Image Processing | Lab 9

Different Frequency Domain Filtering Operations

Raj Panchal
17CEUBG104

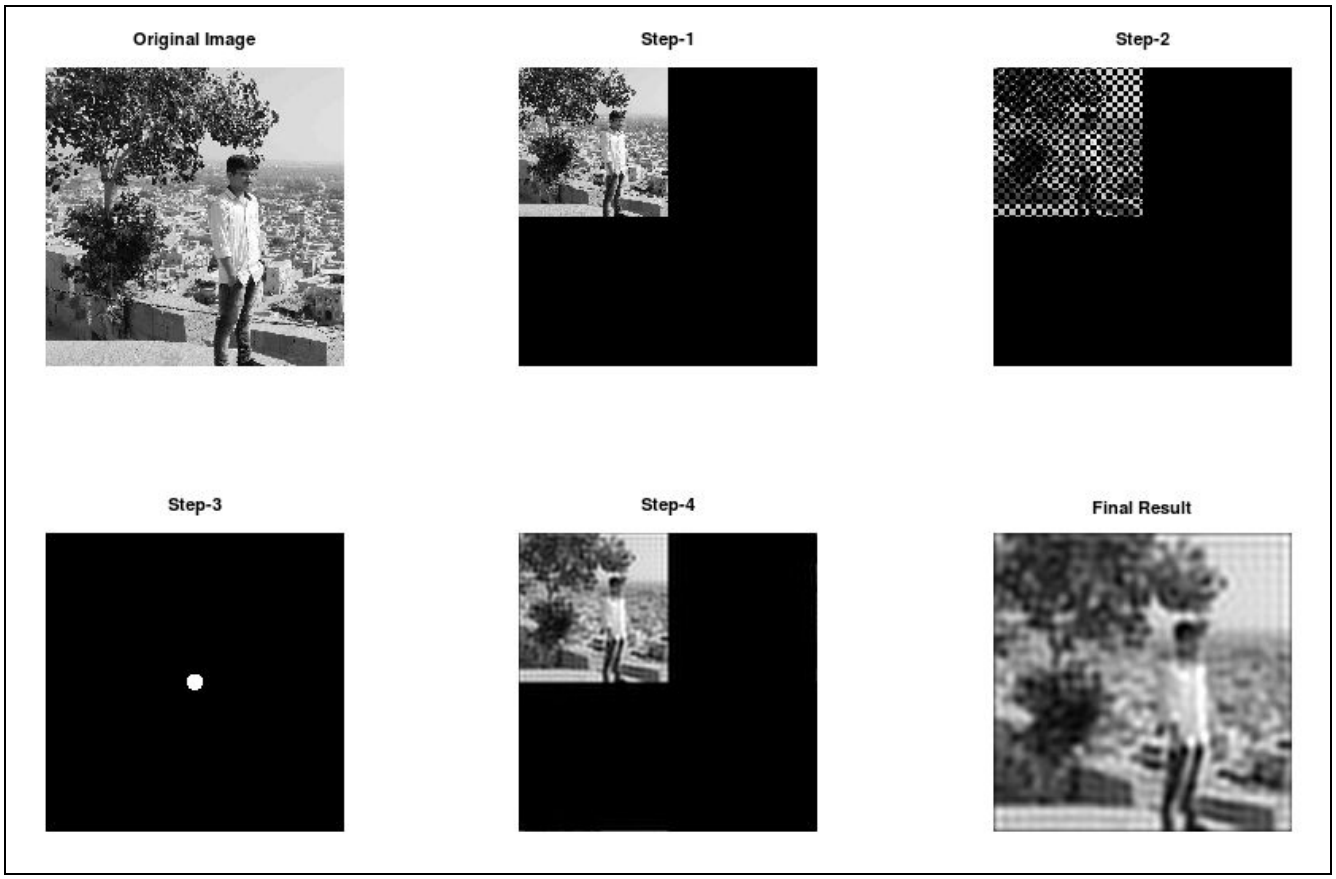
Task 1 : Ideal low pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);imshow(r);title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);imshow(uint8(pad));title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    if(D<=D0)
      H(i,j)=1;
    else
      H(i,j)=0;
    endif
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
```

