Scilab Manual for Image Processing by Mr Biren Patel Others Dharmsinh Desai University[1]

Solutions provided by
Mr Biren Patel
Others
D.D. University

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Contents

List of Experiments

Experiment: 1

Digital Image Fundamentals

Scilab code Solution 1.1 Digital Image Fundamentals

```
1
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //
6 //
7 clc //to clear command window.
8 clear all //to kill previously defined variables.
9 xdel(winsid())//to close all currently open figure(s
    ).
10
11
12
13 SIVP_PATH = getSIVPpath(); //to locate a directory
    in which SIVP toolbox is installed.getSIVPpath()
    is pre-defined function in SIVP toolbox.
14  i = imread(SIVP_PATH + 'images/lena.png');//Reading
      from sub-directory of images.
15
16 b=rgb2gray(i);//to convert an image into grayscale
    image.
```

```
17 imwrite(b,'3.jpg');//to write an image.
18 info=imfinfo('3.jpg');//to get information like size
     , width ,height etc using imfinfo() function.
19 disp(info.Width);//imfinfo store data into info
     variable and disp() is function to use for
     displaying content of argument in Scilab console.
20 disp(info.Filename);
21 disp(info.FileSize);
22 disp(info.Width);
23 disp(info.Height);
24 disp(info.BitDepth);
25 disp(info.ColorType);
26
27 SIVP_PATH = getSIVPpath(); //to locate a directory
     in which SIVP toolbox is installed.getSIVPpath()
     is pre-defined function in SIVP toolbox.
28  i = imread(SIVP_PATH + 'images/lena.png');//Reading
      from sub-directory of images
29 ShowColorImage(i,'Original Image');//To show a color
     image in graphical window using "ShowColorImage
     ()" function .one can use imshow function which
     uses tk image show widget for displaying an image
     .
30 title('Original Image');//title() is used for
     providing  a title to an image.
31
32
33  im=imresize(i,1.3);//To resize an image,1.3 is
      scale factor
34 ShowColorImage(im,'Resized Image');//To show an
     image in graphical window using "ShowImage()"
     function .one can use imshow function which use
     tk image show widget for displaying an image.
35 title('Resized Image');// title() is used for
     providing  a title to an image.
36
37  im1=imresize(i,1.3,'bilinear');//to resize an image
      .Third parameter is used for selecting one
```

```
    method.
38 ShowColorImage(im1,'Resized Image using bilinear
     interpolation');//To show an image in graphical
     window using "ShowImage()" function .one can use
     imshow function which use tk image show widget
     for displaying an image.
39 title('Resized Image using bilinear interpolation');
     // title() is used for providing  a title to an
     image.
40
41
42  im2=imresize(i,1.3,'bicubic');//to resize an image
43 ShowColorImage(im2,'Resized Image using bicubic
     interpolation');//To show an image in graphical
     window using "ShowImage()" function .one can use
     imshow function which use tk image show widget
     for displaying an image.
44 title('Resized Image using bicubic interpolation');
     // title() is used for providing  a title to an
     image.
45
46
47  im3=rgb2gray(i);//To convert an image into
      grayscale image.
48 figure,ShowImage(im3,'Grayscale image');//figure is
     used to display images in separate window.
49 title('Grayscale Image');//title() is used for
     providing  a title to an image.
50
51 subimage=imcrop(im2,[1,1,256,256]);//subimage is
     image left after cropping at 1,1 top left corner.
      Width of an image is 256 and height of an image
     is 256.
52 figure,ShowColorImage(subimage,'Cropped image');//
     figure is used to display images in separate
     window.
53 title('Cropped Image');//title() is used for
     providing  a title to an image.
```

Experiment: 2

Image Enhancement in the Spatial Domain

check Appendix ?? for dependency:

`21.tif`

check Appendix ?? for dependency:

`log.tif`

check Appendix ?? for dependency:

`pollen.tif`

check Appendix ?? for dependency:

`pollensmall.tif`

Scilab code Solution 2.1 Image Enhancement in the Spatial Domain

```
1
2 //
3 //environment: Scilab 5.4.1
4 //Toolbox: Image Processing Design 8.3.1-1
5 //Toolbox: SIVP 0.5.3.1-2
```

```
6  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
7  //Toolbox:Huffcomp Toolbox 1.1.1
8  //OS:Windows 7
9  //
10 //Reference book name : Digital Image Processing
11 //book author: Rafael C. Gonzalez and Richard E.
       Woods
12 clc //to clear command window.
13 clear all //to kill previously defined variables.
14 xdel(winsid())//to close all currently open figure(s
       ).
15
16
17 SIVP_PATH = getSIVPpath(); //to locate a directory
       in which SIVP toolbox is installed. getSIVPpath()
        is pre-defined function in SIVP toolbox.
18 rgb = imread(SIVP_PATH + 'images/lena.png');//
       Reading from sub-directory of images.
19 figure,ShowColorImage(rgb,'Original color image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
20 title('Original Color Image');//title() is used for
       providing  a title to an image.
21
22 grayimage=rgb2gray(rgb);//to convert a RGB image
       into grayscale image.
23
24 figure,ShowImage(grayimage,'Grayscale image');//
       ShowImage() is used to show image, figure is
       command to view images in separate window.
25 title('Grayscale image');//title() is used for
       providing  a title to an image.
26
27 function [negative]=imagenegative(b)//imagenegative
       () is function to find negative of an image.
28     [nr nc]=size(b)//to find dimension of a
           grayscale image.
```

```
29      for i = 1:nr
30          for j = 1:nc
31              negative(i,j)=255-b(i,j);
32          end;
33      end
34  endfunction
35
36  negative=imagenegative(grayimage);
37  figure,ShowImage(negative,'Negative image');//
       ShowImage() is used to show image, figure is
       command to view images in separate window.
38  title('Negative image');//title() is used for
       providing  a title to an image.
39
40  aaa=ReadImage('21.tif');//ReadImage() is function
       defined in IPD toolbox.
41  figure,ShowImage(aaa,'Intensity Ramp Image');//
       ShowImage() is used to show image, figure is
       command to view images in separate window.
42  title('Intensity Ramp Image');//title() is used for
       providing  a title to an image.
43
44  graydouble=double(aaa);//to convert  image into
       double precision.
45
46  function [g1]=imadjust(b,lowin,lowout,highin,highout
       ,gamma1)//imadjust() is used for gamma correction
       .
47      [nr nc]=size(b);
48      for i = 1:nr
49          for j = 1:nc
50              g1(i,j)=lowout+(highout-lowout)*((b(i,j)
                   -lowin)/(highin-lowin))^gamma1;
51          end;
52      end
53  endfunction
54
55  s1=imadjust(graydouble,0.0392,0.7843,0.589,1,2);
```

```
56 d=mat2gray(s1);// to convert matrix into grayscale
      image.
57 figure,ShowImage(d,'Result of enhancing image with
      gamma=2');//ShowImage() is used to show image,
      figure is command to view images in separate
      window.
58 title('Result of enhancing image with gamma=2');//
      title() is used for providing  a title to an
      image.
59
60
61 aaa=ReadImage('log.tif');//ReadImage() is function
      defined in IPD toolbox.
62 figure,ShowImage(aaa,'Image');//ShowImage() is used
      to show image, figure is command to view images
      in separate window.
63 title('Image');//title() is used for providing  a
      title to an image.
64
65 graydouble=double(aaa);//to convert  image into
      double precision.
66 function [log1]=logtransform(b,c);//to perform log
      transformations on an image
67     [nr nc]=size(b);
68     for i = 1:nr
69         for j = 1:nc
70             log1(i,j)=c*log(1+b(i,j));
71         end
72     end
73 endfunction
74
75 s2=logtransform(graydouble,1);
76
77 ans1=255*uint8(s2);
78 figure,ShowImage(ans1,'Result of applying log
      transformations with c=1');//ShowImage() is used
      to show image, figure is command to view images
      in separate window.
```

```
79 title('Result of applying log transformations with c
     =1');//title() is used for providing a title to
     an image.
80
81
82
83
84 aaa=ReadImage('pollen.tif');//ReadImage() is
     function defiened in IPD toolbox.
85 figure,ShowImage(aaa,'washed_out_pollen_image');//
     ShowImage() is used to show image, figure is
     command to view images in separate window.
86 title('washed_out_pollen_image');//title() is used
     for providing a title to an image.
87 bb=double(aaa);
88
89 function [ans]=contraststretch(b,r1,s1,r2,s2);//to
     perform contrast stretching on a image.
90 [nr nc]=size(b);
91 m1=s1/r1;
92 m2=(r2-r1)/(s2-s1);
93 m3=(255-s2)/(255-r2);
94 for i = 1:nr
95     for j = 1:nc
96         if(b(i,j)<=r1) then
97             ans(i,j)=m1*b(i,j);
98         end
99
100        if(b(i,j)>r1) then
101            if(b(i,j)<=r2) then
102              ans(i,j)=m2*b(i,j)+(r2*s1-r1*s2)/(r2-
                   r1);
103            end
104        end
105        if(b(i,j)>r2) then
106                ans(i,j)=m3*b(i,j)+(255*s2-r2*255)
                     /(255-r2);
107            end
```

```
108         end
109     end
110 endfunction
111 s2=contraststretch(bb,70,40,150,200);
112 ans2=mat2gray(s2);
113 figure,ShowImage(ans2,'Result of contrast stretching
    ');//ShowImage() is used to show image, figure is
     command to view images in separate window.
114 title('Result of contrast stretching');//title() is
    used for providing  a title to an image.
115
116
117 aa=ReadImage('pollensmall.tif');//To read an image.
118 a=rgb2gray(aa);//to convert an image into grayscale
119 b=double(a);
120 [nr,nc]=size(a)
121
122
123 [count, cells]=imhist(a);//imhist() is used to
    obtain histogram.
124 scf(10);imhist(a,256,'');//scf() is used to set
    current graphic window.
125
126
127
128 bit=8;          //l is variable to used find
    possible intensity levels of an image.
129 l=2^bit;
130
131 r=zeros(1,l);//rK is used for input intensity levels
     for an image.
132 n=zeros(1,l);//nK is used for number of pixels,
    which have different intensity levels.
133 p=zeros(1,l);//pk is probability of occurrence of
    intensity level rk in a digital image.
134
135 for i = 1:l//for loop is used to define different
    intensity levels.
```

```
136     r(1,i)=i-1;
137 end
138
139
140 for k=1:l//for loop is used to find occurrence of rk
        intensity level
141     for i = 1:nr
142         for j = 1:nc
143             if  a(i,j)==r(1,k) then
144                 n(1,k)=n(1,k)+1;
145             end
146         end
147     end
148 end
149
150 p=n/(nr*nc);//to find probability of occurrence of
       intensity level rk in a digital image.
151
152
153 for k=1:l//for loop is used to find transformation's
        result.
154     temp=0;
155     for j=1:k
156         temp=temp+255*p(1,j);
157     end
158     if(ceil(temp)-temp>0.5) then
159         s(1,k)=floor(temp);
160     else
161         s(1,k)=ceil(temp);
162     end
163 end
164
165 for k=1:l//for loop is used to assign new intensity
       levels.
166     for i = 1:nr
167         for j = 1:nc
168             if  (b(i,j)==r(1,k)) then
169                 dd(i,j)= s(1,k);
```

```
170                 end
171             end
172         end
173 end
174 ddd=uint8(dd);
175 [count, cells]=imhist(ddd,256);//imhist() is used to
        get 256 bins of histogram.
176 clf;
177 scf(11);imhist(ddd,256);//To show histogram
178 scf(12);ShowImage(ddd,' Result of histogram
       equalization ');//ShowImage() is used to show
       image, figure is command to view images in
       separate window.
179 title('Result of histogram equalization');//title()
       is used for providing  a title to an image.
```

Experiment: 3

Filtering In the Spatial Domain

Scilab code Solution 3.1 Filtering In the Spatial Domain

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
     ).
14
15
16 SIVP_PATH = getSIVPpath(); //to locate a directory
     in which SIVP toolbox is installed. getSIVPpath()
      is pre-defined function in SIVP toolbox.
17 rgb = imread(SIVP_PATH + 'images/lena.png');//
```

```
    Reading from sub-directory of images.
figure,ShowColorImage(rgb,'Original color image');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
title('Original Color Image');//title() is used for
    providing  a title to an image.

im=rgb2gray(rgb);//to convert a RGB image into
    grayscale image.

figure,ShowImage(im,'Grayscale image');//ShowImage()
     is used to show image, figure is command to view
     images in separate window.
title('Grayscale image');//title() is used for
    providing  a title to an image.

filter=fspecial('average',3);//fspecial() is used to
     create special filters.
imf = imfilter(im, filter);
figure,ShowImage(imf,'Filtered Grayscale image using
     3*3 average mask');//ShowImage() is used to show
     image, figure is command to view images in
    separate window.
title('Filterd Grayscale image using 3*3 average
    mask');//title() is used for providing  a title
    to an image.


filter=fspecial('average',9);//fspecial() is used to
     create special filters.
imf = imfilter(im, filter);
figure,ShowImage(imf,'Filterd Grayscale image using
    9*9 average mask');//ShowImage() is used to show
    image, figure is command to view images in
    separate window.
title('Filterd Grayscale image using 9*9 average
    mask');//title() is used for providing  a title
```

