EECS225B–Spring 2020 — PROBLEM SET 02

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1 PROBLEM 4.25

The dc term this the center white dot in the right image.
The frequency term is the distance between two spikes.

1.1

Since the wide of stripes double, the frequency of stripes became half of origin. As a result, the distance between the left spike and right spike will be half of origin. They will stay in horizontal. and the center one will stay in center.

1.2

Because the stripe is vertical axis, components of the spectrum will be perpendicular to the stripe.

1.3

Since the wide of stripes becomes half, the frequency of stripes will double. As a result, the distance between the left spike and right spike will double as well. They will stay in horizontal. But since now they seem in the half point between edge and center spike, if we double the distance, they will go the the edge of the spectrum of the image. Matching the true that one pixel is the minimum width(as well as the maximum frequency) so the distance will be max possible position, which is the horizon edge of the image.

1.4

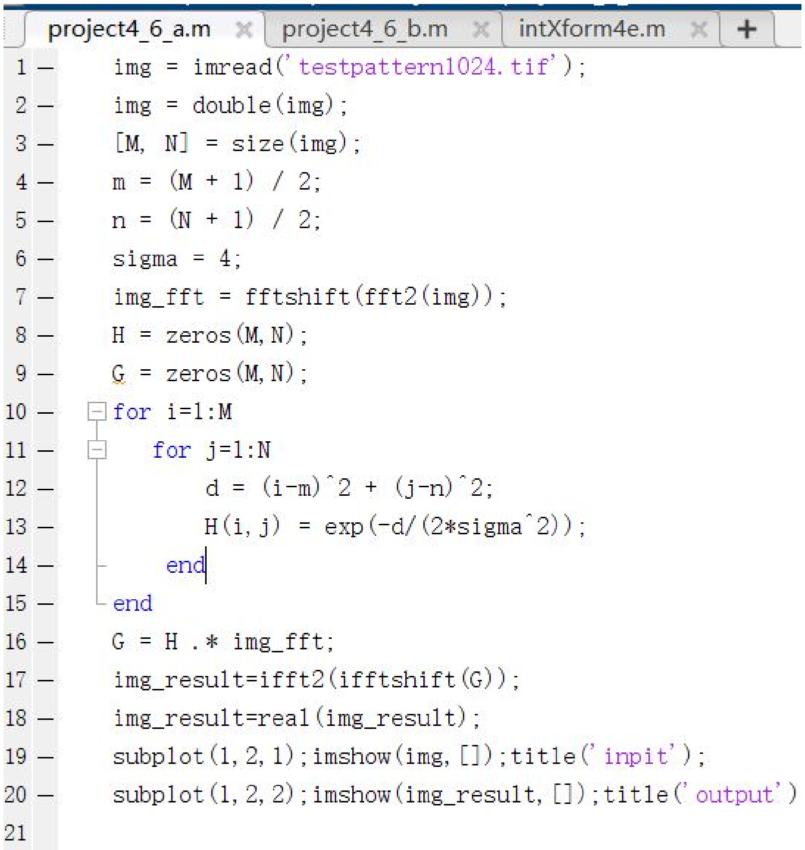
No change.
Change in frequency will not affect the magnitude of image.

2 PROBLEM 4.26

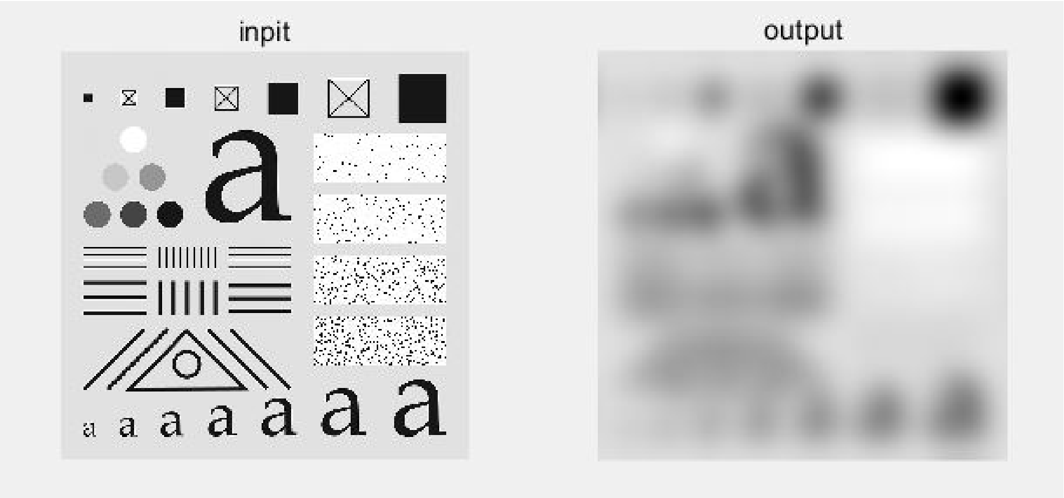
From sampling theorem, we know that a function can be recovered completely from a set of its samples if the samples are acquired at a rate exceeding twice the highest frequency content of the function. The frequency of the image is steady to be 250 per line. So the resolution chip should at least be 500 per horizontal line. Since cost is an important consideration. We choose the smallest choice which is 500 per horizontal.