```
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



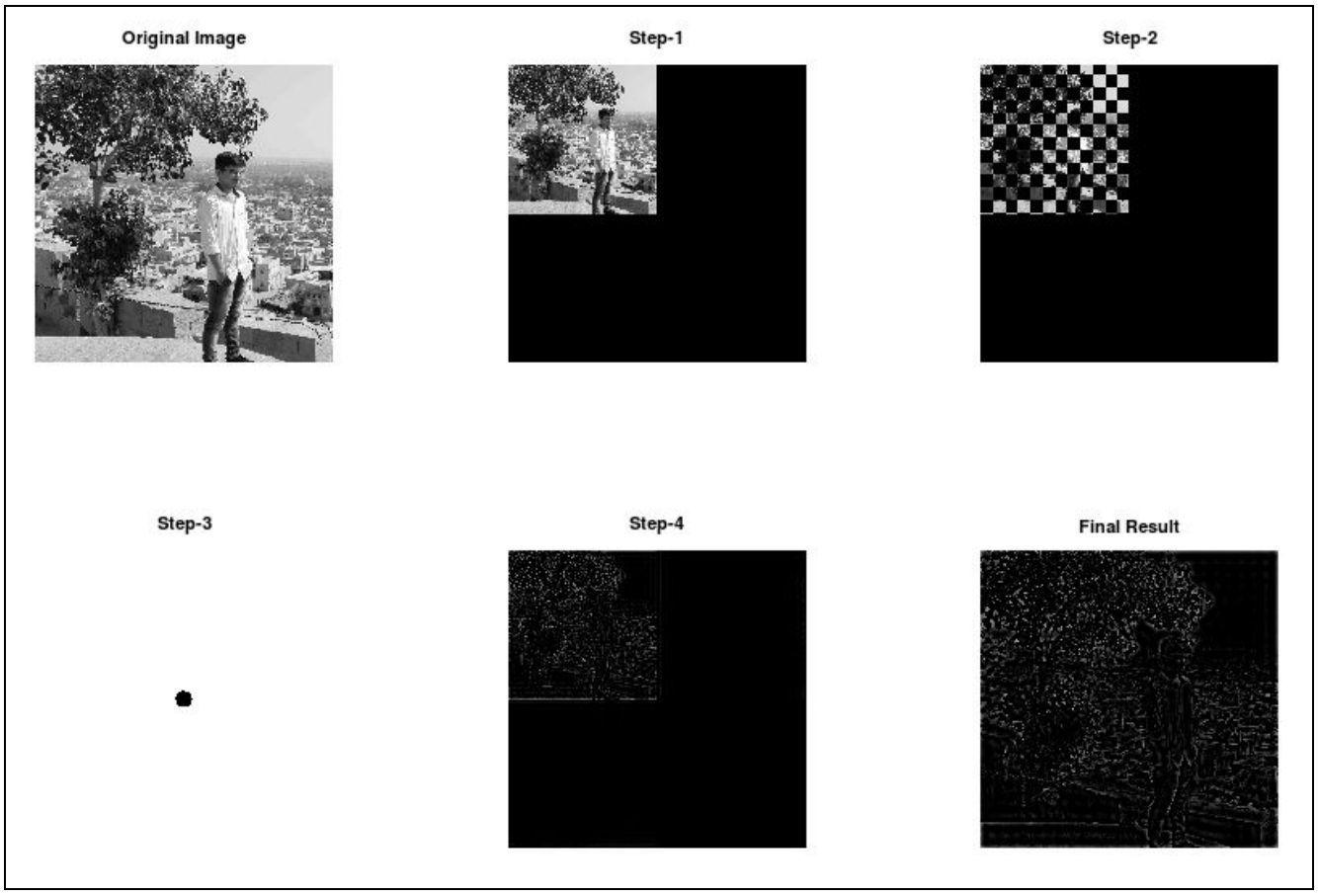
Task 2 : Ideal high pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);imshow(r);title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);imshow(uint8(pad));title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    if(D<=D0)
      H(i,j)=0;
    else
      H(i,j)=1;
    endif
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
```

```
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



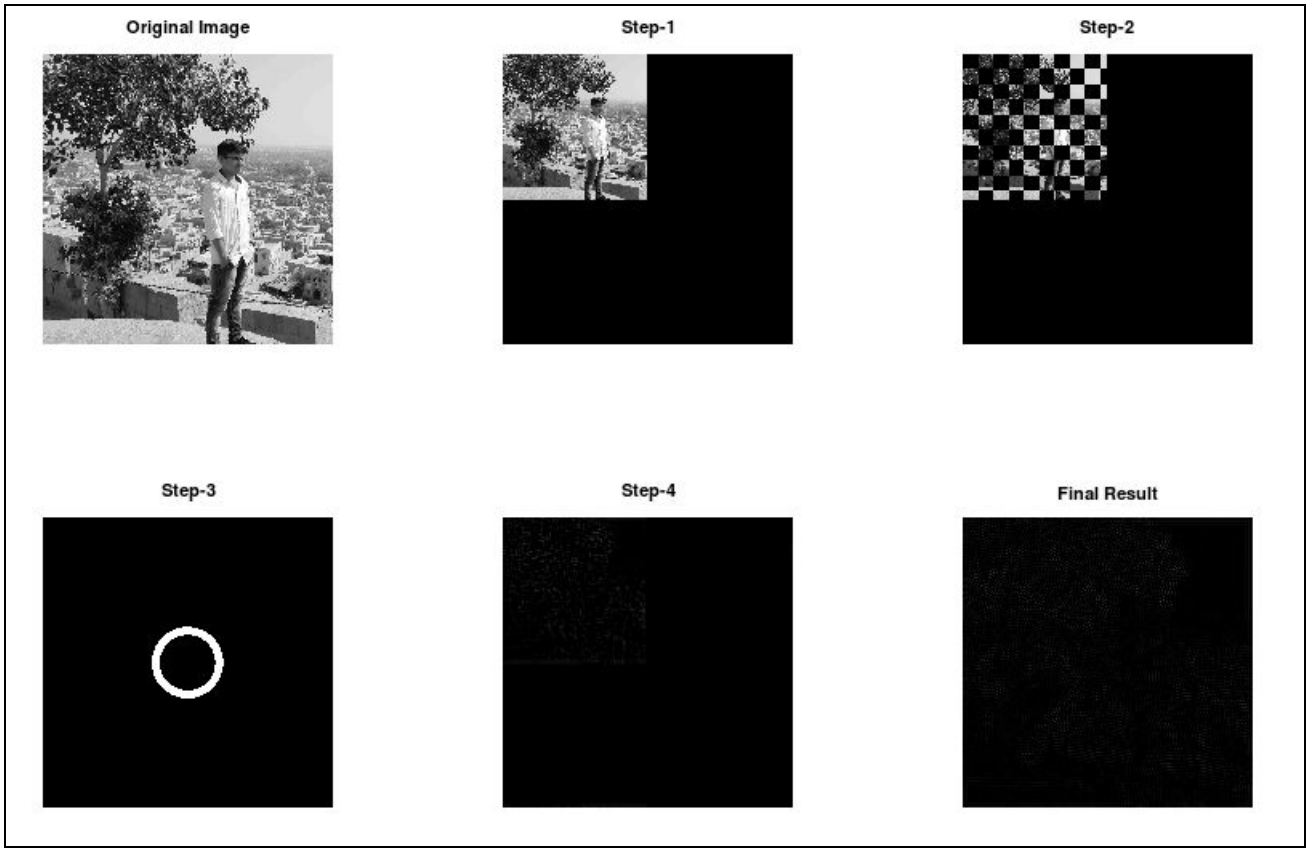
Task 3 : Ideal band pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=200;
W=50;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    if(D0-(W/2)<=D && D<=D0+(W/2))
      H(i,j)=0;
    else
      H(i,j)=1;
    endif
  endfor
endfor
H=not(H);