```
    to an image.
36
37
38 filter=fspecial('average',16);//fspecial() is used
    to create special filters.
39 imf = imfilter(im, filter);
40 figure,ShowImage(imf,'Filterd Grayscale image using
    16*16 average mask');//ShowImage() is used to
    show image, figure is command to view images in
    separate window.
41 title('Filterd Grayscale image using 16*16 average
    mask');//title() is used for providing  a title
    to an image.
42
43
44 imn = imnoise(im, 'gaussian',0.01,0.02);//imnoise()
    is used to add noise in an image.'gaussian' is
    used as a second argument to function for adding
    Gasussian noise
45 figure,ShowImage(imn,'Image corrupted by Gaussian
    noise');//ShowImage() is used to show image,
    figure is command to view images in separate
    window.
46 title('Image corrupted by  Gaussian noise');//title
    () is used for providing  a title to an image.
47
48
49 imn = imnoise(im, 'speckle');//imnoise() is used to
    add noise in an image.'speckle' is used as a
    second argument to function for adding Speckle
    noise.Third argument is used for various.
50 figure,ShowImage(imn,'Image corrupted by Speckle
    noise');//ShowImage() is used to show image,
    figure is command to view images in separate
    window.
51 title('Image corrupted by speckle noise');//title()
    is used for providing  a title to an image.
52
```

```
53 imns = imnoise(im, 'salt & pepper');//imnoise() is
      used to add noise in an image.'gaussian' is used
      as a second argument to function for adding Salt
      & Pepper noise.Third argument is used for noise
      density.
54 figure,ShowImage(imns,'Image corrupted by salt and
      pepper noise');//ShowImage() is used to show
      image, figure is command to view images in
      separate window.
55 title('Image corrupted by  salt and pepper noise');
      //title() is used for providing  a title to an
      image.
56
57 filter=fspecial('average',3);//fspecial() is used to
       create special filters.
58 imf = imfilter(imns, filter);
59 figure,ShowImage(imf,'Filterd Grayscale image using
      3*3 average mask');//ShowImage() is used to show
      image, figure is command to view images in
      separate window.
60 title('Filterd Grayscale image using 16*16 average
      mask');//title() is used for providing  a title
      to an image.
61
62 subim = imcrop(imns, [1, 1, 300, 300]);//imcrop() is
       used to crop an image.
63 function [resimg]=median2(image,filtersize,type1)//
      median2() is function to filter an image.
64     size1=filtersize;
65     [nr,nc]=size(image);
66     if type1=="zero" then
67         temp=zeros(nr+2*floor(size1/2),nc+2*floor(
              size1/2));
68     end
69     temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
          /2));
70
71     temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
```

```
        /2):nc+ceil(size1/2)-1)=subim(1:$,1:$)
72      for i=ceil(size1/2):nr+ceil(size1/2)-1
73          for j=ceil(size1/2):nc+ceil(size1/2)-1
74              t=temp(i-floor(size1/2):1:i+floor(size1
                    /2),j-floor(size1/2):1:j+floor(size1
                    /2))
75              y=gsort(t);
76              temp(i,j)=median(y);
77          end
78      end
79
80      nn=temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
            size1/2):nc+ceil(size1/2)-1)
81      resimg=mat2gray(nn)
82
83  endfunction
84
85  nnn=median2(subim,3,"zero");//median2() is a 2-D
        median filter, second argument is used for filter
         size. It should be odd integer. Third argument
        is used for zero padding.
86  figure,ShowImage(nnn,'Filtered image using 3*3
        median filter');//ShowImage() is used to show
        image, figure is command to view images in
        separate window.
87  title('Filtered image using 3*3 median filter ');//
        title() is used for providing  a title to an
        image.
88
89
90
91  F=fspecial('sobel')//fspecial('sobel') returns a 3x3
         horizontal edges sobel filter.
92  imf = imfilter(im, F);
93  figure,ShowImage(imf,'Filterd Grayscale image using
        3*3 average mask');//ShowImage() is used to show
        image, figure is command to view images in
        separate window.
```

```
94 title('Filterd Grayscale image using 3*3 average
      mask');//title() is used for providing  a title
      to an image.
95
96 F=fspecial('prewitt')//fspecial('prewitt') returns a
       3x3 horizontal edges prewitt filter.
97 imf = imfilter(im, F);
98 figure,ShowImage(imf,'Filtering  Grayscale image
      using 3x3 horizontal edges prewitt filter.');//
      ShowImage() is used to show image, figure is
      command to view images in separate window.
99 title('Filtering  Grayscale image using 3x3
      horizontal edges prewitt filter.');//title() is
      used for providing  a title to an image.
100
101 F=fspecial('gaussian')//fspecial('gaussian', hsize,
      sigma) returns a Gaussian lowpass filter.
102 imf = imfilter(im, F);
103 figure,ShowImage(imf,'Filtering  Grayscale image
      using  Gaussian lowpass filter.');//ShowImage()
      is used to show image, figure is command to view
      images in separate window.
104 title('Filtering  Grayscale image using Gaussian
      lowpass filter. ');//title() is used for
      providing  a title to an image.
105
106 F=fspecial('laplacian')//fspecial('laplacian',alpha)
       returns a 3-by-3 Laplacian filter. The returned
      filter is [alpha, 1-alpha, alpha; 1-alpha, -4, 1-
      alpha; alpha, 1-alpha, alpha]/(alpha+1). The
      default value for alpha is 0.2.
107 imf = imfilter(im, F);
108 figure,ShowImage(imf,'Filtering  Grayscale image
      using 3x3 Laplacian filter.');//ShowImage() is
      used to show image, figure is command to view
      images in separate window.
109 title('Filtering  Grayscale image using 3x3
      Laplacian filter.');//title() is used for
```

```
    providing  a title to an image.
110
111 F=fspecial('log')//fspecial('log',hsize,sigma)
    returns a Laplacian of Gaussian filter. The size
    of returned filter is determined by parameter
    hsize. hsize can be a 1x2 vector which indicate
    the rows and columns of F. If hsize is a scalar,
    F is a square matrix. The default value for hsize
     is [5, 5]; the default value for sigma is 0.5.
112 imf = imfilter(im, F);
113 figure,ShowImage(imf,'Filterd Grayscale image using
    Laplacian of Gaussian filter.');//ShowImage() is
    used to show image, figure is command to view
    images in separate window.
114 title('Filterd Grayscale image using Laplacian of
    Gaussian filter.');//title() is used for
    providing  a title to an image.
```

Experiment: 4

Filtering The Frequency Domain

Scilab code Solution 4.1 Filtering In the Frequency Domain

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14
15 function[H]=lowpassfilter(type1,M,N,D0,n)//
       lowpassfilter is used to filter an image .
16     u=0:(M-1);
```

```
17      v=0:(N-1);
18      idx=find(u>M/2);
19      u(idx)=u(idx)-M;
20      idy=find(v>N/2);
21      v(idy)=v(idy)-N;
22      [U,V]=meshgrid(v,u);
23      D=sqrt(U.^2+V.^2);
24      select type1
25      case'ideal'then
26          H=double(D<=D0);
27      case'butterworth'then
28          if argn(2)==4 then
29              n=1;
30          end
31          t1=D./D0
32          t2=t1.^(2*n)
33          t3=1+t2;
34          [nr1,nc1]=size(t3);
35          a=ones(nr1,nc1);
36          H=a./t3;
37      case'gaussian'then
38          H=exp(-(D.^2)./(2*(D0^2)));
39      else
40          disp('Unknownfiltertype.')
41      end
42  endfunction
43
44  function[H1]=highpassfilter(type2,M,N,D0,n)//
       highpassfilter() is used to filter an image.
45      if argn(2)==4 then
46          n=1;
47      end
48      h=lowpassfilter(type2,M,N,D0,n);
49      H1=1-h;
50  endfunction
51
52  SIVP_PATH = getSIVPpath(); //to locate a directory
       in which SIVP toolbox is installed. getSIVPpath()
```

```
      is pre-defined function in SIVP toolbox.
53 rgb = imread(SIVP_PATH + 'images/lena.png');//
     Reading from sub-directory of images.
54 figure,ShowColorImage(rgb,'Original Color image');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
55 title('Original Color Image');//title() is used for
     providing  a title to an image.
56
57 im=rgb2gray(rgb);//to convert a RGB image into
     grayscale image.
58
59
60 f=double(im);
61 [M,N]=size(f);
62
63 h=fft2(f);//fft2() is used to find 2-Dimensional
     Fast Fourier Transform of an matrix
64 i=log(1+abs(h));
65 in=fftshift(i);//fftshift() is used to rearrange the
      fft output, moving the zero frequency to the
     center of the spectrum.
66 inm=mat2gray(in)
67 figure,ShowImage(inm,'Frequency Spectrum');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
68 title('Frequency Spectrum');//title() is used for
     providing  a title to an image.
69
70
71 filt=lowpassfilter('ideal',M,N,5);
72 n=filt.*h;//convolving an image with a two
     dimensional filter.
73 n1=real(ifft(n));//ifft() is used to find inverse 2-
     Dimensional Fast fourier transform of an matrix
74 filt1=fftshift(filt);//fftshift() is used to
```

```
    rearrange the fft output, moving the zero
    frequency to the center of the spectrum.
filt2=mat2gray(filt1);
figure,ShowImage(filt2,'Frequency Spectrum');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
title('Frequency Spectrum');//title() is used for
    providing  a title to an image.

mm=mat2gray(n1);
figure,ShowImage(mm,'Ideal Lowpass filteredimage [
    cutofffreq=5]');//ShowColorImage() is used to
    show color image, figure is command to view
    images in separate window.
title('Ideal Lowpassfiltered image[cutofffreq=5]');
    //title() is used for providing  a title to an
    image.



filt=lowpassfilter('ideal',M,N,50);
n=filt.*h;//convolving an image with a two
    dimensional filter.
n1=real(ifft(n));//ifft() is used to find inverse 2-
    Dimensional Fast fourier transform of an matrix
filt1=fftshift(filt);//fftshift() is used to
    rearrange the fft output, moving the zero
    frequency to the center of the spectrum.
filt2=mat2gray(filt1);
figure,ShowImage(filt2,'Frequency Spectrum');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
title('Frequency Spectrum');//title() is used for
    providing  a title to an image.

mm=mat2gray(n1);
```

```
94  figure,ShowImage(mm,'Ideal Lowpass filtered image[
       cutofffreq=5]');//ShowColorImage() is used to
       show color image, figure is command to view
       images in separate window.
95  title('Ideal Lowpass filtered image[cutofffreq=50]')
       ;//title() is used for providing  a title to an
       image.
96
97
98  filt=lowpassfilter('ideal',M,N,200);
99  n=filt.*h;//convolving an image with a two
       dimensional filter.
100 n1=real(ifft(n));//ifft() is used to find inverse 2-
       Dimensional Fast fourier transform of an matrix
101 filt1=fftshift(filt);//fftshift() is used to
       rearrange the fft output, moving the zero
       frequency to the center of the spectrum.
102 filt2=mat2gray(filt1);
103 figure,ShowImage(filt2,'Frequency Spectrum');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
104 title('Frequency Spectrum');//title() is used for
       providing  a title to an image.
105
106 mm=mat2gray(n1);
107 figure,ShowImage(mm,'Ideal Lowpass filtered image[
       cutofffreq=200]');//ShowColorImage() is used to
       show color image, figure is command to view
       images in separate window.
108 title('Ideal Lowpass filtered image[cutofffreq=200]'
       );//title() is used for providing  a title to an
       image.
109
110
111
112
113 filt=lowpassfilter('butterworth',M,N,5);
```

```
114 n=filt.*h;//convolving an image with a two
      dimensional filter.
115 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
116 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
117 filt2=mat2gray(filt1);
118 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
119 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
120
121 mm=mat2gray(n1);
122 figure,ShowImage(mm,'butterworth Lowpass filtered
      image[cutofffreq=5]');//ShowColorImage() is used
      to show color image, figure is command to view
      images in separate window.
123 title('butterworth Lowpass filtered image[cutofffreq
      =5]');//title() is used for providing  a title to
       an image.
124
125
126
127 filt=lowpassfilter('butterworth',M,N,50);
128 n=filt.*h;//convolving an image with a two
      dimensional filter.
129 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
130 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
131 filt2=mat2gray(filt1);
132 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
```

```
    window.
133 title('Frequency Spectrum');//title() is used for
    providing  a title to an image.
134
135 mm=mat2gray(n1);
136 figure,ShowImage(mm,'butterworth Lowpass
    filteredimage[cutofffreq=5]');//ShowColorImage()
    is used to show color image, figure is command to
     view images in separate window.
137 title('butterworth Lowpass filteredimage [cutofffreq
    =50]');//title() is used for providing  a title
    to an image.
138
139
140 filt=lowpassfilter('butterworth',M,N,200);
141 n=filt.*h;//convolving an image with a two
    dimensional filter.
142 n1=real(ifft(n));//ifft() is used to find inverse 2-
    Dimensional Fast fourier transform of an matrix
143 filt1=fftshift(filt);//fftshift() is used to
    rearrange the fft output, moving the zero
    frequency to the center of the spectrum.
144 filt2=mat2gray(filt1);
145 figure,ShowImage(filt2,'Frequency Spectrum');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
146 title('Frequency Spectrum');//title() is used for
    providing  a title to an image.
147
148 mm=mat2gray(n1);
149 figure,ShowImage(mm,'butterworth Lowpass
    filteredimage[cutofffreq=200]');//ShowColorImage
    () is used to show color image, figure is command
     to view images in separate window.
150 title('butterworth Lowpass filteredimage[cutofffreq
    =200]');//title() is used for providing  a title
    to an image.
```

```
151
152
153 filt=lowpassfilter('butterworth',M,N,5);
154 n=filt.*h;//convolving an image with a two
      dimensional filter.
155 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
156 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
157 filt2=mat2gray(filt1);
158 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
159 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
160
161 mm=mat2gray(n1);
162 figure,ShowImage(mm,'gaussian Lowpass filtered image
      [cutofffreq=5]');//ShowColorImage() is used to
      show color image, figure is command to view
      images in separate window.
163 title('gaussian Lowpass filtered image[cutofffreq=5]
      ');//title() is used for providing  a title to an
       image.
164
165
166
167 filt=lowpassfilter('gaussian',M,N,50);
168 n=filt.*h;//convolving an image with a two
      dimensional filter.
169 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
170 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
171 filt2=mat2gray(filt1);
```

```
172 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
173 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
174
175 mm=mat2gray(n1);
176 figure,ShowImage(mm,'gaussian Lowpass filtered image
      [cutofffreq=5]');//ShowColorImage() is used to
      show color image, figure is command to view
      images in separate window.
177 title('gaussian Lowpass filtered image[cutofffreq
      =50]');//title() is used for providing  a title
      to an image.
178
179
180 filt=lowpassfilter('gaussian',M,N,200);
181 n=filt.*h;//convolving an image with a two
      dimensional filter.
182 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
183 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
184 filt2=mat2gray(filt1);
185 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
186 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
187
188 mm=mat2gray(n1);
189 figure,ShowImage(mm,'gaussian Lowpass filtered image
      [cutofffreq=200]');//ShowColorImage() is used to
      show color image, figure is command to view
      images in separate window.
```

```
190 title('gaussian Lowpass filtered image[cutofffreq
      =200]');//title() is used for providing a title
      to an image.
191
192
193
194 clc //to clear command window.
195 clear all //to kill previously defined variables.
196 xdel(winsid())//to close all currently open figure(s
      ).
197
198 SIVP_PATH = getSIVPpath(); //to locate a directory
      in which SIVP toolbox is installed. getSIVPpath()
       is pre-defined function in SIVP toolbox.
199 rgb = imread(SIVP_PATH + 'images/lena.png');//
      Reading from sub-directory of images.
200 figure,ShowColorImage(rgb,'Original color image');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
201 title('Original Color Image');//title() is used for
      providing a title to an image.
202
203 im=rgb2gray(rgb);//to convert a RGB image into
      grayscale image.
204
205
206 f=double(im);
207 [M,N]=size(f);
208
209 h=fft2(f);//fft2() is used to find 2-Dimensional
      Fast Fourier Transform of an matrix
210 i=log(1+abs(h));
211 in=fftshift(i);
212 inm=mat2gray(in)
213 figure,ShowImage(inm,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
```

```
    window.
214 title('Frequency Spectrum');//title() is used for
    providing  a title to an image.
215
216
217 filt=highpassfilter('ideal',M,N,5);
218 n=filt.*h;//convolving an image with a two
    dimensional filter.
219 n1=real(ifft(n));//ifft() is used to find inverse 2-
    Dimensional Fast fourier transform of an matrix
220 filt1=fftshift(filt);//fftshift() is used to
    rearrange the fft output, moving the zero
    frequency to the center of the spectrum.
221 filt2=mat2gray(filt1);
222 figure,ShowImage(filt2,'Frequency Spectrum');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
223 title('Frequency Spectrum');//title() is used for
    providing  a title to an image.
224
225 mm=mat2gray(n1);
226 figure,ShowImage(mm,'Ideal highpass filteredimage[
    cutofffreq=5]');//ShowColorImage() is used to
    show color image, figure is command to view
    images in separate window.
227 title('Ideal highpass filteredimage[cutofffreq=5]');
    //title() is used for providing  a title to an
    image.
228
229
230
231 filt=highpassfilter('ideal',M,N,50);
232 n=filt.*h;//convolving an image with a two
    dimensional filter.
233 n1=real(ifft(n));//ifft() is used to find inverse 2-
    Dimensional Fast fourier transform of an matrix
234 filt1=fftshift(filt);//fftshift() is used to
```

```
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
235 filt2=mat2gray(filt1);
236 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
237 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
238
239 mm=mat2gray(n1);
240 figure,ShowImage(mm,'Ideal highpass filteredimage[
      cutofffreq=50]');//ShowColorImage() is used to
      show color image, figure is command to view
      images in separate window.
241 title('Ideal highpass filteredimage[cutofffreq=50]')
      ;//title() is used for providing  a title to an
      image.
242
243
244 filt=highpassfilter('ideal',M,N,200);
245 n=filt.*h;//convolving an image with a two
      dimensional filter.
246 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
247 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
248 filt2=mat2gray(filt1);
249 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
250 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
251
252 mm=mat2gray(n1);
253 figure,ShowImage(mm,'Ideal highpass filteredimage[
```

```
    cutofffreq=200]');//ShowColorImage() is used to
    show color image, figure is command to view
    images in separate window.
254 title('Ideal highpass filteredimage[cutofffreq=200]'
    );//title() is used for providing  a title to an
    image.
255
256
257
258 filt=highpassfilter('butterworth',M,N,200);
259 n=filt.*h;//convolving an image with a two
    dimensional filter.
260 n1=real(ifft(n));//ifft() is used to find inverse 2-
    Dimensional Fast fourier transform of an matrix
261 filt1=fftshift(filt);//fftshift() is used to
    rearrange the fft output, moving the zero
    frequency to the center of the spectrum.
262 filt2=mat2gray(filt1);
263 figure,ShowImage(filt2,'Frequency Spectrum');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
264 title('Frequency Spectrum');//title() is used for
    providing  a title to an image.
265
266 mm=mat2gray(n1);
267 figure,ShowImage(mm,'butterworth highpass filtered
    image[cutofffreq=200]');//ShowColorImage() is
    used to show color image, figure is command to
    view images in separate window.
268 title('butterworth highpass filtered image[
    cutofffreq=200]');//title() is used for providing
      a title to an image.
269
270
271
272 filt=highpassfilter('gaussian',M,N,200);
273
```

```
274 n=filt.*h;//convolving an image with a two
      dimensional filter.
275 n1=real(ifft(n));//ifft() is used to find inverse 2-
      Dimensional Fast fourier transform of an matrix
276 filt1=fftshift(filt);//fftshift() is used to
      rearrange the fft output, moving the zero
      frequency to the center of the spectrum.
277 filt2=mat2gray(filt1);
278 figure,ShowImage(filt2,'Frequency Spectrum');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
279 title('Frequency Spectrum');//title() is used for
      providing  a title to an image.
280
281 mm=mat2gray(n1);
282 figure,ShowImage(mm,'gaussian highpass filtered
      image[cutofffreq=200]');//ShowColorImage() is
      used to show color image, figure is command to
      view images in separate window.
283 title('gaussian highpass filtered image[cutofffreq
      =200]');//title() is used for providing  a title
      to an image.
```