3 Project 4.6

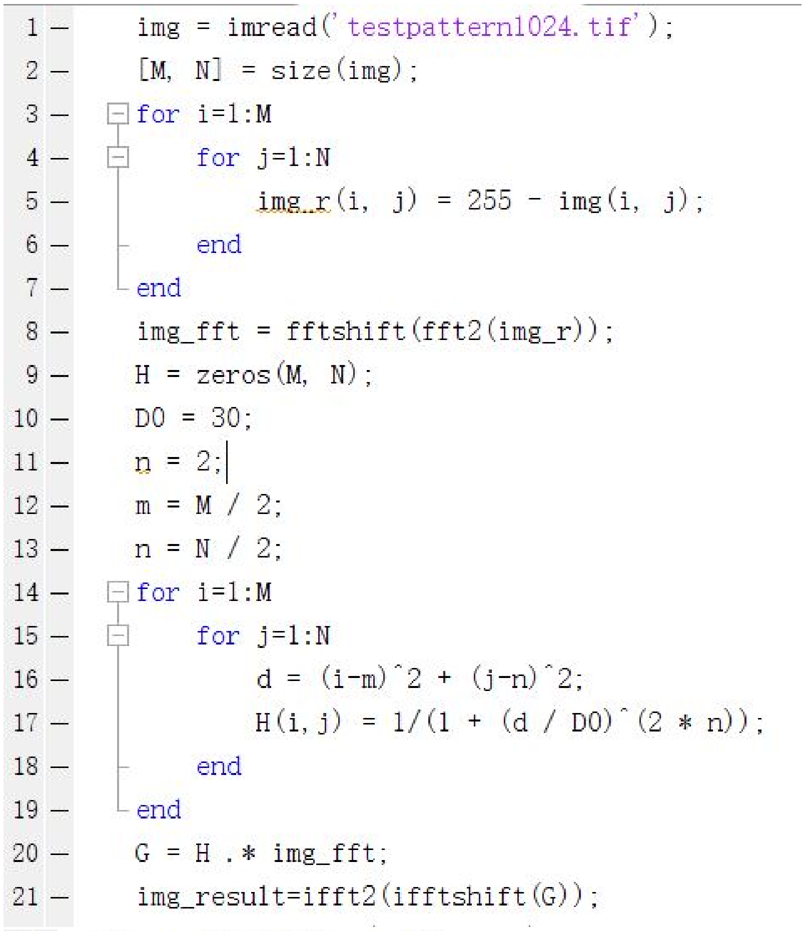
3.1 a



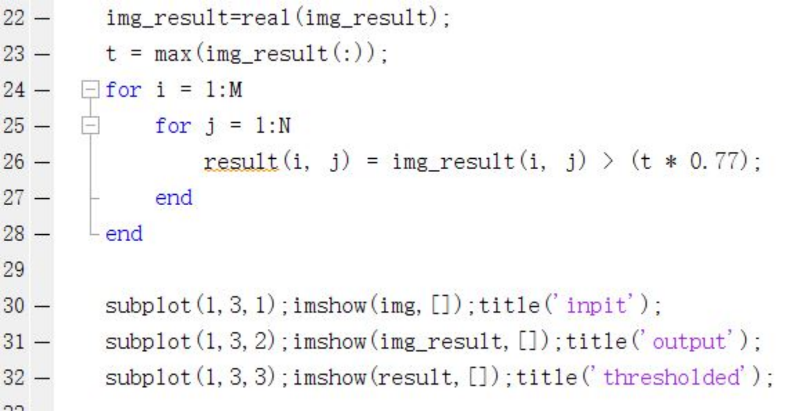
```
img = imread('testpattern1024.tif');
img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
sigma = 4;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
    for j=1:N
        d = (i-m)^2 + (j-n)^2;
        H(i,j) = exp(-d/(2*sigma^2));
    end
end
G = H .* img_fft;
img_result=ifft2(ifftshift(G));
img_result=real(img_result);
subplot(1,2,1);imshow(img,[]);title('inpit');
subplot(1,2,2);imshow(img_result,[]);title('output')
```