subplot(2,3,4);imshow(H);title("Step-3");
```

```
G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



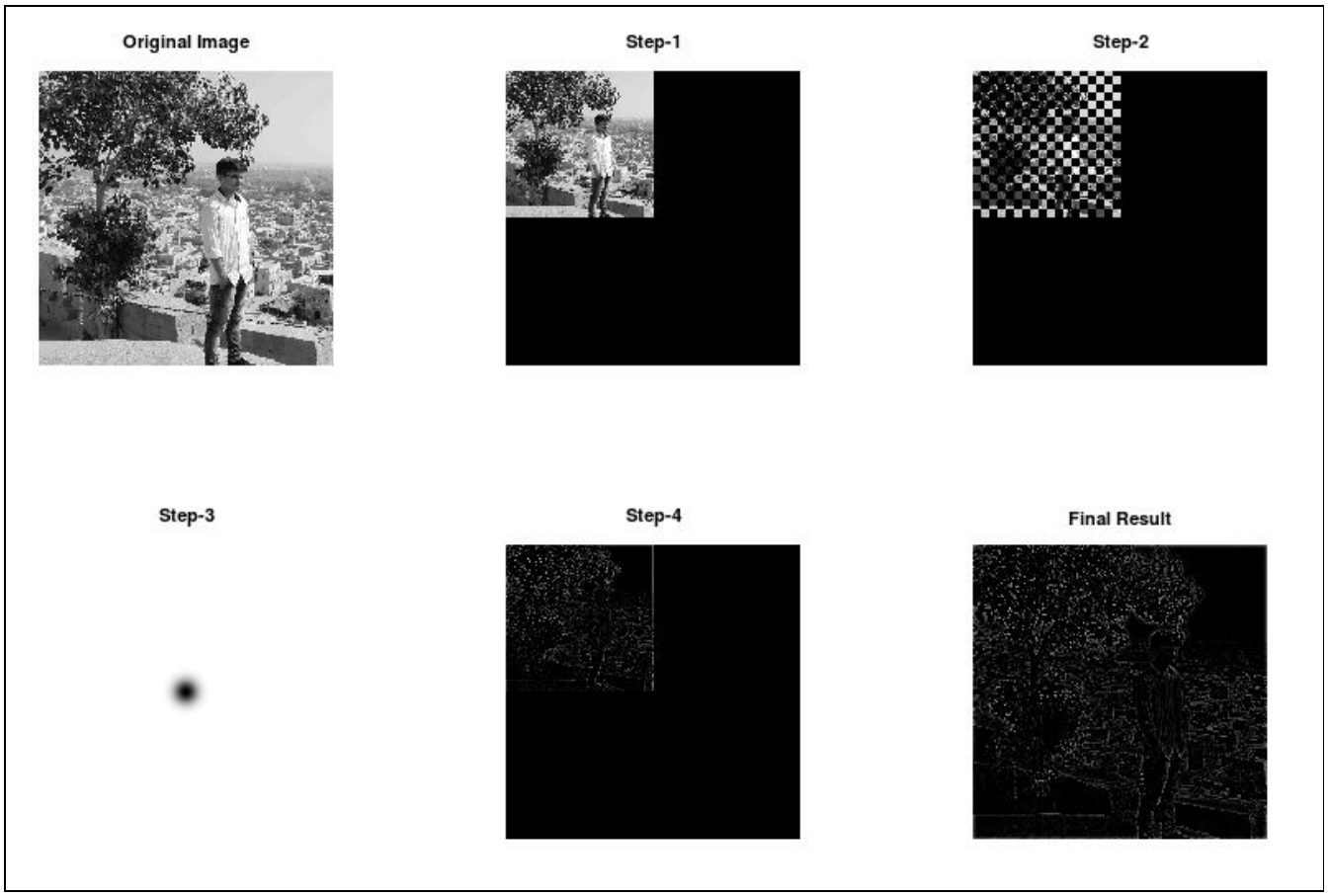
Task 4 : Gaussian High Pass filter.

