lena.jpg`

Scilab code Solution 7.1 Edge Detection using LoG and DoG

```
1 //Caption: Scilab code for Edge Detection using
     Different Edge detectors
2 //[1]LoG  [2] DoG
3 //Software version
4 //For: OS Windows7 and 8
5 //Scilab5.4.1 and above
6 //Image Processing Design Toolbox 8.3.1 and above
7 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
8 //For: OS Ubuntu Linux 14.04 and above
9 //Scilab5.5.1
```

Figure 7.1: Edge Detection using LoG and DoG

Figure 7.2: Edge Detection using LoG and DoG

```
10 //Image Processing Design Toolbox 8.3.1 and above
11 //Scilab Image and Video Proccessing toolbox
     0.5.3.1-2 and above
12 //To read and write in the correct folder
13 //change the current directory in scilab console
14 close;
15 a = imread('Exp7lena.jpg');
16 //LAPLACIAN OF GAUSSIAN
     ////////////////////////////////////////////
17 [c,thresh] = edge(a,'log',0.2,'both',2);
18 //d = edge(a,'prewitt');
19 ShowImage(a,'Original Image')
20 title('Original Image')
21 figure
22 ShowImage(c,'Edge Detected Image-LoG')
23 //
     ////////////////////////////////////////////////////////////

24 //DERIVATIVE OF GAUSSIAN FUNCTION
25 function [mask]=DoG(op1,op2)
26     //If op1 and op2 are not specified -Default size
          3x3
27     if isempty(op1) then
28        siz = [3,3];
29     else
30        if length(op1)==1 then
31            siz = [op1, op1];
32        elseif length(op1)==2 then
33            siz = op1;
34        else
35            error("The second argument should have 1
                 or 2 elements for gaussian filter");
36        end
37     end
38      //set std for the filter
39     if isempty(op2) then
40        g_std = 0.5;
41     else
```

```
42          if length(op2)>1 then
43              error("The third argument should have
                    only 1 element for gaussian filter");
44          else
45              g_std = op2;
46          end
47      end
48       sizx = (siz(2)-1)/2;
49       sizy = (siz(1)-1)/2;
50       x2 = ones(siz(1),1) * ([-sizx:sizx]^2);
51       y2 = ([-sizy:sizy]^2)' * ones(1, siz(2));
52       r = sqrt(x2+y2);
53       sigma = g_std;
54       F = (1/(sigma^2))*(((r.*r)/sigma^2)-1).*exp(-r
            .*r/2*sigma^2);
55       F(F<%eps*max(F)) = 0;
56       sumF=sum(F);
57       if sumF~=0 then
58         F = F / sum(F);
59       end
60       mask = F;
61  endfunction
62  mask =  DoG([],[]);
63  mx=filter2(mask,a);
64  my=filter2(mask',a);
65  border=sqrt(mx.*mx + my.*my);
66  if thresh >=0 then
67     scale_thresh = min(border) * (1-thresh) + max(
          border)*thresh;
68     border=border > scale_thresh;
69  end
70  d = border;
71  //
       ////////////////////////////////////////////////////////////////

72  figure
73  ShowImage(d,'Edge Detected Image-DoG')
```

Experiment: 8

To find Edges using Prewit/ Sobel/ Fri-chen / Robert operators

check Appendix AP 1 for dependency:

`Exp8lena.jpg`

Scilab code Solution 8.1 Edge Detection using Prewit and Sobel

```
1 //Caption: Scilab code for Edge Detection using
    Different Edge detectors
2 //[1]. Sobel [2].Prewitt
3 //Roberts and Fr-Chen edge detection operators are
    not available in this atom
4 //Software version
5 //For: OS Windows7 and 8
6 //Scilab5.4.1 and above
7 //Image Processing Design Toolbox 8.3.1 and above
```

Figure 8.1: Edge Detection using Prewit and Sobel

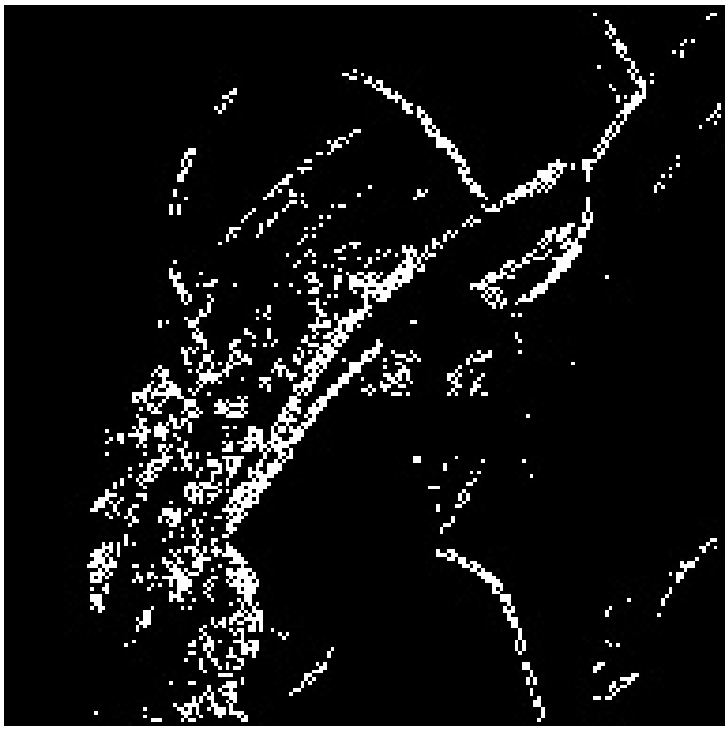


Figure 8.2: Edge Detection using Prewit and Sobel

```
8  //Scilab Image and Video Proccessing toolbox
       0.5.3.1-2 and above
9  //For: OS Ubuntu Linux 14.04 and above
10 //Scilab5.5.1
11 //Image Processing Design Toolbox 8.3.1 and above
12 //Scilab Image and Video Proccessing toolbox
       0.5.3.1-2 and above
13 ////To read and write in the correct folder
14 //change the current directory in scilab console
15 close;
16 a = imread('Exp8lena.jpg');
17 c = edge(a,'sobel');
18 d = edge(a,'prewitt');
19 ShowImage(a,'Original Image')
20 title('Original Image')
21 figure
22 ShowImage(c,'Edge Detected Image-Sobel')
23 figure
24 ShowImage(d,'Edge Detected Image-Prewitt')
```

Appendix


Lena Gray Image


Lena Image

pout
gray image

pout gray image

Cameraman Gray Image


Lena Image