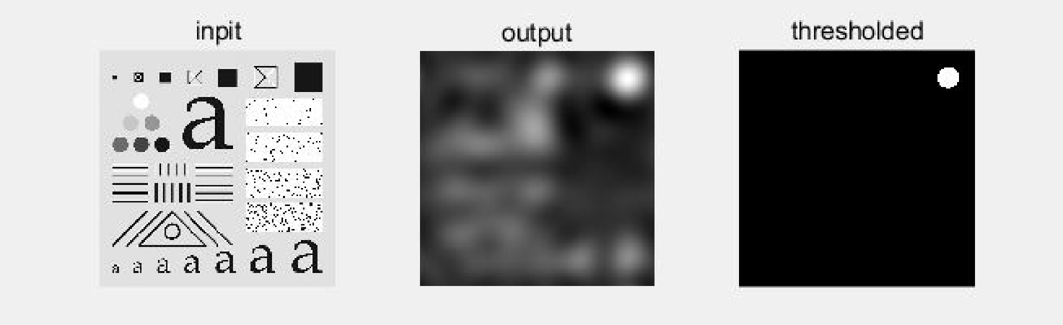
3.2 b



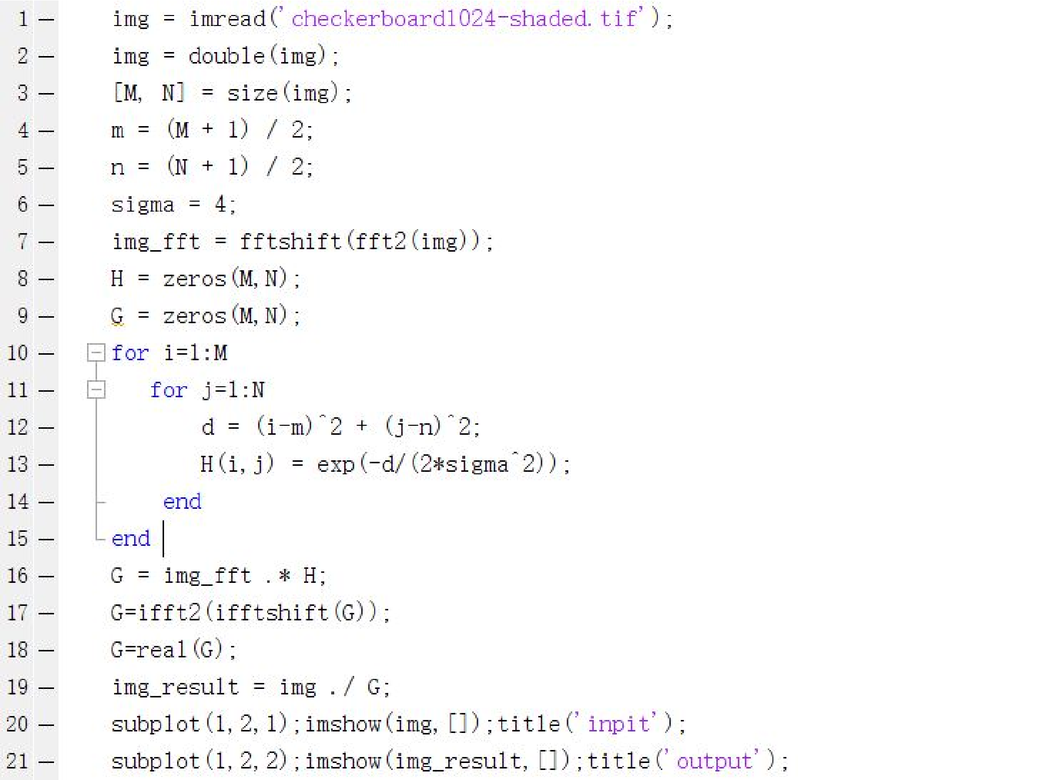
```
img = imread('testpattern1024.tif');
[M, N] = size(img);
for i=1:M
    for j=1:N
        img_r(i, j) = 255 - img(i, j);
    end
end
img_fft = fftshift(fft2(img_r));
H = zeros(M, N);
D0 = 30;
n = 2;
m = M / 2;
n = N / 2;
for i=1:M
    for j=1:N
        d = (i-m)^2 + (j-n)^2;
        H(i,j) = 1/(1 + (d / D0)^(2 * n));
    end
end
G = H .* img_fft;
img_result=ifft2(ifftshift(G));
```



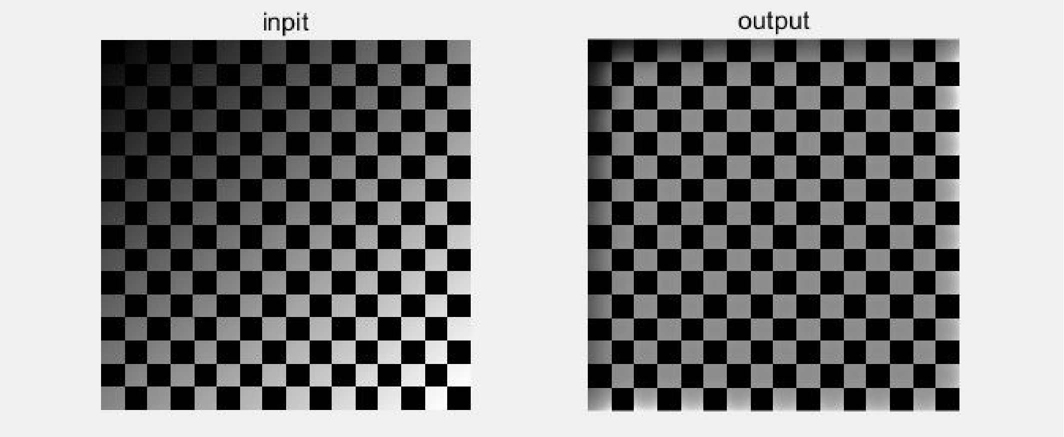
```
img_result=real(img_result);
t = max(img_result(:));
for i = 1:M
    for j = 1:N
        result(i, j) = img_result(i, j) > (t * 0.77);
    end
end

subplot(1,3,1);imshow(img,[]);title('inpit');
subplot(1,3,2);imshow(img_result,[]);title('output');
subplot(1,3,3);imshow(result,[]);title('thresholded');
```