Code :

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    term = -((D*D)/(2*D0*D0));
    H(i,j)=1-(power(e,term));
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
```

```
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



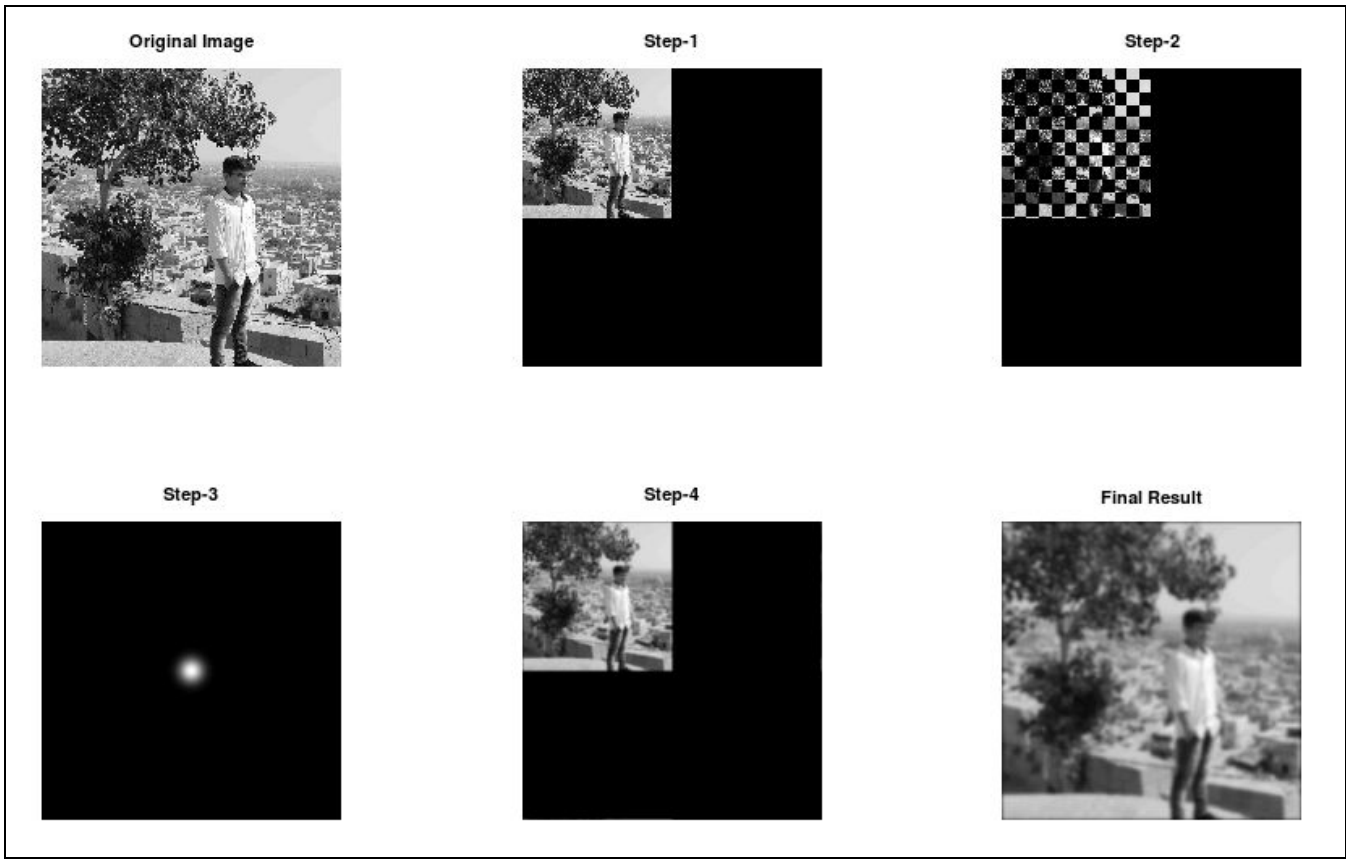
Task 5 : Gaussian Low pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    term = -((D*D)/(2*D0*D0));
    H(i,j)=power(e,term);
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
```