Experiment: 5

Image Restoration

Scilab code Solution 5.1 Image Restoration

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14
15 function imn = imnoise22(im, noise_type, param1,
       param2)
16   imtype = typeof(im(1));
17   im=im2double(im);
18   im=matrix(im(:), size(im));
```

```
19    //Gaussian noise
20    if (noise_type == 'gaussian' | noise_type == '
         Gaussian') then
21      if ~exists('param1','local')
22        m=0
23      else
24        m=param1
25      end
26      if ~exists('param2','local')
27        v=0.01
28      else
29        v=param2
30      end
31
32      old_rand_gen=rand('info');
33      rand('normal');
34
35      imn = im + sqrt(v)*rand(im) + m;
36
37      rand(old_rand_gen);
38
39
40    elseif noise_type == 'localvar'
41      if argn(2) < 3 then
42        error('Too few arguments for noise type ''
             localvar''.');
43      elseif argn(2) == 3 then
44        if( or(size(im)<>size(param1))) then
45      error("The first parameter for ''localvar''
         should have the same"+...
46            " size with the input image.");
47        end
48
49        old_rand_gen=rand('info');
50        rand('normal');
51        imn = matrix(im(:), size(im)) + sqrt(param1).*
           rand(im);
52        rand(old_rand_gen);
```

```
53
54      elseif argn(2) == 4 then
55        if( or(size(param1)<>size(param2))) then
56      error("The two parameters for ''localvar''
           should have the same size.");
57        end
58
59        minp1 = min(param1);
60        maxp1 = max(param1);
61        imn = min(max(im(:),minp1),maxp1); //max(im,
             minp1) can't work
62                                           //because
                                               im is a
                                               hypermat
                                               .
63        imn = matrix(interp1(param1(:),param2(:),imn),
             size(im));
64
65        old_rand_gen=rand('info');
66        rand('normal');
67        imn = im + sqrt(imn).*rand(im);
68        rand(old_rand_gen);
69      end
70
71    //salt & pepper noise
72    elseif noise_type == 'salt & pepper' | noise_type
         == 'salt and pepper'
73      if ~exists('param1','local')
74        d=0.05
75      else
76        d=param1
77
78        if( d < 0 | d > 1) then
79      error("The parameter for ''salt & pepper'' noise
           should in range [0,1].");
80        end
81      end
82
```

```
83      old_rand_gen=rand('info');
84      rand('uniform');
85      prob=rand(im);
86      rand(old_rand_gen);
87
88      imn=im;
89      imn(prob < d/2) = 0;
90      imn(prob >=d/2 & prob < d) = 1;
91
92    elseif noise_type=='speckle'
93      if ~exists('param1','local')
94        v=0.04
95      else
96        v=param1
97        if( v < 0) then
98      error("The parameter for ''speckle'' noise
           should >=0.");
99        end
100    end
101
102    old_rand_gen=rand('info');
103    rand('uniform');
104    imn = im + im .* (sqrt(v) * (rand(im)-0.5) );
105    rand(old_rand_gen);
106
107   elseif noise_type == 'poisson'
108     error('Not yet implemented');
109   else
110     error('Invalid noise type.');
111   end
112
113   //conver the output image to the same type as the
       input image
114
115   select imtype
116    case 'uint8' then
117     imn = im2uint8(imn);
118    case 'int8' then
```

```
119      imn = im2int8(imn);
120     case 'uint16' then
121      imn = im2uint16(imn);
122     case 'int16' then
123      imn = im2int16(imn);
124     case 'int32' then
125      imn = im2int32(imn);
126     case 'constant' then
127      imn = im2double(imn);
128     else
129      error("Data type " + imtype + " is not supported
            .");
130    end
131
132 endfunction
133
134
135 //
136 SIVP_PATH = getSIVPpath(); //to locate a directory
       in which SIVP toolbox is installed. getSIVPpath()
        is pre-defined function in SIVP toolbox.
137 rgb = imread(SIVP_PATH + 'images/lena.png');//
       Reading from sub-directory of images.
138 figure,ShowColorImage(rgb,'Original color image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
139 title('Original Color Image');//title() is used for
       providing  a title to an image.
140 im=rgb2gray(rgb);//to convert a RGB image into
       grayscale image.
141
142 k = imnoise(im,'salt & pepper', 0.02);
143  figure,ShowImage(k,'Salt & pepper noise corrupted
        image');//ShowColorImage() is used to show color
         image, figure is command to view images in
        separate window.
144 title('Salt & pepper noise corrupted image');//title
```

```
      () is used for providing  a title to an image.
145
146
147 [count, cells]=imhist(k,256);//imhist() is used to
      find histogram of an image.
148 figure;imhist(k,255,'');
149  title('Histogram of Salt & pepper noise corrupted
      image');//title() is used for providing  a title
       to an image.
150
151  k = imnoise(im,'gaussian',0.02, 0.02);
152  figure,ShowImage(k,'Gaussian noise corrupted image'
      );//ShowColorImage() is used to show color image
      , figure is command to view images in separate
      window.
153 title('Gaussian noise corrupted image');//title() is
      used for providing  a title to an image.
154
155  [count, cells]=imhist(k,256);//imhist() is used to
      find histogram of an image.
156 figure;imhist(k,255,'');
157  title('Histogram of Gaussian noise corrupted image'
      );//title() is used for providing  a title to an
       image.
158
159
160  k = imnoise22(im,'speckle',0.8);//minor error in
      original function
161  figure,ShowImage(k,'Speckle noise corrupted image')
      ;//ShowColorImage() is used to show color image,
       figure is command to view images in separate
      window.
162 title('Speckle noise corrupted image');//title() is
      used for providing  a title to an image.
163  [count, cells]=imhist(k,256);//imhist() is used to
      find histogram of an image.
164 figure;imhist(k,255,'');
165  title('Histogram of Speckle noise corrupted image')
```