3.3 c

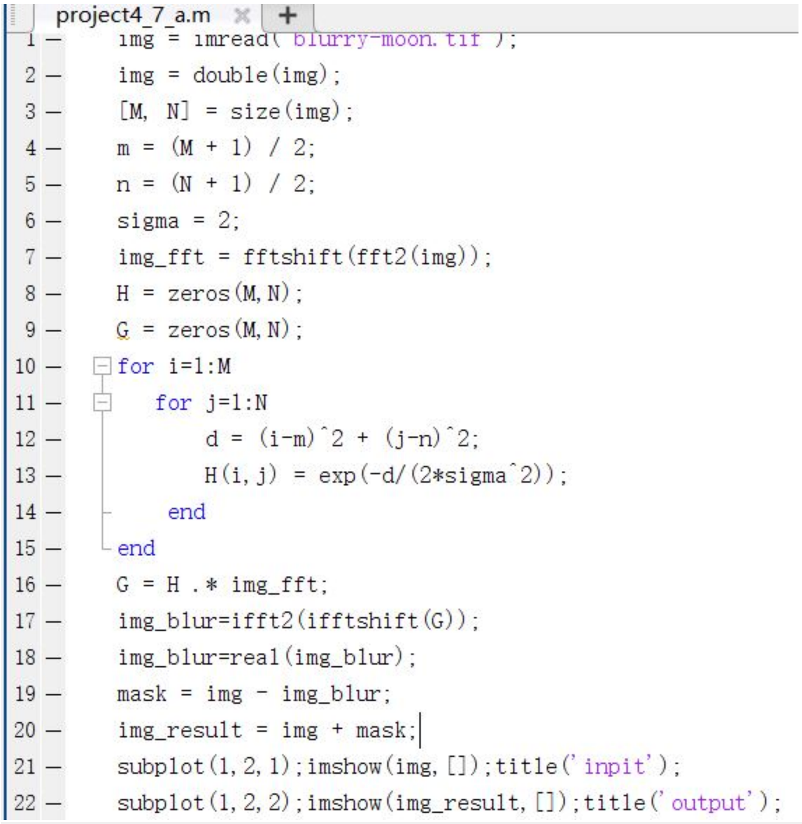


```
img = imread('checkerboard1024-shaded.tif');
img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
sigma = 4;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
    for j=1:N
        d = (i-m)^2 + (j-n)^2;
        H(i,j) = exp(-d/(2*sigma^2));
    end
end
G = img_fft .* H;
G=ifft2(ifftshift(G));
G=real(G);
img_result = img ./ G;
subplot(1,2,1);imshow(img,[]);title('inpit');
subplot(1,2,2);imshow(img_result,[]);title('output');
```