```
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



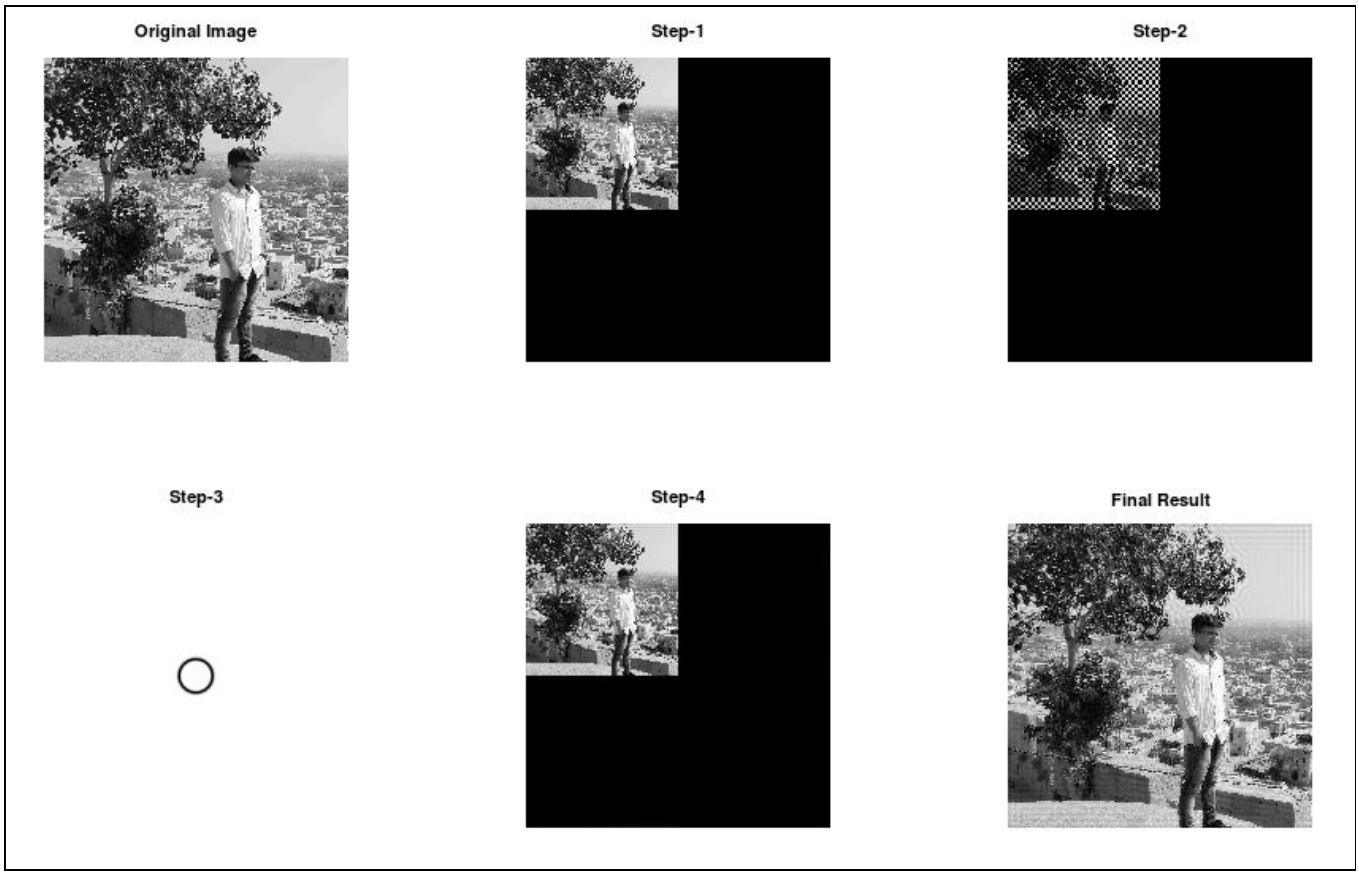
Task 6: Gaussian band reject filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=100;
W=20;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    term = -power((((D*D)-(D0*D0))/(D*W)),2);
    H(i,j)=1-power(e,term);
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
```

```
  for j=1:N
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



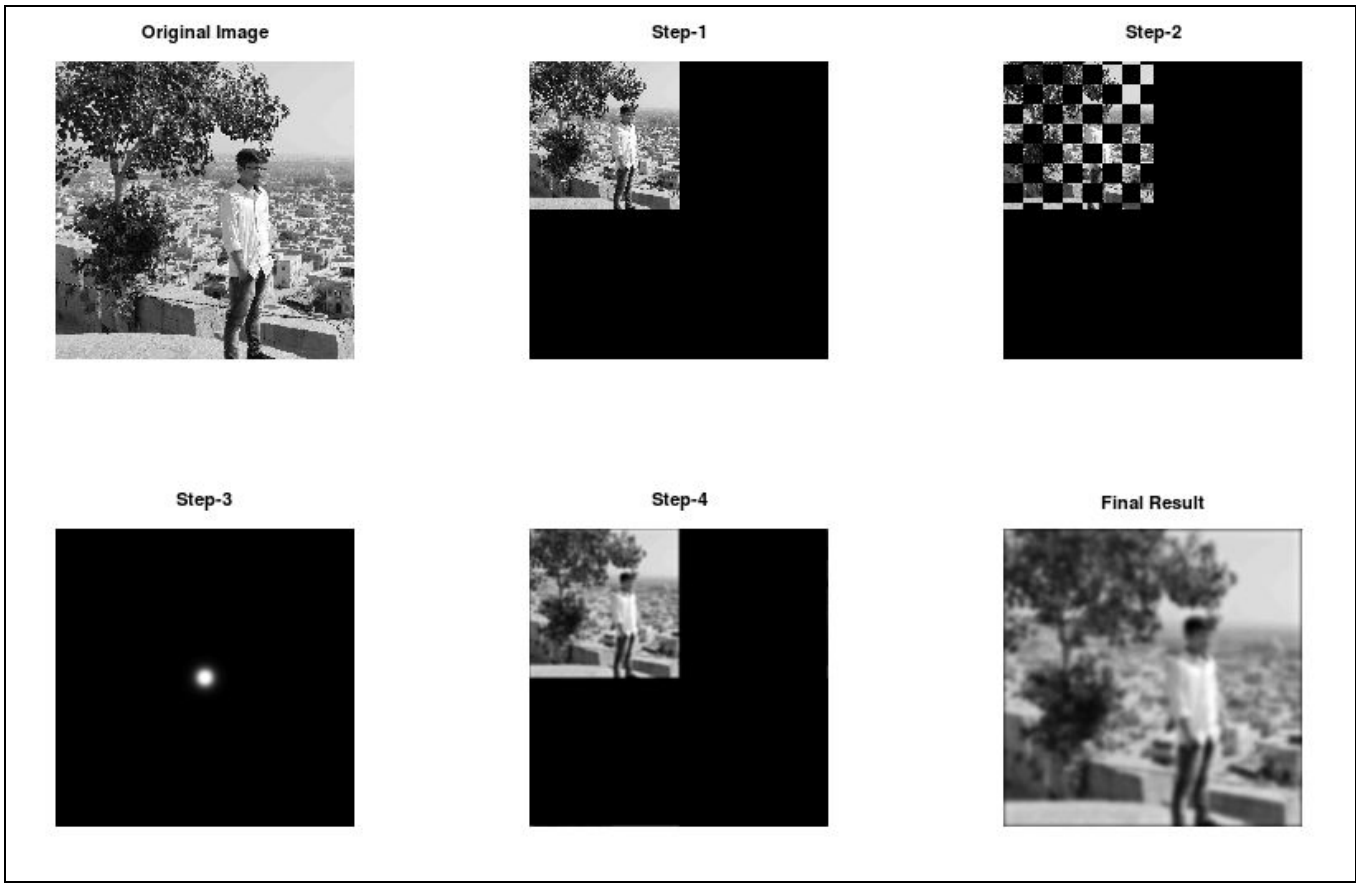
Task 7 : Butterworth low pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
order=2;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    H(i,j)=1/(1+power((D/D0),2*order));
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
```