```
;//title() is used for providing  a title to an
    image.
```

Scilab code Solution 5.2 Image Restoration

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14
15 SIVP_PATH = getSIVPpath(); //to locate a directory
       in which SIVP toolbox is installed. getSIVPpath()
        is pre-defined function in SIVP toolbox.
16 rgb = imread(SIVP_PATH + 'images/lena.png');//
       Reading from sub-directory of images.
17 figure,ShowColorImage(rgb,'Original color image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
18 title('Original Color Image');//title() is used for
       providing  a title to an image.
19 im=rgb2gray(rgb);//to convert a RGB image into
       grayscale image.
20
```

```
21 function [f]=alphatrim(g,m,n,d)//alphatrim() is used
       to filter an image using alpha-trimmed mean
   filter
22     size1=m;
23     [nr,nc]=size(g);
24     temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
         /2));
25     temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
         /2):nc+ceil(size1/2)-1)=g(1:$,1:$)
26
27     for i=ceil(size1/2):nr+ceil(size1/2)-1
28         for j=ceil(size1/2):nc+ceil(size1/2)-1
29             t=temp(i-floor(size1/2):1:i+floor(size1
                 /2),j-floor(size1/2):1:j+floor(size1
                 /2))
30             y=gsort(t);
31             a=y(:)
32             b=a';
33             t1=b(1+d/2:$-d/2);
34             temp2(i,j)=mean(t1);
35         end
36     end
37     nn=temp2(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
         size1/2):nc+ceil(size1/2)-1)
38     f=mat2gray(nn)
39 endfunction
40
41
42 function [f]=gmean1(g,m,n);//gmean1() is used to
   filter an image using Geometric mean filter
43     size1=m;
44     q=m*n;
45     g=double(g);
46     [nr,nc]=size(g);
47     temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
         /2));
48     temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
         /2):nc+ceil(size1/2)-1)=g(1:$,1:$)
```

```
49      temp=temp+1;
50      for i=ceil(size1/2):nr+ceil(size1/2)-1
51          for j=ceil(size1/2):nc+ceil(size1/2)-1
52              t=temp(i-floor(size1/2):1:i+floor(size1
                   /2),j-floor(size1/2):1:j+floor(size1
                   /2)) ;
53              temp2(i,j)=prod(t);
54          end
55      end
56      temp3=temp2.^(1/q);
57      nn=temp3(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
           size1/2):nc+ceil(size1/2)-1)
58      f1=nn-1;
59      f=mat2gray(f1)
60
61  endfunction
62
63
64
65  function [f]=gmean2(g,m,n);//gmean2() is used to
       filter an image using Geometric mean filter
66      size1=m;
67      q=m*n;
68      [nr,nc]=size(g);
69      temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
           /2));
70
71      temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
           /2):nc+ceil(size1/2)-1)=g(1:$,1:$)
72
73      for i=ceil(size1/2):nr+ceil(size1/2)-1
74          for j=ceil(size1/2):nc+ceil(size1/2)-1
75              t=temp(i-floor(size1/2):1:i+floor(size1
                   /2),j-floor(size1/2):1:j+floor(size1
                   /2)) ;
76              temp2(i,j)=geomean(t);
77          end
78      end
```

```
79      nn=temp2(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
           size1/2):nc+ceil(size1/2)-1)
80      f=mat2gray(nn)
81  endfunction
82
83  function [f]=harmean1(g,m,n) //harmean1() is used to
        filter an image using Harmonic mean filter.
84      size1=m;
85      d=m*n;
86      g=double(g);
87      [nr,nc]=size(g);
88      temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
           /2));
89      temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
           /2):nc+ceil(size1/2)-1)=g(1:$,1:$)
90
91      for i=ceil(size1/2):nr+ceil(size1/2)-1
92          for j=ceil(size1/2):nc+ceil(size1/2)-1
93              t=temp(i-floor(size1/2):1:i+floor(size1
                   /2),j-floor(size1/2):1:j+floor(size1
                   /2)) ;
94              t1=ones(m,n)./(t+%eps)
95              t2=sum(t1);
96              temp2(i,j)=d/t2;
97              // temp2(i,j)=harmean(t);
98          end
99      end
100     nn=temp2(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
           size1/2):nc+ceil(size1/2)-1)
101     f=mat2gray(nn);
102 endfunction
103
104 function [f]=charmean1(g,m,n,q) //charmean1() is use
        to filter an image using Contra Harmonic mean
       filter
105     size1=m;
106     d=m*n;
107     g=double(g);
```

```
108      [nr,nc]=size(g);
109      temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
            /2));
110      temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
            /2):nc+ceil(size1/2)-1)=g(1:$,1:$)
111      disp(q)
112      for i=ceil(size1/2):nr+ceil(size1/2)-1
113          for j=ceil(size1/2):nc+ceil(size1/2)-1
114              t=temp(i-floor(size1/2):1:i+floor(size1
                    /2),j-floor(size1/2):1:j+floor(size1
                    /2)) ;
115              d1=(t+%eps).^q
116              n1=(t+%eps).^(q+1)
117              d2=sum(d1);
118              n2=sum(n1);
119              temp2(i,j)=n2/(d2);
120          end
121      end
122      nn=temp2(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
            size1/2):nc+ceil(size1/2)-1)
123      f=nn;
124  endfunction
125
126
127
128  function [resimg]=ordfilt2(image,m,n,type1)//
        ordfilt2() is used to filter an image using min
        or max filter.
129      size1=m;
130      [nr,nc]=size(image);
131      temp=zeros(nr+2*floor(size1/2),nc+2*floor(size1
            /2));
132      temp(ceil(size1/2):nr+ceil(size1/2)-1,ceil(size1
            /2):nc+ceil(size1/2)-1)=image(1:$,1:$)
133      select type1
134      case 'min' then
135          for i=ceil(size1/2):nr+ceil(size1/2)-1
136              for j=ceil(size1/2):nc+ceil(size1/2)-1
```

```
137                 t=temp(i-floor(size1/2):1:i+floor(
                        size1/2),j-floor(size1/2):1:j+
                        floor(size1/2))
138                 y=gsort(t);
139                 temp2(i,j)=min(y);
140             end
141         end
142     case 'max' then
143         for i=ceil(size1/2):nr+ceil(size1/2)-1
144             for j=ceil(size1/2):nc+ceil(size1/2)-1
145                 t=temp(i-floor(size1/2):1:i+floor(
                        size1/2),j-floor(size1/2):1:j+
                        floor(size1/2))
146                 y=gsort(t);
147                 temp2(i,j)=max(y);
148             end
149         end
150     end
151     nn=temp2(ceil(size1/2):nr+ceil(size1/2)-1,ceil(
          size1/2):nc+ceil(size1/2)-1)
152     resimg=mat2gray(nn)
153 endfunction
154
155
156
157 function [f] = spfilt(g,type1, m,n,parameter)
158     if argn(2) ==2 then
159         m=3;n=3;Q=1.5;d=2;
160     elseif argn(2)==5 then
161         Q=parameter;d=parameter;
162     elseif argn(2)==4 then
163         Q=1.5;d=2;
164     else
165         disp('wrong number of inputs');
166     end
167     select type1
168     case 'amean' then
169         filtersize=m
```

```
170         w=fspecial('average',filtersize);
171         f=imfilter(g,w);
172     case 'gmean1' then
173         f=gmean1(g,m,n);
174     case 'gmean2' then
175         f=gmean2(g,m,n);
176     case 'hmean' then
177         f=harmean1(g,m,n);
178
179     case 'charmean' then
180         f=charmean1(g,m,n,Q);
181     case 'median' then
182         filtersize = [m n];
183         f=MedianFilter(g,filtersize);
184         //   f=medfilt2(g,[m n],'symmetric');
185
186     case 'max' then
187         f=ordfilt2(g,m,n,'max');
188
189     case 'min' then
190         f=ordfilt2(g,m,n,'min');
191
192     case 'midpoint'then
193         f1=ordfilt2(g,m,n,'max');
194         f2=ordfilt2(g,m,n,'min');
195         f=imlincomb(0.5,f1,0.5,f2);
196
197     case 'atrimmed' then
198         if (d<0) |(d/2 ~=round(d/2)) then
199             disp('d must be a nonnegative, even
                    integer');
200         end
201         disp(d)
202         d=2;
203         f=alphatrim(g,m,n,d);
204     else
205         disp('Unknown filter type.');
206     end
```

```
207 endfunction
208
209
210 v=imnoise(im,'salt & pepper',0.02)
211 figure,ShowImage(v,'Salt & pepper noise corrupted
      image');//ShowColorImage() is used to show color
      image, figure is command to view images in
      separate window.
212 title('Salt & pepper noise corrupted image') ;//
      title() is used for providing  a title to an
      image.
213
214
215 h=spfilt(v,'median',3,3)
216 figure,ShowImage(h,'Result of filtering with a
      median filter of size 3*3');//ShowColorImage() is
       used to show color image, figure is command to
      view images in separate window.
217 title('Result of filtering with a median filter of
      size 3*3') ;//title() is used for providing  a
      title to an image.
218
219
220
221 h=spfilt(v,'amean',3)
222 figure,ShowImage(h,'Result of filtering with an
      arithmetic mean filter of size 3*3');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
223 title('Result of filtering with an arithmetic mean
      filter of size 3*3') ;//title() is used for
      providing  a title to an image.
224
225
226
227 i=spfilt(v,'max',3,3)
228 figure,ShowImage(i,'Result of filtering with a max
```

```
    filter of size 3*3');//ShowColorImage() is used
    to show color image, figure is command to view
    images in separate window.
229 title('Result of filtering with a median filter of
    size 3*3');//title() is used for providing  a
    title to an image.
230
231 //Filtering the corrupted image with midpoint filter
232 j=spfilt(v,'midpoint')
233 figure,ShowImage(j,'Result of filtering with a
    Midpoint filter of size 3*3');//ShowColorImage()
    is used to show color image, figure is command to
     view images in separate window.
234 title('Result of filtering with a Midpoint filter of
     size 3*3') ;//title() is used for providing  a
    title to an image.
235
236 j=spfilt(v,'min',3,3)
237 figure,ShowImage(j,'Result of filtering with a Min
    filter of size 3*3');//ShowColorImage() is used
    to show color image, figure is command to view
    images in separate window.
238 title('Result of filtering with a Min filter of size
     3*3');//title() is used for providing  a title
    to an image.
239
240
241 km=spfilt(v,'atrimmed')
242 figure,ShowImage(km,'Result of filtering with a
    Alpha-trimmed mean filter of size 3*3');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
243 title('Result of filtering with a Alpha-trimmed mean
     filter of size 3*3') ;//title() is used for
    providing  a title to an image.
244
245 s = imcrop(v, [1, 1, 300, 300]);
```

```
246 s = v;
247
248 l=spfilt(s,'gmean1',3,3)
249 figure,ShowImage(l,'Result of filtering with a
      Geometric mean filter of size 3*3');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
250 title('Result of filtering with a Geometric mean
      filter of size 3*3') ;//title() is used for
      providing  a title to an image.;
251
252 l=spfilt(s,'gmean2',3,3)
253 figure,ShowImage(l,'Result of filtering with a
      Geometric mean filter of size 3*3');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
254 title('Result of filtering with a Geometric mean
      filter of size 3*3') ;//title() is used for
      providing  a title to an image.;
255
256 m=spfilt(s,'hmean',3,3)
257 figure,ShowImage(m,'Result of filtering with a
      Harmonic mean filter of size 3*3');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
258 title('Result of filtering with a Harmonic mean
      filter of size 3*3');//title() is used for
      providing  a title to an image.;
259
260
261
262 n=spfilt(v,'charmean',3,3,1)
263 figure,ShowImage(n,'Result of filtering with a
      Contra Harmonic mean filter of size 3*3 and order
       of filter is 1');//ShowColorImage() is used to
```

```
    show color image, figure is command to view
    images in separate window.
264 title('Result of filtering with a Contra Harmonic
    mean filter of size 3*3 and order of filter is 1'
    );//title() is used for providing  a title to an
    image.
```

Experiment: 6

Color Image Processing

Scilab code Solution 6.1 Color Image Processing Fundamentals

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11 clc //to clear command window
12 clear all //to kill previously defined variables
13 xdel(winsid())//to close all currently open figure(s
     ).
14
15
16
17 SIVP_PATH = getSIVPpath(); //to locate a directory
     in which SIVP toolbox is installed. getSIVPpath()
      is pre-defined function in SIVP toolbox.
```

```
18 rgb = imread(SIVP_PATH + 'images/lena.png');//
     Reading from sub-directory of images.
19 figure,ShowColorImage(rgb,'Original color image');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
20 title('Original Color Image');//title() is used for
     providing  a title to an image.
21
22
23 R=rgb(:,:,1);//Separation of red component from
     image
24 figure,ShowImage(R,'Red component separation from
     original image');//ShowColorImage() is used to
     show color image, figure is command to view
     images in separate window.
25 title('Red component separation from original image'
     );//title() is used for providing a title to an
     image.
26
27
28
29 G=rgb(:,:,2);//Separation of green component from
     image
30 figure,ShowImage(R,'Green comonent separation from
     original image');//ShowColorImage() is used to
     show color image, figure is command to view
     images in separate window.
31 title('Green component separation from original
     image');//title() is used for providing  a title
     to an image.
32
33
34 B=rgb(:,:,3);//Separation of blue component from
     image
35 figure,ShowImage(R,'Blue component separation from
     original image');//ShowColorImage() is used to
     show color image, figure is command to view
```