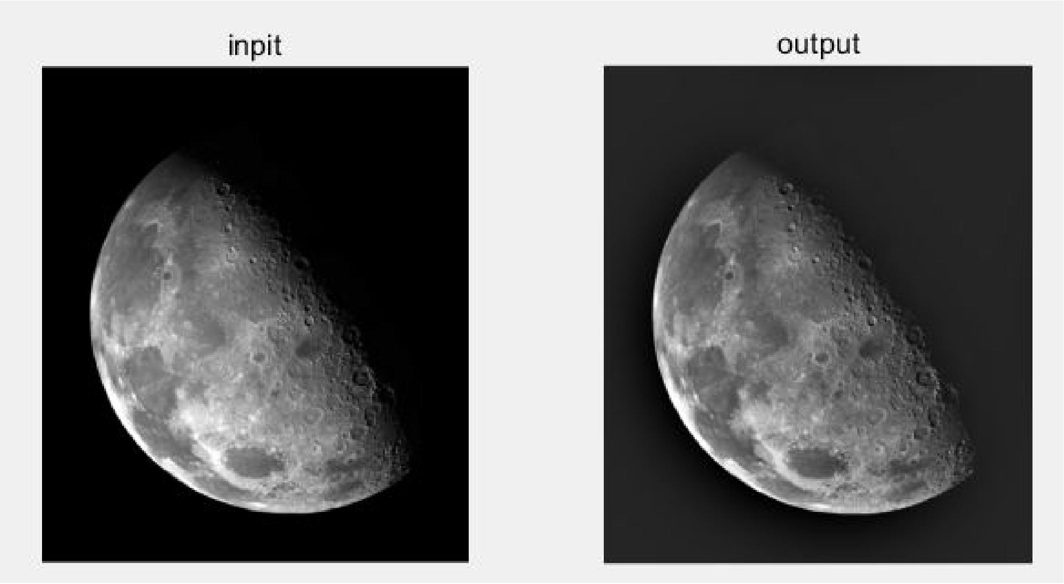


4 Project 4.7

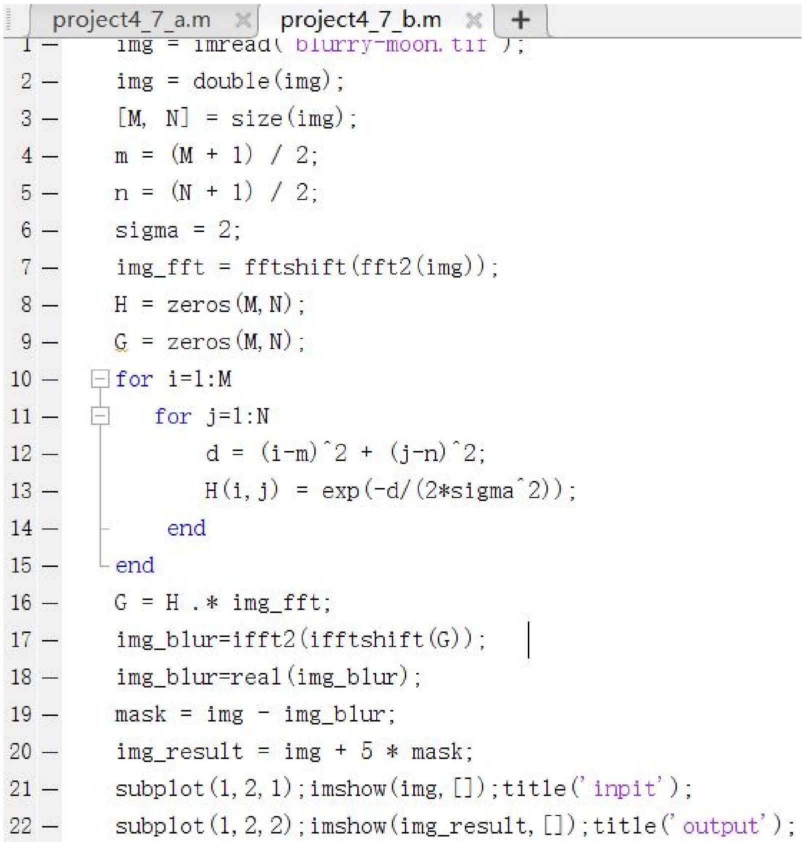
4.1 a



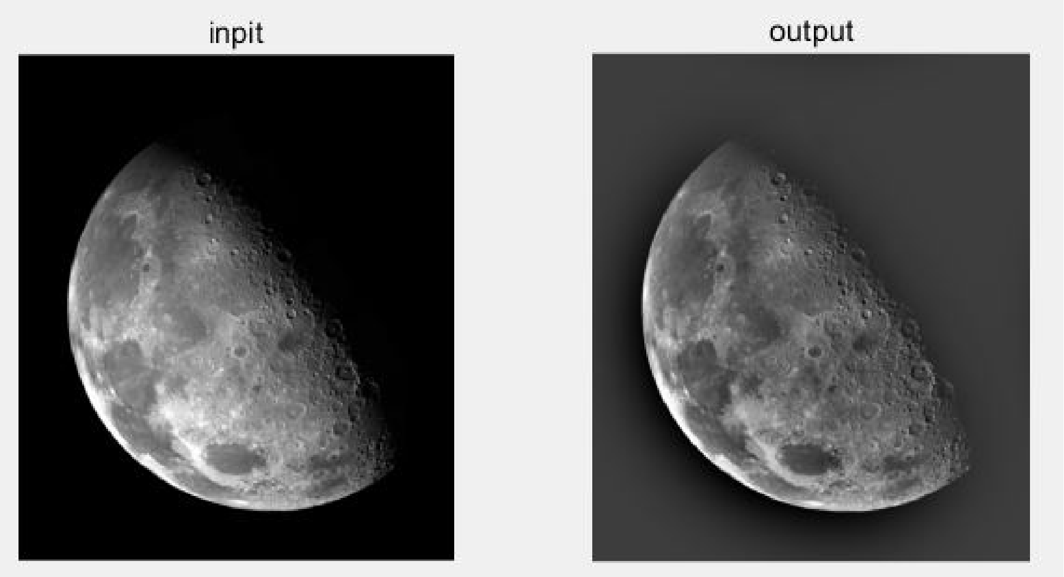
```
img = imread('blurry-moon.tif');
img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
sigma = 2;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
    for j=1:N
        d = (i-m)^2 + (j-n)^2;
        H(i,j) = exp(-d/(2*sigma^2));
    end
end
G = H .* img_fft;
img_blur=ifft2(ifftshift(G));
img_blur=real(img_blur);
mask = img - img_blur;
img_result = img + mask;
subplot(1,2,1);imshow(img,[]);title('inpit');
subplot(1,2,2);imshow(img_result,[]);title('output');
```