```
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output:



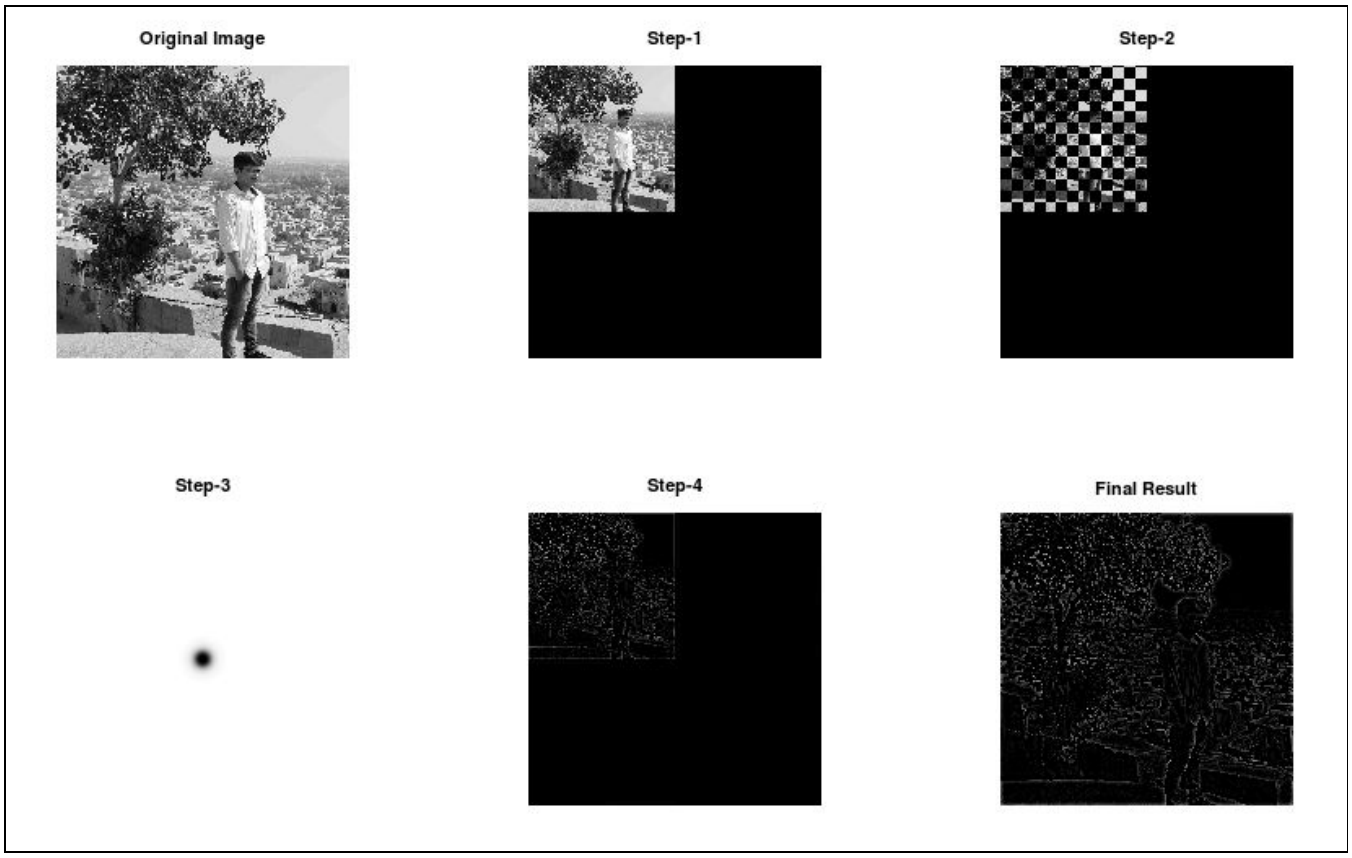
Task 8 :Butterworth high pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=50;
order=2;
for i=1:M
  for j=1:N
    D=sqrt((i-M/2)^2+(j-N/2)^2);
    H(i,j)=1/(1+power((D0/D),2*order));
  endfor
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
```

```
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output :