```
    images in separate window.
36 title('Blue component separation from original image
    ');//title() is used for providing  a title to an
    image.
37
38 [k,map]=RGB2Ind(rgb);//RGB image is converted to an
    indexed image
39 figure,ShowImage(k,'Indexed image',map);//map matrix
    is xolormap matrix of an RGB image
40
41 rg=Ind2RGB(k,map);//to convert indexed image to true
    color image.
42 figure,ShowColorImage(rg,'RGB image is converted
    from an indexed image');//ShowColorImage() is
    used to show color image, figure is command to
    view images in separate window.
43 title('RGB image is converted from an indexed image'
    );//title() is used for providing  a title to an
    image.
44
45 function [y]=ind2gray(x,map)
46 rgb=Ind2RGB(x,map);//to convert an indexed image
    into RGB image
47 yiq=rgb2ntsc(rgb);//RGB image is converted into NTSC
    color system.
48 y=yiq(:,:,1);
49 endfunction
50
51 t=ind2gray(k,map);
52 figure,ShowImage(t,'Indexed image is converted to
    grayscale');//ShowColorImage() is used to show
    color image, figure is command to view images in
    separate window.
53 title('Indexed image is converted to grayscale');//
    title() is used for providing  a title to an
    image.
54
55
```

```
56 yiq=rgb2ntsc(rgb);//YIQ components are obtained from
       RGB components of an image.
57 figure,ShowColorImage(yiq,'Luminance(Y),Hue(I) and
       Saturation(Q) components of a RGB image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
58 title('Luminance(Y),Hue(I) and Saturation(Q)
       components of a RGB image');//title() is used for
       providing  a title to an image.
59
60 rgb1=ntsc2rgb(yiq);//RGB components are obtained
       from YIQ components of an image.
61 figure,ShowColorImage(rgb1,'RGB components are
       obtained from NTSC format');//ShowColorImage() is
       used to show color image, figure is command to
       view images in separate window.
62 title('RGB components are obtained from NTSC format'
       );//title() is used for providing  a title to an
       image.
63
64 ycbcr=rgb2ycbcr(rgb);//YCbCr components are obtained
       from RGB components of an image.
65 figure,ShowColorImage(ycbcr,'Luminance(Y) ,two color
       difference components Cb and Cr components of a
       RGB image');//ShowColorImage() is used to show
       color image, figure is command to view images in
       seperate window.
66 title('Luminance(Y) ,two color difference components
       Cb and Cr components of a RGB image');//title()
       is used for providing  a title to an image.
67
68 rgb2=ycbcr2rgb(ycbcr);
69 figure,ShowColorImage(rgb2,'RGB components are
       obtained from YCbCR color space');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
```

```
70 title ('RGB components are obtained from YCbCr color
       space');//title() is used for providing a title
       to an image.
```

Scilab code Solution 6.2 Color Image Processing

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14 //
15
16 //stacksize() is used to increase stack size to
       achieve maximum performance.Restart Scilab if
       error no 10001(cannot allocate memory) is occured
       .
17 stacksize('max')
18
19
20 SIVP_PATH = getSIVPpath(); //to locate a directory
       in which SIVP toolbox is installed. getSIVPpath()
        is pre-defined function in SIVP toolbox.
21 rgb = imread(SIVP_PATH + 'images/lena.png');//
       Reading from sub-directory of images.
```

```
22 figure,ShowColorImage(rgb,'Original color image');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
23 title('Original Color Image');//title() is used for
     providing  a title to an image.
24
25
26 hsv=rgb2hsv(rgb);//HSV components are obtained from
     RGB components of an image using rgb2hsv().
27 figure,ShowColorImage(hsv,'HSV components of a RGB
     image');//ShowColorImage() is used to show color
     image, figure is command to view images in
     separate window.
28 title('HSV components of a RGB image');//title() is
     used for providing  a title to an image.
29
30 rgb3=hsv2rgb(hsv);//RGB components are obtained from
     HSV color system using hsv2rgb().
31 figure,ShowColorImage(rgb3,'RGB componenta are
     obtained from HSV color system');//ShowColorImage
     () is used to show color image, figure is command
     to view images in separate window.
32 title('RGB componenta are obtained from HSV color
     system');//title() is used for providing  a title
     to an image.
33
34 cmy=imcomplement(rgb);//cyan magenta and yellow
     colors are obtained from an image using
     imcomplement().
35 figure,ShowColorImage(cmy,'cyan magenta and yellow
     are obtained from the RGB image');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
36 title('cyan magenta and yellow are obtained from the
     RGB image');//title() is used for providing a
     title to an image.
```

```
37
38 rgb4=imcomplement(cmy);//RGB components are obtained
       from cyan magenta and yellow components if an
     image.
39 figure,ShowColorImage(rgb4,'RGB components are
     obtained from cyan magenta and yellow components'
     );//ShowColorImage() is used to show color image,
       figure is command to view images in separate
     window.
40 title('RGB components are obtained from cyan magenta
       and yellow components');//title() is used for
     providing  a title to an image.
41
42
43
44 rgb=im2double(rgb)
45 function [hsi]=rgb2hsi(rgb)//rgb2hsi() is user
     defined function, which is used for converting
     RGB format to HSI color model.
46
47     r = rgb(:, :, 1);//separating Red, Green and
         Blue components from the RGB image.
48     g = rgb(:, :, 2);
49     b = rgb(:, :, 3);
50     num = 0.5*((r - g) + (r - b));
51     den1=(r - g).^2 + (r - b).*(g - b)
52     den = den1.^0.5;
53     theta = acos(num./(den+%eps));//%eps is minimum
         number to avoid divide by zero exception.
54     H = theta;
55     H(b > g) = 2*%pi - H(b > g);
56     H = H/(2*%pi);
57
58     num = min(min(r, g), b);
59     den = r + g + b;
60     den(den == 0) = %eps;
61     S = 1 - 3.* num./den;
62
```

```
63      H(S == 0) = 0;
64
65      I = (r + g + b)/3;
66
67      hsi = rgb;
68      hsi(:,:,1)=H;
69      hsi(:,:,2)=S;
70      hsi(:,:,3)=I;
71
72  endfunction
73  hsi=rgb2hsi(rgb);
74
75  figure,ShowColorImage(hsi,'HSI_image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
76  title('HSI_image');//title() is used for providing
       a title to an image.
77
78  function [rgb]=hsi2rgb(hsi)//hsi2rgb() is user
       defined function,which is used for converting HSI
        format to RGB color model.
79
80
81      H = hsi(:, :, 1) * 2 * %pi;
82      S = hsi(:, :, 2);
83      I = hsi(:, :, 3);
84
85      [nr nc]=size(H)//to find dimension of an image.
86
87
88      R = zeros(nr,nc);
89      G = zeros(nr,nc);
90      B = zeros(nr,nc);
91
92
93      idx = find( (0 <= H) & (H < 2*%pi/3));
94      B(idx) = I(idx) .* (1 - S(idx));
```

```
95      R(idx) = I(idx) .* (1 + S(idx) .* cos(H(idx)) ./
           cos(%pi/3 - H(idx)));
96      G(idx) = 3*I(idx) - (R(idx) + B(idx));
97
98
99      idx = find( (2*%pi/3 <= H) & (H < 4*%pi/3) );
100     R(idx) = I(idx) .* (1 - S(idx));
101     G(idx) = I(idx) .* (1 + S(idx) .* cos(H(idx) -
           2*%pi/3) ./cos(%pi - H(idx)));
102     B(idx) = 3*I(idx) - (R(idx) + G(idx));
103
104
105     idx = find( (4*%pi/3 <= H) & (H <= 2*%pi));
106     G(idx) = I(idx) .* (1 - S(idx));
107     B(idx) = I(idx) .* (1 + S(idx) .* cos(H(idx) -
           4*%pi/3) ./cos(5*%pi/3 - H(idx)));
108     R(idx) = 3*I(idx) - (G(idx) + B(idx));
109
110
111     rgb = hsi;
112     rgb(:,:,1)=R;
113     rgb(:,:,2)=G;
114     rgb(:,:,3)=B;
115     rgb = max(min(rgb, 1), 0);
116
117 endfunction
118
119
120 rgb=hsi2rgb(hsi);
121
122 figure,ShowColorImage(rgb,'RGB components are
       obtained from hsi color system');//ShowColorImage
       () is used to show color image, figure is command
        to view images in separate window.
123 title('RGB components are obtained from HSI color
       system');//title() is used for providing  a title
        to an image.
```

Experiment: 7

Image Compression

Scilab code Solution 7.1 Image Compression

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
     ).
14
15 SIVP_PATH = getSIVPpath(); //to locate a directory
     in which SIVP toolbox is installed. getSIVPpath()
      is pre-defined function in SIVP toolbox.
16 rgb = imread(SIVP_PATH + 'images/lena.png');//
     Reading from sub-directory of images.
```

```
17 figure,ShowColorImage(rgb,'Original color image');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
18 title('Original Color Image');//title() is used for
     providing  a title to an image.
19
20 im=rgb2gray(rgb);//to convert a RGB image into
     grayscale image.
21
22 M=8;
23 N=8;
24 [nr,nc]=size(im);
25
26
27 p=imcrop(im,[1,1,8,8]);//image is divided into 8*8
     blocks for computation of DCT.
28 p=double(p);
29 p1=p-128;
30 f=dct(p1);//dct() is used to find DCT
     transformations.
31 //q is Luminance quantization matrix.
32 q=[16 11 10 16 24 40 51 61
33 12 12 14 19 26 58 60 55
34 14 13 16 24 40 57 69 56
35 14 17 22 29 51 87 80 62
36 18 22 37 56 68 109 103 77
37 24 35 55 64 81 104 113 92
38 49 64 78 87 103 121 120 101
39 72 92 95 98 112 100 103 99];
40 //Each DCT coefficient f(u,v) is divided by the
     corresponding quantizer step-size parameter q(u,v
     ) in the quantization matrix and rounded to the
     nearest integer
41 t=f./q;
42 g=floor(t)
43
44
```

```
45 function [out]=zigzag(in)//zigzag() is function to
     find a vector sorted by the criteria of the
     spatial frequency
46     [num_rows num_cols]=size(in);
47
48     // Initialise the output vector
49     out=zeros(1,num_rows*num_cols);
50
51     cur_row=1;  cur_col=1;  cur_index=1;
52
53     // First element
54     //out(1)=in(1,1);
55
56     while cur_row<=num_rows & cur_col<=num_cols
57         if cur_row==1 & pmodulo(cur_row+cur_col,2)
              ==0 & cur_col~=num_cols then
58             out(cur_index)=in(cur_row,cur_col);
59             cur_col=cur_col+1;
                      //move right at the top
60             cur_index=cur_index+1;
61
62         elseif cur_row==num_rows & pmodulo(cur_row+
              cur_col,2)~=0 & cur_col~=num_cols then
63             out(cur_index)=in(cur_row,cur_col);
64             cur_col=cur_col+1;
                      //move right at the bottom
65             cur_index=cur_index+1;
66
67         elseif cur_col==1 & pmodulo(cur_row+cur_col
              ,2)~=0 & cur_row~=num_rows then
68             out(cur_index)=in(cur_row,cur_col);
69             cur_row=cur_row+1;
                      //move down at the left
70             cur_index=cur_index+1;
71
72         elseif cur_col==num_cols & pmodulo(cur_row+
              cur_col,2)==0 & cur_row~=num_rows then
73             out(cur_index)=in(cur_row,cur_col);
```

```
74              cur_row=cur_row+1;
                        //move down at the right
75              cur_index=cur_index+1;
76
77          elseif cur_col~=1 & cur_row~=num_rows &
               pmodulo(cur_row+cur_col,2)~=0 then
78              out(cur_index)=in(cur_row,cur_col);
79              cur_row=cur_row+1;      cur_col=cur_col
                   -1;  //move diagonally left down
80              cur_index=cur_index+1;
81
82          elseif cur_row~=1 & cur_col~=num_cols &
               pmodulo(cur_row+cur_col,2)==0 then
83              out(cur_index)=in(cur_row,cur_col);
84              cur_row=cur_row-1;      cur_col=cur_col
                   +1;  //move diagonally right up
85              cur_index=cur_index+1;
86
87          elseif cur_row==num_rows & cur_col==num_cols
                   //obtain the bottom right element
88              out(M*N)=in(8,8);
                        //end of the operation
89              break
                        //terminate the operation
90          else
91          end
92      end
93
94  endfunction
95
96  out=zigzag(g);
97  disp(out)
```

Scilab code Solution 7.2 Image Compression

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14
15
16 nn=[1 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0 0 0 0 0 0 2 0
       0 3 0 4 4 4 5 0 0 0 0 5 0 0 0];
17 function [rle]=relencoder(nn)//run length encoder
18
19     k=1;
20     n= [nn 1]; // dummy ending
21
22     t=0;
23     for i = 1:length(n)-1
24         if n(i)==0 then
25             t=t+1;
26             if t==15 then
27                 r(k,1) =t;
28                 r(k,2)=0;
29                 k=k+1;
30                 t=0;
31             end
32         else
33             valuecode = n(i);
34             lengthcode =  t;
35             r(k,1) =lengthcode;
```

```
36              r(k,2)=valuecode;
37              k=k+1;
38              t=0;
39          end
40      end
41      rle=r;
42      rle($+1,:)=0;
43      disp(rle)
44      disp(size(rle))
45  endfunction
46
47  rr=relencoder(nn);
```