4.2 b

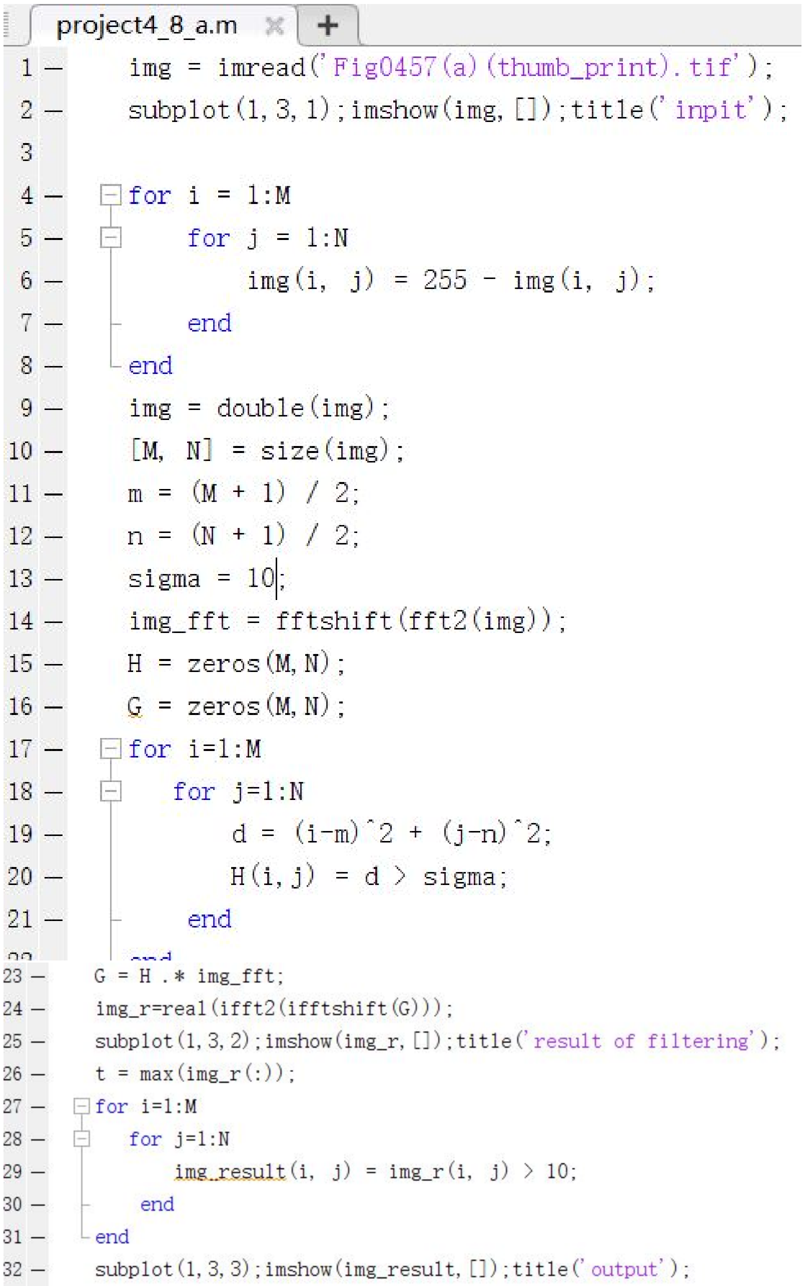


```
img = imread('blurry-moon.tif');
img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
sigma = 2;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
    for j=1:N
        d = (i-m)^2 + (j-n)^2;
        H(i,j) = exp(-d/(2*sigma^2));
    end
end
G = H .* img_fft;
img_blur=ifft2(ifftshift(G));
img_blur=real(img_blur);
mask = img - img_blur;
img_result = img + 5 * mask;
subplot(1,2,1);imshow(img,[]);title('inpit');
subplot(1,2,2);imshow(img_result,[]);title('output');
```

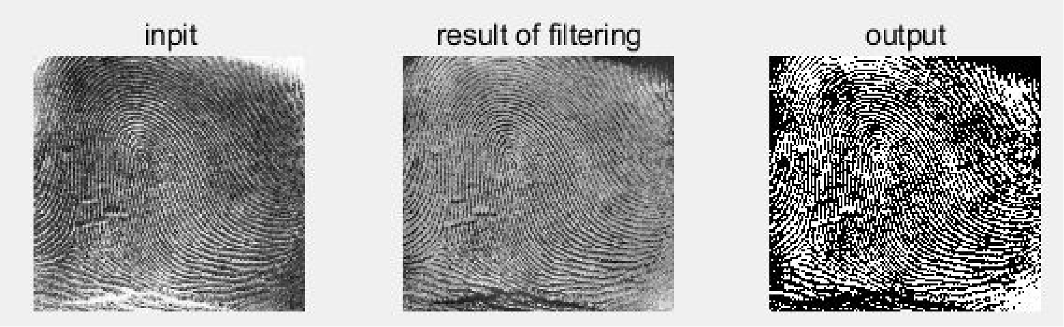


5 Project 4.8

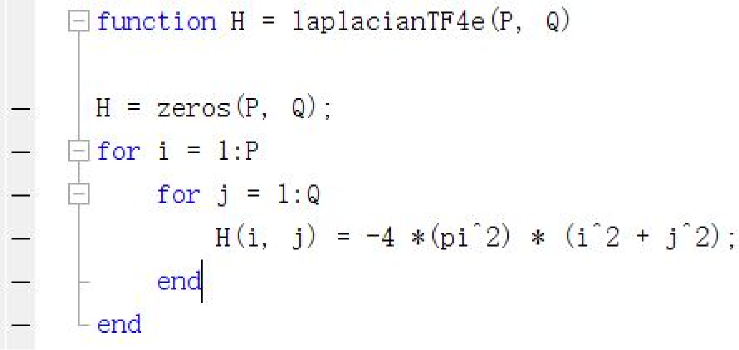
5.1 a



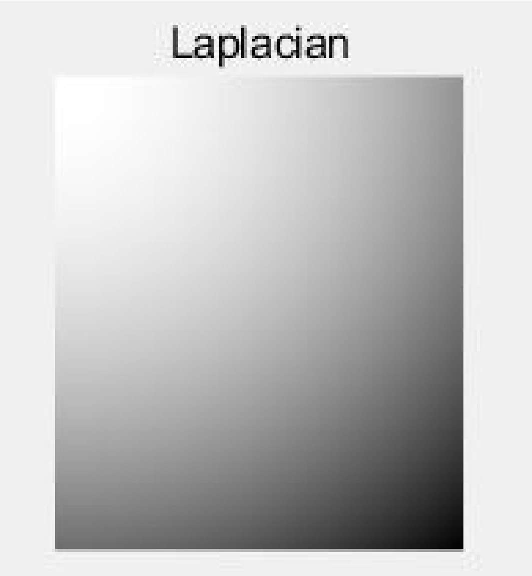
```
img = imread('Fig0457(a)(thumb_print).tif');
subplot(1,3,1);imshow(img,[]);title('inpit');

for i = 1:M
    for j = 1:N
        img(i, j) = 255 - img(i, j);
    end
end
img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
sigma = 10;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
   for j=1:N
       d = (i-m)^2 + (j-n)^2;
       H(i,j) = d > sigma;
    end
end
G = H .* img_fft;
img_r=real(ifft2(ifftshift(G)));
subplot(1,3,2);imshow(img_r,[]);title('result of filtering');
t = max(img_r(:));
for i=1:M
   for j=1:N
       img_result(i, j) = img_r(i, j) > 10;
    end
end
subplot(1,3,3);imshow(img_result,[]);title('output');
```