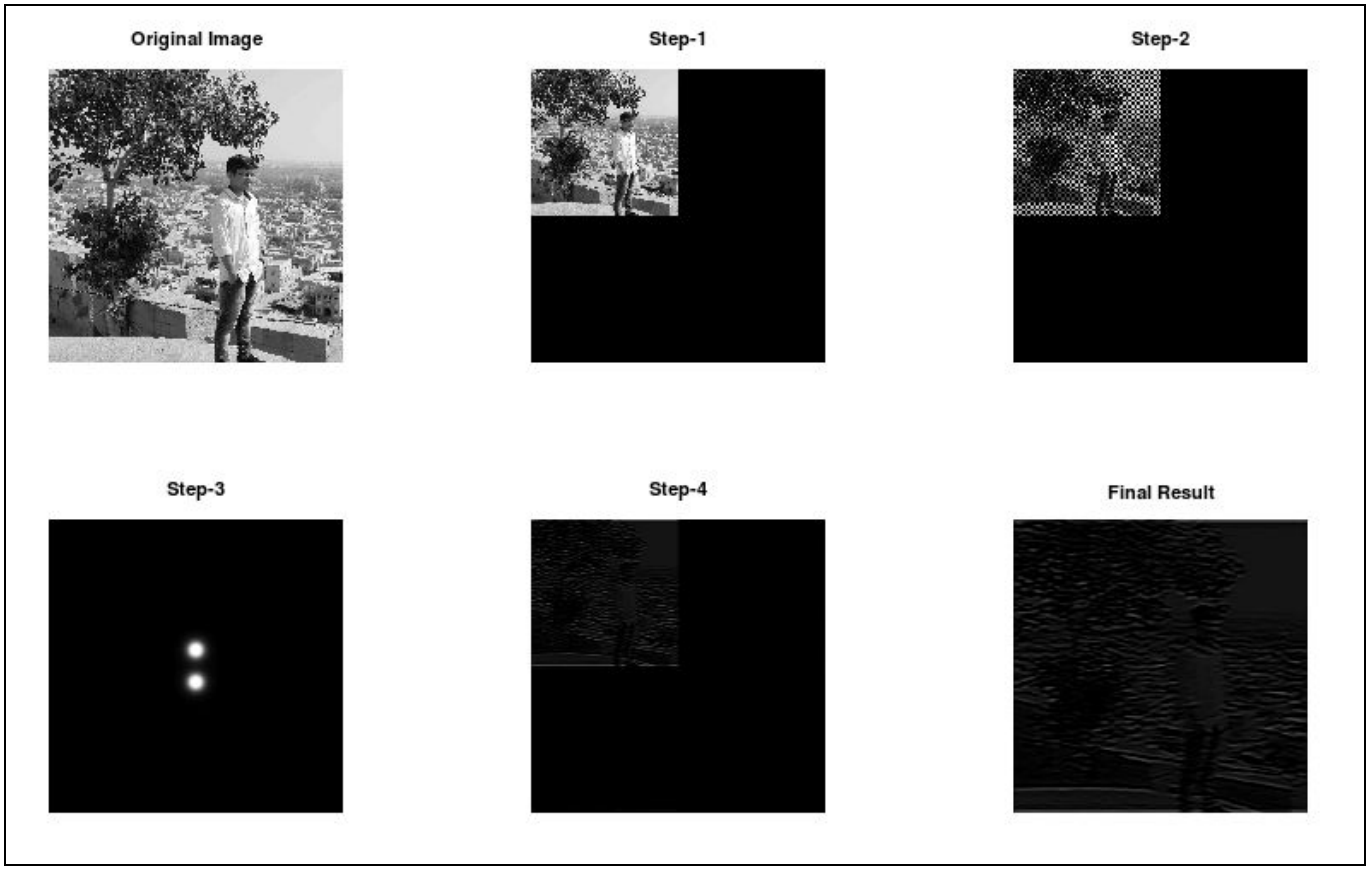
Task 9 : Notch pass filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");
subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=40;
order=2;
u=[100,-100];
v=[0,0];
for i=1:M,
  for j=1:N,
    H(i,j)=1;
    for k =1:2,
      D1=sqrt((i-(M/2)-u(k))^2+(j-(N/2)-v(k))^2);
      D2=sqrt((i-(M/2)+u(k))^2+(j-(N/2)+v(k))^2);
      t1=1/(1+power(D0/D1,2*order));
      t2=1/(1+power(D0/D2,2*order));
      H(i,j)=H(i,j)*t1*t2;
    endfor
  endfor
endfor
```

```
H = 1-H;

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M,
  for j=1:N,
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output :