Scilab code Solution 7.3 Image Compression

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11
12 //this code is for huffman encoding using toolbox.
13 clc //to clear command window.
14 clear all //to kill previously defined variables.
15 xdel(winsid())//to close all currently open figure(s
       ).// Generate a Testmatrix
16
17 sp=sparse
       ([1,1;1,2;1,3;1,4;1,5;1,6],[5,7,10,15,20,45])
```

```
18 [SB,h,L,QM]=huffman(sp);
19 //SB contains the symbols
20 disp(SB);
21 // h is the normalized histogram
22 disp(h);
23 // L contains the number of bits used for the
     symbols
24 disp(L);
25 // QM is the complete code table,
26 // containing symbol, bits and no. of bits
27 disp(QM);
28 disp(sp)
```

Experiment: 8

Morphological Image Processing

check Appendix ?? for dependency:

`82.tif`

check Appendix ?? for dependency:

`wirebondmask.tif`

Scilab code Solution 8.1 Morphological Image Processing

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11 clc //to clear command window.
```

```
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
   ).
14
15
16 a=[0 0;0 1]
17 b=[0 1;1 1]
18
19
20
21 Image=imread('wirebondmask.tif');
22
23 StructureElement = CreateStructureElement('square',
   9);//CreateStructureElement() is used to create
   structuring element.First parameter is used to
   create square structuring elemnt of size 9
24
25 ResultImage = ErodeImage(Image, StructureElement);//
   ErodeImage() is used to perform erosion of an
   image by structuring element.
26 figure,ShowImage(ResultImage,'Erosion of an image by
    square structuring element.');//ShowColorImage()
    is used to show color image, figure is command
   to view images in separate window.
27 title('Erosion of an image by square structuring
   element.');//title() is used for providing  a
   title
28
29
30 Image=imread('82.tif');
31 figure,ShowImage(Image,'Text with broken characters.
   ');//ShowImage() is used to show color image,
   figure is command to view images in separate
   window.
32 title('Text with broken characters.');//title() is
   used for providing  a title
33
34 StructureElement1 = CreateStructureElement('square',
```

```
      3);//CreateStructureElement() is used to create
      structuring element.First parameter is used to
      create square structuring elemnt of size 3.
35 ResultImage1 = DilateImage(Image, StructureElement1)
      ;//DilateImage() is used to perform erosion of an
       image by structuring element.
36 figure,ShowImage(ResultImage1,'Dilation of an image
      by square structuring element.Broken segements
      were joined.');//ShowImage() is used to show
      color image, figure is command to view images in
      separate window.
37 title('Dilation of an image by square structuring
      element.Broken segements were joined.');//title()
       is used for providing  a title
38
39 StructureElement2= CreateStructureElement('square',
      3);//CreateStructureElement() is used to create
      structuring element.First parameter is used to
      create square structuring elemnt of size 9
40 StructureElement2.Data=[%f %t %f;%t %t %t;%f %t %f]
41
42 ResultImage2 = DilateImage(Image,StructureElement2);
      //DilateImage() is used to perform erosion of an
      image by structuring element.
43 figure,ShowImage(ResultImage2,'Dilation of an image
      by square structuring element.Broken segements
      were joined.');//ShowImage() is used to show
      color image, figure is command to view images in
      separate window.
44 title('Dilation of an image by square structuring
      element.Broken segements were joined.');//title()
       is used for providing  a title
45
46
47 ResultImage3 = OpenImage(Image,StructureElement1);//
      //OpenImage() is used to open an image by
      structuring element.
48 figure,ShowImage(ResultImage3,'Opening of an image.'
```

```
    );//ShowColorImage() is used to show color image,
      figure is command to view images in separate
     window.
49 title('Opening of an image.');//title() is used for
     providing  a title
50
51 ResultImage4 = CloseImage(Image,StructureElement1);
52 figure,ShowImage(ResultImage4,'Closing of an image.'
    );//ShowColorImage() is used to show color image,
      figure is command to view images in separate
     window.
53 title('Closing of an image.');//title() is used for
     providing  a title
54
55
56 image1=imread('83.tif');
57 image2=imcomplement(image1);//imcomplement() is used
     to find complement of an image.
58
59 function [result]=hitmiss(i,se1,se2)//hitmiss() is
     used to perform hit and miss transform,which is
     used for shape detection.
60         e=imcomplement(i);//imcomplement() is used to
               find complement of an image.
61  c=ErodeImage(e,se2);//ErodeImage() is used to erode
      an image by struturing element.
62  b=ErodeImage(i,se1)////ErodeImage() is used to
     erode an image by struturing element.
63  result1=b&c;
64  disp(result1)
65   [nr,nc]=size(i);
66  idx=find(result1==%t);
67  result=zeros(nr,nc)
68  result(idx)=255;
69 endfunction
70
71 i=[  0.    0.    0.    0.    0.    0.    0.    0.
       0.
```

```
72      0.     0.     1.     0.     0.     0.     1.     0.
           0.
73      0.     1.     1.     1.     0.     1.     1.     1.
           0.
74      0.     0.     1.     0.     0.     0.     1.     1.
           0.
75      0.     0.     0.     0.     0.     0.     0.     0.
           0.
76      0.     0.     0.     0.     0.     0.     0.     0.
           0.]
77
78  se1= CreateStructureElement('square', 3);
79  se1.Data=[%f %t %f;%t %t %t;%f %t %f]
80
81  se2= CreateStructureElement('square', 3);
82  se2.Data=[%t %f %t;%f %f %f;%t %f %t];
83
84   figure,ShowImage(i,'Original binary image');//
       ShowColorImage() is used to show color image,
       figure is command to view images in separate
       window.
85  title('Original binary image');//title() is used for
       providing  a title
86
87   Result=hitmiss(i,se1,se2); //hitmiss() is used to
       perform hit and miss transform,which is used for
        shape detection.
88   figure,ShowImage(Result,'Result of Hit and Miss
       Transform.');//ShowColorImage() is used to show
       color image, figure is command to view images in
        separate window.
89  title('Result of Hit and Miss Transform.');//title()
       is used for providing  a title
90
91  //boundary extraction
92
93  se1= CreateStructureElement('square', 3);
94  Image=imread('wirebondmask.tif');
```

```
95 result1=ErodeImage(Image,se1);
96 result=Image-result1;
97  figure,ShowImage(Image,'Original binary image');//
      ShowColorImage() is used to show color image,
      figure is command to view images in separate
      window.
98 title('Original binary image.');//title() is used
     for providing  a title
99
100 figure,ShowImage(result,'Extracted boundary of an
     image.');//ShowColorImage() is used to show color
      image, figure is command to view images in
     separate window.
101 title('Extracted boundary of an image.');//title()
     is used for providing  a title
```

Experiment: 9

Image Segmentation

check Appendix ?? for dependency:

`building.tif`

check Appendix ?? for dependency:

`turbineblade.tif`

check Appendix ?? for dependency:

`wirebondmask.tif`

Scilab code Solution 9.1 Image Segmentation

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
    Woods
```

```
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
   ).
14
15 Image=ReadImage('turbineblade.tif');
16 figure,ShowImage(Image,'Gray scale image with a
   isolated black point.');//ShowColorImage() is
   used to show color image, figure is command to
   view images in separate window.
17 title('Gray scale image with a isolated black point.
   ');//title() is used for providing  a title to an
    image.
18
19 image=double(Image);
20 mask =[-1 -1 -1;-1 8 -1;-1 -1 -1];
21
22 res = imfilter(image,mask);
23 g=abs(res);
24 t=max(g);
25 g=g>=t;
26 figure,ShowImage(g,'Detection of point');//
   ShowColorImage() is used to show color image,
   figure is command to view images in separate
   window.
27 title('Detection of point.');//title() is used for
   providing  a title to an image.
28
29
30 hmask=[-1 -1 -1;2 2 2;-1 -1 -1];//mask for
   horizontal line detection.
31 vmask=[-1 2 -1;-1 2 -1;-1 2 -1];//mask for vertical
   line detection.
32 dlmask=[-1 -1 2;-1 2 -1;2 -1 -1];//mask for +45
   degree line detection.
33 dlmask2=[2 -1 -1;-1 2 -1;-1 -1 2];//mask for -45
   degree line detection.
34
```

```
35 Image=ReadImage('wirebondmask.tif')
36 figure,ShowImage(Image,'Image of a wire-bond mask');
     //ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
37 title('Image of a wire-bond mask.');//title() is
     used for providing  a title to an image.
38 image=double(Image);
39 g1=imfilter(image,hmask);
40 figure,ShowImage(g1,'Result of processing with
     horizontal line detector mask.');//ShowColorImage
     () is used to show color image, figure is command
      to view images in separate window.
41 title('Result of processing with horizontal line
     detector mask.');//title() is used for providing
      a title to an image.
42
43 g2=imfilter(image,vmask);
44 figure,ShowImage(g2,'Result of processing with
     vertical degree line detector mask.');//
     ShowColorImage() is used to show color image,
     figure is command to view images in separate
     window.
45 title('Result of processing with vertical degree
     line detector mask.');//title() is used for
     providing  a title to an image.
46
47 g3=imfilter(image,dlmask);
48 figure,ShowImage(g3,'Result of processing with +45
     degree line detector mask.');//ShowColorImage()
     is used to show color image, figure is command to
      view images in separate window.
49 title('Result of processing with +45 degree line
     detector mask.');//title() is used for providing
      a title to an image.
50
51 g4=imfilter(image,dlmask2)
52 figure,ShowImage(g4,'Result of processing with -45
```

```
    degree line detector mask.');//ShowColorImage()
    is used to show color image, figure is command to
     view images in separate window.
53 title('Result of processing with -45 degree line
    detector mask.');//title() is used for providing
     a title to an image.
54
55
56 Image=ReadImage('building.tif')
57 figure,ShowImage(Image,'Image of a Building');//
    ShowColorImage() is used to show color image,
    figure is command to view images in separate
    window.
58 title('Image of a building.');//title() is used for
    providing  a title to an image.
59
60 e=edge(image,'sobel');//edge() is used to detect an
    edge in grayscale image.Second argument'sobel' is
     used for Sobel edge detector.
61 figure,ShowImage(e,'Edge detection using Sobel
    approximation.');//ShowColorImage() is used to
    show color image, figure is command to view
    images in separate window.
62 title('Edge detection using Sobel approximation.');
    //title() is used for providing  a title to an
    image.
63
64 e=edge(image,'prewitt');//edge() is used to detect
    an edge in grayscale image.Second argument'
    prewitt' is used for prewitt edge detector.
65 figure,ShowImage(e,'Edge detection using Prewitt
    approximation.');//ShowColorImage() is used to
    show color image, figure is command to view
    images in separate window.
66 title('Edge detection using Prewitt approximation.')
    ;//title() is used for providing  a title to an
    image.
67
```

```
68 e=edge(image,'canny');//edge() is used to detect an
      edge in grayscale image.Second argument'canny' is
       used for Canny edge detector.
69 figure,ShowImage(e,'Edge detection using Canny edge
      detector.');//ShowColorImage() is used to show
      color image, figure is command to view images in
      separate window.
70 title('Edge detection using Canny approximation.');
      //title() is used for providing  a title to an
      image.
```

Experiment: 10

Wavelets

check Appendix ?? for dependency:

`woman.bmp`

Scilab code Solution 10.1 Wavelets

```
1  //
2  //environment: Scilab 5.4.1
3  //Toolbox: Image Processing Design 8.3.1-1
4  //Toolbox: SIVP 0.5.3.1-2
5  //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6  //Toolbox:Huffcomp Toolbox 1.1.1
7  //OS:Windows 7
8  //
9  //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
       Woods
11 clc //to clear command window.
12 clear all //to kill previously defined variables.
13 xdel(winsid())//to close all currently open figure(s
       ).
14
```

```
15 //stacksize() is used to increase stack size to
      achieve maximum performance.Restart Scilab if
      error no 10001(cannot allocate memory) is occured
      .
16 stacksize('max')
17
18
19
20 r=ReadImage('woman.bmp');//ReadImage() is used to
      read an image
21 X=rgb2gray(r);//rgb2gray() is used to convert an
      image into gray scale.
22 figure,ShowImage(X,'A simple test image');//
      ShowImage() is used to show gray scale image,
      figure is command to view images in separate
      window.
23 title('A simple test image');//title() is used for
      providing  a title to an image.
24
25 wname = 'haar'//wname is used in two dimension
      multiple level discrete fast wavelet transform. '
      haar' is used for Haar wavelet.
26 [nr,nc]=size(r);
27 x=zeros(nr,nc);
28 x=X(1:$,1:$);
29 x=double(x);
30
31 [wc,s] = wavedec2(x,2,wname);// Compute a 2-level
      decomposition of the image using the Haar filters
      .Second argument is used for level.
32
33 // Extract the level 1 coefficients. Fourth argument
       must be 1 to for extraction the level 1
      coefficient in appcoef2() and detcoef2() function
      .
34 a1 = appcoef2(wc,s,wname,1);//appcoef2() is used to
      extract 2-D approximation coefficients.
```

