Hw2_Image Sharpening

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1 Technical description

宣告和讀取

```matlab
clc;
clear all;
img_array=cell(1,2);
img_array{1} = imread('skeleton_orig.bmp');
img_array{2} = imread('blurry_moon.tif');
img_array{1}=rgb2gray(img_array{1});
```

spatial domain

用自定義convolution_spatial函式對圖片做捲積

並顯示結果

```matlab
for i=1:2

    mask=[0,-1,0;-1,4,-1;0,-1,0];
    I_Lap = img_array{i}+convolution_spatial(img_array{i},mask);

    mask=[0,-1,0;-1,5,-1;0,-1,0];
    I_Unsharp = convolution_spatial(img_array{i},mask);

    mask=[0,-1,0;-1,5.5,-1;0,-1,0];
    I_High_Boost = convolution_spatial(img_array{i},mask);

    figure;
    sgtitle('Spatial domain');
    subplot(2,2,1),imshow(img_array{i});title('Original image');
    subplot(2,2,2),imshow(I_Lap);title('Laplacian operator');
    subplot(2,2,3),imshow(I_Unsharp);title('unsharp masking');
    subplot(2,2,4),imshow(I_High_Boost);title('high-boost filtering ');
end
```

frequency domain

用自定義frequency函式對圖片做處理

並顯示結果

```matlab
for i=1:2

    mask=[0,-1,0;-1,4,-1;0,-1,0];
    I_Lap = img_array{i}+frequency(img_array{i},mask);

    mask=[0,-1,0;-1,5,-1;0,-1,0];
    I_Unsharp = frequency(img_array{i},mask);

    mask=[0,-1,0;-1,5.5,-1;0,-1,0];
    I_High_Boost =  frequency(img_array{i},mask);

    figure;
    sgtitle('frequency domain');
    subplot(2,2,1),imshow(img_array{i});title('Original image');
    subplot(2,2,2),imshow(I_Lap);title('Laplacian operator');
```

```matlab
    subplot(2,2,3),imshow(I_Unsharp);title('unsharp masking');
    subplot(2,2,4),imshow(I_High_Boost);title('high-boost filtering ');
end
```

convolution_spatial 函式

產生一個和image同樣大小的output，將原圖轉成double並拉伸到[0 1]之間， 用無視邊界值的方式做 convolution，迴圈的起始和結束分別為2到m-1和2到n-1，並將最後的結果轉到uint8

```matlab
function  output = convolution_spatial(I,mask)
[m,n]=size(I);
I=im2double(I);
output=zeros(size(I));
for i = 2 : m - 1
    for j = 2 : n - 1
        tmp=mask.*I(i-1:i+1,j-1:j+1);
        output(i-1:i+1,j-1:j+1)=sum(tmp(:));
    end
end
output=im2uint8(output);
end
```

frequency 函式

frequency domain的影像處理步驟如下

1. Multiply the input image by (-1)x+y to center the transform
2. Compute F(u, v), the DFT of the image from (1).
3. Multiply F(u, v) by a filter function H(u, v).
4. Compute the inverse DFT of the result in (3).
5. Obtain the real part of the result in (4).
6. Multiply the result in (5) by (-1)x+y.

```matlab
function output = frequency(I,mask)
I = im2double(I);
[m n] = size(I);

% 1.
%影像乘上(-1)x+y,為了置中
for i=1:m
    for j=1:n
        I(i,j) = I(i,j)*(-1)^(i+j);
    end
end

% 2.
F = fft2(I);
% Frequency response
H =  freqz2(mask,[m n]);

% 3.和4.
%G(u,v) = H(u,v)F(u,v)
G = H.*F;

% 5.
%取Filtered image的實部
G = real(ifft2(G));
```

```
% 6.
%乘上(-1)x+y抵銷一開始對影像乘(-1)x+y
for i=1:m
    for j=1:n
        G(i,j) = G(i,j)*(-1)^(i+j);
    end
end

G = im2uint8(G);
output=G;
end
```
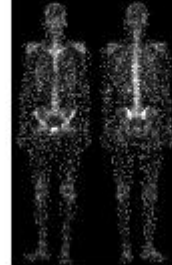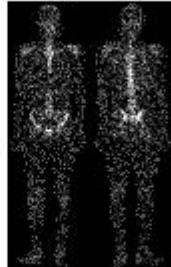
2 Experimental results

Spatial domain

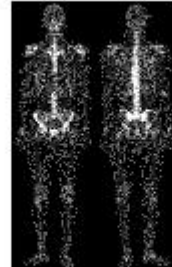Original image

Laplacian operator

unsharp masking

high-boost filtering

Spatial domain

Original image

Laplacian operator
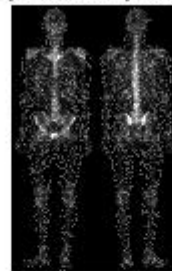

unsharp masking

high-boost filtering

frequency domain

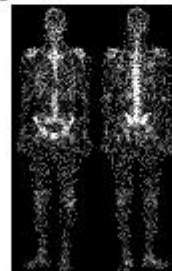### Original image

Laplacian operator

unsharp masking

high-boost filtering

frequency domain

Original image Laplacian operator

unsharp masking high-boost filtering

3 Discussions

(1)spatial domain

跟作業一差不多，差別在mask，過程都是對原圖做捲積。

(2)frequency domain

雖然程式不長，但是因為對 frequency domain 的不熟悉，所以花了不少時間在了解 frequency domain的概念如何在matlab實現。

影像在 spatial domain 的時候需要做 convolution，要對每個點做處理，而frequency domain則是經過轉換後，一次對原圖做處理，最後再還原到spatial domain

在spatial domain和frequency domain處理的圖片看起來差不多

4 References and Appendix

https://www.cs.uregina.ca/Links/class-info/425/Lab5/index.html

https://blog.csdn.net/qq_30815237/article/details/98655630

https://www.youtube.com/watch?v=spUNpyF58BY

https://theailearner.com/2019/05/14/unsharp-masking-and-highboost-filtering/