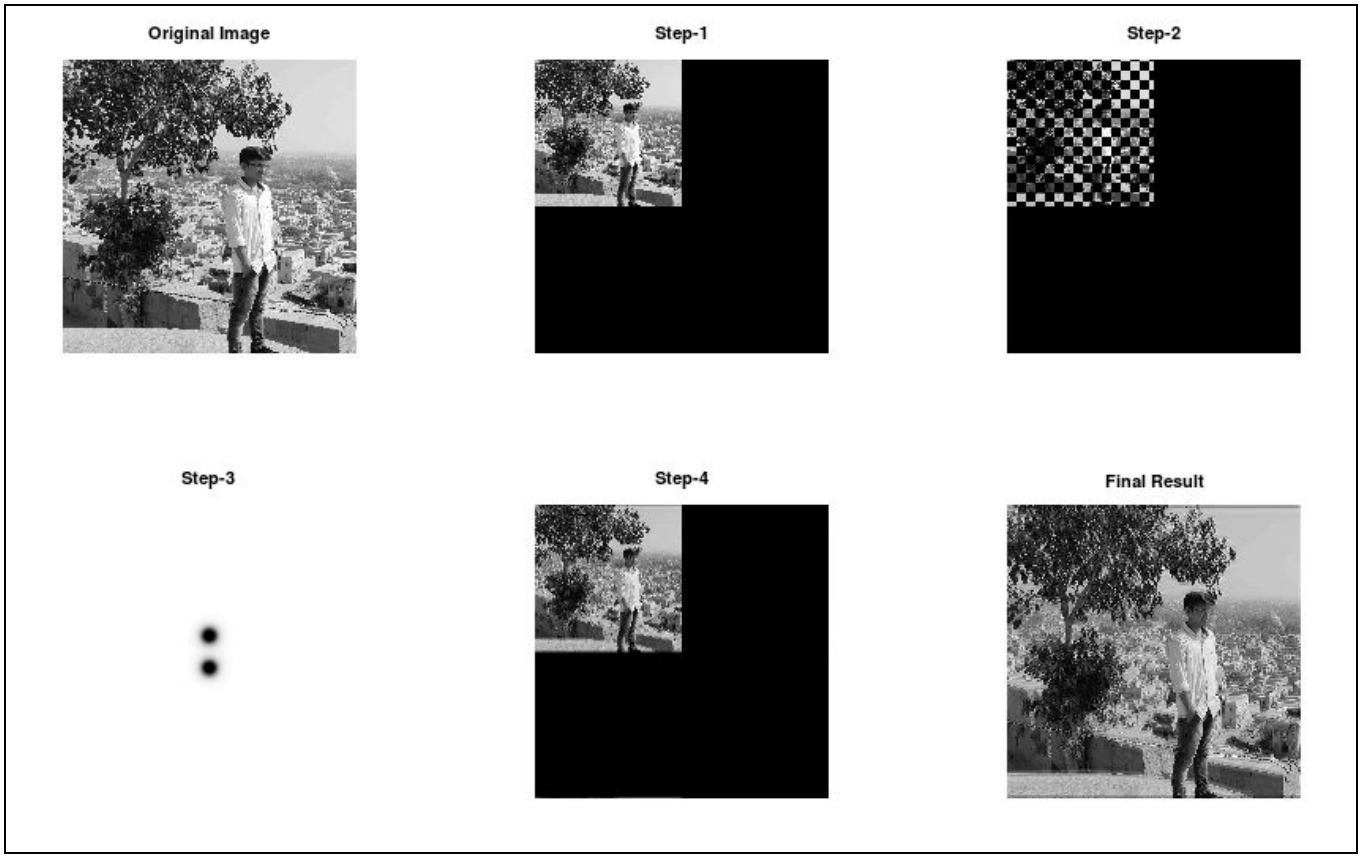
Task 10 : Notch reject filter.

Code:

```
pkg load image;
r = imread("my_gray_img.jpg");

subplot(2,3,1);
imshow(r);
title("Original Image");

[m,n]=size(r);
M=2*m;
N=2*n;
pad=zeros(M,N);
pad(1:m,1:n)=r;

subplot(2,3,2);
imshow(uint8(pad));
title("Step-1");

for i=1:M
  for j=1:N
    pad(i,j)=pad(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,3);imshow(uint8(pad));title("Step-2");

F = fft2(pad);
H = zeros(M,N);
D0=40;
order=2;
u=[100,-100];
v=[0,0];
for i=1:M,
  for j=1:N,
    H(i,j)=1;
    for k =1:2,
      D1=sqrt((i-(M/2)-u(k))^2+(j-(N/2)-v(k))^2);
      D2=sqrt((i-(M/2)+u(k))^2+(j-(N/2)+v(k))^2);
      t1=1/(1+power(D0/D1,2*order));
      t2=1/(1+power(D0/D2,2*order));
      H(i,j)=H(i,j)*t1*t2;
    endfor
  endfor
```

```
endfor

subplot(2,3,4);imshow(H);title("Step-3");

G=H.*F;
Gp = real(ifft2(G));
for i=1:M
  for j=1:N
    st(i,j)=Gp(i,j)*(-1)^(i-1+j-1);
  endfor
endfor

subplot(2,3,5);imshow(uint8(st));title("Step-4");

subplot(2,3,6);s=st(1:m,1:n);
imshow(uint8(s));title("Final Result");
```

Output :



Final Conclusion :

For Ideal Low Pass Filter:

- ➢ Blurring effect which decreases as the cutoff frequency increases.
- ➢ Ringing effect which also decreases as the cutoff frequency increases.

For Ideal High Pass Filter:

- ➢ Ringing effect.
- ➢ Edge distortion (i.e. distorted, thickened object boundaries).
- ➢ Both effects are decreased as the cutoff frequency increases.

For Gaussian Low Pass Filter:

- ➢ Smooth transition in blurring as a function of increasing cutoff frequency.
- ➢ No ringing effect.

For Gaussian High Pass Filter:

- ➢ No ringing effect.
- ➢ Less edge distortion.
- ➢ The results are smoother than those obtained by IHPF.

For Butterworth Low Pass Filter:

- ➢ Smooth transition in blurring as a function of increasing cutoff frequency.
- ➢ Ringing effect in the BLPF becomes significant as the nth order increases.

For Butterworth High Pass Filter:

- ➢ Results are much smoother than obtained with an IHPF.

Document Link :

https://docs.google.com/document/d/1lhM4OsFwrZ5tyxq6fWqSZMe_SBAy5wC-5L7yJ8K0kPE/edit?usp=sharing