```
35 h1 = detcoef2('h',wc,s,1);//detcoef2() is used to
      extract 2-D detail coefficient extraction. First
      argument 'h' is used for horizontal detail
      coefficeint.
36 v1 = detcoef2('v',wc,s,1);  //detcoef2() is used to
      extract 2-D detail coefficient extraction. First
      argument 'v' is used for vertical detail
      coefficeint.
37 d1 = detcoef2('d',wc,s,1); //detcoef2() is used to
      extract 2-D detail coefficient extraction. First
       argumentd  is used for diagonal detail
      coefficient.
38
39 // Extract the level 2 coefficients. Fourth argument
       must be 2 to for extraction the level 2
      coefficient in appcoef2() and detcoef2() function
      .
40
41 a2 = appcoef2(wc,s,wname,2);
42 h2 = detcoef2('h',wc,s,2);
43 v2 = detcoef2('v',wc,s,2);
44 d2 = detcoef2('d',wc,s,2);
45
46 // Display the decomposition up to level 1 only.
47 a1=double(a1);
48 cod_a1 = wcodemat(a1,256);
49 cod_a1=double(cod_a1);
50 cod_a1 = wkeep(cod_a1,[256 256]);
51 cod_h1 = wcodemat(h1,260);
52 cod_h1=double(cod_h1);
53  cod_h1 = wkeep(cod_h1, [256 256]);
54  cod_v1 = wcodemat(v1,260);
55  cod_v1=double(cod_v1);
56 cod_v1 = wkeep(cod_v1, [256 256]);
57 cod_d1 = wcodemat(d1,260);
58 cod_d1=double(cod_d1);
59  cod_d1 = wkeep(cod_d1, [256 256]);
60 ans1=[cod_a1,cod_h1;cod_v1,cod_d1];
```

```
61
62 figure,ShowImage(ans1,' Wavelet Transform of an
      image');//ShowImage() is used to show gray scale
      image, figure is command to view images in
      separate window.
63 title(' Wavelet Transform of an image');//title() is
       used for providing  a title to an image.
64
65
66
67
68 // Display the entire decomposition upto level 2.
69 cod_a2 = wcodemat(a2,260);
70  cod_a2=double(cod_a2);
71 cod_a2 = wkeep(cod_a2, [128 128]);
72 cod_h2 = wcodemat(h2,260);
73  cod_h2=double(cod_h2);
74 cod_h2 = wkeep(cod_h2, [128 128]);
75 cod_v2 = wcodemat(v2,260);
76  cod_v2=double(cod_v2);
77  cod_v2 = wkeep(cod_v2, [128 128]);
78 cod_d2 = wcodemat(d2,260);
79  cod_d2=double(cod_d2);
80  cod_d2 = wkeep(cod_d2, [128 128]);
81 bb=[[cod_a2,cod_h2;cod_v2,cod_d2],cod_h1;cod_v1,
      cod_d1];
82
83
84 figure,ShowImage(bb,'Two scale Wavelet transform an
      image');//ShowImage() is used to show gray scale
      image, figure is command to view images in
      separate window.
85 title('Two scale Wavelet transform an image');//
      title() is used for providing  a title to an
      image.
86
87
```

```
88 // Reconstruction of an image using wrcoef2()
      function. Last argument is used for level of
      reconstruction.
89 ra2 = wrcoef2('a',wc,s,wname,2);//'a' is used for
      approximation coefficients.
90 rh2 = wrcoef2('h',wc,s,wname,2);//'h' is used for
      horizontal detail coefficient.
91 rv2 = wrcoef2('v',wc,s,wname,2);//'v' is used for
      vertical detail coefficient.
92 rd2 = wrcoef2('d',wc,s,wname,2);//'d' is used for
      detail coefficient.
93
94 ra1 = wrcoef2('a',wc,s,wname,1);
95 rh1 = wrcoef2('h',wc,s,wname,1);
96 rv1 = wrcoef2('v',wc,s,wname,1);
97 rd1 = wrcoef2('d',wc,s,wname,1);
98
99 cod_ra2 = wcodemat(ra2,260);
100 cod_rh2 = wcodemat(rh2,260);
101 cod_rv2 = wcodemat(rv2,260);
102 cod_rd2 = wcodemat(rd2,260);
103 cod_ra1 = wcodemat(ra1,260);
104 cod_rh1 = wcodemat(rh1,260);
105 cod_rv1 = wcodemat(rv1,260);
106 cod_rd1 = wcodemat(rd1,260);
107
108
109
110 // Adding together the reconstructed average at
      level 2 and all of
111 // the reconstructed details gives the full
      reconstructed image.
112 Xhat = ra2 + rh2 + rv2 + rd2 + rh1 + rv1 + rd1;
113 X1=double(X);
114 X2=double(Xhat);
115 X3=max(max(abs(X1-X2)));//
116 disp(X3);
117 disp('Reconstruction error')
```

```
118
119 // Another way to reconstruct the image.
120
121 XXhat = waverec2(wc,s,wname);//waverec2() is used
      for two dimension multiple level inverse discrete
       transform.
122 X1=double(X);
123 X2=double(XXhat);
124 X3=max(max(abs(X1-X2)));
125 disp(X3);
126 disp('Reconstruction error (using waverec2)');
127 // Compression can be accomplished by applying a
      threshold to the wavelet coefficients.
128 thr = 20;
129 [X_comp,wc_comp,s_comp,perf0,perfL2] = wdencmp('gbl'
      ,wc,s,wname,2,thr,'h',1);//wdencmp() is used for
      de-noising or compression using wavelets. h
       means use hard thresolding. perfL2 is used to
      find energy recovery. perf0 is used to measure
      compression performance.
130
131 cod_X_comp = wcodemat(X_comp,260);
132
133 figure,ShowImage(cod_X_comp,' Compressed using
      global hard threshold');//ShowImage() is used to
      show gray scale image, figure is command to view
      images in separate window.
134 title('Compressed using global hard threshold')//
      title() is used for providing a title to an
      image.
135 disp('Energy retained');
136 disp(perfL2);
137
138 disp('Null coefficients');
139 disp(perf0);
```

---

check Appendix ?? for dependency:

101.tif

Scilab code Solution 10.2 Wavelets

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11 //edge detection
12 clc //to clear command window.
13 clear all //to kill previously defined variables.
14 xdel(winsid())//to close all currently open figure(s
     ).
15
16 //stacksize() is used to increase stack size to
     achieve maximum performance.Restart Scilab if
     error no 10001(cannot allocate memory) is occured
     .
17 stacksize('max')
18
19
20 X=ReadImage('101.tif');//ReadImage() is used to read
      an image
21 figure,ShowImage(X,'Original Grayscale  image');//
     ShowImage() is used to show gray scale image,
     figure is command to view images in separate
     window.
22 title('Original Grayscale Image');//title() is used
     for providing  a title to an image.
```

```
23
24 [nr,nc]=size(X);
25 x=zeros(nr,nc);
26 x=X(1:$,1:$);
27 x=double(x);
28
29 [CA,CH,CV,CD]=dwt2(x,'db2');//   one level
     decomposition
30 a=(CA-min(CA))/max(CA-min(CA));//normalize the
     approximation coefficients matrix for displaying.
31 h=(CH-min(CH))/max(CH-min(CH));//normalize the
     horizontal detail coefficients matrix for
     displaying.
32 v=(CV-min(CV))/max(CV-min(CV));//normalize the
     vertical detail coefficients matrix for
     displaying.
33 d=(CD-min(CD))/max(CD-min(CD));//normalize the
     diagonal detail coefficients matrix for
     displaying.
34 c1=[a';h'];
35 c2=[v';d'];
36 co=[c1;c2];
37 figure,ShowImage(co, 'Original Grayscale  image');//
     ShowImage() is used to show gray scale image,
     figure is command to view images in separate
     window.
38 title('Original Grayscale Image');//title() is used
     for providing  a title to an image.
39
40 CA(1:$,1:$)=0;//zeroing approximation coefficients
41 a=CA;
42 c1=[a';h'];
43 c2=[v';d'];
44 co=[c1;c2];
45 figure,ShowImage(co, 'Deleted approximation
     coefficients ');//ShowImage() is used to show
     gray scale image, figure is command to view
     images in separate window.
```

```
46 title('Deleted approximation coefficients');//title
      () is used for providing  a title to an image.
47
48 x1=idwt2(CA,CH,CV,CD,'db2',[nr nc]);//idwt2() is
      used to find Two Dimension Inverse Discrete Fast
      Wavelet Transform.
49
50 figure,ShowImage(x1,' Reconstructed image after
      deleting approximation coefficients');//ShowImage
      () is used to show gray scale image, figure is
      command to view images in separate window.
51 title('Reconstred image after deleting approximation
       coefficients');//title() is used for providing
      a title to an image.
52
53
54 //horizontal line detection
55 [CA,CH,CV,CD]=dwt2(x,'db2');//   one level
      decomposition
56 a=(CA-min(CA))/max(CA-min(CA));//normalize the
      approximation coefficients matrix for displaying.
57 h=(CH-min(CH))/max(CH-min(CH));//normalize the
      horizontal detail coefficients matrix for
      displaying.
58 v=(CV-min(CV))/max(CV-min(CV));//normalize the
      vertical detail coefficients matrix for
      displaying.
59 d=(CD-min(CD))/max(CD-min(CD));//normalize the
      diagonal detail coefficients matrix for
      displaying.
60 CA(1:$,1:$)=0;//zeroing the approximation
      coefficients matrix.
61 a=CA;
62 CH(1:$,1:$)=0;//zeroing the horizontal detail
      coefficients matrix.
63 h=CH;
64 c1=[a';h']';
65 c2=[v';d']';
```

```
66 co=[c1;c2];
67 figure,ShowImage(co,' Deleted approximation
      coefficients and horizontal detail coefficients '
      );//ShowImage() is used to show gray scale image,
       figure is command to view images in separate
      window.
68 title('deleted approximation coefficients and
      horizontal detail coefficients ');//title() is
      used for providing  a title to an image.
69
70 x1=idwt2(CA,CH,CV,CD,'db2',[nr nc]);//idwt2() is
      used to find Two Dimension Inverse Discrete Fast
      Wavelet Transform.
71 figure,ShowImage(x1,' Reconstructed image after
      deleting approximation coefficients and
      horizontal detail coefficients ');//ShowImage()
      is used to show gray scale image, figure is
      command to view images in separate window.
72 title('Reconstructed image after deleting
      approximation coefficients and horizontal detail
      coefficients ');//title() is used for providing
      a title to an image.
73
74 //vertical line detection
75
76 [CA,CH,CV,CD]=dwt2(x,'db2');//   one level
      decomposition
77 a=(CA-min(CA))/max(CA-min(CA));//normalize the
      approximation coefficients matrix for displaying.
78 h=(CH-min(CH))/max(CH-min(CH));//normalize the
      horizontal detail coefficients matrix for
      displaying.
79 v=(CV-min(CV))/max(CV-min(CV));//normalize the
      vertical detail coefficients matrix for
      displaying.
80 d=(CD-min(CD))/max(CD-min(CD));//normalize the
      diagonal detail coefficients matrix for
      displaying.
```

```
81 CA(1:$,1:$)=0;//zeroing the approximation
      coefficients matrix.
82 a=CA;
83 CV(1:$,1:$)=0;//zeroing the vertical detail
      coefficients matrix.
84 v=CV;
85 c1=[a';h']';
86 c2=[v';d']';
87 co=[c1;c2];
88 figure,ShowImage(co,' Deleted approximation
      coefficients and vertical detail coefficients ');
      //ShowImage() is used to show gray scale image,
      figure is command to view images in separate
      window.
89 title('Deleted approximation coefficients and
      vertical detail coefficients ');//title() is used
       for providing  a title to an image.
90
91 x1=idwt2(CA,CH,CV,CD,'db2',[nr nc]);//idwt2() is
      used to find Two Dimension Inverse Discrete Fast
      Wavelet Transform.
92
93 figure,ShowImage(x1,' Reconstructed image after
      deleting approximation coefficients and vertical
      detail coefficients ');//ShowImage() is used to
      show gray scale image, figure is command to view
      images in separate window.
94 title('Reconstructed image after deleting
      approximation coefficients and vertical detail
      coefficients ');//title() is used for providing
      a title to an image.
```

---

check Appendix **??** for dependency:

`pattern.tif`

Scilab code Solution 10.3 Wavelets

```
1 //
2 //environment: Scilab 5.4.1
3 //Toolbox: Image Processing Design 8.3.1-1
4 //Toolbox: SIVP 0.5.3.1-2
5 //Toolbox:Scilab Wavelet Toolbox0.1.19-1
6 //Toolbox:Huffcomp Toolbox 1.1.1
7 //OS:Windows 7
8 //
9 //Reference book name : Digital Image Processing
10 //book author: Rafael C. Gonzalez and Richard E.
     Woods
11
12 //wavelet based image smoothing.
13 clc //to clear command window.
14 clear all //to kill previously defined variables.
15 xdel(winsid())//to close all currently open figure(s
     ).
16
17 //stacksize() is used to increase stack size to
     achieve maximum performance.Restart Scilab if
     error no 10001(cannot allocate memory) is occured
     .
18 stacksize('max')
19
20
21
22 X=ReadImage('pattern.tif');//ReadImage() is used to
     read an image
23 figure,ShowImage(X,'Original Grayscale  image');//
     ShowImage() is used to show gray scale image,
     figure is command to view images in separate
     window.
24 title('Original Grayscale Image');//title() is used
     for providing  a title to an image.
25
26
```

```
27 dwtmode('status')//'status' is used to display
      current DWT Extension mode.
28 dwtmode('sym')//'sym' is used for changing DWT
      Extension mode to half symmetrisation
29 wname = 'haar'//wname is used in two dimension
      multiple level discrete fast wavelet transform. '
      haar' is used for Haar wavelet.
30 [nr,nc]=size(X);
31 x=zeros(nr,nc);
32 x=X(1:$,1:$);
33 x=double(x);
34
35 [wc,s] = wavedec2(x,4,wname);// Compute a 2-level
      decomposition of the image using the Haar filters
      .Second argument is used for level.
36
37 // Extract the level 1 coefficients. Fourth argument
       must be 1 to for extraction the level 1
      coefficient in appcoef2() and detcoef2() function
      .
38 a1 = appcoef2(wc,s,wname,1);//appcoef2() is used to
      extract 2-D approximation coefficients.
39 h1 = detcoef2('h',wc,s,1);//detcoef2() is used to
      extract 2-D detail coefficient extraction. First
      argument 'h' is used for horizontal detail
      coefficients.
40 v1 = detcoef2('v',wc,s,1);  //detcoef2() is used to
      extract 2-D detail coefficient extraction. First
      argument 'v' is used for vertical detail
      coefficients.
41 d1 = detcoef2('d',wc,s,1); //detcoef2() is used to
      extract 2-D detial coefficient extraction. First
       argumentd  is used for diagonal detail
      coefficients.
42
43 // Extract the level 2 coefficients. Fourth argument
       must be 2 for extraction the level 2
      coefficients in appcoef2() and detcoef2()
```

```
    function.
44
45 a2 = appcoef2(wc,s,wname,2);
46 h2 = detcoef2('h',wc,s,2);
47 v2 = detcoef2('v',wc,s,2);
48 d2 = detcoef2('d',wc,s,2);
49
50 // Extract the level 2 coefficients. Fourth argument
       must be 3 for extraction the level 2
    coefficients in appcoef2() and detcoef2()
    function.
51
52 a3 = appcoef2(wc,s,wname,3);
53 h3 = detcoef2('h',wc,s,3);
54 v3 = detcoef2('v',wc,s,3);
55 d3 = detcoef2('d',wc,s,3);
56
57
58 // Extract the level 2 coefficients. Fourth argument
       must be 4 for extraction the level 2
    coefficients in appcoef2() and detcoef2()
    function.
59
60 a4 = appcoef2(wc,s,wname,4);
61 h4 = detcoef2('h',wc,s,4);
62 v4 = detcoef2('v',wc,s,4);
63 d4 = detcoef2('d',wc,s,4);
64
65
66
67
68 // Display the decomposition up to level 1 only.
69 a1=double(a1);
70 cod_a1 = wcodemat(a1,256);
71 cod_a1=double(cod_a1);
72 cod_a1 = wkeep(cod_a1,[344 344]);
73 cod_h1 = wcodemat(h1,260);
74 cod_h1=double(cod_h1);
```

```
75  cod_h1 = wkeep(cod_h1, [344 344]);
76  cod_v1 = wcodemat(v1,260);
77  cod_v1=double(cod_v1);
78  cod_v1 = wkeep(cod_v1, [344 344]);
79  cod_d1 = wcodemat(d1,260);
80  cod_d1=double(cod_d1);
81  cod_d1 = wkeep(cod_d1, [344 344]);
82  ans1=[cod_a1,cod_h1;cod_v1,cod_d1];
83
84  figure,ShowImage(ans1,' Wavelet Transform of an
       image');//ShowImage() is used to show gray scale
       image, figure is command to view images in
       separate window.
85  title(' Wavelet Transform of an image');//title() is
        used for providing  a title to an image.
86
87
88
89
90  // Display the entire decomposition up to level 2.
91  cod_a2 = wcodemat(a2,260);
92  cod_a2=double(cod_a2);
93  cod_a2 = wkeep(cod_a2, [172 172]);
94  cod_h2 = wcodemat(h2,260);
95  cod_h2=double(cod_h2);
96  cod_h2 = wkeep(cod_h2, [172 172]);
97  cod_v2 = wcodemat(v2,260);
98  cod_v2=double(cod_v2);
99  cod_v2 = wkeep(cod_v2, [172 172]);
100 cod_d2 = wcodemat(d2,260);
101 cod_d2=double(cod_d2);
102 cod_d2 = wkeep(cod_d2, [172 172]);
103 bb=[[cod_a2,cod_h2;cod_v2,cod_d2],cod_h1;cod_v1,
       cod_d1];
104
105
106 figure,ShowImage(bb,' Second level Wavelet transform
        an image');//ShowImage() is used to show gray
```

```
    scale image, figure is command to view images in
    separate window.
107 title(' Second level Wavelet transform an image');//
    title() is used for providing  a title to an
    image.
108
109
110 // Display the entire decomposition upto level 3.
111 cod_a3 = wcodemat(a3,260);
112 cod_a3=double(cod_a3);
113 cod_a3 = wkeep(cod_a3,[86 86]);
114 cod_h3 = wcodemat(h3,260);
115 cod_h3=double(cod_h3);
116 cod_h3 = wkeep(cod_h3,[86 86]);
117 cod_v3 = wcodemat(v3,260);
118 cod_v3=double(cod_v3);
119 cod_v3 = wkeep(cod_v3,[86 86]);
120 cod_d3 = wcodemat(d3,260);
121 cod_d3=double(cod_d3);
122 cod_d3 = wkeep(cod_d3,[86 86]);
123 bbb=[[[cod_a3,cod_h3;cod_v3,cod_d3],cod_h2;cod_v2,
    cod_d2],cod_h1;cod_v1,cod_d1];
124
125
126 figure,ShowImage(bbb,' Third level Wavelet transform
     an image');//ShowImage() is used to show gray
    scale image, figure is command to view images in
    separate window.
127 title(' Third level Wavelet transform an image');//
    title() is used for providing  a title to an
    image.
128
129
130
131 // Display the entire decomposition upto level 2.
132 cod_a4 = wcodemat(a4,260);
133 cod_a4=double(cod_a4);
134 cod_a4 = wkeep(cod_a4, [43 43]);
```

```
135 cod_h4 = wcodemat(h4,260);
136 cod_h4=double(cod_h4);
137 cod_h4 = wkeep(cod_h4, [43 43]);
138 cod_v4 = wcodemat(v4,260);
139 cod_v4=double(cod_v4);
140 cod_v4 = wkeep(cod_v4, [43 43]);
141 cod_d4 = wcodemat(d4,260);
142 cod_d4=double(cod_d4);
143 cod_d4 = wkeep(cod_d4, [43 43]);
144 bbbb=[[[[cod_a4,cod_h4;cod_v4,cod_d4],cod_h3;cod_v3,
      cod_d3],cod_h2;cod_v2,cod_d2],cod_h1;cod_v1,
      cod_d1];
145
146
147 figure,ShowImage(bbbb,' Fourth level Wavelet
      transform an image');//ShowImage() is used to
      show gray scale image, figure is command to view
      images in separate window.
148 title('Fourth level Wavelet transform an image');//
      title() is used for providing  a title to an
      image.
149
150 // Reconstruction of an image using wrcoef2()
      function. Last argument is used for level of
      reconstruction.
151
152 ra4 = wrcoef2('a',wc,s,wname,4);
153 rh4 = wrcoef2('h',wc,s,wname,4);
154 rv4 = wrcoef2('v',wc,s,wname,4);
155 rd4 = wrcoef2('d',wc,s,wname,4);
156
157 ra3 = wrcoef2('a',wc,s,wname,3);
158 rh3 = wrcoef2('h',wc,s,wname,3);
159 rv3 = wrcoef2('v',wc,s,wname,3);
160 rd3 = wrcoef2('d',wc,s,wname,3);
161
162 ra2 = wrcoef2('a',wc,s,wname,2);//'a' is used for
      approximation coefficients.
```

```
163 rh2 = wrcoef2('h',wc,s,wname,2);//'h' is used for
      horizontal detail coefficients.
164 rv2 = wrcoef2('v',wc,s,wname,2);//'v' is used for
      vertical detail coefficients.
165 rd2 = wrcoef2('d',wc,s,wname,2);//'d' is used for
      detail coefficients.
166
167 ra1 = wrcoef2('a',wc,s,wname,1);
168 rh1 = wrcoef2('h',wc,s,wname,1);
169 rv1 = wrcoef2('v',wc,s,wname,1);
170 rd1 = wrcoef2('d',wc,s,wname,1);
171
172
173 cod_ra4 = wcodemat(ra4,260);
174 cod_rh4 = wcodemat(rh4,260);
175 cod_rv4 = wcodemat(rv4,260);
176 cod_rd4 = wcodemat(rd4,260);
177
178 cod_ra3 = wcodemat(ra3,260);
179 cod_rh3 = wcodemat(rh3,260);
180 cod_rv3 = wcodemat(rv3,260);
181 cod_rd3 = wcodemat(rd3,260);
182
183 cod_ra2 = wcodemat(ra2,260);
184 cod_rh2 = wcodemat(rh2,260);
185 cod_rv2 = wcodemat(rv2,260);
186 cod_rd2 = wcodemat(rd2,260);
187
188 cod_ra1 = wcodemat(ra1,260);
189 cod_rh1 = wcodemat(rh1,260);
190 cod_rv1 = wcodemat(rv1,260);
191 cod_rd1 = wcodemat(rd1,260);
192
193 //zeroing first level detail coefficients.
194 rh1(1:$,1:$)=0;
195 rd1(1:$,1:$)=0;
196 rv1(1:$,1:$)=0;
197
```

```
198 Xhat = ra4+rh4 + rv4 + rd4+rh3 + rv3 + rd3 + rh2 +
      rv2 + rd2 + rh1 + rv1 + rd1;
199 figure,ShowImage(Xhat,' Reconstruction of an image
      after zeroing first level detail coefficients.');
      //ShowImage() is used to show gray scale image,
      figure is command to view images in separate
      window.
200 title(' Reconstruction of an image after zeroing
      first and second level detail coefficients.');//
      title() is used for providing  a title to an
      image.
201
202 // zeroing first and second level detail
      coefficients.
203 rh2(1:$,1:$)=0;
204 rv2(1:$,1:$)=0;
205 rd2(1:$,1:$)=0;
206
207 rh1(1:$,1:$)=0;
208 rd1(1:$,1:$)=0;
209 rv1(1:$,1:$)=0;
210 Xhat = ra4+rh4 + rv4 + rd4+rh3 + rv3 + rd3 + rh2 +
      rv2 + rd2 + rh1 + rv1 + rd1;
211 figure,ShowImage(Xhat,'reconstion of an image after
      zeroing first and second level detail
      coefficients.');//ShowImage() is used to show
      gray scale image, figure is command to view
      images in separate window.
212 title('Reconstruction of an image after zeroing
      first and second level detail coefficients.');//
      title() is used for providing  a title to an
      image.
213
214 //zeroing first, second and third level detail
      coefficients.
215 rh3(1:$,1:$)=0;
216 rv3(1:$,1:$)=0;
217 rd3(1:$,1:$)=0;
```

```
218
219 rh2(1:$,1:$)=0;
220 rv2(1:$,1:$)=0;
221 rd2(1:$,1:$)=0;
222
223 rh1(1:$,1:$)=0;
224 rd1(1:$,1:$)=0;
225 rv1(1:$,1:$)=0;
226 Xhat = ra4+rh4 + rv4 + rd4+rh3 + rv3 + rd3 + rh2 +
      rv2 + rd2 + rh1 + rv1 + rd1;
227 figure,ShowImage(Xhat,' Reconstruction of an image
      after zeroing first, second and third level
      detail coefficients.');//ShowImage() is used to
      show gray scale image, figure is command to view
      images in separate window.
228 title('Reconstruction of an image after zeroing
      first, second and third level detail coefficients
      .');//title() is used for providing a title to
      an image.
229
230
231 //zeroing all level detail coefficients.
232 rh4(1:$,1:$)=0;
233 rv4(1:$,1:$)=0;
234 rd4(1:$,1:$)=0;
235
236
237 rh3(1:$,1:$)=0;
238 rv3(1:$,1:$)=0;
239 rd3(1:$,1:$)=0;
240
241
242 rh2(1:$,1:$)=0;
243 rv2(1:$,1:$)=0;
244 rd2(1:$,1:$)=0;
245
246 rh1(1:$,1:$)=0;
247 rd1(1:$,1:$)=0;
```

```
248 rv1(1:$,1:$)=0;
249 Xhat = ra4+rh4 + rv4 + rd4+rh3 + rv3 + rd3 + rh2 +
      rv2 + rd2 + rh1 + rv1 + rd1;
250 figure,ShowImage(Xhat,' Reconstruction of an image
      after zeroing all level detail coefficients.');//
      ShowImage() is used to show gray scale image,
      figure is command to view images in separate
      window.
251 title(' Reconstruction of an image after zeroing all
       level detail coefficients.');//title() is used
      for providing  a title to an image.
```

Appendix