5.2 b

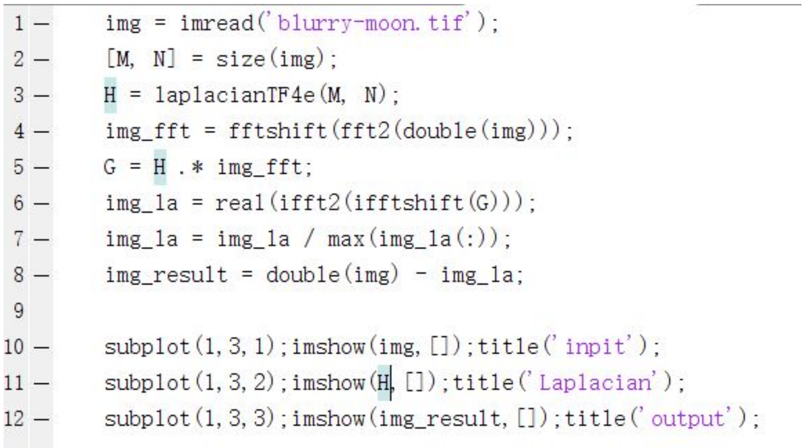


```
function H = laplacianTF4e(P, Q)

H = zeros(P, Q);
for i = 1:P
    for j = 1:Q
        H(i, j) = -4 *(pi^2) * (i^2 + j^2);
    end
end
```

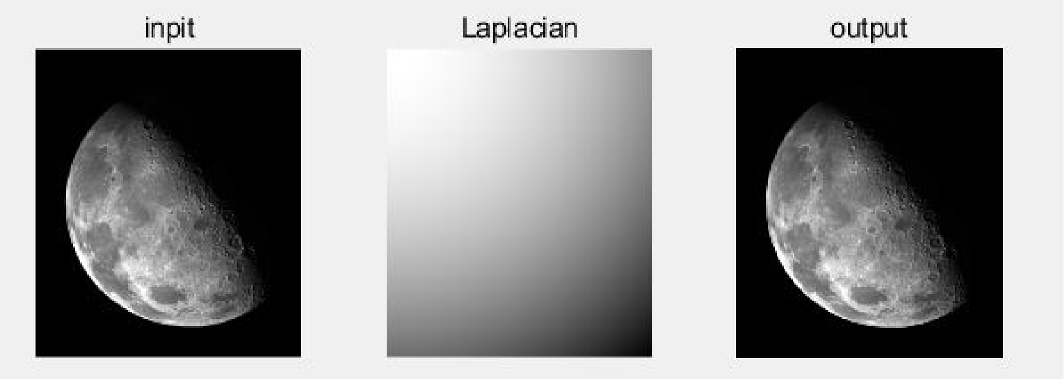


Laplacian

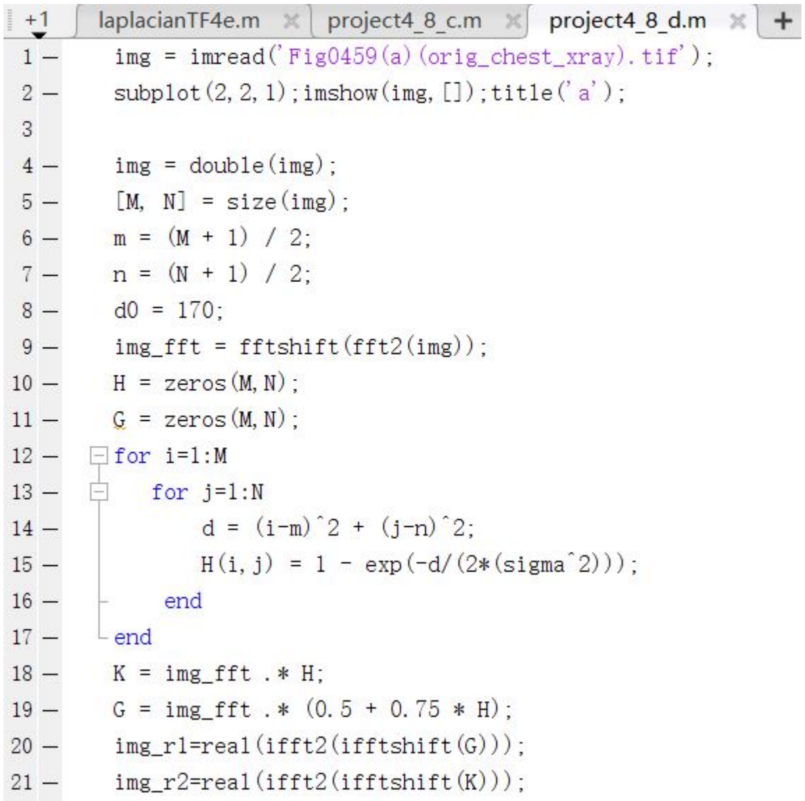
5.3 c



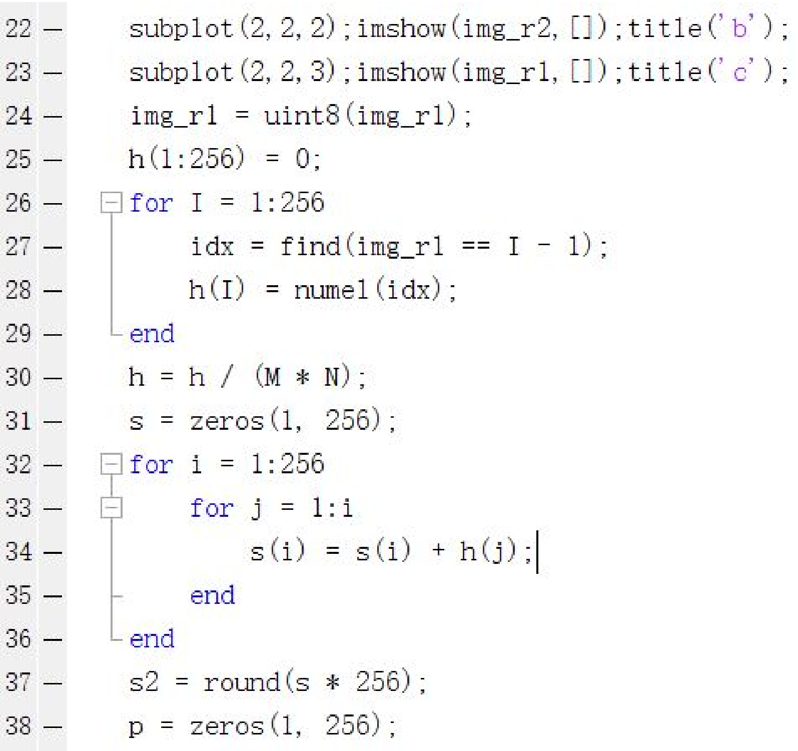
```
img = imread('blurry-moon.tif');
[M, N] = size(img);
H = laplacianTF4e(M, N);
img_fft = fftshift(fft2(double(img)));
G = H .* img_fft;
img_la = real(ifft2(ifftshift(G)));
img_la = img_la / max(img_la(:));
img_result = double(img) - img_la;

subplot(1,3,1);imshow(img,[]);title('inpit');
subplot(1,3,2);imshow(H,[]);title('Laplacian');
subplot(1,3,3);imshow(img_result,[]);title('output');
```



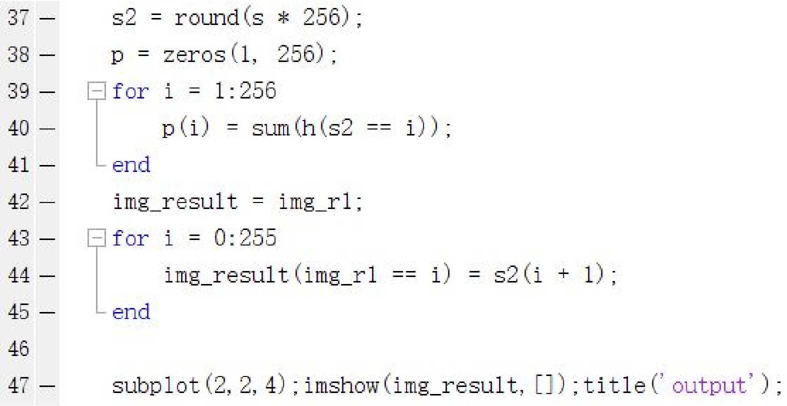
5.4 d



```
img = imread('Fig0459(a)(orig_chest_xray).tif');
subplot(2,2,1);imshow(img,[]);title('a');

img = double(img);
[M, N] = size(img);
m = (M + 1) / 2;
n = (N + 1) / 2;
d0 = 170;
img_fft = fftshift(fft2(img));
H = zeros(M,N);
G = zeros(M,N);
for i=1:M
   for j=1:N
       d = (i-m)^2 + (j-n)^2;
       H(i,j) = 1 - exp(-d/(2*(sigma^2)));
    end
end
K = img_fft .* H;
G = img_fft .* (0.5 + 0.75 * H);
img_r1=real(ifft2(ifftshift(G)));
img_r2=real(ifft2(ifftshift(K)));
```



```
subplot(2,2,2);imshow(img_r2,[]);title('b');
subplot(2,2,3);imshow(img_r1,[]);title('c');
img_r1 = uint8(img_r1);
h(1:256) = 0;
for I = 1:256
    idx = find(img_r1 == I - 1);
    h(I) = numel(idx);
end
h = h / (M * N);
s = zeros(1, 256);
for i = 1:256
    for j = 1:i
        s(i) = s(i) + h(j);
    end
end
s2 = round(s * 256);
p = zeros(1, 256);
```



```
s2 = round(s * 256);
p = zeros(1, 256);
for i = 1:256
    p(i) = sum(h(s2 == i));
end
img_result = img_r1;
for i = 0:255
    img_result(img_r1 == i) = s2(i + 1);
end

subplot(2,2,4);imshow(img_result,[]);title('output');
```